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Face Recognition System by using Block Based Local Binary Pattern (LBP) and Deep Neural Network (DNN)

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Abstract — *Face recognition is used in biometric market for various reasons. Biometric technology plays an important role for providing the security which is imperative part in today's challenging world. Human face recognition is a potential method of biometric authentication. This paper presents a novel technique of face recognition system using deep neural networks (DNNs), where features of face images are extracted with the help of Local Binary Pattern (LBP). We propose an effective deep learning framework by stacking multiple output features that learned through each stage of the deep neural network with block based Local binary pattern. Experiments were conducted using Yale facial image database and FERET database. High rate of performance was obtained through these proposed techniques.*

Keywords- *Face Recognition; Local Binary Pattern; Deep Neural Network; FERET; Yale face database.*

I. INTRODUCTION

A face recognition system is a computer application which is able for identifying or verifying a person from an image or a video source. One of the best ways to do this is by comparing selected facial features from the image and a face database. In recent years, Face recognition has been successful being used in various applications of image analysis. Research in automatic face recognition or verification is being conducted since the 1960s, but this uphill challenge has been solved to a large extent in recent times.

It is commonly used in security systems and can be compared with different biometric machines used for fingerprint, eye iris recognition systems etc. Recently, it has also become popular as a commercial identification and marketing tool. Various face recognition algorithms classify face features by extracting features, from an image of the subject's face. For example, an algorithm may examine the relative position, size, and shape of the eyes, nose, cheekbones, jaw difference between eyes etc. Every one of these features is used to explore for other images with matching features. Other algorithms normalize a gallery of face images and then compress the face data, only saving the data in the image that is useful for face recognition. A test image is then compared with the face data. One of the earliest successful systems is based on template matching techniques. It is applied to a set of remarkable facial features, providing a variety of compressed face representation.

Advances in face recognition have originated from considering different parts of this particular recognition problem. Earlier methods treated face recognition as a standard pattern recognition problem, later on techniques concentrated more on the representation aspect, after realizing its uniqueness using domain knowledge, more recent methods have been concerned with both representation and recognition or verification, so a robust system with good generalization capability can be built by adopting state-of-the-art techniques from learning, computer vision, and pattern recognition. A face recognition system based on the recent method which concerned with both representation and recognition using artificial neural networks (ANN) is introduced. This Report initially provides the overview of the proposed face recognition system. The system produces the promising outcome for face verification and face recognition.

The demand for reliable personal identification in computerized access control has resulted in an increased awareness in biometrics to replace password and identification (ID) card. The password and ID card can be easily broken since the password can be disclosed to an unauthorized user, and the ID card can be stolen by any fraud person. Thus, the development of biometrics has addressed the problems that plague the traditional verification methods. Biometric which make utilize of human features such as iris, retina, face, fingerprint, signature dynamics and speech can be used to verify a person's identity. The biometrics information has an edge over traditional security methods since they cannot be easily stolen or shared. The face recognition system has the advantage of being an inactive, non-interfering system for verifying personal identity.

II. PROPOSED WORK

A. DATABASE

The Yale Face Database [11] contains 164 gray scale images in GIF format of 15 individual persons. There are 11 images per subject or person, one per different facial expression or formation: center-light, w/glasses, happy, left-right, with and without glasses, normal, right-light, sad, sleepy, surprised, and wink.

"***Figure 1. Sample faces images of the same person from Yale face database".***

The FERET is standing on Face Recognition Technology. The FERET database [12] is one of the standard databases. It is used for facial recognition system evaluation and for testing. The Face Recognition Technology (FERET) program is managed by the Defense Advanced Research Projects Agency (DARPA) and the National Institute of Standards and Technology (NIST). A database of facial images was collected between December 1993 and August 1996. In 2003 DARPA released a high-resolution, 24-bit color version of these images. The database tested includes 7,253 still facial gray scale images, representing 856 individuals. The FERET program was made to establish a huge database of facial images.

