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A Survey on EEG Based Emotion Analysis Using Various Techniques

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Abstract:
Emotions play a significant role in human cognition, perception, decision making, and interaction. The main objective of this research methodology is to find, implement and evaluate the various research issues that has been conducted to achieve the high classification rate for Emotion Analysis. Most of the existing system used various pre-processing, feature extraction and classification methods to emotion classification. The classification algorithms like support vector machine, PNN classifier, adaptive neuro-fuzzy inference (ANFIS) classifier, Artificial Neural Network (ANN), Linear discriminant Analysis (LDA), K-Nearest Neighbor (KNN) are used in existing scenarios. In the proposed scenario, Non Negative Principal Component Analysis is used for emotion classification.The performance evaluation conducted were proves that the proposed mechanism gives better result when compared to the existing mechanism in terms of improved accuracy and reduced execution time.

Keywords: *EEG signal, Emotion classification, feature extraction*

1. Introduction

Human emotions play in major role in affective computing and Human Machine Interaction. The general emotions are such as happy, sad, surprise, angry etc., which are used to find the mental stress and mental disorders [i].In human brain each and every cell carries a specific function. Each and every function is used to analysis the decision making for a particular problem. The emotions can be recognized by using past experience [ii]. Emotion has computed by lot of ways. Emotion recognition could be done from audiovisual based methods like speech, facial expression or body gestures.

In the past, bio signals have been used to diffident purposes besides the predictable uses of clinical diagnosis and cognitive neuroscience. The project aims at emotion recognition using EEG signals. The objective of the project is signal pre-processing, feature extraction and classification which will identify the different emotional level [iii]. The basic brain image is shown n Figure1.

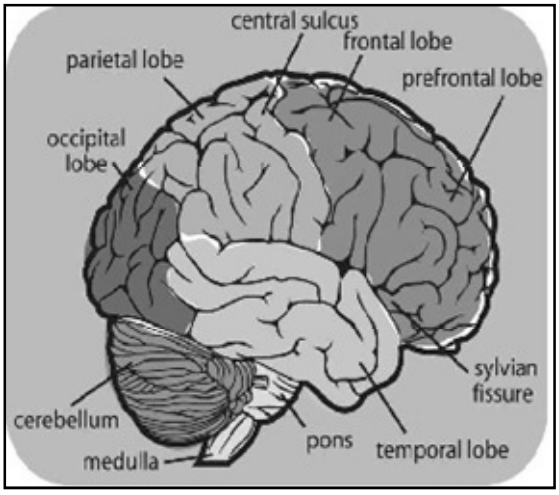

Figure 1: Brain Configuration

Signal Pre-processing: Pre-processing is otherwise called as raw data removal process. The first thing we need is a number of raw EEG data to process. The obtained brain signals are infected by noise and artifacts (unwanted signals). Removal of these artifacts and noise is nothing but preprocessing.
Feature Extraction: Once the signal is pre-processed, efficient features from respective signals are extracted in this process.
Classification: Using machine learning algorithms we can train a classifier to identify from among our features which ones belong to which emotional states.

Band	Frequency Range	Location
DELTA	0-4Hz	Frontal Lobe
THETA	4-7Hz	Midline Temp
ALPHA	8-13Hz	Frontal Occipital
MU	8-12Hz	Central
BETA	13-30Hz	Frontal Central

Table 1: EEG- different Band Levels

From this it can be understood that efficient emotion classification is a very important part. Due to the various problems, there have been several reasons, proposed to solve it. In this paper we will describe various types of emotion classification techniques and analyze each of these solutions, identify their strengths and limitations.
The document of this research work is shown below: the various research work is implemented based on increasing the profit in analysed and evaluated. In section III, the research works that has been discussed in the previous section is evaluated by listing their merits and demerits. The final conclusion of this entire analysis work is listed.

