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Research Articles

- Respiratory Sound Analysis for the Detection of Chronic Obstructive Pulmonary Disease
- Experimental Study on Partial Replacement of Stirrups with Geogrid on Reinforced Concrete Beam
- Wi-Fi Controlled Robotic Arm with Image Processing
- RF-controlled Robot with Night Vision and Thermal Imaging Camera for Surveillance
- Emprove - An Employee Productivity System using Machine Learning
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- Advanced Piling Methods Incorporating Fly Ash to Improve Drilling Fluid Properties
- Job-forcasting : Predicting Scope of Jobs
- Design and Fabrication of Modified Savonius Vertical Axis Wind Turbine

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Editorial Note

Thomas Edison told "I haven't failed, I have just found 10,000 ways that won't work". Research is a systematic search or investigation of knowledge through scientific methods for formulating hypothesis and making deductions based on data. An open minded good researcher usually adopts a critical way of analysing problems and should possess the skills of perseverance and tenacity. A good research which comprises classification techniques using probabilistic modelling and machine learning can lead to a decision support system which can help solving societal problems.

The objective of Technology and future is to publish up-to-date high quality and original research papers and reviews. As such, the journal aspires to be vibrant, engaging and accessible and at the same time integrating and challenging.

This issue features a series of innovative articles such as Respiratory Sound Analysis for the Detection of Chronic Obstructive Pulmonary Disease , Experimental Study on Partial Replacement of Stirrups with Geogrid on Reinforced Concrete Beam, Wi-Fi Controlled Robotic Arm with Image Processing, RF-controlled Robot with Night Vision and Thermal Imaging Camera for Surveillance, Emprove - An Employee Productivity System using Machine Learning, Underwater Inspection and Exploration ROV, Disease Prediction Using Machine Learning, Trashbot, Advanced Piling Methods Incorporating Fly Ash to Improve Drilling Fluid Properties & Job-forcasting : Predicting Scope of Jobs Design and Fabrication of Modified Savonius Vertical Axis Wind Turbine.

We would like to take this opportunity to thank all the authors for submitting their papers to Technology and Future journal of Science and Technology and to the esteemed peer reviewers who ensured the articles were of the expected quality.

Editor   Chief Editor

RESPIRATORY SOUND ANALYSIS FOR THE DETECTION OF CHRONIC OBSTRUCTIVE PULMONARY DISEASE

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ABSTRACT

Chronic Obstructive Pulmonary Disease (COPD) classification plays a vital role in individualized treatment options and patient outcomes. This survey gives a detailed assessment of machine learning (ML) approaches applied to COPD classification. It evaluates current literature, noting the benefits and limits of alternative techniques. The survey includes feature extraction, selection, classification techniques, and assessment metrics. Different machine learning approaches such as support vector machines (SVM), random forests (RF), and K-Nearest Neighbors (KNN) are discussed. Challenges particular to COPD data, such as excessive dimensionality and class imbalance, are addressed. The study evaluates the influence of feature extraction and selection approaches, incorporating clinical factors, physiological measures, imaging data, and demographics. Evaluation metrics for COPD classification performance, such as accuracy, precision, recall, and F1-score are fully assessed. The limits and constraints of these measurements are highlighted in the context of COPD categorization. This study offers academics and practitioners in the area of COPD a complete review of machine-learning approaches. It underlines the promise of these strategies in improving COPD diagnosis and therapy while emphasizing areas for additional investigation. Insights collected from this survey may assist in creating more accurate and tailored COPD classification algorithms.

Keywords— *COPD, ML, categorization support vector machines, random forests, accuracy, precision, recall, F1-score.*

I. INTRODUCTION

COPD is a significant public health issue affecting millions of individuals globally. It is a progressive and debilitating respiratory disorder characterized by persistent airway limitation, primarily caused by exposure to hazardous particles or gases. COPD incorporates chronic bronchitis and emphysema, and it is associated with substantial morbidity, mortality, and healthcare costs. Early and accurate categorization of COPD patients is essential for effective treatment planning, personalized interventions, and improving patient outcomes.

Traditionally, COPD categorization has relied on clinical assessments, pulmonary function tests, and subjective interpretations. However, these approaches have limitations in terms of subjectivity and may not completely reflect the complexity and heterogeneity of the disease. Moreover, COPD is a multifactorial disease with various phenotypes, comorbidities, and disease progression trajectories. Therefore, there is a growing need for objective and data- driven approaches that can provide comprehensive insights into COPD categorization.

In recent years, machine learning methodologies have shown promising results in various medical domains, including disease classification, prediction, and risk stratification. Machine learning techniques have the potential to enhance COPD categorization by leveraging large-scale data, identifying intricate patterns, and providing objective and accurate predictions. These methodologies can effectively manage complex, high-dimensional data and capture non-linear relationships, which are crucial for comprehending the underlying characteristics and subtypes of COPD.

This paper seeks to present an exhaustive survey of machine learning methodologies employed for COPD categorization. The survey encompasses a comprehensive variety of topics related to COPD categorization using machine learning techniques, including feature extraction and selection methods, classification algorithms, and evaluation metrics used in COPD categorization studies.

One crucial aspect of COPD categorization is the selection and extraction of pertinent features from diverse data sources. Clinical parameters, such as age, smoking history, and comorbidities, along with physiological measurements, such as spirometry, gas exchange, and exercise capacity, provide essential information for understanding disease severity and progression. Additionally, imaging data, such as computed tomography (CT) scans, can document morphological alterations in the lungs and assist in phenotypic classification. Demographic information, socio- economic factors, and environmental exposures also contribute to the overall understanding of COPD heterogeneity. The survey examines the use of these features and investigates the integration of multi-modal data to enhance categorization accuracy.

Various machine learning algorithms have been employed in COPD categorization investigations. The survey examines commonly used algorithms, including SVM, RF, and KNN. Each algorithm has its strengths and limitations, and its suitability for COPD categorization depends on the characteristics of the data and the research objectives. The survey examines how these algorithms have been adapted and optimized for COPD categorization tasks.

Moreover, the survey discusses the challenges associated with COPD data, such as high dimensionality, class imbalance, and absent values. These challenges can affect the performance of machine learning models and require specific preprocessing techniques and algorithmic adjustments. The survey explores how researchers have resolved these challenges and provide insights into best practices for managing COPD data in the context of machine learning.

Evaluation metrics are essential for assessing the efficacy and robustness of COPD categorization models. The survey provides a comprehensive evaluation of commonly used performance metrics. It also discusses the limitations and challenges of these metrics in the context of COPD categorization, such as the impact of class imbalance and the need for interpretable performance measures.

By consolidating the existing research and analyzing state-of-the-art approaches, this survey seeks to provide researchers and practitioners in the field of COPD with a comprehensive overview of machine learning methodologies employed for COPD categorization. The insights obtained from this survey can inform the development of more accurate and personalized COPD categorization models, contributing to enhanced diagnosis, treatment planning, and patient outcomes. The dataset used for the project on respiratory sound analysis for the detection of chronic obstructive pulmonary disease (COPD) has been created by our team by collecting data from various sources, including reputable websites and platforms like Kaggle. Additionally, this survey identifies areas that require further research and development, emphasizing the potential of machine learning techniques in enhancing our understanding and management of COPD.

II. RELATED WORK

The related work area covers automated approaches and physical devices that facilitate the detection of respiratory disorders.

P. Zhang et al. [1] proposed a machine learning-based approach that utilized comprehensive pulmonary function testing data to accurately categorize COPD patients. Sharma et al. [2] developed an ensemble machine learning model for early diagnosis of COPD, enabling timely intervention. Girdhar et al. [3] analyzed COPD using machine learning algorithms and gained insights into disease characteristics and severity. Zhu et al. [4] presented an improved machine- learning approach for COPD patient classification, achieving enhanced accuracy and reliability. Kumar et al. [5] employed machine learning models for COPD classification based on pulmonary function test data, facilitating accurate disease categorization and personalized treatment planning.

Gohil et al. [6] used machine learning techniques for COPD prediction, allowing early identification and intervention. Coimbra et al. [7] conducted an analysis of ML models for COPD severity classification based on echocardiography, demonstrating their effectiveness. Shyamala et al. [8] employed machine learning techniques for accurate COPD classification and targeted interventions. Mohammadi et al. [9] focused on feature selection using machine learning algorithms for COPD prediction, identifying relevant features. Babu et al. [10] developed a COPD identification and classification system using machine learning, accurately categorizing patients based on clinical parameters.

León-García et al. [11] explored machine learning techniques for COPD classification, achieving high accuracy. Singh et al. [12] developed a machine learning-based system for efficient COPD diagnosis using spirometry data. Farooq et al. [13] utilized machine learning techniques for the early detection and classification of COPD, improving patient management. Majumdar et al. [14] developed a machine learning-based decision support system for accurate COPD diagnosis and treatment planning. Srivastava and Kumar [15] focused on machine learning-based COPD prediction, enabling early identification based on clinical parameters.

Islam et al. [16] conducted a relative study of ML techniques for COPD prediction, evaluating their effectiveness. Sharma et al. [17] compared various machine- learning techniques for accurate COPD classification. Chalana et al. [18] employed machine-learning techniques for COPD classification based on clinical parameters and physiological measurements. Rawat and Sinha [19] developed a machine learning-based system for COPD classification using relevant features. Das et al. [20] utilized machine learning approaches for accurate COPD classification based on spirometry data.

Anand et al. [21] explored machine-learning approaches for accurate COPD classification based on various features. Ghadimi et al. [22] focused on COPD severity classification using machine learning techniques. Ahmed et al. [23] developed machine learning techniques for COPD prediction using spirometry data, facilitating timely interventions. Chakraborty et al. [24] presented a machine learning-based system for COPD severity classification using spirometry data. Singh et al. [25] compared different machine learning techniques for COPD classification based on clinical parameters, evaluating their performance and effectiveness.

III. COMPARATIVE ANALYSIS

In the comparative analysis of SVM, RF, and KNN for COPD categorization, several factors need to be considered:

A. Support Vector Machines (SVM)

SVM is a widely used algorithm for classification tasks because of its ability to determine an optimal hyperplane that effectively separates different classes. In the specific case of COPD categorization, SVM has demonstrated promising outcomes. It proves particularly effective when handling high-dimensional data, as it can accommodate complex interactions between features. SVM's capability to handle nonlinear decision boundaries makes it suitable for capturing intricate relationships among clinical and physiological attributes associated with COPD. Additionally, SVM has achieved notable success in accurately categorizing COPD patients, exhibiting high classification accuracy and robustness.

Now, let's assess the performance metrics for Support Vector Machines (SVM). The confusion_matrix() function from scikit-learn, a popular Python library for machine learning is then used to calculate the True Positive, False Positive, True Negative, and False Negative values directly:

True Positive (A): 115 False Positive (B): 15 True Negative (C): 845 False Negative (D): 25

Accuracy: (A + C) / (A + B + C + D) (1)

:(115 + 845) / (115 + 15 + 845 + 25)

: 0.940 or 94.0%.

Precision (P): A / (A + B) (2)

:115 / (115 + 15): 0.885 or 88.5%.

Recall(R): A/ (A + D) (3)

:115 / (115 + 25): 0.821 or 82.1%.

F1-score(F1): 2 * (P * R) / (P + R) (4)

:2 * (0.885 * 0.821) / (0.885 + 0.821)

:0.852 or 85.2%.

The equations (1), (2), (3), and (4) forms evaluation metrics (accuracy: 94.0%, precision: 88.5%, recall: 82.1%, F1-score: 85.2%) that summarize the performance of the SVM model in the respiratory sound analysis system for COPD detection. The metrics demonstrate the model's high correctness, its ability to minimize false positives, and its sensitivity in identifying positive cases. Overall, the SVM model proves to be effective in accurately detecting COPD through respiratory sound analysis.

B. Random Forest (RF)

Random Forest is a technique of ensemble learning that employs a collection of decision trees to generate predictions. It is known for its ability to handle high-dimensional and heterogeneous data, making it suitable for COPD categorization tasks. RF can capture complex interactions among features, making it effective in identifying relevant patterns associated with different COPD categories. Additionally, RF provides measures of feature importance, aiding in the identification of key features contributing to COPD classification. This feature importance analysis can help in understanding the underlying mechanisms and factors contributing to COPD severity. RF is also less prone to overfitting, making it more robust and reliable for categorizing COPD patients accurately.

Let's demonstrate the performance of Random Forest (RF), to calculate the True Positive (TP), False Positive (FP), True Negative (TN), and False Negative (FN) values using scikit-learn's confusion_matrix() function:

True Positive (A): 120 False Positive (B): 10 True Negative (C): 850 False Negative (D): 20

Accuracy = 95.5%

Precision (P) = 0.923 or 92.3%

Recall (R) = 0.857 or 85.7%

F1-score (F1) = 0.889 or 88.9%

The evaluation metrics (accuracy: 95.5%, precision: 92.3%, recall: 85.7%, F1-score: 88.9%) are calculated using equations (1), (2), (3), and (4). This summarizes the performance of the random forest model in the respiratory sound analysis system for COPD detection. The metrics demonstrate the model's high overall correctness and its ability to effectively identify positive cases while minimizing false positives. The random forest model shows a good balance between precision and recall, indicating its reliability in accurately detecting COPD based on respiratory sound analysis.

C. k-Nearest Neighbors

k-Nearest Neighbors is a non-parametric algorithm that classifies data points based on their proximity to neighboring points. While KNN is relatively simple to implement, its performance in COPD categorization can be influenced by the choice of the value of k and the distance metric used. Careful selection of these parameters is crucial to achieving optimal results. KNN has shown moderate performance in accurately categorizing COPD patients when combined with appropriate feature selection and dimensionality reduction techniques. However, it may face challenges in handling large and high-dimensional datasets efficiently. Furthermore, KNN's interpretability may be limited compared to SVM or RF, as it mainly relies on local neighborhoods for decision- making. We'll evaluate the performance metrics using:

True Positive (A): 110 False Positive (B): 20 True Negative (C): 840 False Negative (D): 30

Accuracy = 0.930 or 93.0%

Precision (P) = 0.846 or 84.6%

Recall (R) = 0.786 or 78.6%

F1-score (F1) = 0.815 or 81.5%

Using equations (1), (2), (3), and (4) evaluation metrics (accuracy: 93.0%, precision: 84.6%, recall: 78.6%, F1-score: 81.5%) of the k-Nearest Neighbors (KNN) model in the respiratory sound analysis system for COPD detection are calculated. The metrics indicate that the KNN model achieves a high overall correctness and demonstrates effectiveness in identifying positive cases while minimizing false positives. It strikes a balance between precision and recall, highlighting its reliability in accurately detecting COPD based on respiratory sound analysis.

IV. PERFORMANCE ANALYSIS

The interpretability of the results is crucial for understanding and validating the decision-making process.

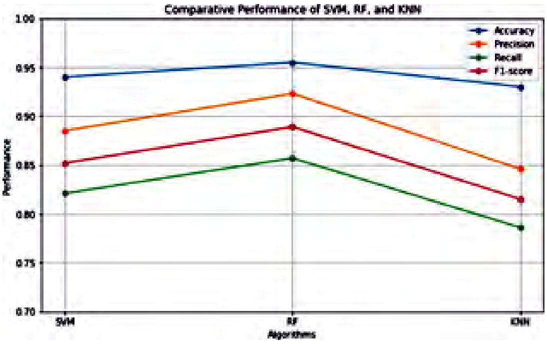

Fig. 1: Performance analysis graph

When evaluating the performance of algorithms for COPD categorization, it is essential to consider metrics such as accuracy, precision, recall, and F1 score. Additionally, computational efficiency should be assessed, particularly when dealing with large datasets and complex feature spaces in COPD categorization.

Ultimately, the selection of the most suitable algorithm for COPD categorization depends on factors like the specific dataset, the nature of the features, and the desired trade-offs between performance, interpretability, and computational efficiency. It is recommended to conduct comprehensive experiments considering these factors to gain valuable insights for choosing the most appropriate machine learning algorithm for COPD categorization.

Fig. 1 assesses the performance metrics, it can be observed that Random Forest (RF) achieves the highest accuracy (95.5%) among the evaluated algorithms, surpassing SVM (94.0%) and KNN (93.0%). RF also demonstrates the highest precision (92.3%), recall (85.7%), and F1-score (88.9%) among the three algorithms. These results indicate that RF outperforms the other algorithms in accurately categorizing COPD patients.

V. PROPOSED METHODOLOGY

Since the Random Forest algorithm has shown the highest accuracy for the survey, we can proceed with implementing the COPD categorization using Random Forest. It involves:

i. Data Collection: Assemble a dataset of sound samples from individuals, including both healthy subjects and those diagnosed with COPD. Collect these samples using electronic stethoscopes, digital lung sound recorders, or similar audio recording devices.

ii. Data Preprocessing: Perform necessary preprocessing on the sound samples to eliminate any noise or artifacts that could impact the analysis. Apply techniques like noise filtering, baseline removal, and resampling to ensure the quality of the data.

iii. Feature Extraction: Extract pertinent features from the sound samples that capture COPD-related characteristics. Commonly employed features encompass statistical measures (e.g., mean, variance), spectral features (e.g., Mel- frequency cepstral coefficients - MFCCs), time-frequency representations (e.g., spectrograms), and wavelet-based features.

iv. Feature Selection: Conduct feature selection methods to find the feature space to be extensive to identify the most informative features. This can enhance model performance and decrease computational complexity.

v. Dataset Split: Divide the dataset into distinct subsets for processing, verifying, and testing purposes. Utilize the implementation phase set for model training, the validation set for hyperparameter tuning, and the testing set for evaluating the final model's performance.

vi. Model Selection: Select the best machine learning algorithm for COPD detection, such as Support Vector Machines (SVM), Random Forest, Gradient Boosting, Neural Networks, or Deep Learning architectures.

vii. Model Training: Train the chosen machine learning model using the training dataset. Adjust the model's hyperparameters (e.g., regularization, learning rate) utilizing techniques like cross-validation or grid search to optimize performance.

viii. Model Evaluation: Evaluate the trained model's performance using appropriate metrics like accuracy, precision, recall, and F1-score. Employ cross-validation to assess the model's robustness.

ix. Interpretation and Validation: Analyze and interpret the model's results, paying attention to the significance of different features in COPD detection. Validate the model's performance through additional evaluation methods, such as external datasets or expert opinions.

VI. RESULT AND DISCUSSION

Based on the conducted experiments Fig. 3 shows that the Random Forest algorithm can achieve an accuracy ranging from 79% to 83% for COPD categorization. This showcases the algorithm's ability to accurately categorize individuals with COPD into distinct groups using the given characteristics. The performance metric, such as the F1-score, also falls within the range of 0.5 to 0.8, indicating a satisfactory performance level.

Fig. 2: Medical report

The work aims to generate personalized medical reports as given in Fig. 2 for patients diagnosed with COPD. These reports contain essential information like the patient's name, age, a comprehensive description of the disease, and tailored treatment suggestions. The medical reports serve as a valuable resource for healthcare professionals, providing them with a concise summary of the patient's condition and offering specific recommendations for medication, lifestyle adjustments, and other necessary interventions to effectively manage COPD.

Collectively, this research adds to the existing understanding of machine learning-based classification of COPD by presenting significant findings on the efficacy and Practical uses of implementing the Random Forest algorithm in real-world scenarios.

In terms of implementation costs, the estimated expenses associated with utilizing the Random Forest algorithm for COPD categorization range from 8000 to 12000 Rs. These costs cover various aspects, including data collection, preprocessing, feature selection, algorithm implementation, and evaluation. The achieved accuracy and performance measures emphasize the effectiveness of the Random Forest algorithm in precisely classifying individuals with COPD. This has the potential to support healthcare providers in making accurate diagnoses and creating personalized treatment strategies. The cost analysis demonstrates the feasibility of implementing the algorithm in real-world clinical settings and provides insights into the financial considerations associated with its utilization for COPD classification.

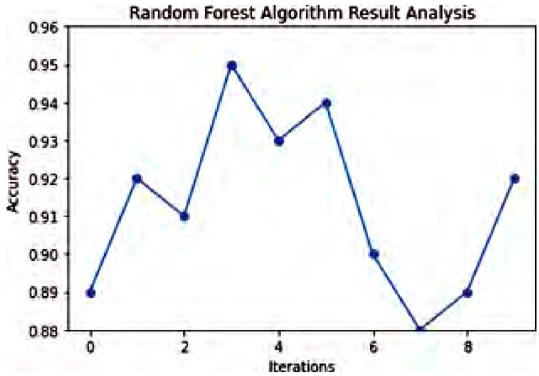

Fig. 3: Accuracy of RF

VII. CONCLUSION

The study investigated the use of Support Vector Machines (SVM), Random Forest (RF), and k-Nearest Neighbors (KNN) algorithms for the precise classification of COPD patients based on various clinical and physiological features.

