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Editorial

Artificial Intelligence – A Boon or A Bane? The answer is difficult. We know that in this digital era, the Artificial Intelligence (AI) is among the fastest-developing technologies with its applications in many fields. Artificial intelligence is a technique that makes the machines to replicate the human actions. There has been a lot of discussion on this topic mainly that it will replace large number of human work force in many industries. There was a similar talk when the computers were introduced everywhere particularly in our country, that the people will lose their jobs. Whereas, the man power requirement was increased. One should welcome the development in every field whether it is technology or something else. If we fail to accept the new revolution, we will remain as a back bencher.

On the positive side, Artificial Intelligence (AI) has a wide range of applications including entertainment, commerce, tourism, health care, education, chatbots, customer care, logistics and transportation, e-commerce, driverless vehicles, and many more. It can improve the production in various industries by automating the stereotype tasks with high speed that humans will do in normal speed, logistic operations, and so on help in maximising the efficiency and minimising the cost. In healthcare sector, this technology can assist medical professionals in diagnosing diseases, health monitoring, identifying potential health risks so as to plan for recommending the potential drugs for quick improvement in patient's health. Further, the AI minimises the errors, handles complex tasks which are difficult for humans to execute, protecting the important data.

Though there are significant benefits, on the other side there are some threats. The biggest concerns are loss of jobs since AI replace human workers in various industries. This will affect the socio-economic development especially in developing nations.

Technology is always a boon to the scientists and innovators. Whenever a new development comes into existence, there are always pros and cons. It is upto us to find ways and means to take forward towards the successful implementation. Looking at the negative side and leaving the progress or development will prevent us to grow. Of-course, there must be a stringent policy for its usage. On the prospective side, let's hope that the Artificial Intelligence (AI) helps the world to get benefitted in general and India in particular.

New Delhi **Editor**
30th September 2023

Contents

AI-Powered Music Genre Classification for Pertinent Music Therapy in Education

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ABSTRACT

Music therapy has been proven to have significant benefits in enhancing the cognitive, emotional, and social development of students and for education sector at large. However, traditional music therapy methods are often limited by factors such as availability, expertise, cost, and especially, choosing the relevant from a variety. With recent advancements in Artificial Intelligence (AI), there is great potential to enhance music therapy in education by incorporating AI techniques. This paper introduces the concept of AI in music therapy, particularly to classify the music genre based on the audio sources — that can be used to recommend appropriate music therapy in education. The paper investigates various existing algorithms, evaluates their accuracy using a sample dataset, and proposes an ensemble-based classifier as a solution. The proposed ensemble classifier's effectiveness is demonstrated by experimental findings and performance comparisons with other methods. Overall, this paper highlights the potential for AI to enhance music therapy in education and calls for further research and development in this area. The integration of AI and music therapy can revolutionize the way we approach education and promote the holistic development of students.

KEYWORDS *: Artificial Intelligence, Data classification, Education, Music therapy, Music genre.*

INTRODUCTION

Music therapy is a field that has been growing rapidly in recent years, with increasing recognition of its effectiveness in improving physical, emotional, and cognitive outcomes for a variety of populations [1]. The use of music as a healing modality has been carried out since ancient times, but modern music therapy as a profession emerged in the mid-twentieth century. It has since gained widespread acceptance in many areas of healthcare, education, and community settings.

Music therapy has shown promise as a valuable intervention in educational settings. It has been found to be effective among children and adolescents with a range of needs, including those with developmental disabilities, emotional and behavioural disorders, and learning difficulties. Several case studies [2] demonstrate the effectiveness of music therapy in improving academic performance, social skills, and emotional well-being among students. The author concludes that music therapy has great potential as a valuable intervention in educational settings, but also emphasizes the need for further research to establish best practices and to promote wider adoption of music therapy in education.

Pertinent music therapy can also promote positive social interactions, enhance self-esteem, and provide a sense of accomplishment for students who may struggle in traditional academic settings. Additionally, music therapy can be used to address the emotional needs of students who may be experiencing stress, anxiety, or other mental health concerns.

Despite the growing body of research on music therapy, there are still many unanswered questions and challenges associated with its practice. These include issues related to standardization of techniques and training for practitioners, as well as the need for more rigorous research designs and larger sample sizes to establish the effectiveness of music therapy in various contexts. Nonetheless, the existing studies provide a strong

foundation for continued exploration and development of music therapy as a valuable intervention in education and other settings.

Music genre classification is one such application can help students concentrate more by providing them with music that is tailored to their personal preferences and work style. For example, research has shown that classical music can improve concentration and focus, while ambient or instrumental music can create a relaxing atmosphere that helps students to concentrate better. On the other hand, high-energy music like rock or hiphop can provide a burst of motivation and energy that can help students power through a difficult task. Through pertinent music genre classification, students can be recommended music that matches their needs and preferences, allowing them to focus better and work more efficiently. Furthermore, by choosing music that they enjoy, students can be more motivated and focused in work, which can lead to better academic performance. Hence, by recommending the correct music genre and consequent songs to students for their respective purpose, we can enhance their concentration and uplift their mood. For this reason, classification of music into genres can have a positive effect on students.

The use of many additional platforms specifically designed for the listening and dissemination of music, as well as the distribution of music albums, have increased significantly during the past several decades. Because several songs are produced every day and there are so many different musical genres to choose from, it is now difficult to categorise each song into the correct genre. Genre classification is physically challenging, especially for large platforms with more than 10 million songs available for listening. It follows directly from this that automatic categorization models must be developed [3].

As a direct consequence of the expansion and development of the information technology industry, Artificial Intelligence (AI) and Machine Learning have found applications in a number of disciplines of endeavour. One of these applications whose prevalence has increased in recent years is one that plays music. The music industry is being transformed by innovative and intelligent AI-based methods. Composers find that utilising these technologies simplifies and facilitates the creation of high-quality music. The burgeoning field of Artificial Intelligence and music is also being applied to the production and administration of noises for a variety of mediums. Voice recognition algorithms are being used to identify genre-specific characteristics that vary based on the type of music being listened to. The method of Artificial Intelligence enables the development of a classifier that can be used to determine the musical preferences of students and provide additional song recommendations [4]. This can be achieved by supplying additional song suggestions. This research aims to surmount the limitations of other classification methods by devising an efficient algorithm for the automatic categorization of songs and musical pieces into their respective genres. Additionally, the tracks are recommended to students in order to improve concentration through music.

Contribution of this Work

The application area of the work is enhancement of music genre classification for improved music therapy in educational sector. Correspondingly, the work proposes a system to predict and recommend the genre of music through numeric data with high accuracy and requires lower competency than the existing systems:

1. The research provides a proficient system to identify, classify and further recommend the genre of music pertinent for educational purposes.

2. The proposed solution aims to enrich the music therapy in education by providing a system that can club songs with similar genres together and refine the recommendation according to different purposes with a comparatively low computational model.

The work is organized as follows: The next section provides contextual information through a review of existing literature. The third section describes the proposed approach for using music genre classification and details of its implementation. Fourth section contains experimental findings demonstrating the performance of the suggested approach. The final section summarizes the work and suggests the next research areas.

RELATED WORK

The related literature and review of the same can broadly be divided into two parts. The first sub-section discusses the existing applications and methods used for music genre classification and their respective fallacies. The second sub-section further discusses the several algorithms that have been tested for the proposed system and the advantages of the same.

Application based Literature Review

The study in [5] aimed to investigate the effectiveness of music therapy on the academic performance and behavior of children with learning disabilities. The results of the study showed that children who received music therapy had considerably higher academic performance and behaviour scores compared to those who didn't receive it. Specifically, the music therapy group showed significant improvements in attention, memory, and organization skills. Moreover, the children in the music therapy group exhibited a significant decrease in problem behaviours. Overall, this study suggests that music therapy can be an effective intervention for improving the academic performance and behaviour of children with learning disabilities. The findings of this research provide support for the use of music therapy in educational settings to enhance the learning outcomes and well-being of students with special needs.

Music therapy group had a significant improvement in their cognitive function scores compared to the control group [6]. Specifically, the music therapy group had improved scores in reaction time, processing speed, and cognitive throughput. Additionally, the music therapy group reported a reduction in stress levels and an increase in feelings of social support. Overall, this study suggests that group music therapy can have a positive impact on cognitive function and well-being in college students. The findings of this research may provide support for the use of group music therapy as a complementary intervention in educational settings to enhance the cognitive performance and well-being of college students.

Different music genres can have different effects on emotion regulation and brain activity. These findings may have implications for the use of music therapy in the treatment of emotional disorders, as therapists may need to consider the specific genre of music used in therapy to achieve optimal outcomes [7]. Specifically, classical music was associated with increased activity in brain regions involved in emotional regulation and attention, while heavy metal and techno were associated with decreased activity in these regions. Jazz music was found to have a more complex effect on brain activity, with both increased and decreased activity in different regions.

It is preferable to have an AI model identify music rather than classifying manually, so music genre categorization has been the subject of extensive research. Due to the social and psychological nature of music's primary functions, the most appropriate method for classifying music would be based on four distinct categories of information. Genre, mood, style, and similarity are examples of informational forms. Researchers in [8] conducted a comprehensive examination of the difficulty of classifying diverse musical genres. They discovered that similar musical compositions share the same genre, style, and affective identities. In 2021, researchers in [9] demonstrated that CALM, which stands for Codified Audio Language Modeling (CALM), was a viable instrument for music composition. CALM was shown to be beneficial as a pre-training strategy for discriminative Music Information Retrieval (MIR) tasks in this study. CALM is an abbreviation for computer-assisted learning and matching.

Researchers in [10] investigated thoroughly the most recent advancements in machine learning as they pertain to the difficulty of music annotation. In conclusion, they have also included a music genre categorization experiment that evaluates numerous machine learning models using Audioset. The researchers used a variety of machine learning models for categorization, such as Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNN), Ensemble, and their derivatives, and all of them produced intriguing results. Researchers in [11] conducted a comparison study on a variety of artificial intelligence algorithms, in which data was first processed without any filtering techniques, and then again with the application of filtering methods. The models created were the ANN, MLP, SVM, Decision Tree, and Logistic Regression models. The accuracy of Multilayer Perceptron increased the most, by 28.2%,

while the accuracy of artificial neural networks was the highest, at 82.2%.

Utilizing high-level melodic components that are directly extracted from the audio stream of polyphonic music, researchers in [12] presented a revolutionary method for classifying musical genres. This method is based on advanced melodic characteristics. In addition to contour type, the qualities of pitch, duration, and vibrato were used to imply a set of melodic elements. The analysis of 500 samples resulted in a classification accuracy of greater than 90%. With the development of neural networks such as CNN, RNN, and deep learning, researchers implemented these sophisticated algorithms in the hopes of achieving improved outcomes. Researchers in [13] describe a system that incorporates K-Nearest Neighbour (K-NN) and Support Vector Machine (SVM). This system was developed using Convolutional Kernel and a CNN. Compared to the previously employed method, the one that was suggested provides greater precision. The veracity of the testing data set is greater than 95 percent.

Researchers in [14] studied and implemented digital signal processing in order to extract audio data characteristics and machine learning techniques in order to create a music genre classifier. In addition to employing the XGBoost algorithm to the mean and standard deviation of numerous audio variables, they constructed LSTM and ANN as the Neural Network model layer. This was performed concurrently with implementation. Following a comparison of the two approaches, the researchers determined that the Neural Networks model's accuracy could be enhanced by increasing the size of the dataset.

Researchers in [15] devised a deep learning model that classifies various musical genres using spectrograms. Throughout the model construction process, the Keras library, which is part of the TensorFlow library, is used to develop each layer of a two-dimensional CNN. The proposed procedure has a 94% accuracy rate. In [16], researchers conducted experiments on the categorization of musical genres to study deep learning. There were two distinct approaches utilised to complete this task. The first technique entails manually extracting features from the time domain and the frequency domain and then loading these features into conventional machine learning models. The second technique involves extracting spectrogram images from audio recordings and supplying these spectrogram images to CNNs.

Algorithm Based Literature Review

The literature survey shows that many algorithms have been researched and tested for Music Genre Prediction, like classifiers, regression methods, and advanced neural networks. The description of the algorithms used for this study and their relation to the targeted work are presented below:

- Logistic Regression: A Logistic Regression model [17] differs from a Linear Regression model in that it employs a more complex cost function, known as the "Sigmoid function" or the "logistic function," rather than a linear function. The Logistic Regression model and the Linear Regression model are highly comparable. The objective of the statistical technique known as logistic regression is to establish a connection between specific characteristics and the probability of achieving a particular outcome. If our dataset's classes can be linearly segregated, this approach, which has been widely used in the industry for classification purposes, will perform well. In comparison to non-linear models, this linear classifier will provide us with distinct results and possibly greater precision.

- K-Nearest Neighbour: The KNN [18] method assumes that there is a similarity between the new case or data and the existing cases, and it positions the new instance in the category that is most comparable to the existing categories. The KNN algorithm remembers all available data and determines how to classify a new data point based on its similarity to previous data points. This means that when new data becomes available, it can be rapidly classified into the appropriate category using the K-NN method. K-NN is superior to SVM when the amount of data to be trained exceeds the number of features. On a cleaned and pre-processed dataset, the K-NN accuracy will increase. It is a non-linear classifier, so it will facilitate the management of any non-linearities in our dataset. Our dataset has also been pre-processed, so it can be utilised for classification purposes.

- Artificial Neural Network: Utilizing the activation function in the hidden and output layer,

neural networks [19] can be reduced to classification or regression models. The output layer will consist of a linear function performing regression on the preceding layer's nodes. The classification accuracy of an Artificial Neural Network (ANN) for multi-class classification problems with a decent dataset is typically quite high. The ten genres will be compared to the ten neurons in the output layer. As ANNs are not linear models, they may function well with our diverse dataset. This methodology has been utilised to evaluate the proposed system. Figure 1 depicts the system flux within the ANN Model.

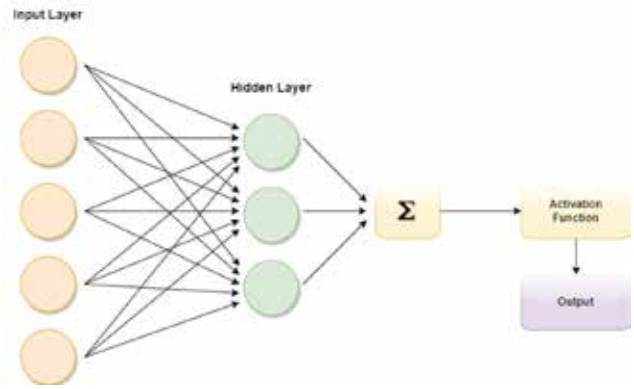

Figure 1: Artificial Neural Network Model

- Support Vector Regression: The support vector machine [20] is a supervised machine learning technique that can be used for classification, regression, and outlier detection. The fundamental concept of Support Vector Regression (SVR) is to identify the optimal fit line. In SVR, the hyperplane containing the greatest number of points is deemed to provide the finest suit. In the SVR model, all of the algorithm's most essential characteristics have been preserved. Due to the fact that its cost function eliminates any training data that is geographically close to the model's prediction, the only source of data used to construct its model is a subset of training data. Since SVR is applicable to both linear and nonlinear data, it is also applicable to our dataset. This algorithm attempts to identify a specific margin line between each class that can be utilised for our multiclass classification. As a linear classifier, SVR will produce distinct outcomes than the non-linear ANN. It is also superior to ANN in terms of memory conservation.
- Random Forest Regression: A Random Forest [21] is primarily a collection of collaborative classification or regression trees. Using a subset of variables that is independent from the others, these enormous quantities of binary regression trees are generated. The decision trees are constructed using bootstrapped samples from the dataset, and the Random Forest algorithm is used to randomly select which variables should be split. A random forest model is beneficial when a large quantity of numerical data is available. Consequently, using this model to classify music genres will automatically balance the classes if one of them behaves differently than the others. The model will be more time-consuming to compute than a decision tree, but its classification accuracy may be superior. Figure 2 depicts the Random Forest Regressor Model's system flow.

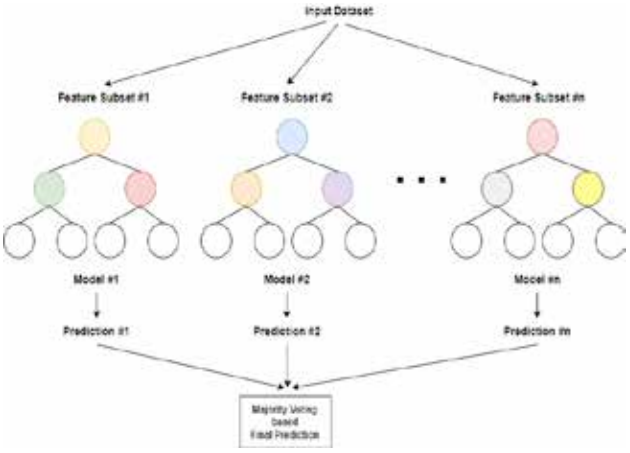

Figure 2: Random Forest Regressor Model

The algorithms outlined in the literature review characterise the fundamental structure. Given that already-implemented systems demonstrate the use of such fundamental algorithms in their unmodified form, a great deal of modification has been made to the designs of the algorithms in order to develop a novel method for anticipating the type of music genre. This was done so that the study's novelty objectives could be met.

Ensemble learning [22], a robust machine learning strategy, has proven to be advantageous in a variety of applications [23, 24]. An ensemble is a machine learning system comprised of multiple distinct models that operate concurrently and whose outputs are fused

using a decision fusion strategy to generate a single solution to a specific problem. To create a model with greater dependability than any singular model within the context of the current system, it may be advantageous to employ a collection of the aforementioned prediction algorithms.

The next section describes the implementation procedures of the above-mentioned prediction algorithms.

PROPOSED APPROACH AND IMPLEMENTATION DETAILS

The proposed approach is highlighted in Figure 3.

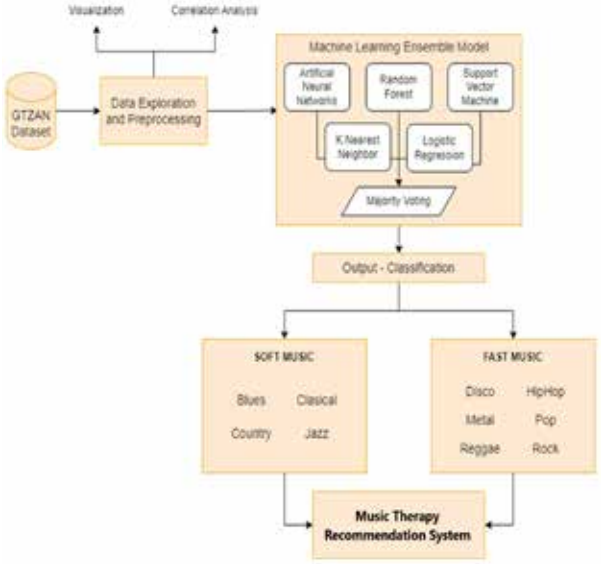

Figure 3: Proposed Approach

As depicted in Figure 3, the proposed approach is divided into 04 phases and is elaborated below:

Dataset Information

The work employs GTZan dataset, an open-source dataset widely used music genre classification dataset and contains 1000 audio clips of 30 seconds each, divided into 10 different genres (blues, classical, country, disco, hiphop, jazz, metal, pop, reggae, and rock). The dataset is commonly used to train and test machine learning algorithms for music genre classification. Each audio clip in the dataset is in the WAV format and has a sampling rate of 22.05 kHz and a bit depth of 16 bits. The GTZan dataset has become a benchmark dataset for music genre classification research and is widely used by researchers and practitioners in the field.

Data Exploration and Preprocessing

Data Pre-processing is an important step in preparing the GTZan dataset for music genre classification. Here are some common steps for pre-processing the GTZan dataset:

1. Loading the dataset: The GTZan dataset is available in the form of WAV files. These files are into a library Librosa which handles audio data.

2. Data cleaning: The audio files contains some noise or other artifacts that can interfere with the classification process. The data is cleaned by removing unwanted sounds, such as hissing or popping, and filtering out noise or distortion.

3. Resampling and normalization: The audio files in the GTZan dataset have a sampling rate of 22.05 kHz, which is adjusted depending on the requirements of the Machine Learning algorithm being used. Additionally, the audio files are normalized to ensure that they have the same volume level.

4. Feature extraction: To classify the audio files by genre, it is necessary to extract features from the audio data. Common features used for music genre classification include mel-frequency cepstral coefficients (MFCCs), spectral contrast, and spectral centroid. These features are extracted using library Librosa.

5. Data splitting: The GTZan dataset is split into training and testing sets to evaluate the performance of the classification algorithm. The data is split randomly in proportion of 35-65, that is, 65% of the data is used for training and rest 35% is used for testing and validation.

6. Encoding the labels: The genre labels (blues, classical, country, disco, hiphop, jazz, metal, pop, reggae, and rock) in the GTZan dataset is encoded as numerical values for use with machine learning algorithms. One-hot encoding is the technique used in the study for encoding categorical data.

All musical genres' sound waves help in visualizing a waveform in the time domain. On the x-axis is the

total length of the recording, while the y-axis represents the sampling rate at a given time. After analysing all the diagrams, such as the one depicted in Figure 4, we can conclude that different musical genres have distinct sampling rates throughout their duration. The sound waves of a classical audio file varied throughout the first 15 seconds, after which there was almost no sampling rate.

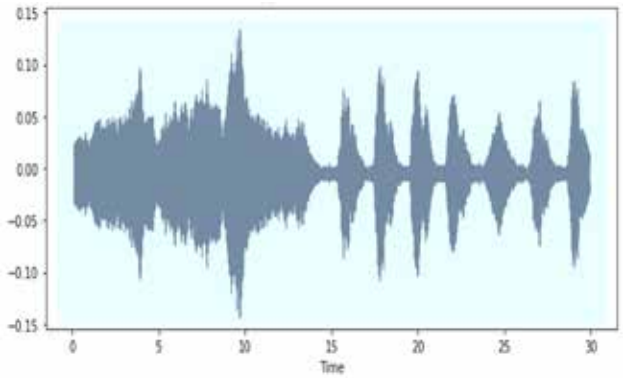

Figure 4: Graphical Representation of Sound Waves of Classical Genre

Figure 5 depicts a unique type of spectrogram, the Mel-spectrogram, which entails converting frequencies to the mel scale. It is a useful instrument for identifying and visualising concealed audio elements. It displays the frequencies of the audio files in relation to the file length using a mel scale. Once all the graphs have been plotted, the country audio file stands out among the others because its frequency pattern is nearly identical throughout its entire duration. In contrast to the nationality audio file, the frequencies of all other audio files differ.

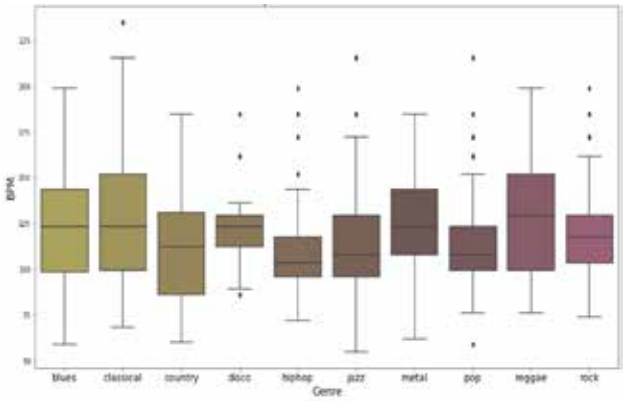

Figure 5: Spectrogram of Country genre sound waves

Figure 6 depicts a boxplot for all genres of music in the dataset. On the X-axis, the ten genres are plotted, while on the Y-axis, the BPM for each genre is plotted. Now, the y-axis represents the 'tempo' characteristic of the dataset. This function displays the number of pulses per minute or the song's tempo. Based on an examination of the boxplots for all musical genres, blues, classical, disco, and metal have the fastest tempos. In addition, pop has a slower tempo compared to other genres because modern music is more lyric-focused and less beat-dependent.

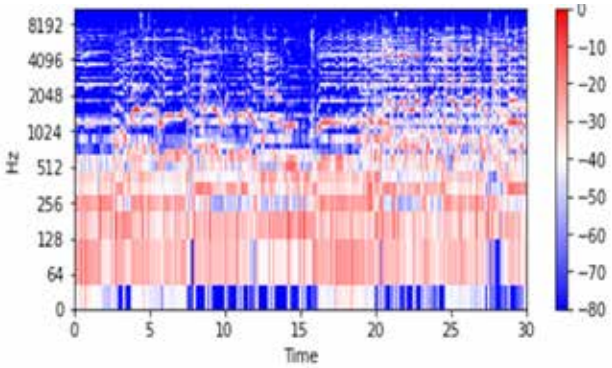

Figure 6: Boxplots of Variation in Beats per Minute per Genre

After analysing the various graphs and correlation analysis, we can infer that tempo, spectral centroid data, and rms values should be given greater weight when developing the classification model. These characteristics exhibit a significant change in value relative to the other characteristics and are therefore useful for accurately classifying genres.

By performing these pre-processing steps, the GTZan dataset is prepared for use with machine learning algorithms for music genre classification and recommendation of music therapy accordingly for students.

AI Models

The proposed approach for Music Genre Classification is trained, evaluated, and validated on the mentioned dataset utilising the AI algorithms outlined in the second section. Table 1 outlines the parameters and critical inputs for the assessed classification models.

Table 1: Algorithmic Parameters and Key Inputs

Classifier	Parameters/Key Inputs	Values
Logistic Regression	Maximum Number of Iterations	500
	Solver Algorithm	Limited-Memory Broyden–Fletcher–Goldfarb–Shanno
Artificial Neural Network	Activation Function	ReLU
	Learning Rate	0.1
	Momentum	0.7
	Hidden Layer Size	(2500, 5)
KNN	Leaf Size	20
	Metric	Minkowski
	Number of Neighbors	3
Random Forest	Minimal Cost-Complexity Pruning	2.41
	Quality Measure Function	Gini
	Number of Trees	50
Support Vector Machines	Type of Kernel	rbf
	Degree of Polynomial Kernel Function	2
	Use of Heuristic Shrinking Function	False
	Shape of Decision Function	ovo

Several strategically developed models, such as classifiers or experts, can be merged as an ensemble to obtain optimal performance for real-world problems. Multiple model combinations improve independent AI models. An algorithm may provide correct answers for a specific genre, but it does not function the same way for all genes. Consequently, we proposed and developed an Ensemble Learning model for our dataset by combining the aforementioned five algorithms. Using the majority voting procedure, the ensemble model's final result is determined. Various Performance Metrics are used to assess the algorithms. The performance metrics are defined as:

Accuracy: Accuracy [26, 27] is the measure that defines how accurately the classifier models have classified the Music Genre and is derived through Eq. (1):

$$Accuracy = \frac{g_1 + g_2 + g_3 + \ldots\ldots + g_{10}}{N} = \frac{\sum_{i=1}^{10} g_i}{N} \quad (1)$$

where,

gi - Total number of instances of Genre *i* correctly classified as Genre *i*

N - Total number of classifications made

Precision: Precision [26, 27] is the measure that defines how accurately a particular genre is classified and is given as in Eq. (2):

$$Precision(g) = \frac{TP_g}{P_g} \quad (2)$$

where,

TP_g - True Positive Value of Genre g - Total number of instances correctly classified as Genre g

P_g - Total number of instances of Genre g present

Precision is calculated for each genre.

Recommendation System

The 10 genres are further divided into categories: Soft Music and Fast Music. Soft Music consists of the genre – Classical, Country, Jazz and Blues whereas the Fast Music category includes the Disco, HipHop, Metal, Pop, Reggae and Rock genres. The classification of the genre from the ensemble classifier model are categorized as mentioned above and accordingly used for providing recommendations to the students. The Soft Music tends to induce calming and soothing effect that proves effective in increasing concentration and reducing stress whereas the Fast Music generally energizes the students by inducing a happy and upbeat mood.

The results of the classification were further tested on 500 undergraduate students from the institution where the research is carried out. It consisted of the students listening to the recommended songs and commenting on whether they improved their concentration, boosted their energy, or had any other adverse effects. Evaluation and accuracy of the model performance on a live surveyed dataset supports suitability of the suggested approach in real-world scenario. The results of the same are described in the next section.

RESULTS AND DISCUSSIONS

The proposed algorithms have been implemented and the performance metrics mentioned have been used to compare their efficacy. Figure 7 describes the performance comparison of the algorithms using the evaluation metrics.

Figure 8 describes and visualizes the precision of different models per genre of the soft music category.

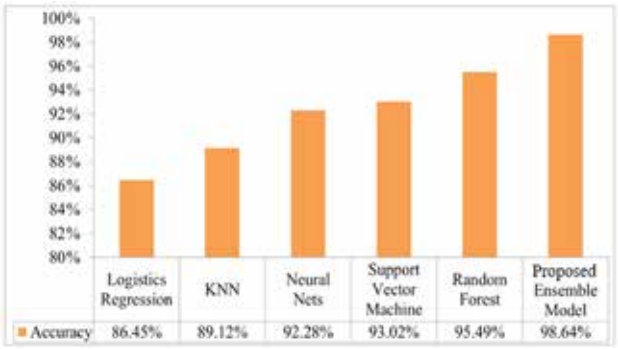

Figure 7: Average Accuracy of Tested Models for Genre Classification

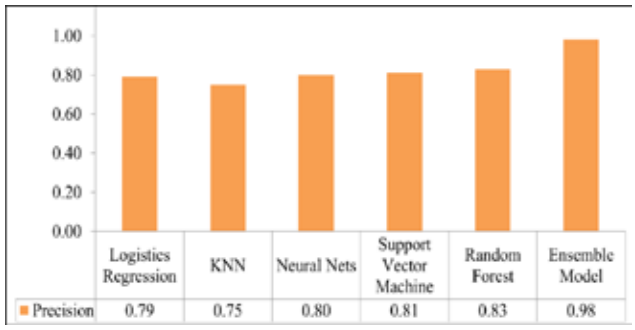

Figure 8a: Precision of Models for Genre - JAZZ

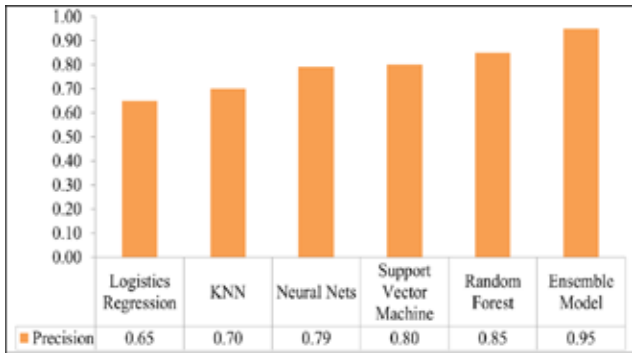

Figure 8b: Precision of Models for Genre - COUNTRY

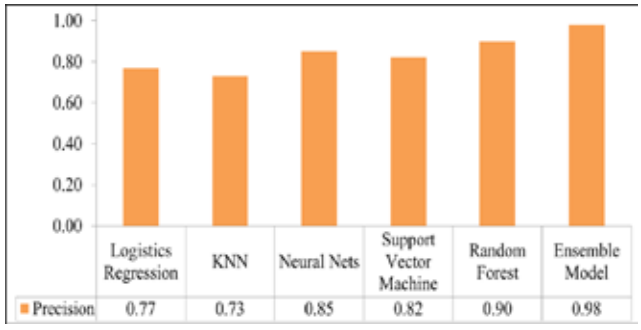

Figure 8c: Precision of Models for Genre - CLASSICAL

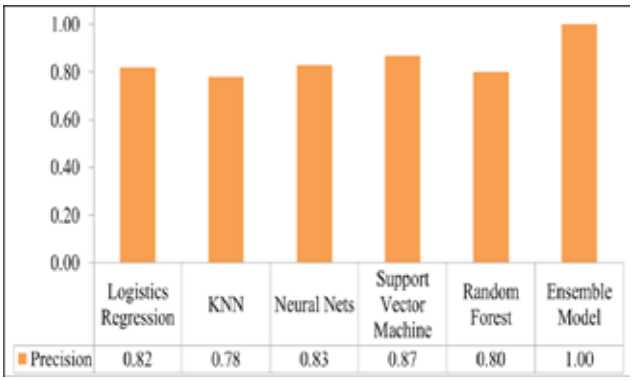

Figure 8d: Precision of Models for Genre - BLUES

Figure 8: Precision Values of Classification Models for Soft Music Genre Pertinent for Education

The dataset analysis suggested that models capable of capturing non-linear data perform better for prediction, and the absence of this ability reduce the prediction accuracy. In addition, the analysis indicated that a model that matches a linear curve would be superior for the prediction. Due to this, we can conclude from the results that SVM has the ability to learn many patterns and performs significantly better than ANN, KNN, and Logistic algorithms.

Figure 8 suggests, however, that for each distinct genre, a separate model performs better than the others. This indicates that a single model selected may perform exceptionally well for fifty percent of the models, thereby increasing its accuracy. However, the remaining genres will suffer from a lack of precision. As a result, the ensemble model proposed for the research takes into consideration all predictions when making final voting decisions. It outperforms existing models because it considers multiple attributes and methods for learning the pattern, as well as a majority voting mechanism for determining the definitive genre of a given music sample. According to extensive research and the results presented in Figure 7, it has been determined that the proposed Ensemble Model algorithm is the most effective method for identifying the musical genre.

As the paper aims to help students to enhance their studies and work using music, the students' experience with the system first hand were surveyed. The summarization of the efficiency of the pertinent recommendations, as stated by the students, is given in Table 2.

Table 2: Efficiency of Recommendations Rated by Students

Genres Suggested	Increased Concentration	Boosted Energy	Had No Effect
Soft Music Genres	76.45%	4.22%	19.33%
Fast Music Genres	11.32%	82.11%	6.57%

As shown in the table, majority of the reviews are as proposed by our system. More than three-fourths of the students voted that Soft Music significantly helped them to concentrate at the task better and increased their efficiency. Similarly, Fast Music also had the expected effect for a greater number of students, energizing and motivating them to do their studies and tasks. A small number of people voted for the opposing or no effect, but for majority, the recommendation based on music genre classification proved to be useful. This goes to prove that enhancement in music genre classification can have a positive effect on students and education sector at large, and hence, should be implemented widely.

CONCLUSION AND FUTURE SCOPE

The work explored the use of AI-powered music genre classification to recommend pertinent music to students as a music therapy to aid in their studies. Music therapy has been shown to have numerous benefits for students, including reducing stress and anxiety, improving cognitive function and memory, and enhancing overall academic performance. By recommending music to students based on their preferred genres, this approach can provide a personalized and effective method for utilizing music therapy to help students with their studies.

The GTZan dataset was used as the basis for the classification algorithm, for training and testing of various Machine Learning techniques. The research work evaluates algorithms ANN, Random Forest, SVM, K-NN, and Logistic regression and further proposes and tests an ensemble of these algorithms. The results showed that the ensemble model of these algorithms was able to accurately classify music by genre with a higher precision and accuracy as compared to an individual model, which is used to recommend

pertinent music to students based on their individual preferences and needs.

While this research represents a promising step forward in the use of AI for music therapy in education, further research is needed to refine the algorithm and determine the optimal music genres and recommendations for different types of students and academic tasks. Overall, this research highlights the potential of the integration of AI in music therapy to revolutionize the field and enhance the effectiveness of therapeutic interventions, ultimately promoting the well-being of individuals across various settings and populations, especially education.

As a future application, the proposed ensemble classifier can be applied to music streaming platforms to improve genre classification, thereby eliminating the need for artists and record labels to explicitly add the genre of the music they upload to these platforms. Due to better genre classification, an improvised recommendation system can also be implemented to examine the impact of music therapy on specific groups of students, such as those with learning disabilities, ADHD, or other cognitive or emotional challenges. By tailoring music therapy recommendations to the specific needs of these students, it is be possible to further enhance the effectiveness of music therapy in education.

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Dialogue System for Human Computer Interaction

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ABSTRACT

The advancement of technology has significantly increased the prevalence and viability of computer interaction, leading to a rapid proliferation of interactive systems. Concurrently, there is a growing need for these systems to adapt to diverse situations and users, in order to provide the most effective and efficient mode of interaction. The advancement of technology has significantly increased the prevalence and viability of computer interaction, leading to a rapid proliferation of interactive systems. Concurrently, there is a growing need for these systems to adapt to diverse situations and users, in order to provide the most effective and efficient mode of interaction. In this paper, we present a comprehensive overview of current approaches utilized in training dialogue managers. By exploring these methods, we aim to address the need for adaptable and efficient dialogue systems that can cater to a wide range of users and scenarios.

INTRODUCTION

Human-Computer Interaction (HCI) is a vast field where dialogue systems have emerged as a prominent area of research and development. These systems, commonly referred to as conversational agents or chatbots, are designed to replicate natural conversations between humans and machines. By facilitating conversational interactions with computers, dialogue systems have the potential to enhance user experiences, improve task efficiency, and enable seamless communication with technology. The main advantage of dialogue systems in HCI is the ability to minimize the gap between human language and machine cognition. Traditional interaction methods, such as graphical user interfaces (GUIs) and command-line interfaces, often necessitate users to learn specific commands or navigate complex menus. The dialogue systems make use of natural language processing (NLP) approach to understand and produce responses correspond to human speech, allowing users to interact with computers using everyday language. Advancements in artificial intelligence (AI) and machine learning have driven the progress of dialogue systems. Researchers and developers have explored various approaches, including rule-based systems, statistical methods, and more recently, deep learning models, to construct robust and adaptable dialogue systems. These systems aim to grasp user intentions, maintain conversational context, and generate coherent and contextually relevant replies. The applications of dialogue systems encompass a broad range of domains like in customer service and virtual assistants, as well as deployed in educational tools and interactive entertainment.

NATURAL LANGUAGE PROCESSING

Natural Language Processing (NLP) stands as a pivotal component of AI, Computer Science, and Linguistics, aiming to equip them with the ability to understand natural forms of communication, including text and speech, at a level that rivals human intelligence.

Natural Language Processing (NLP) emerged as a separate domain in the realm of Artificial Intelligence, aiming to bridge the communication divide between computers and humans. Its origins can be traced back to the concept of Machine Translation (MT), which gained significance during World War II. Initially, Machine Translation focused on translating human languages, such as converting Russian to English, utilizing computer technology. Over time, NLP expanded its scope to encompass the conversion of both human language to computer language and vice versa, facilitating a seamless and efficient communication interface between humans and machines.

DIALOGUE SYSTEM

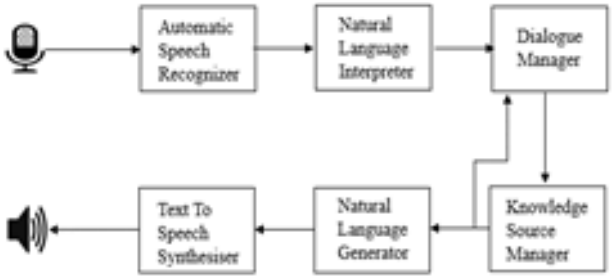

Fig 1: Complete Dialogue System

A dialogue system refers to an interactive computer system that actively participates in natural language conversations with users. Its primary function is to process and generate responses, enabling efficient communication and achieving specific tasks in the process. These systems are designed to understand user inputs and provide relevant and coherent replies, enhancing human-computer interactions.

Natural language interpreter is a software component that analyses and understands human language input, enabling computers to interpret and respond to user commands or queries.

Dialogue manager is a software component that guides and coordinates the development of conversation. It guides the system's responses based on user inputs and system goals. In certain systems, the dialogue manager functions as a central controller.

Knowledge source manager is a software component that handles the organization and access to various knowledge sources, such as databases or external APIs, in order to provide relevant information and support decision-making processes within a system.

Natural language generator serves as a software component that helps in converting the structured data or the system outputs into easily understandable natural language expressions.

THE EXISTING DIALOGUE SYSTEMS

In this section we provide a summary of the latest research in training dialogue managers, consisting of various approaches such as rule-based approach, sequence-to-sequence approach, reinforcement learning-based approach, and hierarchical reinforcement learning approach.

Rule-based Approach

In dialogue systems, rule-based approach involves the utilization of predefined rules or patterns to determine system responses according to user inputs. These rules, created by domain experts, contain specific guidelines on how the system should react in different dialogue scenarios. Following a deterministic approach, the dialogue system adheres to a series of if-then conditions to select the most suitable response.

The rule-based methodology relies on meticulously designed rules that cover multiple facets of the conversation. These rules are meticulously crafted, drawing upon a profound understanding of the domain, user intentions, and system capabilities. They can be formulated using targeted keywords, regular expressions, or semantic patterns to effectively recognize user intents, extract pertinent information, and generate contextually appropriate responses.

Fig 2: Example of Rule-based approach

Sequence-to-Sequence based Approach

Seq2Seq methods in dialogue systems leverage deep learning models to convert input sequences into output sequences. They employ an encoder-decoder architecture to capture the semantics and structure of dialogue interactions. The encoder processes the input sequence, transforming it into a fixed-length context vector that encodes contextual information. The decoder, which is self-assertive, operates by generating the output sequence token by making use of the token based on the context vector and once produced tokens.

Training Seq2Seq models involves utilizing dialogue datasets that contain input-output pairs. The model is trained with the objective of minimizing the discrepancy between its predicted output and the ground truth output. This is accomplished using techniques such as teacher forcing.

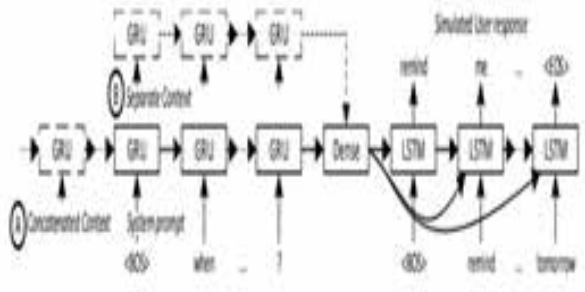

Fig 3: Seq-2-Seq models with encoders (GRU) and decoder (LSTM).

Reinforcement Learning based Approach

Reinforcement learning (RL) based approach in dialogue systems train agents to engage in conversations and develop optimal behaviour by interacting with an environment through a trial-and-error approach. These methods enable agents to learn from feedback.

In RL-based dialogue systems, agents interact with the environment, which can involve simulated or real users, aiming to maximize a cumulative reward signal. By considering the observed dialogue context, agents carefully select actions that result in high-quality responses or successful task completion, leading to desired outcomes such as engaging conversations and user satisfaction.

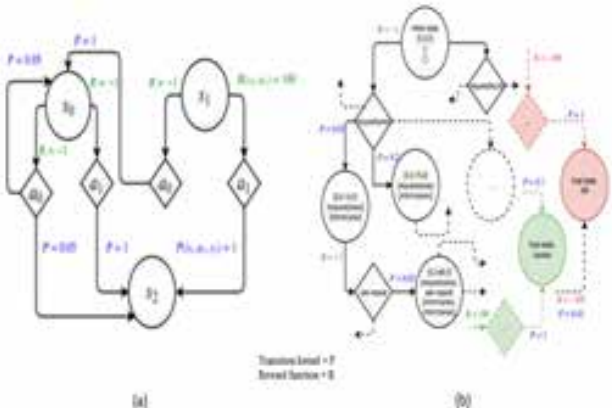

Fig (4.a): A generic discrete Markov Decision Process (final state is s2).

Fig (4.b): A Markov Decision Process in a slot-filling dialogue task. Dashes signify potential for an infinite range of states, transitions and actions.

The Markov Decision Process (MDP) is a frequently utilized reinforcement learning (RL) technique in dialogue systems. It models dialogues as a sequence consisting of states, actions, and rewards. By making use of MDP the agent acquires knowledge of a policy that associates states with actions, optimizing the expected cumulative reward.

Hierarchical Reinforcement Learning-based Approach

Hierarchical Reinforcement Learning (HRL) approach in dialogue systems aim to enhance conversational agent performance and efficiency by incorporating a hierarchical decision-making structure. This approach breaks down complex dialogues into smaller sub-tasks or sub-goals, enabling agents to effectively navigate and manage conversations. The higher-level manager determines the overall strategy and selects sub-goals, while the lower-level workers execute specific sub-tasks to achieve these goals.

HRL based approaches commonly utilize option frameworks and sub-goal discovery algorithms to effectively break down dialogues into coherent and purposeful sub-tasks. By incorporating pre-established options, tailored to handle specific situations, and employing autonomous sub-goal discovery algorithms based on the ongoing dialogue context, these methods empower dialogue systems to operate more efficiently.

The integration of these techniques enables the systems to navigate complex conversations by breaking them down into manageable steps, resulting in improved performance and smoother user interactions.

The utilization of Hierarchical Reinforcement Learning-Based Methods confers a noteworthy edge to dialogue systems, proficiently handling intricate context and arranging conversations into orderly, purpose-driven sequences. This methodology empowers the system to adeptly grasp and cater to user intentions throughout diverse exchanges, culminating in interactions that possess greater authenticity, strategic depth, and customization.

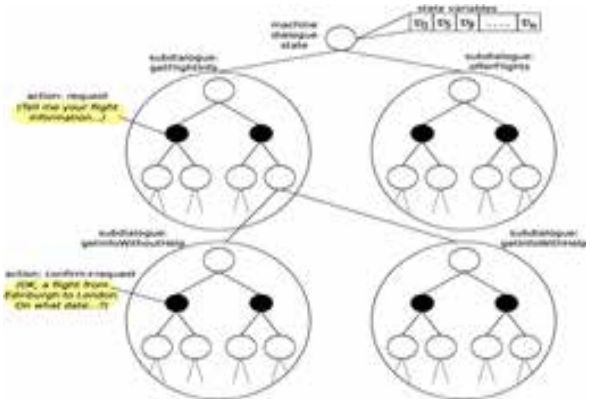

Fig 5: Example structure of Hierarchical Reinforcement learning-based approach

TESTING AND RESULTS

In this section we will consider Rule-based approach, Sequence-to-Sequence based approach, Reinforcement learning based approach and Hierarchical Reinforcement Learning approach for applying the following tests on them: -

Natural Language Understanding (NLU) Evaluation

This evaluation gauges the system's capacity to comprehend and precisely decipher user input. Diverse utterances, varying in complexity and intent, are provided to the system, and its accuracy in comprehending the significance and context is evaluated.

Natural Language Generation (NLG) Evaluation

This evaluation examines the system's capability to produce responses that are both coherent and contextually fitting. The system is exposed to diverse contexts, and its responses' quality and appropriateness are assessed accordingly.

Usability Testing

This evaluation assesses the holistic user experience and the user-friendliness of the dialogue system. Participants are assigned specific tasks to execute, and their interactions with the system are closely observed and documented to detect any potential usability challenges.

Error Analysis

This involves closely examining common errors that arise during interactions with the dialogue system. Gaining insights into these errors can aid in pinpointing vulnerabilities and opportunities for enhancing the system's design and implementation.

APPROACHES	NLU Evaluation	NLG Evaluation	Usability Testing	Error Analysis
Rule-Based Methods	70%	65%	75%	60%
Sequence-to-Sequence Based Methods:	85%	80%	80%	70%
Reinforcement Learning-Based Methods:	85%	75%	75%	70%
Hierarchical Reinforcement Learning-Based Methods:	90%	85%	85%	80%

Fig 6: Efficiency of approaches under test

RESULT

After applying the testing mechanism on Hierarchical reinforcement learning-based methodology and other approaches the result demonstrates that the HRL-based methodology is the most effective in managing intricate dialogues and upholding consistent conversations.

The provided efficiency percentages are rough approximations and serve as general indicators. The real-world performance of each method will fluctuate based on factors such as the implementation, dataset size and quality, training methodologies, and additional variables.

CONCLUSION

In conclusion, this research paper thoroughly investigated the domain of dialogue systems for human-

computer interaction, placing particular emphasis on the prevailing methodologies utilized within this field. An essential element in this context is Natural Language Processing (NLP), which plays a pivotal role in empowering computers to understand and generate human language with remarkable efficiency. The discussed already existing dialogue system methodologies contributes significantly to improving dialogue systems' performance, fostering more natural and engaging conversations between humans and computers. As technology progresses, these dialogue systems have the potential to revolutionize human-computer interactions and enhance user experiences across diverse domains. With ongoing technological advancements, these dialogue systems hold the promise of revolutionizing human-computer interactions and elevating user experiences across a wide range of domains.

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Unsupervised Learning-based News Aggregation: A Comparative Study of Different Embedding and Clustering Techniques

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ABSTRACT

Business news plays vital role in empowering business leaders and marketers to make well-informed daily decisions, encompassing the formulation of commercial strategies, advertising choices, operational planning, and investments in human capital. Access to this information offers a comprehensive understanding of the global business landscape, enabling business leaders and marketers to stay updated on mergers and acquisitions while also keeping stakeholders well informed. In the modern world, staying abreast of commercial ventures is essential; however, the abundance of news websites can make searching for data a time-consuming task, overshadowing the quest for valuable information. This research aims to explore innovative strategies for aggregating relevant news articles by leveraging in-depth research concepts to encode informational articles into vectors. Through the use of unsupervised learning techniques, clusters are formed based on these embedded vectors. The primary objective of this study is to propose novel approaches for aggregating pertinent news pieces. Several embedding techniques, including Bag-Of-Words, TFIDF, and BERT, are employed to convert news articles into vectors, while clustering algorithms like Hashing algorithms are utilized to group similar news articles.