"***Figure 2. Sample faces images of the same person from FERET database".***

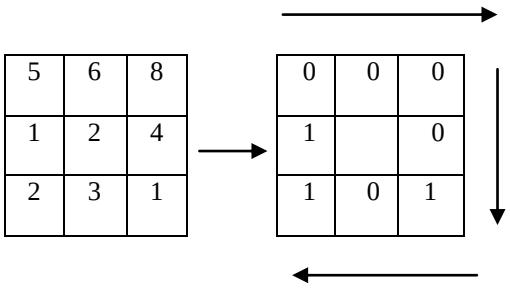
B. FEATURE

2.1. LOCAL BINARY PATTERN (LBP)

Local Binary Pattern (LBP) [1] [2] works on local features that use LBP operator which summarizes the local special structure of a face image. LBP is considered as a well-organized set of binary comparisons of pixels intensities between the center pixels and its eight surrounding pixels. Local Binary Pattern does this comparison by applying the following formula:

$$LBP\ (X_c, Y_c) = \sum_n^7 = 0\ S(i_n - i_c)2^n$$

Where i_c corresponds to the value of the center pixel (X_c, Y_c), i_n to the value of eight neighboring pixels. LBP is used to resolve the local features in the face and also works by using basic LBP operative. Feature extracted matrix originally of size 3 x 3, the values are compared to the value of the center pixel, then binary pattern code is produced and also LBP code is obtained by converting the binary code into decimal one.

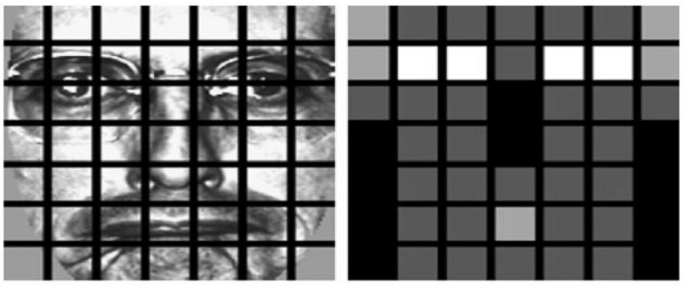


Binary value- 11010000
Decimal value- 208

"***Figure 3. Sample of Local Binary Pattern".***

2.2. Local Binary Pattern Block

Local Binary Pattern Block divides or partitions the image into many blocks. First, the image segmented into several blocks. Then it will start calculating the LBP histogram for each block. After that, it will merge every LBP histogram for that image. Then we will get LBP histogram into one vector. An LBP histogram is calculated for every block and joining as the final histogram. Multi Block LBP feature extraction can also be very fast or quick.



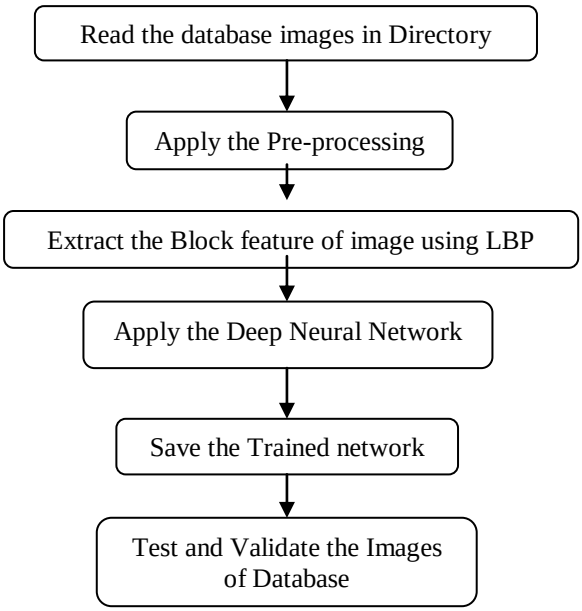
"Figure 4. (a) Sample of face image which split into 7*7 block (b) Image after the blocks splitting".

C. DEEP NEURAL NETWORK (DNN)

Deep learning algorithms have been used in several vision tasks such as handwriting recognition, face detection, and face recognition. A Deep neural network (DNN) is an artificial neural network (ANN) [3] with multiple hidden layers between the input and output layers. DNN [4][5][6][7][8] are typically feed-forward networks in which the data flow from the input layer to the output layer without any looping back. In this paper, we use the deep neural network for face recognition system. In this paper deep neural network makes two layers; in the first layer which is called auto encoder one is utilized which encoded the face feature of the image by utilizing n-hidden layers. After that second layer called auto encoder two is utilized. At the end, we merge the both layers by using soft-max layer and we will take the output. The soft-max layer defines the number of classes which are present in the trained database.

