An Implementation and Analysis of Hybrid Face Recognition Algorithm

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Abstract - **The face is our primary focus of attention in social intercourse, playing a major role in conveying identity and emotion. Although the ability to infer intelligence or character from facial appearance is suspect, the human ability to recognize faces is remarkable. It is widely acknowledged that the face recognition have played an important role in surveillance system as it doesn't need the object's cooperation. The actual advantages of face based identification over other biometrics are uniqueness and acceptance. As human face is a dynamic object having high degree of variability in its appearance, that makes face detection a difficult problem in computer vision. In this paper work, we proposed hybrid face recognition approach using LDA and back propagation network. Initially, we input bi-part human faces which is processed by LDA algorithm and return extracted feature. On this features we apply neural network namely back propagation network using input faces to train the algorithm. After training of images we recognized particular face ID. The proposed system is an effective and efficient for the accurateness of the human face recognition for end user applications.**

Keywords: *Face Recognition, Feature Extraction, Neural Network, LDA, Face Data, Computer Vision, Authentication, BPN*

I. INTRODUCTION

Deep learning provides a natural way to obtain feature representations from data without relying on hand-crafted descriptors. Biometric security systems based on facial characteristics face a challenging task due to variability in the intrapersonal facial appearance of subjects traced to factors such as pose, illumination, expression and aging. A wide variety of systems require reliable personal recognition schemes to either confirm or determine the identity of an individual requesting their services. The purpose of such schemes is to ensure that the rendered services are accessed only by a legitimate user, and not anyone else. Humans often use faces to recognize individuals and advancements in computing capability over the past few decades now enable similar recognitions automatically. Humans have the ability to recognize faces easily and effortlessly but in the area of image analysis and computer vision it remained as a difficult problem on which many years of research is going on. It is often useful to have a machine perform pattern recognition. In particular, machines which can read face images are very cost effective. The domain of machine learning and data analysis is frequently used in various real world applications. Some of them are used for providing ease in reducing the amount of data during intelligence system development and some of them are used for directly producing the outcomes to the applications. Among them the recognition and classification is a classical issue of machine learning. A machine that reads passenger passports can process many more passports than a human being in the same time [1] [2] [3].

Therefore the proposed work is dedicated to find the solution for face recognition using neural network based applications. During investigation of the face detection approaches in our research work we will implement face recognition technique using deep leaning of neural network strategies that will enhance figures are found to be better than other traditional approaches.

II. BACKGROUND

The background study is an important part of our research paper. It provides the context and purpose of the study. Hence there is requirement of background study that contribute to prepare proposed system.

A. Computer Vision

The human ability to interact with other people is based on their ability of recognition. This innate ability to effortlessly identify and recognize objects, even if distorted or modified, has induced to research on how the human brain processes these images. This skill is quite reliable, despite changes due to viewing conditions, emotional expressions, ageing, added artifacts, or even circumstances that permit seeing only a fraction of the face. Furthermore, humans are able to recognize thousands of individuals during their lifetime. Understanding the human mechanism, in addition to cognitive aspects, would help to build a system for the automatic identification of faces by a machine. However, face recognition is still an area of active research since a completely successful approach or model has not yet been proposed to solve the face recognition problem. Automated

face recognition is a very popular field nowadays. Face recognition can be used in a multitude of commercial and law enforcement applications. For example, a security system could grab an image of a person and the identity of the individual by matching the image with the one stored on the system database [4] [5].

B. Face Recognition

Face recognition is becoming an active research area spanning several disciplines such as image processing, pattern recognition, computer vision, neural networks, cognitive science, neuroscience, psychology and physiology. It is a dedicated process, not merely an application of the general object recognition process. It is also the representation of the most splendid capacities of human vision. In this section we emphasize of face recognition scenario.

Face recognition is a biometric technique used for surveillance purposes such as search for wanted criminals, suspected terrorists, and missing children. The term face recognition refers to identifying, by computational algorithms, an unknown face image. 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. Face recognition (FR) has emerged as one of the most extensively studied research topics that spans multiple disciplines such as pattern recognition, signal processing and computer vision [6] [7].