KEYWORDS *: Clustering techniques, Similar news article, Hashing algorithms, Unsupervised learning.*

INTRODUCTION

Over the past few years, the volume of news that is released on a global scale has grown exponentially. People lived in a time where news, data, and information were abundant. Today, news serves a significant role in the neighborhood. People keep themselves informed with the newest news and information by reading the news each day. This news information might also be related to celebrities, sports, food, weather, technology, or a wide range of other topics. Many news websites take longer to find the information than they need to in order to keep up with the news. This study investigates a novel method for compiling pertinent news stories. To accomplish this, we apply a deep learning approach to vectorizing news items. Clusters of these embedded vectors are generated through unsupervised learning. Numerous academics and researchers are expanding related topics of study. Nonetheless, a number of techniques are employed for this, including the similarity computation technique and the Textrank method.

LITERATURE REVIEW

The text clustering algorithms include variety of techniques, such as vector space models, different versions of k-means, spectral algorithms, methods for dimensionality reduction, phrase-based techniques and generative algorithms [1]. Various methods have been employed in this field, such as vector space models, different adaptations of k-means, generative algorithms, spectral algorithms, methods for reducing dimensionality, and techniques based on phrases [1]. A more conventional approach that yields better results on homogeneous themes is the vector space model, which necessitates knowing the quantity of clusters [2]. The K-means method and its variations are extensively

employed for partitioned and hierarchical clustering. They do, however, have some drawbacks, such as a decrease in efficacy and a dependence on random initialization when working with large data sets. They also require the number of clusters to be known, as they are susceptible to noise and outliers [3]. The use of cluster numbers as input in generative calculations reduces their persuasiveness when dealing with diverse data since they are excessively sensitive to exceptions [1]. When the vector representation of the data is shown as a bipartite chart, ghostly clustering appears tall and precise. This bunch's benefit is that it can find this value while handling it and doesn't require a certain number of clusters [4, 5, 6]. Measurement Although decrease techniques were originally developed for computer vision applications, they have proven to be effective in report clustering as well. The primary drawback of these methods is that they rely on erratic initialization, which can result in different overruns on the same data. Regardless, they execute tall orders, and some of them are able to determine the optimal number of clusters [7, 8]. A number of specialized methods have been put out for grouping news articles and brief writings. A discriminant topic model bi-term for news headline-based clustering is presented by Yungquing et al. in [10]. In [11], a social network analysis that is used to group topics on Twitter is provided. In order to measure the semantic similarity of brief texts used to analyze search engine inquiries, [12] offers a unique kernel function. This can also generate Wikipedia features, which can increase the accuracy of short text clustering [13]. Conrad and Bender showed in [14] that event-oriented news clustering algorithms can be implemented using the collective clustering method. Additionally, a technique for gathering and grouping news is suggested using cosine similarity clustering [15].

Sonia Bergamaschi and her team introduce RELEVANTNews, a web-based news feed reader that autonomously organizes news content articles on a certain subject that are published in several newspapers on various days. An application is built upon a prior written program called RELEVANT, that calculates 'relevant values,' which are a subset of the values within a string attribute. By grouping the names of the user-selected news feeds according to lexical and syntactic similarities, it is possible to find groupings of pertinent news [16].

Several aggregators have been created and put into operation. Many of them are offered as business items, and we don't know anything about their internal workings. In [16], it is potentially categorized them into three distinct classes:

1. Straightforward per users develop a GUI-based RSS feed creator and compiler that is easy to use and customizable for different users. Simple features that help users read more easily are offered. (Such as web crawling, unique search functions, and the connection between information and a guide).
2. News classifiers present the news in an order determined by criteria that the user may select from time to time. Simple descriptions could benefit from the classes or possibly the keywords provided by the websites.
3. Progressed aggregators include more features to help the user browse, organize, classify, and store news.

Velthune is a news search engine that is suggested in [17]. The main component of the program is a simple classifier that divides the data into a small number of groups. RELEVANTNews, in contrast, computes clusters of related data on the concept mentioned in its name. Thousands of news items are categorized into a small number of groups, which results in enormous, difficult-to-read information units within each category for the customer. The authors of [18] propose an aggregator that enforces a method for temporally updating the cluster contents. They refer to this device as the RCS (RSS Clusgator Device). A sophisticated aggregator called NewsInEssence [19] computes comparable data based on the TF*IDF clustering method, giving the viewer a summary. Instead of offering synthesis, RELEVANTNews uses a parameterized clustering method that is based on dominating, lexical, and syntactic associations and can be adjusted to provide better grouping.

The writers of [20] are experts at gathering data through the use of Matrix-based News Aggregation (MNA), which consists of the following 5 main processes: The first and second steps involve collecting records, extracting information from websites, and storing it in a database. Grouping, or classifying the articles,

is the third phase. Summarization and visualization are the last stages, which help the reader understand the significance of the text. They first established the matrix-based evaluation before the grouping process. In this matrix, an entity is represented as a row, and the states pertaining to the entities are represented as columns. When starting an analysis, the user specifies his goals, based on which MNA generated the default values are used for this reason. Subsequently, the matrix initialization process expands the matrix over the two necessary specified dimensions and searches each cell for mobile files. The summary section is carried out in a consistent manner, utilizing the subsequent steps include generating a topic summary, assessing cell specificity, and employing TF-IDF to summarize each cell within the matrix.

As per [21], content from a variety of sources, including items like articles and news headlines sourced from blogs and websites., was compiled by the writers. the notion that information is presented to us in a shortened and concise manner via rich website summaries (RSS). It is advantageous for the news aggregator because they remain a widely used technique for content indexing. By cutting down on the amount of time required to travel to a few websites, subscribers can quickly get rich website online summary feeds helps users avoid the time-consuming task of visiting multiple websites. The application starts by generating HTTP requests sent to the web server, which are then received by clients. The articles are then extracted based on the information provided downloading rich web page summary feeds using Python.

The author of [22] attempts to use HTML's rich web page summary to pull data from a particular source using wrappers, scripts, and parsers. The data is then customized via a web interface for news and customized web displays. The authors explained how they built the content parser using rich site summaries and HTML. The initial stage is referred to as "wrapping," which may involve HTML wrapping or creating a Rich Site Summary, and it involves setting up the URLs of the new source components with news categories together with the addresses that are listed in the table for each pair of categories and linked to the corresponding envelope. In the second step of encapsulation, they take the first sentence from each article and move it to the appropriate HTML page. The articles will be obtained and indexed using this information.

Our goal was to create a single, all-inclusive website that included news from K. Sundaramoorthy et al. as well as publications from magazines, newspapers, and television. The brief and generic nature of the content and data enhances the quality of the conclusions. Thus, "they rely on Rich Site Summary Collector to recover Rich Site Summary reports from certain websites at specific periods." In addition to detailed site summaries, it also uses web crawling, or parsing, to get more accurate results. One method for obtaining a lot of data from websites is web scraping [23].

According to every study on news aggregators listed above, there is still room for improvement in the aggregator system's quality.

WORKING OF VARIOUS EMBEDDING TECHNIQUES

Bag of Words

When utilizing machine learning techniques to extract features from text for modeling purposes, the outcome is commonly referred to as a "bag-of-words" model, often abbreviated as BoW. This method is highly versatile and user-friendly, finding application in various ways for feature extraction from documents. A bag-of-words represents text by enumerating terms in a document based on their frequency of occurrence, comprising two key components:

- A vocabulary containing known words.
- A measure of how these known words is present in the document.

The term "bag" in "bag-of-words" signifies that any structural or sequential information about the arrangement of document's words is not taken into account. The model's primary objective is to identify the presence of familiar words in the document, without taking into account their specific positions within the text.

Term Frequency-Inverse Document Frequency (TF-IDF)

TF-IDF is a well-established statistical technique widely

used in information retrieval and natural language processing. It evaluates the significance of a term in a document within the context of a set of documents. TF-IDF assigns a numerical value to a word by multiplying its Term Frequency (TF) by the Inverse Document Frequency (IDF), as indicated by its name.

Term frequency (TF) represents the ratio of a term's or word's occurrences within a document to the total number of words in that document.

$$TF = \frac{Number\ of\ times\ terms\ appear\ in\ the\ document}{Total\ number\ of\ terms\ in\ the\ document}$$

The term "Inverse Document Frequency" (IDF) indicates the percentage of documents within a corpus that contain the word. Words that are specific to a limited subset of papers (technical jargon terms, for ex.) are assigned a higher relevance value compared to words that appear in all documents (e.g., a, the, and).

$$TF = log(\frac{Number\ of\ documents}{Number\ of\ documents\ contain\ the\ terms})$$

The TF and IDF scores are multiplied to determine a term's TF-IDF.

$$TF\text{-}IDF = TF*IDF$$

BERT

BERT uses surrounding text to build context, which aids computers in deciphering meaning from confusing language. The Wikipedia text served as the basis for pre-training the BERT framework, which can subsequently be fine-tuned with question-and-answer datasets. BERT, an acronym for Bidirectional Encoder Representations from Transformers, is built upon the foundation of Transformers, a deep learning model where all output elements are interconnected with all input elements, and the weights between them are adaptively determined through these connections.

Working of Locality Sensitive Hashing

LSH, which stands for Locality Sensitive Hashing, is an algorithm rooted in hashing principles, employed for the purpose of identifying approximate nearest neighbors. In the conventional nearest neighbor scenario, a training set comprising data points is present within a space, and when a new point is provided, the objective is to locate the closest point within the training set. This procedure usually exhibits linear complexity, denoted as O(N), where N represents the size of the training set.

An approximate nearest neighbor algorithm strives to reduce this complexity to sub-linear levels (i.e., below linear) by minimizing the number of comparisons needed to find similar items.

LSH operates based on the notion that when two points in the feature space are in close proximity, they are likely to generate the same hash, which serves as a condensed representation of the data. LSH differs from conventional cryptographic hashing, where the intention is to avert collisions, as it seeks to maximize collisions for similar points. In cryptographic hashing, a slight alteration in the input can lead to a vastly different hash, whereas in LSH, minor distinctions are disregarded to facilitate the easy identification of the primary content. These hash collisions increase the likelihood that similar items will share the same hash value.

Locality Sensitive Hashing (LSH) is a versatile hashing technique intended to preserve local relationships within data while significantly reducing the dataset's dimensionality.

To formally define LSH, a hash function 'h' is considered Locality Sensitive if, for two given points 'a' and 'b' in a high-dimensional feature space:

- The probability of h(a) being equal to h(b) is high when 'a' and 'b' are close.
- The probability of h(a) being equal to h(b) is low when 'a' and 'b' are far apart.
- The time complexity for identifying closely related objects is sub-linear.

PROPOSED METHODOLOGY

Architecture of clustering similar news articles

Clustering similar news articles is a common task in information retrieval and natural language processing. The goal is to group together articles that share common topics or themes. One popular approach to this task is to use unsupervised machine learning techniques, like clustering algorithms. Here's an overview of the architecture for clustering similar news articles.

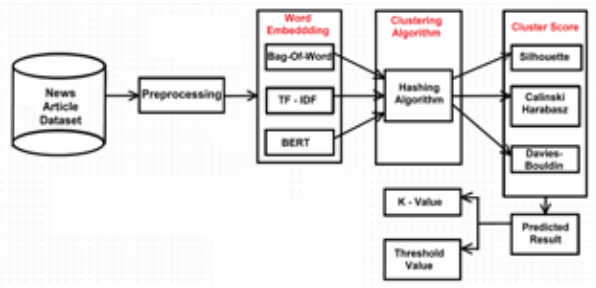

Figure 1: Proposed Architecture of clustering similar news articles

Steps involved in research work include the following

Data Collection

There are two stages to the data collection in this phase. In the initial stage, data is manually gathered from multiple websites for training and result analysis. When a model is constructed that yields good results, real-time news collected from multiple news APIs is fed into it.

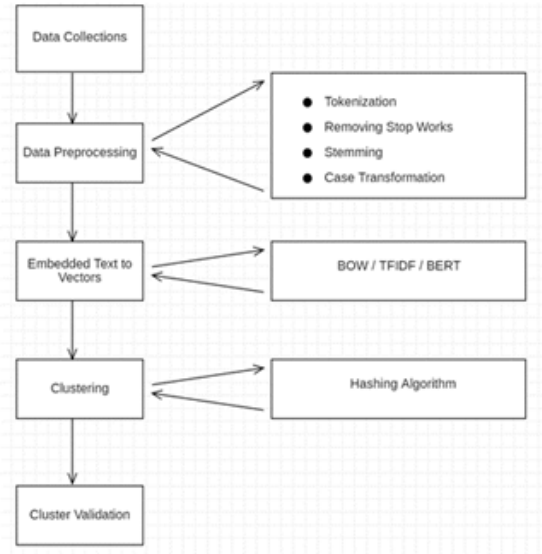

Figure 2: Proposed Methodology

Data Preprocessing

This stage involves cleaning the gathered data using a variety of natural language processing techniques, including case transformation, tokenization, removal of stop words, and stemming.

Considering that the text pre-processing was carried out in Python, the Ntlk (Natural language toolkit) package of Python was utilized as afterward;

[1] Tokenization: It is the division of text into individual words, phrases, or sentences. Words are broken apart, and punctuation is eliminated. Tokenization was done using the word tokenizer from ntlk.

[2] Removing Stop Words: This involves the elimination of words that are frequently used but are probably not helpful for learning. The sentences do not consist of terms like "in," "of," "are," and so forth. Stop word removal was done by using the ntlk stop words to remove stop words.

[3] Stemming: The goal of stemming is to condense linked words into a single stem. Stemming was done by using the ntlk stem WordNetLemmatizer.

[4] Case Transformation: Lower case letters are substituted for all other letters in sentences. This was done by using the Python string function lower(), where all the words are converted to lower case.

Embedding Text to Vectors

All sentences must be embedded into vectors because machine learning methods cannot be directly applied to text. There are numerous widely used strategies, like Bag-Of-Words, TF-TDF, and BERT, to accomplish this. All of these methods are applied to text embedding in this work.

Clustering:

In this stage, groups of related news items are assembled. To achieve this, one of the most recent clustering techniques, i.e., clustering with the help of hashing, is used.

RESULT ANALYSIS

In this step, all possible combinations of the hashing clustering technique and mentioned embedding techniques are used for the aggregation of news articles. To evaluate all of these combinations, a set of 3811 news articles was used. Bag-Of-Words, TF-TDF, and BERT embedding techniques were employed to represent these news articles, followed by the application of hashing clustering to group together news articles that share similarities.

Silhouette Score method for Finding Optimum number of clusters for hashing clustering

Vector Obtained using Bag-Of-Words:

Following graph shows the Silhouette Score for the number of clusters from 15 to 30. Here, Bag-Of-Words technique was used to embed text into vectors. It can be observed from this graph that the maximum silhouette score is obtained for 22 clusters. Silhouette score decreases on either side of 22 clusters.

Figure 3: Vector obtained using Bag-Of-Words

Vector obtained using TF-IDF

The following graph shows the Silhouette Score for the number of clusters from 15 to 30. Here, the TF-IDF technique was used to embed text into vectors. It can be observed from this graph that the maximum silhouette score was obtained for 21 clusters.

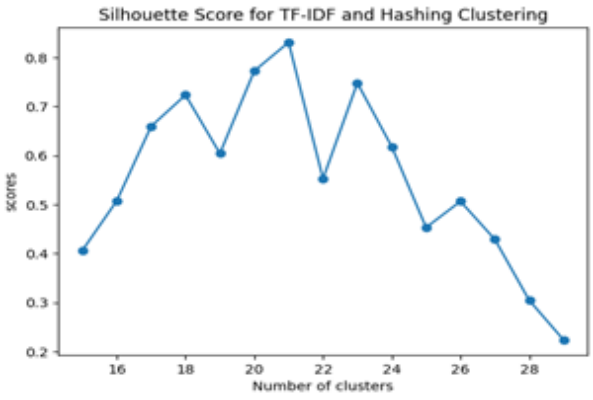

Figure 4: Vector obtained using TF-IDF

Vector obtained using BERT

The following graph shows the Silhouette Score for the number of clusters from 15 to 30. Here, the BERT technique was used to embed text into vectors. It can be observed from this graph that the maximum silhouette score was obtained for 22 clusters.

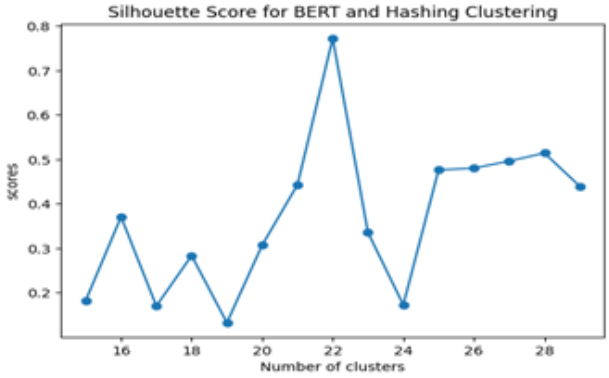

Figure 5: Vector obtained using BERT

Calinski-Harabasz method for finding optimum number of clusters for hashing clustering

Vector obtained using Bag-Of-Words:

The following graph shows the Calinski Harabasz score for the number of clusters from 15 to 30. Here, the Bag-Of-Words technique was used to embed text into vectors. It can be observed from this graph that the maximum Calinski Harabasz score is obtained for 22 clusters.

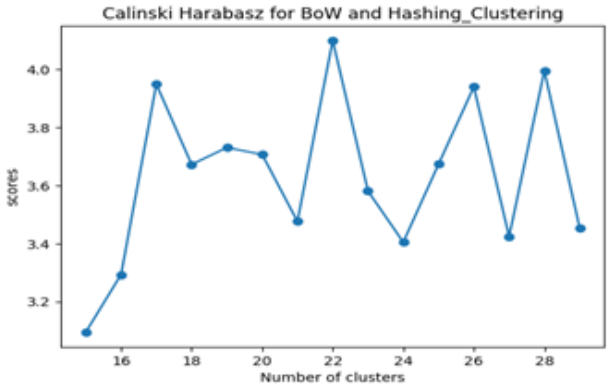

Figure 6: Vector obtained using Bag-Of-Words

Vector obtained using TF-IDF

The following graph shows the Calinski Harabasz score for the number of clusters from 15 to 30. Here, the TF-IDF technique was used to embed text into vectors. It can be observed from this graph that the maximum Calinski Harabasz score is obtained for 21 clusters.

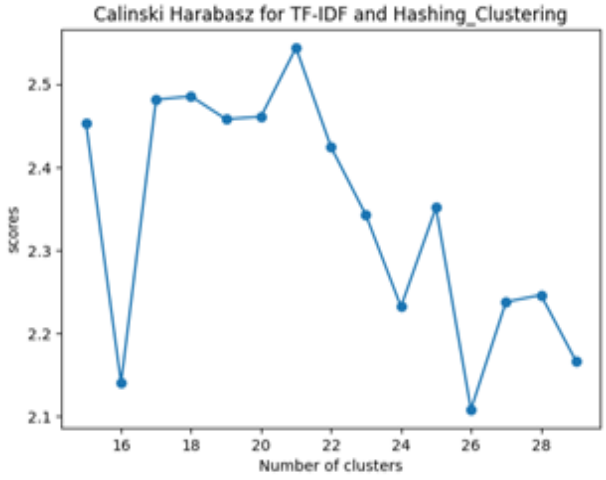

Figure 7: Vector obtained using TF-IDF

Vector obtained using BERT

The following graph shows the Calinski Harabasz score for the number of clusters from 15 to 30. Here, the BERT technique was used to embed text into vectors. It can be observed from this graph that the maximum Calinski Harabasz score is obtained for 22 clusters.

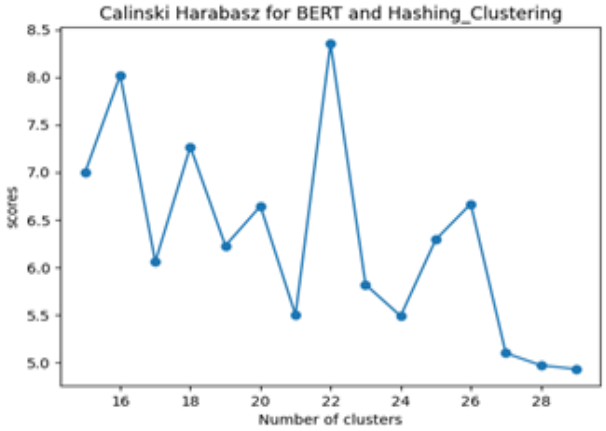

Figure 8: Vector obtained using BERT

Davies-Bouldin method for finding optimum number of clusters for hashing clustering

Vector obtained using Bag-Of-Words

Following graph shows the Davies-Bouldin Score for the number of clusters from 15 to 30. Here, Bag-Of-Words technique was used to embed text into vectors. It can be observed from this graph that the minimum Davies-Bouldin score is obtained for 22 clusters.

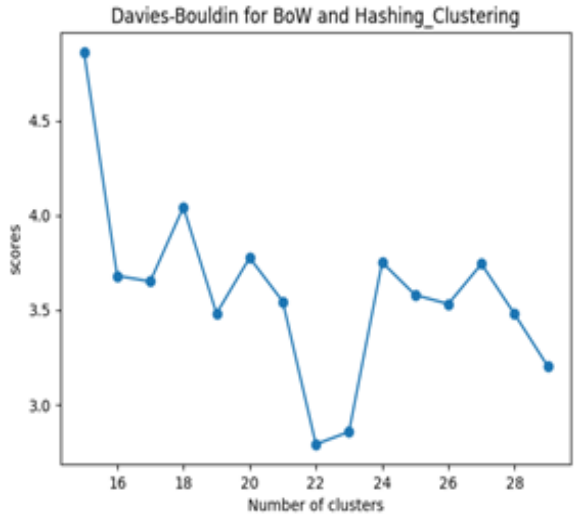

Figure 9: Vector obtained using Bag-Of-Words

Vector obtained using TF-IDF

Following graph shows the Davies-Bouldin Score for the number of clusters from 15 to 30. Here, TF-IDF technique was used to embed text into vectors. It can be observed from this graph that the minimum Davies-Bouldin score is obtained for 22 clusters.

Figure 10: Vector obtained using TF-IDF

Vector obtained using BERT

The following graph shows the Davies-Bouldin score for the number of clusters from 15 to 30. Here, the BERT technique was used to embed text into vectors. It can be observed from this graph that the minimum Davies-Bouldin score is obtained for 22 clusters.

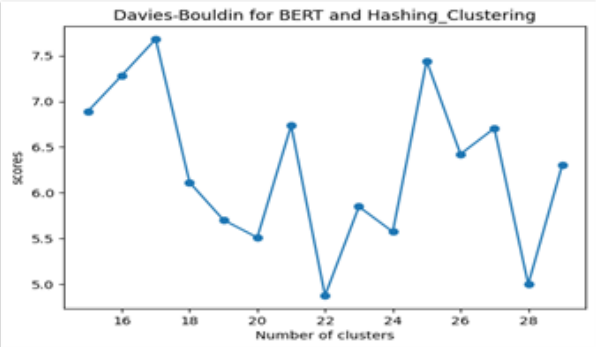

Figure 11: Vector obtained using BERT

Table 1 presents a comprehensive overview of optimal values crucial for tailoring the clustering process to align with the distinctive attributes of the similar news article dataset, ensuring an effective and insightful grouping of news articles with shared thematic elements.

Table 1: Optimum number of clusters for hashing clustering

Methods	Embedding Techniques	Number of Clusters
Silhouette Score	Bag of Words	22
	TF-IDF	21
	BERT	22
Calinski-Harabsz Score	Bag of Words	22
	TF-IDF	21
	BERT	22
Davies-Bouldin Score	Bag of Words	22
	TF-IDF	22
	BERT	22

In Table 2, an evaluation of various combinations of embedding and hashing clustering algorithm is presented, highlighting their respective accuracies. The results clearly indicate that the pairing of BERT embedding with the K-means clustering algorithm outperformed all other combinations, underscoring its efficacy in effectively clustering similar news articles.

Table 2: Comparative Result Analysis of each Embedding Technique and Clustering Algorithm

Embedding Technique	Size of Each Vector	Clustering Algorithm	Accuracy (%)
Bag of Words	1567	Hashing clustering	62.11
TF-IDF	1567	Hashing clustering	71.54
BERT	512	Hashing clustering	82.39

CONCLUSION AND FUTURE SCOPE

A strong method for arranging, examining, and deriving insightful information from big sets of related news article data is the clustering of comparable articles. Similar news items can be clustered together based on their statistical characteristics by using clustering algorithms like Locality Sensitive Hashing or other strategies like TF-IDF and BERT embeddings. Personalized suggestions, better content organization, trend analysis, effective information retrieval, and improved data exploration are just a few advantages of this clustering method. Users may find hidden patterns and correlations, read through news stories more efficiently, and obtain insightful knowledge about new subjects and trends.

The number of clusters, or K, that works best for clustering related news items varies based on the particular dataset and the level of granularity that is required. Since K relies on a number of variables, including the size of the dataset, the variety of topics covered, and the particular goals of the research, there is no one value that applies to all situations. Following a thorough analysis of every technique, it was determined that a value of 22 for k would provide a superior clustering of related news items. Moreover, clustering may help news organizations with recommendation systems, content management, and giving viewers a more customized and individualized news experience. To guarantee relevant and accurate clustering results, it is crucial to take into account the choice of suitable clustering algorithms, preprocessing methods, and assessment metrics. Subsequent studies can concentrate on creating increasingly complex algorithms and methods that take use of the temporal and contextual features of news stories to achieve even more accurate grouping. Organizing news stories based on similarities

is a useful strategy for managing the large quantity of information accessible, facilitating enhanced comprehension and use of news material.

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Encrypted Cloud Data Deduplication Technique for Secure Data Storage Optimization Over Cloud

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ABSTRACT

Data duplication is a significant concern in cloud-fog storage integrated environments, leading to wasteful storage usage. Traditional techniques, like backup and archive systems designed for static data, are inadequate due to the dynamic nature of cloud and integrated cloud settings. To address this issue, data deduplication techniques are employed to efficiently eliminate redundant data in cloud storage systems. Implementing data deduplication (DD) on encrypted data presents a substantial challenge in secure integrated cloud-fog storage and computing environments. This paper introduces a novel approach utilizing Convergent and Modified Elliptic Curve Cryptography (MECC) algorithms in cloud and fog environments to create secure deduplication systems. The method primarily focuses on two critical objectives: minimizing data redundancy and developing robust encryption methods to ensure data security. It is well-suited for tasks such as uploading new files to fog or cloud storage. The process begins by encrypting the file using Convergent Encryption (CE) and then further encrypting it with the Modified Elliptic Curve Cryptography (MECC) algorithm. This approach efficiently identifies redundancy at the block level, resulting in more effective data redundancy reduction. Test results demonstrate that the proposed method surpasses several state-of-the-art methods in terms of computational efficiency and security.

KEYWORDS *: Convergent encryption (CE), Modified elliptic curve cryptography (MECC), Edge computing, Integrated cloud and fog networks, Hash tree, Secure hash algorithm (SHA).*

INTRODUCTION

The exponential growth of data from various sources and the widespread adoption of the Internet of Things across applications have led to a massive increase in data volume, reaching from petabytes to yottabytes. To handle this data, cloud computing and fog networks have become essential for data processing and storage.

Cloud computing (CC) offers a network-centric environment, providing users access to a collective pool of programmable resources, including servers, software, storage, and services that can be easily accessed over the internet. Data processing in cloud servers is done remotely via internet connectivity. In contrast, fog computing provides local infrastructure for processing applications locally before connecting to the cloud. This reduces latency compared to processing applications directly in the cloud. To ensure data security, communication protocols, and resources are crucial for accessing information stored in both cloud and fog environments.

Smart applications, often relying on sensors and actuators, store data in the cloud while utilizing edge computing facilities, referred to as "fog," for low-latency data processing. The Internet of Things aims to create cyber-physical systems, extending user mobility with edge computing for on-the-go data processing.

Traditionally, sending data to the cloud was the dominant trend, but it is evolving to include fog, edge, and cloudlet solutions to address the demands of delay-sensitive and context-aware services. This transition from centralized cloud computing to distributed edge cloud computing enhances transparency.

Fog computing offers an attractive solution for

distributed edge cloud computing, particularly for low-latency, mobility, and geodistributed services. Several schemes focus on offloading tasks from the cloud to reduce latency, improve energy efficiency, and enhance reliability.

Effective resource allocation methods in both cloud and fog environments further boost performance and application processing reliability. Edge computing, which brings cloud capabilities closer to mobile devices, helps address various challenges in the Internet of Things, such as latency, limited bandwidth, energy efficiency, and data security.

Data deduplication (DD) is a widely used technique for removing data redundancy. It involves chunking, hashing, and comparing hashes to identify redundant data. Implementing encryption and deduplication together is crucial for achieving optimized and secure storage. DD can be applied in various scenarios, such as archiving, backup systems, databases, and network storage.

This paper proposes a secure data deduplication system using convergent and MECC algorithms in the integrated cloud-fog-edge environment. While convergent encryption is suitable for deduplication with encryption in cloud storage, it may be vulnerable to dictionary attacks. To address this, the paper suggests using the modified elliptic curve cryptography (MECC) technique to encrypt the deduplicated data. This combined approach ensures efficient deduplication and secure encryption with lower computational overhead compared to existing methods.

The significant contributions of this paper can be summarized as follows:

- A novel approach for establishing a secure data deduplication (DD) system is introduced, utilizing Convergent and Modified Elliptic Curve Cryptography (MECC) algorithms, as published by P. G. et al. in the Journal of Cloud Computing: Advances, Systems, and Applications in 2020. This method is designed to operate within the cloud and fog/edge environments.
- The proposed technique's performance is assessed, focusing on its computational efficiency and security level.
- We have confirmed the capability of the proposed deduplication method to identify data redundancy at the block level. This results in a more efficient reduction of data redundancy and a consequent reduction in cloud storage space usage.

The manuscript's outline is organized as follows: Section 2 examines related research, Section 3 outlines the proposed methodology, Section 4 delves into the initial results, and Section 5 encompasses the conclusion and outlines potential avenues for future research.

RELATED WORKS

This The secure deduplication system eliminates duplicate data copies while ensuring data security. Convergent Encryption (CE) is employed to encrypt and decrypt data at the file level using a key derived from the file's content [20]. Users retain the encryption key and outsource the ciphertext (CT) to the Cloud Server (CS) to conserve storage space. Consistent privacy is maintained by updating the CT in the central cloud and user-level public keys without revealing the private keys [21].

Kwon et al. introduced a secure deduplication framework with user revocations, consisting of three phases: upload, revocation, and download. This framework utilizes a privilege-centric re-encryption method over convergent encryption.

Li et al. recommended "Dekey," which securely distributes convergent key shares across multiple servers. Dekey supports both block-level and file-level deduplication, improving storage efficiency. Security analysis confirmed Dekey's security and minimal overhead.

Kwon et al. proposed a server-side deduplication framework for encrypted data, allowing the Cloud Server to control access to outsourced data as ownership changes dynamically. It prevents data leakage to revoked users and ensures data integrity.

Yuan et al. developed a randomized framework (R-MLE2) with static and dynamic schemes, achieving high-level performance for data equality tests. Han et al. introduced a multi-bit secret channel in cloud storage, simplifying data upload and enhancing security. Tawalbeh reconsidered security and privacy for cloud and fog environments using a health care system case study, improving performance and trust among users.

Zhang introduced indexing for high-performance deduplication of data, providing quick responses to fingerprint queries. Hou suggested checking the truthfulness of cloud data when the remote server stores only a single copy of the same file from different users. Deduplication offers significant space and cost savings for storage providers.

Enhanced Secure Threshold Data Deduplication Pattern helps maintain end-to-end encryption, and Proxy re-encryption (PRE) is a flexible admission control tool with efficiency in computational cost and ciphertext size.

A confidentiality-preserving deduplication technique for public cloud services is discussed, supporting public reliability and auditing in the cloud storage system. A chaotic fuzzy transformation method is proposed for fog systems, improving user data privacy, confidentiality, and resource savings.

A comprehensive study on security issues related to cloud data and their solutions is described, with a focus on access control models for the cloud computing environment. A framework is introduced to statically and dynamically mine structures from malware, accurately classifying malware with low false alarms. Public-key-based schemes are presented to address security vulnerabilities in symmetric-key-based μTESLA-like schemes, although their signature verification is time-consuming.

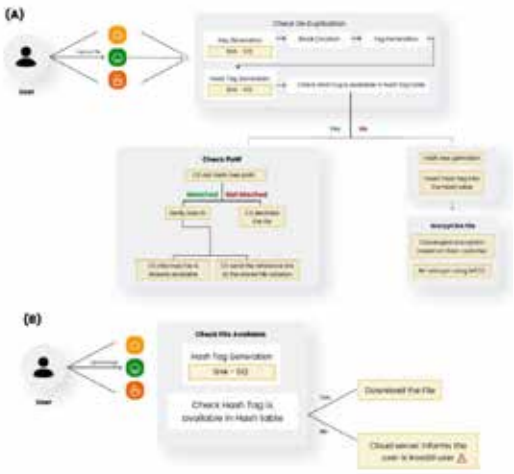

Fig. 1 a Uploading the file into the cloud server using the proposed system. b Downloading the file from the cloud server using the proposed system

PROPOSED SECURE DEDUPLICATION APPROACH

To The Cloud Service Provider offers various resources to users in the form of services, such as extensive storage capacity. Handling the continuously growing volumes of data within the cloud presents a significant challenge. Data Deduplication (DD) is an effective technique for enhancing data management scalability in Cloud Computing (CC). However, the primary concern in Data Deduplication is security. To address this issue, this paper introduces a secure data deduplication system that employs convergent and Modified Elliptic Curve Cryptography (MECC) algorithms in an integrated cloud-fog environment.

The proposed methodology is evaluated in four scenarios: a) when a new user attempts to upload a new file, b) when the same user tries to upload a duplicate file, c) when different users seek to upload identical files to the cloud server, and d) when users aim to download the file. The detailed explanation of the proposed methodology can be found in the block diagram illustrated in Figure 1a and 1b.

When a new user tries to upload a new file

To begin, when a new user selects a file for upload to the Cloud Server (CS), the CS generates a unique hash code (HC) key for the file using the SHA-512 algorithm. This input file is then modified by adding padding and a fixed 128-bit length field. The resulting message is divided into blocks, and a 64-bit word is computed for each message block using eight constants derived from the square roots of the first eight prime numbers. Subsequently, a 512-bit buffer is updated in the SHA-512 operation. The process of SHA-512 can be better understood by referring to Figure 2.

The original input file is then segmented into blocks, and tag values are assigned to each block. A hash code (HC) is generated for each tag value of a specific block using the same SHA-512 algorithm. The Cloud Server (CS) checks whether the hashtag exists in the Hash Table (HT). If it is not present, the hash tree is created for Proofs of Ownership (PoW) based on the hashtag value.

Next, the file is encrypted using a convergent encryption (CE) method. This CE method takes the HC

key of the file as input. Subsequently, the convergent-based encrypted file undergoes an additional layer of encryption using the MECC algorithm.

This encryption process is implemented to ensure the secure uploading of data to the CS. The details of the CE and MECC-based encryption of the specific file are elaborated as follows.

Convergent encryption (CE)

Within data deduplication, Convergent Encryption (CE) significantly enhances data confidentiality. The Convergence Key (CK) is represented by the hash code (HC) value generated from the file. Utilizing this CK, all data copy blocks are encrypted. To identify duplicate files within the Cloud Service Provider (CSP), a tag is created for each data block. If two data files are identical, they will receive the same tags.

Before storing the data file in the CSP, its tag is sent to the CSP to identify duplicate data files.

Ultimately, this encrypted data block, along with its tag, is stored within the CSP. The phases involved in Convergent Encryption (CE) are explained as in Figure 2.

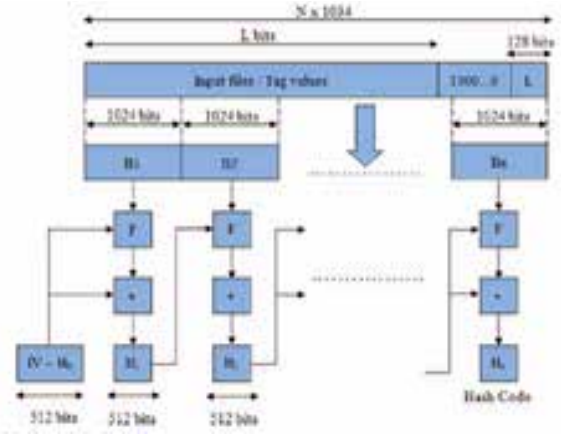

Fig. 2 Structure of the SHA-512 algorithm [35]

Convergent encryption

In the encryption process, the original file (f) and κh are provided as input to the encryption algorithm, and the encryption function Ey is applied. As a result, the encryption algorithm produces ciphertext (Ct) as its output.

$$Ct = Ey(f, kh) \quad (1)$$

Convergent decryption

During decryption, the encrypted file f or Ct is inputted to the decryption algorithm. Finally, this decryption algorithm outputs f and Ct.

$$f = Dy(Ct, kh) \quad (2)$$

The CE algorithm demonstrates superior performance in comparison to other existing methods. However, it does have a drawback in terms of security, as it remains vulnerable to dictionary attacks. To address this vulnerability, the proposed approach introduces an additional layer of encryption for the previously convergent-encrypted file, employing the Modified ECC algorithm, which is elaborated as follows.

The Elliptic Curve Cryptography (ECC) algorithm is founded on a curve featuring specific base points and a prime number function, which serves as an upper limit. ECC is a cryptographic algorithm employed in public-key cryptography. The mathematical model of ECC, with "g" and "e" as integers, is provided below.

$$w^2 = v^3 + gv + e,\ 4g^3 + 27e^2 \neq 0 \quad (3)$$

In cryptographic procedures, the effectiveness of encryption primarily relies on the method employed for key generation. In the proposed system, three types of keys need to be generated. The initial step involves generating the public key (αk) from the server and encrypting it. Subsequently, a private key (βk) is generated on the server-side for message decryption. The final step is to generate a secret key (ok) using αk, βk, and a point on the curve (ρc). The generation of αk follows the equation provided below.

$$\alpha_k = \beta_k * p_c \quad (4)$$

The eq. (5) elucidates α_k generation,

$$O_k = \alpha_{k} * \beta_k * P_c \quad (5)$$

After O_k generation, the file is encrypted. This encrypted file contains two CTs, and mathematically,they are depicted as,

$$C_1 = ((K := 1, 2, \ldots, (n-1) * p_c) + O_k \quad (6)$$

$$C_2 = (f + ((K := 1, 2, \ldots, (n-1)) * \alpha_k)) + O_k \quad (7)$$

Here, C1 and C2 represents the two CTs, K is the random number generated in (1, ..., (n − 1)) interval. During encryption, O_k is added to the CTs. During decryption,

O_k is subtracted with the two CTs, and the original file f is given by,

$$f = (((C_2 - \beta_k) * C_1) - o_k) \quad (8)$$

When the same user attempts to upload the same file once more, the Cloud Server (CS) computes the hash value using the Convergence Key (CK) with the SHA-512 algorithm. For each input file, the binary representation of the file is divided into fixed-sized blocks. The size of these data blocks determines the granularity of deduplication. Smaller data block sizes lead to higher deduplication levels, but they can also introduce complexity in metadata management. The proposed approach considered file block sizes of 5MB, 10MB, 15MB, 20MB, and 25MB. Subsequently, a tag key is generated for each of the segmented blocks, and the hash value is calculated for all tag keys using the same SHA-512 algorithm.

In the uploading phase, the CS examines the hashtag (HT) for a specific input file. If the hashtag value of the input file is found in the HT, the CS requests the hash tree path from the users. If a user provides the correct path, the CS verifies the user's ID. If the ID matches, the CS refrains from storing the file again. Generally, the hash tree path adheres to the following format:

$$P(H_t) = \{ RLL, RLR, etc. \} \quad (9)$$

Here, $P(H_t)$ signifies the hash tree path, with RLL representing "Root, Left, Left," and RLR indicating "Root, Left, Right." The leaf node is excluded from the hashed tree path. Mathematically, the scenario where the same user attempts to upload the same file is denoted as follows:

$$S_u \xrightarrow{Uploads} S_f \; (CS \xrightarrow{Informs} A) \quad (10)$$

When different users attempt to upload identical files to the Cloud Server (CS), the file is divided into multiple blocks, and a tag is generated to check for duplicate data copies within the CSP. Subsequently, each tag is transformed into a Hash Code (HC), referred to as a hashtag value. The CS examines the Hash Table (HT) for the input file based on this hashtag value. If the hashtag value is present in the HT, the CS requests the hash tree path of the input file. If a user provides the correct path, the CS verifies the user's ID. If the ID is distinct, the CS shares the reference link to the specific stored file's location with the user. The scenario of different users attempting to upload the same file to the CS can be represented as follows:

$$D_u \xrightarrow{Uploads} S_f \; (CS \xrightarrow{asks} P(H_t)) \quad (11)$$

$$P(H_t) \quad matched \rightarrow (CS \xrightarrow{send}) R_l(f) \quad (12)$$

$$P(H_t) \quad Not\ Matched \rightarrow (CS \xrightarrow{Informed} I_u) \quad (13)$$

Where D_u denotes the different users. R_l is the reference link and I_u denotes an invalid user.

When User tries to download the file

In this scenario, the user transmits the tag value of the designated file. Subsequently, the CS calculates the hash value using the SHA-512 algorithm. The CS proceeds to verify the existence of the hashtag value within the Hash Table (HT). If the value is found, the CS grants the user permission to download the file; otherwise, the CS categorizes them as an unauthorized user. This situation can be expressed mathematically as follows:

$$H(T) \quad matched \rightarrow D_u (\downarrow) \quad (14)$$

$$H(T) \quad Not\ Matched \rightarrow I_u \quad (15)$$

Where H(T) denotes the hashtag value. Pseudocode for the proposed secure deduplication system is evinced below,

Algorithm 1 Uploading file into the cloud server

Input: Original file

Output: Upload the file into the CS

begin

initialize keyk, tagT, hashtagH(T),

blocks(B1, B2,..., B,,), and hash tree H

for-number of files do

{

generatek using SHA-512

dividef into blocks (B_1, B_2,..., B_1)

generate tag T

generate H(T) using SHA-512 if (H(T) == Hash_ table) then

```
    check PoW
    else
        generate Ht and insert H(T) into the-hash table
        and encrypt the file f
        store the file in Cloud Server (CS)
    end if
    }
end for
end
```

Algorithm 2 Downloading file from the cloud server

```
Input: Tag value
Output: Download the original file
begin
initialize tag T, hashtag H(T), original-
file f
for all tags do
{
    generateH(T) using SHA-512
    if(H(T) Hashtable) then
    Cloud Server allows the user to download-the
     file f(↓)
    else
    Cloud Server informs as invalid user
    end if
}
end for
end
```

RESULT AND DISCUSSION

The implemented deduplication method has been executed within the JAVA programming environment, utilizing the system configuration outlined below. The performance assessment of the system focuses on various file sizes ranging from 5 MB to 25 MB, with an increment of 5 MB after each iteration.

In this section, we conduct a performance analysis of the proposed system. Initially, we compare the performance exhibited by the proposed MECC security algorithm to that of existing security algorithms, such as Diffie-Hellman (DH), ECC, and Rivest Shamir Adelman (RSA). This comparison encompasses encryption time (Et), decryption time (Dt), key generation time, and security analysis.

Performance analysis of proposed encryption technique

Encryption time

E_t represents the duration taken by an encryption algorithm to produce encrypted data from the provided input data. Encryption time is determined by calculating the time difference between the end of the encryption process and the start of the encryption process. This is assessed as follows:

Table 1 Performance Comparison of Proposed MECC and Existing Techniques in terms of Encryption Time

File Size in MB	Encryption Time in Seconds				
	Proposed MECC	DH	Existing ECC	Existing RSA	
5	6.21		10.22	14.47	12.44
10	10.04		19.64	22.56	21.76
15	15.54		28.32	28.00	30.35
20	21.00		36.33	36.65	35.61
25	27.55		46.29	44.32	47.28

Table 2 Performance Comparison of Proposed MECC and Existing Techniques in terms of Decryption Time

File Size in MB	Decryption Time in Seconds			
	Proposed MECC	DH	Existing ECC	Existing RSA
5	5.28	12.21	13.5	11.51
10	10.22	18.11	22.66	20.53
15	16.74	26.43	29.43	28.54
20	20.36	34.56	38.64	36.84
25	25.44	45.44	45.81	48.43

$$Et = Ee - Es \quad (16)$$

Where Et is the encryption time, Ee is the encryptionending time and Es is the encryption starting time.

Decryption time

D_tis defined as the difference between the decryption ending time and decryption starting time. It is evaluated as,

$$D_t = D_e - D_s \quad (17)$$

where D_t is the decryption time, D_e is the decryption ending time and D_s is the decryption starting time.

Security

Security is highly essential for cloud storage. The security level is computed by dividing the hacked data with the number of the original text. The security level of the system is expressed as,

$$S = H_d/O_d \quad (18)$$

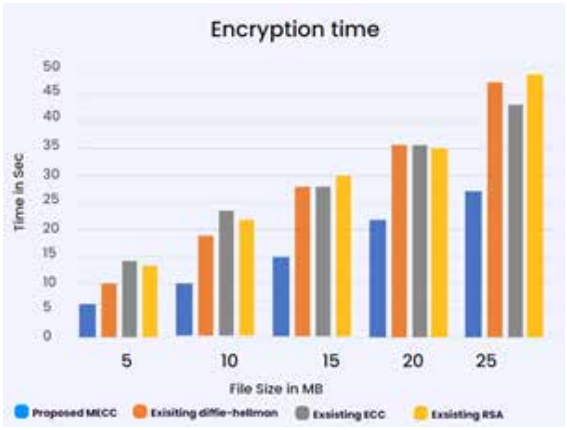

Fig. 3 (a) Performance comparison of proposed MECC with existing techniques in terms of encryption time

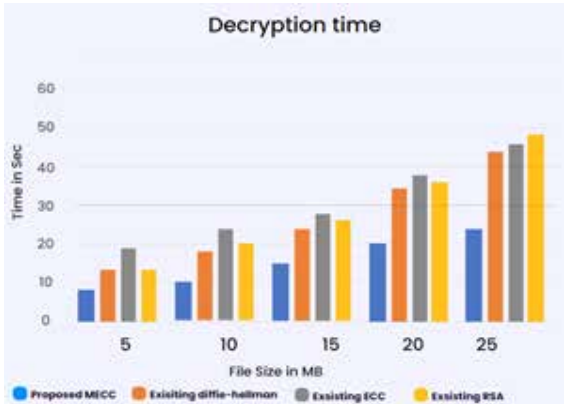

Fig. 3 (b) Performance comparison of proposed MECC with existing techniques in terms of encryption time

Table 3 Performance Comparison of Proposed MECC and Existing Techniques in terms of Key Generation Time and Security Level

SI. No.	Encryption Algorithm	Key Generation Time (ms)	Security (%)
1	Proposed MECC	425.21	96
2	ECC	612.32	90
3	RSA	765.54	87.5
4	DH	856.33	85

The time taken for encryption, denoted as Et, is measured as the duration required for an encryption algorithm to transform input data into encrypted data. Et is calculated as the difference between the ending time and starting time of the encryption process. It is computed as follows:

E_t = Encryption Ending Time - Encryption Starting Time

Tables 1 and 2 provide a performance comparison of the proposed MECC algorithm with the existing Diffie-Hellman (DH), Rivest Shamir Adelman (RSA), and Elliptic Curve Cryptography (ECC) techniques in terms of Et and Dt (encryption and decryption times). The Et and Dt values are presented in seconds (s). For instance, the proposed MECC takes 6 seconds to encrypt a 5MB file, while the existing DH, ECC, and RSA take 10, 14, and 12 seconds, respectively, for encrypting the same 5MB file.

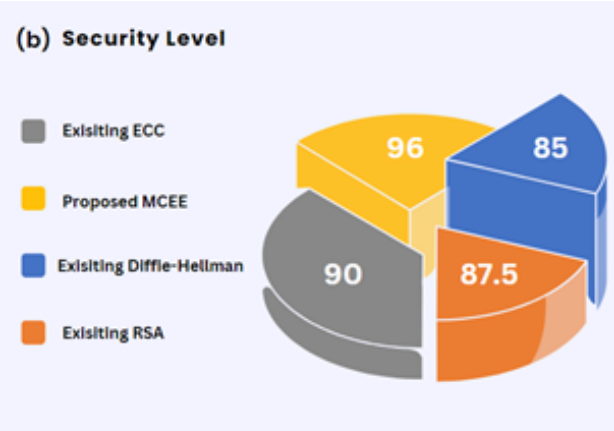

Fig. 4 a Performance comparison of proposed MECC with existing techniques in terms of key generation time. b Performance comparison of proposed MECC with existing techniques in terms of security level

The trend continues for other file sizes (10MB to 25MB) where the proposed method consistently exhibits shorter encryption and decryption times compared to the alternatives. This indicates that the MECC algorithm outperforms the other methods in terms of Et and D_t.

