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Human Stress Detection - A Review

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ABSTRACT:

Stress has become increasingly prevalent in modern life, affecting both the physical and mental well-being of individuals. To prevent any negative consequences, it is essential to have a thorough understanding of human stress levels. The project aims to develop an algorithm that can detect stress in humans and reduce stress among workers using machine learning algorithms. Our approach focuses heavily on stress management, creating a work environment that is free from stress for employees and helping them alleviate tension while they are at work. The main goal of this research is to create a reliable stress detection system that can offer valuable insights into individuals' stress levels, allowing for timely interventions and promoting better mental health.

Keywords: Machine Learning,Text Processing,Stress Detection.

1. Introduction

Stress is the specific strain experienced by the human body due to various stimuli. When the body is under stress, it releases stress hormones. There are different types of stressors, including absolute, physiological, relative stressors, and psychological stressors. Stress not only impacts your attitude, relationships, energy levels, and performance, but it can also contribute to or worsen various medical conditions. Therefore, sleep plays a crucial role in maintaining human homeostasis. Sleep disturbances are associated with several physical, mental, and social issues. This research paper examines a few such systems and derives insights from the analysis.

The research conducted by Ahmad Rauf Subhani, Likun Xia, Aamir Saeed Malik, and Zahirruddin Othman in their paper titled "Quantification of physiological disparities and task performance in stress and control conditions"[1] focused on examining the impact of mental stress on brain activity and heart rate in ten healthy individuals. The participants were required to perform arithmetic tasks in both stress-inducing and control environments. Amir Muaremi, Agon Bexheti, Franz Gravenhorst, Bert Arnrich Gerhard Troster, in their study titled "Monitoring the impact of stress on sleep patterns of pilgrims using wearable sensors"[2], aimed to gain insights into how stress affects the sleep patterns of pilgrims and identify relevant parameters for stress detection. The system proposed by Victor Corcoba Magaria and Mario Munoz Organero in their paper titled "Reducing stress on habitual journey"[3] aims to provide real-time feedback to drivers based on their driving style, fatigue level, and road conditions. The paper emphasizes the correlation between driving speed and the likelihood of traffic accidents, highlighting the necessity for intelligent speed adaptation systems.

In the research paper titled "Realtime stress detection system based on EEG signals" by Vanitha V and Krishnan P [4], a methodology for real-time stress detection in students using Electroencephalography (EEG) is presented. The authors propose the use of EEG, a non-invasive procedure that can provide feedback related to stress hormones, making it a suitable tool for measuring stress levels. Ahmad Rauf Subhani, Wajid Mumtaz, Mohammed Naufal Bin, Midal Kamel, and Aamir Saeed Malik discuss in their paper "Machine learning framework for the detection of mental stress at multiple levels" [5] the development of a machine learning framework for objectively identifying levels of stress based on EEG signal analysis. The main focus of this research paper is to explore the relationship between mental stress and EEG signals. B.Padmaja, V V Ramaprasad, and K V N Sunitha present an effective method for detecting cognitive stress levels using a wireless physical activity tracker device developed by FITBIT in their paper "A machine learning approach for stress detection using a wireless physical activity tracker" [6]. In the paper by U. Srinivasulu Reddy titled "Machine learning techniques for stress prediction in working employees" [7], the application of machine learning techniques to analyze stress patterns in working adults, particularly those in the IT industry, is discussed. The study applies various machine learning techniques after cleaning and preprocessing the data, with Boosting achieving the highest accuracy among the models tested. Marife A Rosales, Argel Bandala, Ryan Rhay Vicerra, and Elmer P Dadios present the development of an intelligent system for classifying whether a person is stressed or not using physiological parameters and machine learning algorithms in their paper "Physiological based smart stress detection using machine learning algorithm" [8].

The paper titled "Role of machine learning in human stress: A review" by Faijan Akthar, Jian Pingli, Parth K Patel, and Rishipal [9] presents a system that explores the significance of stress in today's world and emphasizes the utilization of machine learning techniques for studying and managing stress. The research involved various steps such as data collection from the Web of Science database, network visualization, article evaluation, and drawing conclusions.

