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Human Facial Expression Recognition using Eigen Face and Neural Network

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***Abstract:** In many face recognition systems the important part is face detection. The task of detecting face is complex due to its variability present across human faces including color, pose, expression, position and orientation. A face detection system based on principal component analysis algorithm and neural network techniques. Facial expression as a natural and efficient way of communication, it can also be considered as a special case of pattern recognition and also many techniques are available. In principal component analysis algorithm, eigenvector and Eigenfaces are identified the initial face image set and these faces are projected onto the Eigenfaces for calculating the weights. These weights created a face database to recognize the face by using neural network. Classification of face detection and token matching can be carried out any neural network for recognizing the facial expression.*

***Keywords** – Eigen face, Eigenvector, face recognition, facial expression recognition and neural network.*

I. INTRODUCTION

The human face is a primary focus which playing a major role to show the identity and emotion. Human has an ability to recognize thousands of faces and also to infer intelligence or character from facial appearance. The image gesture recognition is done using the image pixel to train the neural network. The Viola and Jones describe the face detection technique using Add Boost Haar classifier. Depending on threshold value the researchers system can recognize the facial expression. The approach of this system can be adapted to real time and it briefly describes the schemes of capturing the image and to recognize the gestures. [1] The author Chibelushi and Bourel discussed the different techniques to recognize the features such as line face detection, canny edge detection and different extracted morphology techniques.

The paper proposes the different techniques to extract the features such as forehead, mid forehead, mouth, and cheek. These extracted features provide us the different recognized output using back propagation method. [9]

In an efficient algorithm for motion detection based facial expression recognition using optical flow proposed an efficient algorithm for facial motion detection. This technique is based on optical flow technique which extracts the motion vectors. This algorithm works on frames of segmented image and gives us their result which is depending on motion vectors. [3] This paper proposes the different techniques to recognize the different feature points. The rough contour estimation routine method is used to obtain the contours of eyebrows, eyes and mouth. [10] Face is a complex multidimensional visual model and for developing a model for face recognition is difficult task. This paper presents coding and decoding methodology for face recognition. This paper proposed the method is based on the information theory concepts viz. principal component analysis method. The proposd system or the recognition system is implemented on eigenface, principal component analysis and artificial naural natwork. For recognising face the system can be used the eigenface and principal component analysis algorithm technique and for recognising the facial expression the artficial neural network system is worked.

A. Human Gesture Recognition

A vast array of algorithms is available for each module of face recognition system, how to combine them is still a challenging problem, especially for an expression recognition task. The human facial expression recognition system is tested in different ways and had some of the difficulty in clearly recognising the facial expression. The system is divided into three major components, *i.e.*, Image Pre-processing, Feature Extraction and Classification. Almost all modules are based on statistical methods and they will be trained using a training set. The working of classification is depending on principal component analysis and neural network technique. For principal component analysis, Eigenfaces method will be used for extracting feature vector. An input sensing device such as web-cam, it reads the human body movements and communicates with the computer. The mathematical algorithm interpreted with the human gesture and it is based on artificial intelligence techniques. The block diagram of gesture recognition arrangement is as shown in Figure 1.

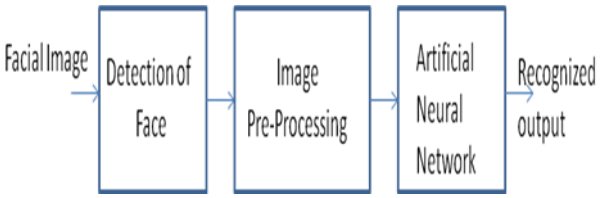

Figure 1: Block Diagram of Gesture Recognition Arrangement

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In the gesture recognition arrangement each box treated as one module. First the web-cam captures the image and gives to the face detection block which can detect the face from the captured image. In the face detection, the input block stores the captured image which finds the face area from the image. The face area provides to the pre-processing block which removes the unwanted noise and it also normalize the image. The output is provided to the trainer module, it trains the image and decides whether the image belongs to the face class or not and finally it will provide the information about the recognition of face. [12]

