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An Automatic Stress Analysis and Emotion Detection Framework for Humans Based on Several Brain Signals

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Abstract

In common parlance, stress is the feeling people get when they have a lot on their plates and are having trouble keeping up with everything. Although some degree of stress might be useful in the short term, chronic stress has serious negative effects on health, including increased risk of cardiovascular problems such heart disease, high blood pressure, and stroke. Depression, anxiety, and personality disorders are also possible outcomes. Hence, stress detection is helpful for managing stress-related health problems. Perceptual, behavioural, and physiological reactions all provide useful indicators of stress levels. Based on feature extraction and classification methods, numerous researchers have presented a wide variety of methods. Some of these methods are difficult to implement and produce unreliable outcomes when applied to the study of human stress.

Patient denial, insensitivity, subjective biases, and inaccuracy are only some of the issues that arise from relying solely on doctor-patient interaction and scale analysis when diagnosing Stress. To better predict clinical results, a computerised, objective system is needed for Stress diagnosis and treatment. In an effort to better detect Stress, this research modifies EEG data and use machine learning algorithms. Ten participants' EEGs were recorded using a Narosky system while they were exposed to various emotional face cues. Psychologists relied on the EEG signal as a diagnostic tool for Stress. Both machine learning and deep learning were used to analyse the features. Using PCA, ICA, and EMD for BCI applications yields significant results. With SVM, a programmer can reap many benefits: PCA has great generalisation properties, and it can detect tension and pressure from EEG signals. The effect of overtraining is particularly vulnerable to the curse-of-dimensionality when the signals are negative. By analysing EEG waves, we were able to detect Stress with these benefits. The experimental study provides a somewhat comprehensive summary of the various methods, all of which rely on frequency domain analysis of 14 EEG data.

Keywords: Human Stress, EEG signal, Feature extraction, BCI.

1. Introduction

In psychological science, stress is an type of emotion which consist of strain and pressure. A little stress is useful and even healthy. The excessiveness of stress can cause various health related issues like high blood pressure, cardiovascular disease, heart attack and stroke. It also impacts on mental health such as anxiety, depression, and personality disorders. There are different ways to measure stress through psychological, physiological, emotional, and physical activity. Stress recognition through Electroencephalogram (EEG) signal analysis is one effective medical diagnostic tool in the physiological measurement. The central organ of the body is the brain and it is made up of billions of interconnected neurons that relate the brain activity to the physiological actions which are calculated by Electroencephalogram (EEG). In the field of neuroscience, EEG has been used to examine the regulations and methods of human emotions for decades. The review of existing work concludes that, the implementation of brain-computer interaction systems requires more expert knowledge of BCI field. The EEG signal analysis is performed using the ratio of EEG power spectrum and average value of spectral centroid are selected as features for K-nearest neighbor classifier. Zhai et al. (2005) has investigated physiological signal for stress detection and shows the enhancement for Human Computer Interactions. Rahnuma et al. (2011)have described the relationship of brain signals with emotion detection model by classifying the human emotions. The subjects that participated in emotion detection process were shown in audio and video emotions stimuli by utilizing the international affective pictures and system (IAPS)[3]. N. Zaini et. al (2014) have used kernel density estimation (KDE) technique to extract the features from the signals and multi-layer perceptron (MLP) is used for classification. The emotions are categorized into 'sad,' 'fear,' 'happy' and 'calm.' for stress detection. A lot of researchers have used several machine learning and deep learning techniques for EEG signal analysis and discovered the features for emotion classifications. EEG signals are used to identify human stress level by monitoring neural functions with the help of different feature extraction and classification algorithms.

1.1 Motivation

Currently, stress is affecting all kinds of people, regardless of their age, gender and way of living, as understudies need to contend in their investigations while the grown-ups need to battle in playing out the best in their employments. The vast majority are experiencing a few mental sicknesses, for example, sadness and tension. Self-destructive endeavors, and passings, are the regular result of being caught in an unpleasant situation as shown in figure 1.11. World Health Organization (WHO) have reported that 16 out of 100,000 people in the world committed suicide every day due to stress. Hence there is a need to effectively recognize stress. Stress is a type of emotion which consists of strain and pressure. The state of depression is better understood with the help of brain signal with various human emotions. Stress recognition is done by analyzing human emotions in different states of mind. It also helps us to interact with computers, peripherals, or other electronic devices by using our thoughts. Emotion recognition with accuracy will form the base for future BCI application such as illness analysis (medicine), human conduct (psychology), mental confusion (neuroscience) and humanism.

