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Review Article

RECOGNITION OF FACIAL EXPRESSION BY UTILIZING FEED FORWARD ARTIFICIAL NEURAL NETWORKS

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Abstract
One of the vital requirements of person to person communication is facial expression which are an output of inner emotions. To understand human behaviour, it is important to understand the facial expressions. There are wide varieties of emotions expressed by face. This paper intends to review on use of Feed forward Artificial Neural network in recognition of various facial expressions like happiness, sad, anger and surprise.

Keywords: Feed Forward Neural Network, Facial Expression Recognition.

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INTRODUCTION

Emotion is a feeling that is derived from a person's circumstances, mood, and relationships with others. Rational behaviour and intelligent behaviour mostly depend on human emotions of the time. Emotions does not always follow free will but is based on physiological and psychological changes. To understand behaviours, different types of emotions must be studied, which can be done by analysing facial expressions. Each and every individual makes decisions based on their current status of happiness, sadness, anger and surprise. Most of us design our hobbies and activities based on above emotions.

Two types of behaviours can be studied. Verbal behaviour which can be identified when watched closely during verbal communications which convey two thirds of human emotions and non-verbal cues which gives about one third of human emotional behaviours [1, 2]. Various non-verbal behaviours like gait, voice, gaze, body movements are there. We look at the person's face while we communicate with them. So, recognition of facial expression can be useful in many ways. But it becomes difficult when we try to create a recognition system for facial expressions, since our faces are complex multidimensional visual models.

Ekman is the pioneer of facial expression studies and in 1969, he studied human facial expressions in various countries and cultures using 6 basic emotions such as happy, angry, sad, surprise, fright and disgust [3], fig 1,2,3,4. Even today Ekman's six basic emotions are used widely.

Fig. 1: Happy face (Paul-Ekman database)

Fig. 2: Sad facial expressions (Paul-Ekman database)

Fig. 3: Facial expressions for surprise(Paul-Ekman database)

Fig. 4: Various Facial expressions of anger (Paul-Ekman database)

In today's world, automatic facial emotion recognition systems are used widely, in the fields of Human-computer interaction, Virtual Reality, Augmented reality, and entertainment. Face recognition has gained importance in security systems, credit card verification, criminal identification etc., Today, various sensors like Electroencephalogram, Electromyogram, Electrocardiogram, and camera are widely used to capture and analyse facial expressions.

Face expression recognition usually comprises of three steps such as:

1. facial component detection,
2. feature extraction and
3. facial expression classification.

Facial image is recognized using eyes/ears/nose from image or video, after which various temporal and spatial features are extracted and finally using their extracted features, classification is obtained.

In the last few decades there is an increased interest of applying Artificial neural networks (ANN) in extracting, classifying and recognizing the facial expressions. This paper aims to discuss on various methods using Feed Forward ANN to do the same.

HISTORY OF FER (Facial Expression recognition)

Facial expressions' importance was being understood during 19th century and a system used to detect the facial expressions was introduced by Suwa et al in 1978 [4]. Video is an easier and common form of capturing facial emotions even today. Valstar et al in 2006 [5] designed a system to extract and read facial expressions using video. He developed an automated system to analyse even minor alterations in facial expressions and by observing the facial muscle action units, studied their temporal behaviour. He used the respective action units to detect facial expressions of above said emotions, and moods.

Breuer and Kimmel [6] used Convolutional Neural Networks (CNN) to study various facial expression datasets. They achieved moderate success in classifying them. Two distinct CNN were used by Jung et al. [7]. He quoted that these methods use to get the patterns for temporal appearance from the set of images as well as the temporal facial landmark points were detected using the various geometric features in temporal domain. Based on the combination of these 2 features the facial expression finding performance rate can be increased.

Agrawal et al. in 2010 [8] captured faces of people and calculated eigenfaces (fig 5), using Principal Component Analysis (PCA). An accuracy of 97% is achieved using the 2 neural network methods namely PCA and feed forward back propagation neural network method.

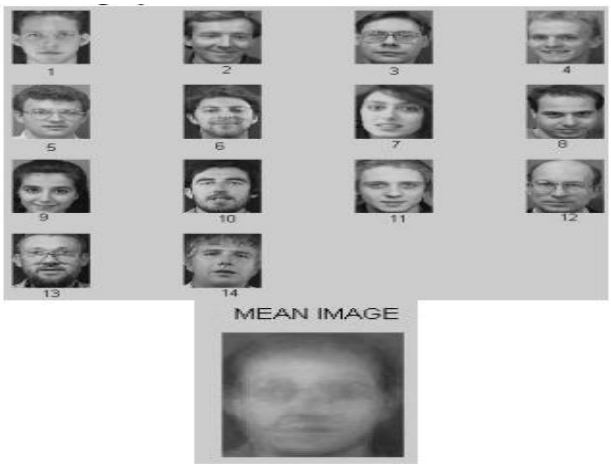

Fig. 5: Eigenfaces described by Agarwal et al.

Pushpaja et al. in 2012 reviewed various techniques of FER system by using Neural Networks [9]. A approach for coding and decoding of face recognition has been given by her. They calculated Eigenfaces from the training sets of images by matching with Eigenfaces and calculated Eigenvalues using PCA. They used a Feed forward propagation ANN for training (fig 6).