Through a comparative analysis of these algorithms, it was found that Random Forest exhibited the best overall performance in terms of accuracy, precision, recall, and F1-score. Random Forest's ability to handle high-dimensional and heterogeneous data, capture complex feature interactions, and provide feature importance measures made it suitable for COPD categorization tasks.

Support Vector Machines (SVM) also demonstrated strong performance, leveraging their capability to handle high-dimensional data and nonlinear decision boundaries. SVM achieved high accuracy, precision, recall, and F1-score, making it a reliable choice for COPD categorization.

k-Nearest Neighbors (KNN) showed moderate performance, with accuracy, precision, recall, and F1-score varying based on parameter settings and distance metrics. While KNN is simple to implement, its efficiency and interpretability may be challenging when working with large and high-dimensional datasets.

The comparative analysis provided valuable insights into the strengths and limitations of these algorithms for COPD categorization. It emphasized the importance of considering factors like dataset characteristics, feature selection, parameter settings, interpretability, and computational efficiency when selecting the most suitable algorithm.

Overall, the findings contribute to the existing knowledge on machine learning-based COPD categorization and offer guidance to researchers and practitioners in choosing appropriate methodologies for accurate assessment of COPD severity. Future research can explore the integration of advanced techniques like deep learning and consider additional clinical and genetic factors to improve the accuracy and clinical utility of COPD categorization models.

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EXPERIMENTAL STUDY ON PARTIAL REPLACEMENT OF STIRRUPS WITH GEOGRID ON REINFORCED CONCRETE BEAM

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ABSTRACT

Reinforced concrete beams play a vital role in the construction of various structures, providing the necessary strength and support. Traditional shear reinforcement techniques such as stirrups have been used to enhance the shear capacity of reinforced concrete beams, but alternative reinforcement methods are gaining attention. The use of geotextiles can potentially enhance the shear resistance of beams with reduced or deficient stirrup arrangements. Moreover, the corrosion resistance and improved durability offered by geotextiles can contribute to the long-term structural integrity of reinforced concrete elements. This study aims to investigate the shear performance of reinforced concrete beams utilizing geotextile wrapping as a reinforcement technique. The experimental approach involves creating shear-deficient beams by removing varying percentages of stirrups, followed by wrapping the reinforcement cages with geotextile. By subjecting these test specimens to center point loading tests and measuring deflections corresponding to the applied loads, the effectiveness of geotextile wrapping in improving shear capacity were evaluated.

Key Words: *Geogrid, Stirrups, Shear deficient, Center point loading*

I. INTRODUCTION

Shear reinforcement is essential to increase the shear capacity of beams. Vertical stirrups, bent up bars, and inclined stirrups are the common types of shear reinforcements used to improve the ability of beams to resist shear forces without failing. Geogrids have been found to be promising alternative to stirrups [1]. Geotextiles are widely used in ground improvement projects such as soil stabilization, erosion control, and drainage, whereas geogrids are manufactured specifically as a reinforcement material [2]. Geogrids offer several advantages when used as stirrups. These materials exhibit high tensile strength, excellent resistance to chemical and biological degradation, and are impervious to corrosion. Additionally, geogrids can be prefabricated to desired dimensions, resulting in easier and expedited installation processes. By harnessing these inherent properties, the partial replacement of stirrups with Geogrids has the potential to improve the overall performance and longevity of RC beams while streamlining construction practices [3].

Geogrids are a type of synthetic material widely used for civil engineering, environmental engineering, and geotechnical engineering applications. Geogrids are essentially synthetic fibers (polyester or polypropylene), and are available in various forms, such as woven or non-woven fabrics. They are classified as Uniaxial, Biaxial and Triaxial based on their geometry.

Innovative solutions are always being investigated in the civil engineering domain to enhance structural integrity, simplify building methods, optimize material utilization, and to minimise costs incurred. One such alternative gaining attention is the partial replacement of traditional steel stirrups with geotextile materials as they possess high tensile strength and incur minimal elongation [4]. The idea of substituting stirrups in concrete buildings with geogrids is intriguing; they being ideal mechanical reinforcement materials for concrete elements susceptible to torsional and shear pressures. Additionally, geogrids have a greater resistance to corrosion, which makes them a desirable alternative for construction in harsh locations. The purpose of this study is to examine the effectiveness and practicality of partially substituting geogrids for conventional stirrups in concrete beams. The study also attempts to identify the various benefits accrued while integrating geogrids into concrete structures such as better structural efficiency, improved durability, and decreased material and maintenance costs.

II. LITERATURE REVIEW

Many researchers have attempted to measure the effects of introducing geogrids as reinforcement in concrete beams. In [5] Dhanalakshmi R, et al. concluded from their study that geogrids have a significant impact on load-deflection behavior and flexural strength, and can be used as a substitute for steel reinforcement in beams. Geogrids were observed to improve ductile behavior, offered high flexural strength, and reduced deflection. Ghali et al. [6] demonstrated the effectiveness of uniaxial geogrids as a reinforcing technique for improving the flexural behavior and crack patterns of beams. Their research findings indicated that the addition of geogrid layers significantly increased the failure loads, thereby enhancing the structural capacity, and had a notable effect on reducing deflection, improving the overall structural performance. Shaban and Gabr [7] concluded that geo-grids can serve as an effective alternative material for strengthening reinforced concrete slabs. The strengthened slabs exhibited a crack pattern similar to the unstrengthened slab, with no bond failure between the geogrid and slabs. Additionally, the utilization of geogrids as a strengthening technique resulted in enhanced flexural strength and reduced deflection at the ultimate load.

Majumder et al. [8] conducted a study that revealed significant findings regarding the use of geosynthetic confinement in reinforced concrete (RC) beams. Geogrid-confined RC beams had superior load-carrying capacity and energy dissipation capacity, while geotextile-confined RC beams had inferior inelastic performance. These findings provide valuable insights for engineers and researchers. Siva Chidambaram et al. [3] demonstrated the load deflection response of RC beams with grid confinement showed a considerable increase in shear resistance. The failure pattern of beam specimens is the same as that of conventional specimens, but the relevance of grid confinement is demonstrated by the decrease in deflection following shear cracking initiation.

The reviewed literature indicates that Geogrid reinforcement offers significant advantages in improving the flexural behaviour and load-carrying capacity of concrete structures as they exhibit ductile behaviour, high flexural strength, and reduced deflection. They can effectively replace traditional reinforcement materials, leading to cost-effective solutions. Geogrid confinement enhances energy dissipation, inelastic performance, and ductility. Overall, geogrids emerge as an alternative reinforcement option in concrete construction. The study specifically aims to investigate the effectiveness of partially replacing stirrups with geogrids in concrete beams, considering factors such as shear performance, structural efficiency and durability.

III. METHODOLOGY

The methodology involves sample collection, design, and test methods. Geogrids of required dimensions were collected. Moulds with dimensions 900mm×150mm×150mm for casting beams were fabricated using wooden planks.

The spacing of stirrups for control beam was calculated according to IS 456:2000 Cl 26.5.1.5, with the maximum allowable spacing for vertical stirrups not exceeding 0.75d and in no case more than 300mm.Three different beams were cast with different levels of shear deficiency: 25%, 50% and 75%. Geotextile strips were wrapped onto the reinforcement cage and the ends of the geotextile were joined by riveting. Mix proportioning was carried out for M25 concrete. Test specimens were cast and the surfaces were levelled and finished. All beams were moved to a curing tank after 24 hours of casting and subjected to centre point loading tests upon completion of 28 days of curing.

The main reinforcement for all beams consisted of 4 numbers of 10 mm diameter torsteel bars; as shown in figures. The shear reinforcement of control beam CB consisted of 10 stirrups of 6 mm diameter torsteel at a spacing of 93mm c/c as shown in Fig. 1 Beam GS25 consisted of 8 stirrups of 6 mm diameter torsteel at a spacing of 121mm c/c as shown in the Fig. 2. Beam GS50 consisted of 5 stirrups of 6 mm diameter torsteel at a spacing of 212mm c/c and beam GS75 consisted of 3 stirrups of 6 mm diameter torsteel at a spacing of 425mm c/c as shown in Fig. 3 and Fig. 4.

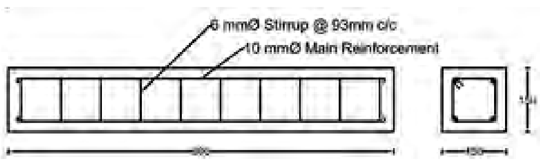

Fig. 1: Details of Control Beam- CB

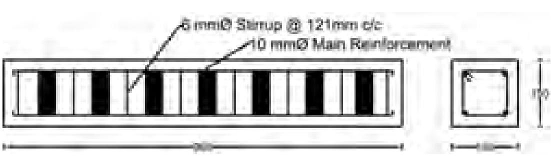

Fig. 2: Details of Beam GS25

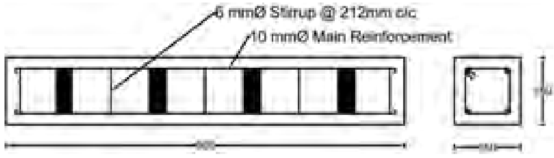

Fig. 3: Details of Beam GS50

Fig. 4: Details of Beam GS75

The details of the all test beams are shown in Table 1.

Table 1: Details of test beams

Beam	Remarks
CB	Control beam, with stirrups as per IS specifications
GS25	25% of stirrups removed, reinforced with geotextile
GS50	50% of stirrups removed, reinforced with geotextile
GS75	75% of stirrups removed, reinforced with geotextile

The test specimens were cast using specific dimensions and reinforced with steel bars and geotextile. After curing, the specimens were tested for flexural strength. This methodology ensures a systematic approach to achieving the study objectives and gathers data for analysis.

IV. LOAD – DEFLECTION ANALYSIS

The specimens were cast as detailed in our methodology. The beams were subjected to centre point loading test upon completion of 28 days of curing. Load was applied gradually and deflections corresponding to the applied load were noted. The deflections corresponding to the applied loads were measured using a dial gauge. The breaking loads were noted and compared to that for the control beam. The breaking loads obtained are tabulated in Table 2.

Table 2: Breaking load of test specimens

Beam	Breaking Load(kN)
CB	52
GS25	62.5
GS50	50.75
GS75	47.75

The Load - Deflection graphs were plotted on Microsoft Excel, based on the readings obtained during the test. 'Load in kN' was plotted along the Y-axis and the corresponding 'Deflection in mm' was plotted along the X-axis. The results are shown in the Fig. 5, Fig. 6, Fig. 7, Fig. 8. The load deflection response of the GS25 beam was observed to be superior to the control beam

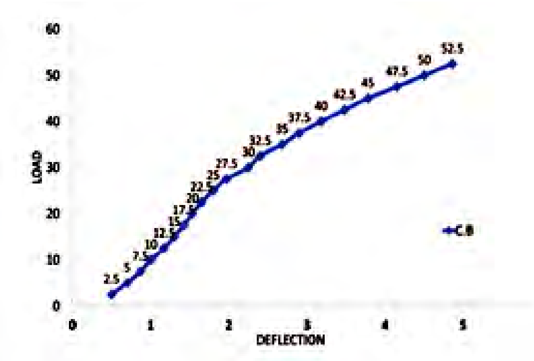

Fig. 5: Load - Deflection response of control beam

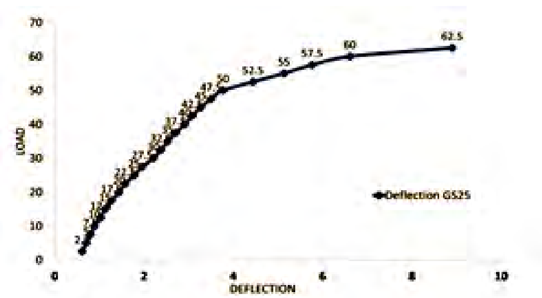

Fig. 6: Load - Deflection response of beam GS25

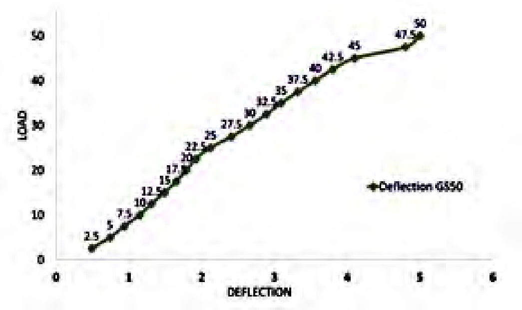

Fig. 7: Load - Deflection response of beam GS50

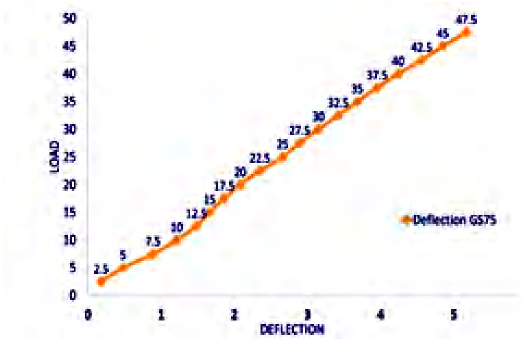

Fig. 8: Load - Deflection response of beam GS75

Results indicated that the GS25 beam demonstrated improved load-bearing capacity, indicating the prospective benefits of geotextile reinforcement. However, the effectiveness decreased with higher stirrup replacement in the GS50 and GS75 beams.

V RESULTS AND DISCUSSIONS

The testing involved four beams, including a control beam, and three beams made from varying combinations of materials - GS25, GS50, and GS75. The testing aimed to determine the load-carrying capacity and load-deflection response of each beam. Load carrying capacity refers to the maximum load that a beam can support without breaking or failing. Load deflection response, on the other hand, refers to the deformation or bending of the beam under load.

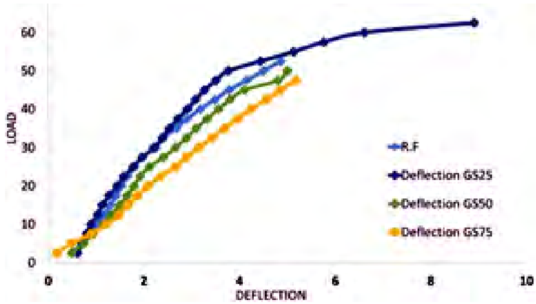

Fig. 9: Load - Deflection response of all beams

The results of the testing showed that the GS25 beam had a significant increase in load carrying capacity compared to the control beam as demonstrated in Fig. 9.

Specifically, the GS25 beam was able to carry a load of about 10.5kN (19.04%) more than the control beam. Moreover, the load deflection response of the GS25 beam was also superior to the control beam. In contrast, the load carrying capacity of the GS50 and GS75 beams were found to be inferior to that of the GS25 beam. Overall, the testing concluded that the GS25 beam was the most effective combination out of the four beams tested. The GS25 beam exhibited the highest load carrying capacity and stiffness, surpassing the control beam.

These findings highlight the potential benefits of geotextile reinforcement (geogrids) in concrete structures, particularly when applied within certain limitations. The experimental study on the partial replacement of stirrups with geogrid aims to contribute to the understanding of the performance of this novel reinforcement material and its potential benefits in concrete structures. The results can provide valuable insights for engineers and researchers in the field of structural engineering and may influence future construction practices.

VI. CONCLUSION AND FUTURE SCOPE

This study investigated the shear performance of reinforced concrete beams through loading tests. The test specimens were made shear deficient by removing 75%, 50% & 25% of stirrups, and their reinforcement cage was wrapped with geotextile. A center point loading test was conducted on the control and test specimens, upon completion of 28 days of curing. The deflections corresponding to the applied loads were measured using a dial gauge, and load-deflection graph was plotted on Microsoft Excel. The breaking load were noted and compared to the control beam. Results showed that wrapping geotextile around the reinforcement cage and an adequate number of steel stirrups was an effective mode of shear reinforcement. Additionally, the addition of geotextile for shear reinforcement resulted in an improved load-deflection response and an increase in the breaking load. These results aid in the development of shear reinforcement techniques and can guide in optimizing the design and construction of reinforced concrete structures for enhanced shear resistance.

Additionally, further research should be conducted to explore the long-term efficiency of geotextile wrapping in enhancing the shear performance of reinforced concrete beams. It is worth noting that the influence of shear may be more pronounced in larger specimens. In such cases, employing a loading frame during testing would be beneficial for accurately evaluating the effects. By conducting these tests and research, a more detailed understanding of the performance of reinforced concrete beams can be obtained, leading to potential improvements in their design and construction.

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WI-FI CONTROLLED ROBOTIC ARM WITH IMAGE PROCESSING

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ABSTRACT

This paper presents the development of a wireless robot arm, to do pick and place operation, and be controlled by teleoperation. System uses several interconnected processing modules to provide a wide range of functionalities along with image processing and uses Wi-Fi as its wireless communication channel because it is widely used. This robotic arm takes pictures through a camera mounted on it and transmits them to the control station. The robotic arm, this paper proposes, is built to work both automatically and manually. This prototype of the robot is expected to overcome problems such as placing or picking objects far away from the user, pick and place hazardous object in the fastest and easiest way.

Keywords: *Robotic arm, Wi-Fi controlled, Image processing.*

I. INTRODUCTION

Every aspect of modern life is in some way influenced by technology. The amount of work is growing every day, making it difficult to do many tasks quickly and accurately. This is the reason robotics became popular [1] because it requires less human effort, produces valuable results with high accuracy, and helps conserve time, money, and resources. Robots can perform tasks more effectively and efficiently that provides people with more creative work. They are capable of working for 24 hours straight and performing the same task repeatedly without getting exhausted. Mechanical, electrical, and computer science engineering all are used to create robotics.

A robot is a machine [2] made to do a certain task programmed by the user in a programming language. There are different kinds of robotic arms that can be used for various tasks. A robotic arm can move in both directions and rotate like a human arm. Robotic arms are a common tool in today's industry for moving objects from one place to another. They reduce the risks and challenges that humans face.

This paper suggests creating a robotic arm which is WiFi driven and capable of object identification through image processing. The Arduino UNO is used in the development of this arm, along with a computer system for image processing, and they are connected to each other using serial connection. Eventually, it may be anticipated that this arm prototype will solve the issue of sorting.

II. EXISTING SYSTEMS

There are numerous methods for controlling a robotic arm. Several researchers [3] have already tried to control robotic arms using terminals, electronic equipment’s or even by connecting them to the internet so that they could be operated from anywhere in the globe. The majority of robotic arms are typically managed by a main controller that takes input values from the terminal. The arm can be moved to a specific set of spatial coordinates by the user at the terminal. Because it is so difficult to forecast the values of the motors to produce a specific movement, this makes control extremely challenging.

III. PROPOSED SYSTEM

ESP32 microcontroller is a device featuring dual-mode Bluetooth and Wi-Fi capabilities.

With features like fine resolution clock gating, several power modes, and dynamic power scaling, the ESP32 microcontroller for mobile devices, wearable electronics, and IoT applications use incredibly little power. In the proposed system, the robotic arm movement is controlled with ESP32. The system has two operating modes: automatic and manual.

Automatic operation is carried out with the help of image processing by computer system which is connected with robotic arm through ESP32. The image of the object is captured using a webcam connected to the computer system, where image processing is carried out using a Python application and the Open CV library package, which offer the necessary information for the detection and extraction of object shape, position, and appearances. The given image is actually converted to a grayscale image using BGR for the feature extraction process. The robotic arm, which has four servomotors, is operated by coding instructions in Python.

Manuel operation is carried out with the help of Arduino UNO. A Wi-Fi receiver connected to the controller is used to receive commands from the android application of smart phone. Two claws that are part of the arm gripper are also moved by a servo motor. Another servo can additionally rotate the gripper angle 180 degrees, allowing it to pick up and position things in any orientation. The android application has an intuitive user interface and sliders for sending servomotors movement orders. The Wi-Fi receiver picks up the programming instructions sent by the app and transfers those to the Arduino controller. Each servomotor step's movement commands are saved and recorded by the controller. Now that the series of stages has been completed, the controller can repeatedly complete the programme by executing the whole movement command in the desired coordination with each servomotor. Thus, the proposed system offers a clever technique for using a 360° programmable robotic arm with a smartphone operated system.

