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"Recognition of Stress using Face Image and Facial Landmarks"

M Shalini[1], Thanmai V[2], Vidhya[3], Vishnu C Gudimani[4], Mrs Chandini M S[5]

Final Year B.E, Department of CSE, Ballari Institute of Technology and Management, Ballari, India[1]

Final Year B.E, Department of CSE, Ballari Institute of Technology and Management, Ballari, India[2]

Final Year B.E, Department of CSE, Ballari Institute of Technology and Management, Ballari, India[3]

Final Year B.E, Department of CSE, Ballari Institute of Technology and Management, Ballari, India[4]

Assistant Professor, Department of CSE, Ballari Institute of Technology and Management, Ballari, India[5]

Abstract: Machine learning is an application of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed. By using this machine learning technique, we have implemented a project that detects stress in students of age 12 to 25. Recently, as modern people suffer from extreme levels of stress, a system is being developed to recognize whether a user is under stress and to give feedback in a direction of reducing stress when under stress.

Keywords: Stress level, ECG, Mental Stress, Neurological Signals.

I. INTRODUCTION

Growing technological facilities lead to increased level of stress in humans which is unavoidable one. Mostly stress occurs due to increased work pressure which might occur in any form. The higher level of stress happening on humans would cause serious effects such as give up self-control due to feelings like frustration or helpless. It occurs due to increased stress level which affects the pace of life. There is various analysis have been conducted by various researchers to find the main source of stress. Many scientists conclude that the human brain is the main source of increased stress level. Thus, the stress level can be easily recognized by processing the brain signals based on variation. Many research works focused on capturing EEG signals to detect and analyze the stress level of humans.

Human stress is mainly categorized into two types. Those are "Acute and chronic". Here acute stress is found to be short term stress which is frequently found in the humans. Chronic stress is the long-term stress which occurs during increased frustration. Here acute stress is found in more humans than chronic stress. However chronic stress is the more serious threat which might affect the normal living of humans. It would be hard for the humans from get relieving from the chronic stress. Electroencephalograph (EEG) signal plays an important role in more researches which can be utilized to detect the human stress level and relaxation state. EEG signals are captured from the central nervous system by using some electrodes.

EEG measures the human brain activity by measuring the electrical activity happening on the human brain from cerebral cortex. These activities are mainly generated by the neurons of brain which would vary based on human emotions. Capturing these EEG signals is complex in nature which can be done by using two methods. Those are invasive and non-invasive. The nerve cells activities happening on the brain can be captured by fixing the electrodes on scalp surface, thus the accurate recording can be ensured. This process is both cost effective and free of side effects. From these signals stress level can be identified. There are three processes performed on EEG signals to predict the stress level. Those are: Pre-processing, feature extraction and classification. In the pre-processing stage, unwanted noises present the captured EEG signals would be removed by using various filters. After pre-processing features extraction would be done to reflect the characteristics or behaviour of EEG signals. Finally these features are classified in order to predict the stress level. The overall view of the processed happening on the EEG signal processing is shown in the figure 1.

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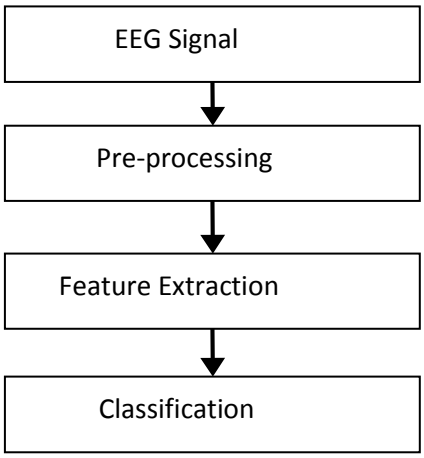

Figure. 1 Stress Analysis

In this research method, initially EOG artifacts present in the raw EEG signals are filtered out, thus the classification error can be reduced. After noise reduction, time domain features are extracted from the EEG signals thus the classification accuracy can be increased considerably. Finally stress level classification using time domain features are done by using Artificial Neural Network approach. This proposed method ensures the accurate classification outcome which leads to efficient human life saving. If high stress, next mantras are listened or chanted and statistical examination is conversed, in the course of the performance analysis. The overall organization of the research method is given as follows. In this section, general introduction about the stress level and their effects on humans is given. In section 2, various related research methodologies that attempts to perform the stress level analysis has been given. In section 3, proposed research method has been discussed in detailed with suitable examples and explanation. In section 4, experimental evaluation of the proposed research techniques has been given in detail with suitable example and explanation. Finally in section 5, overall conclusion of the research method is given based on simulation outcome obtained.

