Improving Accuracy of Classification of Emotions Using EEG Signal and Adaptive PSO

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Abstract: For detecting the feelings or emotions of the human being by using brain signals and its classification has been attempt by many researchers. The EEG headset is used for collecting the brain signal of the subject. Because of lots of noise in the input signal taken by EEG headset, various features need to be used as a single feature that cannot give accurate output. The Number of feature used is the key for identifying the emotion of a person automatically. So, we identify various features using an AI based scheme from EEG recorded signals. This various features are saved in the database. Features include mean, maximum, minimum, std. deviation, variance, corr. Coefficient, cov. Coefficient, Median, Kurtosis, Energy, Zero crossing rate. By using Maximum Relevance Minimum Redundancy (MRMR), as per the name we arrange the features to minimum-relevance and maximum-importance of every feature. For removing essential segments PCA is used to diminish the produce feature. The proposed system will outperform and improve the accuracy of emotion detection by using brain wave and Adaptive PSO.

1. INTRODUCTION

EEG is the procedure of electrophysiological checking, this records the electrical developments of mind. EEG is noninvasive technique with terminals set close to the human scalp. In Electrocortocography obtrusive terminals are been used in which the sign from the mind that is electrical signal[1]. This electrical action going on in the scalp is recorded by the EEG headset. EEG headset is set on the scalp of the human from which the distinctive sign is recorded from the scalp of the human for feelings and emotions which is used for distinguishing or classification. EEG may moreover be valuable for diagnosing or treating the disperses like brain disability cerebrum hurt from brain injury, mind tumor that can have a collection of causes encephalopathy, rest issue, stroke. EEG can moreover be used in start to finish thought contraptions for cerebrum feature.
Lots of inefficiency come with the existing work to make it efficient new technologies can be created. Like the SVM requires a legitimate determination of part so as to perform precise location of feelings from the EEG sets[2]. Therefore, so as to tune the exactness, we are planning to coordinate a PSO and SVM based calculation which will perform characterization, and will gain from the output themselves so as to get the best possible after effects of feeling classification. The issue recognized by us is the issue of low precision given by the framework, and how to improve it utilizing the idea of adaptive swarm optimization, and its self-adaptive learning calculation.

The above Figure 2 shows the emotion detection using Adaptive PSO[3]. In this system the different modules explained as follows:
1. Module for collecting the data: This module is use to gather information from EEG headset for all kind of feelings such as excited, sad, neutral and happy.
2. Preprocessing of Signal: Signal is preprocessed by utilizing adaptive Gaussian filter for eliminating the noise from the signal from EEG headset and to get the spike free signal. This is done for smoothening of the signal by using the filter before using classification algorithm.
3. Extraction of Feature from the Signal: With the help of statistical and wavelet features will be extracted once preprocessing is done the feature extraction in done to describe the signal as per required[4].
4. Classification of Signal: Classification of emotion can be done by using adaptive PSO which is the combination of SVM (Support Vector Machine) and PSO (Partial swarm optimization). The extracted features are further given for training and evaluation process for obtaining the classification of the emotions [3].
2. METHODOLOGY

2.1. Training

1. Various input EEG signals of feelings & emotions such as happy, sad, neutral and excited are taken from the EEG headset for training process.
2. Pre-processing using Adaptive Gaussian filter. The collected data will be pre-processed in order to obtain the noise free signals from the system. Adaptive Gaussian filter is used to remove power line interference in EEG signals. PLI noise is also known as spike noise. This noise appears because of the electrical gadgets which are operating nearby.
3. Features like Mean, Max, Min, Std. Deviation, variance, corr. Coefficient, cov. Coefficient, Median, Kurtosis, Energy, ZCR. These features are extracted using wavelet and statistical features.
4. The collected signals and their features are taken with the emotions and signals of all emotions are saved in the database with the features.

2.2 Testing

Figure 3. Block Diagram for training process.

Figure 4. Block Diagram for testing process.
1. As the signal is taken from the EEG headset for testing the signal, this signal is pre-process by using Adaptive Gaussian filter for removing spike noise from the signal for testing the state of emotion.

2. After preprocessing the signal has been smoothen due to the filter used. After extraction of the features the features which are nearby to the original signal is consider from the database and the features which are not nearby are eliminated. Maximum features matching the original signal feature will be selected from the database and accordingly the signals will the selected

3. By using PSO signal is classified in which the original signal is the pbest i.e. personal best value and data stored (signal stored in the database) is the gbest signal i.e. group best value. pbest signal search for the nearby value of signal in the gbest signals. As the nearby value is found it display the emotion of that gbest signal which is nearer to the original signal.

3. TOOLS

The tools as well as platforms which are required to complete this project are listed below:

3.1 Project Requirements

- Hardware Components:-
  EEG Headset
- Software Requirements:-
  MATLAB
- Languages to be used:-
  Programming language C

3.2 Identification of device

Electroencephalography (EEG):

A test which is used for identification of electrical signals or action of mind by using electroencephalography (EEG). Anodes (slight wires) and small plates made of metal are put on the scalp of the person and then to record the outcomes impart signals to a computer. An electrophysiological identifying technique is used for recording electric movement of cerebrum. EEG identifies covert process which is handling that doesn't require a reaction. EEG is utilized in subjects which can be unequipped for making an engine reaction. Parts of ERP can recognized in any event when the subject isn't taking care of improvements. Dislike many methods for examining response time. Phases of preparing (as opposed to simply the last final product) can be explained by ERPs. EEG is a powerful asset for following mind changes during various periods of life. EEG rest investigation can demonstrate noteworthy parts of the planning of mental health, including assessing immature mind development. In EEG, there is a superior comprehension of which sign is estimated when compared with other research procedure [5].