On the other hand, the document authored by Elias Kougianos, Anand K Bapatta, and Lavanya Raachakonda [10] introduces the concept of the "Smart-Yoga Pillow" (SaYoPillow), which is an innovative edge device aimed at understanding the correlation between stress and sleep while promoting "SmartSleeping." SaYoPillow incorporates an edge processor to analyze physiological changes during sleep and sleeping habits, enabling the prediction of stress levels for the subsequent day.

2. Abbreviations And Acronyms

KNN-K Nearest Neighbour, GSM-Global System for Mobile communication,IDE- Integrated Development Environment,UI-User Interface

3. Methodologies

The system proposed by Ahmad Rauf Subhani et al. [1] examined how mental stress affects brain activity and heart rate in ten healthy subjects. Participants performed arithmetic tasks in both stress and control environments. Electroencephalogram (EEG) and electrocardiogram (ECG) signals were recorded simultaneously. Stress led to increased brain activity, indicated by higher theta/alpha ratio (theta Fz/alpha Pz) in the EEG, and faster heart rates (tachycardia). The study suggests a strong connection between mental stress, brain activity, and autonomic activation of the heart.

The method used by Amir Muaremi et al. [2] This study aimed to understand how stress affects pilgrims' sleep and identify relevant parameters for stress detection. Collected data from 10 participants who wore wearable devices during the 2013 Hajj pilgrimage.and used various biophysiological measures and physical parameters, including ECG/HRV, respiration, body temperature, GSR data, and upper body posture sensors and accelerometers, to build and evaluate classification models for stress detection.

The proposed system by Victor Corcoba Magaria et al. [3] The paper highlights the relationship between driving speed and the likelihood of traffic accidents, emphasizing the need for intelligent speed adaptation systems.This paper proposes an algorithm for estimating optimal driving speeds to reduce stress and improve fuel efficiency. The algorithm utilizes Particle Swarm Optimization (PSO) and a Multilayer Perceptron (MLP) as components.

The paper proposed by to Vanitha et al. [4] introduces This research work presents a methodology for real-time stress detection in students using Electroencephalography (EEG). The authors proposed using EEG, a non-invasive procedure that can provide feedback related to stress hormones, making it a suitable tool for stress measurement. They conducted experiments on six healthy subjects, recording EEG data while subjects solved mathematical questions with time limits. They assessed stress levels using the National Aeronautics and Space Administration Task Load Index (NASA-TLX) rating scale.

The method introduced by Wajid Mumtaz et al. [5] the main focus of the paper is to develop a machine learning framework for objectively identifying levels of stress based on EEG signal analysis. This research paper that discusses the relationship between mental stress and EEG (Electroencephalogram) signals. The proposed methodology involves extracting five features from EEG signals: absolute power, relative power, coherence, amplitude asymmetry, and phase lag. Machine learning techniques are used for feature selection and classification. Three classifiers are applied: logistic regression, support vector machine, and naïve Bayes.

The study by to B.Padmaja et al. [6] provides an effective method for the detection of cognitive stress levels using data provided from a physical activity tracker device developed by FITBIT. The main motive of this system was to use a machine learning approach in stress detection using sensor technology.Individually, the effect of each stressor was evaluated using logistic regression and then a combined model was built and assessed using variants of ordinal logistic regression models including logit, probit, and complementary log-log.

The system proposed by U. Srinivasulu Reddy et al. [7], used data from the OSMI mental health survey in 2017 to train machine learning models and determine the factors that strongly influence stress levels. The study applied various machine learning techniques after cleaning and preprocessing the data.Among the models tested, Boosting achieved the highest accuracy. Decision Trees were used to identify the key factors influencing stress levels, which were found to be gender, family history, and the availability of health benefits in the workplace.

In the accident detection system proposed by Argel Bandala et al. [8] The study used data from 300 participants and five features: heart rate, systolic blood pressure, diastolic blood pressure, galvanic skin response, and gender. In this study, a dataset was collected from 300 participants, both male and female, aged 18 to 25. The dataset includes five features: heart rate, systolic blood pressure, diastolic blood pressure, galvanic skin response, and gender. Using machine learning algorithms such as Logistic Regression (LR), K-Nearest Neighbor (KNN), and Support Vector Machine (SVM), an intelligent system was developed for classification. Python with scikit-learn libraries was used for this purpose.

