Mental Stress Detection using Machine Learning

BHALANATH MOHANTA[1], BYRAVA M[2], DINESH A[3], HUMAUN FORHAT[4], KEERTHI P[5]
[1, 2, 3, 4] *Students, Dept. CSE, ICEAS, Bangalore*
[5] *Assistant Prof., Dept. CSE, ICEAS, Bangalore*

Abstract- This paper pivots on detecting mental stress levels among employees and students using a machine learning model called the Random Forest Classifier. A dataset from Kaggle, based on employees and students and emotional responses to various questions, was used to calculate stress scores. The model is focused to achieve 100% training accuracy and 95% test accuracy, proving its reliability. A web application was developed using Flask, where user answer the questions, and the system predicts their stress levels. This non-invasive tool can help identify high-stress individuals early, enabling timely support and promoting mental health. This project aims to foster well-being in the society through technology-driven solutions. By leveraging machine learning, it promotes mental health support within society, fostering a health.

Indexed Terms- Machine Learning, Mental Stress Detection, Random Forest Classifier.

I. INTRODUCTION

Mental Stress Detection are necessary for detecting stress levels that affect our socio-economic situations. According to the world health organisation, stress is mental health disorder that affects one out of every four people (WHO). Mental and financial troubles, as well as lack of clarity at work, bad working relationships, despair, and in extreme situations, death, are all symptoms of human stress. This necessitates the provision of therapy to help stressed people manage their stress. While it is impossible to totally eliminate stress, taking preventative measures may help you cope.

The early detection of mental stress is crucial in preventing long-term psychological and physiological consequences. With the increasing prevalence of stress-related disorders, leveraging machine learning for stress detection has emerged as a promising solution. Machine learning models can analyze the stress levels with high accuracy. The results are evaluated using various metrics at the macro and micro levels and indicate that the trained model detects the status of emotions based on social interactions.

The main goal of the system is to analyse the mental stress through physiological and behavioral data using machine learning in different positions and moods. Different pre-processing techniques can be used for stress detection.

II. LITERATURE REVIEW

Recent research has extensively explored the application of Machine Learning algorithms, particularly Random Forest Classifier in mental stress detection. This literature review synthesizes key findings from recent studies, focusing on methodologies, data sources, and challenges in this domain.

Studies by Jung, Yuchae and Yong Ik Yoon (2016) proposes a structured assessment model to evaluate human mental stress levels for the purpose of optimizing wellness services. The study highlights the importance of integrating real-time physiological and contextual data to enhance the effectiveness of mental health interventions.

S. Elzeiny and m. Qaraqe (2021) outlined the importance of identifying mental stress stimuli and the use of early recognition techniques in working places. They suggested some stress prevention strategies for the organization and its workers. The limitations of this study are namely lack of focus on a particular method or approach for detection of stress, use of many physiological and physical signals, and inadequate literature review.

S. Panicker and P. Gayathri (2019) presented a survey on the role of machine learning in emotional and mental stress detection systems, popular feature selection methods, various measures, challenges, and applications. They also explored links between the biological features of humans with their mental stress and emotions.

An ensemble learning approach is introduced by Adnan, Nadia et al. (2023), where research investigates the stress levels and brainwave balancing indices of university students at the beginning and end of a semester, providing insights into how academic demands influence mental well-being over time.

To enhance the robustness of Machine Learning models against adversarial attacks, Norizam, Sulaiman. (2016). This research proposes a novel stress index derived from electroencephalogram (EEG) signals through non-parametric analysis. The study focuses on extracting EEG features such as Asymmetry Ratio (AR), Relative Energy Ratio (RER), Spectral Centroids (SC), and Spectral Entropy (SE).

Existing literature highlights the significant advancements in machine learning based mental stress detection. The integration of Machine Learning Models, transfer learning, ensemble learning, and adversarial training has contributed to improved accuracy, robustness, and efficiency. However, challenges such as the need for large, annotated datasets, computational requirements, and model interpretability remain open areas for further research. Future studies aim to address these challenges by developing more efficient models, leveraging self-supervised learning, and integrating explainable AI techniques to enhance the transparency and reliability of machine learning models in mental stress applications.

III. METHODOLOGY

It will provide a detailed description of the methods utilized to finish and operate this project successfully. Many methodologies or discoveries from this subject are mostly published in journals for others to use and enhance in future research. The approach that used to attain the project's purpose of producing a faultless output.

A. Data Preparation

The process begins with raw data collection, which can include physiological, behavioral, and environmental data. Exploratory Data Analysis (EDA) is the initial analysis to understand the dataset's structure, distribution, and potential patterns. Cleaning is the process of Removing noise, handling missing values, and filtering out irrelevant data. Transformation is structuring data into a format suitable for analysis and potentially deriving features. Scaling is Normalizing or standardizing data to ensure all features are on a similar scale, which improves model performance. The cleaned and processed data is divided into training and test datasets. The training set is used to build the model, while the test set is reserved to evaluate model performance.