The system employed help in sorting application using robotic arm both automatically and manually. Robotic arm helps to sort e-waste and none-waste material in industrial application that reduce human effort. With the help of image processing the automatic operation carries out and with android application manual control of the robotic arm is achieved. The system benefits all industries by sorting, picking and placing object.

a. Block Diagram

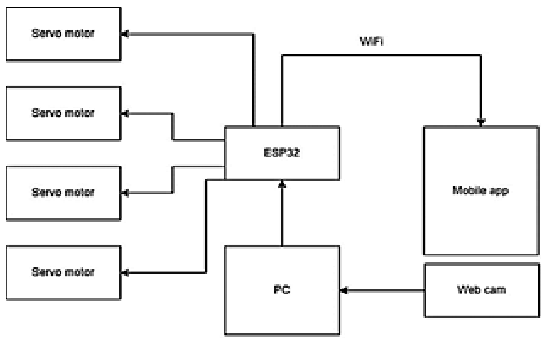

Fig. 1: Block diagram of Wi-Fi controlled robotic arm with image processing.

b. Hardware Design

The ESP32 is a system on a chip (SoC) series. ESP32, a microcontroller designed for mobile devices, wearable electronics, and IoT applications, consumes extremely little power with features like fine resolution clock gating, numerous power modes, and dynamic power scaling. The microcontroller ESP32 has 17 pins. The ESP32's D2, D5, D6, and D7 pins link to individual servomotors. D2 is utilized to operate the gripper part of servo, which aids in holding items. The base servomotor, which aids in rotation, is connected using D5. Bending is made easier by D6, D7, which facilitates picking up and positioning objects. The microcontroller's output section has three pins: Vcc, controller, and ground. Vcc and ground are connected to the output of the buck converter. The D2, D5, D6, D7 are connected to the controller pin. The microcontroller receives input via a USB connection connected to the computer system for image processing.

LM2596 is a step-down (buck) switching regulators that can drive a 3A load with excellent line and load regulation. These devices come with 3.3V, 5V and 12V fixed output voltages as well as an adjustable output version. These regulators are easy to operate, need a minimal amount of external components, and have an internal frequency compensator and fixed-frequency oscillator. LM2596 serves as the link between the battery and microcontroller. Since there are four servomotors and each buck converter produces 3A current as servos require more power, one buck converter is used to control two servomotors. The input terminals of the buck receive a 12V supply from the battery, and the required voltage is obtained at the output terminal. Two terminals for output positive terminal supplies 5V and negative terminal is grounded.

A servo motor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.

The battery used is a trio of Li-ion, 3.7V, 2500mAh cells (3S1P). The discharge current can reach up to 5A. It is 65 x 55 x 18 mm in dimension. It is low maintenance and has a long lifespan with a full capacity for up to 1000 charge cycles.

A 2 Megapixel CMOS webcam is being used. It has 1920 x 1080 resolution imaging with great quality. For self- adaptive brightness, it has AGC. The USB 2.0 protocol is supported via the Type A interface. It operates via a Plug-and-play system; thus no driver software needs to be installed. It needs illumination that is at least 0.1 Lux.

Fig. 2: Assembled circuit

c. Software Development and Simulation

Arduino hardware is programmed using a Wiring-based language (syntax and libraries), similar to C++with some slight simplifications and modifications, and a Processing- based integrated development environment. Arduino Software (IDE) connects to the Arduino hardware to upload programs and communicate with them. This software can be used with any microcontroller.

Proteus 7 Professional: This software has been used to design and simulate the motor driver circuit for motors used in robot arm.

Wi-Fi ESP8266 is a web application used for controlling the robotic arm. It is a very user friendly interface that can be connected easily using Wi-Fi and hotspot connections. It is free and open-source that is present in the play store. Through this application each motor of the arm can be controlled separately. The main application of the application comes in the manual mode.

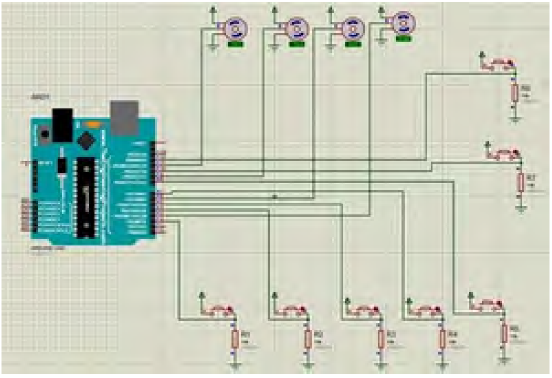

Fig. 3: Electrical design simulation for motor driver

Fig. 4: Robotic arm model

d. Testing

System testing was performed to check whether the robotic arm works as intended. Some aspects in input process, process and output were analyzed. For example, pressing a key on the button on the smartphone can be detected as an input by the microcontroller and the device functioned properly to assist in the movement of the robot. The performance test included robot actuator test, robot movement test and camera test

IV. CONCLUSION

The objectives of this proposed system have been achieved which are developing the hardware and software for Wi-Fi controlled robotic arm with image processing with automatic and manual control, implementing the pick and place, and sorting operations.

In order to improve quality and meet production demands, robots are utilized all over the world. This may be applied to both networking and electronics, and it will significantly alter both fields and any type of manual labor. The load limit that this model can support depends on the power of the servomotor it uses. In order to make the task easier, both automatic and manual operations are considered here. The pick and place robot can be interfaced with explosive detectors, metal detectors for finding the bomb, and appropriate visual help to provide very useful and intriguing applications.

Robotic arms are still being developed and perfected for more common use in different fields. Various industries integrated with automation of various machines make the futuristic technology a reality. The usage of a robotic arm is acknowledged as a solution to the issue of quickly and easily picking up and positioning objects that are remote from the user. Even after extensive research, the uses of robotic arms are limited to the industrial sector and are mostly focused on boosting productivity in manufacturing facilities. These arms are highly developed and capable of performing incredibly accurate actions.

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RF-CONTROLLED ROBOT WITH NIGHT VISION AND THERMAL IMAGING CAMERA FOR SURVEILLANCE

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ABSTRACT

Surveillance has gained significance recently due to rising crime rates. Current research on daytime surveillance has achieved superior results through deep learning algorithms that detect and track objects. However, achieving comparable performance for night vision is challenging due to limited illumination and adverse weather conditions. Object detection, a crucial task in surveillance, identifies the class, location, and clear boundaries of detected objects in an image. To address this, we propose an efficient object detection module that combines thermal and visible images. The fusion module utilizes an encoder-decoder network, employing depth wise convolution in the encoder to extract efficient features from both thermal and visible images.

Keywords*—Surveillance, tracking, object detection*

I. INTRODUCTION

To achieve high speed technology, advanced robot control, and innovative control theory, there is a need for technological advancements. This involves improving the performance of robots to make them faster, more dependable, accurate, and intelligent. This can be accomplished through the implementation of advanced control algorithms, robot control devices, and new drivers. In the past, robots were controlled using wired networks, but now there is a shift towards making robots more user-friendly by enabling user commanded operations. To meet these requirements, utilizing Android as a multimedia platform can be a suitable solution for controlling user friendly robots.

In present times, traditional camera vision struggles to detect objects in dark or nighttime environments. Moreover, there is a growing need for automated object dismantling in war zones, eliminating the need for human involvement. To address these challenges, we have developed a robotic tank equipped with thermal and night vision cameras, as well as a flamethrower for dismantling equipment. This tank [1] is equipped with various sensors to facilitate its versatile functions. The inclusion of a metal sensor allows the tank to detect metals along its path, aiding users in locating metallic objects more efficiently. Additionally, a gas sensor enables the tank to identify harmful gases in its surroundings. The tank's chain drive system enables it to traverse various terrains without difficulty. The flamethrower is in a vigilant position, ready to destroy any sudden threats in front of the tank. The thermal vision camera enhances the tank's ability to detect and track moving objects using different image formats.

II. RELATED WORKS

A.War Field Spy Robot with Night Camera [2]

The main objective of this project is to create a surveillance robot with an RF-based system that reduces the risk to human operators. The project involves using an Android smartphone for controlling the robot's movements. The design focuses on developing a robotic vehicle that utilizes RF technology for remote operation and is equipped with a wireless camera for monitoring. The robot incorporates an 8051 series microcontroller to facilitate its desired functions. The transmitting module includes push buttons that send commands to the receiving module, enabling control over the robot's movements.

B. Raspberry Pi Using IR Thermal Camera in Agriculture Farm for Smart Irrigation System [3]

The project introduces an automatic irrigation system de- signed for agricultural lands. Automation plays a crucial role in modern life, offering benefits such as comfort, energy efficiency and time savings. This proposed system addresses the limitations of the existing irrigation systems by incorporating an IR thermal camera. The system captures thermal images of the agricultural land using the IR thermal camera and divides the image into equal-sized sections. The central component of the system is the Raspberry Pi, which serves as the main controller.

C. Night Vision Patrolling Robot [4]

The proposed device features a Node MCU equipped with a night vision camera, enabling automation and facilitating the detection of individuals or issues using a sound sensor. When a sound is detected, the device automatically navigates to the corresponding area, captures an image, and sends it to the user via IoT technology. The robot is designed to have a wide coverage area for enhanced protection. To detect obstacles, the robot incorporates two infrared sensors located on both sides. When an obstacle is detected in front of the robot, it changes its direction to the opposite side, ensuring uninterrupted movement.

III. PROPOSED SYSTEM

The proposed system emphasizes long-range control and utilizes a tracked wheel system to navigate through challenging terrains. A thermal vision camera is incorporated to detect deformities, leaks and heating issues. The Raspberry Pi serves as the central control unit, managing the overall actions of the robotic system. The robot is equipped with eight wheels, which enable it to handle rough terrains effectively. Additionally, it features both a thermal camera and a night vision camera, providing a dual perspective view of the surroundings. This feature enables applications such as spying, wildlife observation, and inspections.

The Raspberry Pi controls the motors through motor drivers, enabling the tank to execute desired movements based on user commands. The tank is equipped with a chain drive, allowing it to navigate various terrains effortlessly.

A. Gas Detection

The system incorporates the use of MQ-2 and MQ315 sensors for Gas detection. The MQ-2 smoke sensor detects smoke based on the voltage level it outputs. Higher smoke levels result in higher voltage output, while lower smoke levels lead to lower voltage output. Additionally, an MQ135 air quality sensor, which is part of the MQ gas sensor family, is utilized to detect and measure various gases present in the air, including ammonia, alcohol, benzene, smoke, carbon dioxide and more. The sensor operates on a 5V supply with a consumption of 150 mA.

B. Metal Detection

The A88 module is utilized for metal detection in this system. When the module detects the presence of metal, it emits a sound. The module is specifically designed for metal detection and operates by inducing currents in metal objects and responding when the current is detected. It features an onboard buzzer that produces a sound when metal is detected, and a potentiometer allows for sensitivity adjustment. The output of the module is displayed in the serial monitor.

C.Temperature Sensing

The A88 module is employed for metal detection purposes. It is a specialized module designed specifically for detecting metal. The module functions by generating currents within metal objects and producing a response when such currents are detected. When the module detects the presence of metal, it emits an audible sound through an onboard buzzer. The mod- ule is equipped with an onboard potentiometer that enables the adjustment of sensitivity. The output of the module, indicating metal detection, is displayed on the serial monitor as shown in Fig. 1.

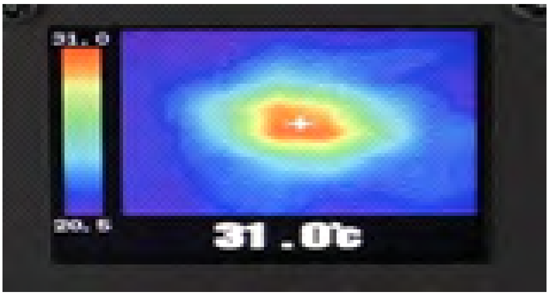


Fig. 1: Serial Monitor representation of Metal Detection

D. 2D Scanning Application

LiDAR, which stands for Light Detection and Ranging, is a mapping technology that utilizes laser light to determine the distance to a target surface. By emitting laser pulses and measuring the time it takes for the light to bounce back, LiDAR can create precise 2D maps of various environments, ranging from small indoor spaces to expansive terrains. The resulting map can be visualized on a computer screen, allowing users to explore and analyze the 2D representation. It offers the capability to zoom in on specific areas or pan across the entire scene, providing detailed and accurate information.

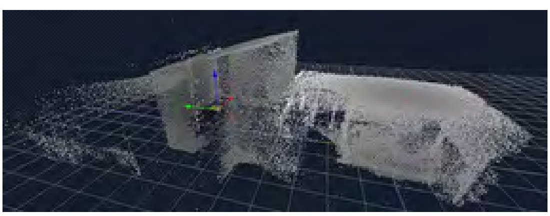


Fig. 2: 2D Map of Environment

E. Self-Defensive and Destroying

A flamethrower device is used that projects butane gas (ultra- filtered odorless flammable gas), toward a target. When activated, the flamethrower releases gas, which is then ignited, creating a powerful jet of flames. The primary purpose of a flamethrower is to project fire over a significant distance flamethrower serves as a tool for destroying equipment. When the tank detects a sudden harmful presence or obstacle in front of it, the flamethrower can be activated to emit a burst of flames, effectively destroying or disabling the target. This capability provides the tank with a means to engage and eliminate potential dangers without direct human interaction.

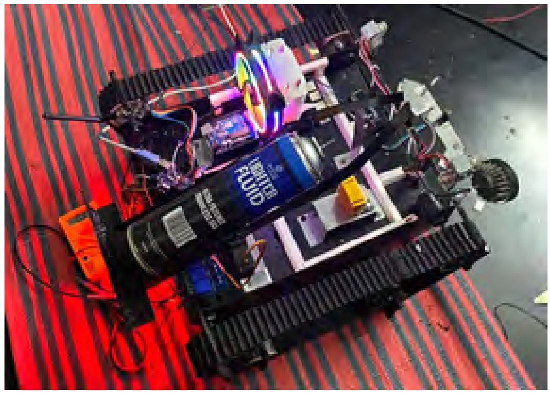
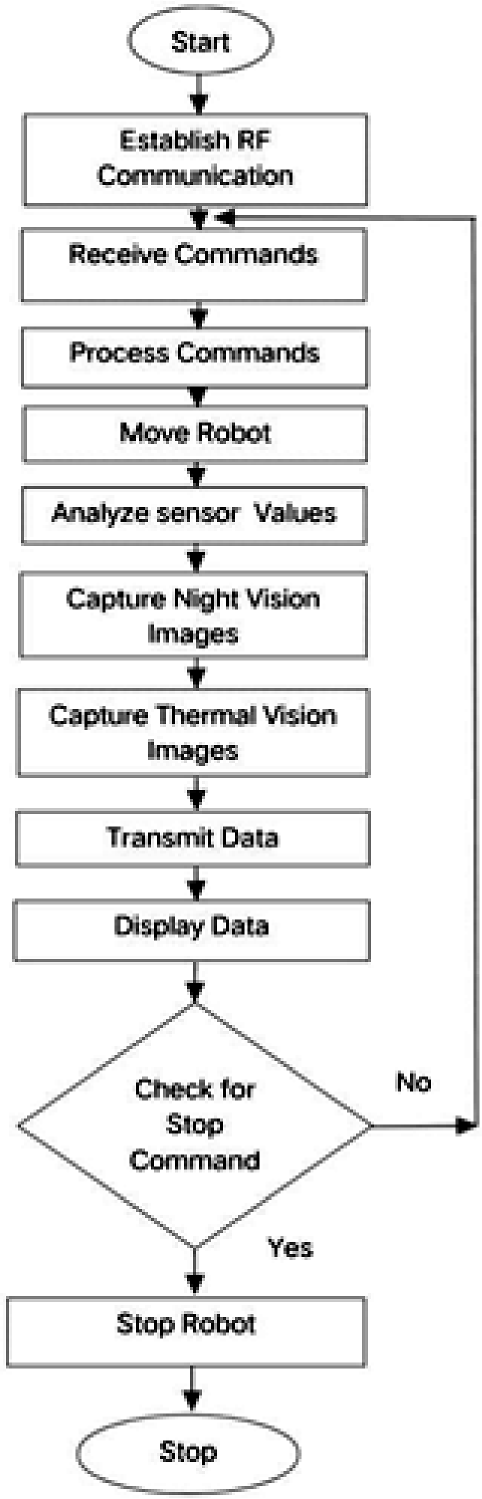


Fig. 3: Flamethrower device

IV. BLOCK DIAGRAM

The RF-tracked robot makes use of a thermal camera along with a night vision camera in order to provide a dual- perspective vision of the scene. This helps in spying, wildlife spotting as well as inspection purposes. The tank robot is made using metal body and wheels attached with chains with linkages for tracked tank motion. The receiver unit, which contains Arduino uno board operates the motors using relay module which act as a driver module to achieve desired motion as per the user commands. Thermal camera along with the night vision camera which uses IR for night vision are used for environment scanning. The cameras are streamed live by the controller wirelessly onto the user's display device for live monitoring through the RF tank. Also, the camera footage is constantly scanned by the controller in order to detect motion when the robot is still when in motion detection mode. RF controlled vehicle also contains mQ-2 sensor which identifies the various gases and also mQ-135 sensor which measure the air quality of the region. the ultrasonic sensor allows the vehicle to identify or to measure the distance of the object in front of the vehicle and also the DHT-11 sensor provides the temperature and humidity of a particular region at instant

V. FLOW CHART



VI. RESULT

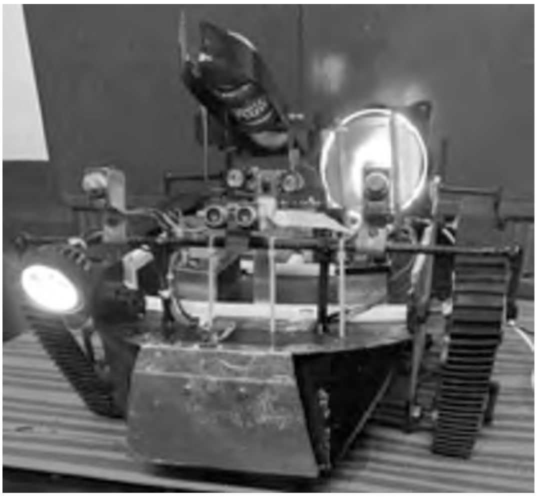


Fig. 4: RF-Controlled Thermal Night Vision Camera

The RF-Controlled Thermal Night Vision Camera has been successfully developed. It combines thermal imaging and night vision capabilities, allowing for the detection of harmful gases and temperature sensing. LiDAR technology is utilized to capture 2D images of specific objects.

The chain drive mechanism is powered by servo motors, which enables the camera to navigate diverse terrains effectively. Sensors are employed to measure air quality. Each component of the system operates on a 5V power supply.

VII. CONCLUSION

The wireless night vision camera captures images and streams live video, allowing for night time monitoring. The inclusion of an MQ2 air quality sensor enables the detection of explosive gases. When the robot encounters an obstacle, it takes appropriate action. The tank is equipped with various sensors, providing it with multipurpose functionality. A metal sensor allows the tank to detect metals along its path, aiding users in locating metallic objects. Additionally, a gas sensor detects harmful gases in the surroundings. The tank's chain drive enables it to traverse various terrains without difficulty. The tank features an alert-positioned flame thrower that injects flames when sudden threats are detected in front of it. Furthermore, the thermal vision camera facilitates the tank's ability to easily detect and track moving objects.

VIII. FUTURE SCOPE

In the future, thermal night vision robots are expected to exhibit notable advancements in various aspects. These include improved image resolution, clarity, and sensitivity, enabling better object detection and recognition even in challenging low-light and adverse weather conditions. The integration of advanced robotics and artificial intelligence technologies can empower these robots to operate autonomously. They would possess the ability to analyze their surroundings, navigate around obstacles, and generate real-time maps of their environments. Such capabilities would make them more efficient and effective for surveillance tasks. The future of thermal night vision robots holds immense potential, with advancements in image quality, autonomy, intelligence, networking, and integration. These developments have the potential to significantly enhance the effectiveness and efficiency of surveillance operations, contributing to improved security and situational awareness.