C. Face Recognition Structure

Typical structures of face recognition system consist of three major steps, gaining of face data, extracting face feature and recognition of face. Figure 1 shows typical structure of face recognition system in which subject under consideration given to the system for the recognition purpose this is consider being acquisition of face image. Later on feature is extracted from the image and finally it is given for the recognition purpose [8] [9]. These steps are elaborated as follow.

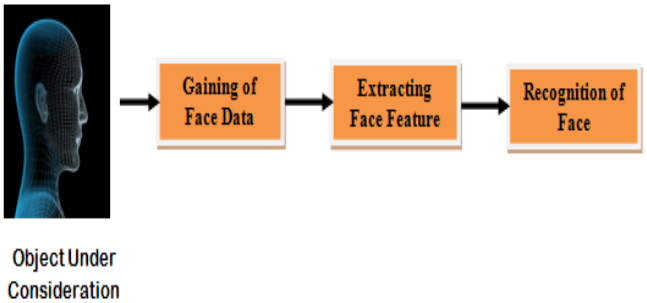

Figure 1: Face Recognition Systems

- ✓ ***Gaining of Face Data***

Acquisition and Processing of Face Data is first step in the face recognition system. In this step face images is collected from different sources. The sources may be camera or readily available face image database on the website. The collected face images should have the pose, illumination and expression etc. variation in order to check the performance of the face recognition system under these conditions. Processing of face database require sometimes otherwise causes serious effect on the performance of face recognition systems due changes in the illumination condition, background, lighting conditions, camera distance, and thus the size and orientation of the head. Therefore input image is normalized and some image transformation methods apply on the input image.

- ✓ ***Extracting Face Feature***

Feature extraction process can be defined as the process of extracting relevant information from a face image. In feature extraction, a mathematical representation of original image called a biometric template or biometric reference is generated, which is stored in the database and will form the basis (vector) of any recognition task. Later these extracted features used in recognition. A grayscale pixel is considered as initial feature.

- ✓ ***Recognition of Face***

Once the features are extracted and selected, the next step is to classify the image. Appearance-based face recognition algorithms use a wide variety of classification methods Such as PCA, LDA. In classification the similarity between faces from the same individual and different individuals after all the face images in database are represented with relevant features. Sometimes feature extraction & recognition process done simultaneously.

III. PROPOSED WORK

The given section provides the detailed understanding about the proposed work and the contribution placed for improving performance of face recognition system. Therefore the section includes the proposed methodology with algorithm summery.

A. Methodology

The proposed model for hybrid face recognition approach based on two classical algorithm described in this section. Following are the figure 2 depicts the working system architecture for recognizing multi-pose human faces by using their ID's.

