"Emotion Detection from Brain and Audio Signal"

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Abstract: *In this paper reports on the human emotion recon- ignition using different set of electroencephalogram (EEG) channels using discrete wavelet transform. Emotion recognition could be done from the text, speech, and facial. We concentrate on recognition of "inner" emotions from electroencephalogram (EEG) signals as humans could control their facial expressions or vocal intonation. In this system work EEG signals have been used to extract the feature, the feature is extracted by using wavelet transform such as Db6. After extracting the feature signal is given to Neural Network for classification. In the past few days, many studies have been done on emotion recognition. Anderson utilized facial expressions to recognize emotion. However, these signals shared the same disadvantage. They are not reliable or perfection is not there to detect emotion, especially when people want to conceal their feelings. In this paper, The EEG-based emotion recognition algorithm based on spectral features and neural network classifiers is proposed.*

Keywords: EEG, Human Emotion, Discrete Wavelet Transform, Audio.

1. Introduction

An electroencephalogram (EEG) is the basic building block for Brain-Computer Interfaces. The EEG signals will be used to specified the extract data and classify with different variety of human emotions using audio etc. The EEG recognition procedure mainly involves feature extraction from EEG signal and classification of Emotions. The useful EEG signals contain huge data of brain signals. Numerous methods have been used to extract feature vectors from the EEG signals. The different wavelet transform have been used to extract the feature. WT plays an important role in the recognition and diagnostic field it compresses the time-varying biomedical signal, which comprises many data points, into a small few parameters that represents the signal. As the EEG signal is non stationary, the most suitable way for feature extraction from the raw data is the use of the time-frequency domain methods like wavelet transform (WT) which is a spectral estimation technique in which any general function can be expressed as an infinite series of wavelets. There has been a large number of published works in the domain of emotion recognition from physiological signals [05], Murugappan Murugappan, Nagarajan Ramachandran, Yaacob Sazali, "Classification of human emotion from EEG using discrete wavelet transform" [06]. In the current work, music video clips are used as the visual stimuli to elicit different types of emotions. To this end a relatively large set of music video clips was crowded using a novel stimuli selection method. A subjective test was then performed to select the most appropriate test material. For each video, a one-minute highlight was selected automatically. 32 participants took part in the experiment and their EEG and peripheral physiological signals were recorded as they watched the 40 selected music videos. Participants rated each video in terms of arousal, valence, like/dislike, dominance and familiarity. For 22 participants, frontal face video was also recorded.

2. Materials and Method

2.1 (DEAP) A Database for Emotion Analysis using Physiological signals.

We obtained the pre-processed EEG data along with users' subjective affective ratings from the publicly available (DEAP) "database for emotion analysis using physiological signals"[05].

TABLE 1 Database content summary

Physiological Experiment

Number of participants	32
Number of videos	40
Selection method	Subset of online annotated videos with clearest responses (see section 2.3)
Rating scales	Arousal Valence Dominance Liking *(how much do you like the video?)* Familiarity *(how well do you know the video?)*
Rating values	Familiarity: discrete scale of 1 - 5 Others: continuous scale of 1 - 9
Recorded signals	32-channel 512Hz EEG Peripheral physiological signals Face video (for 22 participants)

The database consists of EEG recordings from thirty two participants, average age is 25 years while they experienced forty, one-minute long, audio videos with emotional content. The EEG data was acquired using a Active Two system (Amsterdam, Netherlands), at a sampling frequency of 512 Hz, while placing thirty two electrodes according to international 10-20 system over the scalp. The data was then pre-processed by common referencing, down sampling to 128 Hz, band-pass filtering between 4-45 Hz, and eye blink artifact removal via independent component analysis.

2.2 Experiment Setup

The experiment started with a 2 minute baseline recording, during which a fixation cross was displayed to the participant (who was asked to relax during this period). Then the 40 videos were presented in 40 trials, each consisting of the following steps:

1) A 2 second screen displaying the current trial number to inform the participants of their progress.
2) A 5 second baseline recording (fixation cross).
3) The 1 minute display of the music video.
4) Self-assessment for arousal, valence, liking and dominance.

Figure 1: A participant shortly before the experiment

In this figure 2, The standardized placement of scalp electrodes for a classical EEG recording has become common since the adoption of the 10/20 system. The essence of this system is the distance in percentages of the 10/20 range between Nasion-Inion and fixed points.

Electroencephalography (EEG) is a method used in measuring the electrical activity of the brain. This activity is generated by billions of nerve cells, called neurons. It is the measurement of potentials that reflects the electrical activity of human brain.

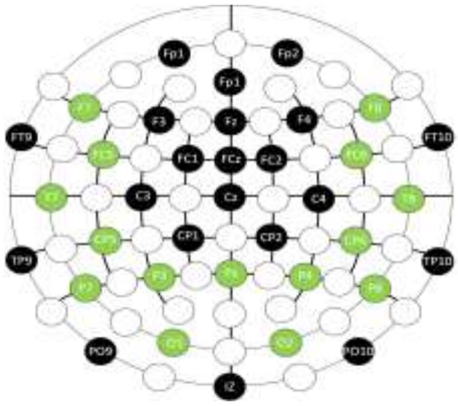

Figure 2: Selected electrodes as modeled with the 10/20 system

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2.3 Rhythms

The bands of frequency associated to brain activity are denominated as rhythms (Table II), and many of studies suggest that are associated to a specific emotion task; as another measure to perform signal conditioning a band pass filter of 0.5 Hz to 47 Hz, were implemented to consider only the frequencies of rhythms .

TABLE II: Brain rhythms.