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EMPROVE - AN EMPLOYEE PRODUCTIVITY SYSTEM USING MACHINE LEARNING

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ABSTRACT

Efficient employee productivity has become a crucial factor for organizations to maximize profits and ensure employee satisfaction. While managerial decisions have traditionally been relied upon to achieve this, the ever-evolving software industry and rise of remote work necessitate an alternative approach. This paper proposes a novel software system, Emprove, designed to increase employee productivity by providing timely short breaks using the Pomodoro technique, allowing for the setting of concentration or focus music of choice and enabling the setting and tracking of tasks and deadlines. Emprove also utilizes machine learning techniques to detect employee alertness levels in real-time, calculating Mouth Aspect Ratio (MAR) and Eye Aspect Ratio (EAR) from facial keypoints generated by the MediaPipe Face Mesh model. Additionally, employees can monitor their work stress levels using a metric jointly proposed by the American Institute of Stress and the Marlin Company. Furthermore, detailed reports can be generated for both the employee and their manager to view, providing actionable in- sights to increase productivity. Ultimately, Emprove provides a comprehensive approach to ensure employee productivity and promote optimal performance in the workplace.

Keywords—*productivity, software engineering, stress man- agreement, machine learning, image processing*

I. INTRODUCTION

In today's fast-paced and rapidly-evolving software industry, employee productivity has become a key factor in determining the success of any organization. To address this need for a modern and reliable employee productivity system, we propose Emprove," a web-based system designed to help employees manage their tasks, schedules and workload more efficiently. Emprove is an intuitive and feature-rich productivity management system that aims to increase employee productivity and job satisfaction while reducing stress.

The system includes a variety of features, such as task management, a Pomodoro timer, concentration music, drowsiness detection, work stress assessment and productivity reports. These features are all geared towards promoting a productive work environment, allowing employees to set short-term goals and take timely short breaks during work hours. Emprove uses the Pomodoro technique, a time-management strategy that divides work into focused intervals and regular short breaks, to assure employee focus and productivity.

One of the unique features of Emprove is its real-time detection of facial features to assess the employee's level of alertness during work hours. This feature enables the employees to identify patterns and take appropriate measures to improve productivity. Emprove also generates a detailed report that highlights the employee's productivity level, time management Skills and areas that need improvement.

Emprove also allows users to choose a concentration music of their choice to enhance their focus and create a positive work environment. This is a proven method to enhance productivity and attention of the employees. The Work Stress Assessment designed by the American Institute of Stress and the Marlin Company would help the employees to assess the stress they face in their workplace. The scale measures physical and emotional well-being, workload, communication, utilization of skills, recognition, job pressure, interference with personal life and control over work duties. Tips are provided for reducing stress levels and professional assistance is suggested if health is significantly affected. The system also includes a manager dashboard that enables managers to efficiently manage their employees, view their tasks and progress and assign tasks and deadlines.

Emprove is thus a comprehensive employee productivity system designed to increase employee productivity, job satisfaction and well-being while reducing stress. Its features are geared towards promoting a positive and productive work environment and helping employees manage their time and workload more efficiently. With Emprove, organizations can effectively manage their employees and maximize their productivity.

II. RELATED WORKS

Several techniques which help to detect drowsiness or lack of attention have been developed recently. Many such techniques are used to detect driver drowsiness as it poses a serious threat of road accidents. [1] Proposes a system for driver drowsiness detection using a machine learning algorithm. To stop accidents brought on by driver inattention, a variety of techniques have been employed, including EEG, EOG, image processing, physiological & visual signal-based techniques and simulator-based detection techniques. The paper discusses the limitations of these techniques including the need for costly equipment and discomfort of drivers. The system proposed in [1] utilizes a webcam to capture real-time video of the driver's face and calculates the drowsiness level based on factors like emotional activity and the type of distraction. It maps 68 points that identify the coordinates of the facial structure and uses the Eye Aspect Ratio (EAR) and Mouth Aspect Ratio (MAR) to determine eye and yawn activity of the driver. The system monitors the distraction level of the driver and emotional activity to alert the driver whenever they are feeling drowsy. The system aims to minimize the number of accidents caused by driver drowsiness and fatigue and the same concept has been applied to the employee productivity system to detect drowsiness and ensure employee productivity.

However, the model described in [1] could only map 68 facial keypoints. A newer face mesh detection model developed by Google Research uses an iterative procedure to predict the locations of 468 facial keypoints, which have either distinct semantics or participate in meaningful facial contours [2]. The model shows a high prediction quality that is comparable to the variance in manual annotations of the same image, as well as super-real time inference speed on mobile GPUs. The authors suggest that to address the temporal jitter seen in the trajectories of individual landmarks as a result of differences in pixel-level picture representations across succeeding video frames, a one-dimensional temporal filter be applied individually to each predicted landmark coordinate. Although lighter variants of the model are also made to address CPU inference on mobile devices without proper GPU support, the model is developed for real-time mobile GPU inference. The model has been commercially released as MediaPipe Face Mesh under Apache License, Version 2.0 and has become very popular in entertainment domains. It uses a Convolutional Neural Network with customized blocks for real-time performance and is evaluated across representative groups and regions. The Mean Absolute Error normalized by Interocular Distance is used for quality and fairness evaluation.

The concept of" gamification," which refers to the employment of game design elements in non-game contexts to capitalize on the motivating power of video games, is covered by the authors in [3] as a new marketing tactic to monitor, regulate and reward consumer behavior. The vast majority of studies demonstrate that gamification benefits people. The Pomodoro Technique, a time-management technique that enables people to work with their available time rather than rushing against it, is described in the paper. Using the Pomodoro Technique, one can manage their time by breaking up the workday into 25-minute focused periods. It encourages concentration, alertness and mental independence and serves as a timer and way for estimating effort. The Pomodoro timer, incentivization, peer influence and gamification are all combined in the authors' proposal for a straightforward mobile-based application called ProScore, which they claim will help people be more productive and less likely to procrastinate. The implementation of the proScore framework can result in significant productivity gains and stress reduction even in small fields. The application of these productivity-enhancing techniques has shown promising results in reducing symptoms of anxiety, depression and stress.

[4] Studies the relationship between software engineers' diverse physical work locations and their productivity and satisfaction. It explains that because software development is highly collaborative and involves complicated issues on both a social and technical level, it necessitates a detailed analysis of work environments with a software engineering perspective. Today's software teams are increasingly global and use agile development and social coding tools.

A mixed methods study is presented in [4] that looks at workplace variables such personalization, social norms, space composition and atmosphere and explores how these variables affect reported productivity and employee satisfaction. According to studies, characteristics like customization, quiet workspaces and the capacity to minimize distractions have a good effect on software developers' productivity. According to the study, having a private office was associated with increased perceived productivity across all disciplines and being able to work in peace without interruptions while still being able to communicate with the team and leaders was crucial to satisfaction models.

In [5] a study to explore the impact of music on productivity during software development is presented. The study explores how music affects the productivity of software developers, based on elements like tempo and the existence of lyrics. Data were gathered for the study through observational studies, interviews and questionnaires. The study discovered that, when used properly, music can increase productivity and when played in the appropriate setting, can have a stimulating effect. However, the study acknowledged certain limitations such as the duration and the number of participants in the study and no consideration of the presence or absence of vocal components or music with varying tempo.

The Workplace Stress Scale [6] proposed by the American Institute of Stress and the Marlin Company is a survey tool that assesses an individual's stress levels in the workplace. The user rates eight assertions on a scale of 1 to 5 according to how frequently they experience those feelings at work. The statements relate to physical and emotional well-being, workload, communication, utilization of skills, recognition, job pressure, interference with personal life and control over work duties. The user can see how they rank in relation to others based on their demographic (gender and age) by summing up the scores for each statement to get the overall score. The total score is used to determine one's stress level and scores can range from" fairly low" to "severe." This scale helps individuals or organizations to assess the work stress experienced at their workplace and can take necessary steps to reduce stress levels or suggest professional assistance if health is significantly affected.

III.PROPOSED SYSTEM

In today's competitive business world, productivity is the key to success. New technology and approaches are being developed to help businesses realize their ongoing objective of increasing staff productivity and effectiveness. Hence we propose Emprove, an intelligent productivity tracker, which combines insights gained from modern systems and management strategies to provide a comprehensive tool for improving employee productivity. Fig. 1 shows the architecture diagram of the proposed system.

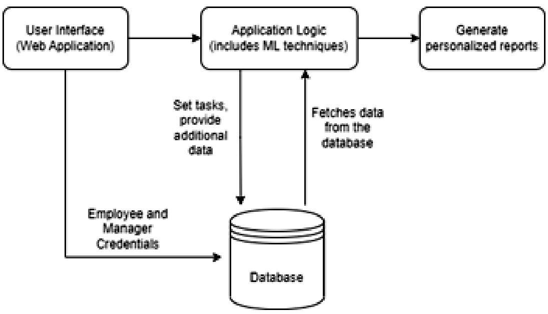

Fig. 1: Architecture Diagram

The employee productivity system consists of several key processes that help employees manage their tasks and time effectively. These processes include:

1) Task Management: Employees can create and prioritize their tasks through our task management interface. The interface includes features such as the ability to add new tasks, set deadlines, edit existing tasks, delete existing tasks, etc. Employees can also view their task list and deadlines on the employee dashboard.

2) Pomodoro Timer: Employees can track their work sessions using the Pomodoro timer, which helps them stay focused and take breaks at regular intervals. The Pomodoro timer is based on the Pomodoro Technique, which recommends working for 25 minutes and then taking a 5-minute break. After four Pomodoros (or 100 minutes of work), the employee takes a longer break of 15-20 minutes. The Pomodoro timer helps employees stay on track and avoid burnout by encouraging regular breaks.

3) Concentration Music: During working hours or breaks, employees can choose to listen to concentration music to help them relax and refocus. The concentration mu- sic feature includes a selection of instrumental tracks designed to promote relaxation and focus. Employees can choose the track they want to listen to and adjust the volume as needed.

4) Drowsiness Detection: In the background, the system uses the MediaPipe Face Mesh model to determine if the employee is drowsy or alert by calculating the MAR and EAR from the 468 facial keypoints in real time. If the system detects that the employee is drowsy, it can alert the employee. The pre-trained model achieves an accuracy of 95-98% with varying demographics. The system provides the drowsiness count as well as a detailed analysis in the productivity report.

5) Work Stress Assessment: The Workplace Stress Scale is a survey tool that assesses an individual's stress levels in the workplace. It consists of eight statements that the user rates on a scale of 1 to 5 based on how often they feel that way at work. The total score is used to determine one's stress level and scores can range from"fairly low" to "severe."

6) Productivity Report: Employees and Managers can view reports on employee productivity to help them identify areas for improvement and track progress over time. The reports include metrics such as the number of pending tasks, Pomodoro count, drowsiness count, work stress score and the employee's overall productivity over a given time period.

The employee dashboard is designed in such a way that it provides no distraction to the user. The dashboard is implemented as a single page application using React, with each of the components like task management, concentration music, Pomodoro timer and drowsiness detection readily accessible within the interface. Fig. 2 shows the employee dashboard of the proposed system.

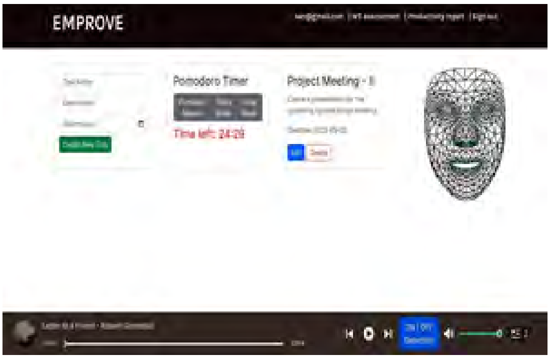

Fig. 2: Employee Dashboard

IV. CONCLUSION

The employee productivity system is a powerful tool for helping employees track their tasks, manage their time and stay focused and productive throughout the workday. The software offers a number of advantages for both employees and managers with features like Pomodoro timer, task management, focus music, work stress assessment and drowsiness detection. For employees, the software helps them increase their productivity, manage their tasks more effectively and achieve a better work-life balance. The Pomodoro timer and concentration music features help employees take breaks and relax, improving their overall well-being. The drowsiness detection feature can help employees stay alert and avoid mistakes caused by fatigue. For managers, the software provides valuable insights into employee productivity and areas for improvement. They can assign tasks to those employees assigned to them. The reports feature allows managers to view metrics such as the number of assigned tasks, Pomodoro count, drowsiness count, work stress score and the employee's overall productivity over a given time period. This data can help managers identify areas where employees may be struggling and provide support to help them improve

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UNDERWATER INSPECTION AND EXPLORATION ROV

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ABSTRACT

Remotely controlled underwater robot vehicles, sometimes known as ROVS, are widely used in the offshore industry and other purposes. The primary goal of this class of underwater mobile tethered robots is to replace people in risky or challenging-to-reach underwater environments for a range of specialized tasks like inspections, site surveys, and the search for important individuals or goods. Umbilical cables, also known as copper or fibre optic cables, are frequently used for the remote control of ROVs. Underwater search robots have been a popular option for peering into the depths of ponds, lakes, and oceans alike. The purpose of the study is to design and produce a device that can scan and analyze tiny lakes. The remotely controlled vehicle (ROV) that is the topic of the following research contains modules that are dedicated to the gathering of data, such as movies, images, etc. The device will also find and identify any undesirable items that are buried in the bottom. We recommend a low-cost approach that use wired media for communication and a more straightforward thruster configuration. A network camera, a bore scope, and four motors powered by a 12 volt battery system will be included in the low-cost ROV. The ROV will have the capability of diving up to 20 meters under the surface to conduct underwater inspection and observation activities.

Keywords: *Remotely operated vehicle, Umbilical cables, Underwater search robots, low- cost ROV*

I. INTRODUCTION

A remotely operated vehicle (ROV) [1] is a type of vehicle that is designed to be operated remotely using a remote control. ROVs are often used in situations where it is not practical, safe, or possible for a human operator to be present, such as in hazardous or inaccessible environments, such as deep oceans or in space. They are also used in a variety of industries, including oil and gas, marine research, military, and media production [2]. ROVs are equipped with a variety of sensors and tools that allow them to perform tasks such as inspection, maintenance, repair, and scientific research. They may also be equipped [3] with manipulators or other specialized tools to perform specific tasks, such as cutting or welding. ROVs are usually connected to a control console or computer on shore or on a vessel, from which the operator can control the vehicle and view its surroundings through cameras or other sensors. An inspection and exploration ROV (Remotely Operated Vehicle) is a small, unmanned submersible vehicle that is remotely controlled by an operator from a surface vessel or from a control room on shore. These vehicles are typically equipped with cameras, sensors, and manipulator arms to allow them to inspect, survey, and perform tasks underwater [4]. They are used in a variety of applications including oil and gas exploration, scientific research, underwater construction, and environmental monitoring.

II. METHODOLOGY

The methodology of the project is illustrated as a flow chart in Fig. 1. The methodology of the project includes generation of 3D design, procurement of different materials and parts, fabrication and field testing.

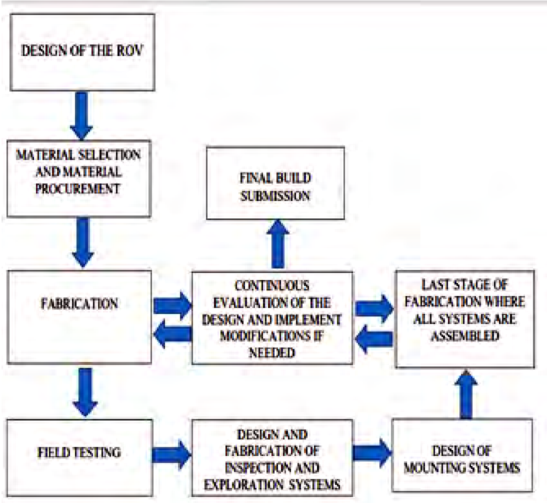

Fig. 1: Methodology of the project

III. DESIGN

As shown in Fig. 2, the components of the underwater inspection and exploration ROV include:

- Frame
- Thrusters
- Buoyant tank
- Sensors and camera system
- Control system

The isometric view with labeled parts of the ROV is shown in Fig. 2 shows the layout design of the ROV

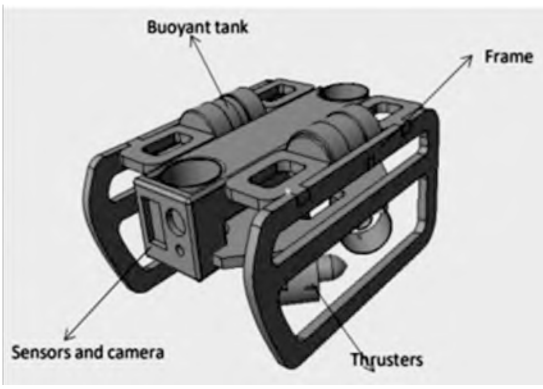

Fig. 2: Design of ROV

IV. FABRICATION

Fabrication of the ROV was done during the months of March and April 2023. The fabrication was carried out in different steps.

I. Electronics parts and material procurement: According

to the design, specifications and requirements, various electronic components and materials were purchased.

II. Fabrication of the frame: The frame material was selected based on the properties of the materials such as density and strength. The material selected was 18mm PVC fiber board which had a density less than that of water, which helps it to float in water and its strength can resist the pressure forces up to a depth of about 100m. The dimensions of the frame were designed in such a way that it gave good clearance for the water that was passing through the propellers and it does have a good aesthetic design [5]. PVC boards can be easily machined using wood working machines, The frame was cut to shape using a jig saw at a carpentry shop. The Fig. 3 shows the frame structure of the ROV.

Fig. 3: Different view angles of the frame

III. Fabrication of thrusters: The design of the ROV is such that there are 6 thrusters with 4 arranged in a x- orientation for the lateral movements and 2 at the top arranged vertically for horizontal movements,

The thrusters are designed such that it offers bi-directional rotations as well as variable speed control. The different parts of the thrusters are as follows: -

Propeller: After determining various propeller parameters required from a similar sized ROV, we designed the propeller using PTC Creo Parametric 9. The propeller was then 3Dprinted. The Fig. 4 shows the design and the 3D printed propeller, respectively

Fig. 4: Printed thrusters

Specifications:

Material: Polylytic acid polymer

Blade diameter: 50mm

Pitch angle: 20 degrees

Number of blades: 3

Motor: Each thruster is powered by a 12v DC brushed

motor which is directly connected to the propellers.

The motor used works well underwater, but with prolonged

time, under water corrosion can set in, therefore water

proofing is required. A PVC pipe enclosure was used and

the inside was filled with thick grease and oil.

Fig. 5: Motor

Specification:

Make: Thermisto

Model: RS 775

RPM: 7000

Voltage: 12-24v

Amp rating under water: 5Amp

Diameter: 43mm

Motor driver module: A motor driver module is a device used to control the speed and direction of rotation of a DC motor using a micro-controller. The motor drivers must be powered separately for them to work. A total of 3 motor drivers are used to control the 6 motors, each motor driver can control the speed and direction of two motors. Fig. 6 shows ZK5AD motor driver shield which is used in the ROV.

Fig. 6: Motor driver

Specifications:

Make: Generic

Model: ZK5AD

Working voltage:6-14V

Maximum current supplied at each channel:5Amp.

Voltage drops at each channel:0.4v

Other parts: These include the thruster supports which were 3D printed out of PLA, 50mm PVC pipe for the motor casing and 50mm PVC end cap.

IV. Control system wiring: The ROV has 5 degrees of freedom, all of which are controlled using 3 joysticks marked as A, B and C. The different controls associated with each joystick are given below.

Joystick A: Heave (translational movement in up and down direction).

Joystick B: Yaw (rotational movement to left and right on the y axis). Pitch (rotational movement to up and down on the x axis).

Joystick C: Surge (forward and backward movement). Sway (left and right movement). Fig. 7 shows the control.

board of the ROV along with the camera display.

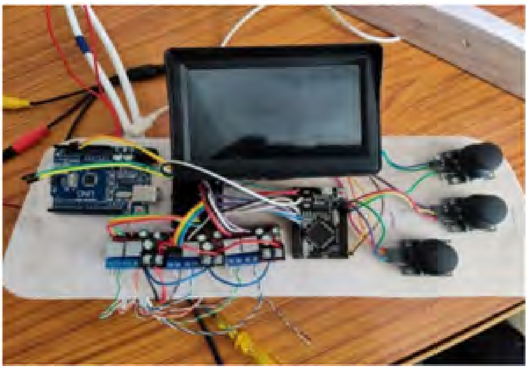

Fig. 7: Control board with electronics fixed

The joystick coverts mechanical signals into analog inputs for the micro-controller, which then interprets the signals and gives output signals to the motor drivers and the motor drivers to the motors. The micro-controller used is an ARDUINO MEGA 2560 PRO, which has 54 io pins out of which 15 are PWM pins, which are required for the speed control of the motors. Fig. 8 shows the micro-controller which is used in the ROV.

