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DEEP LEARNING FOR FEATURE CLASSIFICATION OF EEG TO ACCESS STUDENT'S MENTAL STATUS

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ABSTRACT

Electroencephalography (EEG) analysis has been a significant tool in neuroscience with uses of, neural designing and Brain–PC interfaces. A large number of the explanatory tools are utilized in EEG contemplates have utilized machine learning to reveal significant data for neural classification and neuro imaging. As of late, the accessibility of enormous EEG informational indexes and advances in machine learning have both prompted the arrangement of deep learning structures, particularly in the examination of EEG signals and the usefulness of cerebrum. In our proposed work, cuttlefish optimized (CFO) deep neural networks are utilized to distinguish depression in individuals by analyzing EEG signals. Best highlights of alpha, beta, theta values chose by CFO so as to improve an accuracy. The execution is assessed utilizing the Database for Emotion Analysis Physiological Signals (DEAP), which is an open EEG dataset. A list of capabilities is removed in 32 EEG channels, which comprises of measurable highlights, Hjorth parameters, band power, and frontal alpha asymmetry. MATLAB tool has been utilized to assess the execution of proposed framework.

Key words: *Depression, EEG, CNN, Cuttlefish Optimization.*

I. Introduction

Depression is a mental problems that influences almost 10 percent of the total peoples. As of now, the location of depression incorporates organized polls that are regulated as a meeting [1]. The depression analyze have the conspicuous weaknesses like incorrectness, reduced affectability, quiet refusal and emotional predispositions [2]. In the other hand, the literatures [1-6] have utilized EEG to inspect frontal mind actuation. These are affectability, moderately minimal effort and accommodation of recording. In any case, these strategies for the most part target distinguishing significant depression [6-8], there are hardly any investigations that give compelling discovery intends to mellow depression [2,6], in order to enable gentle depression to play it safe and evade gentle depression developing

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into significant depression [2]. In this work, a novel EEG based technique is proposed which is usedto recognize depression.

This paper is organized as: In the section 1 and 2 described EEG depression analysis. The Section3 describes a multi objective cuttlefish optimized framework using neural network is explained. The experimental analysis is described in Section 4 and the Section 5 concludes the work respectively.

II. Related Work

Yan Guo [1] et al described a depression detection method using particle swarm optimization. Their work divided into, categorized by linear discriminant analysis (LDA), particle swarm optimization (PSO) which is used to detect the depression and also in experiments that accuracies achieved 100% of positive.

Shamla Mantri [2] et al tried to classify the mental state of the person using the combined approach of FFT and machine learning algorithm. The machine learning used for non invasive detection of depression is support vector machine. Verification results shows that improved accuracy of proposed system when compared to others.

Nagabushanam [3] et al defined new methods to detect amplitude spikes, location and duration of EEG signal. Severity of epilepsy related to EEG signal parameters to find disorder in earlier stage. Implementation results shows, proposed method detects depression state earlier.

Jian Shen [4] et al proposed a depression detection system with negative, positive and neutral affective auditory stimuli. The work conducted experiment by collecting EEG signal from three position of prefrontal lobe (Fpl, Fpz, and Fp2). Then, features extracted using Empirical Mode Decomposition (EMD). The implementation results shows that high frequency affective auditory stimuli has better efficiency than other methods.

Jing Zhu [5] et al proposed depression detection method using content based ensemble method (CBEM) with high accuracy. The proposed method uses both static and dynamic CBEM. Finally, majority voting applied for classification. The proposed system test on eye tracking and resting state EEG data sets and achieved a accuracy of 82.5% and 92.65% respectively.

Yu-Hsun Lee [6] et al developed sleep state detection using only single channel. The proposed system tested by hypnogram and applied in REM sleep stages. It achieves accuracy of 80%.

Xiaowei [7] Li et al studied the cognitive procedure for depression detection in mild stage. The output results shows that right hemisphere of brain is in normal state during cognitive process. But the activities of prefrontal and parietal regions in normal depression state.

Prima Dewi Purnamasari [8] et al introduced a new system for stress level detection. It shoes that, Meditation Application in order to reduce a stress level based on measurement. It uses FFT for feature extraction and k-Nearest Neighbor (k-NN) for feature classification. The features like Delta, theta, alpha, and beta waves classified by KNN and achieve accuracy of 80%.

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Pascal Ackermann [9] et al proposed a method for detecting emotion in EEG waves. The proposed system uses 12 channels to measure a signal and machine learning classifier for classification. The work achieved a 93% results than conventional methods.

