

Electroencephalogram-Based Mental Stress Detection

¹Mr. Siddesh K T, ²Soujanya N

¹Assistant Professor, Department of MCA, BIET, Davangere, India

²Student, Department of MCA, BIET, Davangere, India

ABSTRACT

In the present fast-moving world, mental stress has become a rather widespread factor, leading to its widespread impacts on the physical and mental conditions of people. It can be clarified that avoiding physically and psychologically stressful situations is what defines mental stress. mentally. Thus, the development of the identification of mental stress would be the focus of the proposed project. the EEG technology where the calculation and analysis of waves in the brain are carried out in order to identify. the level of mental strain. Thus the technology would be employed in the process of acquiring the EEG headsets. EEG signal that will primarily aid in obtaining the brains electrical signals. Otherwise, it would be expected that the signals would produce Alpha Beta and Theta waves while ignoring noise. as well as Gamma Waves. Otherwise, the assumption would describe the waves as directly influencing the mental degree. There are three different levels of mental stress: low medium and high. This technology would otherwise be assumed to result in a relatively precise and efficient approach to the. obtaining and identifying mental stress with the aid of reasonably accurate and effective results. Otherwise, it would be assumed that the technology would use relatively to produce outputs and results automatically. simpler GUI principles. From now on it would be assumed that the technology would help with tracking the mental state. utilizing the real-time reports and outputs that were obtained. The technology would henceforth provide assistance in the development of the mental health status using the. assistance in making wise and reasonably effective decisions regarding mental stress management.

Keywords: *EEG-based stress detection, Artificial Intelligence, Machine Learning, Neural Networks, Predictive Analytics*

1.INTRODUCTION

The EEG-Based Mental Stress Detection System would be an intelligent system with the capability of detecting a certain level of stress in a human merely by evaluating the electric signals emitted by the human brain. Unlike the prevailing scenario where the modern system for the measurement of stress in the industrial environment involving the stress levels of any human being as measured by questionnaires as well as certain Physiological signals (where the signals are considered as the second level of detection of the signal intensity) this system would involve the use of the EEG signals which are in reality the direct interpretation of the signals emitted by the human neurons as they measure the certain waves of the human brain signals such as Beta Waves thereby confirming the conditioned circumstances of Alertness/Stress and/or the Alpha Waves thereby confirming the circumstances of a certain level of Relaxation. The system also has the capability to process the data collected with the objective of attaining feature extraction; which could

be features of the spectrum. The system also has definitions for stress levels that belong to the user.

The data collected from the EEG process goes for data processing to get rid of any unnecessary noise/signals for example those generated by the blinking of an eye muscle movement and other distracting cues that might be originating from the surrounding environment. Upon data processing data features such as power and frequencies of waves are derived. The stress levels in the user are measured as low moderate and high based on the measurement from the system designed. Given that the stress level measurement system is a real-time system therefore it will aid in continuously monitoring the mental health of the individual. The calculated stress level in this system designed will be presented in the form of a GUI to present an aid in instantaneous feedbacks. The stress level measurement system will also aid in providing some fundamental ways to reduce stress for example by taking deep breaths or short pauses in environments that might have high stress levels. Given an innovation in the EEG signal

processing method in conjunction with artificial intelligence this project will aid in providing an exact unbiased and non-contact approach for the mental health analysis of an individual facing stress conditions. The use of this project might particularly benefit college-studying individuals working individual's doctors as well as patients who might use this in calculating their stress levels to act accordingly upon them. Also with an increase in digital technology and an enhanced concern within the body for mental health awareness in the present digital age the given project has been given prime importance.

II. LITERATURE REVIEW

Stress recognition is becoming a vital subject matter for investigation due to the growing prevalence of stress among humans and its effects on their health and productivity. Conventional approaches to measuring stress include psychological assessment tools, such as the Perceived Stress Scale (PSS) and Depression Anxiety Stress Scale (DASS). These procedures are easy and inexpensive but highly dependent on self-reports. Thus, these tools are subjective and unable to assess real-time stress levels.

To enhance precision, investigators have developed physiological signal-based systems that can evaluate the Heart Rate (HR), Galvanic Skin Response (GSR), and Respiration Rate. Physiological signals are reliable sources of information about stress, since stress has a physical effect on the human body. Nonetheless, these techniques are affected by external stimuli, such as temperature, motion, and noise pollution. In addition, these systems work in an off-line mode and do not analyze brain activity directly.