II. RELATED WORK

Previous work on stress measurement has been focused on the collection and analysis of physiological data and the identification of the correlation between perceived stress and multiple physiological features.

Qianli Xu, Tin Lay Nwe, and Cuntai Guan (2015), Proposes a novel Cluster-Based Analysis method to measure stress using physiological signals, which accounts for intersubject differences. This research uses the clustering process that assigns the subject into subgroups, so as to exploit the inherent homogeneity of subject's stress response within the cluster. Thus, the intersubject differences are automatically accommodated, and the overall accuracy of stress evaluation is improved.

Chee-Keong Alfred Lim and Wai Chong Chia (2015), Focuses on evaluating to what extent a single electrode EEG headset – NeuroSky MindWave is able to classify brainwave in terms of subject's stressor level. In this study they use the MATLAB environment for processing the EEG signals. By reducing the number of electrodes needed, it also means cheaper EEG headset can be used to diagnose various mental disorders.

Tong Chen, Peter Yuen, Mark Richardson, Guangyuan Liu, and Zhishun She (2014), Present a method to detect psychological stress in a non-contact manner using a human physiological response. In this paper they use a Hyper Spectral Imaging (HSI) camera to obtain tissue oxygen saturation (StO2) data as a feature for detecting human stress.

Cornelia Setz, Bert Arnrich, Johannes Schumm, Roberto La Marca, Gerhard Tr¨oster, and Ulrike Ehlert (2010), Developed a personal health system for detecting the stress. They use the discriminative power of electro dermal activity (EDA). This EDA power is use for distinguishing stress from office work load. They do the analysis on EDA data and evaluate the information about stress level of a person.

Awanis Romli, Arnidcha Peri Cha (2009), Suggested a system which deals with stress management. They change the manual system into computerized one. This system does the stress management for particular individual based on their

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activity interest and provides a solution for stress management. This system using combination of rule based technique and Holland's Self Directed Search Model to determine the best solution for managing the stress. This system use Rule-Based technique. In this technique user is given a test to develop the system's knowledge-based. From this test system can determine the user's interest, behavior and through their thinking, the system gives the best solution to manage user's stress according to their interest.

Jennifer A. Healey and Rosalind W. Picard (2005), Shows how physiological data is useful during real-world driving task to determine a driver's relative stress level. In this study they show how physiological sensor can be used to obtain electrical signals that can be processed automatically by an on-board computer to give dynamic indications of a driver's natural state under natural driving conditions. The experiment was design to monitor the driver's physiological reaction during real-world driving situation under normal condition.

2.1 Existing System

Existing system proposes a novel cluster-based analysis method to measure perceived stress using physiological signals, which accounts for the inter subject differences. The system contains three stages Data Gathering, Data Pre-processing and Data Classification. Data is collected by using wireless sensor. Wireless sensor was used to collect a subject's physiological signals. Data pre-processing discover the useful information. This is responsible for collecting raw data and converting it into information useful for decision making by users. It does the feature extraction on data means redundancy in the dataset is reduced by this process. In Data classification mode feature extracted data are used to classified subjects into different classes.