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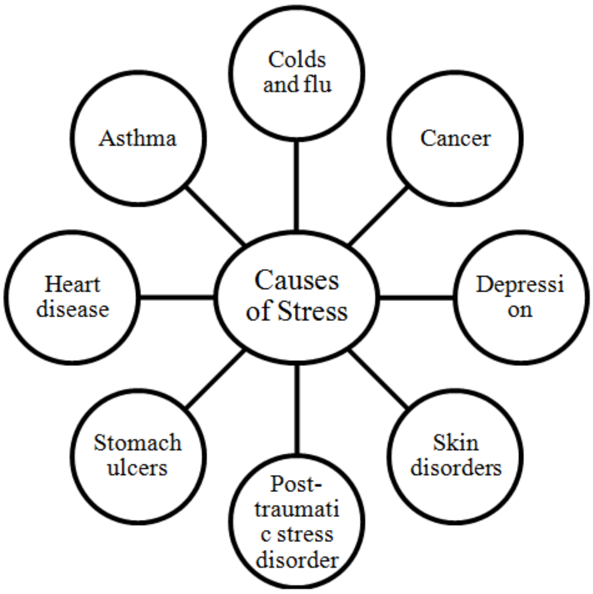

Fig.1 Causes of stress on health

1.2 Problem statement

Based on the existing work, it is clear that feature extraction has a significant role to play in the process of human stress recognition in any BCI applications. Most of the methods have used multiple EEG channels and bands for signal processing due to which the computational complexity is increased. No one has claimed about the suitable channels and bands for stress recognition. Specifically in the field on brain-computer interface, fully automated real-time stress recognition has not been implemented yet. Most of the feature extraction methods has used statistical property and spectral property features for classification rather than cepstral coefficient property features. Hence, an attempt is made to automate the process of feature extraction and classification which would be further process for emotion detection and stress recognition. Therefore, an automated framework is designed and implemented for human stress recognition based on different feature extraction and classification techniques of emotion detection. Also EEG signal analysis serves as various purposes of making individual's life healthy through emotion detection, stress recognition.

1.4 Objectives

This research work pertains to the following specific research objectives:

- To identify and implement suitable EEG channels and bands for feature extraction and classification algorithms on Benchmark DEAP (Dataset of Emotion Analysis for Physiological signals)
- To investigate and propose novel feature extraction algorithms for human stress recognition

- To implement an automated stress recognition system using Neurosky single channel device
- Implement the automatic notification system, if stress cross threshold value sends automatic notification so can take preventive action
- Performance analysis of proposed System

2. Related Work

There is a substantial research on the classification of emotions from human brain activity, in large part due to studies conducted by several researchers around the globe. Their extensive work has discovered the ways of EEG signal processing using different feature extraction and classification techniques. The majority of published works include a plethora of machine learning algorithms directed toward analyzing speech signals, face images and EEG signals. While these previous studies offer valuable insight in marking the predominant factors governing the human stress, it presents only partial solutions to the contemporary human stress framework. This chapter highlights the preeminent contribution of researchers in the modern era from the perspective of Electroencephalography signal processing tool as well as illuminating the associated methodologies.

Figure 2.1 shows the number of responses from each country. In each of the countrywide stress estimated, there was significant variation between countries workplace stress faced by the people. These results indicate that controlling for demographics, perceived job conditions, and job dissatisfaction does not explain all of the variation between countries in perceived risk of occupational stress. Figure 2.1 shows the estimated the number of stress symptoms for each regression model between countries, and the rank of each country on these estimates. From the perspective of Indian continent, a significant proportion of the working people are plagued with different forms of stress.