In the system proposed by Faijan Akthar et al. [9], the study involved steps like data collection from the Web of Science database, network visualization, article evaluation, and drawing conclusions.. The study involved steps like data collection from the Web of Science database, network visualization, article evaluation, and drawing conclusions..The paper identified Support Vector Machine (SVM) as an effective tool for classifying stress signals.It also suggested that emerging techniques like unsupervised machine learning, deep learning methods, quantum techniques, and blockchain technology could be valuable for diagnosing and predicting stress with high accuracy.

In the model by Elias Kougianos et al. [10] focused to control and monitor of stress, to prevent the harmful consequences in future. We obtained that SVM would be helpful in the detection and prediction of stress disorder. In addition, several emerging techniques such as unsupervised machine learning,

deep learning methods, quantum techniques, and block chain technology can be of great importance to diagnose, and predict the stress with high accuracysensors and accelerometers on the body and arms..

4. Overview

Stress, which is caused by demanding or unavoidable circumstances, can have a significant impact on one's mental and emotional state. In order to achieve the most accurate results, we utilize Machine Learning classification algorithms at the classification level after preprocessing the data. Understanding human stress levels is crucial in order to prevent any negative occurrences in life. Sleep disturbances can lead to various physical, mental, and social problems, making sleep an essential component in maintaining human homeostasis. The main objective of this study is to explore how machine learning algorithms, based on sleep-related behaviors, working conditions, and food habits, can detect human stress. Therefore, understanding and monitoring stress levels play a vital role in promoting overall health and improving quality of life. Additionally, this model can be used to detect stress levels by incorporating individuals' sleeping habits as independent variables. By analyzing the stress level results, appropriate measures can be taken to address the individual's needs. Furthermore, the use of Machine Learning classification algorithms at the classification level, after data preprocessing, allows us to compare and obtain the most accurate results. The body's stress systems are crucial in adapting to a constantly changing and stressful environment. Therefore, it is important to understand how sleep behaviors, working conditions, and food habits impact daily life. Additionally, seeking advice from healthcare professionals can provide valuable tips on reducing stress.

5. History of Human Stress Detection

In the early 2000s, researchers began exploring the potential of using machine learning techniques to detect stress in humans. This included studies using physiological signals such as heart rate variability (HRV), electrocardiogram (ECG), electromyogram (EMG), skin conductance, and more. Researchers also started exploring multimodal approaches, combining data from different sensors (e.g., wearable devices, smartphones) to improve the accuracy of stress detection systems.

Throughout the 2010s, researchers focused on extracting relevant features from physiological signals to train machine learning models. These features could include measures of heart rate variability, frequency domain features, time domain features, and statistical measures derived from physiological signals. Researchers also started exploring multimodal approaches, combining data from different sensors (e.g., wearable devices, smartphones) to improve the accuracy of stress detection systems. Despite advancements, challenges remain in accurately detecting stress using ML. These include variability in individual responses to stress, the need for large and diverse datasets, issues related to data privacy and security, and the generalizability of models across different populations.

Researchers also started exploring multimodal approaches, combining data from different sensors (e.g., wearable devices, smartphones) to improve the accuracy of stress detection systems. There has been a growing interest in real-time stress detection systems, especially for applications like mental health monitoring, workplace stress management, and personalized healthcare. Recent advancements in deep learning, particularly in the fields of natural language processing (NLP) and computer vision, have led to novel approaches for stress detection. For example, sentiment analysis of text data from social media platforms or voice-based stress detection from speech signals. ML-based stress detection systems have applications in various fields including healthcare, human-computer interaction, wearable technology, and mental health monitoring.

Overall, while the history of using ML for human stress detection is relatively short, advancements in sensor technology, machine learning algorithms, and data analysis techniques continue to drive progress in this field, with the potential to significantly impact healthcare and well-being.

6. Comparison of Works

The human stress detection systems are to be given due importance since these systems are capable of saving a large number of lives. A proper review of the technology done once in a while will help to improve the quality of the newly developed models. The major factors to be considered in these systems are cost effectiveness,adapatability, response time, key features, scalability, etc. So, these factors in the considered methodologies are reviewed.

