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Feature Extraction and Classification Techniques for Analysis Stress Using EEG Signals with Web Application

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***Abstract*- The biological response to stress originates in brain that involves different biochemical and physiological effects. Numerous basic clinical strategies to survey pressure depend on the nearness of explicit hormones and on highlights separated from various signs, including electrocardiogram circulatory strain, skin temperature, or galvanic skin reaction. To screen pressure various strategies can be utilised. In this task for an anxiety acknowledgment, Electroencephalogram (EEG) signal is utilised. Electroencephalogram (EEG) signal is a neuro-signal that is produced due to diverse electrical exercises in the mind. Various sorts of electrical exercises related to various conditions of the mind. These signs can be caught and handled to get the helpful data that can be utilised in early location of some physiological state. In this proposed system, EEG signal database is pre-processed and features are extracted. Classification of stress level is done by implementing machine learning algorithms. In which Random Forest will provide the better accuracy.**

Keywords- Electroencephalogram (EEG), Electroencephalogram (EEG), neurosky mind wave and emotiv epoc headset.

I. INTRODUCTION

Stress is a body's method for reacting to a challenge. Human stress can have an impact on a person's mental and physical well-being. Stress can lead to a change in behavior and in physiology. Many people suffer from stress in everyday life. Stress is related to human work in one way or other.

Originates of stress have different sources such as time pressure while working in company, responsibility, economic problem or physical factors such as noise. Signs of stress are human fell tension, anxious, angry, frustrated or irritated by things over which he has no control.

According to the World Health Origination (WHO), stress is the major problem of human being and it has large effect on physical as well as mental health. The state of emotional tension or mental resulting from adverse or demanding circumstances is called as stress. It can be experiences by each and every person in regular lifestyle due to job, some family problems or other personal issues. Some kind of stress is important for the completing task but lot stress causes harm to the human health.

Hence, nowadays, identification of stress level is important. Sundry traditional techniques for stress detection are available, but this application proposes one of the simple methodologies for the detection of stress using EEG signal analysis. Stress detection is an on-going research topic among both psychologists and engineers. Wearable sensors and bio signal processing technologies are developed for detecting the human stress.

There are various bio signal processing technologies use for human stress detection such as Electro Encephalo Graphy (EEG), Electro Cardio Graphy (ECG), Electro Myo Graphy (EMG), Blood Pressure (BP), Blood Volume Pulses (BVP), Galvanic Skin Resistance (GSR), Respiration and Skin Temperature (ST) etc. Also to measure the stress level human physiological features are used for that human physiological signal processing technology is used.

There is difference between Individuals physiological features. Person physiological features are changes when he/she response to stressful events. By considering various physiological features occur in human while he/she is in stress the estimation of stress are done by using cluster based analysis method.

Essentially, there are three kinds of stress:

1. **Acute Stress:** This stress is for short time span in which some energy present and bring thrill. For example roller coaster rides.
2. **Episodic Stress:** This stress is for longer span of time in which individuals makes self harm or having absurd demands or stressing.
3. **Chronic Stress:** This stress is for long haul, which results in unfortunate and hazardous for human well being. Different techniques were created for the

distinguishing proof of stress like Electroencephalography (EEG), Response of skin sensation alongside its temperature. Rate of breath Electromyography (EMG), Electrocardiography (ECG), level of blood pressure [4].

India is the second most populated country in the world with nearly a fifth of the world's population. According to the 2017 revision of the World Population Prospects, the population stood at 1,324,171,354. During 1975-2010 the population doubled to 1.2 billion. The Indian population reached the billion marks in 1998. India is projected to be the world's most populous country by 2024, surpassing the population of China. In this vast growing population of India today's pressures and demands of modern life has made stress and anxiety a common mental health among people across the globe, including India's population.

Recent survey commissioned by Cigna TTK Health Insurance found that stress levels seem to be relatively high in India compared to other nations, both developed and emerging ones. Majority, or about 89 percent, population in India admitted that they are suffering from stress compared to the global average of 86 percent. The cost was cited to be one of the barriers that made them reluctant to visit professional mental health services according to India Times Report. Nearly 9 in 10 Indians suffer from stress.