B. Eigenfaces Recognition Systems

In the Eigenfaces theory, the information in a face image is extracted, encoded as efficiently as possible, and then the face image is compared with the training database. In mathematical term, the principal component of the faces or the eigenvectors of the database images, treating an image as point in very high dimensional space. [7] The face descriptor module automatically reduce every face image to $X*Y$ pixel to improve the face recognition performance. Face images are stored in a face library for performing every action of training set. The face library is divided into two sets training dataset and testing dataset. The process of this system is shown in Figure 2

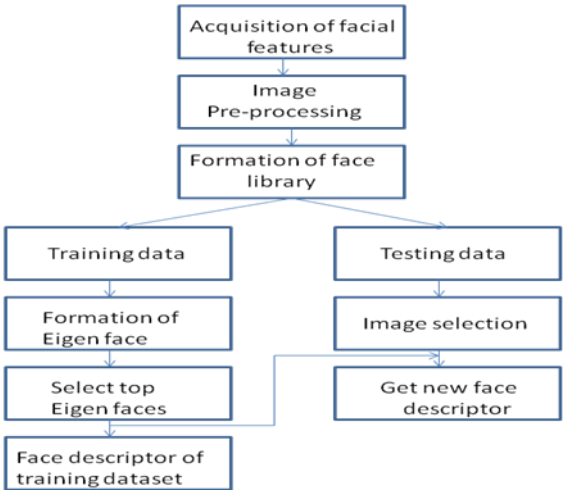

Figure 2: Face Library Formation and Face Descriptor

The original face images are calculated a best coordinate system for image compression, where each coordinates is actually an image that they termed an "Eigen picture". Any collection of face images can reconstruct by storing a small collection of weights for each face, and a small set of Eigen pictures. [7]

C. Evaluation Schemes

The back-propagation of feed-forward architecture is designed based on facial features. The neurons are organized in the form of layers. It consist of an input layer containing four neurons representing input variable to the problem, that is extracted data from the forehead wrinkle, the mid forehead wrinkle, the cheek wrinkle, and the mouth length. One hidden layers containing one or more neurons to help capture the nonlinearity in the data and an output layer containing seven nodes representing output variable to the problem that is facial expression: anger, disgust, surprise, happiness, sadness, fear and neutral. [9]

Neural network have been trained to perform complex function in various field of application such as pattern recognition, identification, classification, speech, etc. These feature vectors are used as inputs to train the networks. In training algorithm, the face feature vectors that belong to same person are used as positive examples for the network ("1" as output), and negative examples for the others network ("0" as output), Figure 3 shows the simulation of neural network. Firstly the system gets the image as an input and it pre-process the image. In pre-processing, it removes the unwanted noise and it provide to the Eigen face. By using principle component analysis we get the highest Eigen value images and this images is provided to the neural network system for gesture recognition. [7]

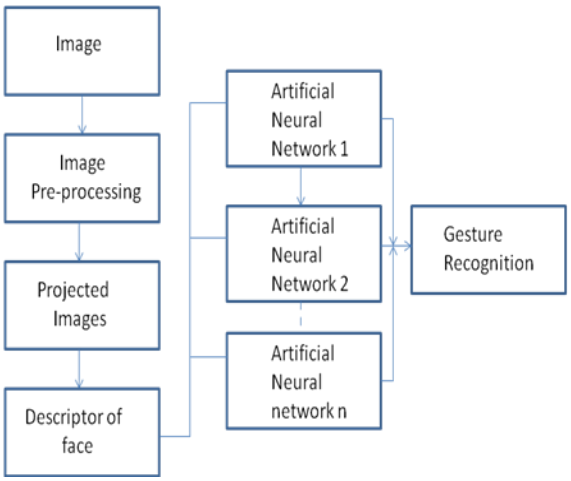

Figure 3: Simulation of Neural Network

II. RESULT AND DISCUSSION

To test the proposed solution, there are different sets of gestures of persons are prepared. These images are totally different from the learning subset of images in the sense that each image was taken at different time with different instance of gesture. In this chapter we are going to present the results from the training and the testing procedure of the algorithm and also the performance of the neural network that was designed for facial expression recognition. The database is used in order to test our methods; there are 7 different images of different expression. All the images were taken uniform background Figure 4 shows the whole set of images, with 7 different facial expressions and Table 1 shows the different performances for the different expressions. The total no of network is always equal to the no of people available in database. All the images used for the processing of neural networks, for this database the mean face of the whole database, calculated the Eigenfaces with highest Eigen values. During the training sessions, the weights and biases of the network are iteratively adjusted to minimize the network performance error. Depending on that we get the accuracy of result.

