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FACIAL EMOTION RECOGNITION USING NEURAL NETWORK

Kashyap Chiranjiv Devendra, Azad Singh Tomar, Pratigyna.N.Javali, R Jagdeesh Kannan
School of Computing Science and Engineering, VIT University, Chennai.
Email: jagadeeshkannan.r@vit.ac.in

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Abstract

Facial expression is the most natural and instinctive means for human beings to communicate with each other Automatic analysis of human facial expression remains a very challenging area of research in computer vision and machine learning. Therefore, facial emotion recognition can be considered as a vital and useful visual based tool for building systems which can identify, interpret, process, and simulate human emotions. The traditional approach for performing facial emotion recognition is tracking changes in the facial muscles which are defined as Action Units (AU). Although Action Units has proven to be a quite successful approach in the process of identification of facial expressions, there are a total of 7000 AUs combinations of different AUs characterized to distinguish the emotions, which can prove to be really a very extensive and time-consuming procedure.

Key Words: Facial Recognition, Facial Expression, Neural Network.

Introduction

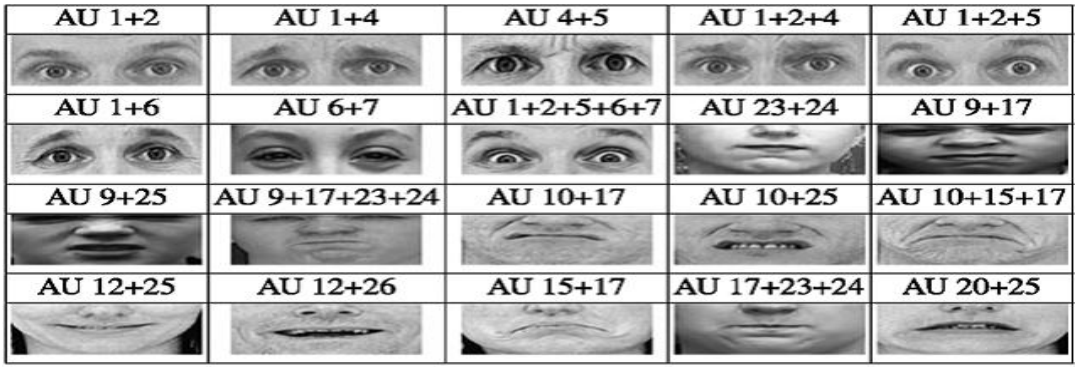


Figure 1: Action Units of several facial configuration.

Human emotion is a visible manifestation of affective state, cognitive activity, emotional state and personality. Like face detection, human emotion analysis is also a very challenging area of research in the field of computer vision and machine

learning. Neural networks (NN) have found profound success in the area of pattern recognition. By repeatedly showing a neural network inputs classified into groups, the network can be trained to discern the criteria used to classify, and it can do so in a generalized manner allowing successful classification of new inputs not used during training. With the explosion of research in emotion in recent year, the application of pattern recognition technology to emotion detection has become increasingly interesting. Automatic facial expression recognition involves two vital aspects: facial representation and classifier design. Facial representation is to derive a set of features from the original face which effectively represent the face. The features should be well defined because it is the key point to distinguish different facial expressions. In this study we focus on movement of two such features i.e. eyebrows and eyes and to determine how the variation in these two components help us to differentiate the 7 basic emotional states of a human i.e. happiness, fear, anger, sadness, disgust, surprise and normal (neutral).

Literature Survey

Facial Action Coding System is the most commonly used research tool in tracking the changes in the facial muscular activity. FACS helps in translating the varying changes in facial muscles to the appropriate Action Units. It is an anatomically based system for describing all notable facial movements in detail[2]. Each notable component of facial movement is called an Action Unit or AU. All facial expressions can be compartmentalized into their constituent AUs[2]. According to Ekman and Friesen, these changes can be transformed into 46 action units by combinations of which we can cover all the basic emotions. Maja Pantic and Ioannis Patras[8] took up the challenge of automatic analysis by recognizing facial muscle actions which are generated through different expressions. They performed particle filtering to obtain 15 fiducial or feature points on sequence of profile face images and were able to obtain recognition rate of 87%.

