A Novel Approach for Human Emotion Assessment Using Data Mining Techniques

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Abstract: Emotions play a vital role in human decision handling, interaction and cognitive process. In human brain, frequency changes occur at almost every moment and produces electroencephalography (EEG) signal. The present work is to capture this signal using Neurosky mind wave device and assess emotion as accurately as possible. EEG signal fulfills the necessity of capturing real emotions direct from the brain by disregarding superficial features like facial expressions, gesture or speech. This paper suggests the use of Principal Component Analysis (PCA) for preprocessing EEG signal and multi-class Support Vector Machine (SVM) to classify emotions into Happy, Angry, Sad and Relaxed. Emotion assessment can be further implemented in applications like music therapy, marketing and military recruitment process.

Keywords: Neurosky mind wave, Electroencephalogram (EEG), Brain Computer Interface(BCI), Valence (V), Arousal (A), Support Vector Machine (SVM), Emotion, Principal Component Analysis (PCA).

I. INTRODUCTION

Emotion is the reflection of mental state of an individual experienced from consciousness.

In human brain, a signal between neurons is established by an action potential i.e. electric impulse. The downstream postsynaptic cell receives the signal and converts it into an electric signal. The electric signals are in micro volts and are captured by Neurosky mind wave headset. For every emotion, the values of these signals vary significantly. Hence, these signals can be processed further in order to recognize an emotion.

Following sections brief about electroencephalography (EEG), Brain Computer Interface (BCI), valence arousal model.

A. Brain Computer Interaction (BCI)

BCI provides a direct communication path between brain and an external device. There are several types of BCI depending on position of sensors viz., invasive BCI, non-invasive BCI and partial BCI.

Invasive BCIs are implanted into the grey matter of brain while partial-invasive BCIs are implanted outside the grey matter but inside the scalp. BCIs placed outside the scalp are called non-invasive BCI and are considered to be the safest among all.

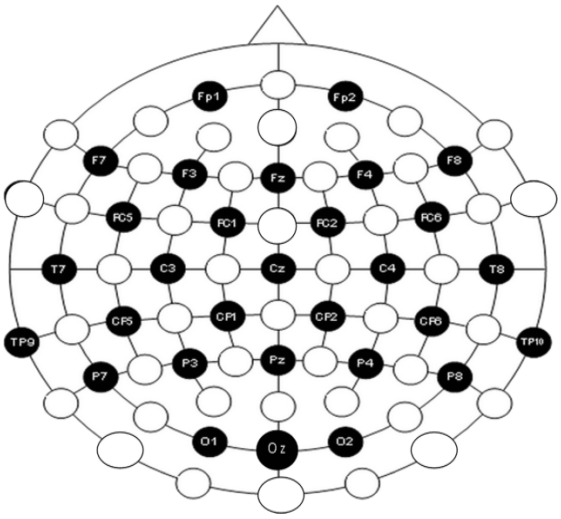

Fig 1.1 electrode positions on scalp

Figure 1.1 represents the 10-20 system for positioning electrodes [6]. Electrodes FP1,F3 and P3 transmits electrical signal when the person is in active state. All these three electrodes lie in left hemisphere which comprises signals regarding normal activities of a person. The Neurosky device which is being used in this proposed design uses FP1 electrode to extract the brain signals.

B. Electroencephalography (EEG)

EEG signal captured from human brain can be classified further on the basis of their frequency ranges as described in fig.1.2 [5].

TABLE 1: Frequency bands and their

Frequency (Hz)	BAND
< 4 (Deep Sleep/Coma)	Delta
4-7 (Trance Dreams/Unconscious)	Theta
8 – 13 (Awareness/Conscious)	Alpha
14 – 30 (Concentration/Perception)	Beta

Alpha and beta waves play a vital role in recognizing emotions. Hence, alpha and beta waves are further classified into low alpha (7.5 - 9.25 Hz), high alpha (10 - 11.75 Hz), low beta (13 - 16.75 Hz), high beta (18 - 29.75 Hz)[ ].

