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EEG-Based Emotion Recognition Using Different Neural Network and Pattern Recognition Techniques – A Review

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***Abstract*—** Emotion recognition is a critical problem in Human-Computer Interaction. Numerous techniques were useful to enhance the strength of the emotion recognition systems using electroencephalogram (EEG) signals particularly the problem of spatiotemporal features. Automatic emotion recognition founded on EEG signals has received increasing attention in current years. The human being is blessed inquisitiveness has always wondered how to make machines feel, and, at the same time how a machine can detect emotions. In this paper, we elaborated the difference emotion recognition techniques. An automatic approach to address the emotion recognition problem of EEG signals using fused ResNet-50 and LFCC features and several classifiers. Performance of proposed approach with 10fold cross validation and LOO cross validation. Results show that the model is effective for emotion classification. KNN achieves the best performance in dissimilar classifiers.

***Keywords*—** EEG, CNN, Pattern Recognition

I. Introduction

In this paper, the use of the 3-Dimensional Convolutional Neural Networks (3D-CNN) is examined using a multi-channel EEG data for emotion recognition. A data expansion phase is developed to enhance the performance of the proposed 3D-CNN methodology. And, a 3D data representation is expressed from the multi-channel EEG signals, which is used as data input for the proposed 3D-CNN model. Wide-ranging experimental works are showed using the DEAP (Dataset of Emotion Analysis using the EEG and Physiological and Video Signals) data [1]. Emotion recognition using brain wave signals involves using high dimensional EEG data. A window selection technique based on mutual information is presented to select a suitable signal window to reduce the length of the signals. The motivation of the windowing method comes from EEG emotion recognition being computationally expensive and the data having low signal-to-noise ratio. The aim of the windowing method is to find a condensed signal where the emotions are toughest. The reduced signal with the highest mutual information is used for extracting the features for emotion classification. A practical framework for emotion recognition is introduced. Experimental results on openly available datasets, DEAP and MAHNOBHCI, show significant development in emotion recognition accuracy [2].

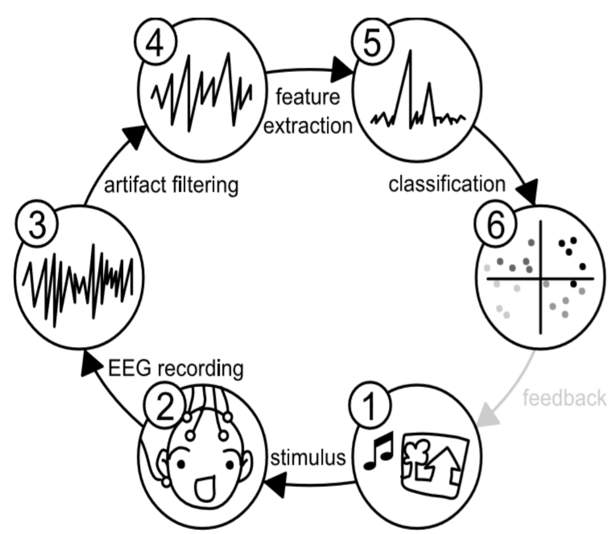

Figure 1: Brain Computer Interface Cycle

Bi-hemispheres Domain Sdversarial Neural Network (BiDANN), for EEG emotion recognition. BiDANN is motivated by the neuroscience findings, i.e., the emotional brain's irregularities between left and right hemispheres. The basic idea of BiDANN is to map the EEG data of both left and right hemispheres into discriminative feature spaces separately, in which the data representations can be classified easily. For additional exactly predicting the class labels of testing data, spreading shift between training and testing data by using a global and two local domain discriminators, which work adversarial to the classifier to encourage domain in different data representation stoemerge. After that, the learned classifier from categorized training data can be applied to unlabeled testing data naturally [3].