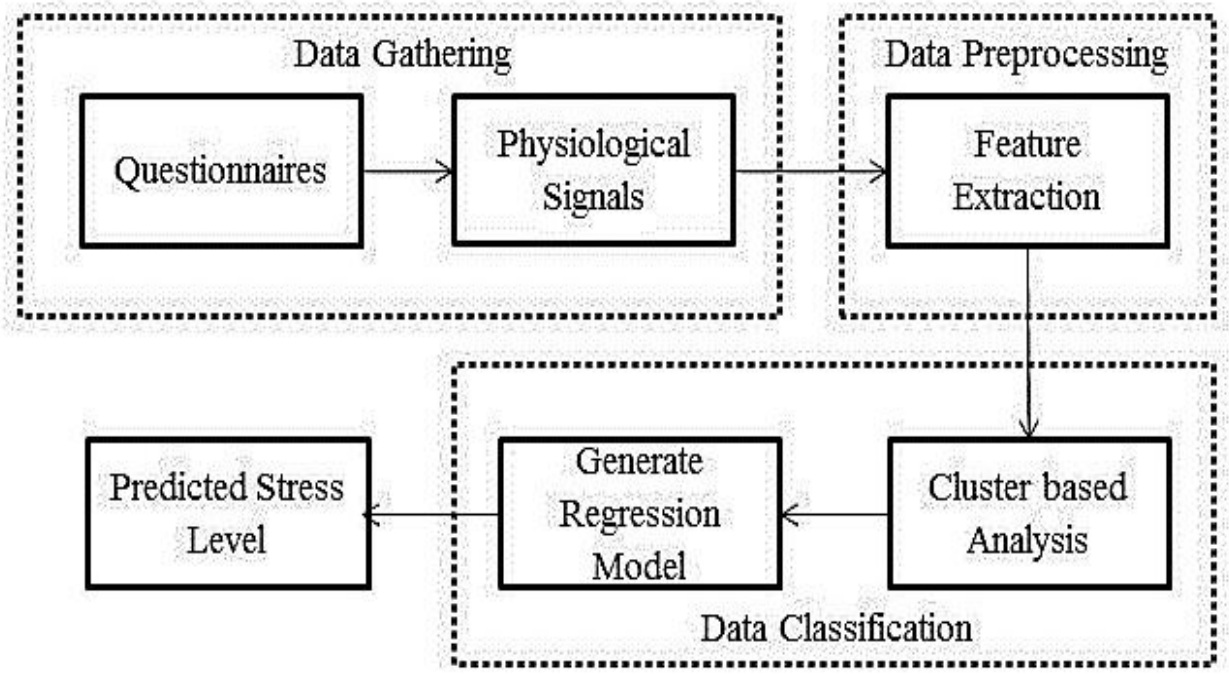

Figure. 2: Architecture of Existing System

2.2 Limitations of the Existing System

There are various researches are going on human stress detection and estimation of stress. For detecting human stress various methods is use such as EEG (Electroencephalography), EMG (Electromyography), GSR (Galvanic Skin Response), BVP (Blood Volume Pulses), BP (Blood Pressure), ST (Skin Temperature) etc. Some researchers estimate the stress by using various classification methods but not implement the reduction technique yet. There are studies which also done on stress management. They change the manual system into computerized one. This system does the stress management for particular individual based on their activity interest and provides a solution for stress management. From this test system can determine the user's interest, behavior and through their thinking, the system gives the best solution to manage user's stress according to their interest. But these studies are also time consuming to manage the stress. From the survey it has been seen that, none of the proposal provide a method for human stress reduction using technology. Till now work is done on detecting the stress and evaluating it Also some works are done on identifying the

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stress level. But only few studies have been done on stress management. However, it makes the process complex and time consuming. Therefore to control the health related issues generate from stress, stress reduction technique is important in relation to technology. It would be beneficial to propose a method for developing products for human stress reduction.

III. PROPOSED SYSTEM

Proposed system design and develop a method that analyze the stress level effectively and also tackle the inter subject difference of human stress and provide techniques for reducing the stress among individuals for improving their performance in work. Fig -2 shows the architecture of proposed system.