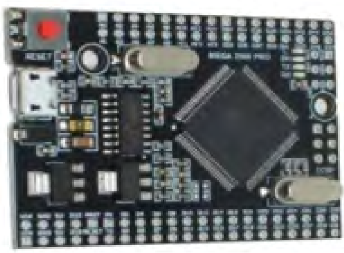

Fig. 8: Arduino mega

All the control systems are made into the control board which is connected to the ROV using two 10m Ethernet cables providing 8 channels of communication. The detailed wiring of the control circuitry drawn using CIRCUIT IO is shown in Fig. 9.

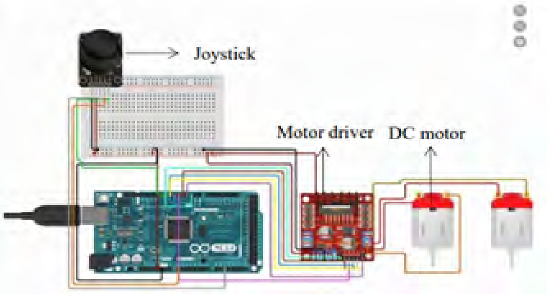

Fig. 9: Control circuit for movement

V. Programming the Arduino: We primarily used conditional statements (if, else if, and else) to determine the appropriate motor control action based on the joystick inputs. The motor speed and direction are controlled by varying the PWM (Pulse Width Modulation) values using analogWrite() function, while the motor direction is controlled by setting the digital pins HIGH or LOW using digitalWrite() function The code functionality is given below:

Pin Definitions: d0 to d11: These variables store the pin numbers for the motor driver pins. j1y, j1x, j2y, j2x, j3y: These variables store the analog input pin numbers for the joystick inputs. j1yr, j1xr, j2yr, j2xr, j3yr: These variables store the analog readings from the joystick inputs.

setup() Function: Sets the pin modes for all the defined pins. Configures the motor driver pins as outputs and the joystick pins as inputs.

loop() Function: Continuously reads the analog values of the joystick inputs using analogRead() function. Performs different control actions based on the joystick input readings. The control actions are executed using the analogWrite() and digitalWrite() functions.

VI. Sensors and camera mounting: A

temperature sensor and turbidity sensor is mounted on to the ROV to obtain the temperature and clarity of the water at various locations. The sensors give input signals to the micro-controller via the Ethernet cable and the output is displayed on the screen of a smartphone or laptop through a Bluetooth connection. Fig. 10 and Fig. 11 shows the temperature and turbidity sensors used in the ROV

Fig. 10: Temperature sensor

Fig. 11: Turbidity sensor

A car rear-view camera was used as a proof of concept. The camera output signal is received by the monitor through a 10m long av cable.

Fig. 12: Shows the camera and display used in the ROV.

Fig. 12: Display and camera

VII. Power unit assembly: The ROV was designed such that there are minimal electronic components inside the ROV, lmost all electronics except the two sensors, everything else is integrated into the control board, including the power unit. Also, the ROV can be powered either by a DC battery or directly from a 250v AC power source. In the case of a battery, a 14v20ampbattery should be used. We used a direct AC source coupled with a 12v 20-amp SMPS to power the ROV. The SMPS is integrated into the control board for compatibility.

The complete fabrication of the ROV was finished and testing was done. Fig. 13 shows the different views of the completed ROV.

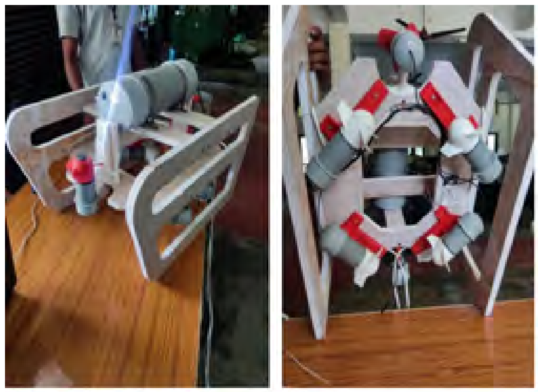

Fig. 13: Completed ROV

V. TESTING

Testing: The testing involved checking the stability and movement of the ROV under water, All the controls worked as expected in the first trial, but due to the large buoyant force acting upwards, the ROV was not able to submerge completely and also, due to some problems with the wiring sensor values were not displaying on screen. Fig. 14 shows a picture of the ROV taken during the first trial.

Fig. 14: ROV in first trial

On the second trial, after adding dead weight to counter the buoyant force, the ROV was finally able to submerge as shown in Fig. 15, also the sensor values were displayed on screen as shown in Fig. 16.

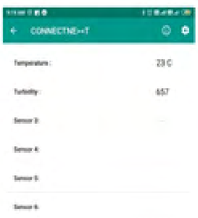

Fig. 15: Submerged ROV   Fig. 16: Sensor values

VI. CONCLUSION

ROVs are a valuable tool for inspection and exploration in underwater environments, as they allow humans to access and study areas that would otherwise be difficult or impossible to reach.The use of ROVs for mapping and surveying can provide important data on ocean conditions and help inform decision-making for a range of applications, including environmental monitoring and conservation .Further research and development in the field of ROVs, particularly in areas such as sensor technology and data analysis, can help to improve the effectiveness and efficiency of these vehicles for inspection and exploration purposes. The use of ROVs for inspection and exploration can be enhanced through the development of multi-vehicle systems and collaborative approaches involving both ROVs and other types of underwater platforms. Overall, the continued advancement of ROV technology has the potential to significantly expand our understanding of the underwater world and provide valuable insights into a wide range of scientific and practical applications

VII. FUTURE SCOPES OF INSPECTION AND EXPLORATION OF ROV

- Inspecting underwater structures and facilities: ROVs are often used to inspect underwater structures, such as oil and gas platforms, pipelines, and ships. They can be equipped with sensors and imaging systems that can detect problems and defects, and they can be used to perform maintenance and repair tasks.
- Conducting scientific research and surveys: ROVs can be used to collect data and samples from the ocean floor and other underwater locations. This can help scientists better understand the ocean and its ecosystems and inform conservation efforts and resource management.
- Exploring uncharted areas of the ocean: ROVs can be used to explore deep-water environments that are otherwise inaccessible to humans, such as the deep sea or remote coral reefs. They can be equipped with cameras and other sensors to collect data and images from these environments.
- Responding to disasters and emergencies: ROVs can be used to assess damage and assist with rescue and recovery efforts in the aftermath of natural disasters or other emergencies, such as oil spills or sunken ships.

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DISEASE PREDICTION USING MACHINE LEARNING

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ABSTRACT

The project of disease prediction aims to employ classifiers in order to predict the probability of an individual developing a specific disease. This undertaking involves gathering diverse data from sources such as medical records, genetic information, lifestyle factors, and environmental factors. Subsequently, this data is analyzed using various classifier techniques to construct predictive models. These models are trained on a dataset and then validated on a separate dataset to ensure their accuracy and generalizability. The ultimate objective of the project is to create a tool that healthcare professionals can utilize to identify individuals who are at a high risk of developing certain diseases, enabling early intervention and prevention. This has the potential to enhance health outcomes and reduce healthcare costs by identifying and treating diseases before they progress into chronic or life-threatening conditions. Multiple machine learning algorithms can be employed for disease prediction, such as Gaussian Naïve Bayes Classifier, Random Forest Classifier, and Support Vector Machine. The algorithm choice depends on the data type being analyzed and the desired outcomes. Once a model is developed and validated, it can be implemented in clinical practice, which might involve integrating the model into electronic health records or developing a standalone tool tailored for healthcare professionals. Disease prediction using machine learning also raises ethical considerations such as privacy, confidentiality, and bias, which must be carefully addressed during the development and implementation of the model.

***Keywords**: Gaussian Naïve Bayes Classifier, Random Forest Classifier and SVM.*

I. INTRODUCTION

Healthcare plays a vital role in society [1], and advancements in technology have greatly enhanced patient outcomes. Among these advancements, machine learning has emerged as a promising tool for predicting diseases, facilitating early detection, accurate diagnosis, and targeted treatment. Disease prediction through machine learning [2] involves the creation of predictive models utilizing extensive datasets derived from patient records, genetic information, and other health data. This approach empowers healthcare providers to identify individuals at risk and offer timely interventions to prevent, diagnose, and treat diseases effectively. The article [3] presents a well-defined overview of the current technologies in disease prediction using machine learning. It explores various machine learning algorithms employed in disease prediction, their strengths, limitations, and associated challenges. Furthermore, recent developments in the field are discussed, emphasizing the potential of machine learning in enhancing patient outcomes. The article [4] aims to provide a holistic understanding of disease prediction using machine learning and its implications for the future of healthcare. Additionally, it provides a valuable resource for researchers and healthcare providers seeking to leverage machine learning for disease prediction. Ultimately, this article [5] contributes to the existing technologies concerning the intersection of healthcare and machine learning, while highlighting the transformative potential of this technology within the medical field.

Machine learning techniques have the potential to revolutionize disease prediction in healthcare by leveraging the vast amount of medical data available. The utilization of machine learning algorithms enables the identification of hidden patterns and valuable insights that contribute to the early detection and treatment of diseases. Recent years have witnessed remarkable progress in the application of machine learning for disease prediction, prompting the need for a thorough examination of the current state of the field. This paper serves to provide an extensive review of disease prediction using machine learning, delving into the various techniques employed. The focus will primarily be on the application of machine learning in predicting specific diseases like cancer, diabetes, and heart disease. Through an analysis of recent studies and research papers, this paper will discuss the findings and implications of utilizing machine learning for disease prediction. Furthermore, it will conclude with an exploration of the future prospects of disease prediction using machine learning, including potential areas for further research and development. The integration of machine learning with other technologies like genomics and wearable devices will be considered as well. In summary, this paper provides a comprehensive survey of the current state of disease prediction using machine learning in healthcare and highlight its transformative potential for the future of the field.

Machine learning algorithms are integrated into mobile applications to analyze symptoms provided by users and offer diagnoses or a list of potential diagnoses. These applications serve individuals or healthcare professionals in diagnosing diseases and promoting early intervention. Users input their symptoms into the application, which then employs machine learning algorithms to generate accurate and personalized diagnoses. Additionally, the app can predict the disease based on their symptoms. Users receive personalized recommendations based on their symptoms and potential diagnoses, which may involve suggested lifestyle modifications, medication options, or referrals to healthcare professionals. Furthermore, the application allows users to store their medical records, encompassing diagnoses, medications, and test results. This feature assists healthcare professionals in making well-informed decisions. Overall, these mobile applications harness the power of machine learning to enhance disease diagnosis, provide personalized recommendations, and facilitate informed decision-making in healthcare.

II. RELATED WORKS

This section discusses the application of the grounded approach in AI. According to the author of the paper titled "Early-stage prediction of non-communicable diseases using machine learning in health cyber-physical systems (CPS)," CPS provide computational and communication capabilities for effective control and monitoring tasks. In the healthcare sector, Health CPS, a specific variant of CPS, serves as a health monitoring system that securely captures, processes, and analyzes data from health sensors. It specifically caters to individuals dealing with non-communicable conditions (NCDs) and offers the advantage of accurate prognosis without human intervention. However, it should be noted that one drawback of this system is its higher cost due to its Internet of Things (IoT) integration.

The paper [6] introduces the DWRF algorithm, which aims to identify relations between metabolites and diseases. The algorithm utilizes DeepWalk and Random Forest techniques. It starts by integrating semantics and information entropy of diseases to calculate the final disease similarity. Moreover, DeepWalk is applied to extract valuable features of metabolites based on the network of metabolite-gene associations. Lastly, the algorithm employs the random forest algorithm for analysis and prediction purposes.

The author [7] of the paper discusses the prediction of CircRNA-disease relations using the metapath2vec++ and matrix factorization techniques. The study involves establishing networks for CircRNA annotation, sequence, and functional similarity, while incorporating disease-related genes and semantics. The metapath2vec++ algorithm is utilized on an integrated heterogeneous network. Furthermore, matrix factorization is employed, considering relation as a constraint and optimizing it to generate the output results.

The paper [8] proposes a novel approach that combines healthcare big data analysis and deep learning technology to identify cases with implicit diseases. The algorithm, referred to as the medical-history-grounded implicit complaint prediction algorithm, leverages deep learning techniques to make accurate predictions regarding a case's potential complaint based on their medical history.

The author of the paper [9] introduces a system capable of predicting and semantically interpreting stroke prognostic symptoms based on machine learning techniques. The system utilizes real-time multi-modal bio-signals, specifically ECG and PPG. It employs an ensemble structure that combines CNN and LSTM models to create a stroke complaint prediction system.

The author of [10] describes a CNN based algorithm that predicts the risk of common complaints associated with cerebral infarction. The algorithm utilizes both structured and unstructured data from hospital records.

The author of [11] discusses the prediction of relations between human microbes and diseases. The proposed computational model uses matrix completion and incorporates multi-source information. The microbe feature is calculated using a Gaussian kernel-based similarity measure. The potential associations between microbes and diseases are treated as missing elements of a matrix, which is completed using matrix completion techniques to obtain the predicted microbe-disease associations.

In [12] the author focuses on predicting chronic diseases in the paper, utilizing seven different classifier algorithms: Artificial Neural Network (ANN), C5.0, Chi-square Automatic Interaction Detection (CHAID), Logistic Regression, Support Vector Machine (SVM) with L1 and L2 penalties, and Random Forest.

In [13] the paper introduces a smartwatch-based prediction system called "MedAi" that utilizes machine learning algorithms to predict multiple diseases. The system consists of a prototype smartwatch with sensors for data collection, a machine learning model for analysis and prediction, and a mobile application for displaying the results. Ethically obtained patient data from a local hospital is used for training and evaluation. Several machine learning algorithms, such as SVM, SVR, KNN, XGBoost, LSTM, and RF, are employed to identify the best performing algorithm. Experimental results demonstrate that the RF algorithm achieves an impressive accuracy of 99.4% in predicting the mentioned diseases. The system provides continuous monitoring of users' body condition and offers appropriate remedies, making it a valuable tool for early disease prediction and prevention. The paper concludes by comparing the proposed method with existing approaches in the field.

In [14] paper, a federated learning algorithm is introduced to protect the privacy of healthcare data. By incorporating differential privacy, the algorithm enables the training of machine learning models using distributed data from various institutions. The effectiveness of the algorithm is demonstrated through its application in predicting breast cancer status using gene expression data. The results show comparable accuracy and precision to non-private neural network models. The framework provided offers a valuable tool for clinical data scientists to develop differentially private models for federated datasets.

III. PROPOSED METHOD

A) OVERVIEW

The proposed system [15] uses an ensemble machine learning model to predict diseases. The proposed system has an Android application on the client side. The server comprises the REST API which holds the ensemble model as a microservice that is trained to predict the disease. The ensemble model is deployed on a server's Docker container. It incorporates Gaussian Naïve Bayes Classifier, Random Forest Classifier, and Support Vector Machine algorithms to create the ensemble model. JSON format is used for both input and output data. The system consists of four modules: Admin Page and Database, Android Application, Docker Container, and Machine Learning Models.

1) ADMIN PAGE AND DATABASE

The admin page allows the admin to add disease-related information to be shown on the client side. It also allows the admin to enter symptoms that the user chooses from in the client application. The database used is MySQL. The webpage is built using HTML, CSS, and Bootstrap and hosted on an XAMPP server. The webpage is hosted on a XAMPP server. The front end is developed using HTML, CSS, and Bootstrap, while PHP is utilized for the back end and database connectivity. The MySQL database is employed for data storage.

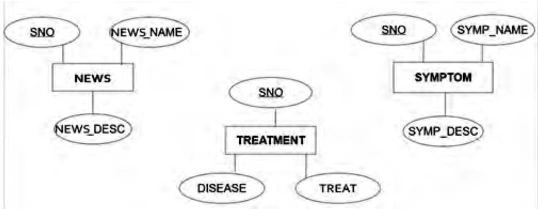

Fig. 1: ER Diagram

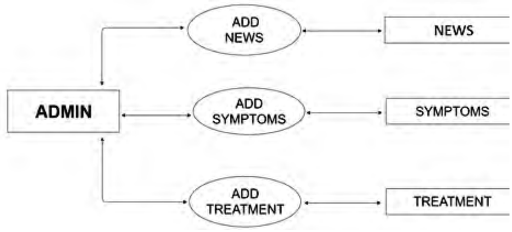

Fig. 2: Dataflow diagram of admin module

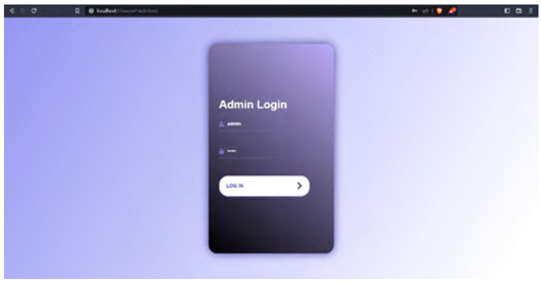

Fig. 3: Admin login page

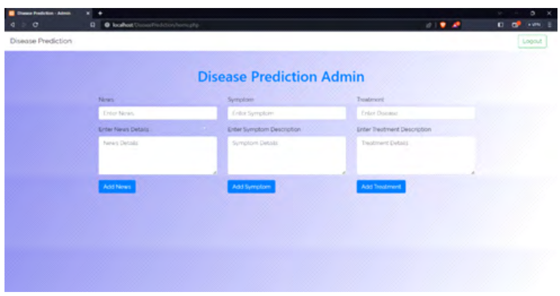

Fig. 4: Admin can change the contents of the application through this page

2) ANDROID APPLICATION

The application offers users a dropdown list to input their symptoms. Upon submitting the symptoms, the app connects to a remote server to compute the corresponding disease.

Additionally, the app provides news-related information sourced from a database located on the remote server. The app is developed using Java in Android Studio, and its communication with a REST API is facilitated by the Volley library in Java. The REST API, built using Flask, incorporates the machine learning model responsible for processing the user's symptoms. The result is obtained as a JSON response, which is then displayed to the user. Database connectivity is established through the execution of PHP scripts on a server, utilizing the Volley library in Java. These PHP scripts retrieve data in JSON format, which is subsequently converted for display on the client-side.

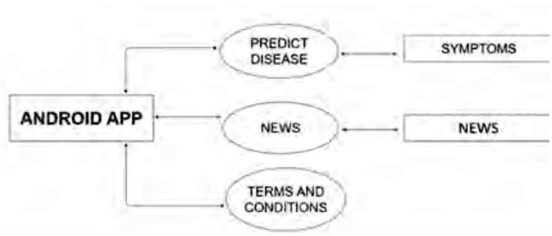

Fig. 5: Dataflow diagram of Android application

Fig. 6: Screenshots of mobile application

3) DOCKER CONTAINER

Docker is a platform that facilitates containerization, allowing developers to package their applications and associated dependencies into portable containers. These containers ensure consistent and reliable execution of applications across different environments, simplifying the deployment process and promoting greater flexibility. Here, the machine learning model is hosted on a Docker container. A custom-built Docker image is constructed from a Docker configuration file which has the necessary configurations on how to set up the platform for the machine learning model to run and expose a port for network connectivity.

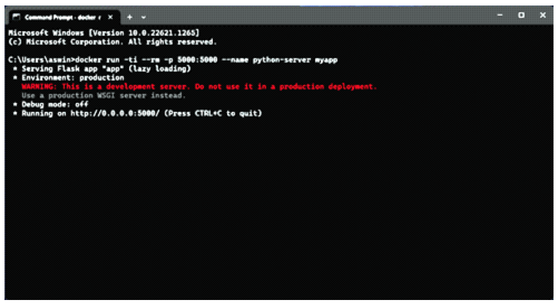

Fig. 7: Running a Flask app with Docker

4) MACHINE LEARNING MODELS

An ensemble machine learning model is used here. The ensemble model consists of Gaussian Naïve Bayes Algorithm, Random Forest, and Support Vector Classifier. The final output is determined by returning the mode value from these three models. Thereby, we increase the final model's accuracy using the ensemble model. The dataset has 132 symptoms of which 42 different types of diseases can be predicted.

