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The Facial expression detection from Human Facial Image by using neural network

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ABSTRACT
Face recognition process pertains to recognizing meaningful expressions of motion by a human, involving the angry, happy, fear, sad, disgust, anger and neutral. It is of utmost importance in designing an intelligent and efficient human computer interface. The face is a rich source of information about human behavior. The proposed method will recognize the facial expression from a well captured image. The approach for Facial Expression Recognition System is based on Neural Network. The paper briefly describes the schemes for selecting the image and then processing the image to recognize the expressions. In this present paper, however, we address some of the issues above by focusing on getting a neural network to be able to recognize differences in levels of expressiveness from different emotions that are angry, happy, fear, sad, disgust, anger and neutral.
Keywords: Face Detection, Neural Networks, Facial Expression, Database.

1. INTRODUCTION

Face recognition is one of the most successful applications of pattern recognition and image analysis which has recently received significant attention, especially during the past several years. At least two reasons account for this trend: the first is the wide range of commercial and law enforcement applications, and the second is the availability of feasible technologies after 30 years of research. Face Recognition has gained momentum and practical vitality in the wake of increased and growing security concerns. A facial recognition and face verification system can be considered as a computer application for automatically identifying or verifying a person in a digital image in as much as the processing is carried out on digital still facial images [1]. The facial expression recognition system was introduced in 1978 by Suwa et. Al. The main issue of building a facial expression recognition system is face detection and alignment, image normalization, feature extraction, and classification. There are number of techniques which we use for recognizing the facial expression. Facial expressions are generated by contractions official muscles, which results in temporally deformed facial features such as eye lids, eye brows, nose, lips and skin texture, often revealed by wrinkles and bulges [2]. The term face recognition refers to identifying, by computational algorithms, an unknown face image. Facial expressions give us information about the emotional state of the person. Moreover, these expressions help in understanding the overall mood of the person in a better way. Facial expressions play an important role in human interactions and non-verbal communication. Classification of facial expressions could be used as an effective tool in behavioral studies and in medical rehabilitation. Facial expression analysis deals with visually recognizing and analyzing different facial motions and facial feature changes. This operation can be done by comparing the unknown face with the faces stored in database. Face recognition has three stages a) face location detection b) feature extraction c) facial image classification. Various face recognition algorithm exits and each has advantages and limitation. Lots of research work has been published on face recognition. In the field of neural network, back propagation method mostly used for recognizing the facial expression [3]. The paper proposes the different techniques to extract the features such as angry, happy, fear, sad, disgust, anger and neutral. These extracted features provide us the different recognized output using back propagation method. The experimental results show that the back propagation algorithm or method can recognize the appropriate facial expression than other methods. These networks are most widely used and the work is considered as a main part of artificial neural network.

2. RELATED WORK

2.1 Chovil (1991), Nagao and Takeuchi (1994) [4]:- Facial expressions can be viewed as communicative signals associated with syntactic displays, speaker displays, or with listener comment displays in a conversation. This approach has been used to improve human computer interaction with speech dialog.

2.2 Ekman, Friesen (1975) and Russel (1994) [5]:- Facial expressions can also be considered as expressions of emotion, raising ongoing debates about their discretness and universality. One of the most documented research effort led by Ekman has permitted to identified six basic universal emotions: fear, anger, surprise, disgust, happiness, and sadness .Others like Russel prefer to think that facial expressions and labels are probably associated, but that the association may vary with culture.

2.3 Wierzbicka (1992) and Lisetti (1998) [6]:- Whether or not there exist universal facial expressions, Wierzbicka points at the difficulty to talk about emotions, and warns that what we refer to as basic emotions with labels such as "anger", may have concepts which may very well be culturally determined . Studying these

concerns is beyond the scope of this paper, and need to be addressed in further details when dealing with particular applications. Relevant expressions and their interpretations may indeed vary depending upon the chosen type of application.

2.4 S. Adebayo Daramola et al. [7]:- It proposed a system with four stages: face detection, pre-processing, principle component analysis (PCA) and classification. Firstly, database with images in different poses was made, then image was normalized and noise was removed from the image. After that, the eigenfaces were calculated from the training set. Then Eigen values were calculated using the PCA approach and then largest eigenvalues were found comparing training set images and eigenfaces. At last ANN approach was used in which the face descriptors were used as an input to provide training to the network.