In fact, the recently-released findings of the 2018 Cigna 360 Well-Being Survey Future Assured, conducted by Cigna TTK Health Insurance, show that stress levels are higher in Indian compared with other developed and emerging countries, including the United States, the UK, Germany, France, China, Brazil and Indonesia.

According to Money control, the survey further revealed that 95 per cent of Indian millennial between the age group of 18-34 are stressed compared to the global average of 86 per cent. This project is an attempt for inclusion of the individuals who are suffering from problems because of stress. This can be reduced and achieved by using the existing technologies to implement an application which is intuitive and help people to reduce their work pressure by knowing their own stress condition. And consult the related doctor and overcome the mental diseases.

II. LITERATURE SURVEY

Studies involving the stress analysis using EEG signals and implementing the techniques can be found in literature. Instead of actualizing the surveys based strategy, for example, Cohen's Perceived Stress Scale, International Journal of Innovative Research in Computer and Communication Engineering.

Rather than implementing the questionnaires based method such as Cohen's Perceived Stress Scale, Stress Response Inventory and Hamilton Depression Rating Scale to detect the level of stress, use of feature extraction techniques to extract required features from EEG signals also offers a good alternative.

For example, Fast Fourier Transform (FFT), Discrete Wavelet Transform (DWT), Discrete Cosign Transform (DCT) etc. can be used for feature extraction before classifying the data. Sulaiman proposed a combination of EEG Asymmetry and Spectral Centroids techniques to detect unique pattern of human stress. Spectral Centroids technique was widely used in speech and audio recognition.

Poulus used EEG spectral power and mean frequency of Alpha band as a feature to NN (Neural Network) in order to identify person's characteristic.Also, kNN classifier was used to detect and classify human personality and characteristics from the EEG signal pattern when listening to music.

1. EEG Device:
Electroencephalography is a medical imaging technique that reads scalp electrical activity generated by brain structures. The electroencephalogram (EEG) is defined as electrical activity of an alternating type recorded from the scalp surface after being picked up by metal electrodes and conductive media.EEG device, which is a head set was placed according to international 10-20 system. The electrodes were attached to the scalp at position A1, F7, F3, FP1, T3, C3, O1, O2, C4, T4, FP2, F4, F8 and A2 as shown in Figure.

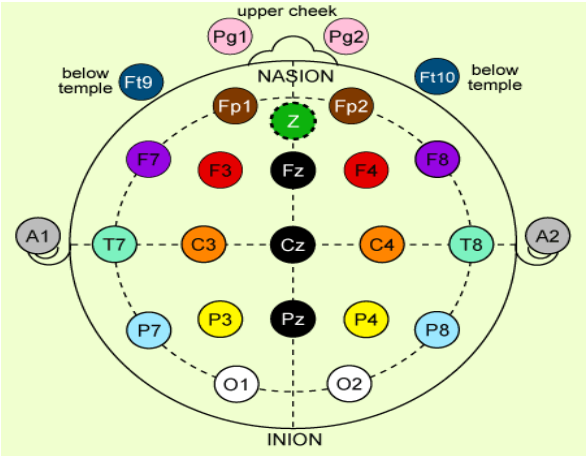

Fig 1. Electrode placement on the scalp.

III. PROPOSED SYSTEM

In the present proposed system we are increasing the feasibility of the system by making use of Machine

learning algorithm. Collecting the dataset from the source. Data set is pre-processed.

Feature extraction is done. Data set is passed to the machine learning algorithm for further classification of the stress level.

IV. SYSTEM DESIGN SYSTEM ARCHITECTURE

1. System Architecture:
System architecture is a conceptual model that defines the structure, behavior and more views of a system. An architecture description is a formal description and representation of a system organized in a way that supports reasoning about the structures and behaviors of that system.