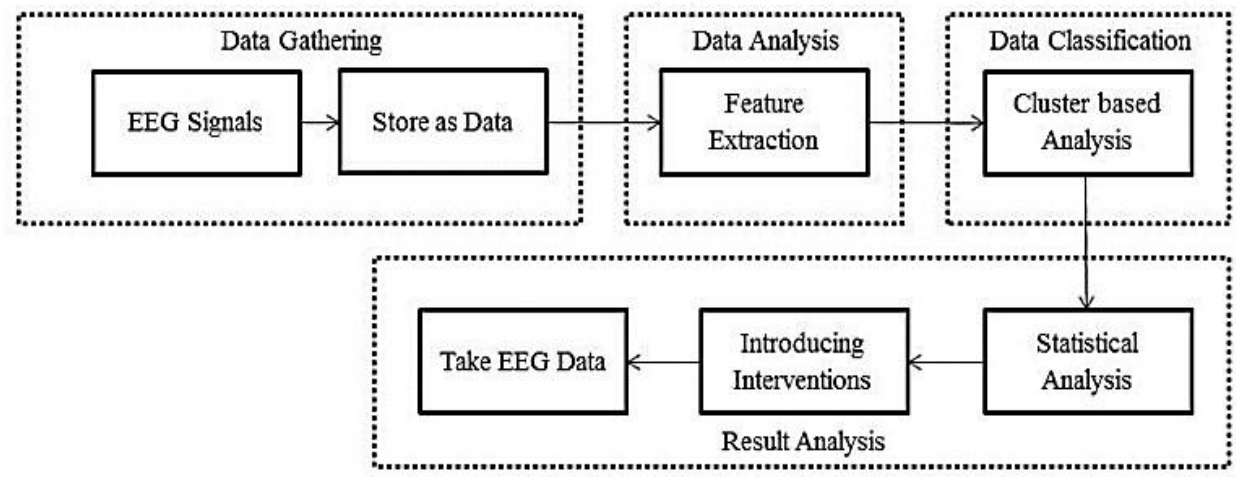

Figure. 3: Architecture of Proposed System

In the proposed approach, the goal is to reduce the human stress after detecting the stress by using the EEG signals. The objective of this research is to accurately estimate the human stress and diagnose the human stress level. The estimation of stress can be done by analysing the EEG features and the human stress level i.e. stress or relaxed mode is shown by using clustering process [1]. The k-means clustering will be used for dividing the subjects into subgroups for predicting the human stress level [1]. The aim is to reduce stress by introducing the interventions into the system if stress level of human is high and do the statistical analysis for checking that stress level is reduced or not. In the proposed approach, a method will be implemented to reduce the human stress, so that they can efficiently improve his/her performance in the work.

Stress reduction is an objective of proposed approach. To achieve this objective steps used in this study are describe below.

1. Get the test data for checking the stress.
2. Do the data pre-processing on collected data.
3. Classifying data using clustered based analysis method.
4. If stress is high then introducing the intervention into the system.
5. Perform statistical analysis on data for getting the results.

IV. PROPOSED WORK

4.1 Data Collection:

Data Collection module contains the data related to patients. This patient data contains Name of patient, doctor's name who gives the treatment to that particular patient, age of patient, gender, admit date of patient etc. This information will be stored into the database for further processing. Also data collection module stores the patient's EEG data which will be useful for detecting the stress and analyzing it. The EEG data will be collected from lab study by involving subjects. Eight channel EEG is used here for collecting the brain signals. Once the signals are collected by using EEG, then stored that signals into dataset. EEG can track brain changes during different phases of life without disturbing a patient. Eight channel EEG is adopted in our study for collecting the brain signals. EEG is used to capture the brain signal in order to

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detect the stress and analyse it. Through EEG monitoring, individual's stress level can be detected and quantified in an efficient manner. Once the signals are collected by using EEG, then stored that signals into dataset.

4.2 Data Analysis:
Analysis of data is a process of inspecting, cleaning, transforming, and modeling data with the goal of discovering useful information, suggesting conclusions, and supporting decision making. Analysis refers to breaking a whole into its separate components for individual examination. Data analysis is a process for obtaining raw data and converting it into information useful for decision making by users. Data is collected and analyzed to answer questions. This module will be responsible for analyze the data for discovering useful information. For analysis phase, there are two sub phases

a) Stress Indices and
b) Feature Extraction.

EEG is an electronic record of the oscillations in the human brain, recorded from multiple electrodes attached to the scalp. Depending on the individual's state of relaxation, EEG can vary in shapes. In healthy adults, the amplitudes and frequencies of such signals change from one state of a human to another, such as wakefulness and sleep. The characteristics of the waves also change with age. Therefore, In Stress Indices phase, subject's threshold value will be calculated. This value will be used as subject's normalized stress indices value. This stress indices value computed as using formula

$$s_{ij} = \frac{S_{ij} - \min(S)}{\max(S) - \min(S)}$$

Where s_{ij} is, normalized stress indices of subject i.
S_{ij} Is, Average value of subject i.
$\min(S)$ is smallest value of the subject.
$\max(S)$ is largest value of the subject.

Human's EEG signal is a kind of weak electrical signal. Without processing, we will get EEG signals with a variety of noise interference, especially ocular artifacts. Eyeblinks and movement of the eyeballs produce electrical signals that are collectively known as Ocular Artifacts (OA). Signals recorded from electrodes will be mixed with noises such as: blinks, eye movement artifact etc. Therefore, in order to meet the requirements of data analysis and processing, we should do noise reduction processing to original EEG signal at first. In order to clean EEG signal data, algorithm based on discrete wavelet transformation (DWT) is designed to identify and remove ocular artifacts from EEG signal. Denoising EEG using this algorithm yields better results, in terms of ocular artifact reduction. In Feature Extraction phase, data preprocessing will be done on EEG dataset. This process will be useful for avoiding over fitting and improving the model performance. This process provide us noise-filtering feature.