2. EEG Data
Electroencephalograms simply called as EEGs are electrical signals created due to the activity of neurons in the brain. These can be recorded non-invasively from outside the scalp. They are an important tool in the diagnosis of functional brain disorders. EEGs are complex signals. Their statistical properties depend on the state of the subject and on external factors. Cognitive tasks, sensory stimuli motor tasks etc. induce changes in the EEG activity. The EEG data is collected from the healthy subjects. The subject is seated in the experimental room in front of the system and asked to fill the same set of questions, after finishing that process, some electrode has to be placed on the scalp. The EEG recorded using BIMEC from brain maker BV. The BIMEC has the reference channel with eight EEG sample with 250Hz.
The EEG signal has collected from several activities. It has to be recorded using different factors like event elicited vs. subject-elicited, real world vs. laboratory setting, feeling of the emotion vs. focus on expression, hidden recording vs. openly recorded and emotion-purpose vs. other purpose. The emotion has to be captured by one-minute eye closed and eye opened also it has to be recorded with different kind of picture related signal. The pictures are collected from International Affective Digitized Sound and the International Affective Picture System. The signal has the different kind of band levels like Alpha, Beta, Gamma and Theta. Each band stores the particular information about the emotions, which was shown in the Table 1 The following table contains the different band details and its frequency ranges and their location in the brain and the different wave form of the signal.
Emotions can be identified by using the EEG signal. By using the EEG signal, three types of emotions are determined. They are Flow blown emotions, Mood of the particular person, Emotional disorder of the particular person also identified. The sample EEG signal has been shown in Figure 2.

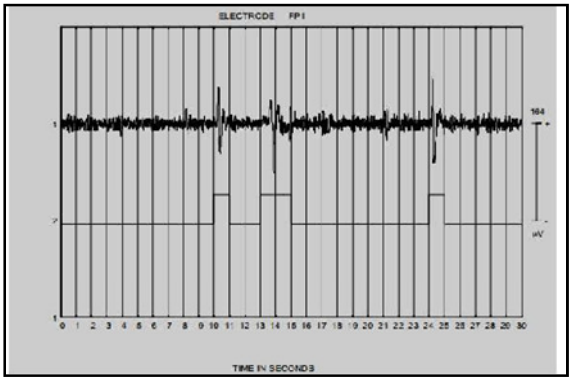

Figure 2: Sample EEG Signal

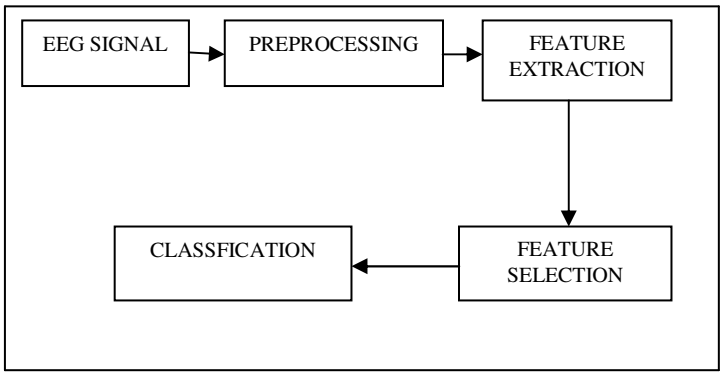

Figure 3: Overall Structure

3. EEG Data Analysis Method

EEG Signal is an analysis based on three main steps. There are Preprocessing, Feature Extraction and Classification. The signal preprocessing methods and various techniques of feature extraction and classification are shown in the Figure 4.

3.1. EEG Preprocessing

EEG signal has to be preprocessed before analyzing the human emotions. The signal has many artifacts like noise, heartbeats, errors. These noise may cause the inaccurate emotion. So that the EEG signal has to be preprocessed using spectral filtering, Surface Laplacian Filtering etc., to reduce the noise and get the signal range up to 2 to 40 Hz. Because the emotions have occurred in the short term, so that the signal has to be get within the range.

3.2. Feature Extraction

Feature extraction is the process of analysis the characteristics of waves and extracts the useful information bearing feature which was used for pattern classification. The main aim of feature extraction is used to analyze the raw signal. There are various feature extraction techniques are DWT (Discrete Wavelet Transform), HOC (Higher Order Cumulant), PCA (Principal Component Analysis), MMC (Maximum Margin Criterion), STFT (Short Time Fourier Transform) etc.

3.3. Feature Selection

Features are used to identify the human emotion. So that extract feature only used to identify the best emotion and related emotional disorder. Features are selected using the optimal methods like PSO (Particle Swarm Optimization), GA (Genetic Algorithm), FIREFLY, CSA (Cuckoo Search Algorithm) etc., is used to analyze the optimized feature which was used in the feature classification to classify the emotions into negative elicited and positive emotions.

3.4. Classification

Classification is the process of grouping the related emotions. Features have to be grouped by using various techniques like KNN (K-Nearest Neighbor), ANFIS (Adaptive Neuro Fuzzy Inference System), ANN (Artificial Neural Network), LDA (Linear Discriminant Analysis) etc. Grouping the emotion which is based on how the features are interconnected using particular character and all. Based on these features, emotional disorder has to be identified and person's temporary mood also identified.