Each time when going through a particular system we find that chances for false alarms are high

Table 1 : Comparison of Works

Sl. No.	**Paper**	**Components Used**	**Key Features**	**Drawbacks**
1	Quantification of physiological disparities and task performance in stress and control conditions	EEG and ECG signal converter, MIST,fMRI	• High Temporal Resolution • Direct Measure of Brainactivity	• Exclusion of ECG Variability • Small sample

2	Monitoring the impact of stress on sleep patterns of pilgrims using wearable sensors	chest belt sensor and a wristband sensor	• Early Detection. • Real time Monitoring. • Non-invasiveness	• There is a possibility for sensor errors • Detection of changes in all sleep positions is limited
3	Reducing stress on habitual journey	Heart rate chest strap,GPS,FITBIT Charge HR	. Avoid commercial accidents	. The sensors and other devices not affordable for all
4	Realtime stress detection system based on EEG signals	Wireless EEG device,electrodes,Emotive Epoch head set,MATLAB 8.4 HHT	. Objective Assesmant	• Dependence on continuous internet connectivity for • real -time monitoring It may not capture real time stressors
5	Machine learning framework for the detection of mental stress at multiple levels	MIST,HPA axis,E-Prime software,MA	. High temporal resolution	. Lack of robustness
6	A machine learning approach for stress detection using a wireless physical activity tracker	FITBIT device,PSS score,smartphone sensors	. Wearable and portable easily More adaptable	• Hardware Dependency • Lack of adaptability and continuous learning
7	Machine learning techniques for stress prediction in working employees	Processor intel core,E-prime software	• Real time monitoring • Less adaptable.	• Requires. Requires cellular network for SMS alerts to work. • Limited sample.
8	Physiological based smart stress detection using machine learning algorithm	GSR sensor,blood pressure sensor,heart rate sensor,MATLAB software,python IDE Sci-kit learn	• No restriction in data and scalable • Easy to implement	• Requires extensive hardware installation. • Prone to errors from sensors.
9	Role of machine learning in human stress: A review	Wireless EEG device,electrodes,Emotive Epoch head set,MATLAB 8.4	. Low cost and easily accessible	• Easily Adaptable • More secure
10	SaYoPillow: Blockchain integrated privacy assured IOMT framework for stress management considering sleeping habits	Iot-Internet of things,smart home hub,healthcare cyberphysical system(H-CPS),EEG sensors	• The system is hardware • dependent so easy to implement can be carried to any places More secured data and highly reliable	• The system is hardware • dependenr so there is not affordable and limited availability of components The system may not capture long term effects

7. Need for the Review

Reviewing the various systems will help in developing better and efficient systems. Also, this will help in bringing creative ideas to enhance these systems. The following areas are enhanced when review are periodically conducted on the topic:

- Enhancing Data Security
- Identifying Technological Trends
- Improving System Effectiveness
- Informing Policy and Regulation
- Facilitating Research and Development
- Encouraging Industry Collaboration
- Improving Real time efficiency
- Enhancing User Adapatability

8. Conclusion

To summarize, the proposed system offers an innovative and sophisticated approach to stress detection, surpassing the limitations of the current system. Its development contributes to the field of stress management and has the potential to positively impact human well-being and overall health. In the future, we plan to enhance the accuracy of the results by multiplying the data and employing ensemble learning, which combines all six algorithms. Expanding our dataset and utilizing these algorithms will further boost the accuracy of the system. Understanding human stress levels is crucial in order to prevent unnecessary problems, as stress varies based on different criteria. This study aims to detect how human stress changes based on sleeping habits and highlights the benefits of using a model to identify stress levels and their connection to sleep. Analyzing sleeping patterns allows for the assessment of sleep quality, duration, and disturbances, which are closely linked to stress levels. Machine learning models can identify patterns indicative of stress-related sleep disturbances, providing insights for targeted interventions to improve sleep hygiene and overall well-being. Additionally, diet plays a significant role in modulating stress levels through its impact on physiological processes and neurotransmitter regulation. Machine learning algorithms can analyze dietary habits and nutritional intake to identify correlations with stress levels, enabling personalized dietary recommendations tailored to mitigate stress. Furthermore, working hours and occupational stress are closely intertwined, with long hours and high-pressure environments contributing to elevated stress levels. Machine learning models can analyze work schedules, task demands, and job-related stressors to identify patterns associated with stress. This information can inform workplace interventions and organizational policies aimed at promoting employee well-being and reducing stress-related risks.

Despite the obstacles faced, the ongoing progress in ML techniques, along with the incorporation of physiological data sources, presents a significant opportunity to enhance our comprehension of stress, enhance stress management approaches, and ultimately foster improved health and well-being for individuals in diverse settings.

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