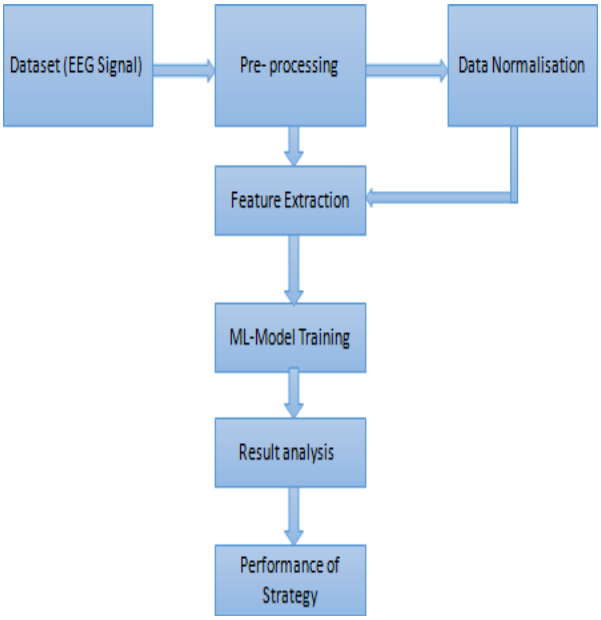

Fig 2. System Architecture.

Dataset of EEG signals are collected from various hospitals and saved in database. Input will be the value of the dataset which has to be processed and to obtain the result. The signals obtained will be preprocessed and resized for required size and format. Different features are extracted from the signals for classification of stress level.

Features are extracted by the notch filter. Classification of stress level will be done using appropriate machine learning algorithms. The results are analyzed and find the best method. By the accuracy we can predict the performance of the system.

V. IMPLEMENTATION DATA EXTRACTION

CSV (comma-separated value) files are common file format for transforming and storing data. The ability to read, manipulate and write data to and from CSV files using Python. Pandas are the most popular data manipulation package in Python and data frames are the Pandas data type for sorting a 2D data.

Dataset of EEG brainwave data that has been processed with our method of statistical feature extraction. The data was collected from four people (2 male, 2 female) for 60 seconds per state - Relaxed, Medium, High, Low. We used a Muse EEG headband which recorded the TP9, AF7, AF8 and TP10 EEG placements via dry electrodes.

1. Data Preprocessing:
Raw EEG is contaminated with noise from different form and sources. As EEG has very small amplitude, filtering out unwanted noise is a critical step to extract useful information. We eliminated ocular artefacts that arise due to body moment. The notch is a very selective filter with a very high rejection just for a tiny frequency band around the selected frequency. It will not attenuate other frequencies, which belong to the EEG signal.

- Importing libraries
- Getting the dataset
- Importing dataset
- Finding missing values
- Splitting dataset

2. Features Selection and Reduction:
From among the all attributes of the data set, one attributes pertaining to target value and label are used to identify the personal information of the person. The remaining all attributes are considered important as they contain vital clinical records. Clinical records are vital to diagnosis and learning the severity of EEG Stress. As previously mentioned in this experiment, several (ML) techniques are used namely, NB, LR, DL, DT, RF, GBT and SVM. The experiment was repeated with all the ML techniques using all attributes.

3. Classification Modelling:
The classification of datasets is done on the basis of the variables then; the classifiers are applied to each EEG Stress dataset in order to estimate its performance. The best performing models are identified from the above results based on their low rate of error. The performance of the classifier is evaluated for error optimization on this data set. Applying classification algorithms such as Naïve Bayes, Logistic Regression, MLP, Decision Tree, Random Forest, and Gradient Boosted Tree. Support Vector Machine (Proposed).

4. Performance of Measures:
Several standard performance metrics such as accuracy, precision and error in classification have been considered

for the computation of performance efficacy of this model. Accuracy in the current context would mean the percentage of instances correctly predicting from among the entire available corrective in the positive class of the instances. ML technique focuses on the best performing model compared to the existing models. Introduce of Best- Model, which produces high accuracy and less classification error in the prediction of EEG Stress.