C. Model of emotion

The most popular model used for mapping of emotions is the circumflex model, based on valence and arousal.

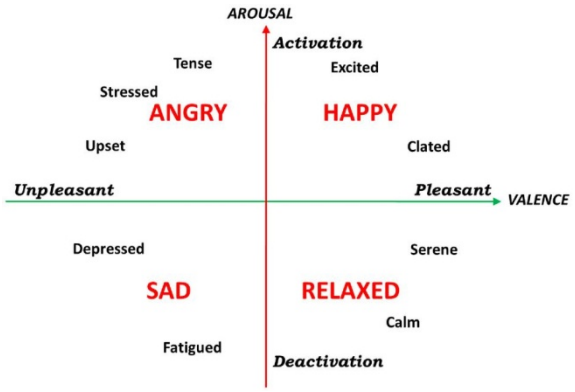

Fig.1.2 Valence-arousal model

Valence gives us a brief idea about an emotion whether it is positive or negative and arousal indicates the intensity of an emotion.

II. LITERATURE SURVEY

EEG was first recorded on an animal brain in 1875 by Richard Caton and was first recorded on human brain by Hans Berger in 1929[9]. FFT was identified by Joseph Fourier in 19th century. It extracts the signal features by transforming the signals from time domain to frequency domain.

It works well for stationary signals and linear random processes. It cannot measure both time and frequency simultaneously. A study of different classifiers is put forward by Rajya Lakshmi, Dr. T. V. Prasad Dr. V. Chandra Prakash which compares their advantages and disadvantages based on accuracy and complexities [7].

Danny Oude Bos proposed a mapping of alpha, beta values with valence arousal model for distinguishing them into various emotions based on the nature of EEG Signals. [9]

TABLE 2: Comparative study of emotion recognition methods

Disadvantages	Advantages	Methods
1. Depends on age and gender. 2. Differentiating between two emotions is difficult as we get same pitch values for two emotions.	1. Emotion can be detected even if the language is unknown. 2. Speech can be easily recorded In extreme environmental condition. Implementation cost is less.	Speech Recognition
1. Use of facial markers is not possible in real time applications. 2. Extracting features in different poses and lightning conditions is a complex task. 3. Moustache, beard gives error.	1. Facial recognition overcomes the limitations of speech recognition technique.	Facial Recognition
1. Low spatial resolution. 2. Non stationary signal.	1. Feature extraction is easy. 2. High temporal resolution. 3. Safe and easy technique. 4. Cannot be faked.	EEG based Recognition

III. PROPOSED DESIGN

The implementation work can be broken down into the following components such as acquiring the EEG signal from the user, processing the obtained signal for better accuracy, extracting the required features from the signal and training the system using Multiclass SVM.

A. Signal Acquisition

The EEG signal can be acquired using the Neurosky Mind wave device. It captures signal from FP1 position. The main components of device are a headset, a sensor arm and an ear clip. The sensor arm has an EEG electrode to be placed on forehead above the left eye (FP1 position) while the ear clip has a ground electrode.

The experiment included collecting the EEG signal of subjects and training the system to recognize their emotion. This was achieved by showing various emotion evoking

videos with by referring DEAP dataset. The process of recording EEG signal was done for a minute.

