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Emotion recognition through Brainwaves Using Supervised Learning

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Abstract — *Human emotion recognition has become one of the key steps towards advanced brain-computer interactions. Brainwaves or brainwaves is one of the frequently used bio signals in emotion recognition as it is found that the signal measured from the central nervous system has a relationship between physiological changes in mind and emotions. Utilizing facial expressions will be another option that Might a chance to be utilized to emotion. Our research work is possibility of recognize emotions using brainwaves. Brainwaves feature extraction is done, using band pass filtering and Standard deviation methods and Artificial Neural Network for emotion recognition. The solution is used to study about the behavior of brainwaves based on motions in different mental states.*

Keywords- Brainwaves, EEG signal, SVM (Support vector machine), Emotion recognition, ANN (artificial neural network)

I. INTRODUCTION

The electroencephalogram (EEG) is the delineation of the electrical movement happening at the surface of the mind. This movement shows up on the screen of the EEG machine as waveforms of changing recurrence and sufficiency measured in voltage (particularly small scale voltages). Brainwaves are for the most part grouped by their recurrence, abundances, and shape, and also the locales on the scalp at which they are recorded. The most commonplace order utilizes Brainwave recurrence (eg, alpha, beta, theta, and delta).

II. THEORY OF BACKGROUND

At the establishment of every one of our contemplations, sentiments and practices is the correspondence between neurons inside our brains. EEG signals are conveyed by synchronized electrical beats from masses of neurons talking with each other. EEG signals are found using sensors put on the scalp.

A. Description of brainwaves [3]

Delta waves (5 to 3 Hz) are the slowest and loudest brainwaves (low recurrence and profoundly infiltrating, in the same way as a drum thump).

Theta waves (3 to 8 Hz) happen frequently in slumber but on the other hand are predominant in the profound thought.

Alpha waves (8 to 12 Hz) are available amid quietly streaming musings, however not exactly reflection. Alpha is 'the force of now', being here, in the present. Alpha is the resting state for the mind. Alpha waves help general mental coordination, tranquility, sharpness, brain/body joining and learning.

Beta waves (12 to 38 Hz) overwhelm our typical waking condition of cognizance when consideration is regulated towards cognitive undertakings and the outside world. Beta is also quick action waves.

Low Beta (Beta1, 12-15 Hz) can be considered a quick sit still, or pondering. Another Beta is also known as Beta2 (15-22 Hz) is considered as high engagement.

Gamma waves (38 to 42 Hz) are the fastest of cerebrum waves (high recurrence, in the same way as a woodwind), and identify with concurrent preparing of data from diverse mind territories [3].

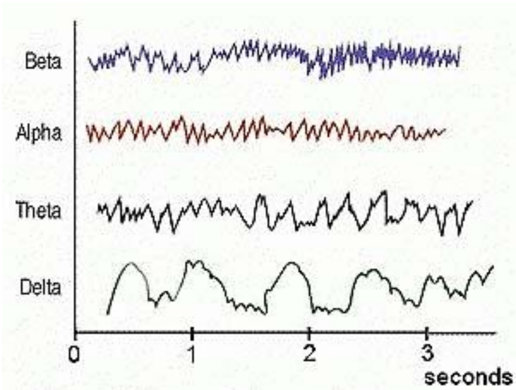

Figure 1: Brainwaves patterns with their frequencies

B. Working of Brainwaves [1]

The human cerebrum is involved billions of inter-jointed neurons about the traverse of a pinhead. As neurons convey, cases appear as single thoughts, for instance, a math number, and far reaching enthusiastic states, for instance, thought and consideration. The ordinary human thinks about 70,000 thoughts consistently. Consequently, every correspondence between neurons makes a miniscule electrical discharge, quantifiable by EEG machines. These charges are hard to gage from outside the skull. In any case, a transcendent mental state, dictated by total neuron activity made by a few thousand synchronous discharges, can be measured. Brainwaves measure the mind development from the scalp with EEG sensors joined to the head on a terminal top or headset without being surgically installed and it is most by and large used. This is the genuine clarification behind Neurosky's standard sensor set on a position known as Fp1.