Thanks to the developments in neurology and artificial intelligence, there is a growing interest in using the EEG system for stress detection. Electroencephalogram (EEG) signals record brain electrical activities, which help in understanding the mental state of an individual. The EEG signal consists of different types of brain waves like Alpha, Beta, Theta, Delta, and Gamma waves. Alpha waves are indicative of a relaxed state, while Beta waves represent stress and concentration.

Recent advancements in EEG-based systems involve the preprocessing of EEG signals for eliminating any noise due to eye blinks and muscle movements. The significant attributes such as frequency, amplitude, and power spectral density are obtained from EEG signals, followed by the application of machine learning

algorithms like SVM, KNN, and ANN to classify the level of stress into low, medium, and high.

III. EXISTING SYSTEM

Current stress measurement systems use subjective evaluation processes in the majority of cases. As an example, there are two well-known tools - Perceived Stress Scale (PSS) and Depression Anxiety Stress Scale (DASS). Individuals should answer questions related to emotional experiences, and stress is measured according to their answers. This process is easy to conduct; nevertheless, it is highly subjective. Results are determined based on personal awareness and ability to be honest, and the method itself does not help to measure current stress. In order to make this process more objective, physiological signal-based measurement appeared.

The main difference between the two methods is that physiological signals are used to measure stress. There are some physiological indicators that change when people experience stress. They include heart rate, galvanic skin response (GSR), respiration rate, and so on. In this case, signals are captured by different sensors, which are placed on individuals' bodies. Despite all benefits, this process also has some drawbacks. For example, physiological indicators can be affected by external factors, including temperature, physical activities, and so on. Moreover, in many cases data analysis happens offline, which means that real-time monitoring is impossible.

IV. PROPOSED SYSTEM

The design for the EEG-Based Mental Stress Detection System focuses on detecting the amount of stress that a person undergoes in terms of brain activities. The use of EEG signals is necessary since EEG signals capture brain activities or electrical activities in the human brain. The design is such that the EEG signal sensor can be worn in the form of a headset on the head.

This proposed system will be able to detect various brain activities through the different types of brain waves. These brain waves include alpha waves, beta waves, theta waves, delta waves, and gamma waves. Alpha waves dominate during relaxed situations while beta waves dominate in stressful conditions.

The first step of the system design involves collecting the EEG signals of the users of the system. During the process of collection, any disturbance in the EEG

signals needs to be eliminated, for instance, eye blinks. In the next step, the EEG signal features are extracted.

After feature extraction of the EEG signals, the analysis stage comes up. The machine learning algorithm utilizes the stress-related brainwave data in its training process, hence making it able to categorize and determine the stress level at different degrees. As observed from the analysis, the level of stress is correctly classified.

The correctly classified stress level is then displayed to the individual through a graphical user interface, such as a computer screen, and thus, a quick determination of their mental status is achieved. In case of a high stress level detected by the system, instructions on how to manage the stress are provided. This involves prompting the person to perform activities like breathing deeply.

This system has some considerable benefits over other conventional means of measuring stress, such as surveys and heart rate monitoring. In this case, there is a quick and accurate result that does not need human intervention. The approach is also non-invasive, and hence, the individual will not be uncomfortable during the process.

System Architecture

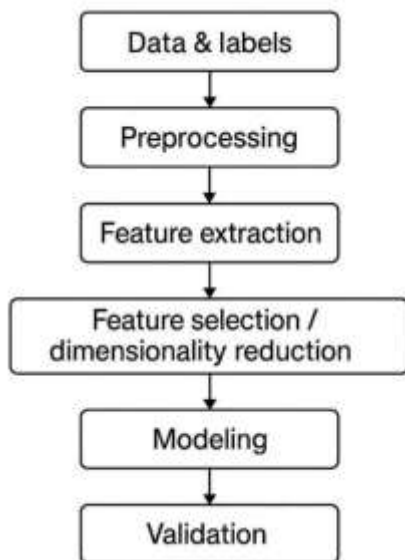


Fig 1. System Architecture

V. METHODOLOGY

MODULES DESCRIPTION:

EEG-Based Mental Stress Detection System is based on a methodology that will help to detect and classify the levels of mental stress effectively. The whole system can be divided into several stages, which include signal

acquisition, preprocessing, feature extraction, classification, and result display.