Ahmad Rauf Subhani [10] et al proposed a logistic regression classifier based depression detection system in the experimental setup uses Montreal imaging stress task to validate a stress level and subjective feedback. It classify the features with algorithms of logistic regression, support vector machine and naive bayes classifiers. The proposed system achieved a results of 94.6% compared to conventional techniques.

III. Proposed system

World wide optimization calculations are typically sorted as deterministic and meta heuristic [1]. Deterministic calculations will in general use angle method and find more noteworthy use in taking care of unimodal issues, while meta heuristic models will in general learn as they run. Along these lines, meta heuristic models are known to be increasingly adaptive and intelligent. They are for the most part quicker when finding a world wide ideal than the deterministic calculations.

In this work , a meta heuristic cuttlefish optimized deep CNN network design is recommended to classify human EEG signal data in to depression stages, and that improves upon the classification performance of prior CNN using feature selection. Propose system includes following data processing modules as shown in fig .1

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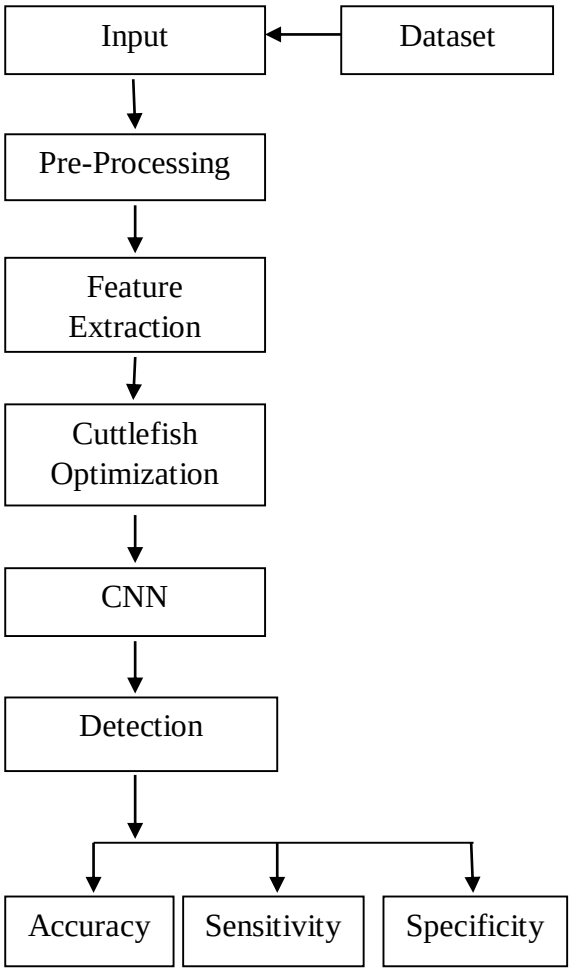

Fig.1 Overview of Proposed Work

Signal Dataset

In this work the EEG signals are taken from Database for Emotion Analysis using Physiological Signals (DEAP), which is a public EEG dataset. It is used for training and evaluating the neural network models. The dataset has two parts i.e. normal and depressed. All these signals are available in (.edf) format.

Pre-processing

EEG is a non invasive technique of taking the physiological signal of brainwave activity. The low pass filter is used to calculate approximately the contaminants which can take away from the EEG data.

Feature Extraction

The EEG signal has weak, nonlinear, and time sensitive characteristic, which shows normally complex dynamics. In order to get the feature matrix, perform the feature extraction of the EEG. The EEG features are mostly separated in to Time Domain Features and Frequency Domain Features.

Feature Selection

It becomes more important when the number of features are very large. It enables the deep learning algorithm to train faster. It reduces the complexity of a model. Cuttlefish Optimization Algorithm(CFA) is used to select the best features, which is a population based search algorithm.

Cuttlefish Optimization

Cuttlefish is a sort of cephalopods which is well known for its capacities to change its color to either apparently vanish in to its condition or to deliver staggering presentations. The cephalopods are created by various layers of cells stacked together including leucophores, chromatophores and iridophores.