III. PROPOSED SYSTEM

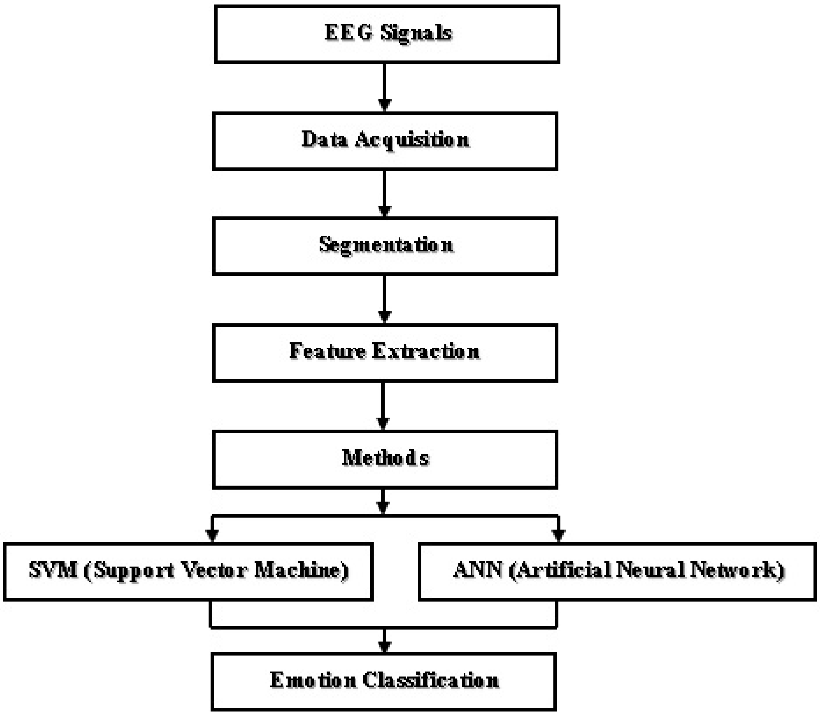

Figure 2: Proposed System Flow

3.1 EEG signals [1]

Electroencephalography (EEG) is an electrophysiological observing strategy to record electrical action of the cerebrum. It is regularly non-intrusive, with the anodes put along the scalp, albeit obtrusive cathodes are in some cases utilized as a part of particular applications. [1].

3.2 Data acquisition [3]

This progression is essentially gathering the required cerebrum signals frame the live subject. Feeling are evoked in a volunteer by indicating them information from the prepared datasets [3]. While seeing information of EEG signals is produced in the mind which is aided by the think equip gadget.

3.3 Segmentation [3]

EEG signs were stored for same time term of around, this flag involved a sum of same occasions, that comparing to the EEG signals (8 seconds each) produced while seeing a photo and 15 were Grayed – Clear slides (15 seconds each). To isolate these EEG signals division handle done. [3]

3.4 Feature extraction

3.4.1 Band pass filter [3]

EEG signals filtered 1-50Hz and different types of signals that filtered Delta (1-4Hz), Theta (4-7Hz), Alpha (7-13Hz), Beta (13-30Hz) and Gamma (30-50Hz).

Keeping in mind the end goal to assemble just the basic data from the accumulated signs, we have sifted through the information by utilizing a 0.2 - 45Hz band pass channel.

Here we use band pass filter because it preprocess the data and remove the unnecessary data.

3.4.2 Standard deviation [3]

The deviation of the terminal from its principle esteem over various passionate signs is named as Standard deviation (SD) and is numerically characterized as:

$$\sigma = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(X_i - \overline{X})^2} \quad \text{…………... (1)}$$

Where N = No. of data inputs.
Xi = Individual data.
$\overline{X}$ = Mean of all data inputs.

In, here we collect the thousands of data per every second. We apply a standard deviation on that data. This way we can minimize a large amount of data in small data. For do some further operation on it.

3.5 Classification methods

3.5.1 SVM [3]

"Support vector machine" (SVM) is a machine learning calculation which can be utilized for both order and relapse challenges. Support vector machines (SVMs) are now accepted as powerful tool for developing pattern classification and function approximation systems. SVM are used to tackle the emotion recognition problem. Classification of emotion can be performed using SVMs. [3]. SVMs can productively play out a non-straight order.