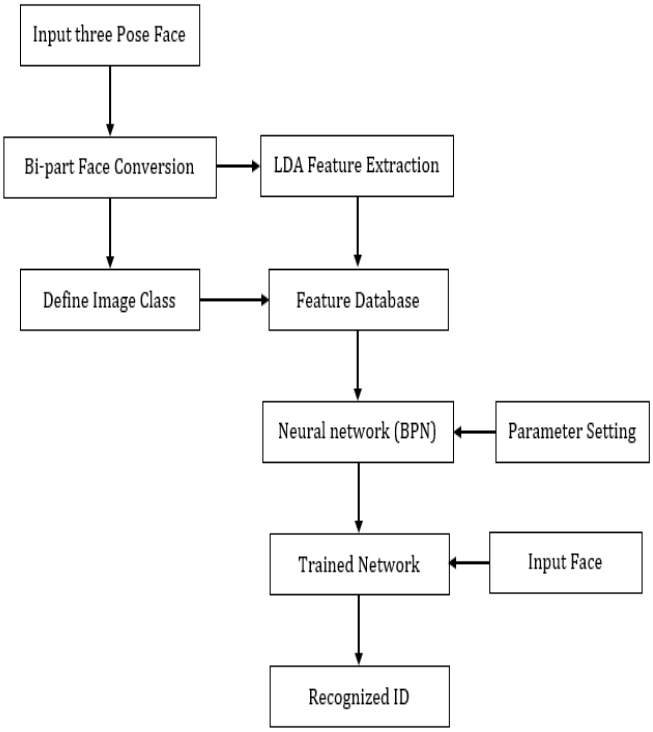

Figure 2: Proposed System Architecture

According to the given model proposed system accepts three face poses for training purpose. Among them first pose is taken from front, second is from left side and the third face image is taken from right side. All the face images are processed in next phase for bi-parting these images and the entire images are converted into six partial phases. After conversion of these faces into six parts the provision is made to define the image classes. These image classes are used with the LDA feature extraction algorithm. The LDA features and the class definition are preserved in a database. Now a neural network is prepared for training with the extracted features. Therefore first the user provides the setting parameters for the neural network. Now using these parameters system perform training with the features and trained model is prepared. In further this trained data model is used to accept the user face image and image recognition is performed.

Additionally we described each of the point individually which is responsible for completion of the proposed system

Input three Pose Face- To process the entire hybrid face recognition approach, in this phase we take a number input faces. The input face image have to be right side, left side and front.

Bi-part Face Conversion- In this phase for a single face class three primary images are taken and then each image of face is sub-divided into 2 parts. Therefore total six face images are used for defining the single image class

LDA Feature Extraction- This phase finds the key features in the face that will be used in classification. It is responsible for composing a feature vector that is well enough to represent the faces. For this purpose we apply standard LDA algorithm for extracting the image features.

Define Image Class- After the bi-part face conversion, we define image class of the face and we provide ID to each image group.

Feature Database- On being classified as unknown by the classification module, the face can be added to the collection with their feature vectors for future comparisons.

Neural Network (BPN) – In this phase we have applied neural network by means of back propagation network. Generally, neural networks have the ability to adapt to changing input so the network produces the best possible result without the need to redesign the output criteria. BPNN is a supervised algorithm in which error difference between the desired output and calculated output is back propagated. The procedure is repeated during learning to minimize the error by adjusting the weights thought the back propagation of error. Here, we used BPN for prediction class of images.

Parameter Setting- In this phase we have to set diverse number of parameter for processing the back propagation neural network. Following are the list of the parameters / criteria which affects the performance of the BPNN.

1. Learning Rate
2. Number of Hidden Units
3. Overtraining and Early Stopping Criteria
4. Number of Learning Samples
5. Number of Output

Trained Network- The trained neural network model is used for accepting the user face input either complete face or partial face to predict the most likely class of face image.

Input Faces- After this trained data model is used to accept the user face image for recognized human Face ID.

Recognized ID- In this, we have taken faces of a single person which is divided in sub parts are correctly matched that will be shown by their ID.

B. Proposed Algorithm

In order to demonstrate proposed hybrid face recognition approach, we summarize our work using algorithmic stricture. Therefore figure 1 and 2 shows the training and recognition algorithm respectively.

Table 1: Training Algorithm

Input: face image F, number of poses n, Neural Network Parameters P

Output: Trained model NN

Process:

1. $R_n = readInputFaces(F)$
2. $for(i = 1; i \leq n; i++)$
   a. $FaceB = bipartImages(R_n)$
3. $end\ for$
4. $FList_{2n} = LDA.extractFeature(FaceB)$
5. $NN = NeuralNetwork.Initilize(FList_{2n}, UserID)$
6. $return\ NN$

Table 2: Recognition

Input: face image to recognize FR, Trained Neural Network

Output: UserID

Process:

1. $RL = readImage(FR)$
2. $P = NN.predict(RL)$
3. $UserID = FindLiklyFaceID(P)$
4. Return UserID

IV. RESULT ANALYSIS

The section provides the evaluated results and the comparative study among new technique proposed and traditionally implemented algorithm. This section helps to understand how the proposed approach performing better than the traditional technique.