Rhythms	Frequency band (Hz)
Delta	0.5 to 4
Theta	4 to 8
Alpha	8 to 12
Mu	8 to 13
Beta	12 to 30
Gamma	> 30

3. Feature Extraction

In the emotion recognition, the non-parametric method of feature extraction based on multi-resolution analysis of Wavelet Transform is quite new feature extraction method. The different types of temporal and spatial approaches have been applied to extract features from the physiological signal. The joint time-frequency resolution obtained by WT makes it as a good candidate for the extraction of details as well as approximations of the signal. which cannot be obtained either by Fast Fourier Transform (FFT) or by Short Time Fourier Transform (STFT).The signals of EEG is non-stationary

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nature to expand them on to basic functions created by expanding, contracting and shifting a single prototype function (Ψa,b,the mother wavelet), for the signal under consideration.

Wavelet decomposition is One of the most important aspects of the Wavelet Transform, is that transformation coefficients can be employed directly as features for the classification problem and unlike the Fourier transform it provides a commitment between the temporal and spatial information of the signal, which are very useful in the analysis of biological signals. Also Wavelet Transform handles with the non-stationary nature of the EEG signals by expanding, contracting and shifting a function $\psi_{a,b}$ called "mother" wavelet , defined by the equation .

$$\psi a,b(t) = \frac{1}{\sqrt{a}}\psi(\frac{t-b}{a}) \qquad (1)$$

where a, b $\in$ R, a > 0, and R is the wavelet space. Parameters 'a' and 'b' are the scaling factor and shifting factor respectively. The only limitation for choosing a prototype function as mother wavelet is to satisfy the admissibility condition.

$$C\psi = \int_{-\infty}^{\infty} \frac{|\psi(w)|^2}{w} dw \angle \infty \qquad (2)$$

where $\Psi(\omega)$ is the Fourier transform of $\Psi a,b$ (t).

The selection of an appropriate wavelet for a given signal, still implies an extensive search; to perform the presented feature extraction DB6, were selected due it shows the best performance in a heuristic experimental task and also satisfy the following admissibility condition to handle whit the non-stationary propriety of EEG.

4. Classification of Emotion

In this work experiment, we have used neural network classifiers for classifying the discrete emotions. Among these classifiers, design of neural network with respect to the no of layer and transfer function such as log sig, tan sig, pure linear. After training the neural network and simulation the data network with test data. Comparing expected result with actual result.

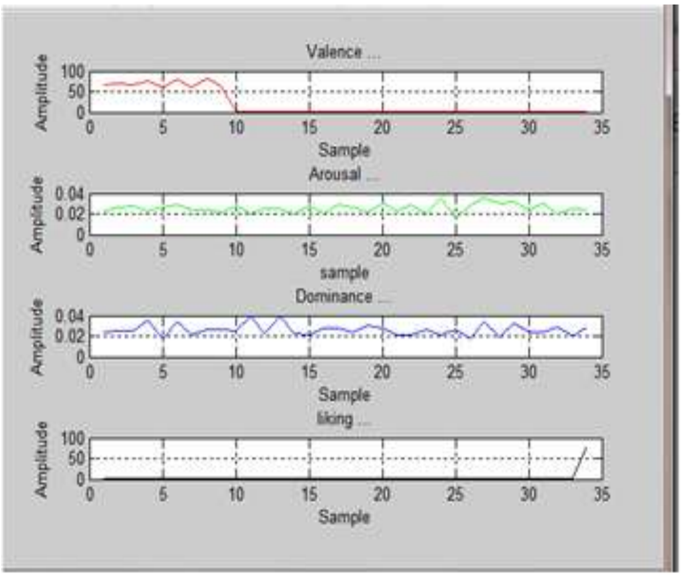

Figure 3: Plot for different emotion waveform

In this paper, there are four emotions like valence, arousal, dominance, liking has been classified using Back propagation neural network with different number of hidden layers and neurons, where as the feature is extracted using Wavelet Transform Method.

5. Result

Following the experimental protocol described in work we report the experimental results for the proposed method. The first refers to the participant number in the original DEAP database. A one-minute highlight was selected automatically. 32 participants took part in the experiment and their EEG and peripheral physiological signals were recorded as they watched the 40 selected music videos. Participants rated each video in terms of arousal, valence, like/dislike, dominance and familiarity. The EEG recordings used for training, development and testing, respectively. As it can be seen, the classification accuracy differs significantly among the individuals. The average classification accuracy for the participants is 75%, where the lowest individual percentage correct is 69% and the highest individual percentage correct is 80%.

6. Conclusions and Future work

In this work, we have presented a database for the analysis of spontaneous and physiological emotions. The database contains physiological signals of 32 participants (and frontal face video of 22 participants), where each participant watch and rated their emotional response to 40 music videos along the scales of valence, arousal, and dominance, as well as their liking of and familiarity with the videos. The proposed system computationally inexpensive automated detector of emotional states, which is based on 32- channel electroencephalographic (EEG) signals, shows that there are significant variations among the EEG activity of people who like or dislike certain video-clip. The classification accuracy of 70% is insufficient for many practical applications, yet we deem that after averaging a number of subsequent measurements it can be of certain use. Further improvement of classification accuracy would require elaboration of the signal parameterization process and computation of a larger set of relevant features from the EEG signal. In conclusion, we seem that the experimental results indicate the potential of the proposed method as a candidate technology which could find certain use in support of video-game based treatment of emotional and psychological disorders. In future, we are interested to develop efficient feature extraction algorithm using different wavelet functions and with a different set of statistical features for improving the emotion classification rate.

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