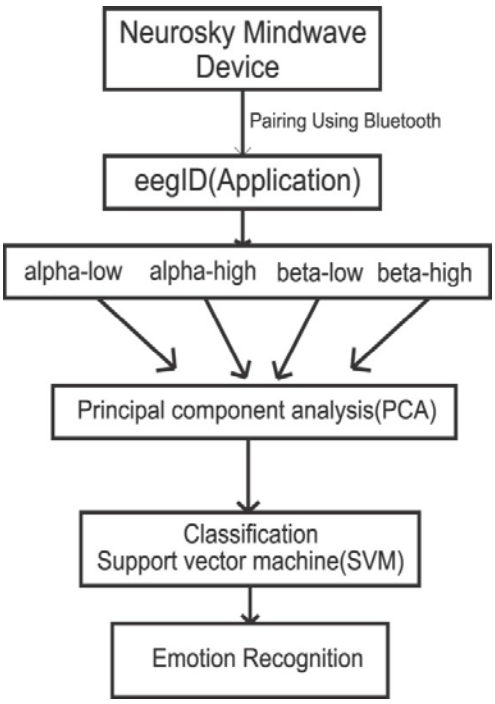

Fig.3.1 : Work Flow Diagram

eegID is an android application through which brainwaves can be captured by pairing it with Neurosky device through Bluetooth. eegID extracts brain waves (alpha-low, alpha-high, beta-low, beta-high, gamma-low, gamma-high, delta and theta) from the raw voltage values i.e. EEG signal. This data is then exported to MATLAB for further processing.

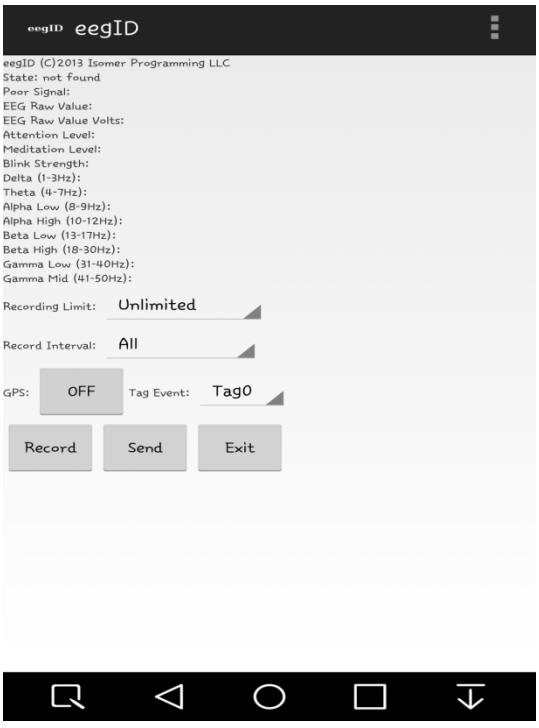

Fig 3.2 : Application Screen shot

B. Feature Extraction

All the information carried by eeg signal are not required to recognize an emotion.

Out of all the eight frequency bands, only Alpha band (alpha-low, alpha-high) and Beta band (beta-low, beta-high) are extracted for emotion recognition. [2]

Feature extraction of the required bands is done using PCA. PCA is a technique of transforming a set of correlated data into uncorrelated values called “principal components”. It comprises of following steps:

1. Subtract the mean of each column from the corresponding values of the column.
2. Calculate covariance matrix.
3. Calculate eigenvalues and eigenvectors.
4. Reduce matrix dimension and form feature vector.

C. Classification

Classification is a supervised learning method of assigning classes to items in a collection. Classes considered in this experiment are - Happy, Sad, Relaxed and Angry.

Multiclass SVM technique, using “one-against-all” approach, trains and tests the data.

There are two steps in classification:

1. Building a classification model:

Data is split into training and test data. A model is made with the training data and finally, a classification model is obtained for further predictions.

2. Using model for classification:

The model obtained is used to classify any new data into relevant class and thus an emotion is predicted. Furthermore, based on this emotion, the person may be recommended with solutions to deal with his/her emotion.

IV. CONCLUSION

The focus of this paper was to design and implement a classification algorithm for emotion recognition from EEG signal in real time. Once the system was well trained, it was tested for its accuracy by checking its correctness. According to test results, it can be concluded that SVM classifier is used for recognizing human emotion efficiently.

V. FUTURE SCOPE

Most of the marketing campaigns and initiatives are focused on emotions. Lots of the marketing strategies aim to move your heart, and then rely on the experience to build a lasting bond with the organization. In addition to recognize emotions, this work may also be involved as a part of various applications that can be used in the field of forensics, education and medicine.

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