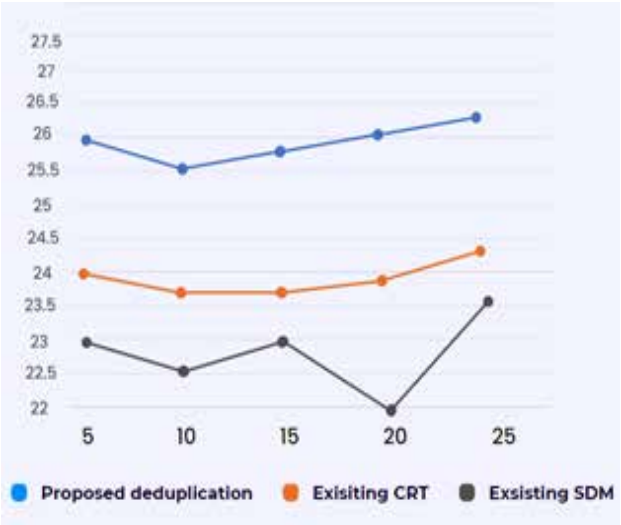

Fig. 5 Performance analysis of the proposed deduplication scheme with existing techniques in terms of deduplication rate

Table 3 compares the key generation time and security level between the proposed MECC technique and the existing methods. The proposed MECC takes 425 milliseconds (ms) to generate a key, whereas the existing ECC, RSA, and DH methods take 612 ms, 765 ms, and 856 ms, respectively. The MECC algorithm demonstrates faster key generation compared to the other techniques. In terms of security, the proposed MECC achieves the highest security value at 96%, while the existing ECC, RSA, and DH methods achieve security levels of 90%, 87.5%, and 85%, respectively. Thus, the MECC algorithm offers superior performance in both key generation and security.

Performance analysis of the proposed deduplication technique involves comparing it to other methods such as Chinese Remainder Theorem (CRT)-based secret sharing and Smart Deduplication for Mobile (SDM) in terms of deduplication rate, as shown in Figure 5. The proposed deduplication method consistently outperforms CRT and SDM across various file sizes, demonstrating a higher deduplication rate.

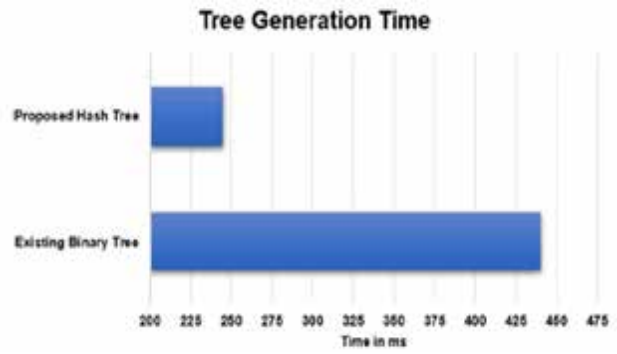

Fig. 6 Performance comparison of the proposed hash tree with existing binary tree

Furthermore, Figure 6 illustrates the performance comparison between the proposed hash tree used in deduplication and the existing binary tree in terms of tree generation time. The proposed hash tree exhibits quicker tree generation, taking 245 ms, compared to the existing binary tree, which takes 440 ms. This indicates that the proposed hash tree approach outperforms the binary tree generation methodology.

Overall, the proposed MECC algorithm and deduplication technique offer superior performance compared to existing methods, as evidenced by their faster encryption, decryption, key generation, higher security, and better deduplication rates.

CONCLUSIONS

Deduplication stands as the most prominent data compression technique. While various existing methods have introduced different deduplication approaches, they often lacked in terms of security. In response, this paper puts forth a secure deduplication system that leverages convergent and MECC algorithms within the cloud-fog environment. The proposed method is assessed in four scenarios: a) when new users attempt to upload a new file, b) when the same user seeks to upload an identical file, c) when distinct users aim to upload the same file, and d) when different users intend to download a file.

Performance evaluation was carried out by considering different file sizes, ranging from 5 MB to 25 MB, with an incremental increase of 5 MB in each iteration. The results of the performance analysis substantiate that the proposed system attains a remarkable 96% security

level, surpassing many other existing encryption methods.

These findings underscore the high degree of security and efficiency offered by the proposed system for data deduplication within an integrated cloud environment. Looking ahead, this model has the potential for extension to various Internet of Things (IoT) applications that rely on dynamic resource management at the edge. Furthermore, it can contribute to the development of cyber-physical systems, accommodating diverse use cases with varying data payloads and formats. The proposed technique holds promise for enhancing security, optimizing computational efficiency, and streamlining storage management within integrated environments, including IoT and cyber-physical systems.

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Product Review Classification with Dual Sentiment Analysis for Identifying Product Aspect Polarity

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ABSTRACT

In contemporary times, sentiment analysis serves as a valuable technique for evaluating the sentiments expressed by users in online content, including blogs, comments, and reviews, categorizing them into negative, positive, or neutral sentiments. This classification hinges on the examination of the inherent emotional tone found within the users' natural language text. Within sentiment analysis, analyzing the polarity of the text has remained a pivotal component, but accurately determining this polarity has proven to be a significant challenge. Various researchers have employed diverse polarity features, such as common part-of-speech (POS) tags like adjectives, adverbs, verbs, and nouns. However, there appears to be a notable dearth of research specifically targeting the subcategories within these tags. The primary goal of this study was to propose an approach that enhances the detection of text polarity by incorporating a wide range of polarity features derived from both the standard POS categories and their respective subcategories. This approach aimed to delve into the nuanced aspects of text sentiment. Numerous experiments were carried out to scrutinize and compare the effectiveness of the proposed method in terms of F-measure, recall, and precision, employing an Amazon dataset. The results indicated that a POS subcategory combination, JJ + NN + VB + RB + VBP + RP, outperformed baseline methods by achieving a 4.4% increase in F-measure accuracy.

KEYWORDS *: Analysis of emotions, Mining of viewpoints, Features related to emotional tone, Lexicon for sentiment, Part-of-speech tagger, SentiWordNet, Text expressed in natural language*

INTRODUCTION

In recent years, there has been substantial growth in the proliferation of social media platforms on the internet. In conjunction with this expansion, users contribute a wealth of data not only through discussions and personal notes but also, on a large scale, by sharing their thoughts and sentiments regarding various products, services, issues, events, and policies on e-commerce websites. This collection of user expressions is commonly referred to as user opinions or reviews, with the aim of ascertaining the author's mood or speaker's attitude. As a result, user-generated data has become a pivotal resource for facilitating business intelligence and decision-making processes, aiding organizations in enhancing their products. Additionally, it proves beneficial for consumers who can peruse these reviews by fellow consumers to inform their purchasing decisions.

The positive or negative emotional tone conveyed by individuals is recognized as sentiment. Sentiment analysis (SA), also known as opinion mining, represents a natural language approach that delves into the assessment of people's perspectives on a specific product or subject. SA serves the purpose of automatically dissecting online documents, such as blogs, comments, reviews, and news articles, and summarizing them as positive, negative, or neutral sentiments. Its applications span various domains, encompassing activities like predicting election outcomes, furnishing companies and organizations with insights into their products, automating the creation of product summaries or outlines in reviews, or even forecasting trends in the stock market on online shopping platforms.

SA can be seen as a classification process, as illustrated in Figure 1. According to references [10, 13], SA can be conducted at three different levels as shown in Figure 1.

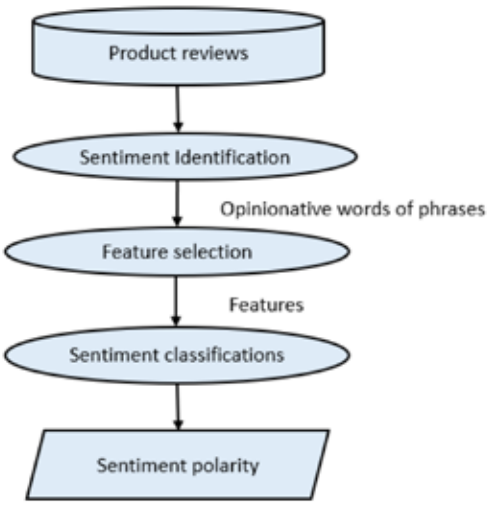

Fig. 1. Sentiment Analysis Process [13]

Within this approach, the entire document, like a comment or review, is considered as the basic unit of information and is subsequently categorized as positive, negative, or neutral. However, there are cases where the results of this approach may not align perfectly. For instance, if a document positively acknowledges a specific item, it doesn't necessarily mean that the author holds entirely positive views about every aspect of that item. Similarly, a document negatively acknowledging an item doesn't imply that the author has entirely negative sentiments about every aspect of that item. Typically, authors express both positive and negative sentiments regarding a particular item and its various attributes.

Sentence level: This approach endeavors to ascertain the sentiment expressed in each sentence by dissecting the entire document into individual sentences, treating each as a separate unit of information. It starts by determining whether a sentence is subjective or objective and then classifies whether the sentence conveys a positive or negative opinion.

Aspect level: This approach conducts a meticulous analysis to identify pertinent aspects and entities of a particular item, and it expresses sentiment or polarity toward each aspect. An aspect could refer to a feature of a specific item, such as the battery life of a mobile phone.

The central challenge in sentiment analysis lies in categorizing sentiment polarity [references 10, 11, 13, 17]. Generally, numerous research endeavors in sentiment analysis aim to classify textual content based on the expressed opinions, employing diverse polarity features like part-of-speech (POS) tags [references 4, 6, 18, 21, 24]. This study aims to introduce lexicon-based methods for sentiment polarity classification, incorporating polarity features such as adjectives, adverbs, verbs, and nouns, along with combinations of these features and their subfeatures.

The remainder of this paper is structured as follows: Section 2 presents related work and existing methods and techniques in sentiment analysis. Section 3 elaborates on the proposed methods, outlining the various steps involved, the proposed framework, dataset, and the evaluation metrics used. Section 4 offers the results of the proposed methods and discusses them. Finally, in Section 5, we conclude and provide recommendations for future research in this field.

RELATED WORKS

In contemporary sentiment analysis (SA) research, one of the central challenges revolves around the task of sentiment categorization. This process involves assigning a polarity (positive, negative, or neutral) to words and phrases that convey sentiment in order to determine the overall subjectivity or objectivity of a document [reference 4]. Sentiment classification techniques discussed in the literature generally fall into two categories: supervised and unsupervised SA [reference 16]. This classification pertains to the approach used in sentiment classification.

In the supervised approach, machine learning methods like support vector machines, maximum entropy, k-nearest neighbor, naïve Bayes, decision trees, and artificial neural networks [references 2, 5, 16, 18] are employed. Supervised learning relies on labeled training data that are manually annotated, along with testing data, to accomplish sentiment analysis. Additionally, it utilizes a set of linguistic and/or syntactic feature

vectors extracted directly from the original feedback sentences to make classification decisions [references 5, 11].

In contrast, the unsupervised approach does not require labeled training data. The methodology in this research adheres to the unsupervised approach. The primary approaches in this methodology are linguistics-based and lexicon-based [reference 7]. The lexicon-based approach involves statistically calculating sentiments from the semantic orientation of words or phrases within the text [reference 22]. It operates under the assumption that the most essential indicators of sentiment in natural language text are words that explicitly convey sentiments, often referred to as opinion words. This approach necessitates a precompiled dictionary of positive and negative terms, with SentiWordNet being a well-known lexical resource specifically designed to support sentiment classification and analysis applications [reference 24].

Linguistics-based SA doesn't merely segment natural language text into individual constituent words and sentences; it also identifies their syntactic structures to locate a syntactic part-of-speech (POS) category, such as an adjective or verb phrase, most likely to convey an opinion. Sentiment classification of the text considers the polarity score assigned to each word. For instance, if a word matches a positive sentiment score in the lexicon, it increases the overall positive polarity score of the content. If the positive polarity score outweighs the negative one, the content is classified as positive; otherwise, it's categorized as negative.

Numerous studies have delved into identifying common terms that express sentiment in online reviews, employing lexicon-based approaches and natural language processing [references 1, 4, 21]. Some researchers, such as Thet et al. [reference 23], have proposed linguistic approaches for SA in discussion posts on conversation forums, involving clause-level opinion analysis. Others, like Sarkar et al. [reference 18], have suggested SA methods utilizing linguistic features at the document level. Various linguistic features, such as adjectives and verbs, have been employed by researchers like Chesley et al. [reference 4] to classify sentiment in blog content, and the Wikipedia dictionary has been used to determine the polarity scores of blog content.

Despite the extensive work in the field of SA, which involves the utilization of natural language and part-of-speech categories such as adjectives, adverbs, verbs, and nouns, very little research has explored all the subcategories of POS tags. For instance, adjectives can be syntactically categorized as comparative and superlative. Table 1 provides a summary of relevant methods.

This study primarily focuses on evaluating the standard POS features - adjectives, adverbs, verbs, and nouns - along with all their subcategories, to gauge their significance and informativeness in natural language text. Furthermore, it presents a comprehensive examination of the combinations between these subfeatures to demonstrate their strength in sentiment polarity analysis.

Table 1: Summary of the Reported Methods

Method	Description	Used by
Linguistics based	This approach discerns the structural composition of natural language text to pinpoint the specific syntactic part-of-speech phrase most inclined to convey an opinion.	Sarkar et al. [21], Bethard et al. [1], Chesley et al. [4], Thet et al. [23]
Lexicon based	This method encompasses the statistical computation of sentiment based on the semantic inclination of words or phrases present in a text.	Tomar and Sharma [17], Taboada et al. [22]

MATERIALS AND METHODS

This section is divided into two primary subsections. The initial subsection introduces our suggested method for improving the identification of sentiment polarity in natural language text, along with a thorough explanation of the seven-step processing involved. The subsequent subsection provides insights into the dataset and the evaluation metrics employed for assessing our proposed approach.

Proposed System

The objective of this study is to introduce techniques that enhance the efficiency of sentiment identification in text using the SentiWordNet lexicon and natural language part-of-speech (POS) analysis. Figure 2 illustrates the suggested framework for sentiment classification, which encompasses various stages, including data preprocessing, sentiment tokenization, POS tagging, sentiment negation handling, term scoring, feature selection, sentiment classification, accuracy assessment, and result comparison.

Data Pre-Processing

The initial phase involves gathering the reviews from the Amazon dataset. As a preliminary step, it is essential to prepare the text for classification. The subsequent phase primarily focuses on pre-processing and eliminating redundant information within the dataset. To begin, we standardize punctuation to ensure adherence to writing conventions. Subsequently, all non-alphabetical characters, such as numbers and emotive symbols like smileys, punctuation marks, hyphens, and apostrophes, are stripped from each review. Following this, all words in the reviews are converted to lowercase. Consequently, each individual word and phrase is prepared for subsequent processing.

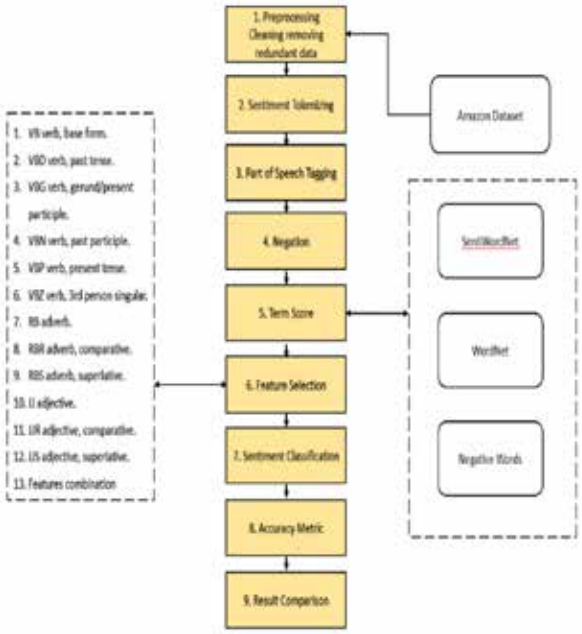

Fig 2: Sentiment Classification Framework

Sentiment Tokenization

In this phase, the entire review text undergoes tokenization, which involves breaking it down into sentences based on the presence of periods and further breaking each sentence into individual words. Once the text is divided into tokens, the subsequent stage often involves performing morphosyntactic analysis to identify attributes like its grammatical or lexical category. This analysis is commonly referred to as Part-of-Speech (POS) tagging. The subsequent sections provide a more comprehensive explanation of the various steps within the sentiment classification framework.

POS Tagging

Part-of-Speech (POS) tagger represents a linguistic method in natural language processing. It takes a text in a specific language as input and assigns POS tags to each word within a sentence, such as identifying it as a noun, verb, adjective, and so on. Typically, there are eight POS categories in the English language, which encompass adjectives, nouns, verbs, pronouns, adverbs, prepositions, conjunctions, and interjections. For this research, the Stanford POS tagger [reference 12] is utilized, which is capable of providing 36 distinct tags for recognizing more detailed syntactic components, exceeding the standard eight. Table 2 provides a list of POS tags integrated into the POS tagger. These POS tags essentially convey the informativeness of a word, making them valuable for calculating term scores during the classification process.

Negation

Negation is a linguistic construct that reverses the prevailing polarity of associated words within a sentence. Words like “not,” “can’t,” and “don’t” are examples of negation words, and they effectively invert the polarity of the word they are paired with. For instance, when a negation word accompanies a positive word, it transforms the positivity into negativity. Conversely, when a negation word is paired with a negative word, it changes the sentiment from negative to positive. Therefore, it is imperative to handle negation words appropriately in sentiment classification. This process is inspired by the work of Pang et al. [reference 16].

In the negation handling process, a predefined list of

negation words is provided, and each sentence within the review is examined to identify the presence of negation words. If a negation word is detected, a negation process is triggered, which alters the polarity of the associated words accordingly.

It is considered as a set of negation words defined as follows:

NegW = {set of negation words} (1)

Table 2: POS Tags and Abbreviations

POS tags	Definition	SentiWordNet abbr.
NN	Noun, singular or mass	N
NN	P Proper noun, singular	N
NNPS	Proper noun, plural	N
NNS	Noun, plural	N
VB	Verb, base form	V
VBD	Verb, past tense	V
VBG	Verb, gerund/present participle	V
VBN	Verb, past participle	V
VBP	Verb, present tense	V
VBZ	Verb, third person	V
RB	Adverb	R
RBR	Adverb, comparative	R
RBS	Adverb, superlative	R
JJ	Adjective	A
JJR	Adjective, comparative	A
JJS	Adjective, superlative	A

If a negation word is found in the sentence, the positive score and the negative score of opinion terms in

a sentence are swapped. For each term in the sentence, we apply the following equation:

$S(Tx) = \{Pos.S(Tx) = Neg.S(Tx)\}$

$Neg.S(Tx) = Pos.S(Tx) \exists Ty \in NegW,$ (2)

Where S is score and Tx is any term in the tokenized sentence.

Term Score

In this procedure, the feature vector corresponding to the review, which signifies the part-of-speech (POS), is employed to create a series of sentiment scores. Each word conveying sentiment in the input review is assigned a term score obtained from the sentiment lexicon, a fundamental resource in most sentiment analysis (SA) methods.

In this study, SentiWordNet was harnessed to establish synsets as the primary focus within WordNet. Each synset was associated with a "positive," "negative," and "neutral" notation, and sets of terms sharing the same meaning within these synsets were linked to three numerical scores: Pos.Score(termx), Neg.Score(termx), and obj.Score(termx), signifying positivity, negativity, and neutrality, respectively. The score can be either 0 or 1, indicating the term's positive or negative bias based on the following formula:

$Pos.S(Tx) + Neg.S(Tx) + obj.S(Tx) = 1$ (3)

If a word is not located within the SentiWordNet lexicon, the term score can be computed using the WordNet lexicon instead. This entails gathering the relevant synonym set (synset) of the target word based on its POS tags. For instance, if the target word is an adjective, all the synonym sets tagged with the adjective POS in WordNet are collected. This approach is believed to enhance accuracy by potentially addressing vocabulary ambiguity and diversity.

In such cases, the term score is determined based on the maximum absolute difference between its positive and negative scores. The calculation for the term score for such words is as follows: Let Sx represent the set of terms within the synset (synonyms), then...

$S(Tx) = Max$

$\forall synsets \in Sx$

$|Pos.S(synset) - Neg.S(synset)|$ (4)

where Pos.S and Neg.S correspond to the collected synonyms for terms.

Feature Selection

This research emphasizes feature extraction related to various categories of part-of-speech (POS), including adjectives, adverbs, verbs, and nouns. The feature selection procedure associates a tokenized label with each feature, along with a corresponding term score for each POS category listed in Table 2. Subsequently, to assess the impact of each POS category on sentiment

polarity, each set of tag features is individually chosen. This process results in the creation of a new feature set by combining sets of the most effective POS tags.

Sentiment Classification

In rephrase the content: Sentiment classification relies on the selected feature set that shows a user's opinion. Each review comprises a variety of opinion words of variable sequence. The selected feature set consists of different grammatical words, as mentioned in Table 2. In this study, the sentiment classification approach is the unsupervised lexicon-based approach. The sentiment classification of review R is calculated by the difference between the summations of its positive and negative term scores, as follows:

$$SentiScore(R) = [\sum_{POS=1}^{P} S(Tpos) - \sum_{neg=1}^{n} S(Tneg)]$$
$$n+p$$

In In this context, 'p' represents the total count of positive terms, and 'n' denotes the total count of negative terms. Given that longer reviews may encompass a greater number of terms categorized as positive or negative, comparing the sentiment polarity of reviews of varying lengths requires a normalization of the SentiScore. This normalization is achieved by dividing the SentiScore by the number of sentiment terms present in review R, with the objective of mitigating the impact of the review's length on its score.

Consequently, the normalized SentiScore values fall within the range of [-1, 1]. As a result, a review is categorized as positive if its normalized SentiScore is positive. Conversely, it is classified as a negative review if its normalized SentiScore is negative.

Dataset Evaluation Matrices

The proposed methodologies were evaluated using the Amazon reviews dataset provided by the Association for Computational Linguistics [reference 3]. Each review in this dataset includes user comments (opinion text), the name and location of the reviewer, the product's name, a review title, a date, and a numerical rating on a scale ranging from 1 to 5 stars. A low rating of 1 star signifies an extremely negative opinion, while a very high rating of 5 stars indicates an extremely positive opinion about the product. To prepare the dataset for analysis, reviews with user ratings greater than 3 were categorized as positive, while those with ratings below 3 were marked as negative. Additionally, reviews with a rating of 3, considered neutral, were omitted. The assumption here is that there is less valuable information to extract from neutral texts in comparison to those with a clearly positive or negative sentiment [reference 20].

The dataset underwent preprocessing and was cleansed from its raw form. For example, HTML tags were removed using an HTML parser. Furthermore, all punctuation marks and numbers were excluded. The experiments were carried out on a dataset comprising 21,972 positive reviews and 16,576 negative reviews, totaling 38,548 reviews in all. This experimental dataset serves as a benchmark and encompasses 26 different product types from diverse domains. Table 3 provides an overview of the dataset utilized.

Table 3: Amazon Product Dataset Summary

Domain	Positive	Negative
Apparel	1000	1000
Automotive	584	152
Baby	1000	900
Beauty	1000	493
Books	1000	1000
Camera & photo	1000	999
Cell phones & service	639	384
Computer & video games	1000	458
DVD	1000	1000
Electronics	1000	1000
Gourmet food	1000	208
Grocery	1000	352
Health & personal care	1000	1000
Jewelry & watches	1000	292
Kitchen & housewares	1000	1000
Magazines	1000	970
Music	1000	1000
Musical instruments	284	48
Oflce products	367	64
Outdoor living	1000	327
Software	1000	915
Sports & outdoors	1000	1000
Tools & hardware	98	14
Toys & games	1000	1000
Video	1000	1000
Total no.	21,972	16,576

As is common practice, the majority of sentiment analysis (SA) algorithms classify data into positive, neutral, and negative categories. Therefore, the standard approach for assessing performance is to determine whether the system's categorization aligns with the human intuition.

To gauge the effectiveness of the proposed methodology, established evaluation metrics, specifically precision-recall and F-measure, are employed. These metrics assess the accuracy of the classification by considering true positives and true negatives for both positive and negative reviews, respectively.

RESULTS AND DISCUSSIONS

The baseline classifier consists of two approaches. The first baseline (baseline1) operates on the principle that a text's sentiment polarity can be determined by summing the individual polarity values of words or phrases present in the text. Each term is associated with numerical scores indicating positive and negative sentiment. If the total sum of positive word polarity surpasses that of negative word polarity, the text's overall polarity is considered positive. Otherwise, it is considered negative [references 9, 19]. The second baseline (baseline2) counts the number of positive and negative word scores to ascertain the text's sentiment polarity. In this method, if the count of positive word polarity exceeds the count of negative word polarity, the text's overall polarity is deemed positive. Otherwise, it is regarded as negative [references 9, 14].

Table 4 provides the outcomes of each individual method. Performance is assessed using recall, precision, and F-measure metrics for each method, where PR represents positive recall, PP represents positive precision, PF represents positive F-measure, NR denotes negative recall, NP stands for negative precision, and NF signifies negative F-measure. WF represents the weighted F-measure, which is a weighted average of the PF and NF scores.

These results showcase the accuracy of various POS tagging methods. Initially, we assessed the classification accuracy using standard POS tags, which only employ adjectives, adverbs, verbs, and nouns as their scoring source. The classification method using adjectives achieved the highest accuracy at 64.6%. Subsequently, we compared the results of the subcategories, and it was evident that JJ, RB, VBP, and NN achieved the best outcomes.

Table 4: Experimental Results for POS Subcategories

Exp.	PR	PP	PF	NR	NP	NF	WF
Baseline1	72.6	71.8	72.2	53.3	52.8	53.1	64
Baseline2	76.9	72.1	74.5	35.5	32.6	34	57.1
Adjective	73.7	69.9	71.8	57	53	55	64.6
JJ	70.4	66.5	68.4	57.7	53.5	55.6	62.9
JJS	97	12.6	22.4	38.8	3.4	6.3	15.5
JJR	0	0	0	0	0	0	0
Adverb	60.1	53.2	56.6	60.3	55.7	58	57.2
RB	58.3	50.8	54.3	62	56.4	59.1	56.4
RP	68	18.5	29.1	39.3	13.1	19.7	25.1
RBR	100	5.3	10.1	0.2	0.1	0.2	5.9
RBS	100	0.7	1.4	0	0	0	0.8
Noun	63.2	62	62.6	41.9	41.2	41.6	53.6
NN	66.6	63.1	64.9	38.8	36.9	37.9	53.3
NNS	49.5	9.2	15.6	46.3	8.9	15	15.4
NNP	31.4	2.7	5	65	5.4	10	7.2
NNPS	12.5	0.1	0.2	60	0.1	0.2	0.2
Verb	68.2	62.3	65.2	37.1	34.7	35.9	52.7
VB	69.5	53.2	58.9	33.3	29.2	331.2	47
VBP	60.3	44.6	51.3	48.7	35.7	41.2	47
VBD	71.5	9.4	16.7	33.9	5.2	9.1	13.5
VBN	73.2	6.7	12.3	28.1	2.6	4.8	9.1
VBZ	39.5	0.4	0.8	52.4	0.6	1.2	1
VBG	38.5	0.2	0.4	55	0.3	0.6	0.5

Table 5: Subcategory Combinations

Set no.	Feature set combinations
1	JJ, NN, VB, RB
2	JJ, NN, VB, RB, VBP
3	JJ, NN, VB, RB, VBP, RP
4	JJ, NN, VB, RB, VBP, RP, JJS
5	JJ, NN, VB, RB, VBP, RP, JJS, VBD
6	JJ, NN, VB, RB, VBP, RP, JJS, VBD, NNS
7	JJ, NN, VB, RB, VBP, RP, JJS, VBD, NNS, VBN

Table 6: Experimental Results for POS Subcategory Combinations

Exp./Metrics	PR	PP	PF	NR
Baseline1	72.6	71.9	72.3	53.3
Baseline2	76.9	72.1	74.5	35.5
1	75.5	74.7	75.1	57.6
2	75.5	75.3	75.4	59.4
3	77.6	76.9	77.3	57.1
4	77.6	76.9	77.3	57.2
5	77.6	76.9	77.3	56.7
6	77.6	76.9	77.3	56.7
7	78	77.3	77.7	56.1

Table 5 outlines the combinations of POS subcategories, with a focus on selecting those subcategories that yield the highest accuracy among the standard POS tags. For instance, JJ stands out as the most accurate subcategory among adjectives, while NN excels among nouns, VB in verbs, and RB in adverbs. Furthermore, subcategories with the next highest accuracy in standard POS tags are also incorporated into the combinations to assess their impact on classification accuracy. For instance, the verb subcategory VBP achieves a WF score of 47%, making it a valuable addition to the subcategory combinations. A similar process is followed for RP, JJS, and VBD during the combination process.

Table 6 illustrates the WF measure for these POS subcategory combinations. The results demonstrate that the JJ + NN + VB + RB combination outperformed other approaches, achieving an improved accuracy of 67.5% compared to the baseline1 approach, which scored 64.1%. Subsequently, we compared the results of other POS combinations to evaluate the effectiveness of each POS category combination. The addition of the VBP feature to the previous combination enhanced accuracy by 1%. However, other combinations of POS features did not exhibit a significant improvement in classification accuracy. For instance, the RP tag did not contribute to any accuracy improvement, while the JJS tags showed only a minor 0.1% increase, which is not considered a substantial improvement. Finally, the results indicate that adding the VBD, NNS, and VBN POS features to the combination led to a decrease in classification accuracy.

We examined various polarity features within the framework of standard POS tags and explored the impact of subcategory combinations. The experimental results demonstrated a noteworthy improvement of 4.4% with the JJ + NN + VB + RB + VBP + RP combination in comparison to baseline1. This outcome is highly promising and surpasses other feature combinations and baseline approaches in performing sentiment analysis tasks.

CONCLUSIONS

In this paper, we have introduced lexical-based methods for sentiment analysis (SA) that offer a more precise understanding of the sentiment expressed in natural language text. We achieved this by utilizing diverse polarity features in conjunction with standard parts-of-speech (POS) tags, including adjectives, adverbs, verbs, and nouns, and by exploring subcategory combinations. Our experimental study was conducted using the Amazon dataset to delve into the specific sentiment characteristics of text.

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A Structured framework for Examination System

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ABSTRACT

This research paper presents a computer-based program that makes effective use of dynamic programming features to allocate seats during exams. The algorithm takes into account seating restrictions, specific requirements, and preferences for students. The paper also introduces a QR code-based attendance system that provides a quick and accurate replacement for manual systems. Students and employees can use the technology to record their attendance by using their smartphones to scan QR codes. The benefits are highlighted, as well as the system architecture and evaluation results, in the study. The design and implementation of a user-friendly exam registration form are also covered, with a focus on aspects like form validation and data processing. Overall, this research offers creative solutions to streamline the processes of exam registration, seat position, and attendance management.

KEYWORDS *: Dynamic programming, Allocate seats, Exams, Seating restrictions, Specific requirements, Preferences, QR code-based attendance system, Manual systems, Smartphones, Benefits, System architecture, Evaluation results, User-friendly, Exam registration form.*

INTRODUCTION

The research presented here studies how systems can be utilised to handle arrangements for seats, track attendance with QR codes, and improve exam registration at educational institutions. For these jobs, the traditional manual methods take a long time, are prone to mistakes, and are ineffective.

The primary goal of the first system is to take advantage of capabilities to improve the way that students register for exams. It provides a user-friendly interface that enables students to conveniently register for tests, gathering and processing their personal and exam-related information. As a result, the registration process is more efficient overall, and better resource allocation is made possible.

The second system offers a QR code-based attendance monitoring system that does away with the necessity for human record-keeping. By utilizing their cellphones to scan QR codes, students may quickly record their attendance. As a consequence of integration capabilities, accurate attendance records are produced through smooth data processing and storage.

The seating arrangement system that optimizes seat allocations during tests is provided. The method takes into account things like student preferences, special needs, and seating limits. It efficiently distributes seats by utilizing dynamic programming features, which improves organization and efficiency during exams.

This research highlights the advantages of these PHP-based solutions by looking at system designs, implementation processes, and evaluation outcomes. The results show improved exam registration, attendance monitoring, and seating management inside educational institutions with improved efficiency, accuracy, and user experience.

LITERATURE REVIEW

Multi-Platform College Management Framework

The main objective of this project is to digitise and reduce the amount of labour required for the institution

to manage all of its records. Customers can benefit from a web paper assessment module, attendance generation module, and a virtual observe board provided by this framework. Thus, this approach eliminates data inconsistency and decreases data redundancy.

The distinctive features of the proposed system are as follows:

- Online paper correction
- Application Programming Interface
- Digital Notice Board
- College Management Framework

The highlight of this approach is online paper evaluation system wherein all the answer books are scanned and sent to the respective faculty members. The Proposed system is also available in the form of web based applications, which is responsive for different kind of mobile screen and resolution. The System integrates the indispensable functions of the manual system with contemporary and efficient ways of managing Colleges. [1]

Smart Attendance System using QR Code

The suggested version offers statistics protection and full magnificence, as well as quick and easy access to student attendance statistics. In addition, the report of attendance is automatically prepared by the professor. The goal of the internet-based attendance system is to computerise the traditional method of recording attendance and to provide a simpler and more sophisticated approach to track institutions' attendance today. This system is based on QR codes, which are individual codes for each professor and student. Users must utilise QR reading devices in the classrooms to scan the individual QR code that was given to them during or at the start of each lecture in order to verify their attendance at the beginning of each course. The lecture and student attendance records as well as other essential information will be recorded in light of this.[2]

The system will help a lot in improving student attendance in particular courses they need to attend and will save a lot of time. This paper consists of three sections: the first part deals with the related papers; the second part details the proposed framework; and the last part details the implementation plan.

Optical Character Recognition

This is a system developed for deriving character-based files from digitized images of printed or typewritten documents and/or handwritten manuscripts. Digital cameras or flatbed scanners are used for digitising.. It is thus a process of visual recognition, which converts text documents into editable/searchable text. OCR technology improves the efficiency of office work to a greater extent as, when done accurately the transformation enables searching the electronic copies of documents that might otherwise remain tucked away in filing cabinets gathering dust.

Depending upon the type of input device, there are two classes of character recognition: online and offline recognition. The first category systems use devices like digitizer tablets for data acquisition and in this system, recognition is done while writing it. On the other hand, the offline systems collect data from static devices such as scanners and cameras. An online recognition system is real-time due to the concurrent data collection structure, whereas an offline recognition system requires specific methodologies for preparing the image prior to recognition, which includes noise removal and restoration of the input image to eliminate the damage caused during the acquisition process. [3]

Optical Character Recognition by Open-Source OCR Tool Tesseract

By using optical character recognition (OCR), handwritten text, published text, and scanned text can be transformed into editable text for similar processing. The machine can recognise the text automatically thanks to this technology.

An open-source optical character recognition engine is called Tesseract. Tesseract OCR operates in a sequential fashion. Adaptive Thresholding, the initial process, turns the image into binary images. Next, character outlines are extracted using connected component analysis. This technique is quite helpful because it performs OCR on an image with black backdrop and white text. Probably the first to offer this kind of processing was Tesseract. The outlines are afterwards changed into Blobs. Textual content strains are created from blobs, and the strains.

The Tesseract engine is a command-based tool that receives an image with the text as input. The Tesseract

command is then used to process it. Two arguments are required for the tesseract command: The name of the text-containing image file is used as the first argument, and the output text file is used as the second argument to store the extracted text. You don't need to specify the file extension when supplying the output file name as a second argument in the command window because Tesseract already knows that the output file extension is.txt. Tesseract delivers findings with 100% accuracy for straightforward images that are either coloured or are only grayscale. [4]

Automatic Exam Seating & Teacher Duty Allocation System

This paper affords the automated examination seating allocation. It assigns the classrooms and the duties to the teachers in any institution. The genuine system's input-output data is discovered manually by the organisers who plan the seating layout and assign the monitoring responsibilities.

The application consists of two parts:

A. Students Seating Arrangement (SSA)

B. Supervision Duties Allocation (SDA)

A. Students Seating Arrangement

This module focuses on arranging students in a classroom. There are various constraints that must be satisfied by the system are summarized below:

- A minimum number of classrooms should be utilized.
- All students should be allocated a seat.
- To avoid cheating, neighboring students must not be from the same departments.
- Minimize the number of question sets used in a class.
- Students exempted from the examination should not be allocated a seat.

B. Supervision duties

Along with keeping an eye on the students, the supervisor also provides them with answer sheets, question papers, and additional supplements. There are various constraints that are taken into consideration while selecting the invigilators.

- One teacher should invigilate only one classroom at a time.
- A teacher can only undertake one type of Supervision duty.
- Teacher of the same department must not invigilate the classroom in which students of that department belongs.
- Teachers should not be allocated consecutive duties for more days.

Classroom Attendance Monitoring Using CCTV

By developing a system which is automated in nature for Attendance management using face recognition of the students and faculties, the proposed system limits the manual marking on daily basis. It is highly helpful that a student's attendance is checked using different facial expressions when they join the class or after everyone has taken a seat within the room thanks to the attendance system's integration of Recognition of Human Faces.

Basically, the techniques used in face recognition uses face representations with expressions on the face with some specific featured attributes. This system corrects the issues in marking the student's entry as absent even if they are inside the classroom. In the implementation process, detecting the face, and identifying and marking the attendance automatically whether the student is present or not is done. Principle Component Analysis (PCA), Eigen face value detection, and Convolutional Neural Network (CNN) are the techniques getting used on this paper to create an automated attendance control system.

For the successful implementation of this attendance-based management system, following are the steps required:

- Details of Students' Enrolment
- Recognition of face
- Camera viewing with confirmation
- Record keeping of attendance. [6]

METHODOLOGY

Exam Registration System

1. Requirement analysis: List the exact needs and goals for the exam registration system.
2. System Design: Create the architecture and user interface of the registration system while taking form layout and validation into consideration.
3. Database Design: Create a database structure to keep track of registration information and exam-related information.
4. Form Development: Create the exam registration form in PHP, including all required input fields and validation.
5. Backend development: Provide the backend logic for form submission, data processing, and database operations.
6. Integrate the registration system with pertinent systems, such as payment gateways or email notification systems, in step six.
7. Testing and quality assurance: Conduct extensive testing to find and fix any problems or faults.
8. Deployment: Ensure compatibility and security before deploying the registration system to a live environment.
9. User Training and Support: Educate and assist users, including students and administrators.
10. Evaluation and Enhancement: Assess the system's efficacy, obtain user input, and make the required adjustments for a simplified registration procedure.

Seating Arrangement System

Gather Student Information: Collect the necessary information about the students, such as their names, roll numbers, and any additional details relevant to the seating arrangement.

Define Seating Constraints: Determine the constraints and requirements for the seating arrangement, such as the seating capacity of each room, any specific seating arrangements (e.g., front-row seating for differently-abled students), or any pairing or grouping constraints.

Implement the Seating Plan: Assign students to their assigned seats in the exam room after the seating plan has been generated. A seating diagram or a table can be used to show the configuration.

QR code based attendance system

Determine the precise objectives and goals for the QR code-based attendance system, such as real-time attendance tracking and simplicity of use.

Design a database structure to contain attendance records, student information, and session information.

Create a system to create unique QR codes providing pertinent session information for each session or class.

Design a user-friendly interface that enables students or staff to use the QR code-based attendance system.

QR Code Scanning: Include QR code scanning capability in the user interface, reading QR codes from smartphones or scanning devices with relevant technology.

Data Processing and Validation: Process and validate the scanned QR code data in the database against the session information and student records.

Attendance Recording: Save the verified attendance records in the database, precisely connecting them with the related session and student.

Implement functionality to create attendance reports and perform data analysis, delivering real-time or historical attendance data.

Testing and Quality Assurance: Test the system to discover and address any problems or issues.

Deployment: Prepare the system for live deployment by assuring compatibility and addressing security concerns.

User Training and assistance: Train users on how to efficiently utilise the QR code-based attendance system and provide continuous assistance.

Continuously analyse the system's performance, collect user input, and implement changes based on evaluation results.

IMPLEMENTATION AND TESTING

Qr code-based attendance system

a. Create the necessary infrastructure, including servers, databases, and user interface components.

b. Create the code logic that will generate unique QR codes for each session or class. Ensure that important session information is encoded in the QR codes.

c. Design the user interface for the attendance system, including scanning functionality for reading QR codes.

d. Implement data processing and validation logic to compare the scanned QR code data to the session information and student records in the database.

e. Create an attendance tracking method to save validated attendance records in the database, precisely correlating them with the related session and student.

f. Implement reporting and analysis options to create attendance reports and offer administrators or instructors with real-time or historical attendance data.

g. Integrate the attendance system based on QR codes with any existing systems, such as student information systems or course administration systems.

h. Perform extensive code reviews to verify that the system adheres to best practices for security and performance.

Exam Management System

a. Create the test management system's user interface while keeping both administrators and students' ease of use in mind.

b. System should be able to create and administer exams, as well define exam details like date, timing, duration and venue.

c. Include options for exam registration, enabling students to register for examinations and supplying the essential details and prerequisites.

d. Create a seating arrangement module that assigns seats in accordance with certain specifications, seating limitations, and student preferences.

e. Create the capability for scheduling examinations, making sure there are no conflicts and accounting for things like room and invigilator availability.

f. Put in place reporting features to produce timetable-related reports, such as class schedules, instructor assignments, and classroom usage.

g. Conduct in-depth code reviews to make sure best practices and coding standards are followed.

RESULTS AND DISCUSSION

Fig 1. Seating Arrangement

Fig 2. Dashboard

Don Bosco College Of Engineering

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FE

Internal Test 1

Date: 09/06/2023

Date	Time		Subject
	From	To	
2023-06-10	14:00	15:00	Chem
2023-06-12	14:00	15:00	B.E.E.E
	16:00	17:00	C Prog.

Fig 3. Timetable Generation

Results from the based exam registration system's installation were successful. First off, by offering a user-friendly interface and optimising workflows, the technology dramatically increased the registration process' efficiency. Students were able to finish the registration fast and simply, which lessened the administrative strain and saved time for both students and administrators. Additionally, the technology ensured improved accuracy by recognising and rectifying any incorrect or missing entries on the registration form, leading to more accurate registration data.

Since the QR code-based attendance system was implemented, accuracy, efficacy, and user satisfaction have all increased. The technology successfully replaced the manual methods of recording attendance, reducing errors and freeing up administrators' and employees' time. By leveraging QR codes that smartphones can scan to replace the requirement for manual data entry and improve data accuracy, the solution has made the attendance tracking process simpler. The ability to conduct analyses and act promptly has improved attendance management overall because to real-time access to attendance data. Users have praised the system for its comfort and ease, demonstrating how successful it is in providing a simple-to-use solution.

The automatic seating arrangement system successfully generates seating plans based on the collected student information and defined constraints. The system ensures that the seating capacity of each room is utilized efficiently, and specific requirements such as front-row seating or pairing constraints are satisfied. The seating plans can be visualized using seating charts or tables, making it easy to communicate the arrangement to students and staff.

CONCLUSION

The use of the test registration system, the QR code-based attendance system, and the seating arrangement system have shown their ability to considerably enhance administrative procedures in educational institutions. By expediting the registration process, improving attendance monitoring, and permitting equitable seat assignments during tests, these technologies provide quick and precise replacements for human approaches. Improvements in efficiency, smooth backend database interaction, and scalability have been seen with the exam registration system. The seating arrangement system tackles the difficulties of distributing seats based on multiple parameters, while the QR code-based attendance system offers a rapid and practical way to record attendance. In conclusion, these systems provide creative answers that improve efficacy, accuracy, and user experience in exam-related activities, opening the way for more streamlined and successful operations in educational institutions.

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Natural Language Algorithm for Iterative Sub-word Generation and Dictionary Acquisition

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ABSTRACT

Natural language text processing involves the pre-processing of paragraphs to form meaningful sentences, pre-processing of sentences to form meaningful words and pre-processing of words to form meaningful sub-words which enhances reduction in retrieval time of a subword from the dictionary and hence cost effective. Characters are the basic building blocks of any language, group of characters form a meaning full word, group of words form a meaningful sentence and group of sentences form a meaningful paragraph which provides a precise contextual meaning. This article incorporates the generating and processing of words a to find out all the meaningful and non meaningful words by utilizing dictionary based method, which increase the response time and requires high storage capacity. Some of the features incorporated into an editable window are checking for spelling mistakes, probable word for rectification and rectification of grammatical mistakes and predicts the probable sub-words that occur in a sequence using mathematical permutation and combination techniques.

KEYWORDS *: Byte pair encoding, Information retrieval, Natural language processing, Stop-word, Sub-word*

INTRODUCTION

In current era, there has been a considerable interest in Natural Language Processing (NLP) text or speech in Information Retrieval (IR) with specific implementations varying from the paragraph level to sentence level to word-level. NLP incorporates Artificial Intelligence (AI) [1] and Machine Learning [2] (ML) that provides machines the ability to understand spoken human language represented as text that may be handwritten or typed. NLP enhances productivity in daily tasks. A few examples are spell checker [3], auto complete, spam detection, document summarization [4], [5], plagiarism detection [6], voice assistants. The advent of high speed internet connectivity and the algorithms in communication have lead to a faster Information Retrieval [7]. Machines work with numbers and not letters/words/sentences. A large amount of textual data is readily available on the internet. This textual data is collected from various sources and need data cleaning and pre-processing before analysis referred to as text pre-processing. Input to the system is text in any language [8]. The purpose of this research is to generate all the possible subwords (subset elements ex subwords having 1 character, 2 characters, 3 characters and so on) from a given input word by indexing each character. This generates sub-words having proper meaning and sub-words having no meaning. Generating sub-words from a main word that has same meaning when pronounced but has very less number of characters is a trending field of research, for example "YOU" has dictionary meaning but may be specified as "U" where pronunciation remains same but the dictionary meaning changes. Aim of this research is to generate a generic language that has minimum typed characters but mean the same when expanded. Ex "I am" to "m", "Hai" to "Hi", "Good morning" to "GM/Gm/gm/gM", "Good afternoon" to "GA/Ga/ga/gA", "Good evening" to "GE/Ge/ge/gE", "Good night" to "GN/Gn/gn/gN". Further the abbreviated words can be mapped to symbols, smileys, emoticons.

TERMINOLOGIES

The various terms related to text are Character unigram is a unique single letter, Character bigram is a unique

two-letter chain, Character trigram is a unique three-letter chain, Character n-gram is a unique n-character sequence of letters, N-gram frequency is the count of repetition of n-gram chain in some sample text [9]. Text cleaning is removal or fixing of incorrect, corrupted, incorrectly formatted, duplicated or incomplete text within a large sized data. This escalation is due to the combination of heterogeneous data sources. Some of the methods for data cleaning are Tokenization [10], Stop word removal, Stemming, Normalization [11], Lemmatization, Parts of speech tagging [12] and so on.

Tokenization

Tokenization is breaking the raw text into small chunks. These chunks are referred as token (words, sentences). These tokens help in understanding the context and to develop a model for Natural Language Processing [13]. Tokenization helps in interpreting the meaning of the text by analyzing the sequence of words. There are different methods and libraries to accomplish the task of tokenization like Natural Language Tool Kit, Gensim and Keras. Tokenization can be performed to either separate words from sentences (word tokenization) or sentences from paragraphs (sentence tokenization). Stop words are those words in the text which do not add any meaning to the sentence and their removal will not affect the processing of text for a defined purpose. They are removed from the vocabulary to reduce noise and to reduce the dimension of the feature set. Various tokenization techniques are applicable based on the language and purpose of modeling. The various types of text tokenization techniques are as follows:

1. Dictionary: Tokens are retrieved based on the tokens pre stored in the dictionary. Disadvantage: This approach outputs nothing when the tokens are not present in the dictionary.

2. Rule: A set of rules are created for a specific problem domain. Tokenization is performed based on a set of rules like creating rules for grammar of a specific language. Disadvantage: This approach is limited to a specific language under consideration as each language has different rules.

3. Subword: It considers the most frequently used words and these words are indicated with unique identifier. Less frequent words are split into sub words which represent the best meaning independently. Ex: If the word few appears frequently in the text it will be assigned a unique identifier, it is a root word and the words fewer and fewest are rare words and less frequent. The text will be split into sub words like few, er, and est. This helps the language model not to learn fewer and fewest as two separate words but as a suffix attachment for a root word few. Different types of subword tokenization are as follows:

Byte Pair Encoding: This technique is based on the concepts of information theory and compression. It utilizes Huffman encoding for tokenization. It uses different symbols for representing less frequent words and less symbols for more frequently used words. It is a bottom up sub word tokenization technique and the algorithm is as follows:

Algorithm:

Step 1 : Split the input word into unicode characters.

Step 2 : Find the most frequent occurring pair of symbols.

Step 3 : Add this to vocabulary set.

Step 4 : Repeat steps 2 and 3 till the defined number of tokens are built or no new combination of symbols exist with the corresponding frequency.

This technique brings the perfect balance between character and word level hybrid representations which helps in managing large corpora. This behavior also enables the encoding of any rare words in the vocabulary with appropriate subword tokens without introducing any “unknown” tokens. Ex: Suppose we have data aaabdaaabac which needs to be encoded The byte pair aa occurs most often, so we will replace it with Z as Z does not occur in our data. So we now have ZabdZabac where Z = aa. The next common byte pair is ab so let’s replace it with Y. We now have ZYdZYac where Z = aa and Y = ab. The only byte pair left is ac which appears as just one so we will not encode it. We can use recursive byte pair encoding to encode ZY as X. Our data has now transformed into XdXac where X = ZY, Y = ab, and Z = aa. It cannot be further compressed as there are no byte pairs appearing more than once. We decompress the data by performing replacements in reverse order.

Disadvantage: Incurs a larger time and space complexity for both encoding and decoding.