Two CSV files:

- Testing.csv of 13.78 kB
- Training.csv of 1.38 MB

The ensemble model is hosted on a Docker container.Training.csv is split into 80% for training and 20% for testing.Testing.csv is then used to evaluate the final model.

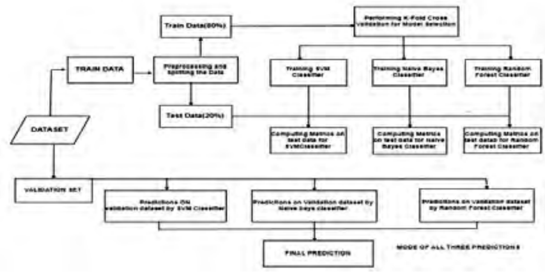

Fig. 8: Workflow diagram

IV. RESULT ANALYSIS

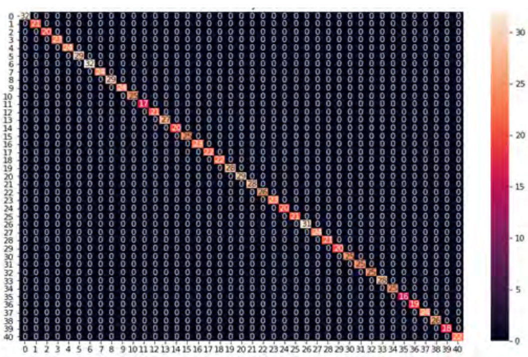

Fig. 9: Confusion Matrix for Naïve Bayes Classifier on Test Data

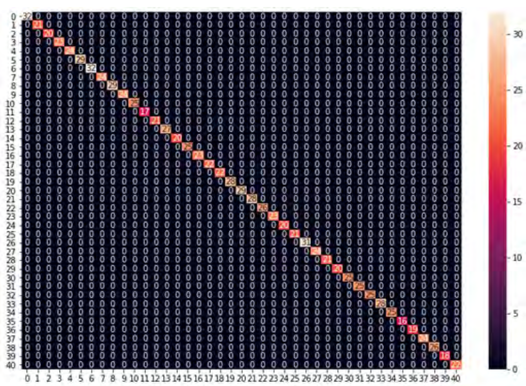

Fig. 10: Confusion Matrix for SVM Classifier on Test Data

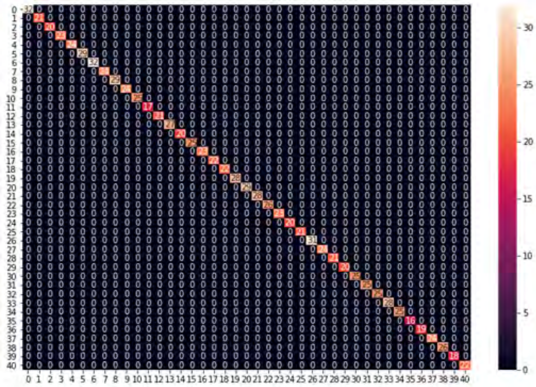

Fig. 11: Confusion Matrix for Random Forest Classifier on Test Data

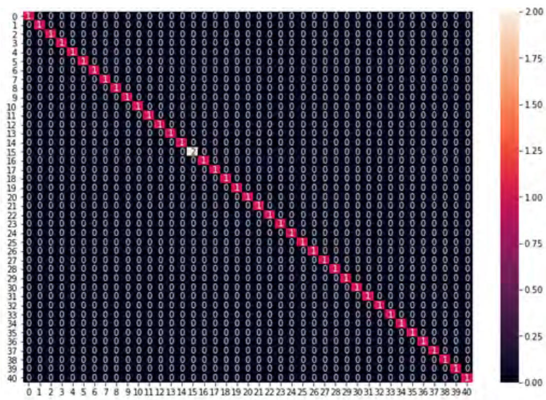

Fig. 12: Confusion Matrix for Combined Model on Test Data

V. CONCLUSION

Being a cloud-based application, updates are needed to be done centrally and users do not have to worry about it. The proposed system is an easy-to-use Android application. It helps common users in early prediction of diseases and thus, lead to better treatment with minimal loss in time.

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TRASHBOT

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ABSTRACT

We are aware that waste collection is a major problem in communities, workplaces, malls, and housing complexes. People from the municipality come with vehicles and stops in front of each house to collect the garbage. Autonomous garbage collecting trucks are used for this in other nations. However, that is incredibly expensive and difficult to execute in developing nations like India. We thus want to do this through our initiative in a way that is economical. Take an office or school building as an example. When the trash cans are full, someone arrive to collect them. Every cabin or room must be visited in order for them to gather it. This procedure takes a long time and demands a lot of labour as well. An autonomous robot can be utilized for this procedure in place of all this human labour. To carry out this task, the robot makes advantage of the route remembrance concept. Servomotors, gearmotors, driver modules, boost converters, batteries, infrared sensors, wiper motors and infrared sensors are used in the implementation of this project.

Keywords—*Path remembering, obstacle detection, collection*

I. INTRODUCTION

We are aware that waste collection is a major worry in communities, workplaces, malls, and housing complexes. Municipal workers arrive in cars and stop in front of each home to collect the trash.

Autonomous garbage collecting trucks are used for this in other nations. However, that is incredibly expensive and difficult to execute in developing nations like India. We thus want to do this through our initiative in a way that is economical. Take an office or school building as an example. When the trash cans are full, someone arrive to collect them. Every cabin or room must be visited in order for them to gather it. An autonomous robot can be utilized for this procedure in place of all this human labour. The robot will first monitor its route before moving towards the trash can, grabbing it, and dumping its contents into the collector. Therefore, after mapping, the robot will always take the same route and complete the procedure. The robot must initially be physically moved by the operator before it can operate on its own after mapping the path. The need for human labour in this can be removed by utilizing a robot like this. We want to help individuals by decreasing their power and making garbage collection simpler and more automated.

II. RELATED WORKS

A. AUTOMATIC-TRASH COLLECTOR ROBOT

In this model [1] the HC-05 module transmits the level sensor's monitored signal to the Arduino board. The motor starts when the garbage can is filled. Line follower movement is started by a signal from their sensor. Left turn is done when signal from left IR sensor is recognized. Right turn is done when signal from right IR sensor is recognized.

Straightening is indicated by the signal from the centre IR sensor. The L298N driver module is running. With the aid of an arm and a gripper, a trash can is picked up and deposited.

Fig. 1: Block Diagram of Automatic Trash Collector Robot

B. GARBAGE COLLECTOR ROBOT

In this method [2] the system is entirely user-friendly, and the project is built on a low-cost solution. The project is divided into two primary components, one of which is voice operated and the other of which is semiautonomous and controlled by buttons. For a wireless connection between the robot and mobile device, a Bluetooth module is used. The mobile device creates the voice command and sends it over Bluetooth to the Arduino microcontroller, which reads the command and does the appropriate action. One robotic hand is mounted to the machine and will pick up the trash and deposit it in the attached basket. These gear motors are used to drive both of the back wheels through a differential. The robot is principally propelled by these motors.

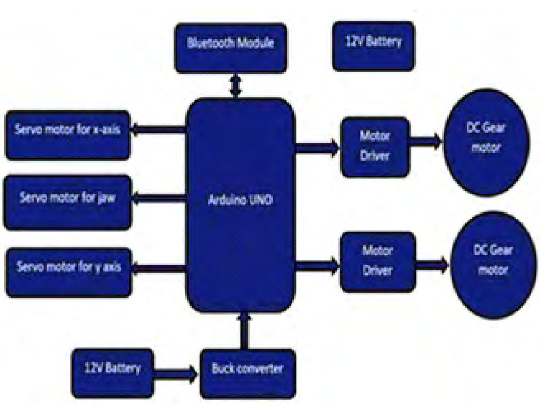

Fig. 2: Block Diagram of Garbage Collector Robot

C. LINE FOLLOWER BASED SMART MOVING DUSTBIN FOR SMART CITIES

In this system [3], intelligent solid waste management is required as a result of the expanding industrial revolution, innovations, and technological development that have resulted in smart cities and technological advancements. A novel concept for managing garbage in smart cities is the moving Smart dustbin. Connecting the LCD to the Arduino and checking that it functions correctly is the first step in creating a moving smart trash can. The Ultrasonic Sensor must now be connected to the initial configuration in order to calibrate the distance using sound waves. The dustbin will automatically travel to the identified common rubbish location if the level detector, scent detector, or deviation sensor is high. Liquid Crystal Display is used to update the dustbin's status for consumers. With the aid of a line follower robot, the dustbin will automatically travel along a predetermined path to reach the primary garbage location as soon as the level detector indicates a high level, and it will then be emptied by dropping the waste there.

Fig. 3: Block Diagram of Smart moving Dustbin

III. PROPOSED SYSTEM

The main aim of the proposed system is to build a trashbot to collect the garbage and reduce manpower especially in schools, offices and buildings. To carry out this task, the robot makes advantage of the route remembrance concept. Servomotors, gearmotors, driver modules, boost converters, batteries, infrared sensors, ultrasonic sensors, wiper motors and infrared sensors are used in the implementation of this project.

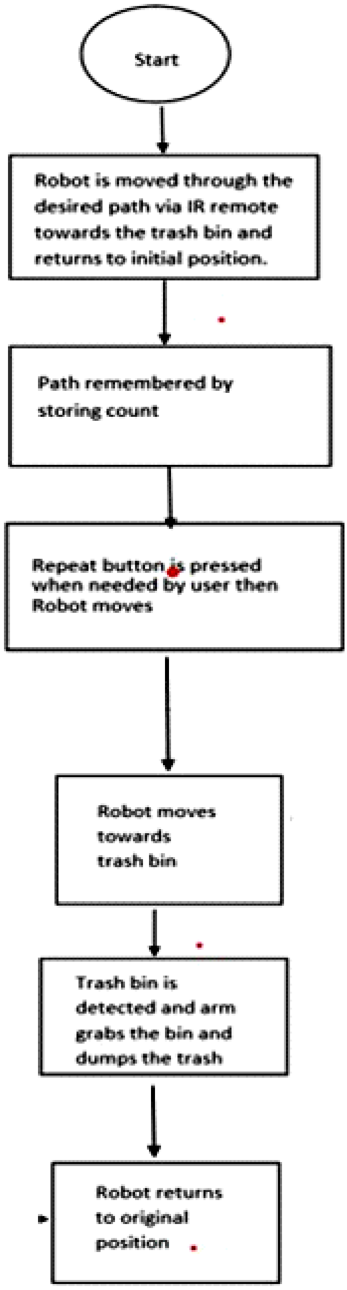

Fig. 4: Flowchart of proposed system

IV. Block Diagram

The working of this project can be categorized into two main functions, path remembering and garbage dumping.

Firstly for the robot to remember the path, the user has to move it via an IR remote through the desired path towards the trash bin. Now as this movement is done, the rpm and time taken by the wheels are calculated and is stored in the EEPROM of the Arduino Uno. Once the path is remembered then whenever we press the repeat switch, the robot will move along the same path. Whenever the robot is placed in a new surrounding this process has to be done.

Trash bin is detected using IR sensor. As soon as the bin is detected, robotic arm with help of gripper will lift the trash bin and dump it on to the collector present in the robot itself. Through the application, the level of the trash bin can be known to the user. This app also notifies the user about the level of trash present in the collector. Now app also has features that helps the user if the robot is in motion or not. This app is implemented using Android Studio SDK and java as the programming language.

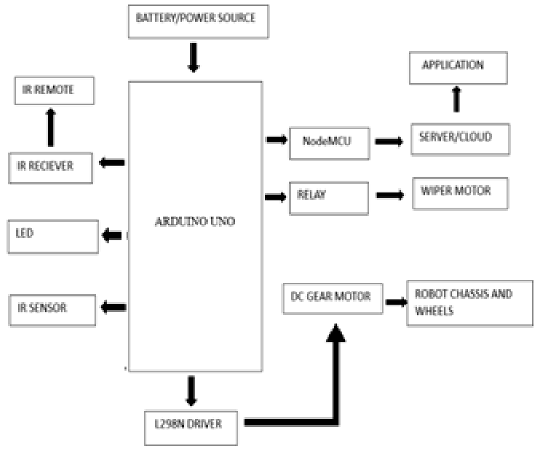

Fig. 5: Block diagram

V.RESULT

This section provides the hardware and software results of the Trashbot

Fig. 6: Structure of Trashbot

Fig. 7: App interface showing the trash level

V. CONCLUSION

In this project, we want to build a low-cost garbage bot that will assist in managing waste by lowering the labour-intensive task of trash collection. The method implemented is very useful for trash collection in offices and schools. The main advantage of this approach is that it uses path remembering mechanism instead of line following. If we use line following mechanism the main disadvantage is that it requires the sticking of black tape everywhere which will make the floor look messy. So in our proposed system we overcome this limitation. We also provide an app to keep the users notified about the trash level and any obstacles. By this project we intend in making the trash collection job easier and thereby reducing manpower.

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ADVANCED PILING METHODS INCORPORATING FLY ASH TO IMPROVE DRILLING FLUID PROPERTIES

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ABSTRACT

Friction piles are an underground piling system utilized to establish a robust foundation for large, heavy structures. This type of pile foundation, characterized by larger diameters and lengths, offers more effective solutions in terms of increased load-carrying capacity and reduced settlement. To stabilize the excavated borehole, two methods are employed: bentonite and polymers. Bentonite consists of clay particles that create a low permeable layer around the excavated soil, while polymers offer enhanced stabilization through chemical means. Achieving the desired fluid properties requires a specific concentration of bentonite and polymer in water. This ensures effective stabilization of the borehole, consequently modifying the frictional resistance of the pile. In this study, water's concentration of bentonite and polymer is varied to find the optimum level for stabilizing the borehole. Direct shear tests are conducted, wherein the bentonite, polymer, and polymer-fly ash slurry are spread on a shearing plane. The purpose is to analyze the impact of these fluids on the frictional resistance of the pile. The results of the tests show that all three slurry samples reduce the frictional resistance of the pile, with bentonite causing a more significant reduction compared to the polymer-fly ash slurry. Furthermore, a standard penetration test is carried out to determine if the same percentage of fly ash can stabilize the soil. The results indicate that this percentage of fly ash allows for soil stabilization through water absorption. However, the study does not consider the effect of fly ash on water absorption from the surrounding soil, leaving it for future study.

Key Words: *Geogrid, Stirrups, Shear deficient, Center point loading*

I. INTRODUCTION

Piling involves the installation of pile foundations beneath a building, enabling the transfer of loads from the structure to the ground. These pile foundations play a crucial role in providing support, especially in unstable soils and when dealing with significant structural loads. The process of driving or boring piles into the ground is carried out using pile drivers. These machines consist of a tall frame equipped with mechanisms to raise and drop a pile hammer or to support and guide a hydraulic hammer or air hammer. Both the design and installation processes of pile foundations are equally important. Various methods are used for installing pile foundations, including driving piles with a pile hammer and boring through the ground with a mechanical auger. It is essential to carefully select the appropriate installation methods and equipment during the design phase to prevent any damage to the piles.1].

Pile types are selected based on strata and site conditions. Two methods of piling are Direct Mud Circulation (DMC) and the Hydraulic Rig Method. DMC involves distributing mud from the pile bore to a bentonite pit, where the pump recycles the slurry and abandons the settled mud. It is a cheaper method for installing piles. The hydraulic Rig Method involves a rotary cylinder and Kelly bar rotating clockwise and anticlockwise [4].

Soil is collected with a bucket, and the rotary is locked. A polymer solution is added to the borehole, and the process is stopped when the required depth is reached. A rebar cage is inserted into the borehole, and concreting is done.

Stabilization is a process that combines various methods to improve soil properties and engineering performance. In this project, soil stabilizers include bentonite, polymer, and fly ash [1]. Bentonite slurry is used to stabilize deep foundations, while polymer GMud forms an invisible membrane to prevent excavation. Fly ash, a silt-sized solid waste produced by coal combustion is used to increase soil strength by increasing compressive and shear strength. Both methods are essential for maintaining the integrity of the soil and enhancing engineering performance.

The project utilizes two major drilling methods: Direct Mud Circulation (DMC) and Hydraulic Rig Method (HRM). DMC takes three days to drill a borehole, requiring a large working space, while HRM takes only one day and requires minimal space. Bentonite slurry cannot be used for HRM, so polymer slurry was used instead. Polymer slurry reduces viscosity and skin friction, while bentonite and polymer slurry may reduce soil friction [2]. To address stability issues during boring, fly ash was incorporated into drilling slurries.

The application of polymer was tested to determine the suitability of incorporating fly ash into the drilling fluid and its effectiveness in increasing friction.

II. METHODOLOGY

This section outlines the methodology employed for the application of polymer to stabilize the soil and incorporate fly ash into the drilling fluid. The study contains application, soil testing, observations, and results.

A. Application of DMC and HMC:

Piling is done using DMC and HMC methods due to the condition of the soil varies.

B. Methods of testing:

a) Specific gravity using a pycnometer

b) Determination of water content of soil solids by oven drying method

c) Standard proctor test

d) Marsh funnel viscosity test

e) Hydrometer test

f) Direct shear test

C. Observations:

a. Initial properties of soil:

The specific gravity of the soil sample was determined using a pycnometer test and was obtained to be 2.62. By conducting the oven drying method the natural moisture content of the soil was found to be 12.51%, and the OMC and MDD of soil were obtained as 14.3% and 1.578 g/cc respectively, by performing a standard proctor test.

b. Possibility of incorporating fly ash into drilling fluids:

As per IS 2911-2010 (Part 5), bentonite slurry density should vary only between 1.03- 1.1 g/cc. the density of fluid slurry is fixed by soil features and geographical conditions. Here for our project, the site required a slurry density of 1.09g/cc which was achieved by adding 4% bentonite concentration. A 5% concentration of silt was also taken into account as there are chances of loose soil particles being mixed with the slurry while boring. We added fly ash into the bentonite slurry with 5% silt content at an increment of 2%. And the density and viscosity of the slurry sample were determined just after mixing and after 2 hours of mixing. The table shows the effect of fly ash on 4% bentonite concentration of fluid with 5% silt.

Table 1: Effect of fly ash on 4% bentonite concentration of fluid with 5% silt.

Fly ash added (%)	Time after mixing (h)	4% concentration of bentonite+5% silt	
		Viscosity (s)	Density (g/cc)
0	0	61.56	1.1
	2	62.98	1.18
2	0	69.40	1.21
	2	71.23	1.29
4	0	-	1.26
	2	-	1.31

For polymer slurry preparation, the property taken into account to determine the amount of polymer to be added is the viscosity of the slurry. The required viscosity for each site is fixed by trial-and-error methods. At the site, polymer slurry viscosity was determined to be between 50-60 seconds, which could be achieved with 0.06% polymer concentration. A 5% concentration of silt was also taken into account as there are chances of loose soil particles being mixed with the slurry while boring. Then we added fly ash at an increment of 2% and the viscosity was determined for each sample just after mixing and after 2 hours of mixing. The table shows the effect of fly ash on 0.06% polymer slurry with 5% silt.

Table 2: Effect of fly ash on 0.06% polymer slurry with 5% silt.

Fly Ash added (%)	Time after mixing (h)	0.06% concentration of polymer+ 5%silt	
		Viscosity (s)	Density (g/cc)
0	0	65.27	1
	2	54.93	1
2	0	67.28	1
	2	53.74	1
4	0	68.89	1
	2	55.17	1
6	0	-	-
	2	-	-

c. Direct Shear Test:

Specimen Preparation:

The oven-dried soil sample was mixed with its optimum moisture content and compacted to the first half of the shear box. Then about 10 ml of the drilling fluid sample prepared was poured into the compacted layer of soil and kept undisturbed for about 20 minutes. Then the upper half of the box was filled with soil and compacted. The mold was then subjected to different shear loadings of 0.5kN, 1.0kN, and 1.5kN. Fig. 1, 2, and 3 show the various steps in the specimen preparation for the direct shear test [5].

Fig. 1: Compacted on the first half of mould

Fig. 2: Application of drilling fluid

Fig. 3: Placement of soil in the upper half of the mould

The field soil sample was subjected to normal loads of 0.5kN, 1.0kN, and 1.5kN. a graph of normal stress v/s maximum shear stress was plotted and is shown in Fig. 4. From the graph angle of internal friction was obtained as 33.69.