Proposed Cuttlefish Algorithm

Chromatophores cells has red, orange, yellow, dark, and earthy colored shades. Furthermore, the "iridophores and leucophores" permit the cuttlefish skin to have the rich and various colors conditions. The presence of the cuttlefish subsequently relies upon which skin components influence the light occurrence on the skin. Light might be reflected by reflecting cells "iridophores or leucophores" or a mix of its physiological variability of the chromatophores and also reflecting cells which empower the cuttlefish to deliver the collection of optical impacts. From the Fig.2, it signifies Cuttlefish skin specifying the three fundamental skin structures (chromatophores, iridophores and leucophores) with two model expresses (a, b) and three unmistakable beam follows (1, 2, 3) that show the complex methods by which cuttlefish can change intelligent color.

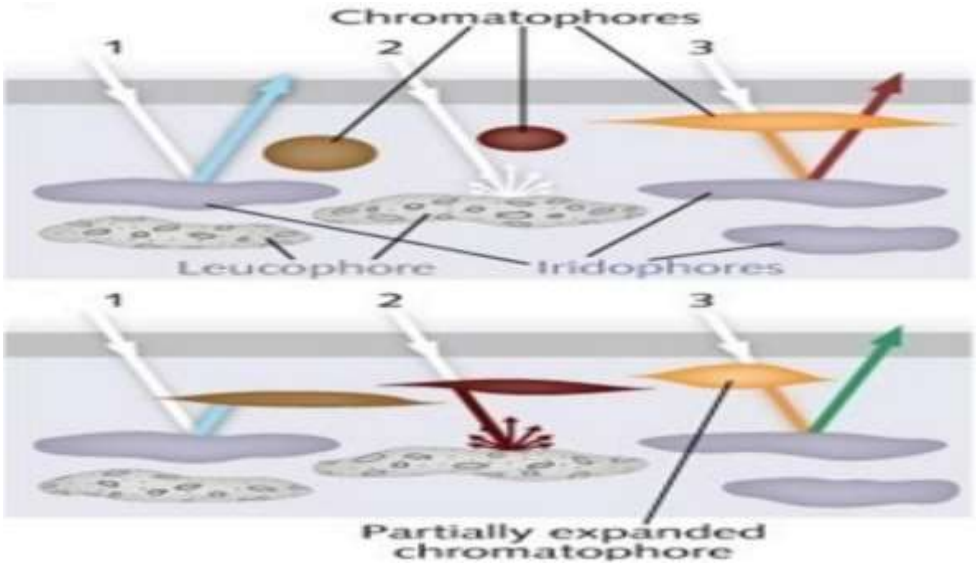

Fig.2 cuttlefish skin specifying the three main skin shapes

The algorithm works on two phases: reflection and visibility. Reflection process mimics the light reflection process, while visibility mimics the visibility of equivalent patterns of the cuttlefish. These two phases are used as a search approach to calculate the global optimal solution. The construction of discovering the new solution (new P) by using two phases is described in below equation.

new p= reflection +visibility

The entire optimal solution finding of cuttlefish described in figure.

Classification

Classification is the process of predicting the class of given data points. After completing the feature selection process, the selected features are apply to the classification phase. CNN is used to classify the normal and depressive subjects.

CNN Architecture

In this architecture, CNN has three sorts of layers namely convolution, pooling, and fully connected. This CNN architecture is consist of 5 convolutional layers, 3 fully connected layers and 5 pooling layers are appeared. During the preparation, the filter is a weighted vector utilized the info for convolving and it gets balanced. The convolutions are set into 5 and pooling tasks are set at 2 in the filters individually. Likewise, the number of testing point window is moved in every activity is fixed at 1 and 2 for the convolution and pooling tasks to be clarified without further ado and individually. The parameters are acquired through experimentation by improving the exactness of the system.

(i) Convolution layer:

The convolution layer is a layer that can be performed by sliding the bit over the contribution to get a convolved yield (include map) utilizing the accompanying the condition:

$$c_m = \sum_{n=0}^{N-1} f_n k_{m-n}$$

Where k is a signal, f is a filter, c is an output and N indicates an informational quantity which focuses in k, individually. The addendum n demonstrates the component of the filter vector in n-th times while m compares to the output component of m-th times which is being determined.

(ii) Pooling layer

The pooling layer diminishes the component map size while simultaneously protecting the highlights in huge number. A most extreme pooling activity is utilized in this investigation, that is, just the biggest incentive inside the step 2, the component map window is held next of each maximum pooling activity.