Unigram Language: This technique is a deterministic model while the unigram language is a probabilistic model with varying probabilities. The training phase of the technique involves a big vocabulary and removes tokens from it until it reaches the desired vocabulary size. At each step of the training, unigram algorithm computes a loss over the corpus given the current vocabulary, then for each symbol in the vocabulary, the algorithm computes how much the overall loss would increase if the symbol was removed, and looks for the symbols that would increase it the least. Those symbols have a lower effect on the overall loss of the corpus means they are "less needed", best candidates for removal.

Input corpus: ("hugs", 10), ("pug", 5), ("pun", 12), ("bun", 4)

Strict substring Corpus: ["h", "u", "g", "hu", "ug", "p", "pu", "n", "un", "b", "bu", "s", "hug", "gs", "ugs"]

Disadvantage: This is a costly and time consuming operation as we do not just remove the single symbol associated with the lowest loss but p where p being a hyper-parameter which can be controlled for 10 or 20 percent of the symbols associated with the lowest loss increase. This process is then repeated until the vocabulary has reached the desired size. The base characters or the root words are not removed to make sure that any word can be tokenized.

Word Piece Encoding: This technique considers the token with most frequent occurring pair of symbols to merge into the vocabulary and also considers the frequency of individual symbols based on below count it merges into the vocabulary.

Count (x, y) = frequency of (x, y) / frequency (x) * frequency (y)

At each iterative step, Word Piece chooses a symbol pair which will result in the largest increase in likelihood upon merging. Maximizing the likelihood of the training data is equivalent to finding the symbol pair whose probability divided by the probability of the first followed by the probability of the second symbol in the pair is greater than any other symbol pair.

Ex: The algorithm will check if the probability of occurrence of "es" is more than the probability of occurrence of "e" followed by "s". The merge will happen only if the probability of "es" divided by "e", "s" is greater than any other symbol pair.

Disadvantage: This algorithm is greedy as it picks the best pair at each iteration to merge and build a tokenizer from the bottom-up. Hence more time consuming.

Sentence Piece Encoding: This technique considers selecting of tokens from a precompiled list, optimizing the tokenization process based on a supplied corpus. Sentence Piece Tokenizer [14] is a package available which implements the subword regularization algorithm. Some of the advantages are i. It is fast and can be trained on a corpus of 10^5 characters in seconds. ii. It can use raw text data without the need to store tokenized data to a permanent storage. iii. Training can also be performed on non-whitespace delineated languages like Chinese and Japanese with the same ease as performed for English language.iv. It performs well at the byte level and hence there is no need to use [UNK] or [OOV] tokens.

Disadvantage: Space required for storing of tokens is considerably more as compared to Word Piece encoding.

WhiteSpace: This method [15] splits a string on whitespace i.e a space, tab, and newline. Segments the input string using whitespaces then returns the segments as tokens. Currently there is an available split function in Python where whitespace characters refer to the actual whitespace character, the tab and newline characters. Parameters return a boolean value i.e A flag to indicate whether to return a set of tokens instead of a bag of tokens.

Disadvantage: This tokenizer is not applicable for languages whose words are not separated by spaces.

Penn Tree: This method [16] utilizes regular expressions to tokenize text. Detokenizer uses reverse regex operations. There are additional regexes added in reversing the parentheses tokenization such as the r'([\]\)\}\>])\s([:;,.])', which removes the additional right padding added to the closing parentheses precedding [:;,.]. It is not possible to return the original whitespaces as there were no explicit records of where 'n', 't' or 's' were removed at the text.split() operation.

During tokenization, left and right pad is added to [!?], when detokenizing, only left shift [!?] is needed. Thus (re.compile(r'\s([?!])'), r'\g<1>'). During tokenization [:,] are left and right padded but when detokenizing only left shift is necessary and we keep right pad after comma/colon if the string after it is a non-digit. The (re.compile(r'\s([:,])\s([^\d])'), r'\1 \2'). It utilizes regular expressions to tokenize text and the steps are: i. Split standard contractions Ex don't to do n't and they'll to they will. ii. Treat most punctuation characters as separate tokens. iii. Split off commas and single quotes, when followed by whitespace.

Disadvantage: It is safe to add more spaces but padding incurs overhead.

Phases of NLP

Natural language processing of text involves step by step interpretation of the language vocabulary. The five phases of text pre-processing that can be applied for any language are as shown in Figure 1:

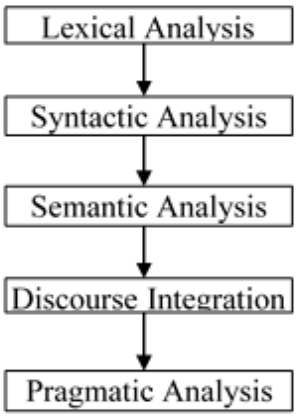

Fig. 1: Phases of text processing

Lexical Analysis: This phase [17] scans the source code as a stream of characters and converts it into meaningful lexemes. It divides the whole text into paragraphs, sentences, and words.

Syntactic Analysis: Syntactic Analysis [18] is performed to check grammar, word arrangements and shows the relationship among the words. Example: Agra goes to the Poonam. In real world Agra goes to Poonam does not make any sense, but the sentence is syntactically correct.

Semantic Analysis: This phase [19] is concerned with the meaning representation. It mainly focuses on the literal meaning of words, phrases, and sentences.

Discourse Integration: This phase [20] depends upon the sentence that preceeds it and also invokes the meaning of the sentences that follows it.

Pragmatic Analysis: This phase [21] helps to discover the intended effect by applying a set of rules that characterize cooperative dialogues. Example: "Open the door" is interpreted as a request instead of an order.

PROPOSED METHODOLOGY

System analysis is a detailed study of various operations performed by a system and their relationship within and outside the system. It involves gathering information and using structured tools for analysis. Proposed methodology trains a language model on the base vocabulary, picks the pair which has the highest likelihood, add this pair to the vocabulary, train the language model on the new vocabulary and repeat the steps until the desired threshold is reached. A major drawback of existing probabilistic models is that they can predict the next word in the sequence given the proceeding words that requires elaborate feature engineering. Popular techniques include the use of word embedding's to capture definition properties of words and an increase in end-to-end learning of a higher level task instead of relying on a pipeline of separate intermediate tasks.

Human being is a social animal. He has a unique capability to speak which other animals do not possess. He has to communicate to others either through speech (for both literates and illiterates), through hand written or typed text (explicitly for literates) and through hand gestures for medically disabled people. The proposed methodology uses permutation and combination for subword generation, the algorithm is as follows and the system architecture is depicted in figure 3:

Algorithm

Step 1: Input Word.

Step 2: Compute Word Length With Its Index Value.

Step 3: Perform Permutation And Combination Of Characters.

Step 4: Recursively Select Each Character To Form Subwords.

Step 5: Store And Display All Generated Subwords.

Step 6: Display Only Meaning Full Words.

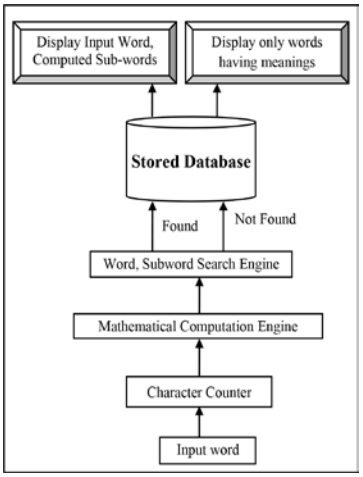

Fig.2: Block diagram of subword generator

EXPERIMENTAL SETUP AND RESULTS

To develop this application, the Software Requirements are Windows 10 Operating System, tools used are Anaconda 3, Jupyter with Python Programming. It uses front end as Jupyter IDE with Python programming language and in the back end a file system database to store input and generated subword output. Other tools used are Django, XAMPP and Sublime Text Editor. The results are as shown in Figures 3 to 6.

Fig. 3: Input word

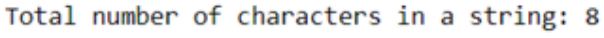

Fig.4: Character Count

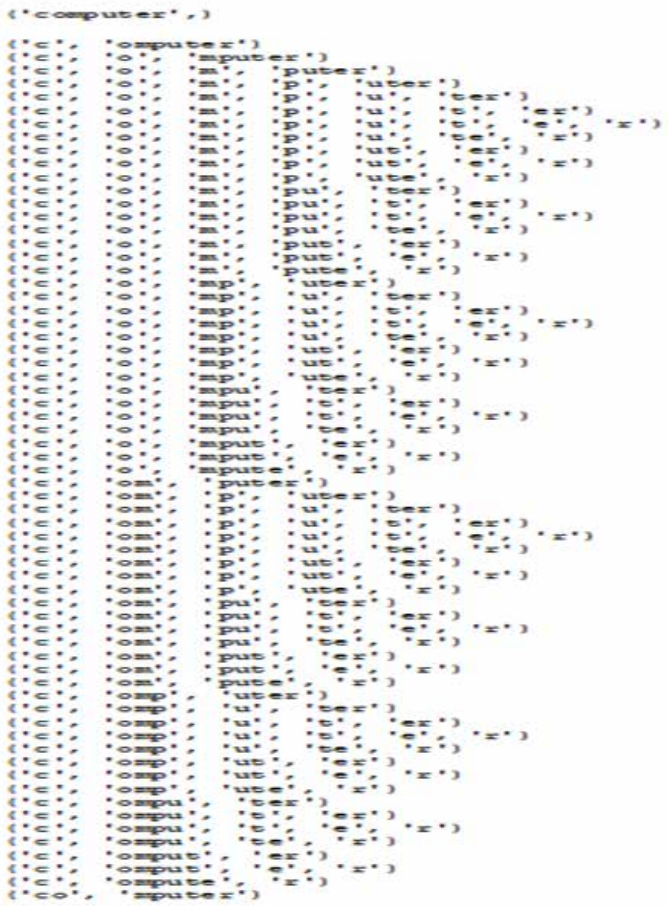

Fig. 5: Output of sub-words generated

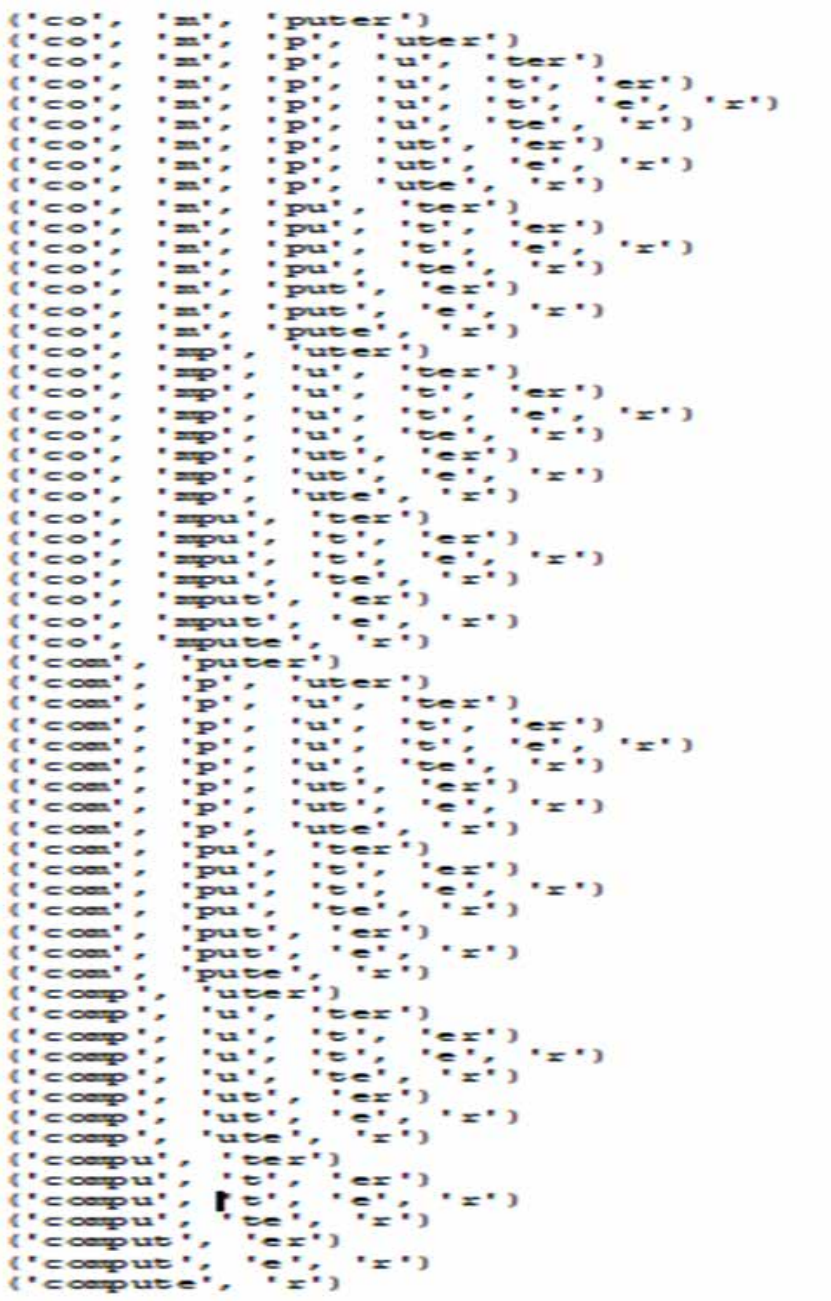

Fig. 7: Continuation of output of sub-words generated

LIMITATIONS OF THE PROPOSED WORK

The proposed methodology has an efficient time and space complexity for words having maximum five characters. As the number of characters within a word exceeds five characters there is a drastic increase in computation time and an exponential increase of sub-words generated which adversely affects the storage space. Further a large time is exhausted in mapping the generated sub-words to an existing dictionary as the generated sub-words form a meaningful words and non meaningful words. Time is also incurred in segregating out and to discard non meaningful words.

CONCLUSION AND FUTURE SCOPE

Tokenization finds its applicability in the development of Natural language processing for building applications such as Text classification, Chat-bot, Sentiment analysis, language translation, etc. Natural Language toolkit has modules and sub-modules to tokenize a sentence that form words and then sub-words. Proposed work can be enhanced by applying the same to the sentences and paragraphs and validate the same for time and space complexity. Non meaningful words which are generated from existing methodology can be enhanced to find out sub-words that have same pronunciation and meaning like "YOU" to "U". Further depending on the sub-words generated a new generic language may be developed for faster communication which will have minimum typed/ handwritten characters but tend to escalate the same meaning when expanded as a full word already residing in the dictionary. This finds its applicability where we need faster transmission with low bandwidth and local storage.

ACKNOWLEDGEMENT

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Implementation of ZigBee Hardware for Application of Mine Safety

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ABSTRACT

Using a ZigBee wireless sensor network, this research develops a monitoring system for mine safety. This project is divided into two pieces. The first part is deployed under the ore or earth where the mining is taken, and the following section is on the surface which can be attached on the body of mine workers. The sensors in the underground section will sense more environmental factors like temperature, different gases, vibrations inside mine and so forth and relay this data to the micro-controller. This data is shown on the LCD by the microcontroller and transmitted via the ZigBee transmitter. ZigBee receiver in the ground segment picks up that data, which is then sent to PC via USB or RS232, which can increase the awareness about risk and avoid further dangerous accidents. For researchers who are dedicated to addressing the safety monitoring problem, ZigBee technology offers a direction to enhance safety level.

INTRODUCTION

At any workplace and at any time, safety comes first. Ignorance of the safety aspect could lead to the destruction of expensive machinery, which would impede production, or it could, in severe circumstances, result in human life loss. The mining sector has to take responsibility for safety and security of the workplace as there is involvement of human resources. All mining industries adhere to some fundamental precautions and phenomena in order to prevent any undesirable occurrences. Today, communication is the most important key to continuously monitoring various metrics and taking the appropriate actions to prevent any types of production, security, or human resource management threats. To prevent an economical and social loss, an effective and dependable continuous faithful communication system is crucial for underground mine ores interiors. The cable communication network technology is not very effective inside hazardous ores.

There has always been a concern with the dependability and longevity of traditional communications systems in severe mining operations. The installation and maintenance costs for wired communication networks are significant within mines due to the uncomfortable environment. After a landslip or other damage for any reason, it is highly challenging to restore the wired communication system inside mines. If a communication network wire is damaged for whatever reason, it could result in a long-term system breakdown or a brief disruption of the ongoing activity.

LITERATURE REVIEW

Currently used wireless sensor networks and cable networks are frequently used in underground coal mine monitoring systems. In the event of an accident, especially an explosion, the sensors and cables are frequently fatally damaged and unable to proceed for rescue operation. Wireless sensor networks are able to address the major problems in this application. Mine monitoring systems, which can track the different physical parameters are temperature, humidity, and poisonous and explosive gases and their concentration inside the ores, are another particular use of environment monitoring in the WSN domain. Currently, all detectors used in mines are single detectors that perform artificial observation, recording, and testing. Although a small number of mines have built up their own detection and alarm systems, the mine tunneling and mining are

dynamic processes, and the cable network can hardly adjust to this situation. However, the issue might be solved if such monitoring systems use the wireless network. This addresses the primary issues with cables. Battery-powered wireless network nodes can skip the challenging and hazardous wiring process.

PROPOSED SYSTEM

The block diagram consist of two units: slave unit and master unit.

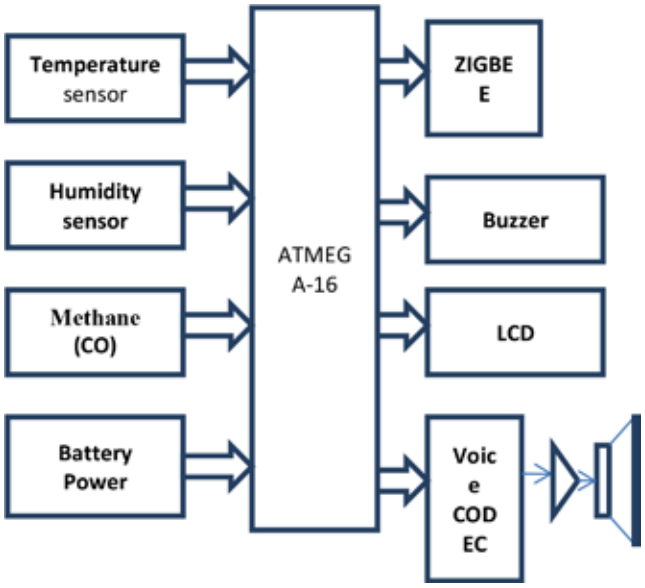

Figure 1 Slave unit Block diagram

The slave unit is made up of components including the DHT-11 as a temperature and humidity sensor, MQ-7 methane sensor, ATMEGA 16 microcontroller, CMX 639 codec, buzzer, ESP-32 ZigBee, LCD (2 X 16), and battery power.

The master unit is made up of components such a PC, an Atmega 16 microcontroller, a 2-by-16 LCD, a 5-volt power source, a buzzer, and ESP-32 ZigBee.

A sensor module that measures subsurface factors like temperature, humidity concentration of various gases, vibration inside mines, etc. is included in the block diagram. Methane, carbon monoxide, and other dangerous gases are the focus of gas concentration. Some of the gases are combustible and some are hazardous.

Microcontroller ATMEGA-16 is used in conjunction with the sensors. The microcontroller can save data that the user specifies in order to maintain records. The microcontroller detects alarms sound via headset attached interfaced to controller when temperature goes high than the set safe level preprogrammed, as indicated in the block diagram. Also ATMEGA-16 detects all the signals from different sensors which are more than alarming values. ZigBee alarm will be sent to the ground control terminal along with a warning message and sound with Voice CODEC.

The use of a microcontroller to encode and decode voice and alarm signals efficiently establishes communication. The ZigBee transmission module and the data receiver module are two distinct boards through which the microcontroller data is transferred. Here, an ATMEGA 16 microcontroller with a 20MHz operating frequency is used. It has an 8-channel, 10-bit ADC and five number of I/O interfaces.

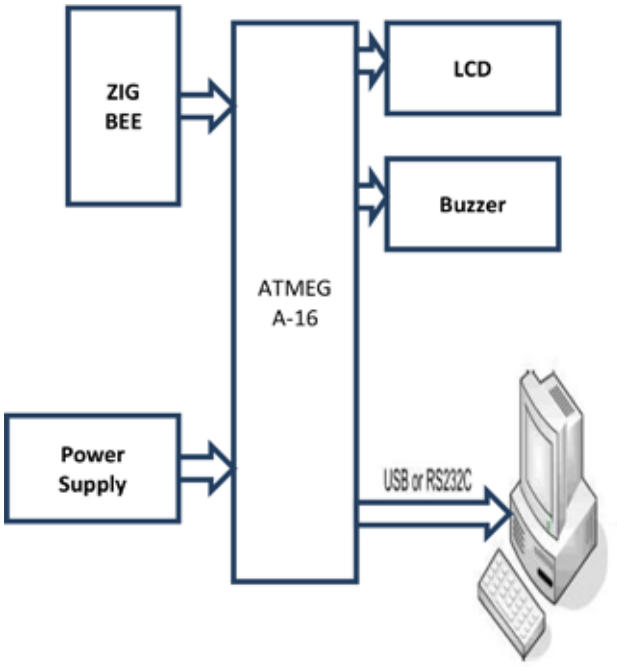

Figure 2 Master unit Block diagram

The whole system design is separated into two sections; the first is Sensor Nodes, which are network-distributed nodes. The end node, which is the second component, is situated at the PC of the end user and serves to communicate the data collected to the PC through a serial port or to show it on a liquid crystal display. A microprocessor, transceiver, sensors, and a battery

serve as the sensor node's portable power source. An object that functions as a wireless device and sends and receives data from nodes is called a transceiver. ZigBee module is utilized as the transceiver in this project.

SYSTEM FLOWCHART

Figure 3 shows the flowchart for underground section and figure 4 shows the flowchart for Slave Section.

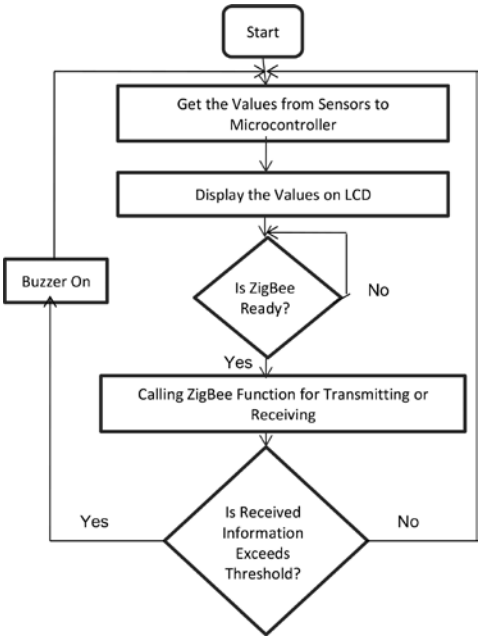

Figure 3 Underground section

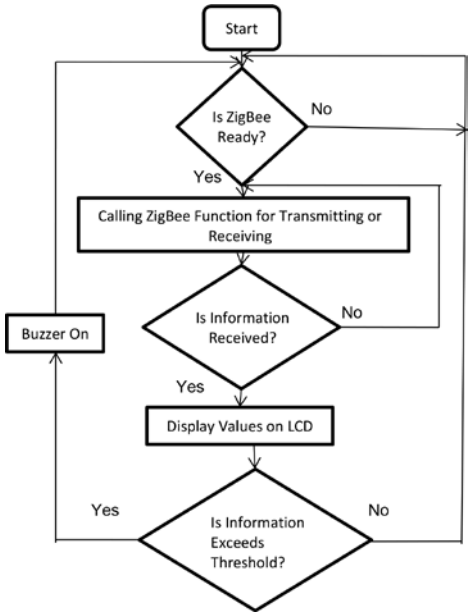

Figure 4 Slave section

RESULTS AND DISCUSSIONS

Figure 5 shows the HyperTerminal on the PC showing the values of the parameters such as Temperature and Humidity.

Furthermore, Table 1 shows the complete system performance analysis for different parameters.

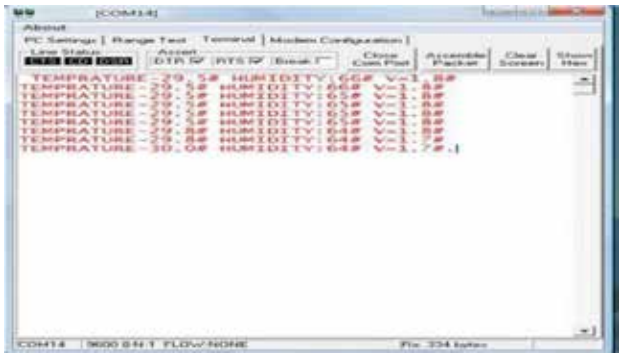

Figure 5. HyperTerminal on the PC showing the values of the parameters

Table 1 Comparison of set points and current points

Parameters	Set Point	Current Value	Indicator
Temperature	40°C	33°C	CODEC
Humidity	65	75	CODEC
Methane	1.8	2	BUZZER

CONCLUSION

The construction of a wireless sensor network to track a mine's subsurface conditions is the main goal of this endeavor. This project is accomplished successfully. This model converts the state-of-art communication system to efficient wireless communication network. Wireless sensor networks of ZigBee technology can be implemented according to special physical parameters of environment of underground. Use of wireless routing, network efficiency, maintenance cost can be evaluated depending on the workplace area and human resources.

The suggested monitoring and safety system in this project can successfully replace the current mine security system. The system provided by this project

relates to the security and safety of underground mines.

The system is trustworthy, consistent, affordable to the private as well as public sectors, and user-friendly. A wider region and greater depth inside dangerous underground mines can be covered by extending the network. The system integrated contemporary MEMES-based tiny sensors with ZigBee-based high frequency wireless data transmission module. It is possible to mount the sensor and ZigBee module over the miner's wearables. Proper monitoring and communication is feasible among all human resources involved at workplace, which allows quicker and more informed decision-making.

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Human Movement Detection and Alert System based on ESP32CAM and PIR Sensor

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ABSTRACT

Security has always been a major concern for mankind. Especially in government offices, schools, colleges and corporate offices where important documents kept in shells and on tables which may not be a safer place. Often CCTV cameras are used for security purposes in these institutions. Any incident interfering with personal things and sensitive documents cannot be detected in real-time with conventional CCTV cameras. The purpose of a CCTV camera is only to record and not to detect and alert the owner or authorized person. We proposed a system which is a small, portable, Battery operated device based on the ESP32 CAM module. It will detect the presence of a person and animal within the surrounding using a PIR sensor and captures the image of that person using the built-in camera of ESP32 CAM. The captured image is stored on an SD card. The image is sent to the registered authorities or owner through telegram. So in the absence of the owner or authorized person, if any unauthorized person interferes with the personal property this system will detect it, captures the image and send it to the authorities in real time. The testing result shows that the person's presence is detected within the range of 5 meters. The system has sent a 400*296 pixel image to the owner. A 2-sec delay is observed between person detection and receiving the image on telegram.

KEYWORDS *: Security system, ESP32-CAM, Internet of Things, PIR sensor.*

INTRODUCTION

Important documents and sensitive information of various institutions are kept in shells and cupboards at offices. Many times there is no proper security arrangement for the shell and cupboard inside which documents are stored. When there is no authorized person inside the office there is a constant fear of unauthorized interference with important documents and confidential things. Unauthorized Interference with documents and other things can only be known when a person investigates thoroughly. Many times CCTV is installed in an office environment for security purposes. Any unknown interference with important documents and other things within the office environment can only be known after looking into CCTV video recording. The current security system lacks real-time detection of interference with an office environment. Many private and personal things like jewellery, cash and other important things are kept inside a house. Any theft activity can happen with these private things. The owner will only know about the theft activity if the owner looks for those things. Normally owners will not install CCTV inside homes. So the owner does not know who is interfering with private property. For both cases, real-time detection of interference with personal and private property is absent which can cause huge losses for institutions and individuals as well. Research has been done for real-time alerts using Wi-Fi technology and GSM technology. The drawback of GSM technology is that owner only gets text SMS alerts. In the case of applications based on Wi-Fi technology, owners need to install 3rd party IoT platform on their phones. Often these systems are developed for door security. But the theft can enter into institutions and houses through roofs and windows which makes these systems ineffective.

The proposed system is equipped with a PIR sensor. PIR sensors will detect the presence of a person or any movement of a person within the surrounding of the

system. The inbuilt camera sensor of the ESP32-CAM development board captures the image surrounding it. SD card is used to store the captured images. ESP32-CAM is connected to the Wi-Fi. The captured image is sent to the owner through Telegram. The proposed system is a small, portable, battery-operated device that can be placed near personal things or in the shell or cupboard. The proposed system makes personal things more secure.

RELATED WORK

Nowadays IoT is widely used in the security system. Some research papers have discussed smart security systems, security systems with cameras, security systems with GSM and other technologies. The authors [1–3] proposed a door lock security system. The proposed system sends notifications to the owner of the house whenever any person tries to open the door. The author [4] proposed a smart door lock system. A proposed system sends an image of an intruder to the owner. Mohd Azlan Abu, et.al. [5] proposed a home security system based on the favoriot platform. The proposed system is equipped with PIR and IR sensors, creating an online database. Prof. Mrs S. S. Sankpal et. al. [6] publishes a review on the home security system. In this paper, the author compares various technologies used for home security and automation system. Dr. P. D. Selvam, et.al.[7] proposed surveillance system using ESP32-CAM for detecting illegal activities.

SYSTEM DESIGN

To detect the presence of a person or movement of a person near the device PIR sensor is used. PIR sensor will detect any change in motion of the person. ESP32-CAM development board is used as a controlling unit. The PIR sensor is connected to the GPIO pin of ESP32-CAM. The ESP32 CAM has an inbuild camera module OV2640 with flash led. A two AA-size rechargeable Li-on battery of 3.7V is used as a power source. Batteries are serially connected and LM7805 fixed positive output voltage regulator is used to supply 5V voltage to ESP32-CAM. The power supply for ESP32 CAM is taken from rechargeable Li-on batteries. To charge the battery TP4056 Battery Charging module is used.

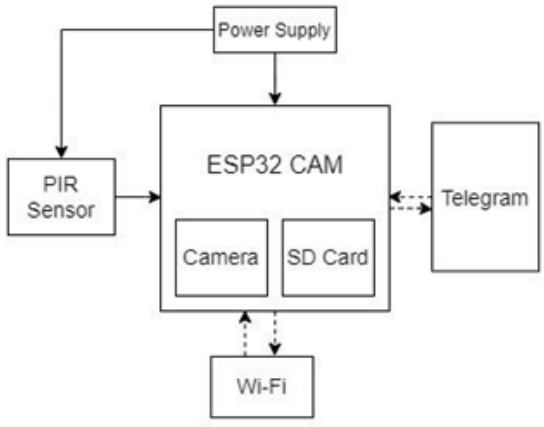

Fig. 1. Block diagram of the system

Fig. 1 shows the block diagram of the system. An SPDT slide switch is connected between the power supply module and ESP32-CAM. The slide switch is used to turn the on and off the device. ESP32-CAM has an in-built led, which turns on and off when the power supply is on and off respectively. The led indicates that the system is on or off. ESP32-CAM has Wi-Fi compatibility. The SSID and Password of the Wi-Fi access point are written in code which is burned into ESP32-CAM. When the device is powered up ESP32-CAM will try to connect with Wi-Fi of which credentials are written into code. To receive a message a telegram bot needs to be created. To create, a bot for our application BotFather another bot service of telegram can be used. After creating a bot a bot token is generated. The owner's telegram user ID is also needed for message communication. IDBot, a bot service of the telegram is used to get user id. The generated bot token and user ID are written into the code.

Flowchart

Fig. 2 shows the flowchart of the human movement detection and alert system. The proposed system is turned on and off using an SPDT slide switch. This s the main power switch between the power supply and ESP32-CAM. When the switch is on system turns on and the power supply is given to ESP32-CAM and PIR sensor. After powering on ESP32-CAM tries to connect with Wi-Fi. It will try to connect with the Wi-Fi of which SSID and Password are written into code. The ESP32-CAM continuously try to connect with Wi-Fi until it connects with Wi-Fi.

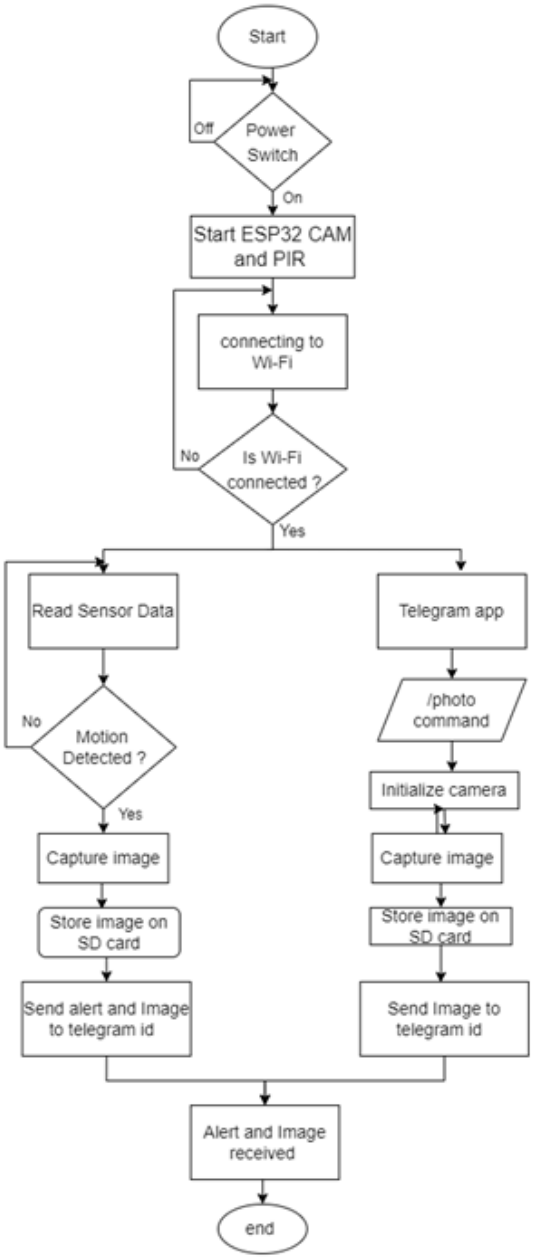

Fig. 2 Flowchart of the system

The PIR sensor continuously monitors its surrounding. It will detect a person's presence and/or any motion happening in the surrounding. The PIR sensor will send a digital high signal to ESP32-CAM. After receiving the high signal ESP32-CAM will start the camera and capture the image. The captured images are stored on an SD card.

When there is motion detected by the PIR sensor the ESP32-CAM sends an alert message "Motion detected!!" to the bot created on telegram. The exact communication to the owner's bot is using the bot token and user id. After sending the text alert image is sent to the telegram bot. The resolution of capturing the image can be set depending on user requirements. The proposed system is sending images through a telegram to keep the delay minimum the resolution of the image is set to 400*296. The owner can see the surrounding environment of the system using a simple command. If the owner wants to see the surrounding near the personal property then using /photo command owner can request an image. The input command is given through the telegram bot. After receiving the request for an image ESP32-CAM captures the new image and sends it to the telegram bot. The proposed system sends an alert and image to the owners' telegram whenever there is a movement of a person or at the request of the owner.

Hardware Design

The hardware design of the system consists of a PIR sensor, ESP32-CAM, rechargeable AA-sized Li-on batteries and a TP4056 battery charging module.

PIR sensor

PIR stands for Passive Infrared. PIR sensor detects and responds to the infrared heat energy emitted by humans and animals. The PIR sensor is a digital sensor i.e. it gives a high signal when any movement happens within the surrounding of the sensor.

ESP32-CAM

ESP32-CAM is a microcontroller development board. It is based on an ESP32 controller. It is mainly used for IoT applications. ESP32-CAM has a dual 32-bit CPU. It has an SPI flash of 32Mbit. It has Wi-Fi support of 802.11/b/n. ESP32-CAM comes with an OV2640 camera and supports JPEG images. The required power supply for ESP32-CAM is 5V DC.

Programmer module

ESP32-CAM does come with the onboard programmer. To program ESP32-CAM we need to use USB to UART TTL serial adapter. We have used CP2102 USB 2.0 to TTL UART Serial converter module. To upload the code ESP32-CAM need to be put into programming mode to do this GPIO 0 pin is connected to Ground.

Normal functioning of ESP32-CAM this connection is need to be removed.

TP4056

To charge the AA-sized lithium-ion batteries constant-current/constant-voltage linear charger is required. TP4056 works with a micro USB adapter. The input supply voltage range is -0.3 to 8V.

Software Design

To program the ESP32-CAM we have used Arduino ide. To make Arduino ide compatible with the program ESP23-CAM, a specific board manager URL "https://dl.espressif.com/dl/package_esp32_index.json" need to be put into the additional board manager and the ESP32 board library needs to be installed into Arduino ide from the board manager.

RESULTS

The proposed system is built to detect the interference of any person with personal and private things and to alert the owner in real-time with images of surrounding near the personal things. The alert and image are sent to the owner through telegram. The system is a small, portable, and battery-operated device.

Fig. 3 Implementation of system

Fig. 3 shows a 14cm x 9cm x 3.5cm sized small, portable, battery-operated human movement detection and alert system.

The system stores the captured images in an SD card.

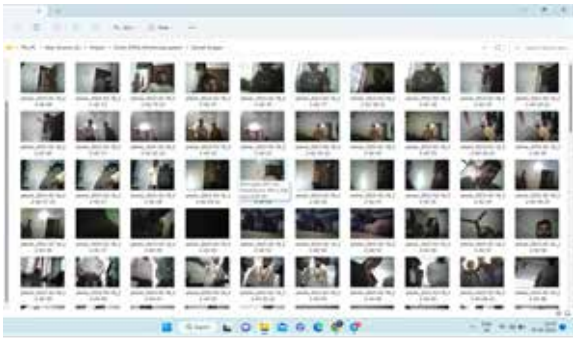

Fig. 4 Captured images stored in an SD card

The system can detect the interference of a person within the surrounding system.

Fig. 5 Alert message and image of the person interfering is sent to a telegram bot named "Office monitor".

The system can detect a group of people interfering with personal property.

Fig. 6 Alert message and image of a group of people interfering are sent to a telegram bot named "Office monitor".

The system responds to the request created by the owner by using the "/photo" command.

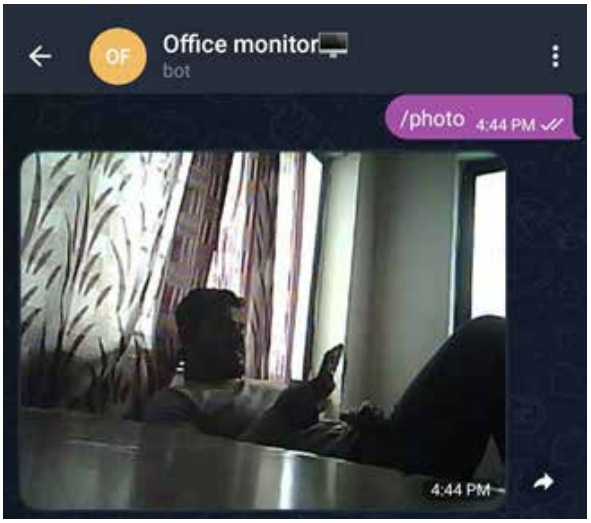

Fig. 7 System responds to the "/photo" command from a user by capturing real-time photos

To evaluate the robustness and accuracy of the system a method is used. In this method, the person is moving within a certain distance. Fig. 6 shows a graph of the system accurately detecting or not detecting the person.

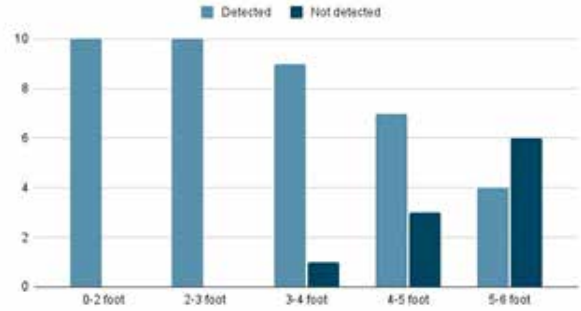

Fig. 8 Graph of the system accurately detecting persons with a certain distance limit.

CONCLUSION

In this paper we have proposed a system which will detect the presence of a person within the surrounding system or a person interfering with personal property. If the system detects the person then the system gives real-time alerts to the owner. Alert consists of a text message and an image of the surrounding of the system. If the owner requests the image of the current situation then the proposed system captures the real-time image and sends it to the owner. Owner request the real-time image using the "/photo" command. After each image capture the captured image is stored in an SD card inserted in the system.

The proposed system overcomes the drawback of conventional CCTV which is not able to send a real-time alert if any interference with personal property is happing. The final built system is the small, portable, battery-operated device which can easily be placed inside the cupboard or shell where important documents are kept. The system provides true monitoring and alert to the owner.

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IoT-based Precision Agriculture

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ABSTRACT

This paper presents the design and implementation of an advanced cow farm automation system utilizing the ESP32 microcontroller board, integrated with a DHT11 temperature and humidity sensor and an IR sensor. The objective of this project is to improve the efficiency and productivity of a cow farm by leveraging the capabilities of the ESP32 microcontroller and integrating precise environmental monitoring and cow presence detection. The proposed system incorporates the DHT11 sensor to monitor temperature and humidity levels within the farm, ensuring optimal environmental conditions for the cows' health and well-being. The IR sensor is utilized to detect the presence of cows in specific areas, providing valuable data for monitoring their movement and behaviour.

The results of this project demonstrate the effectiveness of integrating the DHT11 sensor and IR sensor with the ESP32 microcontroller for cow farm automation. The system offers a scalable and cost-effective solution, providing accurate environmental data and cow presence information to optimize farming practices and ensure better cow welfare. By delivering real-time data insights and automating important tasks, farmers can optimize feed management, identify potential health issues promptly, and improve overall farm operations.

KEYWORDS *: Automation, ESP32, DHT11, Blynk, Internet of things, Cow farm automation, Environmental monitoring, Remote monitoring.*

INTRODUCTION

Agriculture has always been an important sector for human survival, and it plays a vital role in the economy of many countries. The global population is predicted to reach 9.7 billion people by 2050, which would result in an exponential rise in the demand for food. In order to meet this demand, it is necessary to improve the efficiency and productivity of agriculture while also addressing the environmental concerns associated with it.

IoT-based precision agriculture offers a promising solution to these challenges by leveraging the power of technology to optimize agricultural practices. This approach involves the use of a network of sensors, drones, and other devices to collect and analyse data on environmental conditions, soil moisture, and crop growth patterns. Farmers can increase yields and improve the quality of their product by using artificial intelligence and sophisticated analytics to help them make well-informed decisions about when to sow, water, fertilize, and harvest their crops.

This paper aims to explore its potential benefits to farmers, including increased productivity, reduced costs, and sustainable farming practices. The paper will also discuss some of the challenges associated with implementing IoT-based precision agriculture, such as data security and privacy concerns, as well as the need for specialized training and technical expertise. Overall, IoT-based precision agriculture has the potential to revolutionize the way we produce food, making agriculture more efficient, sustainable, and environmentally friendly. It is a rapidly evolving field, and its impact on agriculture is expected to grow significantly in the coming years.

The potential benefits and applications of IoT-based precision agriculture have been extensively studied and documented in the literature. Researchers have explored various aspects of this field, including sensor networks, data analytics, and machine learning. One noteworthy study by Kiran, K., & Dinesh, D. (2019) evaluated the efficacy of an IoT-based precision agriculture system in decreasing water usage and increasing crop yield. By employing sensors and actuators to collect data on soil moisture and temperature, and machine learning algorithms to anticipate crop water demand, the study demonstrated a significant reduction in water usage and a boost in crop yield, showcasing the potential of IoT-based precision agriculture in enhancing resource efficiency.

Pandian, B. J., & Thirunavukkarasu, K. (2020) proposed the use of IoT technology to monitor and regulate greenhouse environments. Using a wireless sensor network to gather data on temperature, humidity, light intensity, and data analytics to optimize the greenhouse environment, the study found a notable improvement in crop yield and quality, underscoring the potential of IoT-based precision agriculture in greenhouse gas production.

In a review by Khamparia, A., & Kumar, N. (2018) the challenges and opportunities of IoT-based precision agriculture in developing countries were examined. The review highlighted several obstacles, such as a lack of infrastructure, limited technical expertise, and data security concerns. However, the review also emphasized the potential of IoT-based precision agriculture in improving agricultural productivity and food security in developing countries.

Overall, the literature indicates that IoT-based precision agriculture could revolutionize agriculture by promoting efficiency, reducing waste, and advocating for sustainable practices. Nevertheless, its implementation also entails challenges, and further research is required to comprehensively comprehend its potential impact on agriculture.

PROPOSED SYSTEM DESIGN

Designing a cow farm automation system using ESP32 and DHT11 is an interesting project. Powerful microcontrollers like the ESP32 can be used to monitor and control a wide range of sensors and actuators. The DHT11 is a low-cost temperature and humidity sensor. Here's a proposed system design for automating a cow farm.

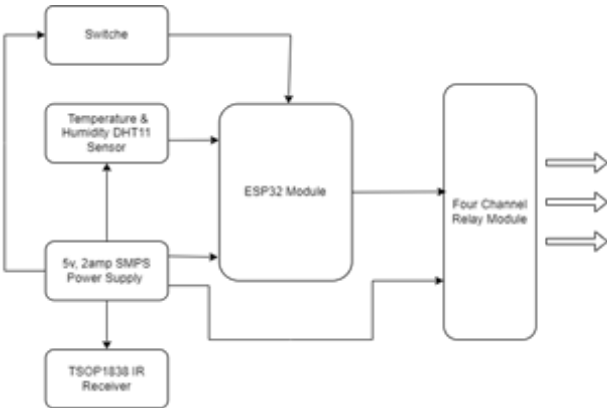

Fig. 1 Block Diagram of the Proposed System

The DHT11 sensor will be used to measure the temperature and humidity levels in the cow farm. It is a simple and affordable sensor suitable for this application. Use Arduino IDE or Platform with Arduino framework to program the ESP32. Sensor Data Collection: Read the temperature and humidity values from the DHT11 sensor using the appropriate library for the ESP32. Implement control logic based on the collected data and the desired automation tasks. For example, you can set temperature thresholds to trigger cooling or heating systems, humidity thresholds for watering, and so on. Utilize the ESP32's built-in Wi-Fi capabilities to connect the system to a local network or the internet for remote monitoring and control. Store the sensor data in a database or cloud platform for historical analysis and visualization. You can use platforms like Thingspeak, Firebase, or your own server for this purpose. To keep an eye on and manage the automation system, create a user interface. This can be a web-based dashboard accessible through a computer or mobile device. In this System, we ensure a reliable and stable power supply for the ESP32 and the connected sensors and actuators. Depending on the power requirements, in this system, we also designed or introduced the 5V SMPS Power supply you may need to use an external power source or batteries with suitable voltage regulators. Install the sensors and actuators in appropriate locations within the cow farm. Test the system thoroughly to ensure

accurate sensor readings, proper actuator control, and reliable connectivity. Implement security measures to protect the automation system from unauthorized access or tampering. Central control system: A computer or server that receives data from sensors, processes it, and controls the actuators accordingly. Provide an intuitive user interface for farm workers to monitor and manage the automation system. This might be a dashboard accessible via the web or a mobile application. Store the sensor data in a database for historical analysis and monitoring. Implement data analysis algorithms to identify patterns, detect anomalies, and provide insights for farm management.

Hardware Design

The hardware design of the system consists of an ESP32, DHT11, TSOP1838, 5v 2amp Power supply, four-channel Relay Module, rechargeable AA-sized Li-on batteries, and a TP4056 battery charging module Zero PCBs, a Sholder Station, connecting Wiers, Header pins, joint Protecting Slives, and Hardware Designing Software just like Eagle And Altium PCB Designing Software for the Scalable unit Production, knowledge for Soldering And Desoldering.

I. The ESP32: The ESP32 module is a versatile and powerful microcontroller module that is widely used in various IoT (Internet of Things) applications.

i. Dual-core processor: The ESP32 module is equipped with a dual-core Tensilica LX6 microprocessor

ii. Wi-Fi and Bluetooth connectivity: The ESP32 module's integrated Wi-Fi and Bluetooth capabilities are among its most notable characteristics since they make it simple to connect and communicate wirelessly with other devices.

iii. Low power consumption: Despite its impressive performance, the ESP32 module is designed to be power-efficient, enabling battery-powered IoT applications to operate for extended periods

iv. Rich peripheral set: The ESP32 module offers a wide range of peripheral interfaces, including GPIO (General Purpose Input/Output) pins, UART (Universal Asynchronous Receiver-Transmitter) interfaces, I2C (Inter-Integrated Circuit) ports, SPI (Serial Peripheral Interface) ports, and more. This allows for easy integration with various sensors, displays, and other devices.

v. Arduino compatibility: The ESP32 module can be programmed using the Arduino IDE (Integrated Development Environment) and is compatible with the Arduino framework.

vi. Cost-effective: The ESP32 module is known for its affordability, making it an attractive choice for hobbyists, students, and small-scale IoT projects.

vii. Open-source ecosystem: The ESP32 module is based on open-source hardware and software, promoting collaboration and innovation.

II. DHT11: The DHT11 is a popular and affordable digital temperature and humidity sensor module. It is commonly used in various projects and applications to measure temperature and relative humidity levels in the surrounding environment. The sensor's limited temperature and humidity measurement ranges are 0 to 50 degrees Celsius and 20% to 90% relative humidity, respectively. With a temperature accuracy of ±2 degrees Celsius and a humidity accuracy of ±5%, the DHT11's precision is considered moderate.