2.5 Hatice Gunes and Massims Piccardi (2006):- They describe Human-Human Interaction (HHI) and Human Computer Interaction on the bases of body gestures database and facial expression database. They proposed a database containing 1900 Videos of facial expression recorded by face and body camera.

2.6 George A. Tsihrintzis (2008) and Nagraha P. Utma (2009):- They found that emotions like "Surprise" is clearly recognized from visual facial modality rather than keystroke pattern information and emotion category "Sadness" are more clearly recognized by Keystroke information. Their findings suggests that the variety of brain region functions cooperatively to process facial emotions and that the activity in these regions is modulated by top-down and bottom-up signals.

3. FACIAL FEATURE EXTRACTION

After getting the exact face region, we first convert it into a grayscale image, and its corresponding edge image is obtained by applying the Prewitt edge operator on the cropped gray scale image. Then the facial features that correspond to a facial expression, namely the eye and mouth blocks are extracted from the face image using this edge information of the face. The actual process is described in following sections.

3.1 Extraction of Eye block

Based on our knowledge that the eyes are present in the upper portion of the face region, we search for eyes only in the upper half portion of the edge image. The method employs an iterative search algorithm which traverses in the vertical direction and counts the number of white pixels in horizontal overlapping blocks. The block which contains maximum number of white pixels is the required block which contains the two eyes. This block is extracted from the grayscale image. Then, the same algorithm is applied on the left half of this image, since we are aiming to get only one eye block. Here we use 'canny' method for obtaining the edges of the left half of the entire eye block. The Canny method finds edges by looking for local maxima of the gradient of the intensity image. The gradient is calculated using the derivative of a Gaussian filter. After smoothing the image and eliminating the noise, the next step is to find the edge strength by taking the gradient of the image.

3.2 Extraction of Mouth block

The same algorithm, which is used to extract eye block, is employed here. Based on the criterion that mouth is present only in the lower half of the face, we take into consideration only the lower half of the edge image of the original grayscale image containing the face region. On applying this algorithm, we get the block containing the mouth and from its edge image, we get the exact mouth block.

3.3 Emotion Recognition

In this section, we have described our method to recognize the emotion from the extracted facial features. Though various methods exist for emotion recognition, neural networks hold its position due to its robustness. So, we employ a neural network based approach for recognizing emotions.

3.3.1 Preprocessing for Neural Network

Before the extracted features are fed as inputs to the neural network, they have to be preprocessed. This preprocessing is nothing but resizing the extracted eye and mouth blocks to a fixed size. We resize the eye block to a fixed size of 28 x 20 and the mouth block to 20 x 32, using 'nearest neighbor interpolation' method. These 2-D matrices are converted into 1-D vectors such that each row follows one another sequentially to form am single column. Thus, a 560 x1 column vector is obtained from the eye block and a 640 x 1 column vector is obtained from the mouth block. Then, we append the two column vectors of eye and mouth, which results in 1200 x 1 column vector, which is given as the input to the neural network.

S. No	Layer	Number of Neurons
1.	Hidden layer 1	120
2.	Hidden layer 2	16
3.	Output layer	6

Table 1: Neurons in each layer for our Three layer neural network

3.3.2 Network Architecture and Training algorithm

We have chosen multilayer feed forward network as the network architecture. The number of neurons that has to be in the output layer is fixed as we know the number of emotions that we are going to consider - Happy, sad, anger, fear, disgust, surprise. Therefore, in our case, the number of neurons in the output layer is chosen as 6. The number of hidden layers in the network and the number of neurons in each layer is chosen by trial and error

method based on the performance function until it reaches the specified goal. By trying various combinations, we have chosen the efficient architecture, which is a three layer feed forward network where there are two hidden layers and an output layer. The neurons in each layer are shown in Table 1. We have chosen Back-propagation training algorithm for training the network because of its simplicity and efficiency.