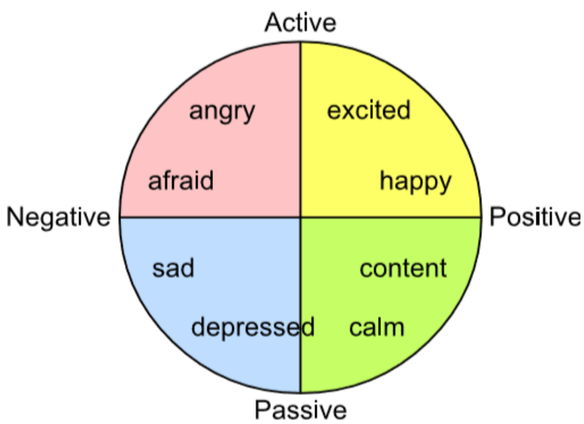

Figure 2: Arousal-valence model

The Deep Residual Networks (ResNets) can solve vanishing slope problem and exploding gradient problem well in computer vision and can learn more profound semantic information. And for basic methods, frequency features regularly play important role in signal processing area. Linear-frequency cepstral coefficients (LFCC) as features from raw EEG signals. Then the two features are fused to improve the emotion classification performance. Classifiers are used for attached features to evaluate the performance a ditshows that the proposed approach is effective for emotion classification. The best performance is achieved when use k-nearst neighbor (KNN) as classifier [4]. Making the computer more empathic to the user is one of the features of affective computing. With EEG-based emotion recognition, the computer can essentially take a look inside the user's head to observe their mental state. Recognize emotion from brain signals measured with the BraInquiry EEG PET device [5].

The human being in his blessed inquisitiveness has always speculated how to make machines feel, and, at the same time how a machine can detect emotions. Maybe some of the tasks that cannot be replaced by machines are the ability of human beings to feel emotions. The field of emotion detection is ahead significance as the technology advances, and mainly due to the current developments in machine learning, the Internet of Things, industry 4.0 and Autonomous Vehicles. Machines will need to be equipped with the capacity to monitor the state of the human user and to change their behaviour in response. An algorithm using EEG data was developed, using the power spectral density of the frequency cerebral bands (alpha, beta, theta, and gamma) as features for classifier training. A K Nearest Neighbors algorithm using Euclidian distance was used to predict the emotional state of the subject. The algorithm was able to recognize nine different emotions (Neutral, Anger, Disgust, Fear, Joy, Sadness, Surprise, Amusement, and Anxiety), nine valence positions, and nine positions on arousal axes. A method developed for evaluating the state of mind of a driver in the context of a semi-autonomous vehicle context [6]. A grouping of distinct features is the key for involuntary emotion detection. A hybrid dimension feature reduction scheme using a total of 14 different features extracted from EEG recordings. The arrangement syndicates these distinct features in the feature space using both supervised and unsupervised feature selection processes. Maximum Relevance Minimum Redundancy (mRMR) is smeared to re-order the combined features into max-relevance with the labels and min-redundancy of each feature. The produced features are further reduced with principal component analysis (PCA) for extracting the principal components [7].

II. METHODOLOGY

A. Using Neural Network

Usually, the automatic emotion recognition process can be approved out using one or more of different types: face, speech, body gestures, and the EEG signals. Using the EEG signals, researches emphasis on solving the problem of correlation in time between emotions. Emotions last for short or long period of time, not just a moment. Thus, the relation between emotion segments in time is highly effective for refining recognition correctness. Inspired by the recent success of the deep learning approaches, the 3DCNN approach is proposed to model the spatiotemporal information from the EEG signals. To influence this objective, data augmentation phase is first applied to increase the number of available EEG samples. Then, the 3D representation of inputs is created from the EEG segments. And finally, the proposed system of the 3D-CNN model is built. The procedure of the system is illustrated in Fig. 3.

B. Adapting Windowing

EEG signals are high dimensional, hence the computational processing of these signals is often complex and expensive. The persistence of feature extraction is to abridge the succeeding emotion classification task by classifying the important elements of the signal, creating a feature vector based on these elements and using the vector to classify the conforming emotion. Obtainable methods to cutting features include wavelet transforms, higher order spectrum and higher order crossings (HOC).