(iii) Fully connected layer

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The Fully connected layer interfaces each neuron inside the layer to each neuron in the following layer utilizing the accompanying the below eqn:

$$x_i=\sum_j w_{ji} y_j+b_i$$

CNN model is utilized with the neurons quantity in every layer, size of the filter and walks. A convolution activity is acted in the information layer with a size of filter as 5 (stride 1) to obtain the initial layer (output neurons of 1996 x 5). At that point a most extreme pooling activity is acted in the principal layer to minimize the neurons quantity to 998 x 5 in layer 2. Then the next the convolution round is executed to shape the layer 3. After the convolution, the extreme pooling activity is applied to obtain a 4th layer with 497 x 5 neurons. Correspondingly, another three convolution and max pooling activities are performed on the other hand to deliver layers 5, 6, 7, 8, 9, and 10. In the first fully-connected layer, 10th layer is connected to 80 neurons. The 11th layer is thusly connected to 40 neurons in layer 12. Finally, 12th layer is connected to the last layer that speaks to typical and discouraged.

IV. RESULTS AND DISCUSSION

The proposed system was implemented and tested to detect depression. It required approximately 6 minutes 12 seconds to finish 5000 epochs of training the EEG data. An average results from all 5000 iterations declares the overall performance of the system which is described in this section

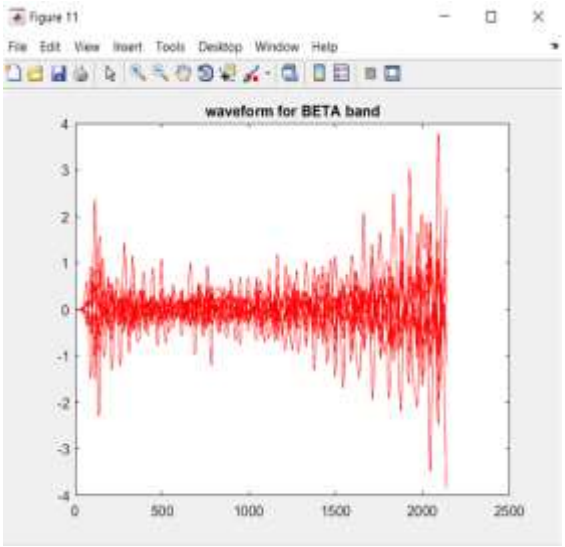

Fig.3 Representation of BETA band

Fig.3 shows that the representation of BETA band after feature extraction process.

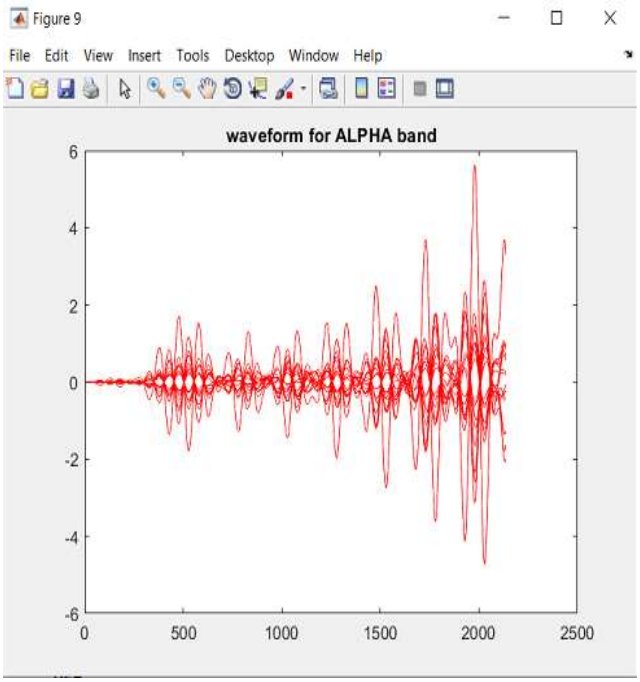

Fig.4 Representation of ALPHA band

Fig.4 shows that the representation of ALPHA band after feature extraction process.

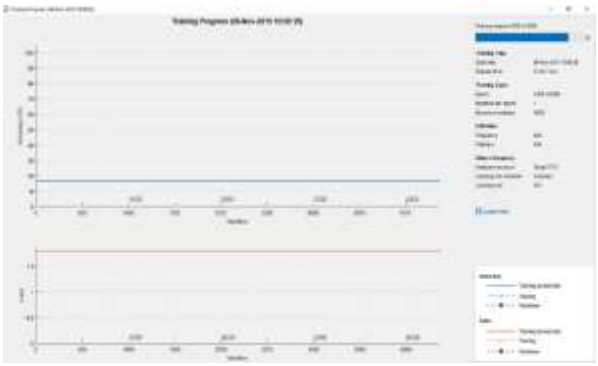

Fig.5 Trained Output

Fig.5 represents the training process of proposed convolutional neural network. After completing the training process, the network is tested and validated using the test dataset.