3.3.3 Training Samples and Network Simulation

For training the network to recognize various emotions, we used different images from different Data bases [8],[9],[10],[11](available in the World Wide Web belonging to various Universities) and created a new database which includes the images from our own database of face images. Some of the faces from which training samples were extracted are shown in Figure 3(a),(b).

rate from visual-facial modality		*from keyboard-stroke pattern information*	
Facial Expression	(%)	Variations in the key-stroke patterns	(%)
Neutral			
	**65%**	• A user types normally (55%) • A user types quickly (35%) • A user types slowly (20%)	**65%**
Surprise			
	**78%**	No additional information provided by this modality	-
Anger			
	**20%**	• A user types slowly (27%), • A user uses the backspace (60 %) • A user hits unrelated keys on the keyboard (40%) • A user does not use the keyboard (27%)	**74%**
Sadness			
	**12%**	• A user types slowly (38%) • A user uses the backspace key often (30%) • A user hits unrelated keys on the keyboard (25%) • A user does not use the keyboard (32%)	**57%**
Disgust			
	**37%**	No additional information provided by this modality	-

Figure 3(a): Training Database Figure 3(b): Test Database

	Angry	Happy	Fear	Sad	Disgust	Surprise	Neutral
Angry	28	0	2	2	1	o	0
Happy	0	30	0	0	o	o	0
Fear	1	1	26	1	1	0	0
Sad	2	1	2	23	2	0	0
Disgust	2	1	1	2	24	1	1
Surprise	0	0	0	0	0	30	0
Neutral	0	0	0	0	0	0	29

Facial Expression	Result of my Project	Result of Base Project
Surprise	100%	100%
Happy	100%	100%
Fear	98%	100%
Sad	94%	80%
Disgust	96%	----
Anger	98%	70%
Neural	100%	70%

Result of Classification

(a) Result of Classification of Surprise Expression, (b) Result of Classification of Happy Expression, (c) Result of Classification of Fear Expression, (d) Result of Classification of Sad Expression, (e) Result of Classification of Disgust Expression, (f) Result of Classification of Angry Expression, (g) Result of Classification of Neutral Expression.

A. Training the ANN with Input Face Images

Back Propagation feed forward Artificial Neural Network (ANN) is used for training the input face images. The computed eigenfaces of the input face images are fed to the neural networks. The number of neural networks taken based on the number of different input face images. As we have taken the 9 networks for nine different face images. After setting the parameters neural networks are trained with eigenfaces of the input images via input layer, hidden layer and output layer. Each eigenface image distance is compared with each other. The eigenfaces images of same person have the zero distance between them and output is taken as 1 otherwise output taken as 0.The mathematical function values for each eigenface image are used to compare the eigenface images. For the eigenfaces of same person, the specific neural network provides the output as 1 and for the eigenfaces of other person it provides the output as 0.Now, only the known faces are recognized as output 1.Hence, Neural Network forms an Identity matrix for different face images using the outputs 1's and 0's.

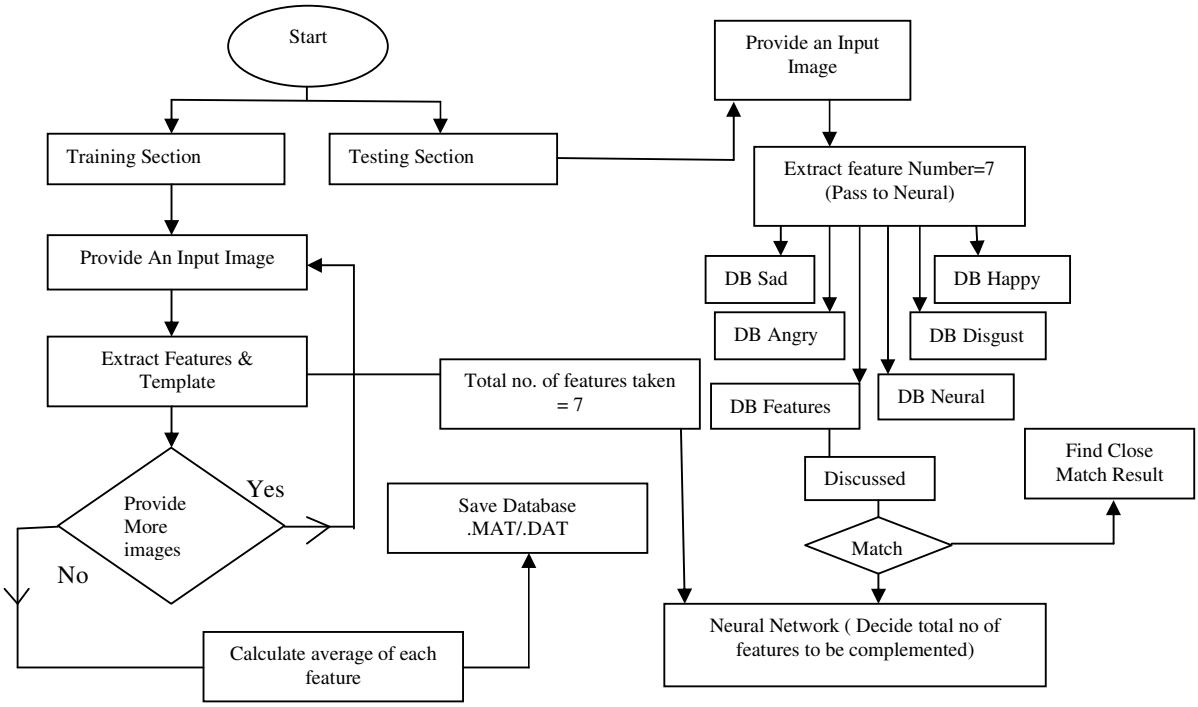
B. Testing the ANN with Tested Face Image :- For face recognition, the eigenfaces images of the test face image is calculated by feature extraction based on PCA. This eigenface image is fed to the each trained neural network. The tested eigenface is compared with the eigenfaces of the trained neural network for best match using the Log-sigmoid function values. As the threshold value is set which is the 25% of the best distance. If the minimum distance between the tested eigenface image and the trained input eigenface image is less than the threshold value, then the output of specific network is 1 and the trained eigenface image is selected from the Identity matrix described as an output image and further recognized as a resulted face image otherwise the test face image is rejected as non-human or unknown face image.