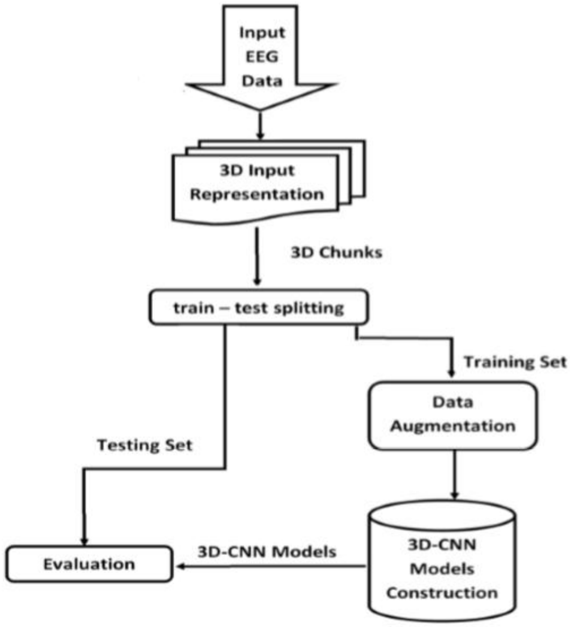

Figure 3: Workflow using Neural Network

The number of features mined is largely dependent on the feature extraction method, and therefore it is supportive to identify the most relevant set of features to enable selection of the most appropriate feature extraction method for emotion recognition. In addition, feature selection is useful for reducing the dimensionality of the EEG signals. Current feature selection methods include minimum redundancy maximum relevance (mRMR), Relief, and differential evolution feature.

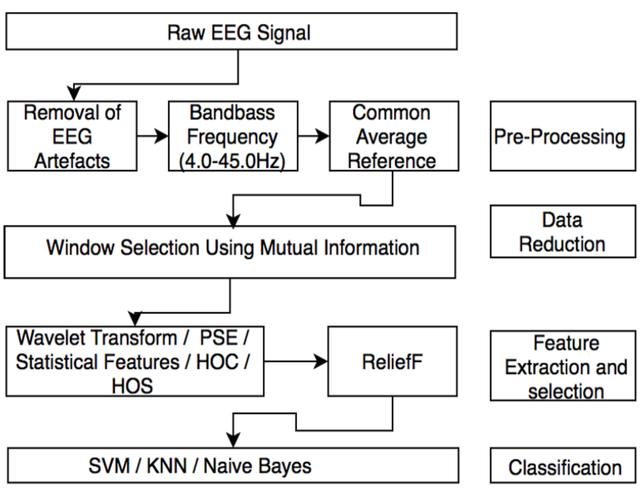

Figure 4: Workflow using Adapting Windowing

III. RESULTS AND DISCUSSION

For EEG recording the BraInquiry PET 2.0 EEG device used, in combination with BioExplorer. The experiments were conducted in the test subject's own homes, using their own personal computers. Reusable electrodes for F3 and F4 attached with conductive glue, throw-away electrodes for Fpz and mastoids. There are two libraries with emotion-annotated images (IAPS) and sounds (IADS) available for non-profit research, which are very useful for emotion research. Figures spread of the 956 visual and 167 auditory stimuli databases on the two-dimensional arousal/valence map. The valence and arousal ratings were obtained by research showing the stimuli to many test subjects and obtaining their aff ect with the self-assessment manikin.

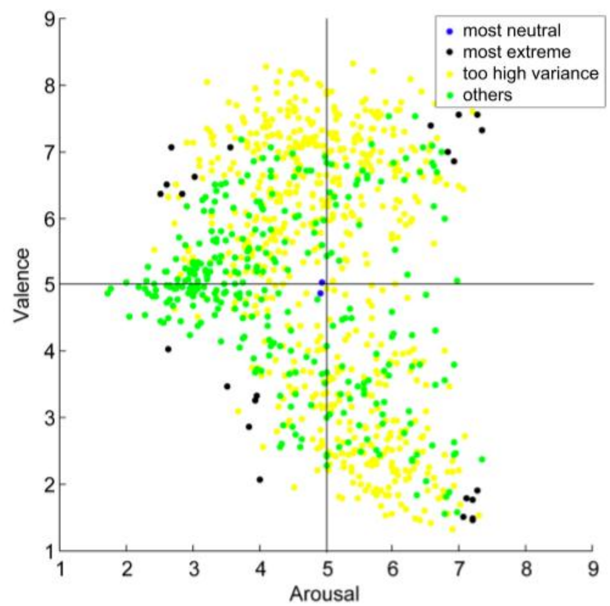

Figure 5: Result

IV. CONCLUSION

An automatic approach to address the emotion recognition problem of EEG signals using fused ResNet-50 and LFCC features and several classifiers. Performance of proposed approach with 10fold cross validation and LOO cross validation. Results show that the model is effective for emotion classification. KNN achieves the best performance in dissimilar classifiers. The comparison of EEG signals produced in similar emotions is higher than by different persons. The model that performances better both on LOO cross validation and k-fold cross validation.

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