4. Literature Survey

In [4], Murugappan et.al introduced a Classification of human emotion from EEG. Emotion is one of the most significant features of humans. It plays a major role in the human life. In the implemented system, The EEG signal is collected from the patient. The collected signal is preprocessed by using surface laplacian filtering technique. Then the signal decomposed into two namely approximation coefficients (CA) and detailed coefficients (CD). Finally, Linear Discriminant Analysis (LDA) and K-Nearest Neighbor (KNN) are used to classify the discrete emotions. By using modified energy features (Absolute Logarithmic Recoursing Energy Efficiency) we obtained better classification rate compared to the conventional features. However, it does not consider the different set of statistical features for improving classification accuracy.

In [5], Emily Mower et.al introduced an Automatic Human Emotion Classification framework. Automatic recognition of emotion is becoming an increasingly significant factor in the intend process for affect-sensitive human–machine interaction (HMI) systems. An introduced system proposes an emotion classification mechanism which is based on emotion profiles (EPs). In audio and video files the motion and capture features are extracted at utterance-level. Then it can be normalized by using z-normalization. The best features are selected for getting high accuracy. Finally, the SVM (support vector machine) is used for classification. The neutral emotion class is difficult to classify because there exists a wide range in the variability of emotion expressed within this class. Neutral expressions may be colored by shades of anger, happiness, or sadness. However, the utility of EP representation is still investigated.

In [6], Saadat nasehi et, al introduced an emotion classification. The six emotions such as happiness, surprise, anger, fear, disgust and sadness are considered. In this system, Gabor functions and wavelet transforms are used to select the specific features such as spectral, spatial and temporal features from EEG signals. Then R effective features were obtained from each representation by applying DFT and PCA. Finally, an optimal nonlinear decision boundary was determined by using PNN classifier. The used PNN classifier had an inherently parallel structure and prevented the premature convergence which can increase the sensitivity of algorithm. The best result is obtained when PNN classifier and Gabor-based features are used. This algorithm can achieve 64.78% accuracy that can be used in brain-computer interfaces systems.

In [7], Giyoung Lee et.al introduced a new Emotion recognition technique which is based on 3D fuzzy visual and EEG features in movie clips. The emotion recognition technique introduced for understanding the emotional state of humans while seeing a movie clip. The positive and negative video clips are taken for process. Here both color and orientation features are considered to decrease computational time. Based on the values represented in the three axes (i.e.) frequency, power and time in the alpha and gamma bands the 3D tensor data for the brain signals are constructed. The orientation information is clustered into group by using fuzzy c means clustering. The EEG emotional features are extracted by using 3D fuzzy tensor. Finally, an adaptive neuro-fuzzy inference (ANFIS) classifier is used to emotion classification. However, it does not suitable for different emotions, such as arousal information. However, the optimal feature selection is needed.

In [8], Prashant Lahane et al. Proposed a EEG Based Emotion Recognition System. In order to recognize the emotions efficiently and get emotions without flaws, the emotion recognition system is introduced. The EEG signal is taken from the humans and it can be

preprocessed by using ICA (Independent Component Analysis). The signal features are extracted by using KDE (Kernel Density Estimation). The KDE (Kernel Density Estimation) is a method which determines the density estimate by using kernel-smoothing method. Finally, the Artificial Neural Network is used to classification. In this network, according to the feature category lot of neurons in input layer and hidden layer are changed, whereas a lot of neurons in the output layer is nothing but the four emotional states. However optimal feature selection is needed to reduce the computational time.

In [9], Mahdi Khezriet.al introduced a Reliable emotion recognition system. The six general emotions such as anger, sadness, fear, disgust, happiness, and surprise are taken from the video clips. EEG signal is taken from the humans for recognizing process. The features are extracted from EEG signal. To use the most salient features and eliminate irrelevant features and therefore speed up the training phase. The best subset of the features for each signal was determined. In order to achieve high accuracy sequential forward floating selection algorithm is used for feature selection. Finally Support vector machine classifier is used to classification. The Support Vector Machine (SVM) is to generate margin between data of different classes is maximized. The proposed system was achieved high accuracy and lower computation time. However optimal feature selection mechanism is needed for achieve high classification accuracy.

In [10], Reza Khosrowabadi et.al introduced a biologically inspired feed forward neural network for classifying emotions from EEG signal. It consists of three phases preprocessing, feature extraction, feature classification. In preprocessing EEG signal has to be filtered by using a band pass filter. The window length has to be selected by using Genetic Algorithm. The second phase is feature extraction. Discrete wavelet transformation is used to filter the signal into different band level. For emotion classification biologically inspired Neural Network is used. The Neural Networks has six layers. Each and every layer process the particular functions. Before classifies the emotion feature dimensions have to be reduced by using Non Negative Principal Component Analysis and connectivity features has to be selected based on the unsupervised learning method. Connectivity features are classified into different group of emotions. Radial basis function is used to classify the emotions. The accuracy of the neural network is compared into the different feature extraction and learning algorithms. The various techniques in EEG analysis is shown in the Figure.4.