4.3 Data Classification: Classification of data is the process of sorting and categorizing data into various types, forms or any other distinct class. Data classification enables the separation and classification of data according to data set requirements for various objectives. The Data Classification Module will be performed to show whether the subject is in stress or relaxed mode. Data classification is diverse process that involves various methods and criteria for storing data. In this module clustering process is use for doing the data classification. The features extracted data are used for classified subjects into different classes. Clustering process is used to divide subjects into a set of subgroups. K-means clustering process is used for dividing the subjects into subgroups.

4.4 Statistical Analysis: Statistics is a term used to summarize a process that an analyst uses to characterize a data set. Statistical analysis involves the process of gathering and evaluating data and then summarizing the data. Statistics studies methodologies to gather, review, analyze and draw conclusions from data. Statistical analysis is a component of data analytics. Statistical analysis involves collecting and scrutinizing every data sample in a set of items from which samples can be drawn. After doing the cluster based analysis the perceived stress effectively reflects the changes in subject's stress level. By getting the subject's stress, statistical analysis is done on individual subject's stress level. This module implemented as first by introducing interventions into the module for getting low stress. After that taking new EEG data of patient and then calculating subject's new stress indices value. New stress indices value will compare with old stress indices value for showing that now stress of patient is low or high.

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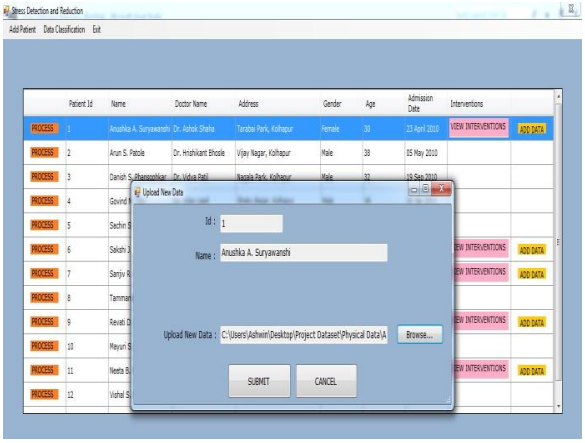
V. SNAPSHOTS



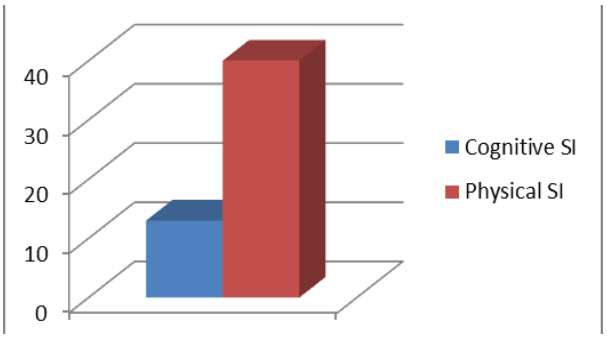
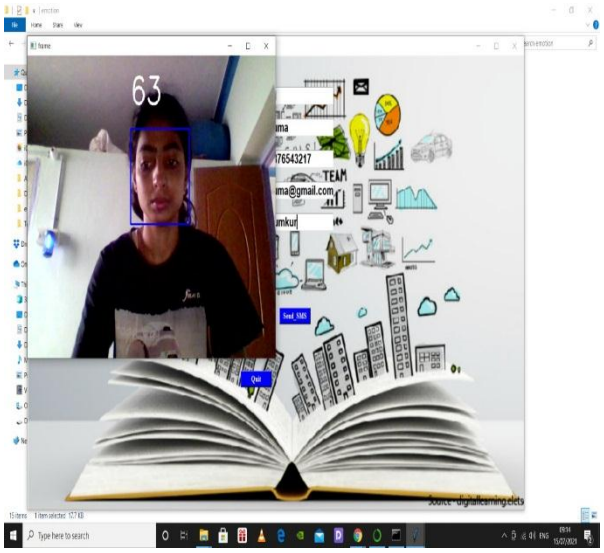
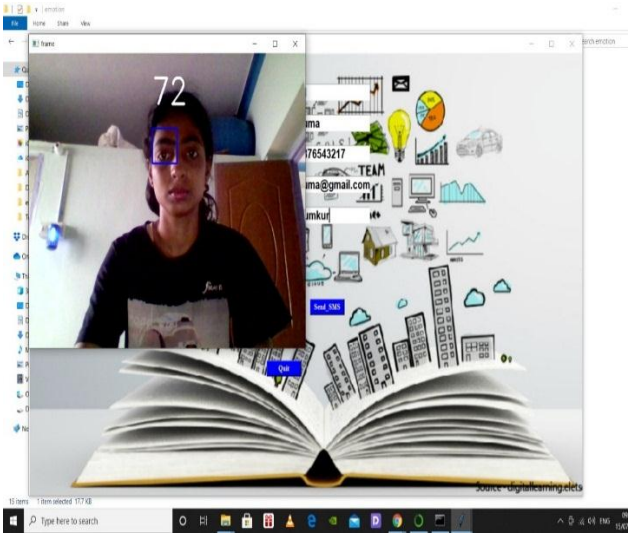