5. Web-Application:

It will display in real time using dash application, when we start EEG file test with Person data then, Machine Learning with Best-Model process to detecting the individual stress level we may optimize the work pressure on an individual.

algorithms = {

"RF":

ske.RandomForestClassifier(n_estimators=50),

"AB":

ske.AdaBoostClassifier(n_estimators=100),

"GNB": GaussianNB(),

"MLP": MLPClassifier(solver='lbfgs', alpha=1e-5,hidden_layer_sizes=(5,2), random_state=1),

"DT": DecisionTreeClassifier(),

"SVM":svm.LinearSVC(),

"LR": LogisticRegression()

}

VI. EXPERIMENT RESULTS

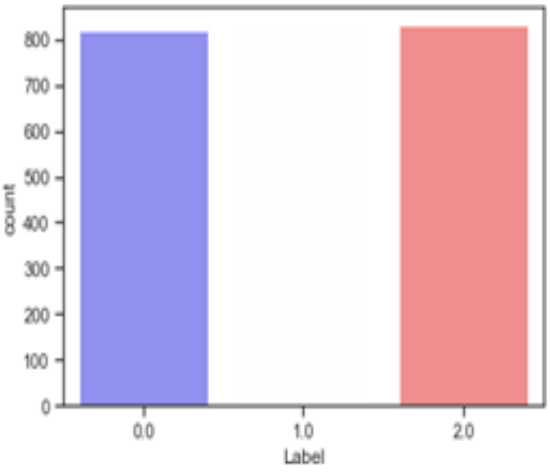

Fig 3. Stress level.

```
Algorithm Test:
RF  : 96.370968 %
AB  : 79.166667 %
GNB  : 68.145161 %
MLP  : 32.123656 %
DT  : 88.440860 %
SVM  : 91.666667 %
LR  : 79.569892 %
Best algorithm is RF with a 96.370968 % success
```

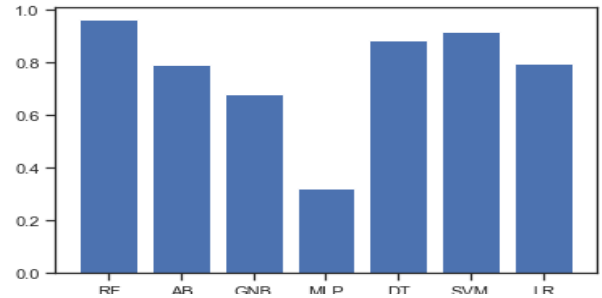

Fig 4. Accuracy of Algorithms.

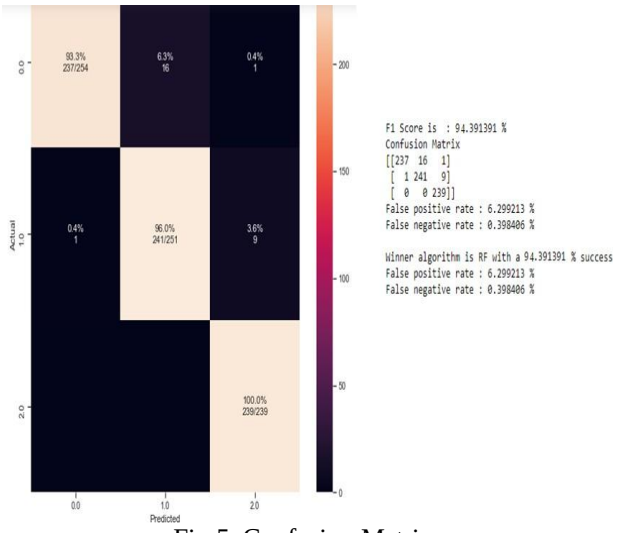

Fig 5. Confusion Matrix.

Fig 6. Stress levels.

VII. CONCLUSION

Human stress estimation framework might be better option in the field of health science. It captures the constant EEG signals and structures the complete loop by showing various qualities according to the fluction of electrical signals on the scalp. The advantage of system are its minimal effort, portable, simple to utilize, simple putting away database and basic application setup for various framework.

This study proposed an EEG-based stress analysis system for the people. We took the useful information from the EEG signals and implemented Random forest as classifier and obtained accuracy of 96.37%. Support vector machine as classifier and obtained accuracy of 91.66%.The outcomes reported the feasibility of using EEG for stress analysis, which is significant for clinical intervention and avoidance of physical and psychological wellbeing issues.

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