A. Memory Consumption

The amount of main memory required to evaluate the face data using the proposed algorithm is known as the memory usage of the algorithm. The figure 3 and table 3 shows the memory performance:

$$\text{Memory Consumption} = \text{Total Memory} - \text{Free Memory}$$

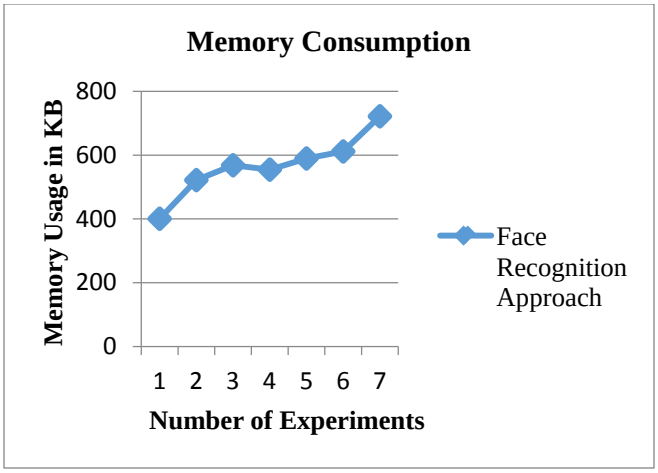

Figure 3: Memory Usage

The amount of memory consumption depends on the amount of data reside in the main memory, therefore that affect the computational cost of an algorithm execution. The performance of the implemented face recognition approach of human face authentication is given using figure 3 and data is numerically show by table 3. For clarification of the result, X axis of figure contains the different amount of code execution and the Y axis shows the respective memory consumption during execution in terms of kilobytes (KB). According to the obtained results the performance of algorithm demonstrates similar behavior with increasing size of data, but the amount of memory consumption is decreases with different faces. The recognition of the face ID is more important for valid authentication.

Table 3: Memory Consumption

Number of Experiments	Hybrid Face Recognition Approach
1	400.53
2	521.66
3	568.21
4	554.45
5	589.41
6	611.48
7	721.69

B. Time Consumption

The amount of time required to evaluate algorithm to process the input faces for face ID recognition termed as time complexity or time consumption. The time consumption can be calculated using following formula:

$$\text{Time Consumption} = \text{Algo. End Time} - \text{Algo. Start Time}$$

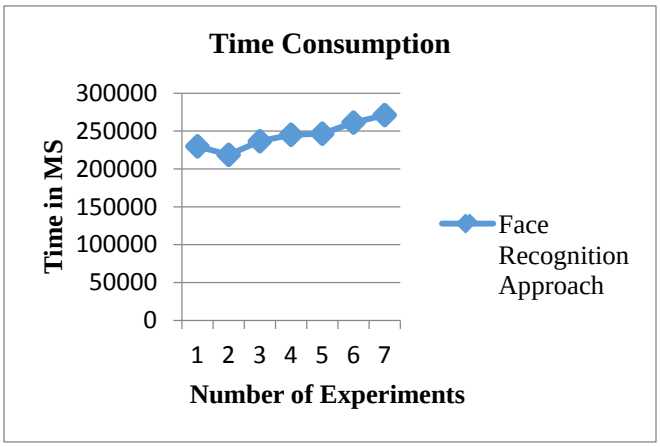

Figure 4: Time Consumption

The time consumption of the proposed algorithm is given using figure 4 and table 4. In this diagram the X axis contains the program execution of the system and the Y axis contains time consumed which is measures in milliseconds. According to the evaluated performance of the proposed technique is process the face ID recognition. For processing algorithm consume time which is illustrated in table 5.4 in numerically. But the amount of time is increases in similar manner as the different face effect i.e. left, right and straight.