Chart 1: Stress indices in two stages

This graph reflects the change into the stress indices value. This graph showed a stress indices value before task and after the task which are cognitive SI and physical SI. Stress indices value after the task was higher than before task load.





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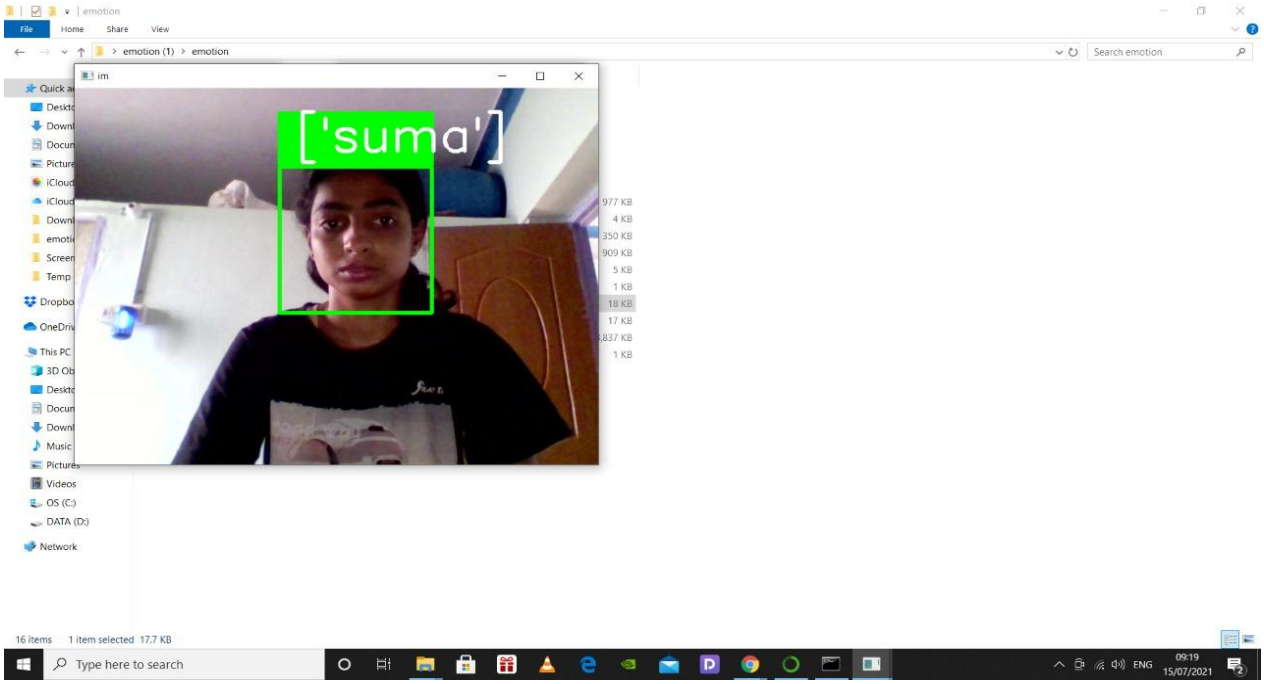