Applications Face recognition is used for two primary tasks

1. Verification (one-to-one matching): When presented with a face image of an unknown individual along with a claim of identity, ascertaining whether the individual is who he/she claims to be.
2. Identification (one-to-many matching): Given an image of an unknown individual, determining that person's identity by comparing that image with a database of images of known individuals.

4. PLANNING OF WORK

1. Read input image from database and localize face using morphological image processing operations
2. Crop the face image.
3. Extract features from cropped face.
4. Find facial feature vectors.
5. Train neural network.
6. Recognize expression by BFO algorithm.



5. CONCLUSION AND FUTURE WORK

We have proposed an efficient method for recognizing emotion from facial expressions. We have presented a novel scheme for face detection based upon a feature invariant approach namely, skin-color based segmentation. Face localization is then performed in an effective manner by adopting a knowledge based criterion resulting in the extraction of the exact rectangular boundary of the face region. And then, facial feature extraction has been performed on the edge information of the cropped face region in gray scale by using an iterative algorithm which searches for eyes and mouth through horizontal and vertical overlapping blocks of the edge image. And finally emotion recognition is performed using a feed-forward neural network. The results are encouraging for the wide range of images that we have used which makes the proposed work to be possibly used for a broad range of applications in human-computer interaction. Our future work is to improve the efficiency of our face detection method by generalizing it perform well in complex background images with varying illumination and pose and at the same time reducing the false detections. We also plan to improve the recognition rates of the neural networks by trying various networks and also selecting additional facial features.

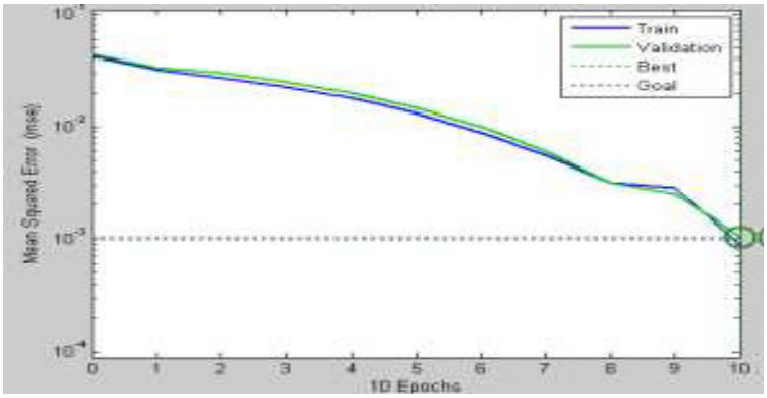


Fig. Performance plot of neural network

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