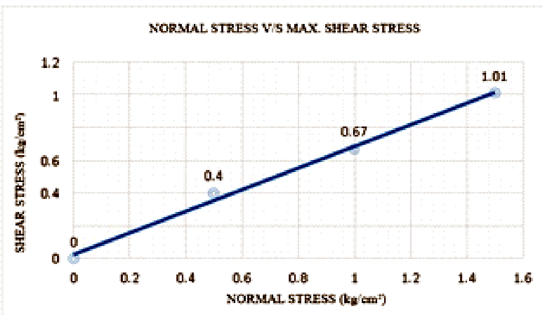

Fig. 4: Normal Stress V/S Max. Shear Stress Graph of Soil

Shear Test for Soil with Bentonite Slurry:

The specimen is prepared as that of field soil. The drilling fluid taken is 4% bentonite slurry mixed with 5% silt. The specimen prepared was subjected to normal loads of 0.5kN, 1.0kN, and 1.5kN. a graph of normal stress v/s maximum shear stress was plotted and is shown in Fig. 5. From the graph angle of internal friction was obtained as 29.57

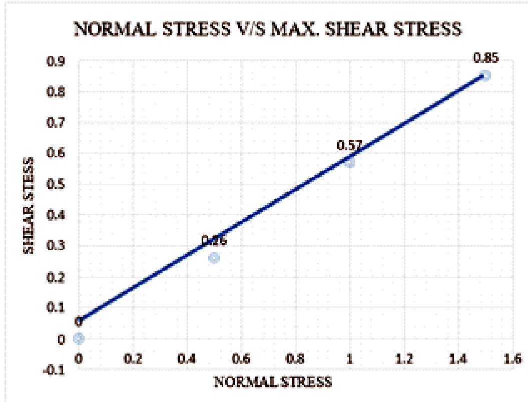

Fig. 5: Normal Stress V/S Max. Shear Stress Graph of Soil with Bentonite Slurry

Shear Test for Soil with Polymer Slurry:

The specimen is prepared as that of field soil. The drilling fluid taken is 0.06% polymer slurry mixed with 5% silt. The specimen prepared was subjected to normal loads of 0.5kN, 1.0kN, and 1.5kN. a graph of normal stress v/s maximum shear stress was plotted and is shown in Fig. 6. From the graph angle of internal friction was obtained as 31.70

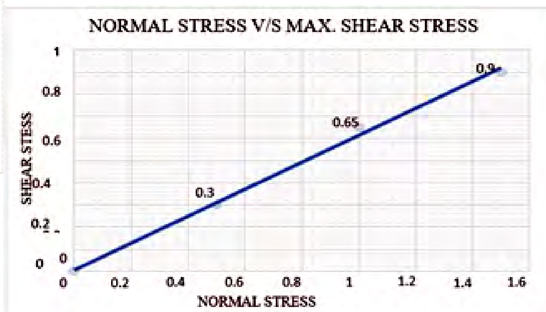

Fig. 6: Normal Stress V/S Max. Shear Stress Graph of Soil with Polymer Slurry

Shear Test for Soil with Polymer Slurry Mixed With 2% and 4% Fly Ash:

The specimen is prepared as that of field soil. The drilling fluids taken is 0.06% polymer slurry mixed with 5% silt and 2%and 5% fly ash. The specimen prepared was subjected to normal loads of 0.5kN, 1.0kN and 1.5kN. a graph of normal stress v/s maximum shear stress was plotted for both samples and are shown in Fig. 7 and Fig. 8. From the graphs angle of internal friction was obtained as 32.57˚ and 30.34˚for Soil with Polymer Slurry Mixed With 2% and 4% Fly Ash respectively.

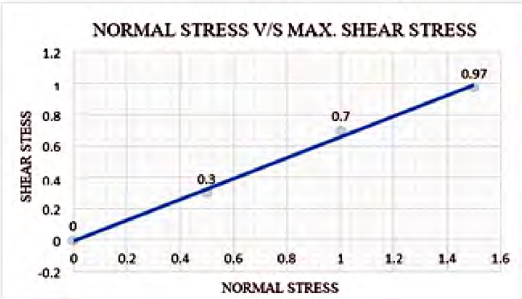

Fig. 7: Normal Stress V/S Max. Shear Stress Graph of Soil with Polymer Slurry Mixed With 2% Fly Ash

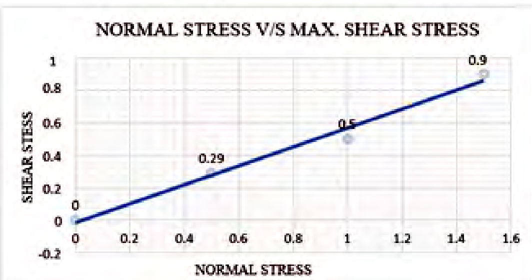

Fig. 8: Normal Stress V/S Max. Shear Stress Graph of Soil with Polymer Slurry Mixed With 4% Fly Ash

d. Standard Proctor Test:

From Direst Shear Test the optimum percentage of fly ash that can be mixed with polymer slurry was obtained as 2%. As fly ash have been used as a stabilizing agent, in order to check whether the 2% fly ash mixed with polymer slurry could stabilize the soil, Standard Proctor Test is conducted by mixing the soil sample with 2% fly ash and 0.06% polymer. A graph was plotted as moisture content v/s dry density of soil and is shown in Fig. 9. The optimum moisture content and maximum dry density were obtained as 12.04% and 1.80 g/cc respectively.

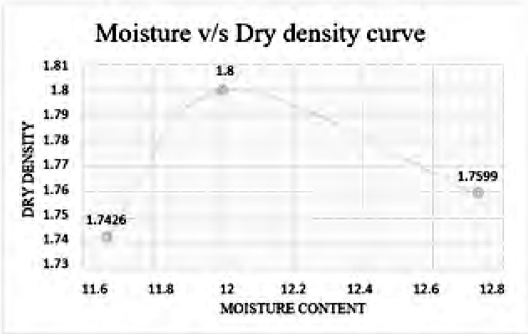

Fig. 9: Moisture v/s dry density curve of soil mixed with 2% fly ash and 0.06% polymer

III. RESULTS AND DISCUSSIONS

a. Initial Properties of Soil

Various test like specific gravity using a pycnometer, moisture content determination using oven drying method, and standard proctor test was conducted to determine the basic properties of initial soil. Table 3 shows the obtained initial properties of soil.

Table 3: Initial properties of soil

PROPERTIES	VALUES
Specific gravity	2.62
Moisture content	12.51 %
Optimum moisture content (OMC)	14.6 %
Maximum dry density (MDD)	1.578 g/cc

b.Incorporation of Fly Ash into Drilling Fluid

From Table 3 it is clear that both density and viscosity values of bentonite slurry increased by the addition of fly ash into the fleshly prepared bentonite slurry. The addition of 2% fly ash into bentonite slurry with 5% silt content resulted in the density to be increased to 1.21 g/cc just after mixing and 1.29 g/cc two hours after mixing. And also, the addition of 4% fly ash into bentonite slurry with 5% silt content resulted in the density to be increased to 1.26 g/cc just after mixing and 1.31 g/cc two hours after mixing. The increased value of density due to the mixing of fly ash into bentonite slurry is much beyond the value limiting value of 1.1 g/cc as recommended by IS 2911: 2010 (Part 5). Hence, we concluded that the incorporation of fly ash into bentonite slurry is not possible.

The addition of 2% fly ash into polymer slurry mixed with 5% silt increased the Marsh cone viscosity to 67.28 seconds just after mixing and decreased to 53.74 seconds two hours after mixing. Also, the addition of 2% fly ash into polymer slurry mixed with 5% silt increased the Marsh cone viscosity to 68.89 seconds just after mixing and decreased to 55.17 seconds two hours after mixing. The addition of 6% fly ash resulted in flock formation and the conduct of Marsh cone viscosity failed. Since the decreased value of viscosity (53.74s and 55.17s) is within the range 50-60 seconds we concluded that the incorporation of fly ash into polymer slurry is possible. But the addition of fly ash should be limited to 4% and added at an increment of 2%.

c. Direct Shear Test on Various Test Samples

The direct shear test was conducted for various combinations of soil and drilling fluids. The angle of internal friction for each was obtained by plotting Normal Stress V/S Max. Shear Stress Graphs. Table 4 shows the results of direct shear tests.

Table 4: Results of direct shear test

Test sample		Angle of internal friction, ϕ
Soil		33.69°
Soil with bentonite slurry		29.57°
Soil with polymer slurry		31.70°
Soil with polymer slurry mixed with fly ash	2%	32.57°
	4%	30.34°

Based on the data presented in Table 4, it is evident that drilling fluid has an impact on reducing the friction of the soil. When using bentonite slurry, the angle of internal friction of the soil decreased to 29.57˚, while with polymer slurry, it reduced to 31.70˚. The reduction in friction is more pronounced when using bentonite slurry.

When 2% fly ash was added to the polymer slurry, the angle of friction increased to 32.57˚. However, with 4% fly ash added to the polymer slurry, the angle of friction decreased to 30.34˚. The experimental study showed that the reduction in angle of friction by using polymer slurry can be reduced by incorporating fly ash with the polymer slurry. But the maximum percentage of fly ash that could be incorporated is 2% because by adding 4% fly ash the angle of friction is reduced to a value that is lower than the angle of friction obtained by using polymer slurry alone. Hence, we concluded that incorporation of fly ash with polymer slurry increases the frictional resistance of soil and the optimum percentage of fly ash that could be incorporated with polymer slurry is 2%.

d. Standard Proctor Test

Since fly ash is conventionally used as a soil stabilizing agent, we conducted a standard proctor test to determine whether 2% fly ash mixed with polymer could stabilize the soil. Table 5 shows the result of a standard proctor test conducted on soil mixed with 2% fly ash and 0.06% polymer.

Table 5: Result of standard proctor test on soil mixed with 2% fly ash and 0.06% polymer

FLY ASH PROPORTION (%)	OMC (%)	MDD (g/cc)
0	14.6	1.578
2	12.04	1.80

From Table 5 it is clear that OMC decreased and MDD increased. The OMC of the initial soil was 14.6% and it decreased to 12.04% with the addition of 2% fly ash and 0.06% polymer. The MDD of the initial soil was 1.278 g/cc and it increased to 1.80 g/cc on the addition of 2% fly ash and 0.06% polymer. The increase in MDD value infers that the soil gets stabilized by 2% fly ash. The OMC of 2% fly ash mixed soil sample was below the natural moisture content of the soil. This infers that the fly ash absorbed about 2.76% of water. This could result in the reduction of water pressure into the borehole, making the borehole more stable and reducing the chances of collapse. But the effect of fly ash on water absorption from the surrounding soil has not been considered and is kept for future study.

IV. CONCLUSION

DMC and hydraulic rig methods of pile construction were executed in association with the 6-lane highway extension work of NH66 which was done under NHAI at Alappuzha. The investigation explores the efficacy of bentonite and polymer for stabilizing the borehole, revealing that a minimal amount of polymer is sufficient compared to bentonite. Furthermore, the use of polymer streamlines the piling process as it eliminates the need to flush the bore before concreting. To assess the impact of drilling fluid on the soil's frictional resistance, a direct shear test is conducted. A layer of bentonite and polymer is applied to a shearing plane, and the test results demonstrate that the drilling fluid reduces the frictional resistance of the soil. Interestingly, the reduction is more pronounced with bentonite than with the polymer The shear test has been performed again by incorporating fly ash with polymer and observed that a 2% of fly ash concentration can reduce the frictional loss, that occurred while using Polymer. SPT was done to find out whether the 2% fly ash could stabilize the soil. The result showed an increase in dry density and a decrease in optimum moisture content. This infers that fly ash could stabilize the soil. Since the decreased OMC is less than the natural moisture content, fly ash could absorb the water and thereby could reduce the water pressure. But the effect of fly ash on water absorption from the surrounding soil has not been considered and is kept for future study

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JOB-FORCASTING : PREDICTING SCOPE OF JOBS

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ABSTRACT

*Day to day changes in technology make it difficult to predict the future of work. Previous studies have predicted the future of work by analyzing job and workforce data or using expert methods, but the process cannot be attributed to new technology. To overcome this problem, this study maps jobs to patents and predicts the future of jobs based on the variation of patents over time. A word embedding model trained on patent classification codes and job descriptions is utilized to identify patent classification codes similar to a given job. This approach is applied to job listings in O*NET, that pertain to information technology (IT). By comparing the patent classification codes of IT jobs, promising job categories with high technical demands can be identified based on changes in the number of patents filed over time. Employed a word embedding model to match patent classification codes with IT-related jobs listed in O*NET. This approach allows us to identify job categories with similar patent classification codes and high technical demands based on changes in the number of patents filed over time*

Keywords—*CPC, EMBEDDING*

I. INTRODUCTION

Advances in technology have led to great changes in the labor market. To manage the business, managers must anticipate the changing position and react early to the new business model. In the past few years, many companies like Google, Microsoft etc. Have created information technologies and employed many experts to support and develop them. After a major change, many companies try to change their current business model and respond quickly and appropriately to the changes.

Other researchers have used approaches like Delphi and structured interview methods which involved subject matter experts and systematically analyzed their opinions. However, since the process is mostly dependent on experts, the estimation results may be affected by the opinions, beliefs and beliefs of the experts. That's why researchers are trying to make more reliable, pragmatic predictions about how the market works.

While financial and operational records do not contain information about the technology, other types of documents (patents) provide important information about how the technology may be modified by future work. Patents include the description and use of technology.

People are trying to get patent registration to secure technology and control rights. Because of this feature, patents are used in technology prediction to determine new technologies and their future. In other words, if researchers can calculate the similarity between projects and patents, they can track and predict changes in specific projects from relevant information.

The proposed method utilizes job descriptions from the Operational Information Network (O*NET) website and patent disclosure classification codes from the Cooperative Patent Classification website (CPC) to create a competition table that matches missing information and patent information better than existing methods. To do this, the annotation from the job descriptions and patent disclosure classification codes are used to train a word embedding model. The embedding vector of the annotation is then extracted to find the number of similar patent distributions for each work.

To ensure clarity, the relevant IT activities are analyzed, and the analysis results are discussed in detail. By doing so, the proposed method can provide a more accurate representation of the job requirements and patent disclosure classification codes, leading to better matching between the two. This, in turn, can improve the effectiveness of the job search process and lead to better patent applications.

Overall, the proposed method represents a significant improvement over existing methods, as it is better able to match missing information and patent information. It achieves this by leveraging the power of word embeddings and analyzing relevant IT activities. As a result, it has the potential to make a significant contribution to the field of patent search and job search. This method not only relies on people's thoughts about the business, but also provides estimates based on changes in patent numbers. This allows people to capture future performance and make reasonable performance estimates

II. RELATED WORKS

A. Patent Classification Using Word Embedding [1]

This paper introduces a new patent classification approach that utilizes word embedding and a long-term memory network to classify patents into IPC subgroup levels. Currently, examiners typically rely on the claims or specifications sections of the patent and their own field knowledge to determine the appropriate classification. However, this approach can be challenging for non-experts to comprehend.

To address this issue, the proposed method trains a classifier using textual data from patent documents to classify patents into IPC categories. Specifically, the study tests the effectiveness of various deep learning techniques, including 4344 word embeddings using Word2Vec and deep neural networks utilizing Long-Short-Term Memory Networks (LSTMs).

By using these techniques, the proposed method aims to improve the accuracy and efficiency of patent classification. This could be particularly beneficial for non-experts who may struggle to understand the current classification system. Overall, the study demonstrates the potential of utilizing deep learning approaches in the field of patent classification

B. Artificial Intelligence on Job-Hopping Forecasting [2]

This paper presents a novel AI technique, Sequential Optimization with Naive Bayes (SONB), that not only predicts but also identifies underlying patterns and automatically estimates missing or unreliable feature values. Specifically, this technique analyzes several key features of job jumping and applies them to predict job jump patterns on highly incomplete employee profiles.

Results from experiments show that SONB accurately estimates missing values and achieves peak performance. Moreover, the accuracy of deep learning improved by 3% when using the new dataset generated by SONB compared to the original data. Overall, this new AI technique can be used for prediction and to estimate missing values in input data.

The proposed method was applied to a large dataset consisting of 20,185,365 employee profiles, successfully predicting employee job change patterns based on their profiles. These predictions can serve as a valuable resource for businesses looking to better understand employee behavior and make informed decisions.

C. In search of a job: Forecasting employment growth using Google Trends [3]

The Google search activity for relevant terms is a reliable predictor of future employment growth in the US, both in the short and long term, for the period spanning 2004-2019. By starting with the initial search term "jobs," a large panel of 172 variables was constructed using Google's algorithms to identify semantically related search queries.

According to recent research, the best Google Trends model has achieved an out-of-sample R2 of up to 29, which is an improvement over benchmarks based on a single search query or a large set of macroeconomic, financial, and sentiment predictors. The model's strong predictability is attributed to the heterogeneity in search terms, which extends to industry-level and state-level employment growth through the use of state-specific search activity.

Overall, the results suggest that the Google search activity for relevant terms can serve as a powerful tool for predicting future employment growth in the US. This approach can help businesses, policymakers, and researchers to better anticipate changes in the job market and make informed decisions.

D. A novel approach to forecast promising technology through patent analysis [4]

Predicting promising technologies is crucial for businesses and countries to effectively manage opportunities, and recent research has shown that patents provide detailed information about technology development. To address this, a new method for predicting promising technologies using patent analysis is proposed.

The proposed method involves three key steps. Firstly, patent documents are gathered and aggregated based on the Cooperative Patent Classification (CPC), which provides a more detailed technology classification system than the International Patent Classification (IPC). Next, the CPC combinations of each technology cluster are examined to define them accurately. Finally, patent parameters such as forward citations, triplet patent families, and independent claims are analysed to determine the potential of each technology cluster.

By utilizing this approach, the proposed method can effectively predict promising technologies by analysing patent data, providing valuable insights for businesses and countries to stay ahead of emerging technologies.

E. Patent classification by fine-tuning BERT language model [5]

This research focuses on optimizing a pre-trained BERT model and using it to rank patents. This method outperforms the state of the art when used on a large dataset of over 2 million patents. Use of CNN techniques with incorporation of words in art. Also, it only focuses on patent claims in patent documents. Following contributions: (1) peak results based on pre-trained BERT models and adjustment of patent classification; (2) USPTO3M, a large dataset at the CPC subclass level, containing SQL statements for future researchers (3) Demonstrate that, contrary to popular belief, patent claims alone are sufficient to obtain advanced results on classification tasks.

The problem with multi-label classification is patent classification. This is difficult because there are potentially large labels; at the small-class level, there could be more than 630. Deep learning has recently achieved state-of-the-art results by pretraining unsupervised language models on large corpora and improving models on downstream tasks.

These pre-training models include BERT (Bidirectional Encoder Representations from Transformers), OpenAI GPT (Generative Pre-Training), ELMo (Embedding's from Language Models), ULMFiT (Universal Language Model with Fine-tuning), and OpenAI GPT -2.

III. METHODS

This study provides a framework for investigating employment opportunities by patent classification codes. To match studies with similar patent CPC numbers, the model uses the properties of the job and the description of the patent CPC numbers, and extracted the vectors from the description. And this vectors are used to calculate similarity identifiers and match job titles to similar patent CPC numbers. After the matching process, the expected position is estimated based on the variation of the patent CPC distribution over time.

A. TRAINING A WORD EMBEDDING MODEL

The study report from the O*NET website and the patent group number from the CPC website to calculate the similarity between the study and the patents. The O∗NET database contains information about 1016 jobs, including job descriptions, knowledge, skills, skills, jobs, skills, tools, and is used to predict future jobs. A patent has many features.

Job specifications and patent materials can be used for training document embedding models. The similarity between each pair of job features and patent components will be calculated as placement vectors.

However, this approach is impractical due to the limitation of computational costs. That's why we decided to explain only the patent classification code, not everything in each patent. In this way, we examined the description of the features of the work and the text structure containing the patent CPC numbers and provided the explanation of the embedding vectors.