III. PROPOSED ALGORITHM

The flow chart of proposed algorithm for face recognition is shown below:



"***Figure 5. Flow chart of proposed algorithm".***

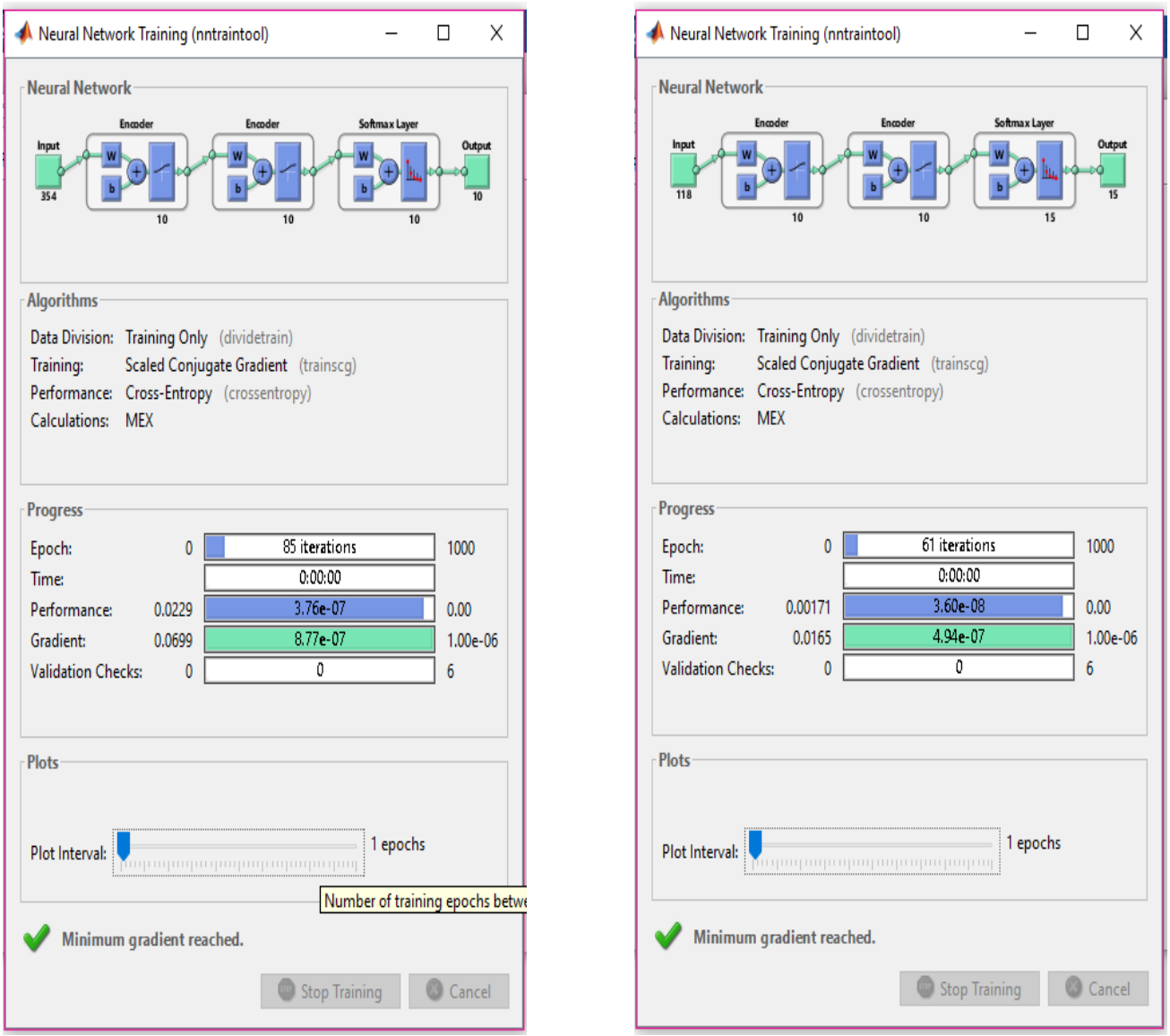
IV. ALGORITHM

Follow the Steps to do the experiment:
1. Read the database images in Directory.
2. Apply the Pre-processing.
3. Extract the Block feature of an image using LBP.
In FERET database extract the K1 for face image recognition and,
In Yale face database extract the K2 for face image recognition.
4. Apply the Deep Neural Network: With n hidden layers
4. (a). The first layer is Auto encoder one.
4. (b). The second layer is Auto encoder two.
4. (c). At the last combine both 1st and 2nd Layer.