Adaptive Gaussian filter:

Equations Gaussian separating has been seriously concentrated in image processing and PC vision. Using a Gaussian channel for eliminating spike noise. Gaussian filter smoothen the signal by removing the noise and the signal is distorted. The utilization of a Gaussian channel as pre-processing for edge detection will likewise offer ascent to edge position removal, edges disappearing, and apparition edges. Here, the creators first audit different strategies for these issues. They at that point propose a versatile Gaussian sifting calculation wherein the channel change is adjusted to both noise characteristic and the local variance of signal [6]. Adaptive Gaussian filter is used in the project for eliminating the noise. Noise such as PLI (Power Line Interference) or spike noise. This noise is because of the electrical equipment that is active nearby is known as PLI noise. Cancellation of this spike noise can
be done by using this adaptive Gaussian filter. After preprocessing the signal is send to extract the features of the EEG signal.

**Feature Extraction:**

Once the signal is preprocessed, then with the help of wavelet and statistical features, the features will be extracted and the signals will be described as per requirement. After preprocessing the signal has been smoothen due to the filter used. The features are extracted from the signal [7]. After extraction of the features, the features which are nearby to the original signal is consider from the database and the features which are not nearby are eliminated. Maximum features matching the original signal feature will be selected from the database and the signals will the selected accordingly. There are many features which are extracted from the EEG signal the features can be extracted are the wavelet and statistical features. Various feature such as Mean, min., max., std. deviation, Variance, corr. Coefficient, cov. Coefficient, median, kurtosis, energy, ZCR (zero crossing rate) are calculated.

**Adaptive particle swarm optimization technique:**

An intelligent technique is introduced for finding a micro seismic source dependent on Particle swarm optimization (PSO) idea [8]. It kills micro seismic source finding mistakes brought about by the inaccurate velocity model. The strategy utilizes, as objective of PSO, a worldwide least of the total of squared discrepancies in between contrasts of displayed appearance time and difference of estimated appearance times[8][9]. The discrepancies are determined for all sets of indicators of seismic monitoring method. At that point, the Adaptive PSO calculation is done to find the micro-seismic source and get optimal value of the Pwave velocity[10]. The PSO calculation inertia weight, accelerating constants, the maximum flight velocity of particles, and different parameters to keep away from PSO calculation catching by local optima at the time of solution procedure. The starting time of micro seismic occasion is evaluated by limiting the addition of squared discrepancies between demonstrated received times and the calculate received times. This addition is determined utilizing the obtained result of micro seismic source directions and Pwave speed. Effectiveness of the PSO calculation was checked through inversion of a theoretical model and to analyze the actual information from mine blasts in many locations. The PSO calculation shows quicker, higher accuracy and convergence of micro seismic source area. In addition, there is no compelling reason to quantify the micro seismic wave velocity ahead of time. The PSO algorithm takes out adverse impacts brought by error in Pwave velocity when finding a micro seismic source using traditional strategies [11].
The above Figure 5 shows the flow chart of PSO classifier which explains the following steps:
1. Random particle vectors are initialized.
2. Values of fitness for each particle is found.
3. For every particle vector pbest value is calculated according to the fitness-values.
4. Then from those pbest or personal best values gbest value is obtained.
5. Update each particle’s position.
6. If the target is not reached go to the step 2 and repeat the process.
7. If criteria fulfilled then end the process [12].

4. RESULT

4.1. Output Using KNN:

k-Nearest Neighbor Classifier

K-Nearest Neighbor classifier is a non-parametric methodology, which classifies a given information point as indicated by most of its neighbors. The KNN calculation finishes its execution in two stages, first finding the number of closest neighbors and second grouping the information point into specific class using first step. To find the neighbor, it utilizes Euclidean distance as given in below equation.
Distance\((x, y) = \sqrt{(x_i - y_i)^2}\)

It picks closest k samples from the preparation set, at that point it takes majority vote of their class, where k must be an odd number to avoid uncertainty.
4.2 Output using Adaptive PSO:

Adaptive PSO:-

Adaptive PSO signal is used for classification on signals. In which the original signal is the pbest and data stored is the gbest signal. pbest signal search for the nearest value of signal in the gbest signals, as the nearest value is found it displays the emotion of that gbest signal which is nearer to the original signal.
Figure 10. Happy signal using Adaptive PSO

Figure 11. Sad signal using Adaptive PSO
Figure 12. Excited signal using Adaptive PSO

Figure 13. Neutral signal using Adaptive PSO

Table 1. Accuracy of KNN and Adaptive PSO.

| Classifier   | No. Of Inputs | No. Of Correctly Classified | Accuracy |
|--------------|---------------|----------------------------|----------|
| KNN          | 20            | 17                         | 85%      |
| Adaptive PSO | 20            | 19                         | 95%      |
We have taken 20 inputs from EEG headset for testing and classifying the emotions of human being. By using KNN we got 17 correct output classified out of 20 and by using Adaptive PSO we got 19 correctly classified outputs. So the accuracy of the classifier KNN is 85% and Adaptive PSO accuracy is 95%.

5. CONCLUSION

The proposed work have compared the output of the KNN and Adaptive PSO and calculated the accuracy of the system by using both classification techniques. We found better correctly classified output by using Adaptive PSO. Thus we have improved the accuracy of the system using adaptive particle swarm optimization technique.

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