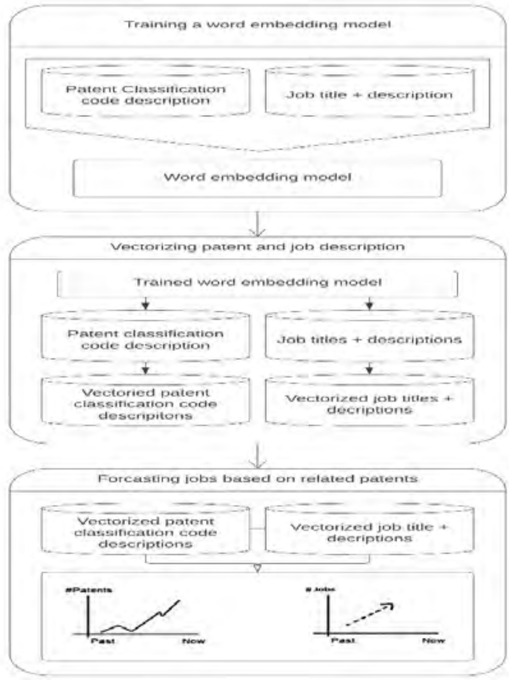

Fig. 1: Flow diagram

B. VALIDATING THE TRAINED MODEL

As the model is trained through unsupervised learning, a separate task is created to assess its performance. O*NET has categorized 1,011 jobs into 28 groups and assigned them names based on the job group. Also the CPC system has a hierarchical structure with numerical classification grouped into 136 categories. To evaluate the model's performance, embedding vectors that define the job attributes and the job representation vectors are extracted for each job. The job representation vectors are then divided into 28 groups and then compared to job groups, from which their job titles and descriptions are derived.

C. MATCHING JOBS AND PATENTS

The cosine similarity between the position representation vector and the patent classification code vector are calculated and found similar patent classification codes for each position. Depending on the depth of the patent distribution numbers included in the comparison (such as whole numbers or specific numbers), different results may be obtained during calculation. Therefore, we examined the similarity between job titles and patent CPC numbers with different levels of patent CPC numbers.

According to the results of the similarity calculation, the works are grouped with similar patent numbers and the future is predicted by looking at the change of the corresponding numbers over time.

IV. RESULT

Data for job attribute descriptions were obtained from the O*NET website, while data for patent classification codes were collected from the CPC website. NLTK library is used to preprocess and clean the patent data, and to perform tasks such as tokenization, stemming, and lemmatization.

Next step is to train a model using the descriptions of job attributes and patent classification codes and extract embedding vectors for the descriptions. Different embedding techniques like, Doc2Vec, Fast Text, SBERT, Sent2Vec, Universal Sentence Encoder and Sentence-T5 were implemented to find the best embedding to represent the data.

KMeans clustering is used to cluster the job and patent embedding vector and calculate the NMI score for each model. Sentence-T5 embedding seems more accurate in the validation phase of job and patent vectors. It gives a NMI score of 0.5041 and 0.4528 for job and patent vectors respectively.

After finding the cosine similarity between job and patents, top 5 CPC for each job is obtained. Patent count for each job from 2013-2022 were obtained from google patents. Changes in the number of patents related to jobs graph is plotted. Natural Sciences Managers are expected to have more future scope according to the study. Investment Fund Managers, Human Resources Managers, Architectural and Engineering Managers and Industrial Production Managers also showed increase in demand.

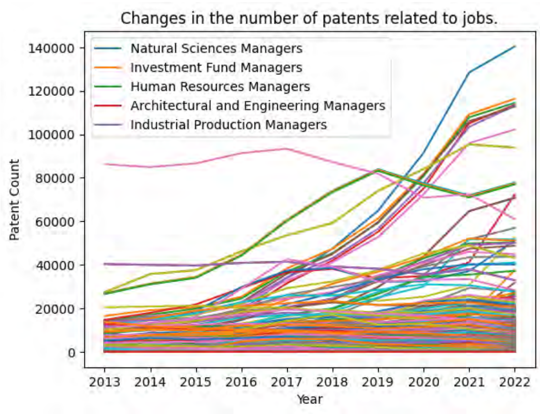

Fig. 2: Changes in the no: of patents related jobs

V. CONCLUSION

This work presents a patent-based method for predicting future performance. We took CPC code definition and job description information to analyze the relationship between patents and jobs and learned a word pattern using this information. The validation results verified that the model accurately mirrored the content in the CPC codes and descriptions of jobs. Jobs are associated with CPC codes and predicting the future of jobs are based on the number of patents in CPC codes. The estimation results show that our method is feasible, but has some limitations.

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DESIGN AND FABRICATION OF MODIFIED SAVONIUS VERTICAL AXIS WIND TURBINE

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ABSTRACT

A vertical axis wind turbine (VAWT) is a type of wind turbine where the main rotor shaft is oriented in a vertical plane, perpendicular to the ground. This arrangement allows the turbine to capture wind from any direction, making it less dependent on the wind direction compared to horizontal axis wind turbines (HAWT). VAWTs have a number of advantages over HAWTs, including a more compact size, a lower profile, and a simpler design with fewer moving parts. However, they are also generally less efficient at converting wind energy into electricity compared to HAWTs, and they are more susceptible to interference from nearby structures. Despite these limitations, VAWTs have gained some popularity in recent years due to their ability to operate in urban and other low wind speed environments. Wind power is a type of renewable energy where we make use of wind velocity as the driving force. There are two types of wind turbines horizontal axis wind turbine and vertical axis wind turbine. Horizontal axis wind turbine is relatively larger than vertical axis wind turbine and it is used in areas where wind velocity is relatively slower. In our project work we design, fabricate, balance and demonstrate a vertical axis wind turbine. We go for two plane rigid rotor balancing in a balancing machine and utilize a cycle dynamo to light a lamp.

Keywords— *Vertical axis wind turbine, Horizontal axis wind turbine, Wind energy*

I. INTRODUCTION

In today's era wind turbines with help of wind energy or wind power is used for the generation of electricity. Wind energy or power being a popular sustainable renewable energy source which has a smaller consequence on the environment than fossil fuel burning. Traditionally, wind energy has been used in sails windmills and windpumps but today it is mostly used to generate electricity. Wind farm consists of many different wind turbines which are sequentially attached to the electric power transmission network. Contemporarily onshore wind farms are low-priced than new coal or gas plants. Expansion of wind power generation is being hindered by fossil fuel subsidies. Onshore wind farms have a greater visual impact on the landscape than some other power stations.

Vertical axis wind turbines (VAWTs) are a type of wind turbine where the main rotor shaft is oriented in a vertical plane, perpendicular to the ground. This design is in contrast to horizontal axis wind turbines (HAWTs), which have a horizontal rotor shaft and are the most common type of wind turbine. VAWTs have been around for many years and have been used for a variety of applications, including pumping water, grinding grain, and generating electricity.

One advantage of VAWTs is that they can capture wind from any direction, making them less dependent on the wind direction compared to HAWTs.

II. LITERATURE SURVEY

A. Aerodynamic design and performance parameters of a lift-type vertical axis wind turbine [1]

For a large-scale offshore floating VAWT, the fixed-pitch straight- bladed configuration (i.e., H-rotor) with integrated tip-speed ratio control is the best design and operational setup. It has been established that controlling the power output at high wind speeds can be accomplished with reliability using the passive stall-regulation of the H-rotor. Optimal values for a variety of VAWT aerodynamic design parameters, such as the blade airfoil geometry, the quantity of struts, and their orientation, have been established. While it is advised that each blade be attached to the struts at its aerodynamic centre and have a toe-out pitch angle of 2°. Depending on the application, the VAWT recommends using two or three blades. In comparison to a three-bladed turbine, a two-bladed turbine is more effective and has a stiffer structural design. As opposed to the two-bladed turbine, the three-turbine has a reduced shaft torque ripple and improved self-starting abilities.

B. Performance improvement of Savonius VAWT using porous deflector [2]

It has been shown that the Savonius turbine with a porous deflector performs better than the normal Savonius turbine with and without a solid deflector. When compared to a solid deflector and a typical Savonius turbine, using a porous deflector allowed the advancing blade to generate a higher positive torque while also reducing the negative torque produced by the returning blade. The right porosity value, location, and deflector height can further enhance the porous deflector's performance. Regarding the flow structure, the stagnation zone was moved closer to the tip of the returning blade by moving the stagnation zone upstream using a porous deflector, which reduced the negative torque. In addition, there were less variations and a greater regularity in the flow structures.

C. Determination of the number of VAWT blades based on power spectrum [3]

The goal of the study was to establish the ideal quantity of blades for a vertical axis wind turbine. On the basis of thrust on the still blade, studies were conducted. For this study, the scientists chose to focus on the intricate phenomena that surround the blades, such as the aerodynamic shadow, turbulence, and other aerodynamic forces. simple (sinusoidal) change of thrust is envisioned, and all wind energy is delivered to the blade. Consequently, Betz's limit might be avoided.

D. Straight-bladed VAWT rotor design guide based on aerodynamic performance and loading analysis [4]

It has been noted that there is no documentation of a thorough design that takes into account all significant elements in the SB-VAWT literature. As a result, in order to determine the appropriate range of various parameters that have already been adjusted, researchers and manufacturers who want to explore a new element of the subject must deal with a lot of data. This work has developed an effective design method for SBVAWTs that can save future researchers a substantial amount of time and money during the initial design stage. Additionally, it may discourage manufacturers from spending money on a design whose parameters are outside of the ideal range. This article includes a design flowchart that explains the design process mentioned here.

III. DESIGN AND FABRICATION

A carousel vertical-axis wind turbine (VAWT) [5] is a type of VAWT that consists of a vertical shaft with blades attached to it, mounted on a horizontal axis that can rotate around a central point. The blades are typically shaped like airfoils and are mounted at an angle, so that the wind pushes against the flat side of the blade and causes the turbine to rotate. The horizontal axis is supported by bearings and is connected to a generator, which converts the mechanical energy of the rotating blades into electrical energy.

One advantage of carousel VAWTs is that they can operate effectively in low-wind conditions. Because the blades are mounted at an angle, they can capture wind from a wide range of directions, rather than just the wind coming directly from the front as with horizontal-axis wind turbines. This makes them well-suited for use in locations where the wind direction can vary significantly.

A. Working of turbine

Wind Capture [6]: As the wind blows, it encounters the blades of the VAWT. The blades are designed to capture the wind's kinetic energy and convert it into rotational motion. The shape, curvature, and angle of the blades are optimized to maximize lift and generate torque.

Rotation: The wind causes the blades to rotate around a vertical axis. The rotor shaft, connected to the blades, also rotates as a result. The rotation can occur regardless of the wind direction, as the vertical axis allows the turbine to capture wind from any angle.

Power Generation [7]: The rotor shaft of the VAWT is connected to a generator. The rotational motion of the shaft spins the generator's rotor, which contains coils of wire and magnets. As the magnets pass by the wire coils, the changing magnetic field induces an electrical current in the coils, generating electricity. The generated electricity can be used immediately or stored for later use.

Control Systems [8]: VAWTs may incorporate control systems to optimize their performance and ensure safe operation. These systems can include mechanisms for starting the turbine at lower wind speeds, adjusting the blade pitch to regulate rotational speed, and governing systems to control the turbine's output in response to varying wind conditions

Transmission and Distribution [9]: The generated electricity from the VAWT is transmitted and distributed through electrical cables to power consumption points. This can include local use, such as powering buildings or charging electric vehicles, or feeding the electricity into a larger power grid for wider distribution.

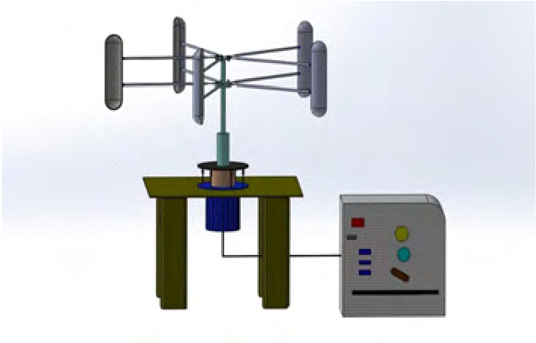

Fig. 1: Components of vertical axis wind turbine

B. Calculation of surface area of the turbine

Considering the specifications of the blade, it is noted that the blade has a cylindrical shape with a height of 650 mm and a radius of 150 mm. Additionally, the blade possesses a dome-shaped structure on both the top and bottom with a radius of 150 mm.

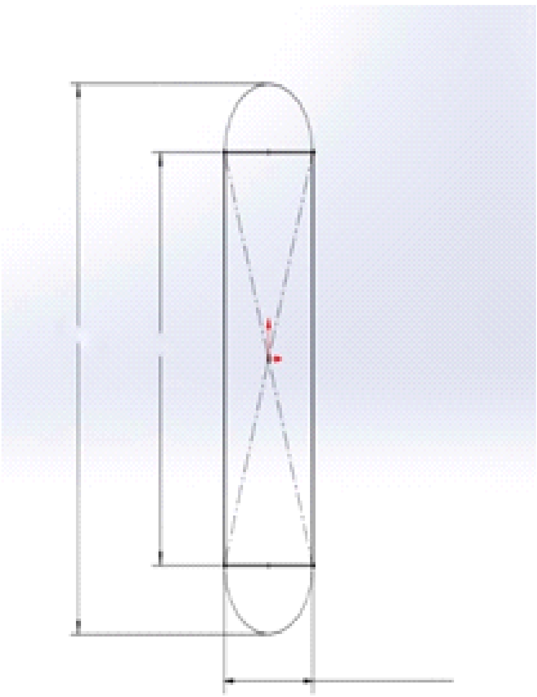

Fig. 2: Dimension of the turbine

Taking into consideration that the thickness of the blade is 2.5mm The formula for the internal surface area of a cylindrical blade:

Surface Area = 0.5($2\pi r^2 + 2\pi rh$) Half the surface area is taken because the selected model has half cylindrical shape

π (pi) is a mathematical constant approximately equal to 3.14159 , r is the radius of the circular base, h is the height of the cylinder.

We can substitute the given values of the height and radius: Surface Area = $0.5(2\pi(147.5)^2 + 2\pi(147.5)(650)$

Surface Area = 0.5(43512.5π + 191750π)

Surface Area = 117631.25 π Surface Area ≈ 670749.67 mm2

For the design we are using ¼ of the sphere on the top and bottom of the blade. So, we are taking half sphere for the calculation. Using the formula for the internal surface area of a sphere:

Surface Area = $2\pi r^2$

Where:π (pi) is a mathematical constant approximately equal to 3.14159, r is the radius of the sphere

We can substitute the given value of the radius:

Surface Area = $2\pi(147.5)^2$

Surface Area = 2π(21756.25)

Surface Area = 43512.5 π

Surface Area ≈ 136698.55 mm2.

Total surface area of a Single blade = 670749.67 mm2 +136698.55 mm2

Total surface area of a Single blade = 0.80744 m2

For our design we are using 5 Blade, So the total surface is being 4.03741 m2

I. Design of motor

Our aim is to generate an electricity of 12v and 2A from a DC motor. So, we are selecting a motor which can generate this much of energy.250W 24V 2750RPM DC Motor is the selected motor for our operation. So, we need to step down the voltage to 12 v and reduce the output wattage.

Specification:

Operating Voltage (VDC)=24

No-Load Current (mA)=1000

Loaded RPM=2600-3000

Efficiency =70%

watt =250w

To step down the voltage from 24V to 12V, we can use a voltage regulator or a DC-DC converter that is designed for this purpose.

LM2596 DC-DC Buck Converter: This is a popular and inexpensive converter that can handle up to 3A of current. It has an adjustable output voltage and includes over-current and over-temperature protection.

To step down the wattage from 250W to 24W, we will need to reduce the load on the motor or use a gear reduction system to decrease the speed and torque of the motor. This will decrease the power output of the motor and allow we to operate it at a lower wattage.

Assuming the efficiency of the motor remains constant at 70%, we can calculate the new operating current required to achieve a power output of 24W as follows:

Power output = Voltage x Current x Efficiency

24W = 12V x Current x 0.70

Current = 24W / (12V x 0.70)

Current = 3.43A

Therefore, we will need to limit the current draw of the motor to approximately 3.43A in order to achieve a power output of 24W at 12V. We need to consider the torque requirements of our application and the specifications of the motor. To find that we first need to find the average velocity of the wind in Kerala.

The breezy part of the yearlong lasts for 5 months, from May 9 to October 7, with average wind speeds of more than 10 miles per hour. The windiest month of the year in Kerala is June, with an average hourly wind speed of 13 miles per hour (5.677408 m/s)

To find the force acting on the blade of a wind turbine, we can use the formula:

F = 0.5 * ρ * A * v^2 * C

where:

F is the force in Newtons (N)

ρ is the density of air (1.225 kg/m^3 at sea level)

A is the area of the blade in square meters

v is the velocity of the wind in meters per second

C is the coefficient of lift (a dimensionless constant that depends on the shape and angle of attack of the blade)

Assuming a coefficient of lift of 1.5 for a typical wind turbine blade, we can plug in the given values to find the force on one blade:

F = 0.5 * 1.225 kg/m^3 * 0.80744 m^2 * (5.677408 m/s)^2 * 1.5

F ≈ 23.911 N

Since there are 5 blades on the wind turbine, the total force on the turbine would be 5 times this amount:

Total force = 5 * 23.911N

Total force ≈ 119.55 N

Therefore, the force acting on the blade of a vertical wind turbine with 5 blades, each blade having an area of 0.80744 square meter and a wind velocity of 5.677408 m/s, is approximately 23.911 N per blade or 119.55 N for all 5 blades.

II. Calculation of torque

To find the torque, we can use the same formula as before:

455 mm is the length of the arm, which is connecting the blade and motor

Torque = force x radius

where force is the force acting on the blade and radius is the distance from the center of the wind turbine to the blade.

Plugging in the given values, we get:

Torque = 23.911N x 0.455 m Torque ≈ 10.87 Nm

Therefore, the torque on the wind turbine with a force of 23.911 N and a radius of 455 mm is approximately 10.87 Nm.

IV. FABRICATION

Fabrication of modified savonious vertical axis wind turbine was done during the month of March and April of 2023.

The fabrication process was divided into various sections:

- Procurement of suitable materials: According to the design and specifications of the turbine, right materials were purchased in order to fabricate the VAWT.
- Fabrication of mould for the blade: The mould of the blades were made using mild steel and cement for the dome
- Fabrication of blades: The blades are made using fiber glass and polyester resin. As shown in Fig. 6.
- Gear assembly: The gear assembly consist of two gears. The main gear consists of 66 teeth while the secondary gear consists of 22 teeth thereby achieving a gear ratio of 0.333.
- Motor selection: The selection of motor depended on 2 factors: The total power of the motor and the rated RPM. A 250 w 2500 RPM motor was selected for the VAWT.

Fig. 3: Mould for the blades

Fig. 4: Moulding using cement

Fig. 5: Finished Blades

Fig. 6: Gear assembly of the turbine

Fig. 7: 250w 2500rpm induction motor

Fig. 8: Finished vertical axis wind turbine

Fig. 9: Top view of the VAWT

V. ADVANTAGES

Advantages of VAWTs:

- They can operate effectively in low-wind conditions, as they can capture wind from a wide range of directions.
- They are relatively simple in design and are relatively easy to manufacture, which can make them a cost-effective option for small-scale power generation.
- They take up less space and are less obtrusive than HAWTs, which can make them a more suitable option for some locations.
- They are less affected by turbulence, as the blades are closer to the ground where the wind is smoother.

Disadvantages of VAWTs:

- They are generally less efficient than HAWTs, so they may not be the best choice for large- scale power generation.
- They can be more expensive to maintain, as the blades are closer to the ground and are more susceptible to damage from debris.
- They can be more prone to structural failure, as the entire turbine rotates and is subjected to more stress than a stationary HAWT.
- They may not be as visually appealing as HAWTs, as they have a more unusual and less familiar appearance.

VI. CONCLUSION

Vertical-axis wind turbines (VAWTs) are a type of wind turbine that has a vertical shaft with blades attached to it, mounted on a horizontal axis that can rotate around a central point. VAWTs have several advantages, including the ability to operate effectively in low-wind conditions, a relatively simple design, and a low profile that makes them less obtrusive than horizontal-axis wind turbines (HAWTs). They are also well-suited for use in locations where the wind direction can vary significantly.

However, VAWTs also have a number of disadvantages. They are generally less efficient than HAWTs, which can limit their usefulness for large-scale power generation. They can also be more expensive to maintain and are more prone to structural failure due to the rotational forces they experience.

Overall, VAWTs can be a useful option for small-scale power generation in some applications, but they may not be the most appropriate choice in all cases. The most suitable type of wind turbine for a particular application will depend on the specific site conditions, power requirements, and available budget.

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