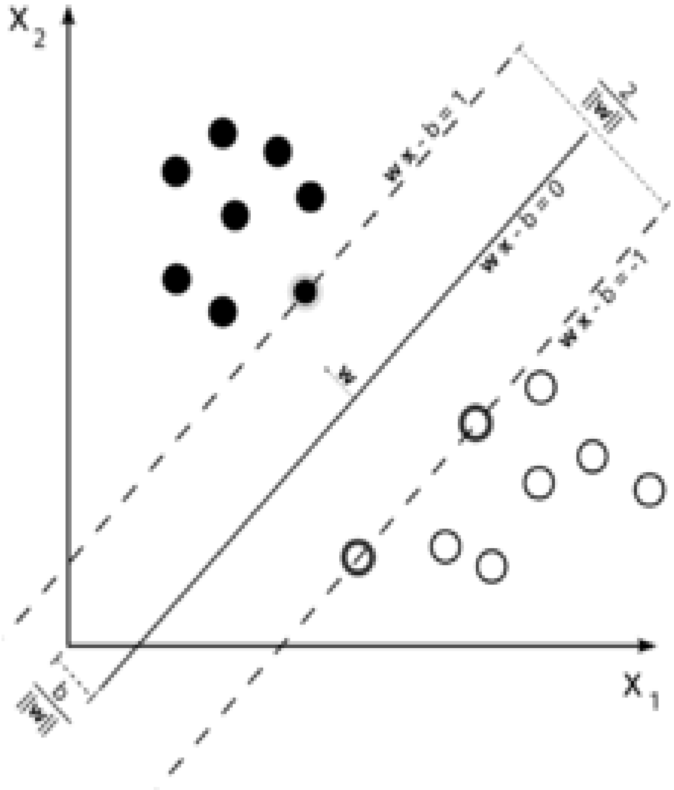

Figure 3: SVM

4.5.2 ANN [2]

Artificial neural system (ANN) is comprised of numerous simulated neurons which are connected together as per particular system engineering. The point of the neural system is to change the contributions to significant yields to coordinate the particular target values as nearly as could be expected under the circumstances. ANN is characterized by 3 sorts of parameters: The inter-jointed design between the distinctive layers of neurons, learning process for refreshing the weights of the inter-jointed and initiation work that changes over a neuron's weighted contribution to its yield actuation [11]. In Artificial Neural Network, the quantity of neurons in the info layer and shrouded layers changes as indicated by the component sorts utilized, though the quantity of neurons in the yield layer is only the four passionate states [11].

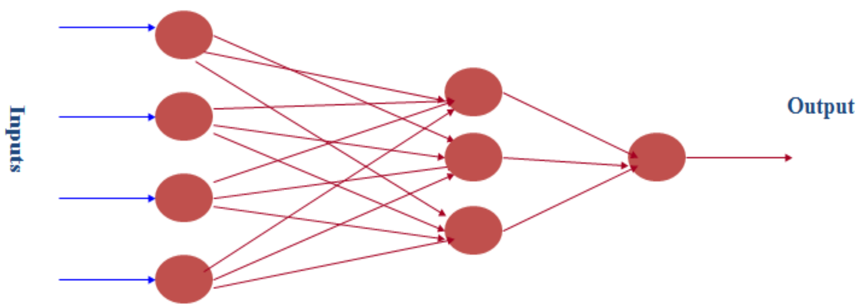

Figure 4: ANN

$$\begin{aligned} y_1^1 &= f(x_1, w_1^1) \\ y_2^1 &= f(x_2, w_2^1) \\ y_3^1 &= f(x_3, w_3^1) \\ y_4^1 &= f(x_4, w_4^1) \end{aligned} \quad y^1 = \begin{pmatrix} y_1^1 \\ y_2^1 \\ y_3^1 \\ y_4^1 \end{pmatrix} \quad \begin{aligned} y_1^2 &= f(y^1, w_1^2) \\ y_2^2 &= f(y^1, w_2^2) \\ y_3^2 &= f(y^1, w_3^2) \end{aligned} \quad y^2 = \begin{pmatrix} y_3^2 \\ y_3^2 \\ y_3^2 \end{pmatrix} \quad y_{Out} = f(y^2, w_1^3) \qquad \text{……….. (2)}$$

Neural network: information / yield conversion.

$$y_{out} = F(x, W) \qquad \text{…………………………....... (3)}$$

The place w is that grid of every one weight vectors.

Table 1: Comparison of classification methods

Classifiers	Merits	Demerits
SVM[3][8]	Achieves optimal class boundaries by finding the maximum distance between classes. Less misclassification Robust Faster Required less memory less complex than ANN Good generalized ability	Expensive trial and run
ANN[2]	Suitable for complex problem. Robust to noisy data	Expensive training Complex Sub-optimal Time consuming
KNN[1][8]	Effective if the training data is large.	Computation cost is quite high. It is computationally expensive to find the k nearest neighbors when the dataset is very large. Give false positive image retrieval

IV. IMPLAMENTATION

4.1 Training the dataset

Initially we have two options, to train our data or to test our data of which testing is disabled at first. By training the dataset we mean to say that for a particular person the values of the movements are considered and saved for that person. Once we start training the dataset, we need to supervise it by taking all the values of happy, sad, relax and anger thoughts of cursor movements that are stored for a multiple person will work for that person till anyone else uses the device and if at any moment, it is found that it's working for any person, training again is suggested.