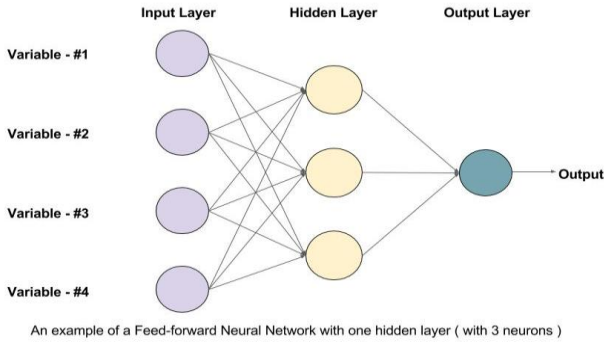

Fig. 6: FFNN

Two procedures are necessary for FER system: Finding the specific features of facial expression and to find the facial expression available in the system. To find the facial features 2 types of methods exists namely geometric feature-based methods and appearance-based methods. Facial feature points were identified, extracted to form a feature vector in geometric feature-based methods. This vector represents geometry of face (figure 7).

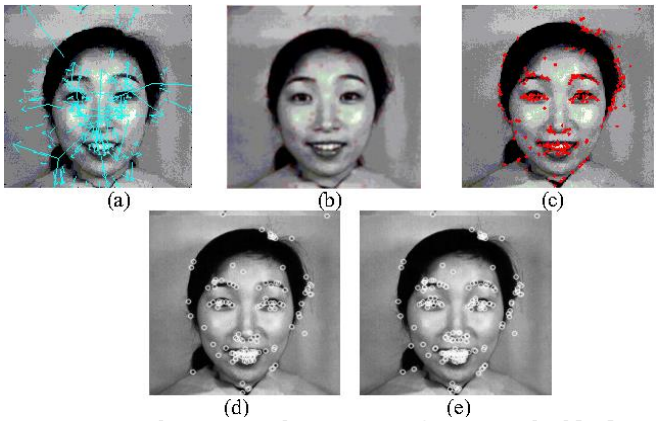

Fig. 7: Facial expression by Geometric feature method [10]

Filters are used in appearance based methods. In such cases filter are used which are added on entire face image or partial face image and suitable feature vectors are extracted from it. Neural networks recognize the facial expression. The neural networks also do tasks based on data provided for training and it creates its own organization during learning time.

FEED FORWARD NEURAL NETWORK FOR FER

In the last few decades, the use of machines in routine life has increased manifold. Also many industries uses machines for various purposes. To achieve a smoother interaction with humans, machines have to evolve and they must understand the surrounding environment, in particular, the emotions of human beings. For example, a house robot (widely used in Japan nowadays) must understand the emotion of its owner and should provide appropriate responses based on owners needs and emotions.

Nowadays, machines have several tools to capture and identify human emotions and environment using cameras and sensors. This information must be used by various algorithms to generate machine's perception. Deep learning methods especially ANN gained lots of ground in recent decades for the above said purpose.

Machine Learning (ML) is a sub-field of Artificial intelligence which gives computers the ability to learn without Pre-programming. In ML, the algorithms use input data to create models. The models generate an output. When a new requirement is asked for, the machine learns itself and provides output by its own without need of further human programming.

One of the Machine learning techniques is called Artificial neural network. When a data is inputted into the network, ANN transforms it using a weighted sum after which an intermediate state is calculated and it acts as input to another layer and finally to output layer (fig 8).

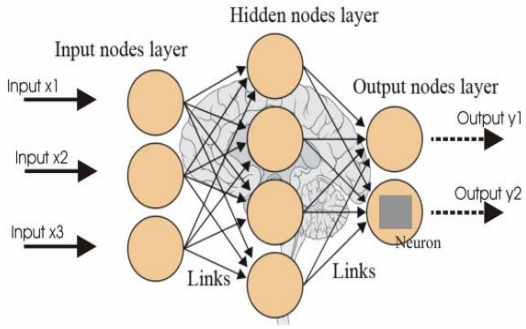

Fig. 8: ANN

Feed Forward Neural Network (FFNN) is an ANN in which the information flows in a forward manner [11]. FFNN has an architecture in which the first layer of neurons obtains the inputs and the last layer delivers the outputs. In between there are hidden layers and have no connection with the outside signals.

In a study [12], 5 facial features of 60 men were used. Neural network was trained by taking in consideration the images of 40 men. Then they tested and generalized using 20 men's images. Four facial expressions namely sad, happiness, anger and surprise were used to examine the performance of the trained network. 100% recognition rate was for training images and 93.75% for the generalizing images. They used a single hidden layer FFNN with fewer number of hidden units and weights, while providing improved generalization and recognition performance capabilities.

When Naïve Bayes algorithm was used to classify emotions from pixels generated from pictures taken from webcam of various individuals [13], it gave better accuracy than other algorithms. And when FFNN coupled with this, it gave even better accuracy on classification.

Adaboost is a popular machine learning method, which is commonly done using face detection and it builds non linear classifiers. It can learn effective features from a large dataset, it can construct weak classifiers based on each of features extracted and it can boost the weak classifier to a strong classifier. When this combined with three layered FFNN with back propagation algorithm, it had detected faces/non faces. When 130 images with 507 labeled faces were provided as input data, this method of Adaboost-FFNN gave a classification accuracy of 92%.[14]

Garghesha et al [15] used multilayer FFNN and radial basis function networks in a research. They were used for non-linear

mapping approximation and pattern recognition. Seven basic emotions such as sadness, anger, neutral, happiness, fear, surprise and disgust were classified. The approach was tested using images from already existing databases and it achieved a 73% classification accuracy.

Another study used back propagation FFNN, where facial image was translated as group of features and provided as inputs to the network. The system contained 11 FFNN connected neural networks and contained 105 inputs for every network and every network had 10 hidden layers. They gave a decent percentage in terms of classification [16].

CONCLUSION

This paper aims to impart the importance of facial expression recognition in today's human life. Many machines move closely with humans and uses sensors and cameras to try to read the human facial expressions to understand their current emotion to act accordingly. It is a difficult task and this paper reviews on few methods on how to do so. We find that Feed forward neural network when implemented with other machine learning methods can effectively classify the emotions at a higher accuracy.

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