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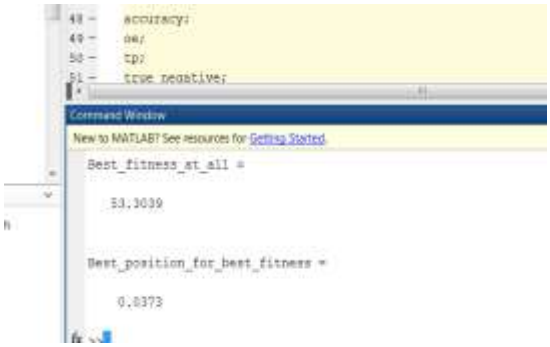

Fig.6 Best Feature Output by CFO

Fig.6 shows that, the best features are obtained using the cuttlefish optimization algorithm.

Table.1 Overall Performance Values

Reference Paper	Accuracy (%)	Sensitivity (%)	Specificity (%)
[8]	80	78	85
Proposed Work	98	90	95

Table 1 shows that the performance (accuracy, sensitivity, specificity) obtained by the proposed network. It represents the variations of performance over the existing and proposed work.

V. Conclusion

Depression is a significant human worry in a large number of people. Consequently, an early stages diagnosing is basic for the treatment so as to spare the life of a patient. In any case, current techniques for depression identification are human serious, and their outcomes are reliant on the experience of the specialist. In this way, an unavoidable and target technique for diagnosing or in any event, screening would be valuable. The current work investigates a novel strategy for depression location utilizing cuttlefish optimized CNN classification. From the outcomes, it is displayed that the best execution classification technique is KNN for all datasets, with the most noteworthy exactness of 80%. The MATLAB software results additionally exhibited the component in all the best execution highlights of the datasets, subsequently recommending a strong association. The general precision of the proposed structure is found by 98%. This could be utilized as a legitimate trademark highlight in the recognition of depression.

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References

[1]Yan Guo ; Haolan Zhang ; Chaoyi Pang ,EEG-based mild depression detection using multi-objective particle swarm optimization,2017 29th Chinese Control And Decision Conference (CCDC)

[2]Shamla Mantri ; Dipti Patil ; Pankaj Agrawal ; Vijay Wadhai ,Non invasive EEG signal processing framework for real time depression analysis, 2015 SAI Intelligent Systems Conference (IntelliSys)

[3]Nagabushanam ; Praharsha Davu ; S. Thomas George ,Morphological Operations on EEG Signals for Spike Detection, 2019 5th International Conference on Advanced Computing & Communication Systems (ICACCS)

[4]Jian Shen ; Xiaowei Zhang ; Junlei Li ; Yuanxi Li ,Depression Detection from Electroencephalogram Signals Induced by Affective Auditory Stimuli, 2019 8th International Conference on Affective Computing and Intelligent Interaction (ACII)

[5]Jing Zhu ; Zihan Wang ; Tao Gong ; Shuai Zeng ,An Improved Classification Model for Depression Detection Using EEG and EyeTracking Data, IEEE Transactions on NanoBioscience

[6]Yu-Hsun Lee ; Yong-Sheng Chen ; Li-Fen Chen ,Automated Sleep Staging Using Single EEG Channel for REM Sleep Deprivation 2009 Ninth IEEE International Conference on Bioinformatics and BioEngineering

[7]Xiaowei Li ; Zhuang Jing ; Bin Hu ; Shuting Sun,An EEG-based study on coherence and brain networks in mild depression cognitive process, 2016 IEEE International Conference on Bioinformatics and Biomedicine (BIBM)

[8]Prima Dewi Purnamasari ; Alya Fernandya ,Real Time EEG-based Stress Detection and Meditation Application with K-Nearest Neighbor, 2019 IEEE R10 Humanitarian Technology Conference (R10-HTC)(47129)

[9]Pascal Ackermann ; Christian Kohlschein ,EEG-based automatic emotion recognition: Feature extraction, selection and classification methods, 2016 IEEE 18th International Conference on e-Health Networking, Applications and Services (Healthcom)

[10]Ahmad Rauf Subhani ; Wajid Mumtaz ; Mohamed Naufal Bin Mohamed Saa ,Machine Learning Framework for the Detection of Mental Stress at Multiple Levels, IEEE Access (Volume: 5)Page(s): 13545 – 13556

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