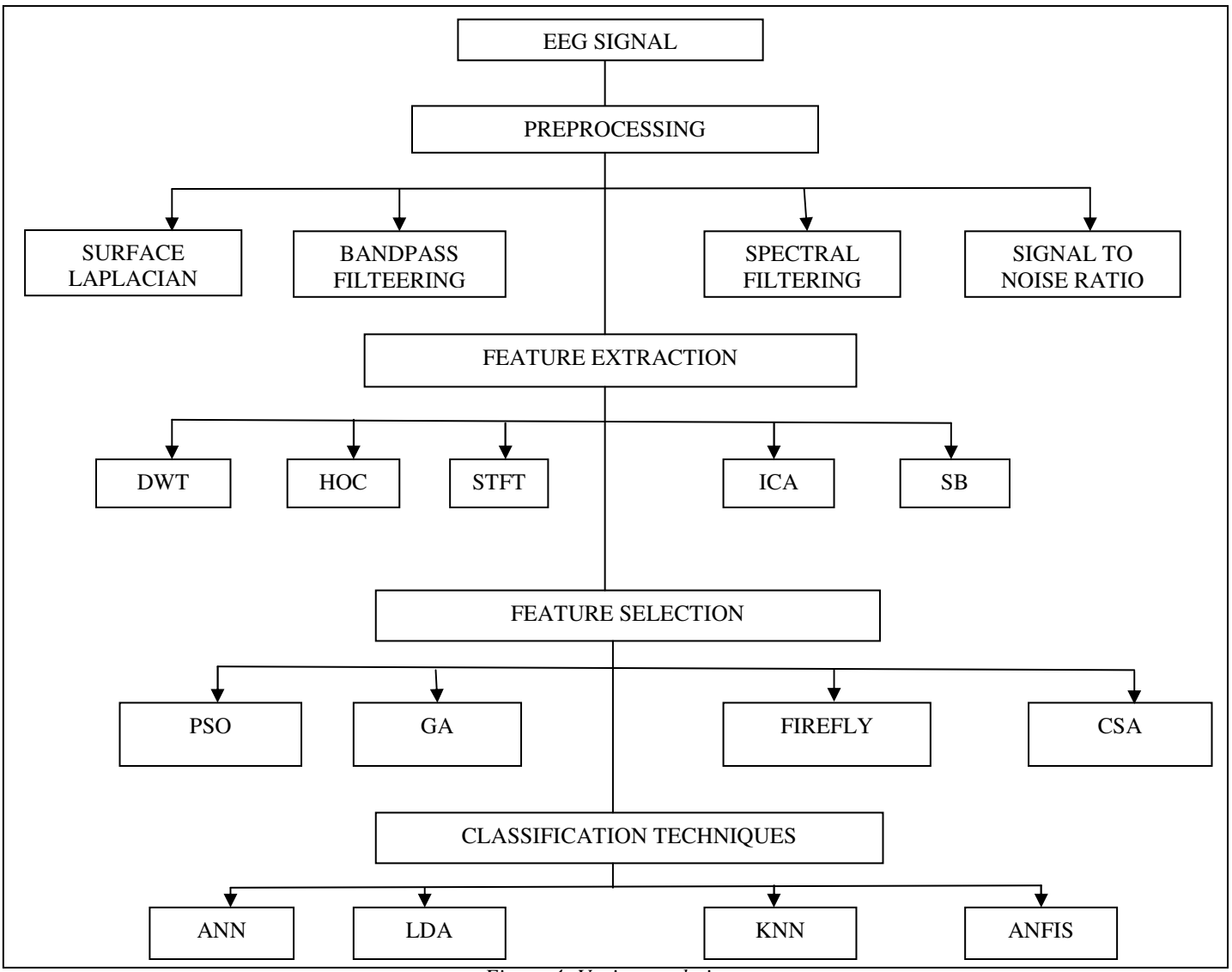

Figure 4: Various techniques

5. Comparison of Methodologies

This section provides an overview about the pros and cons that are occurred in the research methodologies whose functional scenarios are discussed in depth in the previous section. From the following table, it can be predicted a better approach that provides considerable improvement in the proposed scenarios.