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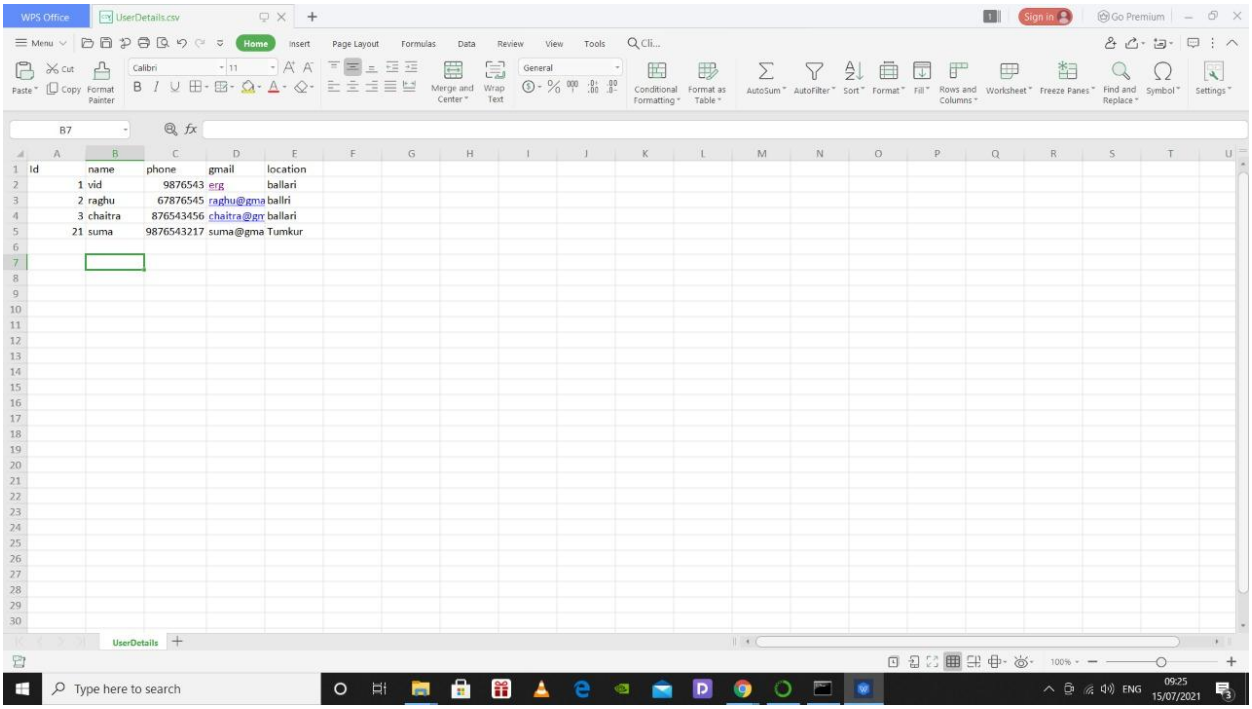