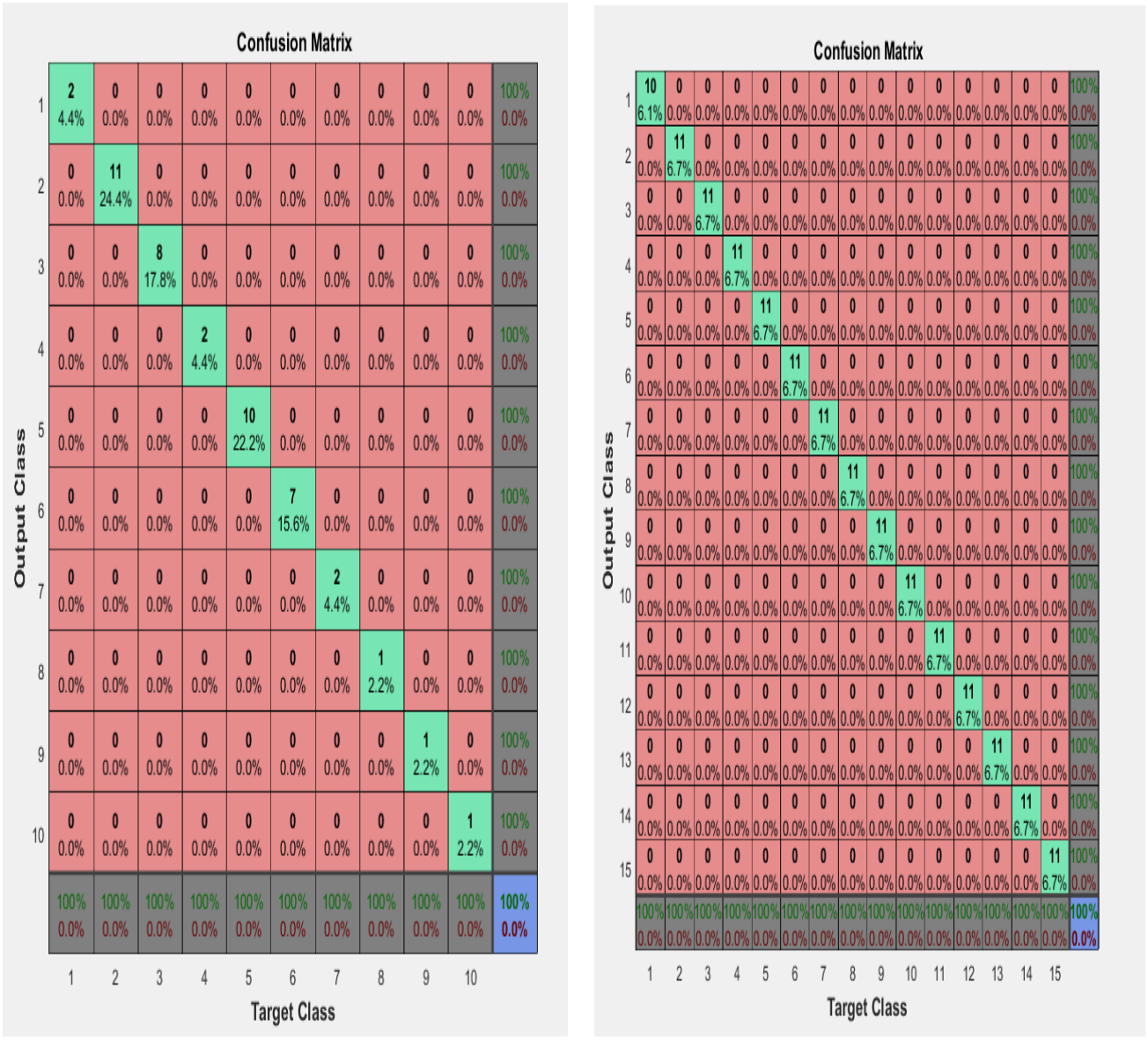
5. Save the trained network.
6. Test and Validate the Image of Database.