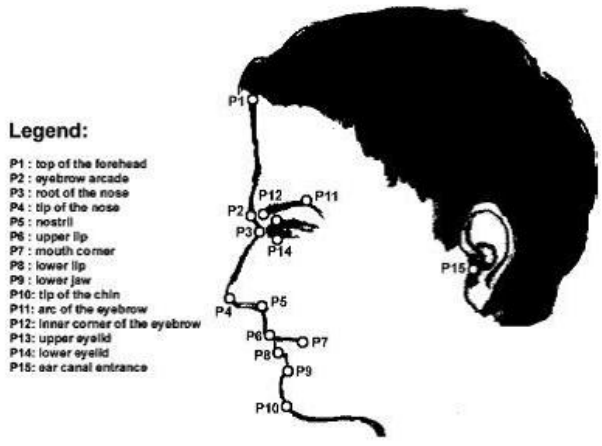


Figure 2: Facial points obtained through Particle Filtering[8].

The selection of these 15 facial points are shown in fig.2. Guided Particle Swarm Optimization (GPSO) algorithm[4], a variation of PSO algorithm implemented by Bashir Mohammed Ghandi, R. Nagarajan and Hazry Desa for facial emotion detection by tracking the relevant points, which here are considered as Action Units (AUs) and is able to detect the six emotions in real time. But a drawback of GPSO algorithm encountered was that image pre-processing needed to be performed, hence its application was limited to pre-recorded images only. Therefore they improved the system by implementing Lucas- Kanade (LK) [4] optical flow algorithm. LK Algorithm helped in keeping track of the positions AUs in real time which eliminated the requirement of pre-processing. However they observed that the Back-Propagation Neural Network (BPNN)[7] has proven more successful in classification based problems.

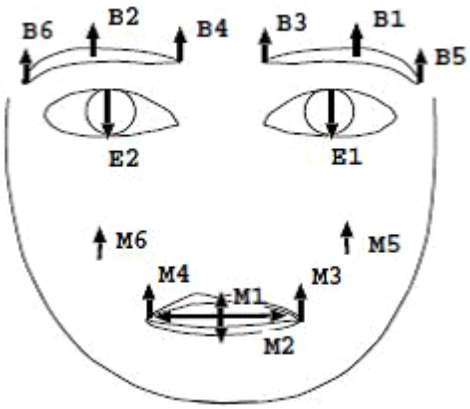


Figure 3: Facial Features classified by Bayesian Network[5].

After comparing both the approaches they concluded that BPNN is better than GPSO in terms of speed however the accuracy of results by BPNN was slight less than GPSO. Yoshihiro Miyakoshi, and Shohei Kato[5] gave an another approach of using Bayesian Network for emotion detection system with facial features. Bayesian network classifiers infer from the dependencies among the target attribute and explanatory variables. The system proposed by them tries to learn Bayesian Network in two phases: internal and external phase. The internal phase uses K2 algorithm to construct casual relations among the facial features whereas the external phase constructs casual relation between facial features and emotions using feature selection. The facial features constructed by the K2 algorithm are depicted in fig. 3. A facial components detection method proposed by Byung-Hun Oh, Kwang-Seok[6] Hong uses the histogram method, the blob labeling method, and the MMGC image for face detection with an accuracy of 81.4%. Tie Yun and Ling Guan[3] proposed an alternative by introducing fiducial points localization using scale invariant feature based Adaboost classifiers and were able to achieve 90.2% average recognition rate using Support Vector Machines (SVM). These 26 fiducial

points as per classification of AUs[2, 10-12] can be described as per given table. According to Tie Yun and Ling Guan, these feature points extracts most important characters of the face and these points must be selected as minimum as possible.

Methodology

The raw images were processed for denoising, edge detection and then latter on for object extraction using the known methods [13-15]. In this we are using Back propagation Neural Network, which is a feed-forward network, the neurons are partitioned into layers, with links from each neuron in layer n being directed (only) to each neuron in layer (n+1). Inputs from the environment are fed into first the layer (the input layer), and outputs from the network are obtained at the last layer (the output layer). The middle layers are referred to as hidden layers. A weight or "connection strength" is associated with each link, and the network is trained by modifying these weights, there by modifying the network function which maps inputs to Outputs.