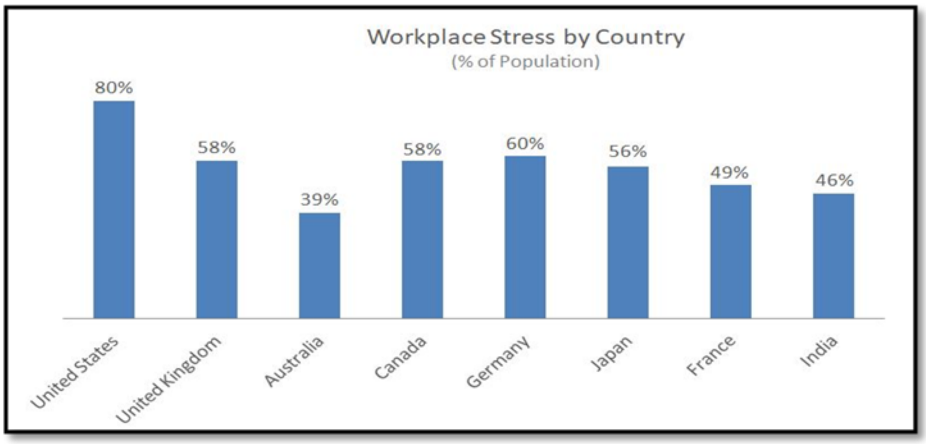

Figure : Motivational Graph for Approach Selection

Several intriguing and worrisome factors emerge from this study, which shows almost 80% of people suffering from stress related to the work. The almost 60% of the workers abandon due to the job relevant stress. More than 90% of employees exercise their option of enrollment to the corporate stress management programs.

In general, the objective of using EEG methodology is to employ a single-channel stress detection mechanism to lead the successful formulation of an efficient approach. Traditional stress detection methodologies result in inconsistent outcomes obtained at a high cost of constituent devices. EEG methodology incorporates an automated system to identify the human emotional pattern. Some of the significant research happened in the last two decades towards the stress identification and its methods are outlined in the following sections.

2.1 Identify And Implement Suitable Eeg Channels And Bands For Feature Extraction And Classification Algorithms On Benchmark Deap

Currently stress is affecting all kind of people, regardless of their age, gender and way of life. Many persons are experiencing a few mental illnesses, for example, melancholy and nervousness due to high stress, self-destructive endeavors and passings, are the regular result being caught in a distressing situation ceaselessly. World Health Organization (WHO) announced that 16 out of 100,000 individuals in world ended their life consistently due to stress. The Monitoring brain exercises with brain computer interfacing (BCI) innovations are of current and new curiosity to because of enormous potential for different medicinal applications & their stressful life. It is essential to perceive and counteract stressful episodes that can happen during working time. Long period results of negative pressure can be considered as barrier in making sound and proficient workplaces. Current and new technical enhancements in the design of wearable wireless sensor hubs, has took into consideration nonstop following of various physiological signals that includes, electroencephalogram (EEG), electrocardiogram (ECG), electrodermal activity (EDA), skin temperature (ST), electromyogram (EMG), and many more. Compare to other techniques, EEG is most preferable. The main reason behind introducing these scenarios in human's life is to understand their feelings. Stress is regularly characterized as the body's response to an apparent mental, enthusiastic or physical pain. This definition may give off an impression of being round, however there are critical ideas contained in it [1].

Table 1: Brain physiological signals monitoring techniques

Technologies	Underlying physical activity	Electrode placement	Key advantage	Key disadvantage
EEG (electroencephalogram)	Synchronous neuronal Activities (potential)	Scalp contact (usually cap)	Non-invasive, portability	Non-invasive, portability
MEG (electromyogram)	Synchronous Neuronal activities	Remote (eg. helmet)	Non-invasive	Non-portability

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MRI (Magnetic resonance imaging)	Increased blood flow at cortical lobes	Remote (eg. helmet)	Non-invasive, non-contact	Non-portability, temporal resolution
ECoG (electrocardiogram)	Local field potential	Intracranial, cortical surface	Signal quality, spatial and temporal resolution	Surgery requirement, highly invasive

Hence, there is need for human stress recognition system through the EEG signal analysis, feature extraction and classification is popular process in these days. Considering the present scenarios of stress recognition system, it is understood that the methods are focus on signal acquisition, pre-processing and feature extraction. The existing researcher have used multiple EEG channels and bands for EEG signal processing which increases the complexity of signal processing due to which still classification accuracy is not able to get as per requirements.