Method to do the experiment, first take Directory and split it into two parts: train and test. In training directory, pick a single image and after that convert the image into n-block of LBP. Extract the LBP of each block. After that, it will make a single feature. The same process is applied to all images. In this paper, FERET database K1 have 354 faces feature are found and Yale face database K2 have 118 faces feature are found. . After that, apply the deep neural network with n-hidden layers. We utilized 10 hidden layers in deep neural network. The deep neural network makes two layers; in the first layer which is called auto encoder one is utilized which encoded the face feature of the image by utilizing n-hidden layers. After that second layer called auto encoder two is utilized. At the end, we merge the both layers by using soft-max layer and we will take the output. The soft-max layer defines the number of classes which are present in the trained database. Deep neural network gives high rate of performance by using Local binary pattern which extracts the important feature of the image.

By using this algorithm, we will input the image of one individual person and by the result; we will get all the related images of that person which stored in database.

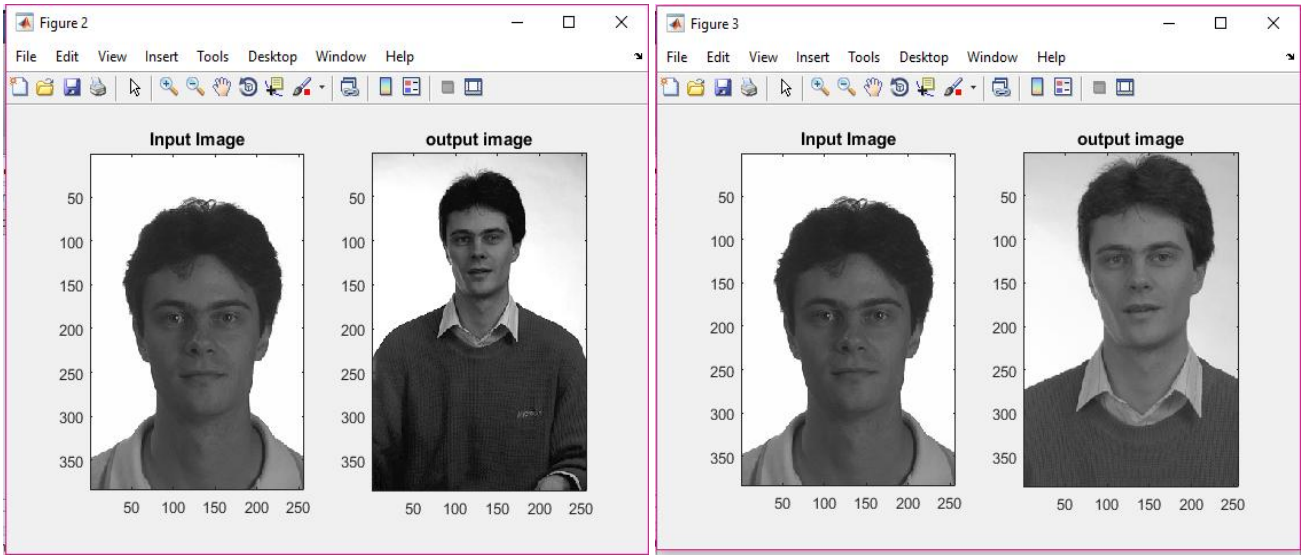


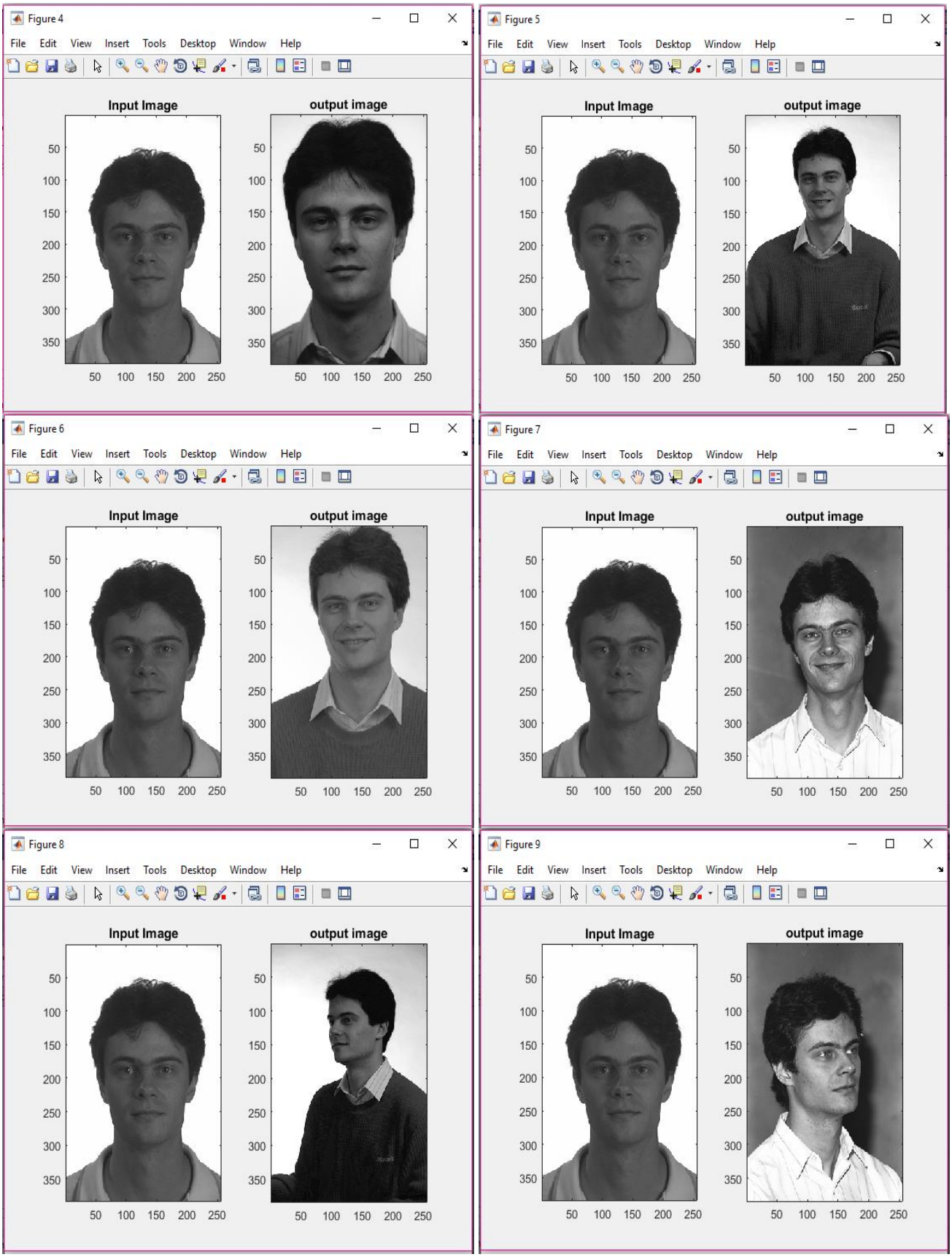
"Figure 6. (a) Deep neural network applied on FERET database. (b) Deep neural network applied on Yale face database".