The architecture of the network we used is shown in Fig 4. It consists of three layers, namely, Input, Output and one Hidden layer. The Input layer has 20 neurons, one for each x and each y coordinate representing the positions of the 10 facial points we tracked from the video clips. The output layer consists of 7 neurons, one for each of the six basic emotions plus the neutral state.

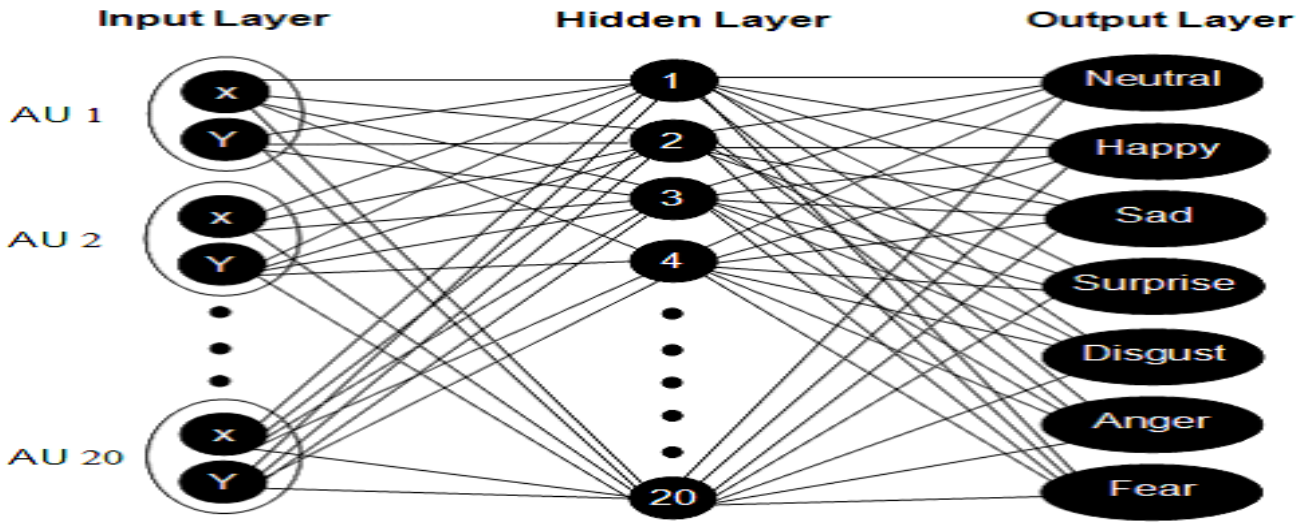


Figure 4: Structure of the BPNN used for the experiment.

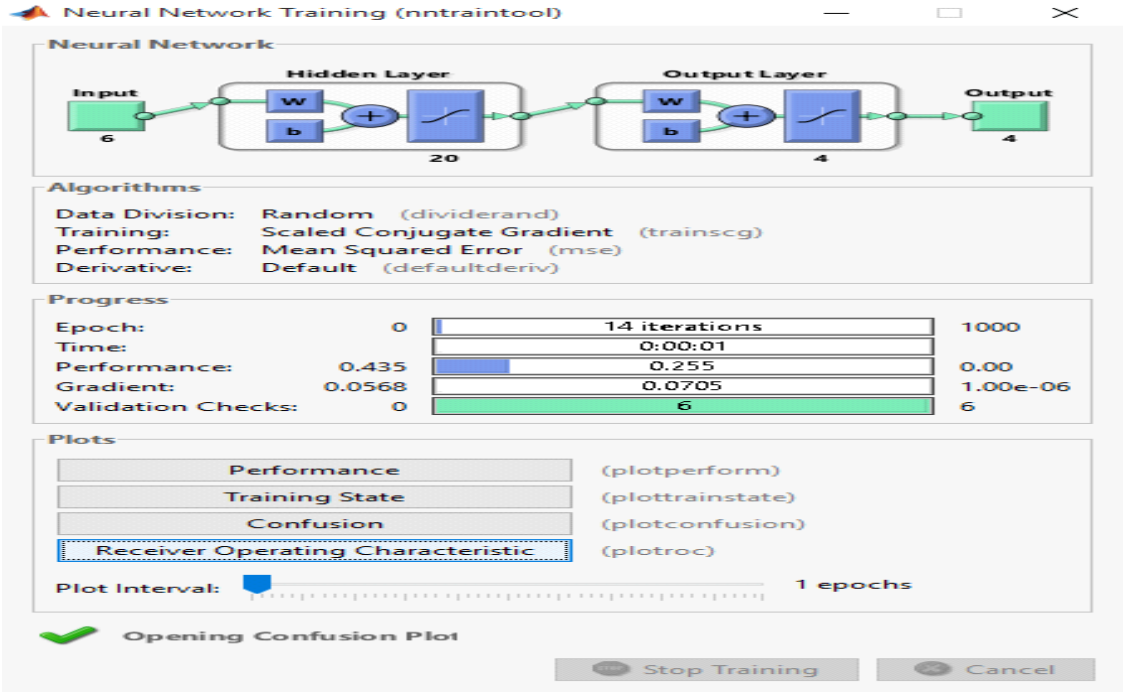
This means the network is trained using the back- propagation algorithm. The back propagation algorithm has become the training algorithm for artificial neural networks. We are using this method for our facial expression data set, to produce the output. The output produced contains the six facial emotions of the human beings.