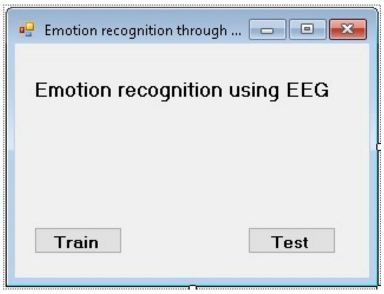

Figure 5: Main GUI

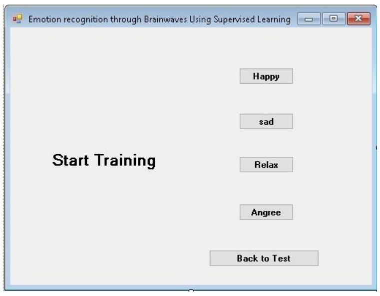

Figure 6: Training datasets

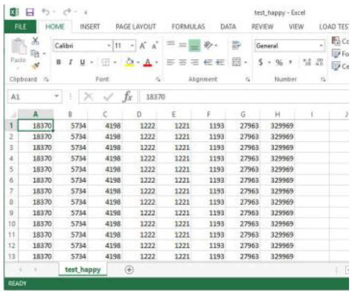

Figure 7: Stored data sets.

Here we have take sample of 5 people with four emotions Happy, Sad, Relax and Agree.

To generate graphs, we have decoded the values of alpha, beta, gamma, delta and theta using .NET framework. By these values, graphical representation of the waves is made. These graphs can be used for biomedical purposes as they can be easily viewed in a laptop and those complex MRI machines are not necessary. Above figure shows the graphical representation of the Brain waves for monitoring purpose which is one of the important parts of our work.

4.2 Testing the dataset

Here we are testing the dataset as the test button gets enabled and we can check if the trained dataset works well.

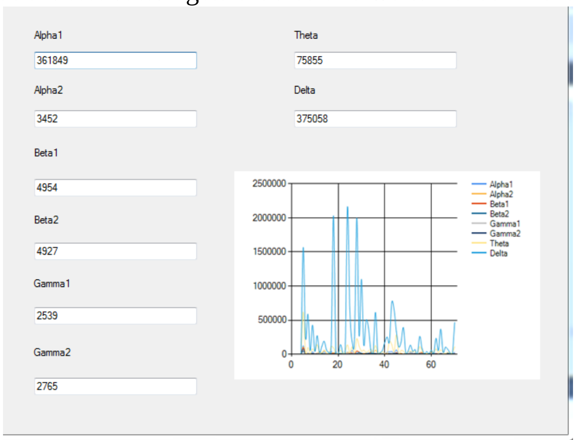

Figure 8: EEG waveforms

V. RESULT

The classification results for trained dataset are shown in Figure 8. This figure contains the classification methods on the x-axis while accuracy is displayed over y-axis. The two classifiers ANN and SVM+STD can be identified by yellow and green color bars, respectively. The highest accuracy was obtained by SVM +STD, which was 90.33 %.

Table 2: Classification result

Method	ANN	SVM + STD
Classification	88.4	90.33

Figure 9: SVM and ANN classification results

VI. FUTUER WORK

Distinctive members might bring diverse things around their personality. Despite the fact that kin would triggered to encounter a portion emotion, their mind action might make still a whole lot impacted by different musings and cerebrum procedures. We might use music or feature information with trigger those feelings in the individual's cerebrum [10] [12].

Some other systems cam wood make used to perform preferred ahead clamor evacuation or relic evacuation. Finer Characteristics extraction Also arrangement systems could additionally make utilized clinched alongside future. Framework cam wood make stretched out on execute some provisions in mind machine Interface, mind state detection, and so on. [11].

VII. CONCLUSION

Study of brain waves is made and hence we conclude they can be shown in a user-friendly manner that is not complex. Measuring of these waves can be done. These waves are plotted down for biomedical purposes. These waves could be measured while the person is conscious or unconscious also including people of all ages. Study of device is made which reads the brainwaves and those are plotted.

Work till now is to take values of these brainwaves as input in computer and hence recognize emotions. To detect the range of waves then after store them preparing a database; in case any fluctuations occur while taking the input, then taking the inputs again from user manually and perform machine learning SVM+STD and ANN for Classification of Emotion.

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