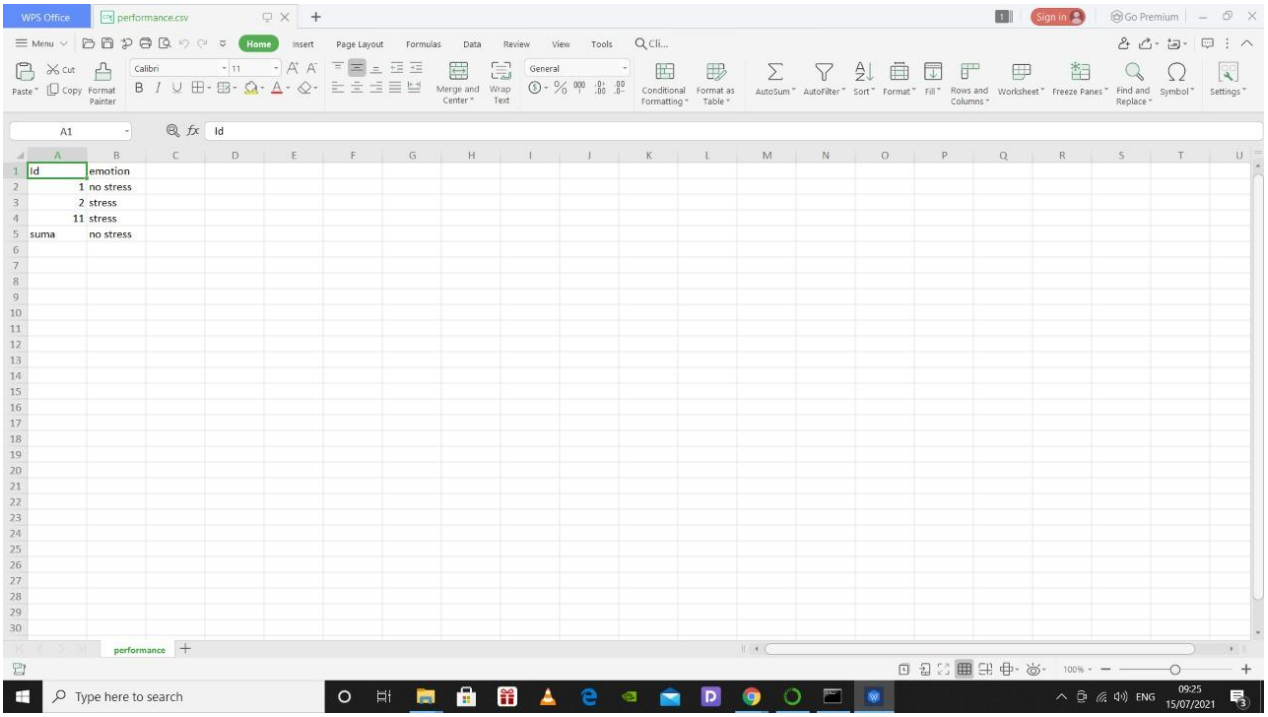

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VI. RESULT ANALYSIS

6.1 Stress Level

The first process within the system is to calculate the stress indices value of subject. After collection of data first process is to calculate stress indices value of cognitive data and physical data. This subject's stress indices value is used as threshold value of that subject. EEG data of subject can vary depending on subject's behaviour. Therefore, its need to calculate individuals threshold value which used for calculating individuals stress level.

We calculate individuals stress indices value for establishing stress level. We analyse collected data and calculate this value. By this analysis we get following graph. This graph indicates individual subject's stress indices value.

6.2 Data Classification

To improve the overall performance clustering procedure were used. Subjects EEG data were preprocessed using DWT with the aim to reduced noise from data. Based on subjects stress classification was done using K-means clustering. We analyze the reduced data for establishing stress level of subject. By this analysis we get following graph which shows stress level of subjects.

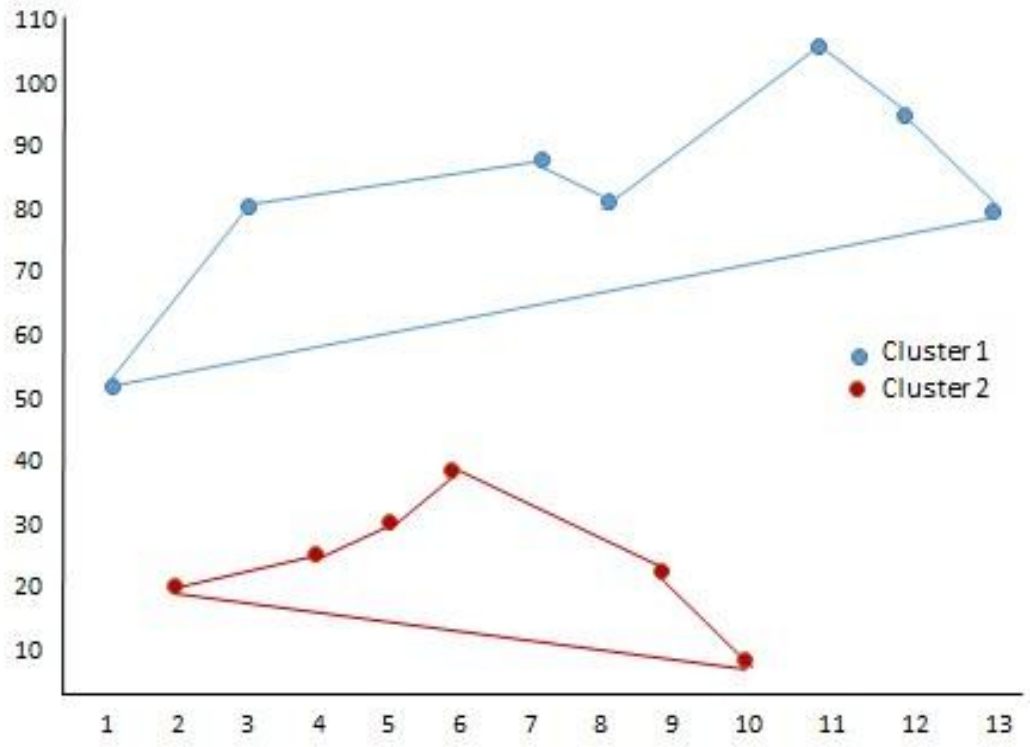

Chart -2: Data Classification outcome

This graph showed two clusters of subject's high stress subject's cluster and other one is low stress subjects cluster. From this classification we can easily differentiate subjects between high stress and low stress.

VII. CONCLUSION

This study was done in order to detect and classify the emotions using EEG signals according to different emotions from different humans. It is based on stress and calm emotions using the features which are gathered from the EEG waves Delta, Alpha, Beta, Theta, and Gamma band width as directed by an EEG signals.

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