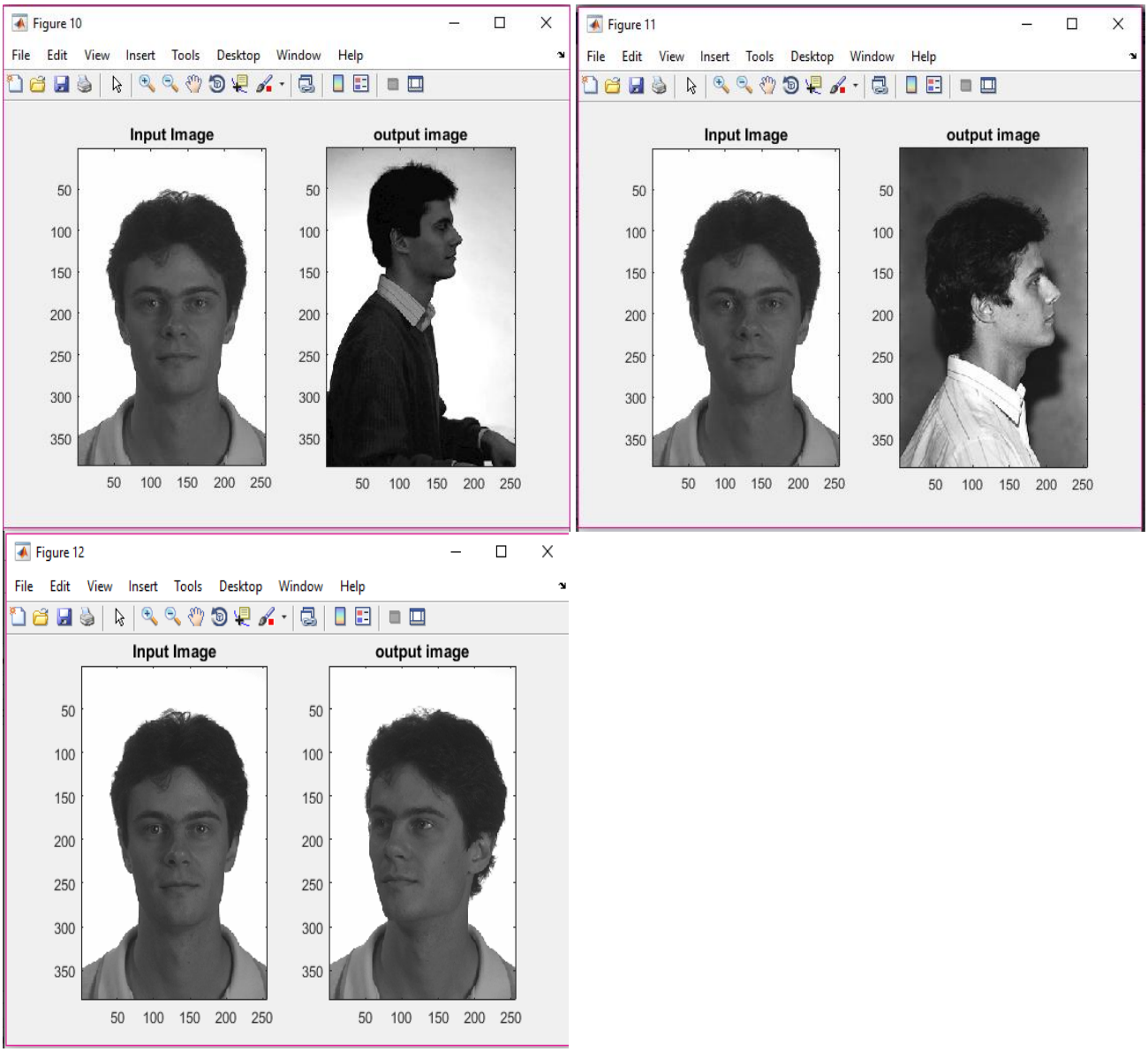


"Figure 7. (a) Confusion matrix of FERET database. (b) Confusion matrix of Yale face database".

For testing an image, we give an input image of an individual person and by the result; we got all the related images of that person which stored in the database.







"Figure 8. All these pictures are showing input and related output images that are stored in the database".

V. RESULTS

The performance of the proposed face recognition method was carried out using MATLAB 2016a, on a 64-bit operating system, 1.80 GHz processor, with 4GB RAM. The Yale face and FERET databases were considered. The Yale face and FERET databases consist of images of different persons having the expression, pose and illumination variation [9]. In FERET database, for demo work, we take 45 images, in which 10 classes of the database are utilized and samples per class not limited. In Yale face database, for the experiment we take 165 images, in which 15 classes of the database are utilized and samples per class not limited. The proposed algorithm has obtained high rate of recognition accuracy over algorithms utilized as a part of existing designs.

VI. CONCLUSION

We have designed 10 and 15 classes for 45 and 165 images respectively. At the time of training, more than 200 images were being used from Yale face database and FERET database which are available online. The designed model is giving accurate results with both deep neural network and local binary pattern (LBP) for the database. It is also concluded that performance of deep neural network (DNN) is better than all the existing Neural Network techniques [10]. It is also summarized that DNN is much more used for face recognition models than any other existing technique.

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