S.NO	TITLE OF PAPER	AUTHOR NAME	MERITS	DEMERITS	CITATION
1.	Classification of human emotion from EEG using discrete wavelet transform	Murugappan, Nagarajan Ramachandran, Yaacob Sazali	Maximum average classification rate	It does not consider the different set of statistical features for improving classification accuracy.	[iv]
2.	A Framework for Automatic Human Emotion Classification Using Emotion Profiles	Emily Mower, Maja J Mataric´, and Shrikanth Narayanan	High performance improvement	The utility of EP representation is still inspected.	[v]
3.	An Optimal EEG-based Emotion Recognition Algorithm Using Gabor Features	Saadat nasehi, Hossein pourghassem	It achieves average accuracy of 64.78%	An improved accuracy is needed for getting correct classification	[vi]
4.	Emotion recognition based on 3D fuzzy visual and EEG features in movie clips	GiyoungLee a, MinguKwon SwathiKavuriSri, MinhoLee	High classification rate	An optimal feature selection is required	[vii]
5.	An Approach to EEG Based Emotion Recognition and Classification using Kernel Density Estimation	Prashant Lahane, Arun Kumar Sangaiah	Better accuracy	An optimal feature selection is needed to reduce the computational time.	[viii]
6.	Reliable emotion recognition system based on dynamic adaptive fusion of forehead bio potentials and physiological signals	Mahdi Khezria, Mohammad Firoozabadib, Ahmad Reza Sharafata	It achieves classification accuracies of 84.7%	optimal feature selection is required	[ix]
7.	ERNN: A Biologically Inspired Feed forward Neural Network to Discriminate Emotion from EEG Signal	Reza Khosrowabadi, Chai Quek, Kai Keng Ang	High accuracy	It requires further improvement More robust techniques needed forfeature selection	[x]

Table 1: Comparison of Research Methodologies

6. Conclusion

Various techniques of classification using EEG signals have been suggested earlier in literature by many researchers.All the research works that has been introduced in the previous works are evaluated and discussed in terms of their merits and demerits. From this, it is concluded that the Biologically Inspired Feed Forward Neural Network to Discriminate Emotion from EEG Signal approach can lead to a performance improved in terms of classification accuracy rate and computational time.

7. References

i. J. Preethi, M. Sreeshakthy, A.Dhilipan, "A Survey on EEG Based Emotion Analysis using various Feature Extraction Techniques", International Journal of Science, Engineering and Technology Research (IJSETR), Volume 3, Issue 11, November 2014.

ii. Shamla Mantri,Vipul Patil, Rachana Mitkar, "EEG Based Emotional Distress Analysis – A Survey", International Journal of Engineering Research and Development e-ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com Volume 4, Issue 6 (October 2012), PP. 24-28 .

iii. Prashant Lahane, Shrutika Lokannavar, Apurva Gangurde , Poonam Bhosale and Pooja Chidre, "EEG Based Emotion Recognition System", International Journal of Computer Science and Information Technologies, Vol. 5 (6) , 2014, 7656-7658.

iv. Murugappan Murugappan, Nagarajan Ramachandran, Yaacob Sazali, "Classification of human emotion from EEG using discrete wavelet transform", J. Biomedical Science and Engineering, 2010, 3, 390-396.

v. Emily Mower, Maja J Mataric´and Shrikanth Narayanan , "A Framework for Automatic Human Emotion Classification Using Emotion Profiles", IEEE transactions on audio, speech, and language processing, vol. 19, no. 5, July 2011 1057.

vi. Saadat nasehi, Hussein pourghassem, "An Optimal EEG-based Emotion Recognition Algorithm Using GaborFeatures", WSEAS TRANSACTIONS on SIGNAL PROCESSING, Issue 3, Volume 8, July 2012.
vii. Giyoung Lee , MinguKwon, SwathiKavuriSri and MinhoLee, " Emotion recognition based on 3D fuzzy visual and EEG features in movie clips", Elsevier , 2014.
viii. Prashant Lahane, Arun Kumar Sangaiah, "An Approach to EEG Based Emotion Recognition and Classification using Kernel Density Estimation", Elsevier, 2015.
ix. Mahdi Khezria, Mohammad Firoozabadib, Ahmad Reza Sharafata, " Reliable emotion recognition system based on dynamic adaptive fusion of forehead bio potentials and physiological signals", Elsevier , 2015.
x. Reza Khosrowabadi, Chai Quek, Kai Keng Ang, Abdul Wahab, "ERNN: A Biologically Inspired Feed forward Neural Network to Discriminate Emotion from EEG Signal", IEEE Transactions on neural networks and learning systems, vol. 25, no. 3, march 2014 609.