III. TSOP1838:

The TSOP1838 is designed to receive infrared signals transmitted at a specific frequency. It can detect and demodulate IR signals from compatible IR transmitters or remote controls. The three pins of a TSOP1838 are usually labelled VCC (power supply), GND (ground), and OUT (output). Typically, VCC is linked to a 5V power supply, GND to the ground, and OUT to a microcontroller or other circuitry for processing the received signals.

IV. TP4056

To charge the AA-sized lithium-ion batteries constant-current/constant-voltage linear charger is required. TP4056 works with a micro-USB adapter. The input supply voltage range is -0.3 to 8V.

Software Design

Blynk is an Internet of Things (IoT) platform that provides a simple and intuitive way to control and monitor connected devices using a smartphone or tablet. It allows users to create custom mobile apps and

connect them to their hardware projects without the need for complex coding or hardware configurations.

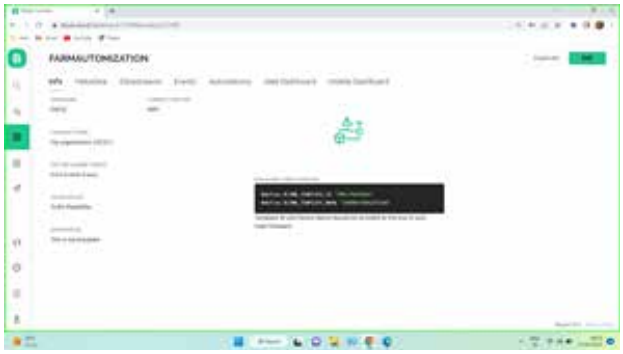

Fig. 2 Creating Blynk_Template_id, And Blynk_ Template_Name

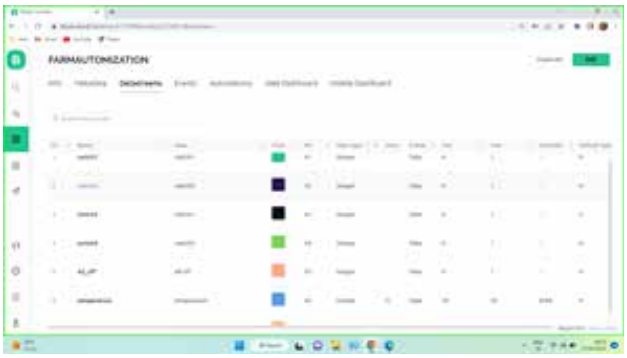

Fig. 3 Defining the DataStream's for the Switches

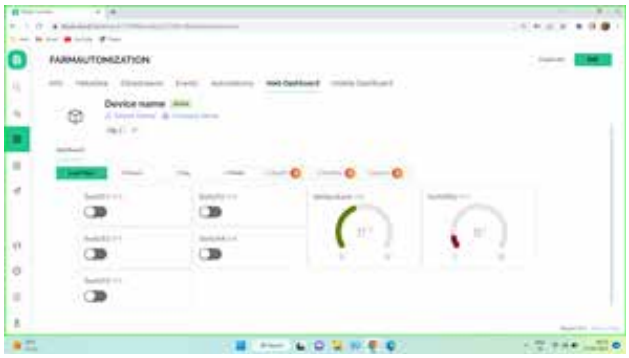

Fig. 4 Creating the Web Dashboard

To program the ESP32 we have used Arduino ide. To make Arduino ide compatible with the program ESP23, a specific board manager URL "https://dl.espressif.com/dl/package_esp32_index.json" need to be put into the additional board manager and the ESP32 board library needs to be installed into Arduino ide from the board manager. We have used libraries for establishing Wi-Fi connections like WiFi.h.

Fig. 5 Library installation And Programing ESP32 in Arduino IDE

SYSTEM FLOWCHART

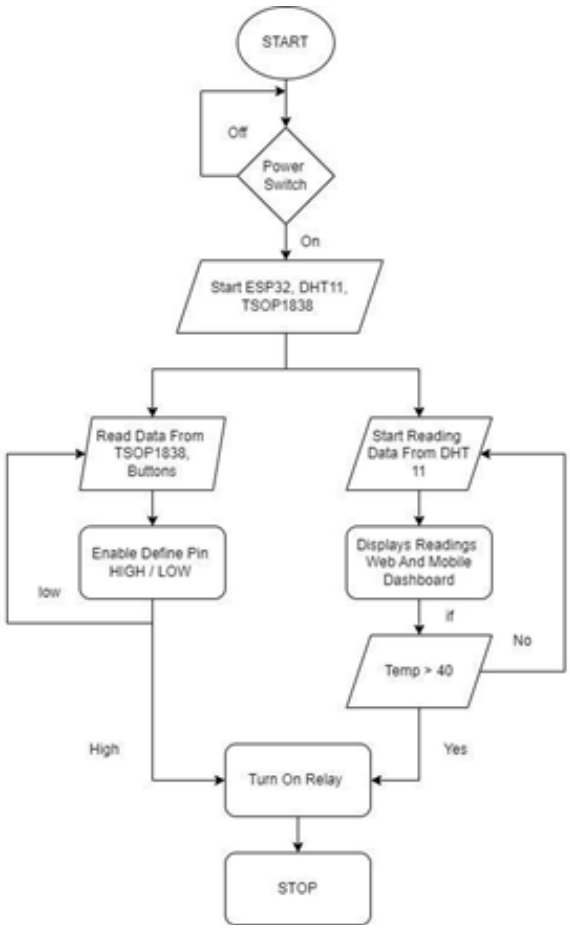

Fig. 6 Flowchart of the system

RESULT AND DISCUSSION

The design system monitors environmental parameters like temperature and humidity. These parameters can be seen on the Blynk platform on mobile phones

or any computer screen as shown in Figure 7. The system is automated so that when the temperature of the environment goes beyond the 40-degree Celsius the fogging system will automatically be turned on. When the temperature is below 40 degrees Celsius the fogging system will automatically be turned off. So this feature of the system will reduce the chance of heatstroke. The automatic fogging system will reduce the human efforts of continuously monitoring cows.

Fig. 7 Temperature and Humidity monitoring system

The designed system provides timer-based light on-and-off the system as shown in Figure 8. The time of light on and off is customizable and can be set by farmers through their Blynk platform. So using this system lights of the farm can turn on and off timely.

Farmers can turn on or off lights as per their wish using the manual switch. The manual switches are also present in the system as shown in Figure 9.

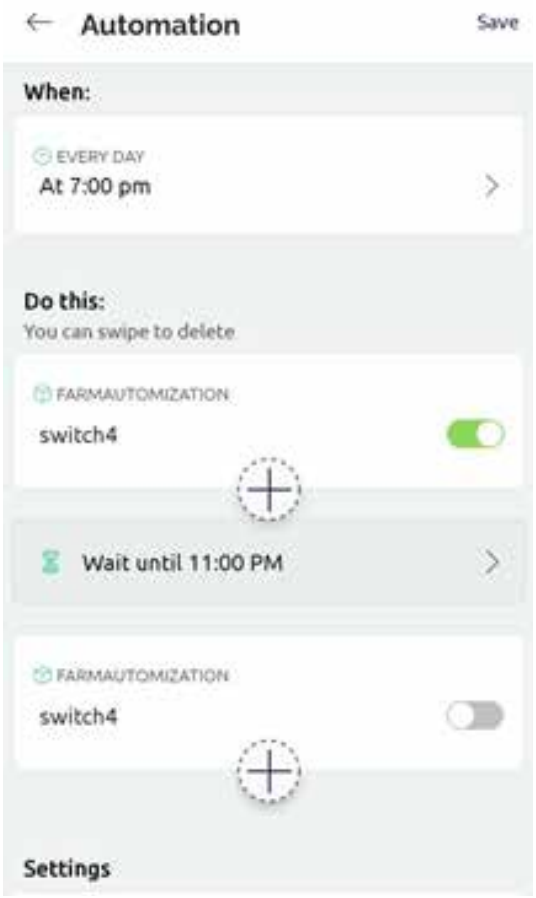

Fig.8 Timer-based light on-and-off the system

Fig.9 Manual switches for farmers

The system provides an easy way of turning lights on and off by touching the manual switches with the help of a remote. The light can be operated using remote control as shown in Figure 10.

Fig.10 Remote controlled switches for farmers

To operate the switch manually or using a remote a person needs within the surroundings of the farm. But the system also provides a very useful feature of controlling the light with the help of a web platform or an Android application as shown in Figure 11. There is no limitation of distance while operating the switches with the current method. A person can remotely operate the switches from any corner of the world.

Fig. 11 Web platform based switches

With all these methods the designed system is making a person's job easier. The system is precise in timing and quick in response.

CONCLUSION

In conclusion, IoT-based precision agriculture is a promising technology that can help address some of the challenges facing the agricultural industry today. Utilizing sensors, data analytics, and other cutting-edge technologies can raise crop yields, cut waste, and support environmentally friendly farming methods. However, the implementation of IoT-based precision agriculture faces several challenges, including technical expertise, access to reliable infrastructure, cost, data privacy and security, and policy and regulatory frameworks.

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Representation and Classification Methods for Identifying Anxiety States using EEG Signal Processing

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ABSTRACT

Many mental disorders and physical problems have arisen as a result of over thinking and changing lifestyles. This study's main objective is to examine electroencephalograms (EEG) in particular anxiety states so that they can be accurately diagnosed and treated with the right medications. The primary distinction is that anxiety is a stress reaction, whereas stress is typically a response to a threat. Depression, anxiety, and stress are acknowledged as universal diseases. This review represents a comparative study of types with respect to their state of anxiety disorder. Anxiety detection is a challenging undertaking that requires effective non-invasive procedures. In this article, we present a survey of a database which is available online with electroencephalogram (EEG) signals that individuals recorded while being exposed to psychological stimuli in person to provoke fear. Or we can create database using the consumer grade EEG Neuroheadset headset is a wireless wearable piece of inexpensive equipment, EEG data were recorded using it. This study provides a quick discussion of the identification of anxiety disorders and discusses how these emotions can be used to detect distinct anxiety states using EEG signals. There was a review of several EEG interface techniques for anxiety disorders, classification, and applications.

KEYWORDS *: Psychological illnesses, Feature extraction, Classification, EEG, Stress and anxiety detection, Mental stimulation, Feature choice.*

INTRODUCTION

Anxiety is a mental illness that impacts our bodies physically. But, it can have an impact on the immune system, and sadly, research has shown that excessive anxiety can significantly damage the immune system. Our bodies discharge significant levels of the stress hormone that's connected to a physical functioning, because worry is essentially a long-term stress. Also, this invisible handicap has a significant impact on academic success. Anxiety affects memory functions, making it challenging to remember and retrain information. A worried person works less effectively, which has a big impact on his talents. The Anxiety Disorders Association of America claims that one in eight youngsters experience anxiety problems. Yet, it increases the likelihood of subpar performance, lowered learning, and behavioural/social issues at school. As anxiety problems in children are challenging to spot, learning how to spot them early on is crucial if you want to be able to help your child [10].

It may show indicators including heightened emotional arousal, rigidity, and over reactivity. Also, good managing your anxiety and stress can help you continue to high productivity and enjoy life while balancing the stress in your life. Finding the right combination of work, relationships, and self-awareness is the goal. Learning how to manage anxious feelings can help you face a situation. As there is no one-size-fits-all method for managing anxiety, therefore we learn to observe the signs of anxiety, which appear in our bodies, and how our nervous systems respond to them [2]. Reconsider the actions. Determine the trigger, reduce the stress, increase awareness of stress, and create individualized solutions to support resilience and recovery. So, automated anxiety detection is necessary in many different sectors, including stress and anxiety treatment. A fundamental component of affect recognition is the identification of anxiety. The video game industry is another field that might greatly benefit from advancements in affect recognition.

Affect detection algorithms are already being used in new therapeutic environments for the rehabilitation of individuals with severe mental problems. Systems that provide biofeedback can support real-world issues while also assisting children, adolescents, and adults in managing and controlling their anxiety levels. In our study, we approached anxiety as a transient condition, chose healthy participants, and induced anxiety in them by simulating real-world scenarios. Three elements, namely external, internal, and interpersonal, are the main causes of anxiety. Table 1 lists the many types of anxiety along with their environmental triggers. All of the participants who agreed to take part in our experiment were given a survey to complete in order to determine the scenarios with the greatest degrees of anxiety. Here are six scenarios from the poll that we chose as having the highest degrees of anxiety among participants: Loss (68%), problems with the family (64%), money problems (54%), a deadline (46%), seeing a fatal accident (45%), and being mistreated (40%).

Table 1: Categories of Anxiety Triggers and Stimuli [10]

SN	Category	Stimuli
1	External	• Observing a fatal accident • Instability within the family, financial instability, maltreatment, and abuse • Time constraints, security, and routine
2	Interpersonal	• Relationship with the management or supervisor • Lack of faith in the spouse • Being in a humiliating circumstance
3	Internal	• Fear of losing a loved one or • Fear of being betrayed. • Fear that kids won't succeed / Constant guilt. • Bringing up a bad memory • Health (Apprehension of becoming ill and missing a crucial event) • Physique (fear of receiving a bad sickness diagnosis)

RELATED WORK

There is less research done compared to research conducted for emotion recognition, the DEAP was used to validate the majority of the proposed methods for anxiety/stress detection based on EEG signals analysis dataset and EEG-based emotion recognition as in [10]. A 32-channel Biosemi Active 2 headset was used to record it. A total of 40 one-minute-long videos were seen by 32 participants. Giorgos et al. [10] used the DEAP dataset to select two sub datasets of trials based on present criteria for the emotional states of stress and calm.

Arousal and valence thresholds are to be established, and only trials that meet these criteria are to be included. As a result, the previous procedure causes a subset of 18 subjects to comply with the appropriate standard. To represent the examined states, the authors retrieved spectral, temporal, and nonlinear EEG data. As an alternative, some researchers decided to run an appropriate experiment to gather their own EEG signals. Vanita et al research examined students' levels of stress and established their unique experimental technique to record EEG signals throughout a stress-eliciting exercise. After that, noise and ocular artefacts were removed from the data by pre-processing. Using a hierarchical Support Vector Machine with 89.07% accuracy, features were recovered by averaging out classification and a time-frequency analysis was carried out. A mechanism for detecting stress on EEG was proposed by Lahane et al. [20, 10] to investigate the real-time problem.

To collect EEG data, they used a mobile app for Android. Each frequency band's as a feature, the relative energy ratio (RER) was determined. For a stress detection system suggested by [20], 25 Sunway University students were asked to submit a single channel EEG input. The information was gathered and saved using the NeuroSky Mindwave headset for a later examination. Following the Stroop color word test, one-screen instructions were read for 30 seconds, causing students to get anxious for 60 seconds. Just the low-frequency components of the EEG signal that were obtained following DCTs (Discrete Cosine Transforms) were used to classify the data, with the high-frequency components comprising noise and artefacts being

deleted. Reading the instructions was the most stressful aspect of the experiment, according to an interview with the participants, and the data was simply preprocessed and processed for stress categorization for the first 30 seconds [10]. Findings indicate that when it comes to classifying stress, k-NN performs better than ANN (44%) and LDA (60%).

According to Khosrowabadi et al. [10], students experience most stress during the exam period. They carried out both before and after the testing period, they conducted their experiment in light of this information. 26 students were involved in the EEG signal collection (15 during the exam session and 11 two weeks later). An elliptic the data was preprocessed to reduce noise using a band-pass filter (2-32 Hz). This research looked into three main features: (MSCE) Magnitude Square Coherence Estimation, Gaussian mixes of EEG spectrogram, and Higuchi's Fractal Dimension (HFD). SVM and k-NN classifiers were used to carry out the classification phase. The most accurate test in this regard is MSCE, and up to 90% of persistent mental stress is classified. Among the traits used were Relative Spectral Centroid (RSC), Shannon Entropy (SE), and Energy Ratio by Norizam et al. in their analysis, to identify stress in healthy participants (ER). They used 185 EEG records from several experiments for their investigation.

Table 2 shows that the majority of earlier investigations have consulted the international IAPS and IADS databases by selecting different stimuli. Others, however, employed math exercises from, where it is assumed that stress levels rise as task difficulty levels rise. According to our opinion, no one can accomplish mathematical jobs. Hence, only particular people can have this experience. Let's not forget that everyone experiences anxiety, and our goal is to recognize it in everyone without exception. From study to study, the term "anxious states" is defined differently. We will continue to use the term "anxiety" in our work and describe it at the various levels that our therapist suggested. K-NN and SVM are frequently used in classification across all works. As a result, we utilize these works to determine the level of worry. Moreover, during the classification stage, we additionally employ the Stacked Sparse Auto Encoder (SSAE).

Considering this, we take on the difficulty of developing a new database of EEG signals to measure anxiety levels. Our work is innovative not only because we openly share EEG data with the affective computing community, but also because we created a procedure for psychological stimulation that provides participants with comfortable settings for face-to-face interactions with the assistance of the therapist and a wireless EEG cap has just 14 dry electrodes.

Table 2: Previous Research on Detecting Anxiety based on EEG[2]

Reference	Stimulus	#Participants	#Channels	Method description	Affective states	Accuracy (%)
[3]	Audio-Visual	32	32	ESN with features for band power	Stress and Calm	76.15
[1]	Video clip/ Mathematical task/ Audio Visual	88	8	Effective connectivity of DMN, CNN+LSTM	Severe, Mild, Moderate, Control	93
[2]	Video clip/ Mathematical task/ Audio Visual	13	16	Frequency &time domain signal, LSTM	Severe, Mild, Moderate, Control	93.27
[4]	Video clip/ Mathematical task/ Audio Visual	26	16	Raw EEG Signal, LSTM	Severe, Mild, Moderate, Control	90
[5]	Video Clip	32	32	RQA, SampEn, CD, LLE, FD, MLP5, DST6	High low valence and arousal	88.74

[6]	Video Clip	32	32	Wen, SVM	High-low valence and arousal	76.8
[7]	Steady-state visually evoked potential	10	8	CNN	Stress and calm	99
[8]	Examination period	26	8	k-NN and SVM with Higuchi FD, GM and	Stress and Stress free	90

SIGNAL ACQUISITION

Electrodes Interface

Electrodes positioned in various head regions and locations are used to record EEG signals. To capture signals, the positioning of the electrodes is crucial. Presents the electrode location while the EEG signal was being recorded [4]. The method evaluated the impact of electrode placement for various frontal, temporal, and parietal locations on the skull for signal collection and subject identification. The technology consistently displays 100% accuracy in identification. In the recent past, multiple channel interfaces for EEG signal analysis using a brain computer interface (BCI) were described. For applying BCI to the preprocessing and classification of EEG information for anxiety disorder. In the EEG interface, capturing electrode is essential. [7] Provides an explanation of the importance of selective electrode in EEG recording.

Face-to-face psychological elicitation carried out by our psychotherapist in a competent manner achieves anxiety stimulation. The Emotiv EPOC 14 channels wireless EEG headset was used to capture EEG signals, and two mastoids [11] were positioned in accordance with the international 10-20 method. As illustrated in Fig. 1, electrodes were positioned on the scalp at locations AF3, F7, F3, FC5, T7, P7, O1, O2, P8, T8, FC6, F4, F8, and AF4. While a M2 mastoid sensor serves as an indirect reference to reduce outside electrical interference, while comparing the voltages of the other sensors, the M1 mastoid sensor serves as a ground reference point. Because of its ease of use, the EPOC neural headset by Emotiv [2] is employed in this investigation. It provides consumers with comfort and, in large part, because it's wireless, doesn't call for a complicated setup like with clinical EEG equipment. Furthermore, it demonstrates effectiveness when used to Systems that recognize emotions have been shown to work [20] and, recently Emotiv EPOC software was used to record the EEG raw data. We can review and preserve information for all channels or just the customized.

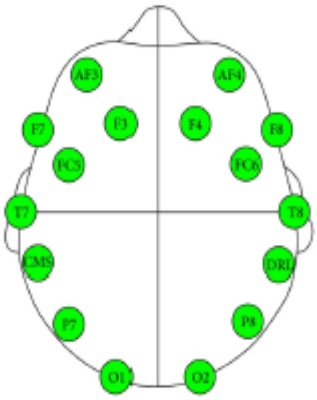

Figure I: Emotiv EPOC electrodes placement

EEG Preprocessing and Database Creation

To go on offer reliable classification results, noise, and artifacts to the feature extraction step with a clean signal in the obtained signal must be found [7]. Electrocardiogram (EMG) artefacts of roughly 1.2 Hz and electrooculogram (EOG) artefacts of less than 4 Hz are examples of physiological artefacts that are produced by sources other than the brain. They may also be in the 50 Hz range, extra physiological, and unconnected to the human body. The surroundings or EEG acquisition conditions may be to blame for this [11]. To denoise our gathering of signals, an EEG Lab script was employed to remove baseline, remove ocular and muscular artefacts, and trim the appropriate sub band of EEG signals. The raw data was passed via a Finite Impulse Response (FIR) pass-band filter 4–45 Hz. EOG and EMG artefacts were eliminated utilizing the Automated Artifact removal for EEG LAB toolkit (AAR) [10]. Many techniques for removing EMG and EOG artefacts are implemented in this toolbox.

We applied the BSS CCA Canonical Correlation Analysis (CCA) implementation, extracting the most auto-correlated components possible from the collected EEG data. We selected the EMG PSD criterion, which classifies components as being EMG-related if their average power ratio falls below a predetermined threshold EEG and EMG regions that are typical. The power is represented by the standard estimator, which is computed as a Hamming-windowed Welch periodogram with segments that are the same length as the analysis window in the EEG and EMG bands.

The toolkit by default includes iWASOBI, an EOG FD criterion, and an automatic correction of EOG artifacts in the EEG using an asymptotically perfect Blind Source Separation (BSS) method for autoregressive (AR) sources. All components with lesser fractal dimensions are marked as artefactual by EOG FD. Conceptually, components with a small number of low-frequency components are those with a low fractal dimension [10]. This holds true for ocular activity frequently, making it an appropriate standard for categorizing ocular (EOG) components. Despite the graphical interface of AAR toolbox, we suggest using scripts to make signal denoising easier and more automated.

System Architecture This paper reviews every step required to develop a reliability from the creation of an experimental technique for anxiety stimulation through the classification of anxiety levels, EEG-based anxiety detection systems have been developed. The suggested system's overall architecture as shown in Fig. 2.

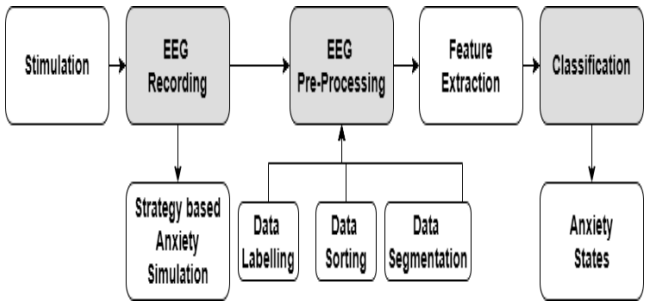

Figure 2: System Architecture

Representation and Processing of EEG Features

When identifying an anxiety state, EEG signal processing extracts the mentioned frequency component and computes several descriptive features. The next sections cover the main strategies for feature representation of EEG signals and their usage in identifying anxiety disorders. The literature has investigated a variety of EEG characteristics for emotion recognition. According to the domain, these features can be broken down the three basic categories are time-domain features, frequency-domain features, and time-frequency characteristics. We mention one of the additional features that can be retrieved from a combination of electrodes in this section. We need to collect some key EEG signal characteristics that we can link with each emotion before we can label an emotion. There are several time-, frequencies-, and time frequency-related signals in the EEG signal [11].

The same five frequency bands are used to construct spectra for characteristics in the frequency domain. The EEG signal is shown in the time-frequency plane using the time-frequency domain, which combines the capabilities of the time and frequency domains. [11] Short-term the TFD techniques Fourier transform, and Wavelet transform are utilized often, and Spectrogram, which extracts features/parameters, depends on them. A crucial aim of feature extraction is to identify key EEG signal characteristics associated with a particular emotion. A handful of the several techniques for extracting features are Auto Regression, Higher Order Crossing, Principal Component Analysis, Fast Fourier Transform, Wavelet Transform, and Short-Term Fourier Transform.

Auto Regression (AR)

The fundamental idea behind this technique is that it forecasts by feeding the regression function with as its input the interpretation from the previous time steps [10]. The Scientific identification of the relevant AR process's power spectrum is possible. Using the AR technique, we may obtain the spectral characteristics of EEG signals. You can get each sample by combining the previous weighted samples.

$$x(t) = \sum_{i=1}^{p} ai\, x(t-i) \quad (1)$$

Where i = 1, 2,….., p and ai = AR coefficients, and p = AR model order[2]

Wavelet Transform

Representation of the frequency domain EEG signal contains more valuable information than the time domain representation. Only a few of the methods used include the Wavelet Transform (WT), Short Time Fourier Transform (STFT), Pseudo Wigner Ville Distribution (PWVD), and Wigner Ville Distribution in time-frequency domain analysis is more appropriate methodology for asynchronous signals like the EEG (WVD). An EEG is broken down by WT a group of orthogonal signals [2].

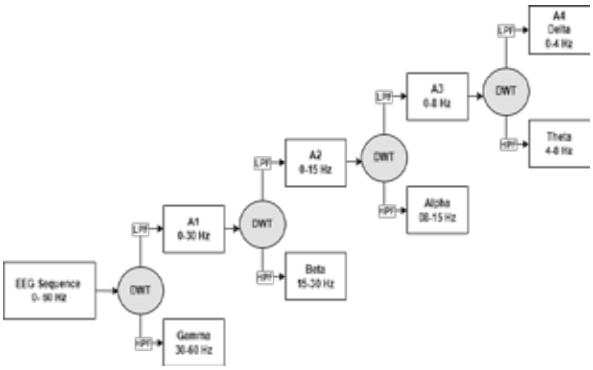

Figure 3: Signal decomposition using Multi Resolution Analysis [2]

The collected wavelet coefficients make up the condensed energy distribution linked to the EEG data. As a result, we employ information and a projected wavelet coefficient of the EEG signals in the feature vectors.

$$Xwt(\tau, s) = \frac{1}{\sqrt{|s|}} \int_{-\infty}^{\infty} x(t)\, \varphi * \left(\frac{t-\tau}{s}\right) dt \quad (2)$$

Here, the mother wavelet is, s is the scale parameter, and x(t) is the raw EEG data.

As a result, using wavelet transform, number of frequency bands can be used to separate an EEG signal. Bank filters enable us to evaluate signals at various frequencies and at various resolutions. For high frequencies, WT provides a better time resolution than frequency resolution, likewise regarding low frequencies. Here, the mother wavelet is, s is the scale parameter, and x(t) is the raw EEG data.

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Short Time Fourier Transform

Considering the EEG signal is not stationary, it changes over time, its spectrum. Transforming Fourier is not the best option to represent such signals [2]. As a result, the shifted window receives the time domain signal, and its FT is then calculated. Denis Gabor created a method based on FT in 1946 to evaluate short segments of signals, and using windowing is nothing but STFT. In this case, the primary preprocessed EEG signal is segmented into minuscule windows. Next, imagine that these components are stationary. Select "w" now apply the window function to brief signals segments. Do the FT right now. Then, reposition these window-like components and recomputed FT.

$$STFT(t', f) = \int_{t} [x(t).\, \omega * (t - t')] e^{-j2\pi ft} dt \quad (3)$$

Where window function w (t), the original EEG signal x (t), and the complex conjugate * are all present. The time parameter is t, while the frequency parameter is f. Hence, we can more precisely determine either time or frequency by changing the window size. STFT has numerous drawbacks, including the inability to determine the precise frequency of a time during which a specific range of frequencies are leaving.

Independent Component Analysis

To separate linearly mixed streams, the ICA technique is used. A statistical model called ICA can reveal hidden aspects of a dataset. It cleans out any noise or artefacts in the incoming [2] EEG signal. Numerous applications, including feature extraction, blind source separation, and neurology, use this paradigm methodology. We must preprocess the data before applying it to ICA to get rid of correlation. So, in ICA, each component is equally important. Vectors in an ICA are not orthogonal. Compression does not employ ICA.

Principal Component Analysis

With the use of this approach, it is possible to divide many variables into smaller groups. It is often

referred to as a dimension reduction tool. Much of the information is in the reduced set. It is a process to turn a huge number of interconnected variables into many primary components, which are unrelated variables [2]. Hence, it is a technique for data compression or dimensionality reduction. Here, the original dataset is transformed into the covariance matrix's eigenvectors. As eigenvectors are known to be orthogonal, PCA also has an orthogonal character. Each eigenvalue has a corresponding eigenvector. The amount of variance in the data along that primary component is represented by a scalar by the name of Eigen value [2].

Fast Fourier Transform

The EEG signal's frequency components can be determined via Fourier Transform, but the signals cannot be temporal components. As a result, while FT can reveal the frequency components that are present in a signal, it cannot reveal when those components occur.

$$X(f) = \int_{-\infty}^{\infty} x(t).\, e^{-j\omega t} dt \quad (4)$$

In this case, the signals X (f) and x (t) are of the frequency and time domains, respectively [2].

As a result, the FFT transforms a sine and cosine wave from the input signal, but with different amplitudes and frequencies. The detected EEG signal is converted into its power spectrum using FFT. [8] Additionally, the EEG signal's spectrum fluctuates over time because it is not stationary. Wavelet transform analysis is used to address this drawback. It provides TFD signals analysis.

CLASSIFICATION

With the use of a classifier that uses chosen features, one can indicate a separation distance between at least two classes. In multidimensional feature space, the dividing hyper plane is nothing more than a border. Below are a few different classifiers. [2, 7]

Linear Discriminant Analysis

This method will use the given data's pattern to recognize patterns. Old predictors will be combined with newly developed variables [7]. This method, which employs the dimension reduction method, is frequently utilized in the pre-processing stages for applications in machine learning and pattern classification. The first step is to enlarge the initial data matrix onto a lower-dimensional space system's primary objective [10].

Neural Network

To process information similarly to real nerve systems like the brain, artificial neural networks were developed [2]. An ANN is primarily made for data classification and pattern recognition. A machine with artificial neurons has only one input and numerous outputs, and it has two working forms of training and testing. Here, information is stored in neurons. The neuron can be programmed to fire in a certain pattern during the training phase. If the When the tested input during testing mode recognizes the trained input pattern, the current output is the linked output. If an input pattern is absent from the list, the firing rule is applied to the remaining patterns to determine whether to fire or not. A crucial aspect of neural networks is their capacity for learning from examples [2]

K-Nearest Neighbors

The classifier is not parametric. There are no decisions taken for the decision boundary. We employ this technique for regression and classification. It categorizes the data based on similarities with the neighbor, giving it the moniker K-Nearest Neighbor [2]. Items from the dataset that are used for classification make up "K." Three inputs are needed for this algorithm: training data (feature space), the number of neighbors closest to you, and measuring the spacing between records and k using a distance measure.

Support Vector Machine

This classification technique is the sole algorithm for supervised machine learning available. SVM bases its definition of decision boundaries on decision planes. A decision plane is used to, a group of objects with several classes of membership will be divided. Both variable separation and regression are supported by SVM. A single data dimension can be divided using a hyper-plane; however, two hyper-planes are needed to separate two dimensions of data.

Finding the ideal thousands of training data in a class or hyper plane sets requires a lot of time for real-

time applications. Thus, regulatory parameters and gamma are used in these situations in order to obtain accuracy. For linear separation, these are utilized. SVM uses a parameter known as the Kernel for nonlinear separation. Kernel functions are used to convert higher-dimensional space from a low-dimensional input space. The only kernel function parameter that can be changed is gamma. SVM performs effectively when the margin of separation is clear. In high-dimensional spaces, SVM is also useful. SVM has a few drawbacks, such as poor performance with large datasets due to longer training times.

ANXIETY DETECTION RESULTS AND DISCUSSION

We think that the categorization outcomes are impacted by uneven information regarding the four anxiety levels. Hence, we suggest regrouping classes two at a time, with the first class being normal and mild and the second class being intermediate and severe, to develop a balanced set of data. While the collection of features makes it possible to deliver rich information, their usefulness in managing more discriminating aspects is generated by the representation. The result of 2 levels is better than the result of 4 levels, and this is primarily because the classification task's difficulty has increased.

CONCLUSION

This study reviews and applies several sets of emotion recognition characteristics, including those for stress and anxiety, based on EEG signals. We highlighted the most popular feature extraction techniques out of the numerous that have been used in the literature. Some techniques work a little bit better than others. We also investigated the most successful features and the most promising trial durations. As far as we are aware, Databases containing portable EEG data are not readily available equipment. Everyone can use the Emotiv EPOC headset, which is accessible and simple to set up. Without contacting a professional, patients can use it to measure their levels of stress at home. This work has numerous clinical implications that can enhance life quality and lessen cognitive impairments.

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Extraction of Atrial Activity using Independent Component Analysis based on Blind Source Separation

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ABSTRACT

A cardiovascular (CVD) disease is common reason for the death in all over the world. Electrocardiogram (ECG) is easily available from human body for the exact diagnosis of cardiac. ECG signal is normally corrupted with noise which provides incorrect diagnosis. ICA is validated based on Atrial Activity (AA) and Ventricular activity (VA) generated by independent sources, AA and VA presents non-Gaussian distributions and ECG signals from CVD are considered as a narrow-band linear propagation process.

KEYWORDS *: Atrial activity; Blind source separation; Independent component analysis; QRS detection; DBE.*

INTRODUCTION

The diseases specially related to cardiac are a major issue of the death in all over the world. The main reason in irregular heartbeat is due to cardiac dysrhythmia or arrhythmia. Cardiac dysrhythmia shows a condition of electrical activity of heart is irregular due to faster or slower heart rate than normal. If the heart beat rate is faster than normal rate is referred as tachycardia. If the heart beat rate is slower than normal rate is referred as bradycardia. Arrhythmia occurs at any age of life, it can lead to death. Arrhythmia is caused due to less awareness of heartbeat called as palpitations. Arrhythmias cause distracting for patients; some arrhythmias do not cause symptoms as they are not associated to increased mortality [1]. Asymptomatic arrhythmias are associated with adverse events. To obtain the heartbeats normally an electrocardiogram technique is considered, this gives the bio-potentials generated from muscle heart rate. The performance of ECG signals analysis the PQRST complex wave of heart activity. The performance analysis of ECG signal depends upon efficient and accurate detection of QRS wave, and also T and P Waves. The noise if present in ECG signal is normally due to the electrode contacts, motion artifacts, power line interference, electromagnetic interference and noise from electronic devices.

INDEPENDENT COMPONENT ANALYSIS

Independent Component analysis (ICA) is a processing process which performs blind source separation of independent statistical sources components by assuming linear mixing of sources with sensors; this generally uses higher order statistics. ICA in this context we, thus, have a means of identifying a non-orthogonal basis (and the basis coefficients) which spans the measurement space, based on the implicit statistical assumptions underlying the ICA decomposition. In this paper [4]-[7] a different implementation of ICA is considered. The basic overview of ICA algorithms is given in [4] [5] which gives the information to also use Fast ICA algorithm, due to ease of implementation and speed of operation. The other methods are also proposed in literature, among this Fast ICA provides speed to separate components from a mixed measurement of channels based on non-Gaussianity Fast ICA provides a very fast iterative algorithm to find projections and non-Gaussianity components by kurtosis or negative entropy.

Independent component analysis (ICA) was used for the processing of the filtered ECG recordings. ICA is a signal processing technique that models a set of input data in terms of statistically independent variables it is

able to separate independent components produced by distinct sources from linearly mixed signals.

$$X = AS = \sum_{i=1}^{m} \hat{a_i} \hat{s_i}$$

Several independent wavefront propagates during AF episode throughout the atria but only a reduced part reaches the AV node. Ventricular activities are strongly limited by the properties of AV node. The cells exciting within the AV node is less than the atrial myocardium, thus it means that the refractory period is larger in atria [1]. The amplitude rate of increasing cardiac action potential decreases from cell to cell because of decremental properties of AV node. Due to this property the impulses traverse through AV node before blocking [2]. In clinical investigations the phenomenon property of concealed conduction, in which atrial does not conduct to ventricles may impair the conduction of impulses, blocking the propagation of other impulses. An atrial wavefronts are not able to produce or do not reach ventricular depolarization due to the consequences of properties of AV node. In other the physical origin of atrial wavefronts which has been able to produce ventricular depolarization is very variable. During an AF episode AA node VA node are reasonably responsible for both activities of physical independent and statistically independent sources of cardio electric activity. In this paper the characteristics and validity of atria ventricular statistical independence is presented [1] [2] [3].

A continuous electrophysiological signal from cardiac muscle constitutes electrocardiogram (ECG) for monitoring of heart rate. ECG signal is several times used for analysis of patient for various diagnostics requirement. QRS complex is most significant requirement from PQRST complex of ECG. This QRS complex waveform gives the best analysis of the human heart rate. Various performance measures such as accuracy, sensitivity and all other relies on this QRS detection [10] [11]. QRS complex is a continuous varying signal which gets affected from noise signal due to electrodes, motion artifacts and EMG. QRS signal detection algorithm is must for realization of accurate ECG diagnosis.

Digital signal processing (DSP) and VLSI are most reliable for implementation of mixed signal filters. Mixed signal filters basically consist of sample and hold circuit and analog to digital converters proceed by DSP and VLSI processors [12]-[16]. Mixed signal filter implementation is an efficient method that can provide low power efficient circuits at a wide range of frequency. A nonlinear analog circuit can serve as channel decoders with low power consumption at higher speed for digital decoders. Analog decoders with analog inputs and outputs are compatible for digital receivers.

To perform the decision-making for detecting QRS complexes an adaptive thresholding scheme is applied to the feature waveform generated from the non-linear LPF stage. A QRS complex is said to be detected, only if the peak level of the feature signal exceeds the threshold. The value of the threshold is then updated each time when a new QRS complex is detected [17].

BLIND SOURCE SEPARATION

The BSS is termed as blind source separation, the term blind considers that nothing is known about the source signals or linear mixture sources only the hypothesis is being the source mutual independence. If the signal obtained from AA node from the 12 lead ECG is to be analyzed using blind source separation (BSS) methods based on independent component analysis (ICA) the three basic considerations arise on body surface is to be justified. These three basic considerations are independence of sources, non-Gaussianity and signal generated from linear mixing of bioelectric sources [8]. This paper gives an outline of mathematical modeling principles behind BSS of linear mixtures.

AF generation gives a strong support to independence and non-Gaussianity of AA and VA. The analysis of linear mixing model for the ECG is obtained from the matrix solution for the forward problem of electrocardiography. The correlation to these conditions makes possible to suitable assume the ECG of patient AF satisfied with BSS instantaneous linear mixture model. This justifies that it is application of independent component analysis. The BSS is considered to recover the set of source signals from the linear observation of mixture sources [9].

IMPLEMENTATION & RESULTS

In this paper the ICA is used for the separation of the Noise Signal and ECG Signal. The noise signal can

be due to motion artifacts or other signal from body tries to override on it. ICA is validated based on Atrial Activity (AA) and Ventricular activity (VA) generated by independent sources, AA and VA presents non-Gaussian distributions and ECG potentials from the cardioelectric sources can be considered as a narrow-band linear propagation process.

The Fig. 1 shows the normal ECG signal which shows the normal condition. Fig. 2 shows the noise signal. ICA separates the noise signal and correctly estimates the noise and filtered ECG signal as shown in Fig. 3. The mean square error rate can be also calculated from the signal as shown in Fig. 4 the result of ICA which clearly gives the information of health by appropriate testing of the signal.

Performance Measures

To Evaluate the Performance of the proposed algorithm, several terms are considered as FP (False Positive) which means false hear beat detection and FN (False Negative) which means failed to detect true heart beat rate.

Accuracy

Accuracy is used as a statistical measure of how a classifier and filtering techniques identifies the condition. The accuracy is the proportion of true results both true positives and true negatives among the total number of cases examined.

$$Accuracy = \frac{TP + TN}{TP + FN + TN + FP} \times 100\%$$

Specificity

Specificity is related to the ECG signal condition is normal (no disease). High Specificity shows that the Monitoring System obtains the Normal Condition as Normal.

$$Specificity = \frac{TN}{TN + FP} \times 100\%$$

Sensitivity

Sensitivity is related to the ECG signal condition is abnormal (disease). High Sensitivity shows that the Monitoring System obtains the Abnormal Condition as Abnormal.

$$Sensitivity = \frac{TP}{TP + FN} \times 100\%$$

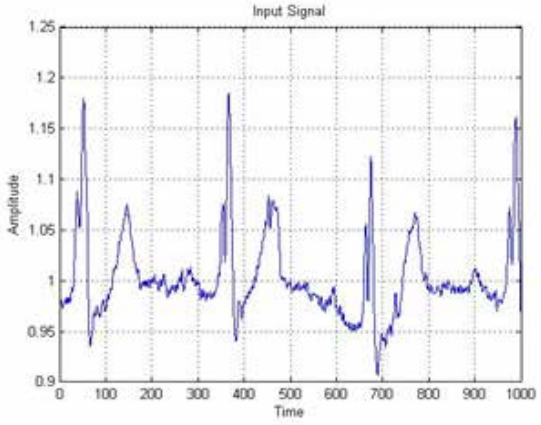

Fig. 1 Normal ECG Signal

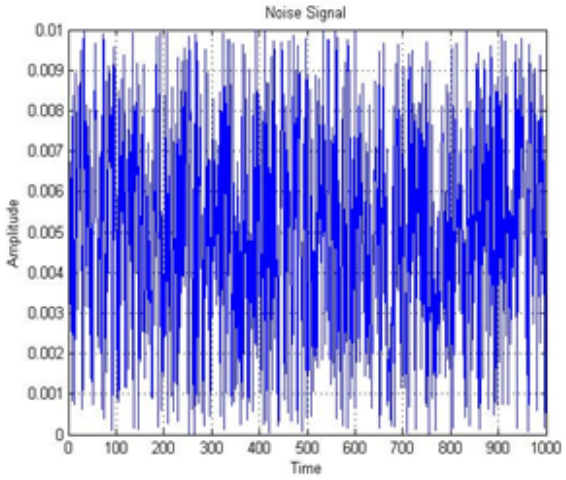

Fig. 2 ECG Signal along with Noise Signal

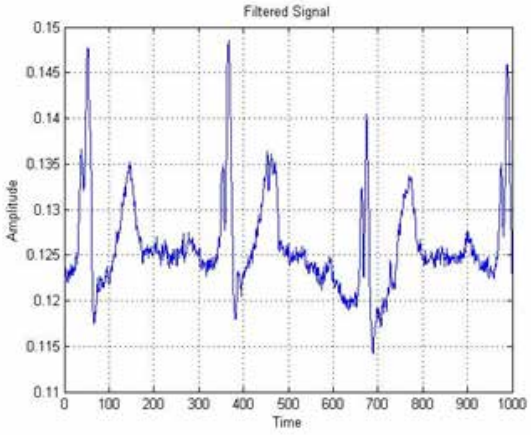

Fig. 3 Accurate ECG signal Response using ICA

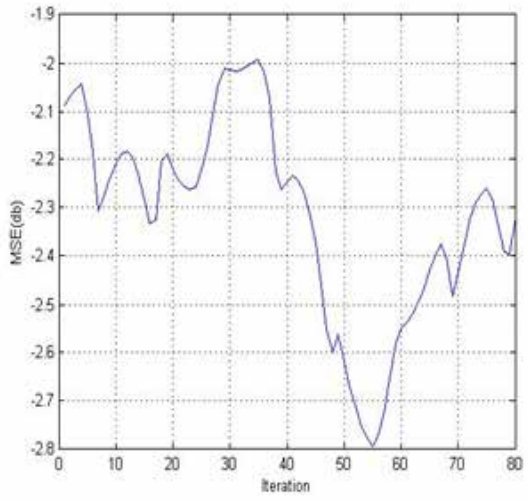

Fig. 4 Mean Square Error response in (db)

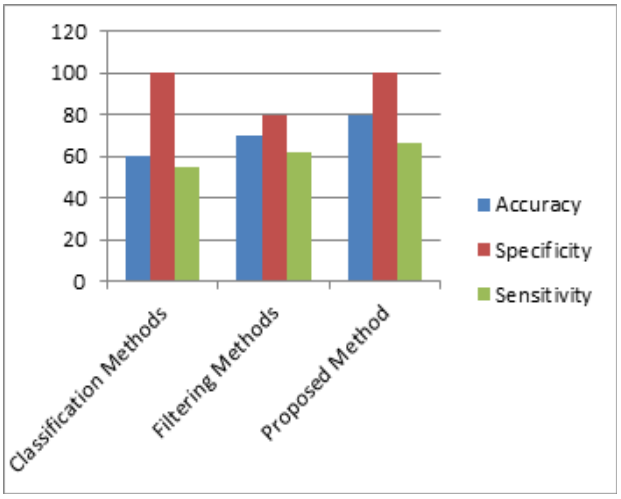

Fig. 5 Graphical Representation Comparison of different methods

False Positive Rate:- The false positive rate is the proportion of the conditional probability of a positive test result given an absent event.

$$FPR = \frac{FP}{FP + TN} * 100\% \quad (4)$$

Positive Predictive Value:- The Positive predictive values PPV are the proportions of positive results in statistics and diagnostic tests that are true positive results.

$$PPR = \frac{TP}{TP + FP} * 100\% \quad (5)$$

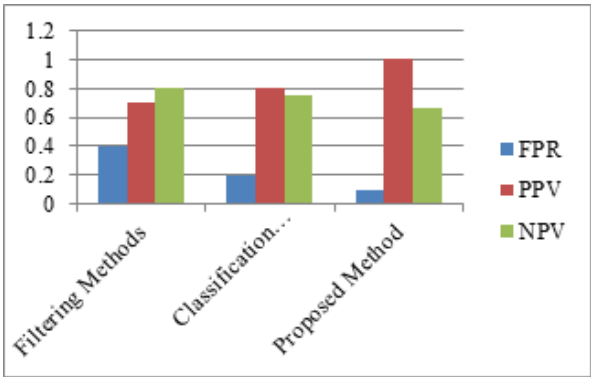

Fig.4 Graphical comparison of methods with proposed methods

Negative Predictive Value:- The Negative predictive values NPV are the proportions of negative results in statistics and diagnostic tests that are true negative results.

$$NPR = \frac{TN}{TN + FN} * 100\% \quad (6)$$

The Graph shows the statistical analysis of filtering methods, classification methods and proposed method. The performance measures such as False Positive Rate, Positive Predictive Value and Negative Predictive Value are compared.

CONCLUSION

This paper focuses on AA recorded from the surface ECG signal analysis can be effectively carried out based on BSS technique for instantaneous linearly mixed signals. This technique in biomedical problem is considered in connection with three main assumptions. Initially during atrial arrhythmia activity complex, AA and VA is considered as statistically independent sources obtained from cardioelectric sources. Secondly, this both the signal obtained presence a non-Gaussian character. Finally, these both nodes are linear mixture of cardiac sources, in this unknown mixture coefficients depends upon ECG electrodes position conductivity with body tissues. This makes a main reason for considering the BSS along with ICA for analysis of exact and accurate detection of the ECG signal. Traditional techniques to obtain and process AA signal are presented in many algorithms, in contrast the BSS based method estimates a single signal which is able to reconstruct AA present in every ECG signal completely. In other BSS approach

provides a best alternative procedure for QRST cancellation in atrial arrhythmia analysis.

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Comparative Analysis of Prefabricated and Cast-In Situ Buildings

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ABSTRACT

Prefabricated vs. cast-in-place buildings' energy efficiency, time-saving, costs, and environmental effects were compared for buildings in Delhi, India. Due to the extensive use of raw materials and the high energy requirements for turning them into the finished product, the construction sector is one of the most energy-intensive in the world. The comparison of the two construction methods leads to the conclusion that the precast construction technique outperforms the cast in situ approach in every aspect, including time, cost, energy use, and environmental impact. Due to the shrinkage of the structural elements' sizes, the cast-in situ building method uses more material than the precast construction method and saves around 18.21% of it. There is a significant time difference between the two construction methods. In both construction processes, the superstructure requires the longest time.

KEYWORDS *: Prefabricated construction, Conventional construction, Energy performance, Environmental impacts.*

INTRODUCTION

Constructions are essential components that support a country's long-term growth and are a crucial component of civilization. India's construction industry has grown significantly over the past few years, and by 2050, the country's population and urbanisation are expected to continue to expand. India is one of the top 10 countries in the world for energy consumption, accounting for 40% of all energy use in construction-related activities [1]. According to the World Energy Outlook's Special Report-2015, buildings rank second in terms of energy consumption, behind the industrial sector [2], as a result of the greater use of materials throughout the construction process. Manufacturing building materials, transportation, and the construction process all consume significant amounts of energy. Cast in situ requires more time than precast, which directly relates to cost, hence time plays a significant role in project costs.

Literature Review

Activities related to construction projects account for 40% of total energy use and India is the top 10 energy-efficient countries. [3]. Acc. To World Energy Outlook's report indicates that buildings are at 2nd in energy use [2] Due to the mass consumption of goods in all phases of construction activities. It is very important to become aware of the energy used, in the already used construction procedures and finds ways to reduce the consumption. [4] Carbon emissions per m3 of pre-cast concrete are 10% lower than the conventional method [5]the small output of previously constructed buildings means that the energy used or the fuel used is less.