Firstly, signal acquisition should be mentioned. In this case, the EEG headset is worn by a person and it measures the brain waves. There are several types of brain waves, including Alpha, Beta, Theta, Delta, and Gamma waves. The signals acquired by the EEG headset measure the current state of mind of an individual. For instance, high-levels of beta wave activity correspond to mental stress and concentration; however, alpha waves demonstrate relaxation of a human being.

Secondly, signal preprocessing needs to be mentioned since the obtained EEG signals have some noises generated due to eye blinking, muscle movements, head movements, or any other electrical interference. Thus, it is necessary to filter out noises in order to improve the quality of the received signal.

Thirdly, the extracted features should be identified. Some important parameters of the brain waves, such as frequency, amplitude, and power spectral density (PSD), can be highlighted as significant features.

The process is then followed by stress classification based on the features obtained. Feature values are fed into a machine learning algorithm. SVM, KNN, and ANN are some of the machine learning techniques used to classify stress levels from low to medium to high. Labelled EEG datasets are employed during training.

Lastly, there is the result display and feedback stage where the detected stress level is displayed using a graphical user interface. Colour codes and graphs are used to show the stress levels. When a person exhibits a high stress level, recommendations such as deep breathing and relaxation exercises are provided. The data may also be saved for future reference.

In conclusion, it is clear that the methodology proposed herein will ensure that stress is accurately detected in real time using an EEG machine-learning approach.

VI. RESULT



Figure: (Analytics Dashboard)

In this segment, you will find the analytics outcome based on the uploaded EEG dataset. These are summarized into key indicators like average stress level, highest point of stress, time taken for measurement, and frequency band of brainwaves (e.g., Alpha – Relaxed). Moreover, stress levels can be viewed on a timeline via a line graph, while a color-coded chart reflects stress levels of low, moderate, and high intensity.

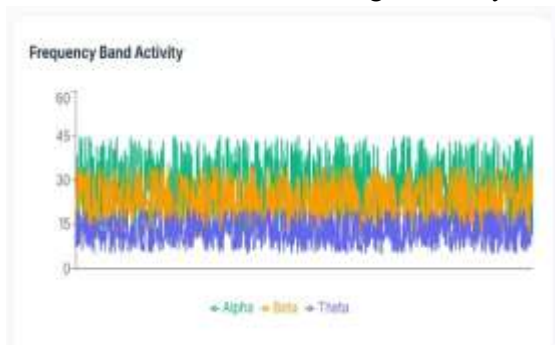


Figure: This figure depicts how the activity within the Alpha, Beta, and Theta frequency bands in an EEG varies with time. This diagram shows the modifications made by the brain waves to indicate different mind states.

The performance of the EEG-Based Mental Stress Detection System has been evaluated by implementing and testing the system to find how well it performs in identifying the various degrees of mental stress. The system was able to record the brain waves effectively from the user through the use of a non-invasive headset.

While testing the system, it was able to recognize brain wave patterns like Alpha and Beta waves and used them to determine the status of the mind. Increased beta waves signified higher stress levels, whereas increased alpha waves indicated relaxation. The results of the classification were displayed on the graphical user interface in an understandable manner.

Real-time output was produced by the system within a matter of seconds after the brain waves were recorded. If high stress levels were detected, the appropriate suggestions like "Take deep breaths" or "Relax for a few minutes" were given. Visual representation was done in order to display the stress level easily.

VII. CONCLUSION

Therefore, the EEG-based mental stress detection system has been successfully developed. First, the system works using various functions that include classification of stress levels and the presentation of results. This has been achieved by the fact that all these functions have their importance in relation to the main objective of the design which is accuracy in results. In this case, the stress level of the individual will be categorized into low medium and high. The results will be presented in a very. Moreover, the proposed system will guide the individual in relaxation if the results indicate a certain stress level. The system is more accurate, non-invasive and immediate than the previous approaches used in mental stress detections due to the fact that the system can measure the brain signal accurately. Finally, the EEG-based mental stress detection system has been successful in mental stress detections. This has been possible due to advances in technology especially concerning the sensor as well as the algorithm.

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