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In our result the accuracy of result is 80%, because many times the features of test data set and train data set are perfectly matched. But sometimes there are little bit mismatches are occurred. Here the neural network system can be described the working of neural network toolbox. In the neural network toolbox, the Trainlm is a network training function that updates weight. Trainlm is often the fastest back-propagation algorithm in the toolbox, and is highly recommended as a first-choice supervised algorithm, although it does require more memory than other algorithms. It assumes that the network has the mean square error (mse) performance function. `Trainlm` can train any network as long as its weight, net input, and transfer functions have derivative functions. Back propagation is used to calculate the performance of the weight and bias variables.

Figure 4: Sets of Images with Different Facial Expressions

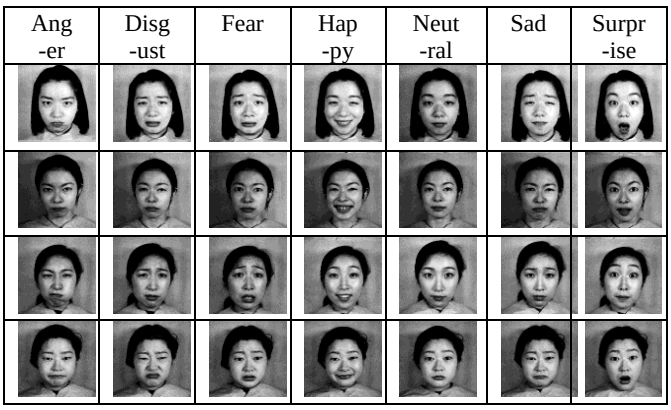

Table 1: Different Performances for the Different Expressions

Expre-ssion	Ep-och	Ti-me	Perfor-mance	Gra di-ent	Mu	Valida-tion Check
1st Set of Images						
Angry	16	2	0.0067	0.009	0.01	6
Sad	11	1	0.0388	0.017	0.01	6
Fear	12	1	0.032	0.002	0.01	6
Happy	11	1	0.0234	0.001	0.01	6
Neut -ral	85	2	0.0165	0	0.01	6
Disgust	25	1	0.0194	0.004	0.01	6
Surpr -ise	12	1	0.0277	0.013	0.01	6
2nd Set of Images						
Angry	11	1	0.0285	0.019	0.1	6
Sad	12	1	0.0258	0.005	0.1	6
Fear	12	1	0.0642	0.006	0.01	6
Happy	28	1	0.0214	0.019	0.01	6
Neut -ral	109	2	0.0165	0.004	0.01	6
Disgust	16	1	0.0169	0.002	0.01	6
Surpr -ise	15	1	0.014	0.005	0.01	6
3rd Set of Images						
Angry	12	1	0.0262	0.014	0.01	6
Sad	15	1	0.0077	0.003	0.01	6
Fear	20	1	0.0181	0.003	0.01	6
Happy	11	1	0.0303	0.017	0.01	6
Neut -ral	18	1	0.0065	0	0.01	6
Disgust	9	1	0.0345	0.031	0.01	6
Surpr -ise	10	1	0.0314	0.002	0.01	6
4th Set of Images						
Angry	14	1	0.0204	0.007	0.01	6
Sad	19	1	0.0232	0.014	0.1	6
Fear	20	1	0.0173	0.002	0.01	6
Happy	21	1	0.0061	0.005	0.01	6
Neut -ral	109	2	0.0165	0.003	0.01	6
Disgust	11	1	0.0457	0.014	0.01	6
Surpr -ise	34	1	0.0183	0.003	0.1	6

III. CONCLUSION

This work is provided for facial expression recognition that can gather about the emotion change and minimize the impact of person identity. Two main issues that are relevant to the design of FER systems were addressed. Firstly the right combination of algorithms features and second is to design a classifier, a more sophisticated face detection algorithm is necessary. Eigenfaces method is a principal component analysis approach, where the eigenvectors of the covariance matrix of a small set of characteristic pictures are sought. Recognition is performed by obtaining feature vectors from the eigenvectors space and using of neural networks to compare these feature vectors. So by using these two algorithms the system can match the features and recognize the different facial expression.

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