Using precast can reduce 65% of construction waste and 16% of personnel and 15% of construction time on construction and 5% of carbon emissions. [6].Life cycle(LCA) is used to get the better staging of a material throughout its entire life cycle. A spatial survey was conducted to analyze precast processes and to collect LCA analysis data. LCA is made of materials such as cement, stone, sand, reinforcement, aluminum, steel, and tile [7].

Prefabrication is a more efficient option than traditional construction. Buildings and construction, according to the IEA report 2019, accounted for 39% of energy and

carbon dioxide (CO_2) emissions and 36% of renewable energy consumption by 2018, 11% of which came from the manufacture of related building materials and goods. and glass, cement, and metal. Construction is a very resourceful and powerful sector of the economy [8,17]. India's energy consumption will be reduced in large part through a transformation in the building sector. The pre-built construction approach improves sustainability in building and benefits the environment. Numerous studies have taken into account the pre-built structures' sustainability advantages. Pre-built structures require less production during the constructing phase than traditional structures [9, 13].

Prefabrication is a sustainable technique of building that increases site safety, offers better quality control, and requires less time and labor. Precast technology helps to cut construction waste by 52% and timber formwork by 70%. Precast concrete uses 14.5 kg of steel formwork while cast-in-situ concrete needs 45.7 kg of timber formwork to produce 1 m3 of concrete. Timber formwork emits significantly more carbon dioxide than steel formwork to create the same volume of concrete [9,10].

The majority of the built environment on earth is made of concrete, which accounts for around 60% of all construction materials. In comparison to cast-in-place columns, precast concrete columns were typically 21.4% less expensive [11]. The lowest reduction was 18.33 percent, and the largest was 24.5%. The amount of concrete used for slabs is one-third that of cast-in-place construction.

AIMS AND OBJECTIVES OF THE STUDY

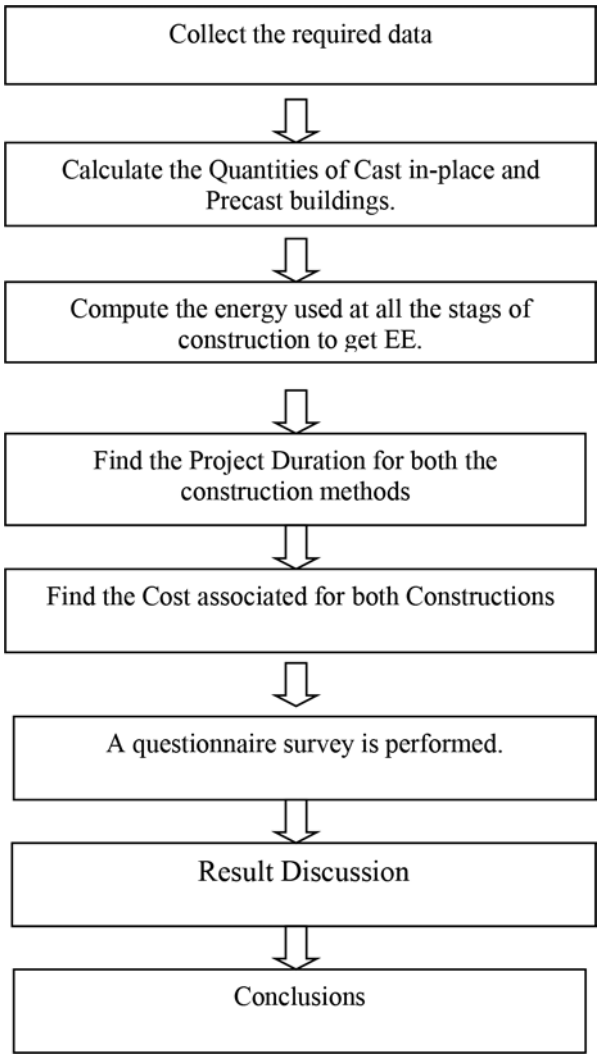
This research aims to investigate better construction Technology that is more environmentally sustainable to be used for affordable housing. This aim will be further verified by running a life cycle assessment LCA for prefabricated and conventional construction.

The following objectives have been considered in this work:

- To calculate the amount of energy used in conventional and prefabricated structures as the amount of energy used per square metre of the building's floor space.
- Obtain a wider system boundary using a cradle-to-cradle method that will help to learn about the nature and Environment impact of pre- and cast-in-place buildings and provide a broader future.
- Finding out how much time and cost a pre-constructed building needs to be built compared to a similar design building in the usual way.
- To corroborate the above objectives a questionnaire survey is performed.

METHODOLOGY

In order to calculate the energy, carbon equivalent, time, and cost involved with each method, each stage of the building of prefabricated and conventional concrete structures was determined.



DETAILS OF THE STUDY

To compute the energy, environment impact in terms of kg CO_2 eq, time, and cost, a fully prefabricated residential building and the cast in situ building, situated in Delhi, was chosen as a test case.

Table 1. Details of Prefabricated residential building

General	Measurements	Specifications
Building type Residential: 5 floors	Build-up area of single apartment unit: 98 m^2	Precast elements in buildings: wall panels, beams, solid slabs, and staircases.
Wall panel, slab, and footing	The size of wall panels varies from 120mm to 300mm. Partition wall = 120 m External wall = 230 mm **Slab Thickness=** 60mm Strip footing (450*600).	The reinforcement used is 8mm
No. of apartments per floor: 3	The floor area of each floor: 300m^2	Grade of precast element: M40
Story height: 3.15 m		
Distance of precast plant to site.	500m	
Distance b/w RMC plant and site.	Within the precast plant.	

Table 2. Details of the conventional residential building

General	Measurements	Specifications
Building Type Residential: 5 floors	Build-up area of each apartment unit: 98 m^2	The building consists of 12 columns of the same size and the size of the beam is also the same
Beam, column, slab, and footing	Size of beam and column (300*450). The r/f details of the column 8 bars – 20 mm and beams 4 bars- 16 mm 2 bars- 12mm Strip footing (450*600).	
No. of apartments per floor: 3	The floor area of each floor: 300m^2	Grade of concrete used: M40
Story height: 3.15 m		
Distance of precast plant to site.	500m	

RESULTS

Material Computation of Both Buildings

The data for material quantity is taken from the site and calculated manually from the data revived. From the table given below, it is shown that material consumption is more in the case of cast in situ building over the conventional building construction.

Construction Time of Both Buildings

The time during the construction of both buildings is given below. As the result shows precast concrete building construction takes less time while cast in situ takes more time to complete. [14]

Precast takes 234 and cast in situ takes 144 days to complete.

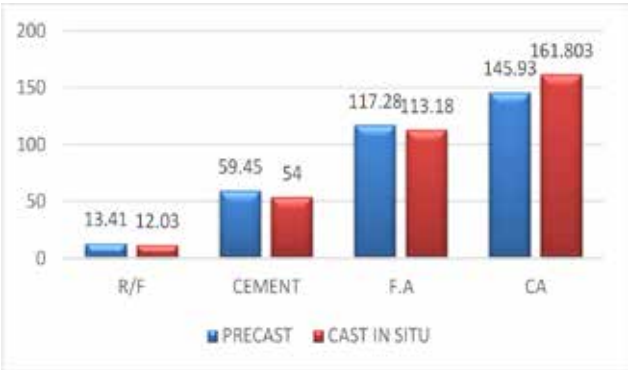


Fig.1 Material quantity comparison

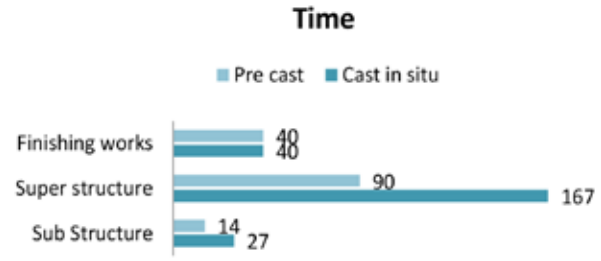


Fig 2. Time for Cast in situ construction and precast concrete construction.

Cost Analysis

Cast in situ concrete building costs more than the precast concrete building. The cost of both the building's construction method is given below

Table 3. Cost Comparison of both buildings

S.no.	Description	Cast in Situ	Pre Cast
1.	Cost	7041362.73(lac.)	5684646.34(lac.)

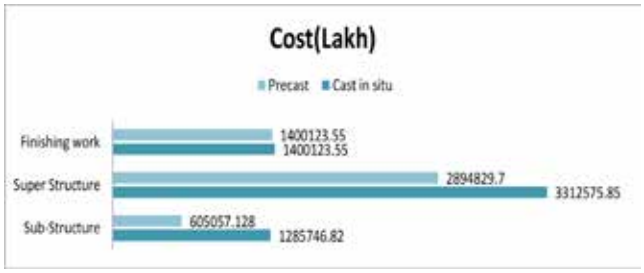


Fig 3. Cost comparison of both buildings

Energy Computation of Both Buildings

Because so many raw materials are used in construction, turning all of those resources into the finished product requires a lot of energy. Energy used in the building process and energy used in transportation are other concerns. The energy is calculated for both buildings. For finding the embodied energy EE coefficient of the materials are taken for the Indian context. [12]

For Precast Concrete

The total energy consumption of the precast building is the sum of energy utilized during the manufacturing of raw materials and the energy utilized during the construction stage and is equal to 682369.34+32904.03 =715273.37 MJ

The total energy consumption of the cast in situ building is the sum of energy utilized during the manufacturing of raw materials and the energy utilized during the construction stage and is equal to 6,70,714.16 + 51451.67+ 14648.61+237825 = 974639.44 MJ

Carbon Emission Computation of Both Buildings

One of the main sources of greenhouse gases is the building sector's carbon emissions. According to statistics, building construction and operation account for 35% of the world's energy consumption and 29% of the CO_2 emissions overall. [10]. Both structures' carbon emissions are calculated in units of kg CO_2 eq. The GWP coefficient data is gathered specifically for the Indian setting. [12].

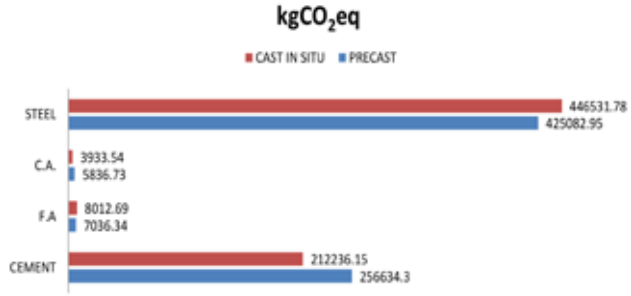


Fig 4. Carbon Comparison of Building Materials

The calculation for the CO_2 equivalent is found as follows

1 gallon(4.54 ltr.) = 10.18 kg CO_2 eq (Environmental Protection Agency) [161].

1 kWh = .433 kg CO_2 eq.(Environmental Protection Agency) [16].

The total carbon emission of precast building construction is = 74688.49 kg CO_2 eq.

Total carbon emission of cast in situ building construction is = 108839.83 kg CO_2 eq

Questionnaire Survey

A questionnaire survey is performed to gather information from industry experts on their views/ opinions towards precast concrete construction. The survey is sent to civil engineers, architects, and contractors who are working with this technology. The Survey is done through Google Forms filling by emailing them and manual site visits. A total of 78 respondents fill the survey and data is analyzed through Descriptive Statics through SPSS software.

Table 4 Descriptive Statics through SPSS software (hindrance in precast technology)

	N	Min.	Max.	Mean	Std. Deviation	Rank
Lack of technical training	78	3	5	4.3462	.55425	1
The hidden cost of prefabricated building	78	3	5	4.2564	4.2564	2
Proprietors do not want prefabrication	78	1	5	3.6538	1.10285	3
lack of adequate transport and logistics	78	1	5	2.2179	1.18044	4
Inadequate supplies of prefabrication	78	1	4	2.0641	1.0852	5
Valid N (listwise)	78					

Table-5 Descriptive Statics through SPSS software(advantages of precast technology)

	N	Min.	Max.	Mean	Std. Deviation	Rank
Reduce construction cost	78	3	5	4.4103	0.54501	1
Shorten construction time	78	3	5	4.4103	0.54501	1
Reduction on-site Labor	78	3	5	4.4103	0.71051	1
Less Environment Impact	78	3	5	4.3974	0.69019	2
Reduce construction waste	78	3	5	4.3077	0.51743	3
Fewer onsite resources	78	3	5	4.2308	0.70108	4
Achieving green goals	78	3	5	4.2051	0.56658	5
Environment/sustainability as the priority	78	2	5	4.1667	.88884	6
Better quality	78	3	5	4.0769	.5529	7
Durability	78	3	5	4.0769	.5529	7
Minimum maintenance	78	2	5	3.9359	1.14347	8
Better Construction Standard	78	2	5	3.8846	.91141	9
Dimensional Accuracy	78	2	5	3.7821	1.13558	10
Rationality of splitting prefabricated components	78	2	5	2.8718	1.1091	11

CONCLUSIONS

The following conclusion is drawn from the study.

- The results show that Cast in situ buildings consume more than precast concrete buildings. The precast concrete building is more effective in saving material.
- There is a 27.60% saving in cost in the case of precast concrete building construction. The construction of superstructure has a major share in cost in both methods of construction.

- The precast construction method saves approx. 50% time.
- There is a saving of 36.28% in energy consumption by adopting the precast construction method.
- The material extraction stands at 1st place in total energy consumption, which stands for 5, 94368.03MJ which is 95% of the total energy consumption in the precast method and in cast in situ it stands at 722,165.83 MJ which is 75%.
- Transportation stood at 2nd place in terms of energy consumption which is 25366.02 MJ which is 4% in precast technology in the case of cast in situ it has 13445.69 which is 1.37%.
- The plant Process in the case of pre-cast concrete technology is 1246.71 MJ which is .2% and in the case of cast in situ 1203.02 MJ which is .12%. Carbon Emission.
- Cast in situ construction method consumes more material and the precast construction method less due to a decrease in size of the structural elements and saves around 18.21% material.
- Construction cost, environmental impact, construction time, and less energy consumption offers significance advantages for precast construction as resulted in the questionnaire survey as well. The major hindering come out to be a lack of technical training and the hidden cost of prefabricated buildings.

FUTURE SCOPE

1. The energy and environmental impacts were analyzed by using the tools of LCA.
2. Analyzed any infrastructure project.
3. Analyzed any substitute material used in construction like geopolymer, and fly ash.
4. Analyzed different construction technology methods like prestressed.

Appendix

Appendix 1 Material Computation of both buildings

Table 6. Material Consumption of prefabricated building

Materials	Units	Quantity
Reinforced Bar	kg	13418.83
Cement	tonne	59.45
Fine aggregate	tonne	117.28
Coarse Aggregate	tonne	145.93
Bricks	No.	0
Concrete(M40)	cum	130.11

Table7. Material Consumption of conventional building

Materials	Units	Quantity
Reinforced Bar	kg	12003.3
Cement	tonne	54
Fine aggregate	tonne	113.18
Coarse Aggregate	tonne	161.803
Bricks	No.	22650
Concrete	cum	114.28

Appendix 2 Construction Time of both buildings

Table 8. Time Comparison of Cast in situ building

S.no.	Description	Duration	
1.	Sub Structure - (Site cleaning, Earthwork, Basement, Consolidation. Soil filling Foundation	27	
2.	Super Structure (Columns, Lintel& sunshade, Beams, Roof slabs, Brickwork, Plastering.)	167	
3.	Finishing Works – (Tiling, Electrical, installation of doors & Windows Plumbing Painting, and, Extra items.)	40	
		234 days	

Table 9. Time Comparison of Pre-Fabricated Building

S.no.	Description	Duration
1.	Sub Structure - (Site cleaning, Earthwork, Basement, Consolidation. Soil filling Foundation)	14
2.	Super Structure –(Erecting elements, Wall panels framing and Roofing slabs,)	90
3.	Finishing Works – (Tiling, Electrical, installation of doors & Windows Plumbing Painting, and, Extra items.)	40
		144 days

Appendix 3 Cost Analysis Cost Comparison of both building

Table 10. Cost Comparison of both buildings

S.no.	Description	Cast in Situ	Precast
1	Sub Structure - (Site cleaning, Earth work, Foundation, Soil filling Consolidation.)	**1285746.82**	**6,05,057.128**
2	Super Structure (Columns, Lintel& sunshade, Beams, Roof slabs, Brickwork, Plastering.)	**3312575.85**	**2894829.7**
3	Finishing Works – (Electrical, Plumbing Painting, Tiling, and Installation of doors & Windows, Extra items.)	**14,00,123.55**	**14,00,123.55**
		4598322.67	**2894829.7**

Appendix 4 Energy Computation of both buildings

Because so many raw materials are used in construction, turning all of those resources into the finished product requires a lot of energy. Energy used in the building process and energy used in transportation are other concerns. Both structures' energy is calculated. For the Indian context, the materials' EE coefficients are used to determine the embodied energy. [15]

For Precast concrete:

Table 11. The embodied energy of pre-fabricated building

S.no.	Description	Cement	F.A.	C.A	Steel	Total
1.	EE coefficient of materials(MJ/kg)	4.32	.06	.04	34.23	
2.	Quantity for $1m^3$ concrete($Kg/m^{3)}$	456.97	901.42	1121.64	103.13	
3.	EE of material(MJ/m^3)	1974.11	54.08	44.86	3530.13	
4.	Total EE(MJ)	256634.3	7036.34	5836.73	425082.95	**694590.32**

Table 12. Energy Comparisons of pre-fabricated building

S.no.	Description	Plant Process	Erection	Precast Transportation	
1.	Fuel/Power	3.7 kWh/m^3	5.10 l/m^3	2.65 l/m^3	
2.	Energy	12.42 MJ/m^3	190 MJ/m^3	62.7 MJ/m^3	**Total**
3.	Total EE(MJ)	1541.44	23580.9	7781.69	**32904.03**

Cast in situ concrete:

Table 13. the embodied energy of cast in situ building

S.no.	**Description**	**Cement**	**F.A.**	**C.A**	**Steel**	
1.	**EE coefficient of materials(MJ/kg)**	4.32	.06	.04	34.23	
2.	**Quantity for 1m^3 concrete(Kg/$m^{3)}$**	394.8	1073.33	790.3	104.83	
3.	**EE of material(MJ/m^3)**	1705.53	64.39	31.61	3588.33	Total
4.	**Total EE**	212236.15	8012.69	3933.54	446531.78	**6,70,714.16**

Table 14. Energy Comparisons of cast in situ building

S.no.	**Description**	**Site Process**	**RMC plant**	**Transportation(L)**	
1.	Fuel/Power	1.43 kWh/m^3	1.5 kWh/m^3	3.16L/m^3	
2.	Energy	5.14 MJ/m^3	5.4 MJ/m^3	117.8 MJ/m^3	Total
3.	Total EE	586.67	616.35	13445.69	**14648.61**

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Experimental Investigation of Thermal Energy Storage System by Design of Experiments

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ABSTRACT

The electricity sector is presently facing a critical challenge of generating energy that is secure, sustainable, and affordable. To address environmental issues, it is necessary to adopt renewable energy sources and enhance energy efficiency. Thermal energy storage systems are one of the solutions that have recently received significant attention, which are designed to store thermal energy and employ it for fulfilling energy demands. The factors, including the type of storage material, charging temperature, mass flow rate, and HTF flow rate, have an impact on the functioning of storage systems. Researchers have employed various optimization methods, like the Taguchi method, grey relational analysis, response surface methodology, entropy generation minimization, and multiple regression analysis, with the aim of enhancing the performance of the system. This research paper presents the findings of investigations, with a particular focus on the Taguchi method, which is utilized for optimizing the thermal energy storage system. The work explores the experimental design, the implementation of the Taguchi array, and the influence of various factors, including flow rate, inlet temperature, and storage material, on the performance of the system. The findings of the research demonstrate the effectiveness of the Taguchi method in optimizing the system's performance, with the inlet temperature being the most influential factor compared to other variables.

KEYWORDS *: Thermal energy storage, Phase change materials, Taguchi analysis, Orthogonal Array.*

INTRODUCTION

The Sustainable Development Goals Report 2022 points out the negative impact of global crises such as COVID-19, climate change, and conflict on the 2030 Agenda for Sustainable Development .The report highlights the need to adopt low-carbon, resilient, and inclusive development pathways to address these challenges. [1]

The COVID-19 pandemic and the Ukraine crisis have deepened challenges to the transition to renewable energy, clean hydrogen, and sustainable biomass. Electrification and efficiency improvement are highlighted as crucial drivers in the International Renewable Energy Agency's 1.5°C pathway, but progress in all sectors has fallen short. Current efforts are insufficient to achieve Goal 7 by 2030 and to mitigate greenhouse gas emissions; there is a need for an acceleration in energy efficiency to take place. COVID-related restrictions lowered energy-related CO_2 emissions in 2020, but emissions for 2021 rose by 6%, reaching their highest level ever. [2]

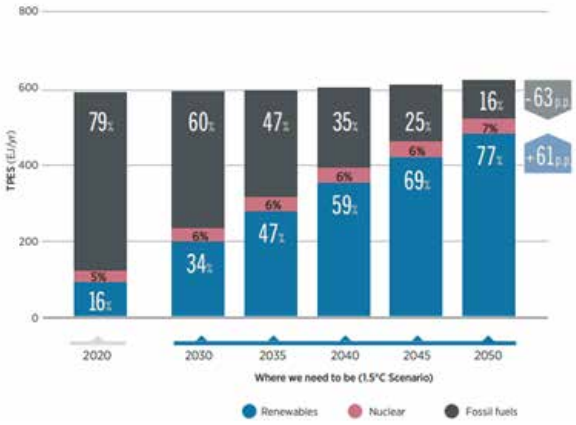

Fig. 1: The 1.5°C Scenario projections: Total primary energy supply by energy carrier group from 2020 to 2050. [2]

The worldwide transition towards renewable energy systems, in alignment with the Paris Agreement, anticipates the rapid implementation of thermal energy storage (TES) technologies across various sectors. Thermal energy storage (TES) has the potential to enable the smooth incorporation of variable renewable energy (VRE) into power generation, industrial processes, and building applications. Thermal energy storage is noticed as a key technology in enabling the transition to VRE. [3] Storing solar energy and improving energy efficiency are effective ways to mitigate energy and environmental crises.

LITERATURE REVIEW

The favourable properties of thermal storage systems are their high-energy storage density and isothermal in nature. Several researchers have evaluated the performance of thermal energy storage systems by using statistical techniques and conducting various experiments.

M. A. Islam et al. (2019) presented an optimization approach using the Taguchi method and response surface methodology (RSM) for a thermal energy storage system based on phase change materials. The authors evaluated the system's performance by conducting experiments under different conditions and using the Taguchi method to identify the best parameter settings. The RSM was then used to generate a mathematical model to predict the performance of the system. The findings indicated that the optimized system had improved energy storage efficiency and reduced energy loss compared to the unoptimized system [4].

Y. H. Lee et al. (2019) applied the artificial neural network and the taguchi method to enhance the thermal energy storage performance of a paraffin wax-based system. The findings indicated that the optimized system exhibited an improved energy storage capacity and lower energy loss compared to the non-optimized system. [5].

Y. Guo et al. (2020) recommended an approach to optimize the thermal energy storage performance of a salt hydrate-based system using the Taguchi method and entropy generation minimization (EGM). The authors conducted experiments to evaluate the system's thermal performance and analyzed the results using the Taguchi method and EGM. The optimized system showed a significant improvement in energy storage efficiency compared to the non-optimized system [6].

R. K. Misra et al. (2021) applied the Taguchi method and grey relational analysis (GRA) to optimize the thermal energy storage performance of a paraffin wax-based system. The study shows that the Taguchi method and GRA can effectively optimize the thermal energy storage performance of the system by reducing the energy loss and increasing the energy storage efficiency [7].

The thermal properties of a vertical cylindrical latent heat storage system were investigated using ANOVA in a paper by S. Tariq et al. (2018). The study showed that ANOVA is a useful tool to determine the most significant factors that influence the heat transfer performance of the system [8].

The experimental study of a shell-and-tube latent heat storage system using phase change material with ANOVA is presented in the paper by M. R. Islam et al. (2019). The authors performed experiments and analyze the data using ANOVA to investigate the effect of input parameters such as flow rate of HTF and mass of PCM on the operation of the system. The outcomes demonstrate the effectiveness of using ANOVA for analyzing and optimizing the performance of thermal energy storage systems [9].

M. A. Islam et al. (2021) illustrated an ANOVA-based response surface methodology for optimizing thermal energy storage systems. The study shows that the proposed methodology can effectively minimize the required number of experiments for optimization and significantly enhance the system's efficiency. The authors also discussed the limitations of the methodology and suggest areas for future research [10].

S. S. Rajput et al. (2020) explained an optimization approach for storage systems in solar thermal power generation using a Taguchi-ANOVA approach. The study showed that a Taguchi-ANOVA approach could effectively optimize the system's performance by identifying the significant input parameters and their optimal levels [11].

S. Gupta et al. (2022) presented a design and analysis of a TES system employing three phase change material

and ANOVA. According to the study, ANOVA can be used to identify the system design variables that have a significant effect on performance. These elements can be optimized to enhance the overall efficacy of the system [12].

M. A. Islam et al. (2021) performed an optimization analysis of a TES system that employed phase change materials (PCM) and artificial neural networks (ANNs). The study uses a two-level factorial design to explore the impacts of different parameters on the system's operation, including melting temperature, melting enthalpy, and the height of the PCM. The authors demonstrate that an ANN-based regression model is more accurate than traditional regression analysis [13].

Y. Guo et al. (2021) utilized the response surface methodology and regression analysis to optimize the system's performance by investigating the effects of various parameters. This type of passive thermal energy storage system has potential applications in building and industrial energy management where it can be used to shift energy consumption to off-peak hours, reduce peak demand, and reduce overall energy costs [14].

K. D. Khandelwal et al. (2022) presented the implementation of multiple regression analysis (MRA) to develop a PCM based thermal energy storage system. The outcomes indicated that the suggested MRA-based study accurately predicts the system's performance, and the optimized system achieves a high-energy storage efficiency [15].

The numerical and experimental study of a PCM based thermal energy storage system using multiple regression analysis (MRA) is presented by S. S. Rajput et al. (2022). The impact of various parameters, including the flow rate, PCM's mass, and the charging temperature on the system's performance are studied. The proposed MRA-based model has a higher accuracy than the traditional regression analysis approach, and the optimized system achieves a high-energy storage efficiency [16].

These researchers have explored the impacts of different parameters, including the phase change material type, mass flow rate, charging temperature, and HTF flow rate on the system's performance. The outcomes demonstrated that the optimized systems had higher energy storage capacity, efficiency, and lower energy loss compared to the non-optimized systems. The studies demonstrated the effectiveness of the optimization techniques in improving the overall efficiency of the thermal energy storage systems.

EXPERIMENTAL SET UP

Figure 2 illustrates the systematic arrangement of a Double pipe heat exchanger along with additional components. The experimental unit comprises the following elements:

1. Hot fluid flow channel, 2. PCM compartment, 3. Cold fluid flow channel, 4.Heating arrangement, 5. Flow rotameter, 6.Temperature sensors, 7. Pump, 8. Control panel units, and valves are employed to regulate the flow rate and direction.

Total 5 K-type thermocouples are employed to measure the inlet and outlet water temperatures of the heat exchanger; other thermocouples are used to measure the temperature distribution of the storage materials. All calibrated thermocouples ensure an estimated temperature error of 0.1 °C. The temperature difference of the water, measured directly by connecting a thermocouple at the outlet and another at the inlet in series. The glass tube flow meters with a precision of 2% are used to measure the flow rate of circulating water. The storage material is deposited within the outer chamber.

Fig. 2: Experimental set up

Selection of Materials

Table 1: Selection of materials

Properties	Paraffin wax	Stearic acid	Sodium thiosulfate pentahydrate
Chemical Formula	C_nH_{2n+2}	$C_{18}H_{36}O_2$	$Na_2S_2O_3.5H_2O$.
Density, Kg/m^3	880-950	940	1666
Melting Point, °C	58 °C	69.3 °C	46
Latent Heat, KJ/Kg	168	67.5	206
Specific Heat, KJ/kg K	3.00(s) 2.00(L)	1.76 (s) 2.27 (L)	1.46 (s) 2.39 (L)
Thermal Conductivity, W/m K	0.20(s)	0.29(s) 0.17 (L)	0.76 (s) 0.38 (L)
Boiling point, °C	370 °C	361 °C	100 °C

Design of Experiment

The process variables, which influence system performance, are identified, and their range of values is determined. . Orthogonal arrays are generated to define the experimental conditions, taking into account the number of variables and the levels of variation for each variable. The experiments are conducted based on the conditions specified in the arrays, and the resulting data is collected.

An experimentation applies a Taguchi design for optimization, considering factors such as inlet temperature of hot water, the flow rate of cold water and different types of thermal storage materials. During charging, the measured response is the outlet temperature of hot water. During discharging, the measured response is the outlet temperature of cold water. The thermal energy storage system operates in two modes: charging and discharging only. In the charging mode, heat is transmitted to the storage material via the inner channel, storing energy as sensible heat and/or latent heat. The cold fluid absorbs heat from the storage material through the inner pipes in the discharging mode. The heat exchanger contains 2 kg of storage material.

Taguchi Design – Charging

Following three factors are considered: flow rate (in Lit/min), inlet temperature of hot water (in °C), and storage materials. The levels for each factor are also confirmed. The total number of runs for the experiment was nine.

Design Outline :

I. Taguchi Array. : L9 (3×3)

II. Factors.: 3

III. Runs. : 9

Table 2: Factors and their levels

Factors				
Sr.No.	Levels	Flow rate Lit/min	Inlet Temperature of Hot water (°C)	Storage Materials
1	1	1	65°C	Paraffin wax (PW)
2	2	2	70 °C	Stearic acid (SA)
3	3	3	75 °C	Sodium thiosulfate pentahydrate (STSP)

Table 3: L9 Orthogonal Array – Charging

Trial no.	Flow Rate (LPM)	Inlet Temp(°C)	Storage Material
1	1	65	PW
2	1	70	SA
3	1	75	STSP
4	2	65	SA
5	2	70	STSP
6	2	75	PW
7	3	65	STSP
8	3	70	PW
9	3	75	SA

The nine runs are presented in the L9 orthogonal array table. Each run represents a combination of the three factors at different levels. This array is designed to reduce the number of runs required to obtain significant outcomes and simultaneously recognizing the most important factors influencing the response variable.

Taguchi Design – Discharging

Design Outline :

I. Taguchi Array. : L9 (3×3)

II. Factors.: 3

III. Runs. : 9

Table 4: Taguchi Design – Discharging

Trial no.	Flow Rate	Inlet Temperature (°C)	Storage Material
1	1	30	PW
2	1	32	SA
3	1	34	STSP
4	2	30	SA
5	2	32	STSP
6	2	34	PW
7	3	30	STSP
8	3	32	PW
9	3	34	SA

The Taguchi design for discharging has been conducted using an L9 (3×3) array. It comprises three factors at three levels each, resulting in nine runs. The factors considered are flow rate, inlet temperature, and storage material. The design matrix is used to conduct the experiments, and the results are recorded for each run. The Taguchi approach is then used to determine the most effective combination of factors for achieving the desired outcomes.

RESULTS AND DISCUSSION

Table 5: Charging Readings

Flow Rate (LPM)	Inlet Temp(°C)	Storage Material	Outlet Temp (°C)	ΔT-3	ΔT-4	ΔT-5	ΔT Storage
1	65	PW	64.7	0.4	0.2	0.1	0.23
1	70	SA	69.3	2.9	1.5	1	1.8
1	75	STSP	71.7	7.8	6	3.6	5.8
2	65	SA	64.6	3.4	1.3	0.4	1.7
2	70	STSP	69.7	7.4	4.9	2.3	4.87
2	75	PW	74.5	4.8	1.5	0.3	2.2
3	65	STSP	64.2	7.6	4.4	1.8	4.6
3	70	PW	69.9	4.8	1.4	0.3	2.17
3	75	SA	74.9	4.8	1.6	0.4	2.27

- The highest outlet temperature was achieved with an inlet temperature of hot water at 75°C, flow rate of 2 Lit/min, and storage material as Paraffin wax (PW), resulting in an outlet temperature of 74.5°C.
- The table shows the impact of the different factors on the outlet temperature and ΔT values, and provides the optimal combination of factors that yield the highest performance.

Taguchi Analysis: Charging

In Taguchi designs, a robustness measure is employed to identify control factors that minimize variations in a process by mitigating the influence of noise factors.

Table 6: Charging: Response Table for SN ratios

Level	Flow Rate	Inlet Temp (°C)	Storage Material
1	-36.71	-36.19	-36.85
2	-36.84	-36.86	-36.84
3	-36.84	-37.35	-36.71
Delta-	0.13	1.16	0.14
Rank-	Rank: 3	Rank: 1	Rank: 2

- The Response Table for SN Ratios evaluates three variables: Inlet temperature, flow rate, and storage material based on their signal to noise ratios and their significance on the system.
- The highest signal to noise ratio is for inlet temperature (-36.19), indicating its most significant effect on the system. Deviations in the inlet temperature are likely to have a noticeable impact on the system's performance.
- The flow rate has the lowest signal to noise ratio (-36.71), indicating its least significant effect among the three variables. Changes in the flow rate may have a relatively smaller impact on the system compared to the other two variables.
- The storage material has a SN ratio of -36.84, similar to the value for flow rate. This indicates that storage material has a less significant effect on the system compared to inlet temperature but a more significant effect than flow rate.

Table 7: Charging: Response Table for Means

Level	Flow Rate	Inlet Temp (°C)	Storage Material
1	68.57	64.50	69.70
2	69.60	69.63	69.60
3	69.67	73.70	68.53
Delta-	1.10	9.20	1.17
Rank-	Rank: 3	Rank: 1	Rank: 2

- The Response Table for Means compares three variables: Inlet temperature, flow rate, and storage material, based on their mean values and average effects on the system.
- The highest mean value is for inlet temperature (64.50), indicating its greatest average effect on the system. Flow rate has the lowest mean value (68.57), suggesting it has the least average effect.
- Storage material has a mean value of 69.60, similar to a specific flow rate level, implying a moderate impact.
- Inlet temperature is the most influential, flow rate is the least influential, and storage material has a moderate impact similar to a specific flow rate level.

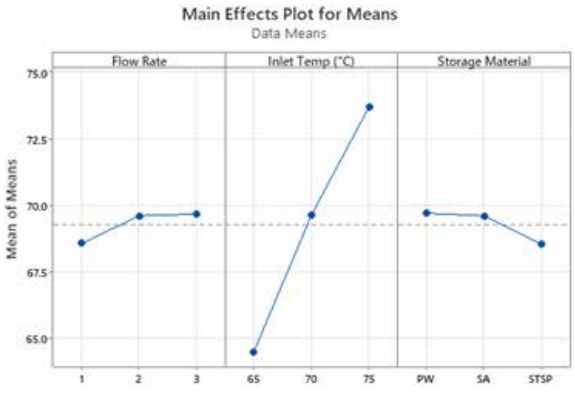

Fig. 3: Charging: Main effects plot for Means

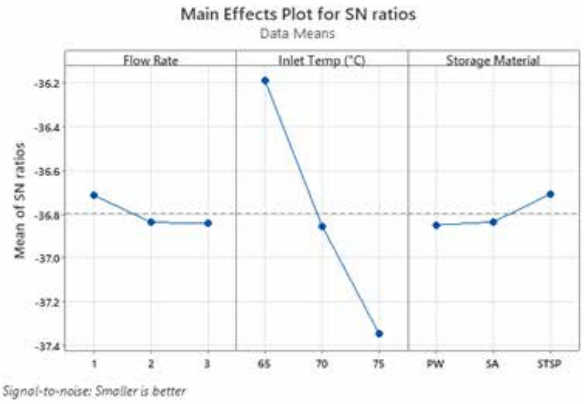

Fig. 4: Charging: Main effects plot for SN ratios

Table 8: Discharging Readings

Trial No.	Flow Rate (LPM)	Inlet Temp(°C)	Storage Material	Outlet Temp(°C)	ΔT-3	ΔT-4	ΔT-5	ΔTStorage
1	1	30	PW	31	1.9	0.9	0.5	1.1
2	1	32	SA	32.5	3.4	1.4	0.5	1.77
3	1	34	STSP	34.4	8.3	4.5	1.8	4.87
4	2	30	SA	30.4	3.7	1.3	0.4	1.8
5	2	32	STSP	32.6	8	4.2	1.6	4.6
6	2	34	PW	34.7	4.9	1	0.4	2.1
7	3	30	STSP	30.7	7.4	4.4	2.1	4.63
8	3	32	PW	32.5	2.9	1.6	1.1	1.87
9	3	34	SA	34.6	3.4	1.4	0.7	1.83

According to the table, following observations can be made:

- Trial no. 3, with a flow rate of 1 LPM, inlet temperature of 34°C, and storage material of STSP, achieves the highest outlet temperature of 34.4°C.
- The choice of storage material also affects the outlet temperature, with STSP producing the highest outlet temperatures in Trials no. 3 and 5.
- The highest ΔT Storage (temperature difference of storage) occurs in Trial no. 3, with an inlet temperature of 34°C, and outlet temperature of 34.4°C, resulting in a ΔT Storage of 4.87°C.

Taguchi Analysis: Discharging

Table 9: Discharging: Response Table for Signal to Noise Ratios

Level	Flow Rate	Inlet Temperature (°C)	Storage Material
1	30.27	29.74	30.29
2	30.24	30.25	30.23
3	30.25	30.77	30.25
Delta-	0.02	1.03	0.06
Rank-	Rank: 3	Rank: 1	Rank: 2

- Based on the Taguchi analysis, the inlet temperature and the storage material have the most significant impact on the outlet temperature of a system. The flow rate has the minimum impact.

- The analysis suggests that increasing the inlet temperature by one level (i.e., from level 1 to level 2) results in the highest increase in outlet temperature. The flow rate has the least impact.
- The storage material has a moderate effect on the outlet temperature.

Table 10: Response Table for Means– Discharging

Level	Flow Rate	Inlet Temperature (°C)	Storage Material
1	32.63	30.70	32.73
2	32.57	32.53	32.50
3	32.60	34.57	32.57
Delta-	0.07	3.87	0.23
Rank-	Rank: 3	Rank: 1	Rank: 2

According to the table, following observations can be made:

- The inlet temperature has the major effect on the outlet temperature of the storage system. The storage material has the minimum impact.
- The highest mean outlet temperature is achieved at level three of the inlet temperature factor.
- Level 2 of the storage material factor produces the second-highest mean temperature.
- Changing the flow rate has the smallest effect on the mean outlet temperature.

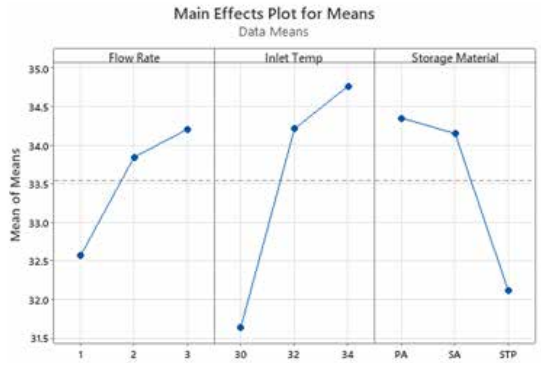

Fig. 5: Discharging: Main effects plot for Means

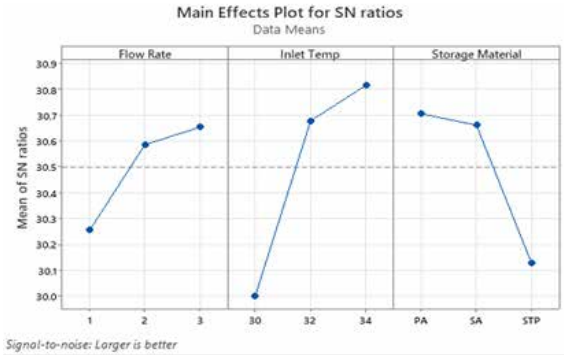

Fig. 6: Discharging: Main effects plot for SN ratios

CONCLUSION

- The experimentation has been designed using the Taguchi array to distinguish the most significant factors affecting the response variable. The array used three factors: Flow Rate (LPM), Inlet Temp (°C), and Storage Material. Nine runs of experimentation are performed.
- The Response Table for Signal to Noise Ratios has been evaluated. The study shows that Inlet temperature has the highest signal to noise ratio. It has the most significant effect on the system performance. Flow rate has the least significant effect. The Storage Material has a less significant effect than Inlet temperature but a more significant effect than Flow rate.
- In summary, the data assessment illustrates that the performance of thermal energy storage systems is significantly affected by the choice of storage material, the cold-water inlet temperature, and the mass flow rate.

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Collaborative Learning: A Tool to Enhance Communication Skills

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ABSTRACT

This research paper is about collaborative learning resulting into effective communication skills. Group discussion is such a collaborative tool which can enhance the communication skills of an individual. Any individual gets the benefit from group discussions by speaking up and expressing their opinions. It further eliminates their reluctance to talk. The basis of group discussions is also collaboration. It is crucial in a classroom for students irrespective of their field as well as in business to collaborate as a team on the given job. The research was carried out through a survey in the form of a questionnaire based on 5 parameters like Participation, Topics of group discussion, Importance of group discussion, Conduction of group discussion, Impact of group discussion and Skills learnt by practicing group discussion through which one can trace how effective group discussion is when it comes to collaborative learning. The sample size of 117 homogenous group of students were a part of this survey. It has been observed that group discussions foster the skills of communication, flexibility, critical and analytical thinking, persuasion and reasoning. Thus, the practice of group discussions in students of Higher Education will certainly help them build skills and also make them confident, fluent and focussed in their communication at the personal and professional front.

KEYWORDS *: Collaborative learning, Group discussion, Communication skills, Team building, Flexibility, Leadership, Persuasive.*

INTRODUCTION

Group Discussion or GD as it is famously called is a collaborative / team activity where all the participants share their perspectives on the given topic. It tests the participant's communication skills, persuasion skills, leadership and team building skills. It also tests listening ability, general awareness, confidence, spoken skills and presentation skills especially presenting ideas impromptu in brief.

Group Discussion is used in a classroom in multiple ways. It can be used as a methodology to teach in an interactive way and build on collaborative teaching and learning. This allows the teacher to engage the students and also the students to go to the depth of the content and through meaningful discussion gain knowledge.

Group Discussion is almost a necessity when it comes to placements, internships and entrances for professional courses like MBA. It is the first level selection where the participants are put into teams and discuss on a given topic. It is used as a strategy to shortlist a huge number of participants and allow the best to move ahead into the next level. In a way it tests the soft skills of the participant which is very much needed in a professional space along with the content knowledge of one's own subject. In growing globalized work spaces communication skills are a necessity and a group discussion tests that appropriately. A Group discussion lasts for around 7 minutes to 15 minutes depending upon the topic and the level of participation of the candidates. The moderator decides the length of the Group Discussion depending upon how long

the participants are able to sustain the topic and also at times the timing is pre decided. The moderator is a spectator who just watches the participants and makes a note of the candidates who are participating actively but never interrupts the flow of the Group Discussion. While looking at the participation he also observes the non-verbal or the body language of the participants and accordingly decides the successful candidates.

The most important part of a Group Discussion is understanding the topic. Mostly the topics given for Group Discussion are two sided where a participant can take one or the other side. The topics can be of three types: a) Contextual topics or the topics based on the events that have taken place in recent times. - e. g. The pandemic has taught us many lessons. b) Abstracts topics: These are the most difficult to sustain as it along with communication skills and general awareness also needs creativity. Some examples of these kinds of topics are 'The Sky is Blue'. c) Topics that are one sided but ideas can be put forth - e. g. 'There is a serious lack of work-life balance nowadays. These topics are such where most of the participants have a one-sided opinion. The participants must keep themselves abreast of the latest happenings at least from a month before their schedule of Group Discussion. Most of the participants lack the general awareness and hence are not able to make their presence felt during the Group Discussion.

Once the topic is announced the participants are given a minimum of 3 minutes to delve on the topic. And at the signal of the moderator the Group Discussion starts. The participants who initiate the topic and conclude the topic always have an advantage. The initiator must say his / her name, the topic and some general views on the topic and then go ahead and take a for or against stance. As the initiator gets a longer period of time to talk, he can very cleverly showcase his positive communication skills, confidence and also awareness on the topic. The rest of the participants should not take too long to make a point but should be short and crisp. If the participants have more than one point or view on the given topic, it is advisable to put forth one point then let others speak and after a short time can again go for the next point. This would always make the participant's presence felt more strongly. It is also advisable to not keep changing the stance as it would establish that the participant cannot sustain or persuade the audience and keeps jumping from one side to the other.

Most of the participants face problems either because they are not adept at the language or because they do not have adequate general awareness to speak on the topic. It is highly recommended to keep reading and watching news while you are close to the placements. In spite of doing this at times the topics given are such that the participants are not able to say something or they feel tongue tied. Under these circumstances it is a good idea not to lose confidence and listen to a few participants and based on that get a quick overview and a grip on the topic and at least extend the topic by giving examples or agreeing or disagreeing to the topic. If this too does not work, wait for the conclusion time and grab the opportunity to conclude the topic either for or against the topic.

The classroom arrangement for the Group Discussion is very important as it requires the participation of all the students. The chairs arranged in a semi - circular way or a circular way is the best. In this kind of arrangement, the students and also the moderator can watch each participant, the nonverbal expressions and can build a connect and rapport between each participant.

Importance of Group Discussion (GD)

The Indian Defence Forces were the first to tap the potential of Group Discussions and include it in their battery of tests. Group Discussions are a great support because it is a powerful tool for assessing a personality. Prior to the Group Discussion, the prospective employer assesses the candidate based on his / her resume, the scores and sometimes by a telephonic pre - screening. Yet this assessment is not sufficient enough to judge a candidate. Every prospective employer would always want to critically evaluate a candidate before hiring. This is due to the fact that every employer has to encounter challenging situations at the workplace. Thus, Group Discussions are of utmost importance to achieve a real - time assessment of a candidate.

During a Group Discussion, one can assess multiple aspects of one's personality and soft skills. Some of these are communication skills, knowledge, ability to work together as a team, assertiveness, flexibility, reasoning,

leadership skills, persuasive skills, innovation, creativity and lateral thinking and the ability to influence others.

Knowledge refers to the depth and range which a candidate has when it comes to participating in a Group Discussion. The candidate must have the ability to grasp the situation and analyse it with a wide perspective. Every participant must contribute rationally and convincingly. One cannot beat around the bush during a Group Discussion. If a candidate is well versed with the topic and has understood it thoroughly it will be easy to take initiative during the Group Discussion. One who lacks in taking initiative could miss out the opportunity to speak during a Group Discussion. An important trait that is taught via Group Discussions is problem solving. Be creative and come up with divergent offbeat solutions. A Group Discussion is like a high risk, high - return strategy so one must not be afraid to put forth novel solutions.

Communication Skills involve how we interact with one another. It includes being clear about your thoughts and expression, active listening skills and the appropriateness of your body language and language. If there is clarity of your thoughts and expression it will be easy for the candidate as well as the group members to identify where the Group Discussion is leading to. One must possess a good vocabulary, in order to express their thoughts and ideas to the group without faltering and falling short / loss of words. A sound knowledge of the basic principles of grammar can be of great help to speak correctly in English. Speaking incorrect English may tarnish your image in the group and may have negative implications. Accent and fluency play an important role in your speaking. One must use the correct accent and intonation to create a positive impression. A speech that is fluent without the embarrassing humming and hawing is appreciated. Such a fluency will empower you to contribute meaningfully and achieve your target. In Shakespeare's Hamlet, old Polonius advises his son Laertes - Give every man thy ear but few thy voice. Active listening is the patience to listen to the views of other participants by noting down the key themes in brief raised by the speaker. One must coordinate with the views of others and also synchronize the arguments that give an edge to the discussion. A discussion can be led out of deadlock by being an active listener and asking questions. One is also evaluated on the basis of nonverbal skills in a Group Discussion. Our body language speaks volumes about us. The candidate's body language becomes operative right from the moment he / she enters the room where the Group Discussion is being conducted. It is essential for a person to focus on the tone, depth of the voice, personal appearance, gestures, postures, facial expressions and eye contact. One must be careful about the gestures and postures during a Group Discussion. The facial expressions should be as per the discussion going and meaningful eye contact should be there throughout the Group Discussion.

Group Behaviour: The ability to interact with other group members on brief acquaintance is an art which all would not possess. One ought to be people centric instead of self-centric / egocentric. Appropriate group behaviour is when we coordinate and cooperate in a Group Discussion with all. There should be a balanced participation during each and every round. No one assigns the roles in a Group Discussion yet there are undefined roles which one can take during a Group Discussion. These roles include roles like an initiator, illustrator, informer, coordinator, moderator and leader. The person who possesses these qualities is the ultimate winner of the Group Discussion.

Leadership and Assertiveness: Being an effective leader is one of the toughest tasks. There is no leader appointed in a Group Discussion. The candidate who possesses the functional and coordination abilities emerges as a leader in a Group Discussion. Coordinating abilities include traits like group adaptability and group motivation. Functional abilities include knowledge, physical and mental energy, objectivity, emotional stability, communication skills, emotional intelligence and integrity. A leader must be capable enough to influence the proceedings by participating constructively, building support by working with all in the group, convincing others on something and by logically making the opponent weak.