Results

We have provided data set containing the facial expression of 150 people and the output estimated is compared with the existing output, to check whether the estimated value is correct or not.

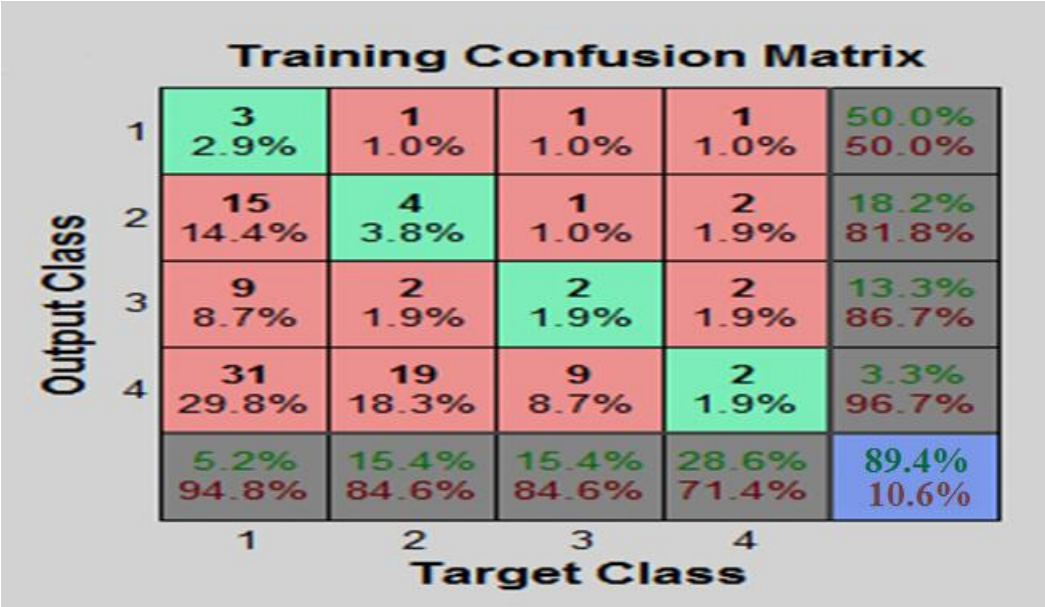
Simulation

When we observe a facial expression of emotion, we often mimic it. This automatic mimicry reflects underlying simulation that supports accurate emotion recognition.



Confusion Matrix

This allows more detailed analysis than mere proportion of correct guesses (accuracy).



Conclusion

In this paper, we have presented the results obtained when Back-Propagation Neural Network (BPNN) is used for emotion detection. In terms of accuracy, the results were reasonably good. This fast speed of the BPNN approach is achieved at the cost of initial overhead involved in terms of data acquisition and training. Therefore, overall, it can be concluded that because of its remarkable speed in the testing phase, if an application is to be personalized for a single person, say an elderly person living in her house requiring assistance, then the BPNN is perhaps the better choice. This is so because there is enough time to adequately train the system for this particular person before it becomes operational.

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Corresponding Author:

R Jagdeesh Kanan*

Email: jagadeeshkannan.r@vit.ac.in