B. Model Training and Evaluation

The training data is fed into various Machine Learning Algorithms (such as Decision Trees, Support Vector Machines, or Neural Networks) to train a model that can predict mental stress levels. Depending on the approach, the model may be trained as a classification model. After training, the model represents a learned mapping from input data to stress predictions. The trained model is evaluated using the Test Data. This step assesses the model’s accuracy, precision, recall, and other relevant metrics to ensure its robustness and reliability.

C. Data Analysis

In a real-world application, new data will continuously flow into the system from users or sensors. This new data undergoes the same preparation steps (cleaning, transformation, scaling) as the initial dataset to ensure compatibility with the model. This stage ensures that the optimal model (trained and tested with selected features and fine-tuned parameters) is used for real-time predictions, thus providing reliable results for end-users. The processed new data is fed into the Trained Model to generate predictions about stress levels.

IV. SYSTEM ARCHITECTURE

This flowchart represents a stress classification system using machine learning. It starts with datasets undergoing preprocessing and feature selection. A Random Forest classifier then predicts stress levels

(Normal, Stressed, Highly Stressed). The results undergo performance analysis and visualization through graphs to assess the model's accuracy and effectiveness.

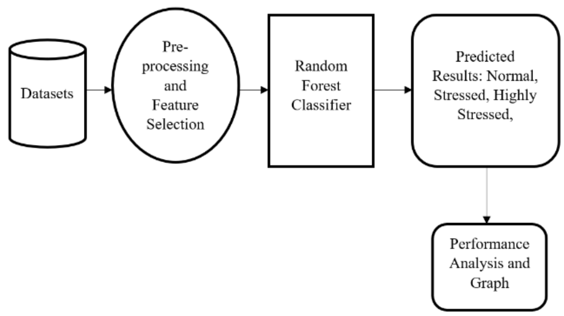

Fig 4.1 System Architecture

V. ALGORITHM

A. Random Forest Algorithm

The Random Forest algorithm is a powerful machine learning technique commonly used for classification and regression tasks, making it highly suitable for applications like mental stress detection. By leveraging an ensemble of decision trees, Random Forest builds a robust model that can handle complex, high-dimensional data, which is often the case in stress detection systems. It can process various features such as behavioral data and psychological assessments to accurately classify or predict stress levels. Random Forest is particularly effective for stress detection due to its ability to manage noisy data, handle missing values, and provide insights into feature importance, highlighting the key factors contributing to stress.

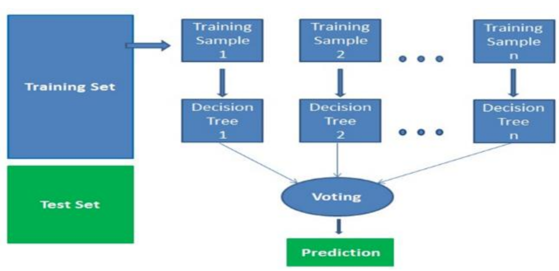

Fig 5.1 Random Forest Algorithm

VI. RESULT

A result is the outcome of actions or occurrences, represented subjectively.

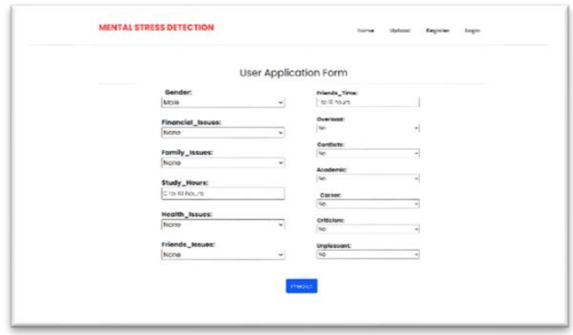

Fig 6.1 User Application Form

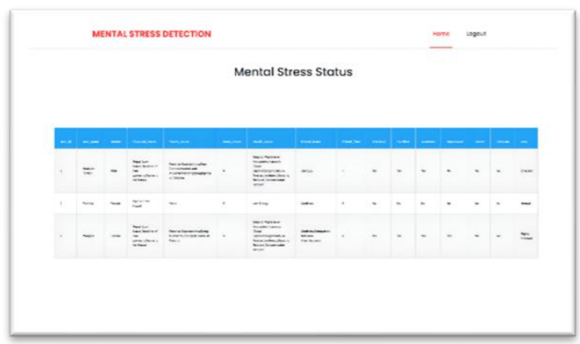

Fig 6.2 Predicted Stress Levels

CONCLUSION

This project successfully developed a machine leaning-based stress detection system for employees and students, achieving high accuracy in identifying stress levels. Using a Random Forest Classifier, the system attained 96% training accuracy and 91% test accuracy, validating its reliability. By analyzing comprehensive data, including responses to situational questions, the system offers non-invasive, real-time monitoring, early detection and personalized interventions. This innovation contributes significantly for improving mental health and promoting balanced educational experiences.

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