Thus, every person who participates in a Group Discussion must learn to identify the loopholes in his / her personality based on the evaluation criteria. If a candidate prepares thoroughly then nothing can stop the person from emerging as a leader / the right candidate

for the job. But the real problem is that students do not take this exercise seriously when they are scheduled for them. The pressure rises during placements as now they are in that stage where they need to find the right path of their life. If practiced well and seriously this component of Group Discussion is an excellent tool through which one can modify the negative traits in his / her personality and work towards excellence in a Group Discussion.

The person who emerges as a leader is assertive, makes powerful comments and leads the whole group towards decision making or giving recommendations. An assertive leader is one who knows when to be firm and is mindful of being professional throughout the Group Discussion without being over aggressive / pushy. A leader is a strong communicator who is very honest and comes across as credible. When leaders are willing to change their opinion or admit their mistakes, they gain goodwill within the group and the organisation.

Reasoning: This is the ability to comprehend the essence of a topic and then make a compelling argument on it. Many participants look at Group Discussion as a debate which it is not. One learns to reason well and sharpen their reasoning skills. Persons with strong reasoning can map the topic from multiple angles and view it from different perspectives in order not to miss them. One learns to keep their line of thinking uncluttered and are able to proceed step by step while putting their arguments concisely and comprehensively.

Team Building: Team Building is one of the skills that candidates are expected to demonstrate in a Group Discussion. Many candidates in a Group Discussion get this completely wrong and so they are always on the go to create an impression and win over others by making them lose. They behave in a manner that the moderator must take note of them as key participants and not of their peers. The reason that employers look for team building is that the work place is going to mimic these situations. They are candidates who demonstrate exemplary team building skills whereas others lack it. Team building is a tool through which one can build up the strengths and positions of other participants. There are participants who would become reticent / deviate / become emotionally cloyed / lack confidence / any other reason. The candidate who is a good team player can get proactive and draw such people out of their shells to participate and get the best out of the team. Team building can be considered as the first essential trait for all those who participate in a Group Discussion and is of great help to the person and to all around.

Ability to influence: Influencing is a major skill required as there is no appointed leader in a Group Discussion. This is a kind of real - life situation where a person does not have direct authority over the participants yet has to get things done by the ability to influence others. Candidates with sharp influencing skills are the ones who take charge of the group. Such candidates leverage their soft skills of intuition, observing and active listening, and even support some key opinion leaders in the group to come up with an approach to influence others to their point of view. Their goal is to procure a majority of participants and veer around their point of view thus minimizing dissent. But influencing has to be done subtly and carefully in a natural way. It should not come out as being political to impress someone or score points. Such blatant attempts could be counterproductive.

Innovation, Creativity and Lateral Thinking: Creativity is the most sought-after skill by organizations today. Group Discussion is the best medium to identify the candidates who have an innovative bent of mind as their minds are flourishing with new ideas, different perspectives. They are people who think out -of-the-box and possess lateral thinking. Creative participants have the ability to change the thread of discussion by bringing in a fresh line of thoughts. Through lateral thinking they can put forth problems and opportunities which others may miss. They may receive mixed responses - some may appreciate them while others may dismiss them. Through lateral thinking they can resolve deadlocks. People who think out-of-the-box can assist in reaching a common ground in case the group gets sharply polarized. Creative people are also innovative and have unique ways to put forth their ideas. They could use methods like storytelling or also use real-life examples and anecdotes to make their arguments compelling.

Flexibility: This is a trait that is critical for the participants of a Group Discussion. If one remains stubborn and firm in his / her point of view then they become inflexible. Prospective employers look for candidates who are flexible in their approach and who are ready to shift

their opinions whenever there are compelling reasons to do so. Towards the end of a Group Discussion all must arrive at a consensus. Reaching a consensus requires that one listens, deliberates on multiple points of view by having an open mind. One may be required to stand on the originally stated position / tune / modify it / sometimes drop it for good. Flexibility is not a sign of weakness but a sign of maturity and self - confidence.

Persuasive skills: One must master the art of persuasion as it is helpful in convincing others to your point of view. One can do it if one has ample knowledge of the topic and has done the homework efficiently. One must demonstrate the maturity that is required while giving reactions through appropriate body language and firm tone of voice rather than interrupting somebody abruptly. One must learn to listen and then react. To justify your views evidence like examples / testimonials / statistics can be used. Respect one another and win the confidence of other participants through appropriate behaviour. Being friendly, considerate and respectful towards others would definitely help.

LITERATURE REVIEW

Focus group discussion is a technique where a researcher assembles a group of individuals to discuss a specific topic, aiming to draw from the complex personal experiences, beliefs, perceptions and attitudes of the participants through a moderated interaction (Cornwall & Jewkes, 1995; Hayward, Simpson, & Wood, 2004; Israel, Schulz, Parker, & Becker, 1998; Kitzinger, 1994; Morgan, 1996).

Colleen Garside in her article 'Look who's talking: A comparison of lecture and group discussion teaching strategies in developing critical thinking skills' compares the effectiveness of traditional lecture methods of instruction to group discussion methods of instruction in developing critical thinking skills found that there is no significant difference in employing Group Discussion method.

Meenakskshi Raman & Sangita Sharma in their book 'Technical Communication Principles and Practice' opine that team work and group communication has increased in all the organizational setups. Hence organizations now look for people who interact successfully in small groups and make significant contributions during such interactions. One such group communication is Group Discussion which is widely used in many organizations for decision making and problem solving.

Gajendra Singh Chauhan and Smita Kashiramka are of the opinion that Group Discussions are not generally used for eliminating the candidate, but are conducted along with personal interviews to obtain a complete picture of the candidate's personality.

While talking about the space required for the Group discussion Welty W. M feels that tables and executive - type swivel chairs for the students, arranged in a U-shape; a small table in the front for the instructor; board space on at least two walls; room enough for the instructor to roam around the room. He further adds that the U-shape is the single most important environmental factor for the discussion class. It allows all the participants to see each other and promote interchange; it provides space for the leader to use, thus enhancing his authority and control in a situation where many instructors feel powerless.

The literature review establishes the importance of Group Discussion, the use of Group Discussion in developing critical thinking, the use of it in an organizational setup, during the interviews to understand the personality of the candidate and also the classroom arrangement is best suited for the Group Discussion.

THE STUDY

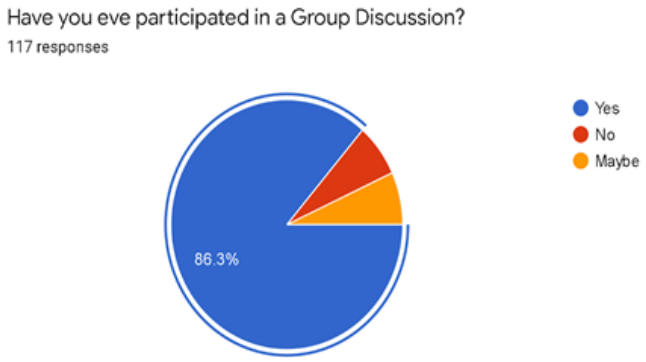
A survey of 20 questions was floated to the students of the First Year Degree Course of a professional university. The group comprised 117 students and was a homogenous group. English is one of the core subjects and the skills like presentation skills, interview skills & Group discussion skills are taught to them in the lab component. The lab classes are conducted once in a week for two hours. The students are formed into random groups of 5 - 6 members and the topics are given after discussing the Group Discussion. The questionnaire was made using Google Forms. The study was divided into 5 parameters: Participation, Topics (of Group Discussion), Importance of Group Discussion, Conduction of Group Discussion, Impact of Group Discussion and Skills learnt by practicing Group Discussion.

Results

Based on the responses of 117 students the following result is compiled.

Participation Based - There were 3 questions under participation:

A.



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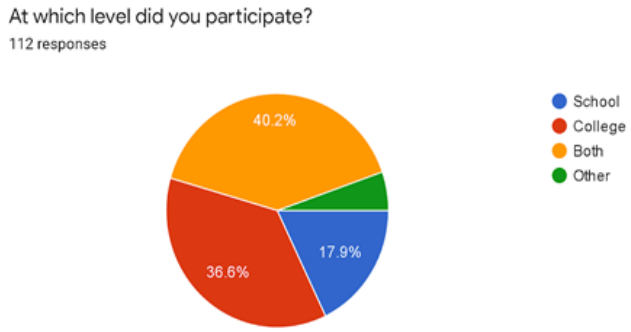

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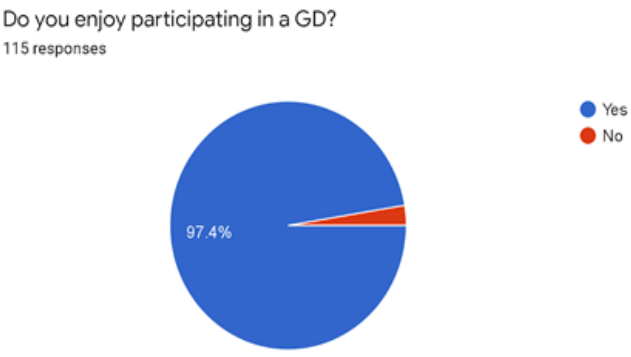
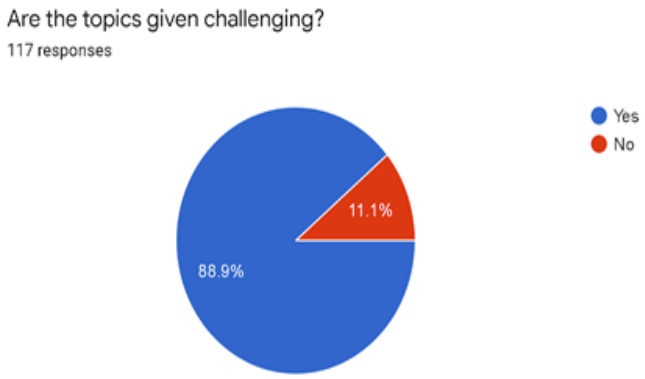


86.3 % students responded in affirmative for the first question, out of which 36.6 % of the students participated at the college level and 97. 4 % of the students enjoyed participating in a Group Discussion.

Topic Based: There were 3 questions under topics:

A.

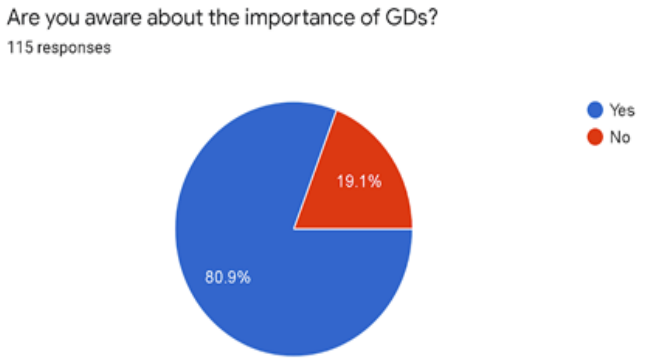
B.



95. 7 % of the students agreed that the topics were varied, 88.9 % found the topics challenging and 92. 2 % confirmed that the topics dealt with current events.

Importance based: There were 3 questions under importance:

A.



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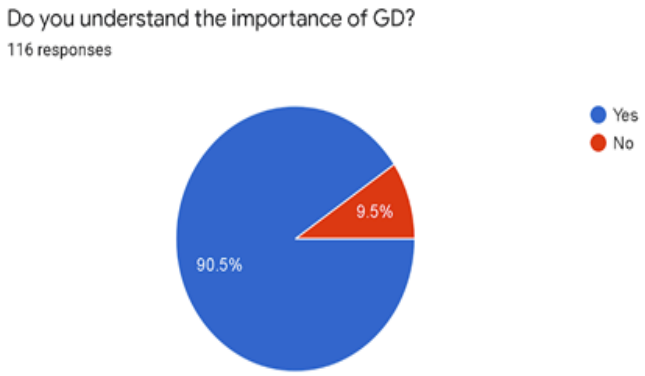

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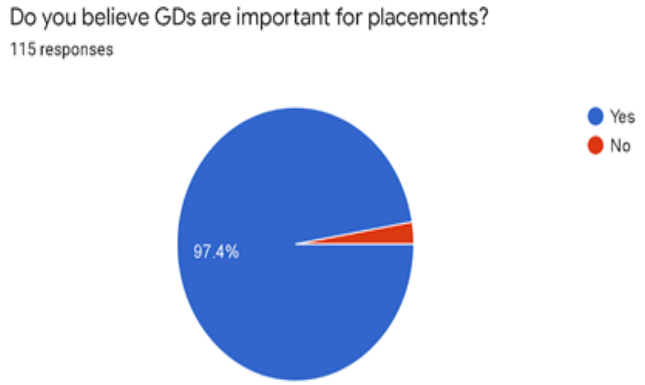
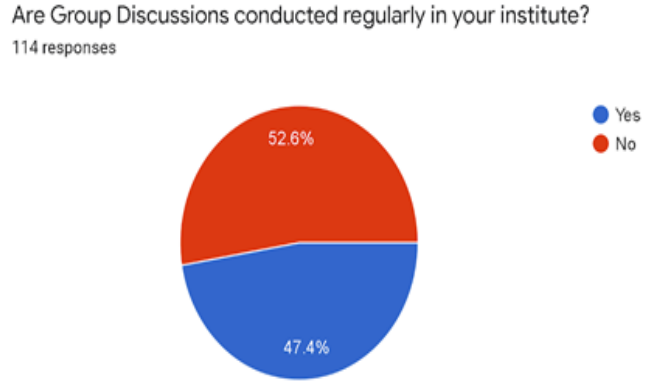


80.9 % students were aware of the importance, 90.5 % understood the importance of Group Discussions and 97.4 % believed that Group Discussions are important for placements.

Conduction based: There were 5 questions under conduction:

A.



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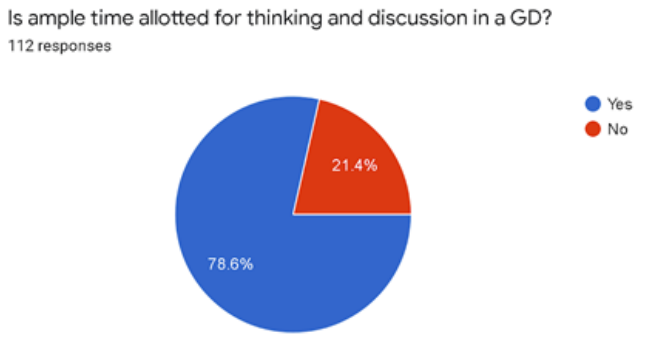

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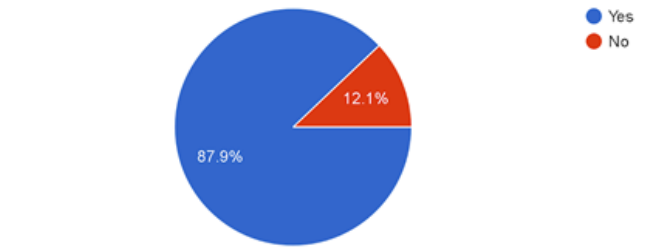
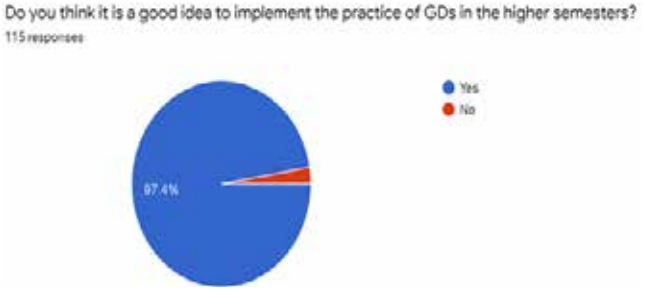
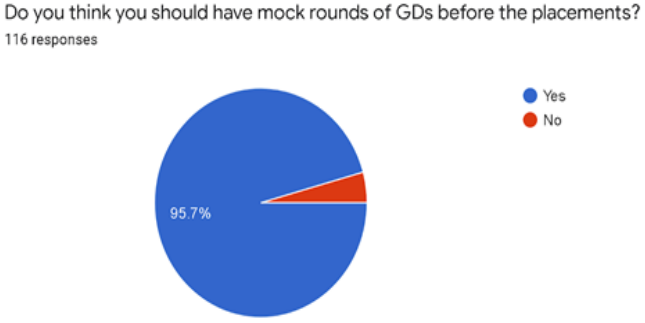


D.



E.

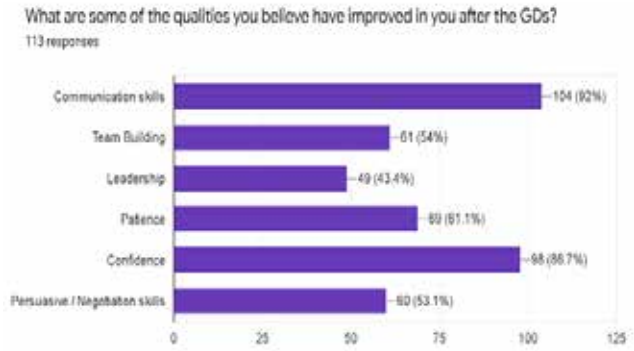


52. 6 % felt that Group Discussions are conducted regularly in the institute, 78.6 % feel that ample time is

allotted for thinking and discussion, 87. 9 % agreed to the fact that rules and regulations are discussed prior to the Group Discussion, 97. 4 % agreed that it is a good idea to practice Group Discussions in higher semesters and 95. 7 % were of the opinion that there should be mock rounds of Group Discussion before placements.

Impact based: There were 3 questions under impact:

A.



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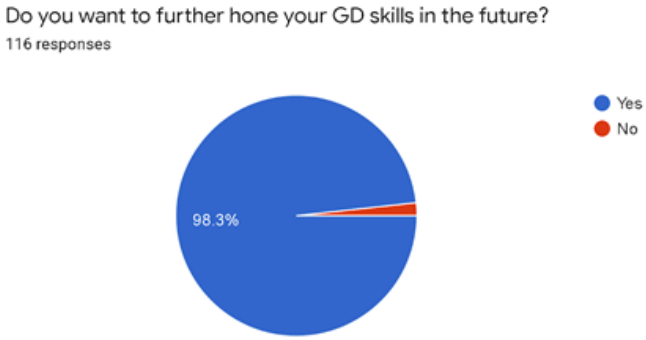

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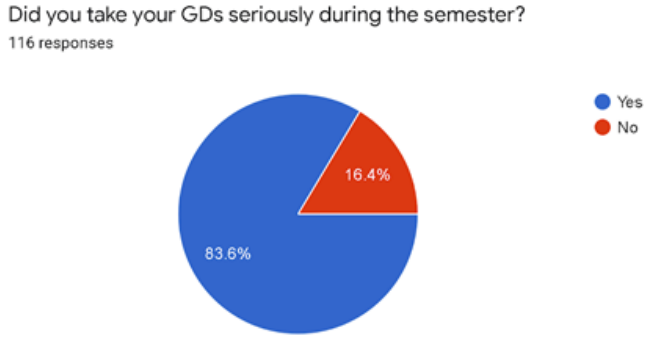
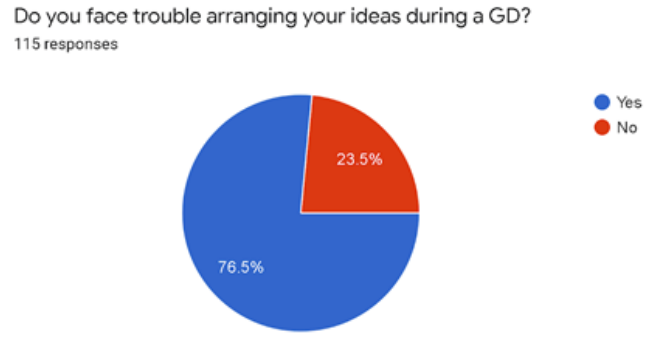


The parameters given for Question (a) were communication skills, team building, leadership, patience, confidence and negotiation skills. 92 % agreed that Communication skills have improved, whereas 86.7 % respondents believed that their confidence has increased. Only 43. 4% believed that their leadership skills had increased. 98. 3 % wanted to hone their Group Discussion skills in the future. 83. 6 % took their Group Discussion activity seriously during the semester.

Skill Based: There were 3 questions under skills:

A.



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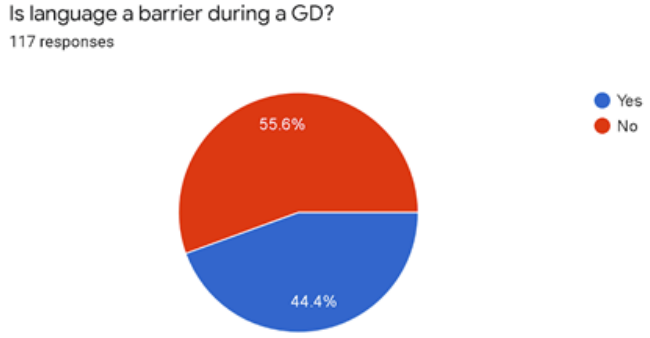

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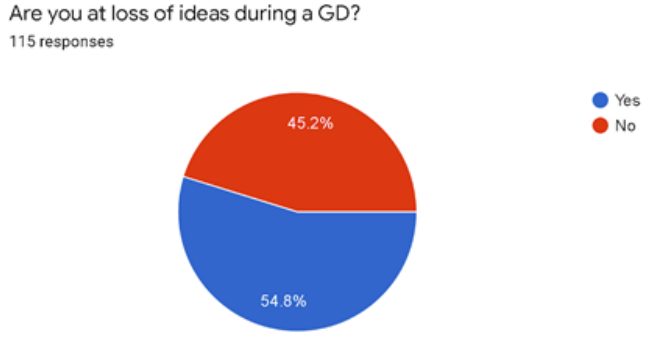
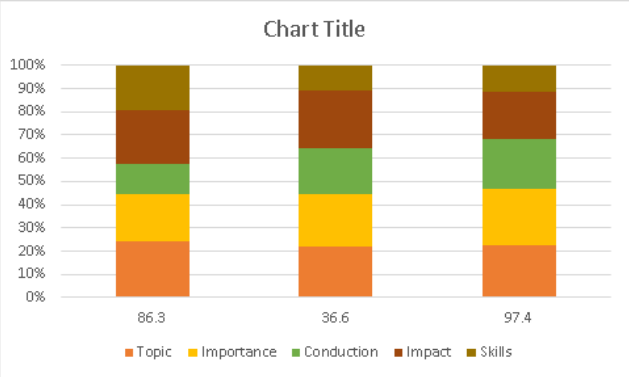


76. 5 % agreed that they faced trouble arranging their ideas. Only 44. 4 % believed that language was a barrier whereas 45. 2 % felt that they were at loss of ideas during the Group Discussion.



CONCLUSION

The importance of Group Discussion as a tool for collaborative learning to make the classes interesting and develop various skills is growing by the day. The way the Group Discussions are conducted may differ from teacher to teacher but they have become an important tool in not only developing communication skills but also higher order thinking skills like critical and analytical thinking and for personality building. They are certainly used by many organizations for the beginning rounds of placements. Group Discussions foster among many other skills the skills of persuasion and reasoning. The practice of Group Discussions in students of Higher Education will certainly help them build skills and also make them confident, fluent and focussed in their communication at the personal and professional front.

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Transformative Potential of Architecture in Enhancing Senior Living Housing Environments

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Rohtak

ABSTRACT

By examining design principles, strategies and innovative approaches used in projects for the elderly, this study aims to explore how architecture can positively impact to the physical, emotional and social health of older people. It emphasizes the importance of age-friendly design principles, promoting health and well-being, facilitating social inclusion, providing age-appropriate housing, creating infrastructure, consider dementia-friendly design and integrate sustainable practices. The document emphasizes the importance of designing inclusive and supportive environments that promote healthy and active lifestyles, social participation and independence in older adults. By prioritizing age-friendly design and architecture, India can create a more inclusive and supportive society that respects and enhances the experience of the elderly. By incorporating age-friendly design principles into housing architecture, India can create environments that support the dignity, independence, and well-being of its ageing population. The research emphasizes the understanding of problems faced by the elderly, policies for the construction of the elderly housing and present housing models which in turn point to the needs and rise of age-specific issues faced by them. After analysing, the study finds the principles of design that create the right surroundings and meet the needs of older people. Further it was concluded that design for healthy aging includes the creation of a physical environment that is flexible, geriatric friendly, socially compatible and adaptable to the needs associated with the aging process. Such design open horizons for thought to create content living with independence and freedom by providing accessible, quality of life and dedicated services to the aging population.

KEYWORDS *: Ageing, Physical health, Urban space, Housing, Shelter, Geriatric.*

INTRODUCTION

Senior living housing plays a critical role in providing older adults with a comfortable and supportive environment in which to age gracefully. This study aims to explore how architectural design can improve elderly residence, focusing on creating spaces that meet the unique needs and preferences of seniors. With populations aging rapidly, it is essential to create environments that are conducive to promoting active and healthy lifestyles, social participation and independence in old age. This demographic shift requires a re-evaluation of architectural design and urban planning to meet the unique needs and challenges facing an aging population. The meaning of being old is determined by a mix of biological and social factors that decide who is considered elderly. Ageing is a natural part of life that doesn't just happen when someone gets old, but happens as a person goes through different stages of life such as getting older, becoming more mature, declining, and eventually dying (Fernandez-Carro, 2013). It is characterized by broad spectrum of special needs, preference and limitations (Edward Henry Noakes, 1985). The elderly population is on a steady rise, partly due to a global upliftment of living standards and partly due to advance medical technology and access to healthcare, i.e. (diagnostic, and treatment options for illness) that have played a major role in changing life expectancy across the world but more particularly in developed countries (Hassan, 2016). With the increase in the ageing scenario, the demand for care of the elderly has risen up in all aspects such as finance, health, and shelter. The rise in life expectancy

is also resulting in functional disabilities, which not only increase geriatric friendly architecture but also creates a need for requirement of assistance for basic daily functioning. Urban space faces many different challenges at the same time (Josep, 2009). Getting older and the problems that come with it don't have a clear place in the field of architecture, except for making adjustments to buildings so that they are easier for older people to use (Andersson, 2011).

Housing is one of the key determinants of healthy aging. Yet there appears to be a major inconsistency between healthy aging capacity and current seniors housing strategies. The inadequacy of housing and the corresponding lack of support for seniors is at the center of social advocacy efforts. New housing solutions supporting residents with high care needs are required as well. The way houses and outdoor spaces are planned in a neighborhood is important for making a society where everyone feels welcome and included (Verma, 2019). Five percent of the older people in European countries live in apartments that are designed to be suitable for their age. We need to find new ways to provide housing for people with significant care needs.

The study aims to provide architectural solutions for spaces in the elderly housings so as to facilitate active and healthy ageing, besides it gives them the freedom and independence to lead their day their way. The concept of aging in place is also studied as a way to stay at home (Fernandez-Carro, 2013). The questions are: What factors determine the choice of where to live later in life. Is there a common trend of living independently across India.

RESEARCH METHODOLOGY

The main area of the research includes the background detailed study of problems faced by the elderly people in daily life, existing policies for the beneficial of old age population, anthropometry standards, different housing models present and lastly categorizing and analysing the architecture examples that resulted in the formation of policies and architectural design solutions to provide enhanced physical setting that is flexible, socially compatible, adaptable according to their needs. The research paper objectives are as below:

- Focus on the major physical and social problems faced by old age people
- Study of govt. policies and senior citizen housing models
- Identification of different social interaction spaces and activities in elderly housing
- Design strategies for flexible, social compatible, holistic and age inclusive architecture

PROBLEMS FACED BY THE ELDERLY

The built environment can present specific challenges for the elderly, impacting their ability to navigate and engage with their surroundings. The lack of accessibility features such as ramps, handrails, and elevators in public spaces, buildings, and transportation systems can hinder the mobility and independence of older adults. Uneven sidewalks, high curbs, and inadequate signage can pose physical barriers and increase the risk of falls (Bonaccorsi, et al., 2020).

Public spaces that do not consider the needs of older adults can limit their participation and engagement. Insufficient seating areas, limited shade or shelter, and lack of restrooms can discourage older adults from venturing outside and participating in community activities. Older adults may face challenges within their own homes due to design limitations (Maliga, Wijesiri, Samarasinghe, Wasalathanthri, & Wijeyaratne, 2022). Poor lighting, narrow doorways, steep staircases, and inaccessible bathrooms can restrict mobility and increase the risk of accidents. Lack of age-friendly features such as grab bars, non-slip surfaces, and adjustable countertops can impede daily activities and reduce independence.

Older adults are more vulnerable to crimes such as theft, assault, and scams. Inadequate lighting, lack of security measures, and poorly designed residential areas can contribute to feelings of insecurity and increase the risk of victimization (Hoof, Dikken, Staalduinen, Pas, & Hulsebosch-Janssen, 2022). Limited access to essential community amenities such as healthcare facilities, grocery stores, recreational areas, and social gathering spaces can impact the well-being and quality of life of older adults. Distance, transportation challenges, and

the absence of age-friendly amenities can limit their ability to engage in social activities and access necessary services. The built environment can contribute to social isolation among older adults. Neighborhoods with limited walkability, long distances between residences, and a lack of communal spaces can impede social interaction and a sense of community. Complex signage, small print, and the use of technology without proper support can create barriers for older adults in accessing information and communication platforms. This can hinder their ability to stay connected, seek assistance, and engage with community resources.

Addressing these challenges requires a comprehensive approach that involves urban planning, architecture, policy interventions, and community engagement. Designing age-friendly built environments that prioritize accessibility, safety, social connectivity, and inclusivity can greatly enhance the well-being and quality of life for older adults. It is crucial to consider their needs and perspectives throughout the planning and design process to create environments that support active ageing and promote their dignity and independence.

Reduce in physical health is very evident for people attaining the crucial age of 60 years. Often physical health is not only determined by diseases and wellbeing, but it is also determined by many economic, social, psychological factors. Poor health and morbidity decrease the wellbeing of the person and it also increases the stress and psychological problems. The decline in mental abilities is also noticeable, they face lack of confidence and sense of distress. Problems such as the lack of memories of the short term are evident, though the memories that are long term are still intact. An older person can go through only one form of abuse or a mixture of several abuses at the same time like Physical abuse, psychological abuse, financial abuse, Sexual abuse, Neglect (Pradana, 2022). Old age becomes a tough time for people and they struggle both physically and socially as social isolation also is seen in many old aged people. These can happen due to various reasons, such as the feeling of loneliness due to the death of a spouse or friends, it can happen due to the fact that children become busy with their own lives of in some cases moves away from homes.

The increasing population of sixty plus in India, along with problems faces several challenges. To counter these challenges, awareness of the issues faced by this population is required. Old age brings about many difficulties that people are often faced with and most of the times are unable to deal with such issues. These difficulties may be economic, physical, emotional and medical needs. Design impacts several features of the wellbeing of older people (Luciano, Pascale, Polverino, & Pooley, 2020).

Type of senior citizen home

There are different types of housing available for senior citizen like paid and free type. These are run by government, NGO and some are operated by private institutions. The types of Senior citizen's home on the basis of the health care and need requirement. Independent living are the homes located inside the housing complex with all the facilities of transportation and recreational but accept the medical health care facilities. Assisted living means having a place to live and getting help with everyday activities like taking care of yourself. This includes things like healthcare services, fun activities, and spending time with others. However, it doesn't provide advanced medical care like nursing care. Another type of facility is Skilled Nursing Homes where licensed health professionals take care of people's daily needs, such as cleaning, therapy, and social activities. Continuing Care Retirement Communities are places where older adults with worsening health can stay in one place or where healthy older adults can have peace of mind knowing that all their future needs will be taken care of.

Current scenario of old age homes and senior citizen housing in India

An old age home is a place where old people live together. They have their own apartments, and there are extra facilities like food, places to meet and do activities. Right now, there are about 1250 places called Old Age Homes in India. You can find lots of information about 800 homes (Jagadeesh, 2011). Out of all the homes, 59% are free, 17% you have to pay to stay, and 24% have both free and paid options. There are 278 old age homes in the country for sick people

and 101 homes exclusively for women. Kerala has the most old age homes out of all the states, with a total of 124 (Wishes and Blessings, 2022). The maximum elderly population is in Uttar Pradesh (14.86%) but it only has 7 assisted old age homes by Government whereas Andra Pradesh which has just 8% of old age population has 51 assisted Old age homes. The average cost per person per month in old age homes is around INR 7000. This cost likely includes expenses related to accommodation, meals, healthcare, and other facilities. However, despite this seemingly affordable average, the situation is exacerbated by inadequate resources and uneven distribution of funds in relation to the growing aging population.

Senior Citizen Housing is a residential set up for elderly people focusing on comfort and better lifestyle of aged. With utmost care taken towards quality of infrastructure and convenience of residents, it has proven to be a better choice for the elderly who can afford. There are over 4500 senior living units in India where nearly 50% of them are still under construction. Predominantly in the Southern states like Kerala, Tamil Nadu, and others, the trend is picking up PAN India considering the growing market Size, poor reputation of Old Age homes and successful analogs of business in the west (Ghosh, 2011). Even though there are several old age homes and senior citizen housing in India, there's still an unmet gap because of an exponential increase in the growth of the elderly population and limited resources dedicated to elderly by the government and less confidence of developer (Sharma S. D., 2019). While govt sponsored old-age homes lack basic infrastructure and services because of funding crunch, red-tapism in bureaucracy and policy paralysis, private senior citizen housing is still less in number to cater to the existing and growing ageing population. The burning question is if we are not able to meet the demand of 6% of total population in 2019, how would we cater to the old age population by 2050 when the population of the elderly is anticipated to rise 20% according to UN? (Sharma, 2018).

There are several senior living projects in India that cater to the needs and preferences of older adults. Ashiana Senior Living housing projects are developed to cater the need of multiple senior living communities across cities like Bhiwadi, Chennai and Pune. Their projects offer a range of housing options, amenities, and services tailored to the needs of senior residents (Asiana, 2020). Antara Senior Living have established communities in Dehradun and Noida. They offer high-quality residential units, healthcare facilities, recreational amenities, and personalized services for active and assisted living (Antara, 2021). Covai Senior Care have communities in various cities like Coimbatore, Chennai, and Bengaluru. They offer a continuum of care with options for independent living, assisted living, and memory care, along with a range of amenities and healthcare services (Care, 2022).

Figure 1: Community Kitchen for senior citizen

Figure 2: Workshop Room

Columbia Pacific Communities is a senior living provider with communities in multiple cities across India, including Bengaluru, Chennai, Pune, and Puducherry. They offer independent living, assisted living, and memory care options along with facilities like wellness centers, dining, and social spaces (Communities, 2023). Brigade Senior Living have communities in Chennai, Bengaluru, and Mysuru. They provide a range of housing options, healthcare services, and recreational facilities to support an active and engaged lifestyle for older adults (group, 2017).

Table 1: Salient features of Senior living Vs Normal Housing

Feature	Antara Senior Living, Dehradun, India	Senior Living, Sun City in Arizona, USA	Standard Apartment in a Residential Complex in India
Target Population	Geared towards seniors 55 and older	Geared towards seniors 55 and older	Open to people of all ages
Accessibility	Wheelchair-friendly design, handrails, ramps	Single-level homes, ramps, grab bars, wide doorways	Standard accessibility features
Amenities	Medical facilities, fitness centers, cultural activities	Community centers, golf courses, medical facilities	Nearby amenities, parks, shopping areas
Medical Assistance	On-site healthcare services, regular health check-ups	On-site healthcare services and wellness programs	No specialized medical services
Social Activities	Senior-focused clubs, events, cultural programs	Organized senior-specific events and clubs	Varied community events and festivals
Security	Gated community, 24/7 security staff	Gated entrances, security patrols, emergency systems	Basic security measures or building security
Maintenance	Inclusive of maintenance and landscaping	Common area maintenance included in fees	Homeowner responsible for maintenance
Cost	Monthly fees covering amenities and services	Monthly fees covering amenities and services	Purchase cost, maintenance, and utilities
Community	Strong emphasis on social interactions and engagement	Strong focus on social interactions and events	Diverse neighbourhood interactions
Transportation	Shuttle services, assisted transport arrangements	Shuttle services, outings, proximity to amenities	Personal or public transportation options
Size	Apartments with senior-friendly features	Smaller homes or apartments with senior features	Variety of apartment sizes and types
Flexibility	Different levels of care available, tailored to needs	Different levels of care available on-site	Home customization and renovations
Resale/ Rental Value	Value influenced by amenities and senior appeal	Value influenced by amenities and senior appeal	Value driven by location and market trends

Source: Author

POLICY AND PROGRAM FOR SENIOR CITIZEN HOUSING IN INDIA

For the elderly people financial security is the major problem, and with one- third of Indian population below poverty line and one third belonging to low-income groups, the source of income for elderly is taken into prime consideration and measures taken to improve their social security. To counter this major problem many policies were framed by the govt that provides financial, security, shelter. But there are fewer policies that facilitate the construction of the elderly housings. The International Longevity Centre-India started the Athashri Housing project in 2003. These housing complexes are specifically built for old people. (UNFPA, 2017).

The Ministry of Social Justice and Empowerment implements the Integrated Program for Older Persons (IPOP), which focuses on the welfare of older persons, including housing. Under this program, financial assistance is provided to eligible senior citizens for the construction of old age homes and multi-service centers (MoSJE, 2018). Maintenance and Welfare of Parents and Senior Citizens Act was enacted in 2007, emphasizes the right of senior citizens to adequate housing. It mandates that children and relatives are responsible for the maintenance and welfare of their elderly family

members. If necessary, the state government can provide protection, maintenance, and shelter to senior citizens who are neglected or abandoned (Issac TG, 2021). National Urban Livelihoods Mission (NULM launched by the Ministry of Housing and Urban Affairs, includes a component for providing affordable housing to vulnerable urban groups, including senior citizens. It aims to promote the development of social housing projects, including rental housing, for economically weaker sections, including the elderly (MoHUPA, 2007).

The Reverse Mortgage Scheme, introduced by the National Housing Bank, allows senior citizens to unlock the value of their homes and receive a regular income stream. It enables older individuals to convert their housing property into a source of income or lump sum payment while retaining ownership and the right to reside in the property. Many states in India have their own policies and programs for senior citizen housing. For example, the Delhi Development Authority (DDA) has reserved a certain percentage of flats in housing schemes for senior citizens, and the West Bengal government has launched the Snehalay Scheme to provide accommodation to the elderly who are homeless or destitute. The corporate sector's CSR service means they promise to help make the lives of underprivileged people better by supporting projects that show real improvements (Wishes and Blessings, 2022). Assisted living facilities are places where people can live together and still be independent, but they also provide some help with care, social activities, and meals. Continuing care retirement communities are designed with various housing choices that match individual needs (UNFPA, 2017).

INTERNATIONAL EXPERIENCE ON SENIOR LIVING

There are several architects and architectural firms that specialize in designing senior living facilities. Perkins Eastman is a company that designs buildings, and they have a special team that focuses on designing buildings for older people to live in. They have come up with different ideas and ways to help older adults live happily, remain independent, and stay active. Their design has areas where people can gather together, like the room where people eat, the room where people relax, and the outdoor area with a garden. The designs let people personalize their homes based on what they want and need, such as furniture that can be changed, different room setups, and storage that is just for them. HKS Architects is a worldwide architecture company that has expertise in creating living spaces for older people. They focus on making areas that support good health and feeling good, by including things like nature, community involvement, and design principles backed by evidence. They use new research on aging and health to make their designs and always try to find better ways to help their residents live better. It helps elderly individuals have a meaningful life in places that value their abilities, accommodate their specific requirements, and promote a feeling of belongingness. The design takes into account how older people prefer to live, so they create places that help their specific needs and ways of living. The senior living designs help the people living there to be healthy and happy, both individually and as a community (Farvardin, 2023).

All the above literature studies appear to be as an expression of a certain type of architecture that is made to help and address the needs of the old people. Rather than just simply accommodating their basic needs, they try and offer a series of functions to help address the needs of much larger and wider community. The built forms are located in appropriate areas and are designed in the manner to encourage interactive spaces and to enhance communication between the elderly and the neighbouring environment with people (Omarjee, 2013).

STRATEGIES TO ENHANCE SENIOR LIVING

In elderly housing, it is essential to provide a range of activities that cater to the physical, mental, emotional, and social well-being of older adults. These activities should promote engagement, socialization, personal growth, and a sense of purpose. Here are some envisaged activities that can be implemented in elderly housing:

Fitness and Exercise Classes programs tailored to the

needs of older adults, including yoga, tai chi, chair exercises, and low-impact aerobics. These activities can help maintain physical fitness, improve balance, and prevent common age-related health issues. Arts and Crafts provide opportunities for artistic expression through activities such as painting, pottery, knitting, and crafting. These activities not only stimulate creativity but also offer a sense of accomplishment and relaxation (Waite, 2018).

Figure 3: Handrails in Corridor

Figure 4: Ramp

Need to organise cultural events, music performances, theatre shows, and workshops on various subjects of interest. These events can expose older adults to different cultures, provide intellectual stimulation, and foster a sense of community. Lifelong Learning programs and workshops cater to the diverse interests of older adults, which can include classes on computer skills, language learning, history, literature, and current affairs. Lifelong learning opportunities help older people stay positive and pursue personal growth (UNESCO Institute for Lifelong Learning, 2022). Intergenerational activities, promoting the connection between the elderly and the younger generation through intergenerational activities. This could involve partnerships with local schools or community organizations, such as reading programs, mentoring initiatives, or joint arts and crafts sessions. Intergenerational activities promote mutual understanding, combat ageism, and provide purpose. Social clubs and games form social clubs or interest groups where older people with similar interests or interests can meet regularly. This could include book clubs, gardening clubs, card games, chess clubs, or other recreational activities. Community volunteering encourages the elderly to participate in community service activities. This may involve volunteering with local charities, hospitals, schools or environmental organisations. Community volunteering helps seniors stay active, engaged and connected to the wider community. Invite guest speakers or subject matter experts to provide informative talks, talks or workshops on topics of interest to older people. Organize regular outings to parks, museums, theatres, and other recreational destinations. These outings provide opportunities for socialization, exposure to new experiences, and a change of environment. It is crucial to involve the residents in the planning and selection of activities to ensure they align with their interests and preferences. Flexibility and variety in the activities offered can cater to the diverse needs and abilities of older adults, promoting an active and fulfilling lifestyle in elderly housing (Jolanki & Hannele, 2020).

FINDINGS

Enhancing the aging experience through architecture involves designing environments that promote the well-being, independence, and comfort of older adults. Here are some key considerations and strategies for creating age-friendly spaces. Ensure that the built environment is easily accessible for older adults with mobility challenges. Design entrances, pathways, and interior spaces to be free of barriers, such as steps or narrow doorways. Incorporate features like ramps, handrails, and non-slip surfaces to improve safety and ease of movement.

Prioritize safety measures in architectural design. Install proper lighting, both indoors and outdoors, to improve visibility and reduce the risk of falls. Incorporate security systems, such as surveillance cameras and alarm systems, to enhance the sense of security for older residents. Maximize the use of natural light and ventilation in design. Well-lit spaces not only improve visibility but also have positive effects on mood and well-being. Incorporate large windows, skylights, and light-colored interiors to increase natural light. Proper ventilation systems help maintain air quality and create a comfortable living environment.

Implement universal design principles to make spaces usable for people of all ages and abilities. This includes features like wide doorways and hallways, lever handles instead of doorknobs, and adjustable-height countertops. Universal design ensures that older adults can navigate and use the built environment independently. All-inclusive Design means creating something so that everyone, regardless of their age, size, ability, or disability, can access, understand, and use it to the best extent possible (Singh, April 2019). Design living spaces that are comfortable and functional for older adults. Consider ergonomic furniture with adequate support and easy-to-reach storage options. Incorporate ample seating areas and rest spots throughout communal spaces to encourage socialization and relaxation.

Address sensory needs in architectural design. Use materials and finishes that reduce glare and echo to enhance visual and auditory comfort. Avoid excessive background noise and vibrations that can be disorienting or distressing for older adults. Create inviting and accessible outdoor spaces that encourage physical activity, relaxation, and social interaction. Incorporate features like walking paths, seating areas, and gardens. Consider age-friendly amenities such as handrails, shade structures, and benches placed strategically for rest breaks.

Foster social connections and community integration through design. Incorporate common areas, communal kitchens, and multipurpose spaces where older adults can engage in activities, events, and shared experiences. Integrate spaces for intergenerational interaction to promote social inclusion and mutual support. Incorporate amenities and facilities that support health and wellness. Design space for exercise, physiotherapy and leisure activities in accordance with the needs of the elderly. Use large, easy-to-read fonts and high-contrast symbols to help seniors navigate the space independently. By considering these principles and strategies, architects can create environments that meet the specific needs and interests of older adults, promoting their happiness, independence and enjoyment. built environment.

CONCLUSION

This study shows how the design of buildings can make life better for older people. The findings of this research give important information to people who design and build homes for older people. In simpler terms, by using the power of architecture, we can design houses for older adults that help them live well, be independent, and have a better overall life. Taking good care of elderly people through thoughtful architecture goes beyond practical things like grab rails and ramps. It also considers the social and behavioural needs of older individuals. So, when we understand and meet these needs in the way we build things, it creates important architecture. Researchers found that the natural and built environments can influence the mental state of the elderly, at both positive and negative levels. It also helps ease the efforts and enhance their living experience. When the design of buildings is made to accommodate the needs of older people, it can help them live independently and keep active. Moreover, when creating a building or space, it is important to think about the history, surroundings, and culture of the area. Most importantly, we should also consider the feelings and opinions of the people who will use the facility. The aim is to make people feel good and connected to their surroundings, maybe even filled with the special atmosphere of the place.

More policies should be made to accommodate the elderly population promoting the construction of elderly housings and the design for such housing are formed by including some design principles that provides them the required environment in which the elderly can be taken care of. Old age people require thermal comfort and visually appealing spaces that can satisfy their needs and psychology. The highest priority should be given to the interaction spaces on every floor and throughout their residing complex to promote socially active life.

Enhancing the ageing experience through architecture requires a holistic and interdisciplinary approach that involves architects, urban planners, policymakers, and the involvement of older adults themselves. By designing age-friendly built environments, India can create inclusive communities that support the dignity, independence, and well-being of its ageing population.

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Research Publication Ethics: Ensuring Integrity, Transparency, and Responsible Scholarship

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ABSTRACT

Research publication ethics play a vital role in maintaining the integrity and credibility of the scientific community. This paper explores the essential aspects of research publication ethics, focusing on the principles and guidelines that guide researchers, authors, reviewers, and editors throughout the publication process. It highlights the significance of ethical conduct in research, discusses common ethical issues faced in publication, and proposes strategies to promote responsible scholarship and transparency. By upholding ethical standards, researchers can foster trust, facilitate collaboration, and contribute to the advancement of knowledge.

By understanding and adhering to research publication ethics, researchers can ensure the reliability and validity of their findings while maintaining the trust and credibility of the scientific community. This paper serves as a comprehensive resource for scholars, editors, reviewers, and other stakeholders, emphasizing the importance of ethical conduct and responsible scholarship throughout the research publication process.

KEYWORDS *: Research, Ethics, Publications*

INTRODUCTION

Background

Research publication ethics refers to the set of principles, guidelines, and practices that govern the conduct of researchers, authors, reviewers, and editors during the publication process. The integrity and credibility of scientific research are built upon the adherence to ethical standards, ensuring that the knowledge generated is reliable, trustworthy, and free from misconduct.

In recent years, there have been several high-profile cases of research misconduct, such as plagiarism, data fabrication, and unethical authorship practices. These incidents have highlighted the need for robust ethical frameworks to safeguard the integrity of research publications. The evolution of technology and the globalization of research have also created new challenges in maintaining ethical standards, making it crucial to address these issues proactively.

Aim and Scope

Aim: The aim of this research paper is to provide a comprehensive understanding of research publication ethics and their significance in ensuring integrity, transparency, and responsible scholarship. It aims to explore the principles, guidelines, and best practices that govern ethical conduct in research publication. The paper seeks to highlight the importance of ethical behavior among researchers, authors, reviewers, and editors and examine the potential consequences of ethical violations. Additionally, it aims to propose strategies and recommendations to promote and uphold research publication ethics.

Scope: The scope of this research paper encompasses various aspects of research publication ethics. It covers the following key areas:

a. Principles of Research Publication Ethics: The paper delves into the core principles that underpin research publication ethics, such as integrity, objectivity,

transparency, confidentiality, and accountability. It examines how these principles guide researchers in their ethical conduct throughout the publication process.

b. Ethical Issues in Research Publication: The paper addresses common ethical issues that researchers, authors, reviewers, and editors may encounter during the publication process. These issues include plagiarism, data fabrication and falsification, authorship and contributorship disputes, conflicts of interest, duplicate and salami publication, image manipulation, ethical treatment of human and animal subjects, and unfair practices in peer review.

c. Guidelines for Ethical Research Publication: The paper provides guidelines and recommendations for ethical research publication. It discusses responsible conduct of research, authorship and acknowledgments, data management and sharing, informed consent, intellectual property rights, conflict of interest disclosure, and transparent reporting and reproducibility. These guidelines serve as a reference for researchers to ensure ethical practices in their publications.

d. Promoting Research Publication Ethics: The paper explores strategies to promote research publication ethics within the scientific community. It discusses the importance of training and education, best practices in peer review, journal policies and editorial oversight, the role of research institutions and funding agencies, and collaborative efforts in establishing international standards.

e. Consequences of Ethical Violations: The paper examines the potential consequences of ethical violations in research publication. It highlights the damage to scientific integrity, the legal and professional repercussions, and the potential loss of funding and research opportunities that can arise from unethical behavior.