In order to overcome and address these issues, it is preferred to design a common framework that is completely automated to carry out the EEG signal analysis, feature extraction and classification process. The brain activity measurement or signal acquisition phase captures the brain signals using EEG sensor. After signal acquisition phase, signals need to be pre-processed. Pre-processing aims to simplify subsequent processing operations, improving signal quality without losing significant information. In this step, the recorded signals are processed to clean and remove noisy data such as eye blinks artefacts, heartbeat artefacts, and muscular movements in order to get the relevant information embedded in the signals. The feature extraction phase identifies discriminative information in the recorded brain signals, stress detection and there is a need to have the scope of new techniques which will improve the classification accuracy. This is needed to identify the suitable channels and bands for stress recognition.

3. Investigate And Propose Novel Feature Extraction Algorithms For Human Stress Recognition

The EEG signal is most broadly utilized signals in biomedicine field because of its rich info about human jobs. EEG catches electrical activity in region of recording electrodes. Doctors and researchers utilize EEGs to distinguish and portray brain action, for example, rest states, stress level, feeling of anxiety, potential seizures, or levels of a trance like state. In practical applications of pattern recognition, there are often diverse features extracted from raw data which needs recognizing. The features are described in different measurements such as spectral property, statistical property, and Band frequency cepstral coefficient property. The above three EEG signal property plays a vital role in feature extractions. The proposed coefficient feature extraction method gives the influential features for stress recognition. This process is used to transform the raw EEG signal into more informative signature of signal. It gives the extract information from the data, serves the need of follow-up modeling procedure, achieve the intended emotion detection objectives of the system. This chapter 4 elaborated the procedure of feature extraction and discussed the feature selection method in which the essential features for emotion detection are identified. The existing feature extraction algorithms consist of high dimensional data, which is problematic for classification algorithms due to high computational cost and memory usage. The dimensionality reduction is made with two techniques, which are band frequency Cepstral coefficient and energy logistic coefficient feature extraction and feature selection. This chapter focuses on feature extraction, also known as feature transformation algorithm and influential feature selection for stress recognition.

3.1 Implement An Automated Stress Recognition System With Autonofication Using Neurosky Single Channel Device & Its Performance Analysis

The Stress is one of the serious issues in our everyday life, and numerous individuals experience the ill effects of it. High remaining task at hand and time weight will build the anxiety. Stress is the subsequent business related medical issue in Europe, and 51% of European specialists admit that stress is normal in their working environment. A few scientists have dissected human stress utilizing essential emotion. To distinguish human emotion and stress recognition Electroencephalogram (EEG) assumes a significant job, and it turned into the most loved for subjective and neuroscience examine. This section shows the plan of the structure for Analysis of Electroencephalogram (EEG) for human stress recognition. Human emotion detection and stress recognition investigation has huge job in field of psychiatry, restorative field and brain computer interface applications.(Zhai et al. 2005) Jing Jhang et al. EEG sign contains immense data about the patient's psychological wellness and in this manner wind up being an incredible decision for assessing the emotion of anxiety of any person. It took focal points of spatial, frequency and asymmetry attributes of EEG signals.

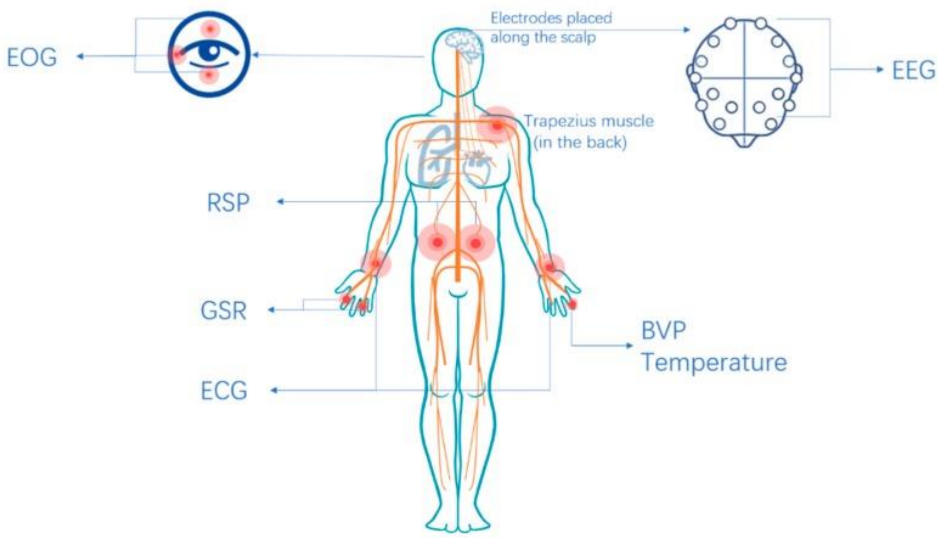

Figure: Position of the biosensors

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Existing researchers have used as Blood Volume Pulse (BVP), Galvanic Skin Response (GSR), facial expression, speech signals and Electrocardiography (EKG) to monitor the emotional state of the subject. The reliability of these systems is not up the mark to indicate the emotional state of person. Thus the limitations of the existing systems are observed to be as follows:

4. CONCLUSION

This research work is an effort to design a human emotion recognition system using EEG signals which is user independent. To find optimal and efficient features for human emotion recognition following feature extraction techniques have been proposed in this research work. This is the initial research to utilize the EEG signal data and its geometrical elements to differentiate between regular and depressed participants.This is the initial research to examine and compare the presentation of optimization techniques designed to reduce feature vector ranges to categorize normal and depressed EEG data. We discovered that the SVM classifiers are superior to other feature choice techniques and classifiers when reducing feature vector displays and detecting sadness accurately. We have examined the presence of the suggested outline with 9 healthy and 9 depressed patients. The suggested technique yielded a classification ACC of 98 percent in categorizing regular and depressed EEG signals.

We presented a precise and healthy computer-assisted screening approach for Stress in other confrontations. The suggested outline obtains substantial MCC values of 0.95 and 0.98 for categorizing standard and depressive EEG indications for the left and right hemispheres, respectively, demonstrating the efficacy of binary classification.

Due to the ease of the RPS matrix and feature removal computation and the small amount of feature vector displays, the suggested outline preprocessed, processed, and classified any participation test indication with different samples in around 0.03 seconds.

References

1. Marcel Trotzek , Sven Koitka , and Christoph M. Friedrich, “Utilizing Neural Networks and Linguistic Metadata for Early Detection of Stress Indications in Text Sequences”, IEEE TRANSACTIONS ON KNOWLEDGE AND DATA ENGINEERING, VOL. 32, NO. 3, MARCH 2020.
2. Systems, C., “ EEG-Based stress detection system using human emotions”, (2018), 10,2360–2370.
3. Thi, T., Pham, D., Kim, S., Lu, Y., Jung, S., Won, C., “Facial Action Units-Based Image Retrieval for Facial Expression Recognition”, IEEE Access, 7, 5200–5207.https://doi.org/10.1109/ACCESS.2018.2889852 , (2019).
4. N.d. ,“shocking statistics of workplace stress you never knew - harish saras.” accessed february 1, 2019. Https://www.harishsaras.com/stress-management/shocking-statistics-of-workplace-stress/.
5. Viegas, carla, and roymaxion , “towards independent stress detection: a dependent model using facial action units.” 2018 international conference on content-based multimedia

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ISSN: 0103-944X
Volume 11 Issue 1, 2023
pp: 899 - 907

indexing (cbmi), 1–6.

6. Woo, seong-woo, “classification of stress and non-stress condition using functional near-infrared spectroscopy.” 2018 18th international conference on control, automation and systems (iccas), no. Iccas: 1147–51.
7. Wan-Young Chung, Teak-Wei Chong, and Boon-Giin Lee ,” METHODS TO DETECT AND REDUCE DRIVER STRESS: A REVIEW,” International Journal of Automotive Technology, Vol. 20, No. 5, pp. 1051-1063 (2019) DOI 10.1007/s12239-019-0099-3.
8. “Shocking Statistics of Workplace Stress You Never Knew - Harish Saras.” n.d. Accessed February 1, 2019. https://www.harishsaras.com/stress-management/shocking-statistics-of-workplace-stress/.
9. M. Tarun Kumar, R. Sandeep Kumar, K. Praveen Kumar, S. Prasanna, G. Shiva,” Health Monitoring and Stress Detection System,” an International Research Journal of Engineering and Technology (IRJET) Volume: 06 Issue: 03 | Mar 2019.
10. Luis G. Hernández , Oscar Martinez Mozos, José M. Ferrández and Javier M. Antelis,” EEG-Based Detection of Braking Intention Under Different Car Driving Conditions,” Frontiers in Neuroinformatics, vol. 12, May 2018.
11. Khalid masood and mohammed a. Alghamdi,” modeling mental Stress Using a Deep Learning Framework,” IEEE Access Vol.7 , 2019.