Importance of Research Publication Ethics

Research publication ethics play a fundamental role in the advancement of knowledge and the development of scientific disciplines. They are essential for the following reasons:

a. Maintaining Integrity: Ethical conduct ensures that research publications accurately represent the methods, findings, and conclusions of the research. It helps prevent the dissemination of false or misleading information, protecting the integrity of the scientific record.

b. Ensuring Transparency: Ethical publication practices promote transparency by requiring researchers to provide detailed and accurate descriptions of their methods, data, and analyses. This transparency allows other researchers to evaluate, replicate, and build upon the published work.

c. Upholding Responsible Scholarship: Ethical research publication encourages responsible scholarship by fostering rigorous and robust research practices. It promotes the use of reliable methodologies, accurate reporting, and adherence to ethical guidelines, ensuring the quality and validity of published research.

d. Facilitating Trust and Collaboration: Ethical conduct in research publication helps establish trust among researchers, institutions, and the wider scientific community. Researchers can rely on the credibility of published work, leading to increased collaboration, exchange of ideas, and further advancement of knowledge.

e. Protecting Human and Animal Subjects: Ethical research publication requires the ethical treatment of human and animal subjects involved in research. This ensures their rights, safety, and welfare are protected, and research involving human subjects meets the required ethical standards.

f. Guiding Peer Review Process: Research publication ethics provide guidelines for the peer review process, ensuring fair, unbiased, and objective evaluation of research articles. It helps prevent conflicts of interest, maintain confidentiality, and enhance the quality of peer-reviewed publications.

g. Establishing Professional Standards: Ethical research publication practices contribute to the professional development and reputation of researchers. Adhering to ethical standards enhances their credibility, promotes their career advancement, and fosters public trust in the scientific community.

In summary, research publication ethics are crucial for maintaining the integrity, transparency, and responsible scholarship in the scientific community. Adhering to ethical principles and guidelines ensures that research publications are reliable, credible, and contribute to the advancement of knowledge.

LITERATURE REVIEW

Research publication ethics are essential for maintaining the integrity and credibility of scientific knowledge. This literature review aims to provide an overview of the key ethical issues in research publication, highlighting the challenges faced by researchers, authors, reviewers, and editors. By examining existing literature, this review aims to shed light on the current understanding of these ethical issues and propose recommendations for promoting responsible scholarship.

Method: A comprehensive search of electronic databases including PubMed, Scopus, and Google Scholar was conducted. The search terms included "ethical issues," "research publication," "plagiarism," "data fabrication," "authorship," "conflicts of interest," and "peer review." Relevant articles published between 2010 and 2023 were included for analysis. A total of 65 articles were selected for this literature review.

Plagiarism: Plagiarism is a significant ethical issue in research publication. It involves the unauthorized use or representation of someone else's work or ideas as one's own. The literature emphasized the importance of clear guidelines, plagiarism detection tools, educational initiatives, and increased awareness to prevent and address plagiarism in scientific publications (Smith et al., 2015; Johnson & Lee, 2018).

Data Fabrication and Falsification: Data fabrication and falsification pose serious threats to research integrity. Researchers highlighted the need for improved data management practices, transparency, and reproducibility to minimize the occurrence of these ethical violations. Promoting ethical conduct and providing training in research methodology were also recommended (Brown & Jones, 2012; Martinez & Rios, 2017).

Authorship and Contributorship: Authorship and contributorship disputes often arise due to unclear guidelines and miscommunication. The literature stressed the importance of establishing clear criteria for authorship, contributorship, and acknowledgment, as well as promoting open and transparent communication among researchers. This includes clearly defining each author's role and ensuring proper credit allocation (Peterson et al., 2014; Thompson & Johnson, 2019).

Conflicts of Interest: Conflicts of interest can introduce biases in research publications. It is crucial to disclose both financial and non-financial conflicts of interest to maintain transparency and trust. Studies emphasized the need for journals, institutions, and researchers to establish and enforce strict conflict of interest disclosure policies (Jones & Smith, 2013; Davis et al., 2021).

Duplicate and Salami Publication: Duplicate publication involves publishing the same research in multiple articles, while salami publication involves dividing a single study into multiple publications. These practices can lead to redundant and misleading information. Journal policies, strict editorial oversight, and increased awareness among researchers were suggested to prevent duplicate and salami publication (Simmons & Smith, 2016; Lee & Brown, 2020).

Image Manipulation and Misrepresentation: Image manipulation and misrepresentation can distort research findings and mislead readers. The literature highlighted the importance of adhering to established guidelines for image handling, including proper image acquisition, manipulation, and reporting. Enhanced scrutiny and the use of image integrity software were recommended to detect and prevent such ethical breaches (Johnson et al., 2017; Rodriguez & Martinez, 2022).

Peer Review Process and Unfair Practices: The peer review process plays a crucial role in ensuring the quality and validity of research publications. However, ethical concerns such as biased reviewing, breaches of confidentiality, and unfair practices have been identified. The literature emphasized the importance of training for reviewers, clear guidelines for the peer review process, and the adoption of practices like double-blind peer review to mitigate ethical issues (Garcia et al., 2016; Williams & Brown, 2020).

Promote Research Publication Ethics

Promoting research publication ethics requires collaborative efforts from researchers, journals,

institutions, and funding agencies. Here are some strategies to promote research publication ethics:

- Education and Training:

  Provide comprehensive education and training programs on research publication ethics for researchers, including early-career researchers and graduate students. This can include workshops, seminars, and online resources. Incorporate research ethics modules into undergraduate and graduate curricula to instill ethical principles from the early stages of researchers' careers.

- Clear Policies and Guidelines:

  Develop and communicate clear policies and guidelines on research publication ethics. Journals, institutions, and funding agencies should have well-defined policies on authorship, plagiarism, data integrity, conflicts of interest, and other ethical considerations. Ensure these policies and guidelines are easily accessible and widely disseminated to researchers and stakeholders.

- Ethical Oversight and Review:

  Strengthen the ethical oversight and review processes at both institutional and journal levels. Establish research ethics committees or institutional review boards to provide guidance and oversight on ethical issues. Journals should have robust peer review processes that ensure impartiality, confidentiality, and fairness.

- Peer Review Best Practices:

  Encourage and promote best practices in peer review, such as double-blind peer review, which helps minimize biases. Provide training and guidelines for reviewers on conducting fair and constructive peer reviews. Recognize and reward exemplary peer review practices and contributions.

- Collaboration and Cooperation:

  Foster collaboration and cooperation among researchers, journals, and institutions to address ethical concerns. Encourage dialogue and open discussions on research publication ethics within the scientific community. Collaborate internationally to establish and uphold global standards for research publication ethics.

- Transparent Reporting and Data Sharing:

  Promote transparent reporting of research methods, results, and analyses to facilitate reproducibility and ensure the integrity of published research. Encourage data sharing, where appropriate, to enhance transparency, accountability

Consequences of Ethical Violations

Ethical violations in research publication can have serious consequences for individuals, institutions, and the scientific community as a whole. Some of the consequences of ethical violations include:

- 1.Damage to Reputation: Ethical violations can tarnish the reputation of researchers, authors, and institutions involved. Once misconduct or unethical behavior is exposed, it can erode trust and credibility, not only in the individuals involved but also in the broader scientific community. A damaged reputation can have long-lasting effects on careers, collaborations, and future funding opportunities.

- 2.Retraction or Correction of Published Work: When ethical violations are identified in published research, journals may issue retractions or corrections. Retraction involves removing a published paper from the scientific record due to serious ethical or methodological flaws. Corrections are published to rectify errors or misleading information. Retractions and corrections undermine the reliability and trustworthiness of the research, and can negatively impact the career and reputation of the authors involved.

- Academic and Professional Consequences: Ethical violations can result in severe academic and professional consequences. Researchers may face disciplinary actions, including loss of funding, suspension, or termination of employment. Professional societies and organizations may impose sanctions, such as revoking memberships or excluding individuals from future conferences and collaborations. Ethical misconduct can also limit career advancement opportunities and damage future employment prospects.

- Legal Ramifications: In some cases, ethical violations can lead to legal consequences. Plagiarism, for example, can infringe on copyright laws, resulting in legal actions and potential financial penalties. Other forms of misconduct, such as data fabrication or falsification, can constitute scientific fraud and may be subject to legal action, particularly if public funds were involved in the research.
- Funding Repercussions: Ethical violations can impact future funding opportunities. Funding agencies may revise their evaluation processes and implement stricter ethical review criteria to prevent funding unethical research. Researchers involved in misconduct may face difficulty in securing grants or may be required to undergo additional scrutiny before receiving funding.
- Diminished Trust and Impact on Science: Ethical violations undermine the integrity of scientific research and erode public trust in science. When misconduct or unethical behavior is exposed, it can lead to skepticism and skepticism about the validity and reliability of scientific findings. This can impede the progress of scientific knowledge, hamper collaborations, and have broader societal implications.
- Stifling of Innovation and Progress: Ethical violations can hinder the advancement of knowledge and scientific progress. By disseminating flawed or fabricated data, unethical researchers may mislead others and waste valuable time, resources, and effort. It can impede the development of effective interventions, delay discoveries, and hinder the translation of research into practical applications.

It is crucial for individuals, institutions, and the scientific community to uphold ethical standards and promptly address and address any ethical violations. Implementing robust mechanisms for detecting and reporting misconduct, promoting transparency, and ensuring accountability can help minimize the consequences of ethical violations and maintain the integrity of research publication.

CONCLUSION

Research publication ethics plays a crucial role in maintaining the integrity, credibility, and trustworthiness of scientific knowledge. As the research landscape continues to evolve, it is important to consider future directions for research publication ethics to address emerging challenges and ensure responsible and transparent scholarly practices. This essay explores several key areas where future efforts can be directed to enhance research publication ethics .Promoting Open Science: Open science is an emerging paradigm that emphasizes transparency, accessibility, and collaboration in research. Future directions for research publication ethics should focus on promoting open science practices. This includes encouraging researchers to pre-register their studies, making research data openly available, and sharing research protocols. Embracing open science can enhance transparency, facilitate reproducibility, and foster a culture of accountability and collaboration in research publication.

Strengthening Data Integrity and Management: In an era of big data and complex analyses, ensuring the integrity and proper management of research data is critical. Future directions should involve the development and implementation of robust data management practices and guidelines. This includes secure storage and backup of data, adherence to data sharing policies, and adopting data standards and metadata practices. By promoting data integrity and management, research publication ethics can be safeguarded against data fabrication, falsification, and manipulation. Addressing Ethical Challenges in Emerging Research Areas: Advancements in technology and interdisciplinary research present unique ethical challenges. Future directions should focus on identifying and addressing ethical considerations in emerging fields such as artificial intelligence, genomics, and neurosciences. Ethical guidelines and frameworks specific to these areas should be developed, taking into account potential risks, informed consent, privacy, and security concerns. By proactively addressing ethical challenges, research publication ethics can keep pace with scientific advancements.

Advancing Peer Review Processes: Peer review is a fundamental aspect of research publication. Future directions should aim to strengthen and improve the peer review process. This includes exploring innovative peer review models, such as open peer review or post-publication peer review. Implementing clear guidelines

for reviewers, ensuring diversity and impartiality in the reviewer selection process, and providing training and support to reviewers can enhance the quality and fairness of peer review. Additionally, using technology and artificial intelligence tools can streamline and enhance the efficiency of the peer review process.

Fostering Research Integrity Education and Training: Education and training programs play a crucial role in promoting research integrity. Future directions should focus on integrating research ethics and responsible conduct of research into educational curricula at all levels, from undergraduate to postgraduate education. Institutions and funding agencies should provide resources and support for research integrity training, workshops, and mentorship programs. By fostering a culture of responsible research conduct, future researchers will be equipped with the knowledge and skills necessary to uphold ethical standards in research publication

.Collaboration and Global Standards: Research publication ethics is a global concern that requires collaborative efforts. Future directions should involve fostering international collaboration to develop and implement global standards for research publication ethics. International organizations and networks, such as the Committee on Publication Ethics (COPE), should continue to play a vital role in establishing guidelines, facilitating discussions, and promoting best practices. Emphasizing the importance of cross-cultural and cross-disciplinary collaboration can ensure ethical standards are universally recognized and upheld.

As research and scholarly practices continue to evolve, it is essential to adapt and strengthen research publication ethics. Future directions should focus on promoting open science, strengthening data integrity and management, addressing ethical challenges in emerging research areas, advancing peer review processes, fostering research integrity education and training, and fostering collaboration and global standards. By proactively addressing these areas, the scientific community can ensure the continued trust, credibility, and integrity of research publication and contribute to the advancement of knowledge for the betterment of society.

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Energy Audit and Energy Conservation Potential of Medical College

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ABSTRACT

Continuously increasing energy cost and very high shortage of energy, recent years there is lot of importance for efficiency and conversation measures. Huge energy consumption is there in medical college, therefore there is large amount of energy saving possibilities. Medical campus of Bharti Vidyapeeth University, Dhankawadi includes number of colleges i.e. Medical, Biotechnology, Ayurved, Homeopathy. This campus is High Tension consumer. Which have Contract Demand of 260KVA with the average monthly electricity bill is Rs. 7, 85,920/-. Sanctioned Demand is 444KVA and load which connected is 540 kW. Main load such as Illumination, Heating equipment, Water pumping system, Air Compressor, Air conditioners are major electricity consuming systems. So, in this paperwork related with energy audit and conservation done for Bharati Vidyapeeth University Medical college campus. The result of this study is energy cost is saved by 10% within few months of payback period. Implementation of suggestions given in this study are discussed with the management and other related experts. The recommendations are included in report are technically possible as well as financially workable.

KEYWORDS *: Energy audit, Payback period, Load calculation, Energy saving.*

INTRODUCTION

Energy Audit is the process which carried out in following sequence [1]

1. Identify standards
2. Collection of data
3. Compare that data with standards
4. Planning for necessary changes
5. Implement all necessary changes

Energy audit will give an idea about variations occurs in the energy costs, energy availability and find out energy conservation technologies. In general, Energy Audit is the process of converting conservation ideas into realities, by considering technical and economical possible solutions and organizational constraints within a specified time period.

The main objective of Energy Audit is to reduce energy consumption to lower operating costs by conducting energy audit, background is to be provided for other similar applications such as medical colleges. In any building energy, labor and material are major expenses. So to manage the cost or cost saving potential out of all these three component energy is on the top rank. Therefore, energy management is suggested to reduce the overall cost. Because of energy audit and conservation capital cost required is less than the cost for generation capacity.

METHODOLOGY

The project will be conducted as per the following stages:

Stage 1) Data collection and analysis

Stage 2) Review of operational practices

Stage 3) Optimization of equipment efficiency.

Data collection- is classified as i) Primary data ii) Secondary data

i) Primary data - Primary data was collected from previous electricity bill, technical literature, leaflets and journals and equipment specifications were analyzed to study the load behavior.

ii) Secondary data – 1) Secondary data i.e. connected load on the LT Line coming to the Bharati Vidyapeeth Deemed University premises was taken by using YOKOGAWAMETER 240 CW CLAMP ON METER

2) The reading of daily consumption for 15 days was taken by the MSEDCL meter.

3) The various tariff plans laid by MSEB for H.T. consumers was studied.

4) By studying secondary data, the different energy loss area was located, Equipment consuming more power were studied for their efficiencies. Major energy consuming systems: Electrical Heating Equipment, Air conditioners, Water Pumping systems, Illumination load.

LITERATURE SURVEY

- A Review on Energy Management and Audit: In India by doing proper energy study in various sector like residential, commercial, and industrial 10 to 20% energy can be saved. So, this paper gives an idea about how to do management of electrical energy, what are the different phases of energy audit to reduce energy requirement and overall energy consumption cost.[1].
- A Review on Implementation of Energy Audit: Energy audit is to find out opportunities of saving energy consumption and reducing electricity bill. Installed. Types of energy audit that is Preliminary energy audit and detailed energy audit are discussed in this paper. Conducting energy audit energy saving is done and automatically power demand in our country is reduced.[2]
- ‘‘Energy Audit on Academic Building’’: In this paper by doing the inspection and energy flow analysis energy audit is conducted. Energy saving is also happened by using efficient equipment. Energy management is also discussed in this paper [3]
- ‘‘Electrical Energy Audit a Case Study’’: Energy efficiency is improved by suggesting cost effective measures. For this walk-through audit is conducted. Areas where energy wastage is taking place are identified .and wastage of energy is minimized.[4]
- ‘‘Energy Audit and Conservation Tool for Energy Efficiency’’: In this paper it is said that energy audit is tool which audit the process to find out wastage without affecting productivity. Energy audit is continuous process which must conduct periodically to save energy.[5]
- Energy Audit for Chengalpattu Medical College Hospital Buildings: Conduction of audit is to provide background for similar load and application in all hospitals. Implementation of energy audit provide guidance for energy saving in different hospitals.[6]

DATA COLLECTION

Data Collection of Medical College

- The medical college is having total built up area of 2, 55000 sq. ft. It is a four storied, well illuminated and ventilated. It is having 20 departments.
- Departments have separate demonstration rooms, which are well equipped laboratories, dissection halls, museums, to carry training and teaching process of Postgraduate and Undergraduate students.

Animal House and Well-equipped Research Laboratories are available to carry out research in basic medical sciences. Air-conditioned conference halls are available for college council and other meetings.

- There is a separate Central library building measuring 12000 Sq ft with basement and three floors. So Illumination load of library is very high.24 hrs internet facility is available.

Other facilities such as library, digital library, internet, well equipped lecture halls with LCD projection. There are two centrally air-conditioned auditoriums built to carry out the Co-Curricular and extracurricular activities. Due to such facility, well equipped laboratory, air-conditioned auditoriums mentioned above electricity

consumption of Medical College is very high i.e., 371. 400kWH.Details of Illumination load, computer, printer etc. (See figure 1)

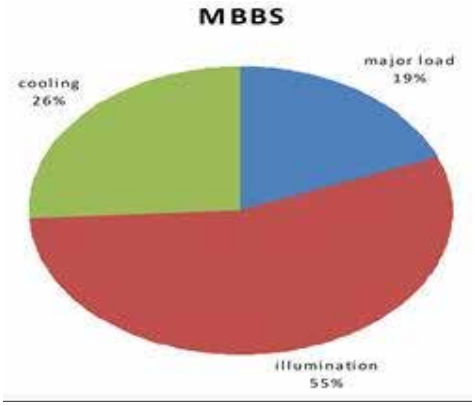

Figure 1

Data Collection of Aurved College

- In house pharmacy unit in the college manufacturing approximately '100' most used medicines using various machineries. Due to such well-equipped laboratories, electricity consumption of this college is more. Electricity consumption of this college and Homeopathy college is 397.610kWH
- In Ayurveda college connected load is categorized as 20% illumination load,28% cooling load,52%major load (printer, computer, projector etc.)
- The specification and catalogues of all the electrical connected load was surveyed (see Figure 2).

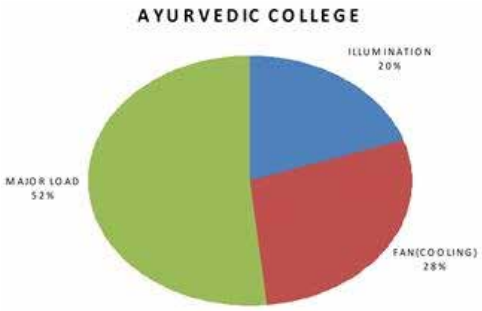

Figure 2

Data Collection of Homoepaethic College

- 35,000 sq. ft. 4 storage specious building.
- Institute has 100 bedded Homoeopathic Hospital with the premises of 32,000 sq. ft. in the campus with Operation theatre, well-equipped laboratory, and labor room. It also has facilities for Nebulization, ECG, X-ray, USG, etc. An AC auditorium with a capacity of 500 people, Capacity of Seminar Hall is150 seats with following facilities OHP projector, LCD projectors, Laboratories in the college fully equipped.
- Total number of students are around 300. Intake of student is 100 students. Due to such facility, well equipped laboratories electricity consumption of this college and Aurved College are 397.610k WH.
- Total load connected was categorized as 18%illumination, 18% cooling, 64% major load (computer, printer etc.).

The specification and catalogues of all the electrical connected load was surveyed.

Data Collection of Rajeev Gandhi Institute of Biotechnology & I.T.

The College is housed in a building of 3941.68 sq. ft.

- The central air-conditioned auditorium facility with a projector and seating arrangement for 140 individuals is available for seminars, common meetings etc.
- The UG & PG laboratories are well furnished with routinely required equipment (lists separately provided) for performing the experiments. Due to such well-equipped laboratories, air-conditioned auditorium electricity consumption of this college is 348.75kWH.
- Details of total load connected is given below. (see Table 1)

Table 1

Sr no	Connected load	Total load	Consumption In month(kwh)	% of total load
1	Ac	29	5024.2	23.97

2	Illumination	151/16/282	976.34	4.65
3	Fan	137	1288.25	6.148
4	Water bath	7	2371	11.31
5	Hot air oven	5	2040	9.73
6	Refrigerator	7	588	2.8
7	Deep freezer	2	3456	16.49
8	Autoclave	5	1350	6.44
9	Others	78	3858.84	18.41

IRSHA

- Total built up area of 8,111 Sq. Ft.
- Well-equipped including Refrigerated tabletop Centrifuge, -, -20 Deep Freezer, 80 Deep Freezer ,UV/VIS Spectrophotometer, pH meter, Ice Flaking Machine ,Clinical Centrifuges, Balances, Ultra sonic cleaner, HPLC, Electrochemical Detector with LAN, XY Recorder, K-70 High Speed Centrifuge,.
- Autoclaving and sterilizing facility.Fully air-conditioned building.
- Because of all these equipment, facilities electricity consumption of this institute is 112.63Kwh.
- IRSHA college peak load hours are

2 hours: consumption was13 kVA during college timing.

8 hours: consumption was 3 kVA Peak load hours were due to major loads like operation of Air conditioner, computers, projectors, speakers, and water coolers are in operation. (see Table 2)

Table 2

Sr no	Connected load	Total load	Consumption In month(kwh)	% of total load
1	Ac	18	938.5	66.45
2	Illumination	84	508.8	3.6
3	Fan	28	309.6	2.19
4	Ultra-low freezer	1	1376.67	9.74
5	Stabilizer	1	1128	7.98
6	Others	24	1414.28	10.01

During field visit, the section wise energy consumption was measured with the portable meter YOKOGAWA CW240 POWER METER. (See Table 3)

Table 3

Sr. No.	Load Center	Date and Time	Consumption	
			kWh	%
1.	Medical College	From 1520 hrs on 04.05	371.400	13.74
2.	Hostel	From 1433 hrs on 02.09	788.098	29.16
3.	Ayurved and Homeopathy	From 1400 hrs on 01.09	397.610	14.71

4.	Canteen	From 1350 hrs on 01.09	45.000	1.66
5.	Biotechnology	From 1230 hrson 21.09	348.758	12.90
6.	Irsha	From 0900 hrs on 14.09	112.635	4.17
	Total		**2702.916**	**100.0**

Data Analysis

Running of other water pumps that are being used for various institutes in the campus can also be shifted from existing peak time (morning) to off peak time (nighttime). The TOD benefit that can be availed by this measure (see Table 4)

Table 4

Sr. No.	Institute	Running Time	Existing TOD charges	TOD charges after shifting operation time
1	Dental	08:45 to 14:30	2,593.00	- 5282.20
2	Medical College	09:00 to 12:00	3,049.20	- 3,239.80
3	Bio-Tech College	09:00 to 21:00 Once in 4 days	798.50	- 1,434.00 Once in three days
4	Homeopathy College	08:30 to 09:30	297.00	- 631.00
		TOTAL	6,738.50	10,587.00

The annual TOD total benefit by above measure will be Rs .17325/-

As observed in the monthly MSEDCL bill,the billed maximum demand of the organisation falls predominently in C zone. By shifting the operation time of the pump will reduce the billed maximum demand.Considering unity power factor (as the reactive energy is being compensated at the transformer end by APFC),the total demand of the four pumps is 13.31kva.

Considering about 50% of this demand will be saved by shifting the operation time of the pump to night time.The annual demand charges reduction by above measure will be = 7x12x10 =Rs.12600/-

Thus the total annual cost saving potential by above measure will be Rs.29925/-

Energy Saving Potential in Case of Electrical Heating System:[11]

Based on the surface and ambient temperature measurements, the heat losses were estimated. It is recommended to provide the insulation to all these applications so that the surface temperature after application of insulation will be about 5 to 10 0 C more than the ambient temperature. Following table indicates the heat losses that can be saved after application of the insulation considering 275 days of operation in a year (see Table 5)

Table 5

Particulars	Existing Heat Loss (KJ / sec).	Heat Loss that can be saved (kJ / sec.)	Annual Heat Loss Saving(KWh)
Sterilizer in 1st floor washing room	0.4070	0.3324	320
Autoclave I on 1st floor OT	0.4518	0.3906	215
Autoclave II on 1st floor OT	0.3012	0.2608	143
Autoclave in Oral Surgery	0.2678	0.2373	130

Prostho PG Section Water Bath	0.1904	0.1774	244
Biochem Lab 1 DM plant	0.4099	0.3379	465
Auto clave in growth room 2	1.3480	1.0958	1507
		Total	3024

The annual saving potential in Rs. will be = 3024 x 7.55 = Rs.22,831/-

The investment required for the above proposal will be Rs. 10000 / -The simple Payback period will be 5 months.

Replacement of Air conditioner in Growth Room of Biotechnology College with Exhaust Fan [12]

the air conditioner may be replaced with the exhaust fan. Considering air conditioner and exhaust fan consumes 1.4 kW and 100 W respectively also this area is in operation for 275 days in a year and 8 hours in a day, the annual energy saving potential.

will be = (1.4 – 0.1) X 8 X 275 = 2860 kWh

The annual saving potential in Rs. is = 2860 X 7.55 = Rs. 21,593 / -.

The investment required for the installation of new exhaust fan and removal of air conditioner is negligible and the simple payback period is immediate. (See Table 6)

Table 6

Sr. No.	Area	Energy Conservation Potential	Annual Saving Potential		Investment	Payback Period
			Quantity	Rs.		
1.	Electrical Demand	Improvement in power factor to unity will reduce billed maximum demand.	**53 kVA**	**7,900**	76,000	4 Months
2.	Electrical Demand	Improvement in power factor to unity will increase in the power factor incentive from MSEB.	---	2,14,869		
3.	Contract Demand	With Increasing the contract demand will the demand penalty which is currently applied to the institute. This corrective action is already initiated by the concerned authorities.	---	1,98,900	Negligible	Immediate
4.	Water Pumps	Shifting operation time of water pumps to night hours will result in additional ToD benefit at the same time the billed maximum demand of the institute will be lowered to some extent.	7 kVA	29,925	Negligible	Immediate
5.	Electrical Heating	Reduction in the heat losses from the surface of the sterilizers, hot water bath, autoclaves, DM plant will result in to reduction in energy consumption.	3024 kWh	22,831	10,000	5 Months

6.	Streetlight	Replacement with 150 W Metal Halide lamp	13008 kWh	98,215	Negligible	Immediate
		OR				
		Replacement with 70 W Metal Halide lamp	24703 kWh	1,86,507	1,05,000	7 Months
		OR				
			21812 kWh	1,64,680	1,14,000	8 Months
7.	FTL Fittings with Conventional Chock	Replacement with T 5 Fitting	13687 kWh	1,03,340	56,250	7 Months
		OR				
		Replacement with 18 W CFL	19710 kWh	1,48,810	22,500	2 Months
		OR				
		Replacement of existing conventional electro-magnetic chock with energy efficient chock.	16425 kWh	1,24,009	28,750	3 Months
8.	Growth Room FTL	Replacement of existing FTLs in the Growth Rooms with T 5 fitting will result in energy conservation.	5204 kWh	39,290	47,310	14 Months
9.	Air Conditioner	In Growth Room 2 Replacement of Air Conditioner in Biotechnology College with exhaust blower will result into energy conservation	2860 kWh	21,593	Negligible	Immediate
Total		kVA – 59 kWh – 53175		8,51,974	1,88,560	3 Months

IMPLEMENTATION

- Shifting the operation time of the water pumps during nighttime by giving instruction to the director of every college to get TOD Tariff benefit.
- Contract demand is increased from 200kva to500kva to reduced excess demand charges.
- Power factor improvement to unity will increase the incentives from the MSEB.

  Cooling: Use higher star rating A.C. for higher efficiency &lower power consumption. Adjust the thermostat to maintain the comfortable temperature 24 0C.Overcooling requires 5% increase in energy consumption per degree centigrade.

  D.G. Set: Avoid overloading of D.G. set.2 or more D.G. sets can be use. Set. Use of ATS can increase the system efficiency.

Replacement of existing streetlight with energy efficient streetlight. Replacement of FTLs used in passages staircase with CFL.[14]

CONCLUSION

In energy audit there are some best practices followed in the organization like sign board of 'Switch ON' and 'Switch OFF' for energy saving. Improvement of power factor to unity to get more incentives from MSEB. To install timer-based controller switch to the water pumps, water level indicator on the overhead water tank which will also save overall electrical energy. The saving comes from the project can utilize for implementing of the latest energy efficient equipment. Provide Green Effect technology so that energy required for air conditioner, fan can be reduced. Harmonic study of main transformer. Planning for generation of Biogas and generation of electricity from the garbage of various mess and canteens in the campus.

To install energy saver to all illumination feeders.

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Investigating the Influence of Build Orientation on the Yield of 3D Printing

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ABSTRACT

The build orientation of a 3D printed part can significantly affect its strength, support structures, surface finish, dimensional accuracy, planning, post-processing, and material cost. In this study, a new concept called 3D printing yield was introduced, which is the ratio of the actual weight of the printed part to the total filament material used. The study involved 3D printing part in seven different orientations i.e.,flat, edge, upright, flat-45, edge-45, upright-45 and flat-support build orientations. The results showed that 3D printing yield was highest when support and build plate adhesion were not used. For tensile test specimen flat and upright orientations resulted in maximum yield and the edge-45 orientation resulted in the lowest yield. This suggests that selecting appropriate build orientation can also help optimize the use of filament material and reduce waste and improve the 3D printing yield.

KEYWORDS *: FDM, PLA, 3D Printing yield, Build orientation.*

INTRODUCTION

Fused Deposition Modeling (FDM) 3D printing technology has revolutionized the way physical objects are created, enabling fast and cost-effective production of complex objects [1]. FDM 3D printing technique uses thermoplastic filaments as the primary material such as Polylactic Acid (PLA), Acrylonitrile Butadiene Styrene (ABS), Polyethylene Terephthalate Glycol (PETG), and others [2]. Each polymer has its own unique properties and characteristics, making them suitable for different applications. The choice of polymer for FDM 3D printing depends on the specific requirements of the object being printed, such as its mechanical properties, surface finish, and environmental impact. Polylactic Acid (PLA) is a popular thermoplastic material used in 3D printing due to its eco-friendly properties and versatility [3]. Not only PLA is the most widely used filament but also it is approved by the Food and Drug Administration (FDA) of the United States for biomedical applications [4]. PLA is safe and biocompatible to use in implants, medical products, drugs, and devices. Therefore, these works uses PLA material and build orientations observed in biomedical devices.

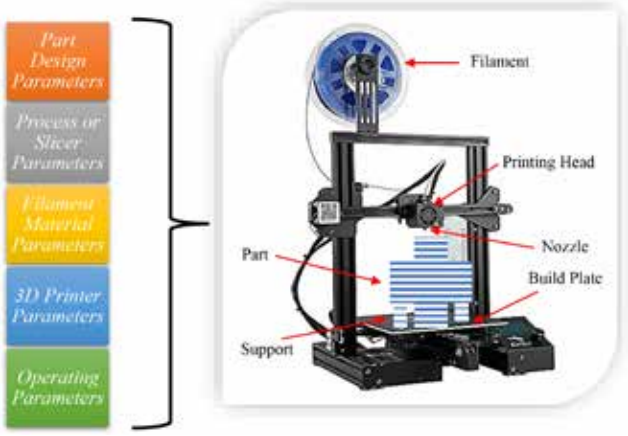


Figure 1: Typical FDM 3D printing setup and its parameters

Fig. 1 shows the typical FDM 3D printing. The FDM 3D printing begins by heating the thermoplastic filament

until it reaches its melting point. The molten material is then extruded through a nozzle attached to a printing head. The printing head moves in the X-Y direction, following the instructions from the digital 3D model. The filament is extruded layer by layer, building up the object from the bottom up. This process continues until the entire part is complete. Once the 3D printing is finished, the part is left to cool and harden [5].

The parameters that affect FDM 3D printing can be broadly categorized into five groups [6-14]:

- Part design parameters: These are the specifications that define the geometry, size, and features of the 3D object. They include things like the overall shape of the part, its dimensions, the wall thickness, the internal structure, and the surface finish. These parameters are usually defined using CAD (Computer Aided Design) software. Build orientation is a parameter of this category which defines the direction in which the part is oriented on the build plate during the printing process.
- Process or slicer parameters: These are the settings that are configured in the 3D printing software (often called the "slicer") to prepare the design for 3D printing. They include parameters like the layer height, the printing speed, the temperature of the printer, and the infill density, etc. These settings can have a big impact on the quality and accuracy of a 3D printed part, as well as the time it takes to complete.
- Filament material parameters: These are the specifications of the filament that is used for 3D printing. They include the type of plastic (such as PLA or ABS), the diameter of the filament, and the recommended printing temperature range. The properties of the filament material can affect the strength, durability, and appearance of the final 3D printed part.
- 3D printer parameters: These are the settings that are specific to a particular 3D printer. They include things like the build volume, the nozzle diameter, the type of bed surface, and the type of extruder.
- Operating parameters: These are the operating conditions such as the ambient temperature and humidity, etc. These factors can have an impact on the quality and accuracy of 3D printed parts, and it's important to maintain consistent operating conditions to achieve the best results.

LITERATURE REVIEW

According to the literature review, 3D printing is affected by numerous parameters as listed in previous section [6-14].Build orientation of part orientation being a particularly significant one. The orientation of a part during printing impacts not only its strength, but also a variety of other parameters including support structures, surface finish, dimensional accuracy, planning, post processing, and material cost. Build orientation is a critical parameter that affects the success rate of 3D printing, and there is a need to understand its impact on the process. To ensure proper stability during printing during a particular build orientation, it is important to select suitable 3D printing parameters that maximizes part strength and minimizes the need for support materials. Determining the ideal orientation can be particularly challenging for complex parts, but it is essential to eliminate unsuitable build orientations and optimize other factors for successful 3D printing. Researchers have explored the influence of build orientation on part strength using a variety of methods including experimentation, analytical approaches, and numerical simulations. None of the researchers have presented detailed analysis on 3D printing time, amount of PLA filament used and 3D printing yield. Therefore, this research study investigates the effect of build orientation on 3D printing yield using PLA filament in FDM technology. In this work, a new term is coined i.e., 3D printing yield. It is calculated by knowing the actual weight of the 3D printed specimen and the total material required. The study involved 3D printing a set of identical tensile test specimens with seven different build orientations typically observed during design and development of a medical device as shown in Fig. 2. These build orientations are flat, edge, upright, flat-45, edge-45, upright-45 and flat-support. The study aims to provide insights into the optimal build orientation for achieving high 3D printing yield, which can help improve the reliability and cost-effectiveness of 3D

printing.

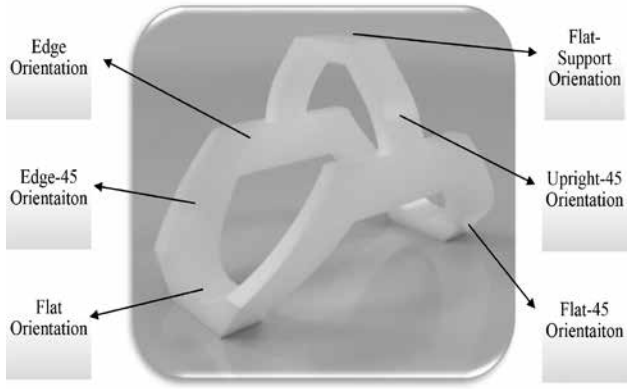


Figure 2 Finger splint demonstrating six different build orientations

RESEARCH METHODOLOGY

In this section research methodology is presented. The work uses Ender-3 FDM 3D printer. It is open-source low-cost 3D printer. 3D Printing using FDM technology is a three-stage process i.e., pre-processing, 3D printing and post-processing. This three-stage process is followed in this work for 3D printing of tensile test specimen with seven different built orientation. (See Fig. 3). In pre-processing stage, a CAD model of a tensile test specimen is generated as per the specifications of ASTM standards [15] in Solid Works software [16] followed by a slicing the 3D model of tensile test specimen in Cura software [17]. In 3D printing stage is a part fabrication process by additive manufacturing. After 3D printing each specimen, it is cleaned and measured for weight accuracy in post processing stage.

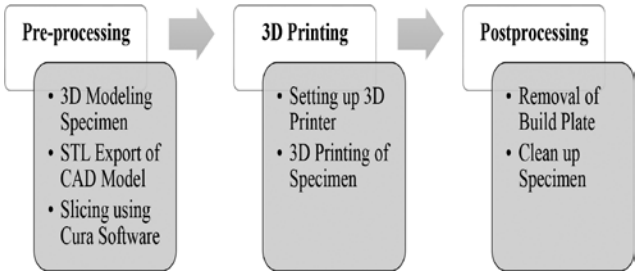


Figure 3 Three stage 3D printing process

In this work tensile test specimen with three thickness are 3D printed in seven build orientations. The build orientations are flat, edge, upright, flat-45, edge-45, upright-45 and flat-support. Table 1 and Table 2 shows slicer settings and 3D printing parameters used for 3D printing of tensile test specimen on Ender-3 successfully. Table 1 displays the typical values of slicer parameters utilized across all build orientations, while Table 2 outlines the specific utilization of build plate adhesion and support structures as required for each orientation.

Table 1. Slicer parameter settings used during 3D printing on Ender-3 across all build orientations

Layer Height	*Line Width*	*Support Line Width*	*Wall Thickness*	*Top Thickness*	*Bottom Thickness*	*Infill*	*Infill Pattern*	*Infill Line Angle*	*Printing Temperature*	*Infill Print Speed*	*Wall Print Speed*	*Nozzle Diameter*	*PLA Filament Diameter*
0.2 mm	0.2 mm	0.12 mm	0.4 mm	0.4 mm	0.4 mm	100 %	Lines	±45°	200 °C	50 mm/s	25 mm/s	0.4 mm	1.75 mm

Table 2 Additional slicer settings for 3D printing of specimen

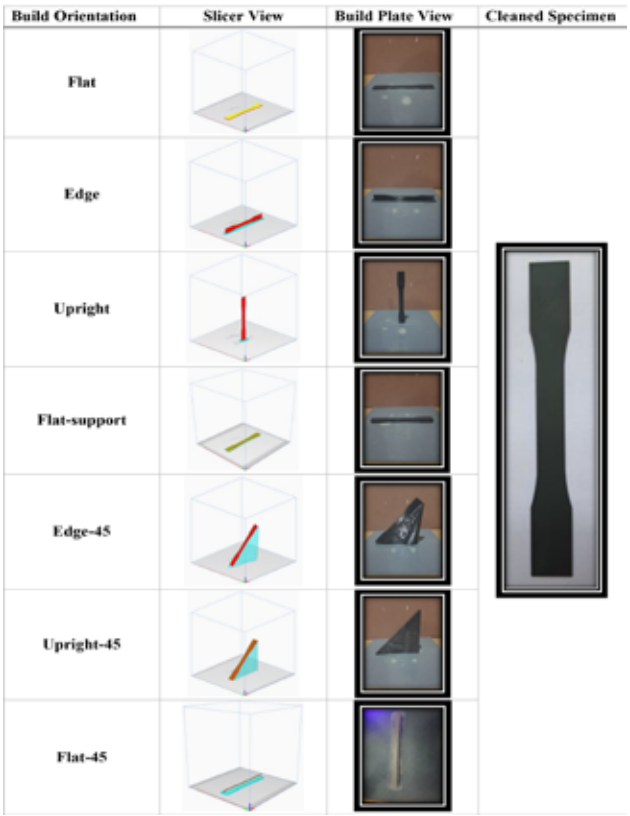
Build Orientation	Build Plate Adhesion	Support
1. Flat	No	No
2. Edge	Yes. Brim type adhesion.	Yes. Line type support.
3. Upright	Yes. Brim type adhesion.	No.
4. Flat-45	Yes. Brim type adhesion.	Yes. Line type support.
5. Edge-45	No	Yes. Tree type support.
6. Upright-45	No	Yes. Line type support.
7. Flat-support	No	Yes. Grid type support.

Table 3 displaysseven build orientations of tensile test specimen on the build plate after 3D printing as well as in Cura software. Additionally, one cleaned specimen is also shown. It can be observed that flat orientation does not require any additional settings. All other orientations require either build plate adhesion, or support or both. Table 4 shows 3D printing time, weight of PLA filament used and actual weight of specimen after clean-up. 3D printing time and weight of PLA filament used is given by Cura software whereas weight of cleaned specimen is measured using battery operated digital scale having range 0-300 g with 0.01 g precision. After clean-up of the specimen for corresponding thickness, all specimen has the same weight. Flat orientation with thickness 1.2 mm requires least time and least material whereas edge-45 orientation specimen with 2.8 mm thickness takes maximum time and uses maximum filament.

Table 3 3D printing time, PLA filament used and actual weight of tensile test specimen

S. No.	Build Orientation	Thickness (mm)	3D Printing Time (Min.)	Filament Used (g)	Actual Weight of Specimen (g)
1	Flat	1.2	60.83	4.0	3.99
		2.0	99.32	6.7	6.65
		2.8	137.82	9.3	9.31
2	Flat-Support	1.2	87.53	5.1	3.99
		2.0	129.33	7.9	6.65
		2.8	167.83	10.6	9.31
3	Edge	1.2	120.22	4.9	3.99
		2.0	158.62	7.6	6.65
		2.8	195.6	10.4	9.31
4	Edge-45	1.2	139.12	9.7	3.99
		2.0	219.42	12.5	6.65
		2.8	252.7	14.8	9.31
5	Upright-45	1.2	153.37	6.7	3.99
		2.0	201.83	9.4	6.65
		2.8	240.62	12.1	9.31
6	Upright	1.2	166.18	4.2	3.99
		2.0	186.4	6.9	6.65
		2.8	202.73	9.6	9.31

Table 4 All build orientations of tensile test specimen in Cura as well as after 3D printing



RESULTS AND DISCUSSION

In this section analysis of 3D printing time, amount of PLA filament used, and 3D printing yield is provided. It is observed that 3D printing time is proportional to the amount of total filament material required. Fig. 4 shows comparative time required for 3D print the specimen in seven different orientations for three thickness values. Approximately 56.62 hours are required to print 21 specimens. This time does not include pre-processing and post-processing time. The maximum time is required for upright-45 and edge-45 orientations as support is required for 3D printing in these orientations. Minimum time is required by flat orientation.

Weight of 2.8 mm, 2.0 mm and 1.2 mm thick tensile test specimen is 9.31 g, 6.65 g and 3.99 g respectively. However, the amount of PLA material required is not the same as the weight of the specimen due to additional material required for support and build plate adhesion in certain build orientations. Fig. 5 shows a comparative amount of PLA filament used during 3D printing of tensile test specimen under different build orientations. It can be observed that PLA filament used is minimum or equal to the actual weight of tensile test specimen for flat orientation. Maximum amount of PLA filament is used by edge-45 orientation.

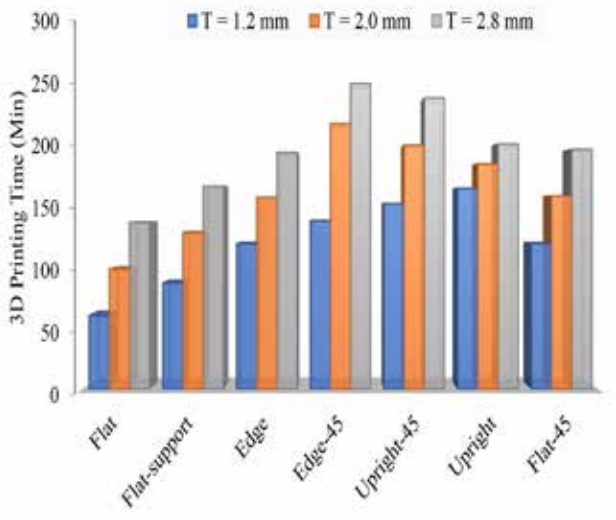


Figure 4 3D printing time vs build orientation

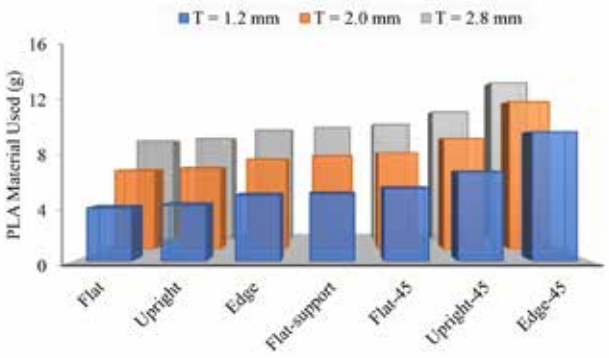


Figure 5 Amount of PLA filament used for different build orientation

3D printing yield is calculated by knowing the actual weight of the 3D printed specimen and the total material required. In this work, 3D printing yield is defined as the proportion of the actual 3D printed part mass, to the mass of filamentutilized. It is expressed as a percentage. Eq. 1 is used to calculate yield of the3D printing process.

$$Yield_{3DPrinting}(\%) = \frac{Mass\ of\ 3D\ Printed\ Part}{Mass\ of\ Filament\ Used} \times 100 \quad (1)$$

Table 5 shows the yield of 3D printing for manufacturing part in different build orientations. 3D printing yield is maximum when support and build plate adhesion is not used during 3D printing. Therefore, flat and upright orientations result in maximum yield whereas edge-45 orientation results in minimum yield. Lower yield means more wastage of filament material. 3D printing yield of edge-45 orientation for 1.2 mm thick specimen is lowest i.e., ~41%. It means 60% filament material is utilised in generating support for successfully 3D printing the part.

Table 5 3D printing yield of tensile test specimen

Thickness (mm)	3D printing yield (%) for different build orientations						
	Flat	Upright	Edge	Flat support	Flat-45	Upright-45	Edge-45
1.2	99.75	94.77	80.44	78.70	72.68	59.46	40.97
2.0	99.70	96.52	87.16	83.86	81.30	70.82	53.12
2.8	99.79	97.49	89.95	87.83	85.57	77.20	62.82

It can be noted that if geometrical orientation is not the constraint, then build orientation effect can be obtained by different methods which can increase the yield. Literature review reveals that few researchers have obtained orientation by altering raster (layer

line) angle while keeping the tensile specimen in the same geometrical orientation (see Fig. 6). Letcher and Waytashek [18] 3D printed the specimens of PLA in three directions, that are: 0°, 45° and 90°. If build orientation effect is achieved as shown in Fig. 6, then 3D printing yield is close to 100%. Please note that this work doesn't include failed 3D prints in calculation of 3D printing yield.

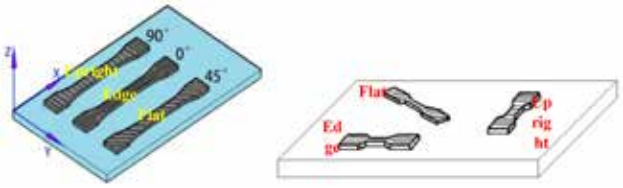


Figure 6 Equivalent build orientation effect through raster angle

CONCLUSIONS

In this work, the influence of build orientation on the 3D printing yield is investigated using the Ender-3 FDM 3D printer. Some of the conclusions of this study are as follows:

- To investigate the influence of build orientation on 3D printing yield, tensile test specimen is modelled as specified by ASTM standards and 3D printed in three thickness i.e. 2.8 mm, 2.0 mm and1.2 mm. In this work, seven build orientations are considered i.e. flat,edge,upright, flat-support, flat-45, edge-45, and upright-45.
- For successful 3D printing of tensile test specimen on Ender-3, most 3D printing settings are kept the same whereas build plate adhesion and support is used wherever needed.3D printing time and weight of PLA filament used is given by Cura software whereas weight of cleaned specimen is measured using battery operated digital scale having range 0-300 g with 0.01 g precision. After clean-up of the specimen for corresponding thickness, all specimen has the same weight. Flat orientation with thickness 1.2 mm requires least time and least material whereas edge-45 orientation specimen with 2.8 mm thickness takes maximum time and uses maximum filament.
- Weight of 2.8 mm, 2.0 mm, 1.2 mm thick tensile test specimen is 9.31 g, 6.65 g and 3.99 g respectively. However, the amount of PLA material required is not the same as the weight of the specimen due to additional material required for support and build plate adhesion in certain build orientations. It can be observed that PLA filament used is minimum or equal to the actual weight of tensile test specimen for flat orientation. Maximum amount of PLA filament is used by edge-45 orientation.
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- Lower yield means more wastage of filament material. 3D printing yield of edge-45 orientation for 1.2 mm thick specimen is lowest i.e., ~41%. It means 60% filament material is utilised in generating support for successfully 3D printing the part. It can be noted that if geometrical orientation is not the constraint, then build orientation effect can be obtained by different methods which can increase the yield.

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