Table 4: Time Consumption

Number of Experiments	Hybrid Face Recognition Approach
1	229873
2	218653
3	236654
4	245162
5	246591
6	261236
7	271156

C. Accuracy

The accuracy of the algorithm provides the estimation about correctly identified prediction of images. Therefore that is an essential parameter for any data analysis algorithm. This parameter can be evaluated using the following formula.

$$\text{Accuracy} = \frac{\text{Correctly Recognized Prediction}}{\text{Total Prediction}} X100$$

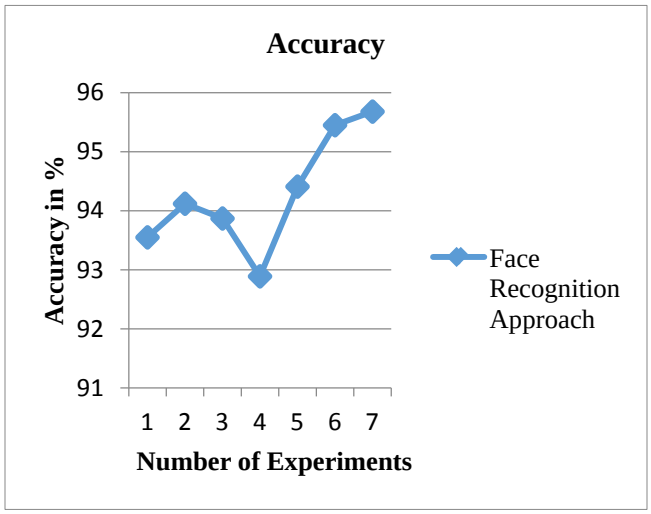

Figure 5: Accuracy

The accuracy of the implemented proposed approach of hybrid face recognition is represented using table 5 and figure 5. The given graph figure 5 contains the accuracy of the implemented algorithms. The X axis of the diagram shows the different experiments and Y axis contains the obtained performance in terms of accuracy (%). To demonstrate the performance of the proposed technique is representing using blue line. This technique is evaluated on the basis of different input images of human faces. The input images are left, right and straight for extracting features. Therefore, we measured the accuracy of the system by the rate at which it correctly recognized human Face ID. Additionally the accuracy of the feature extraction model is increases as the amount of faces for the learning of algorithm is increases.

Table 5: Accuracy

Number of Experiments	Hybrid Face Recognition Approach
1	93.55
2	94.12
3	93.87
4	92.89
5	94.41
6	95.45
7	95.68

Table 6: Error Rate

Number of Experiments	Hybrid Face Recognition Approach
1	6.45
2	5.88
3	6.13
4	7.11
5	5.59
6	4.55
7	4.32

D. Error Rate

The error rate is an amount of data that is not properly recognized during the automated data analysis. That can be evaluated using the following formula:

$$\text{Error Rate\%} = \frac{\text{Total Inaccuate Pradiction}}{\text{Total Prediction}} X100$$

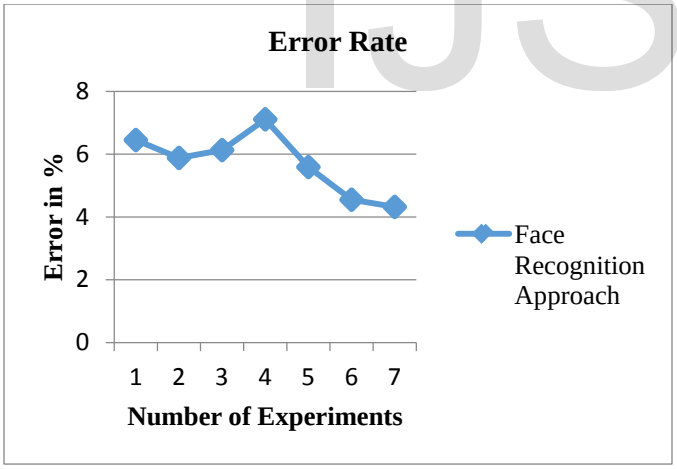

Figure 6 Error Rate

The figure 6 and table 6 shows the error rate of implemented system. In order to show the performance of the system the X axis contains the experiments and the Y axis shows the performance in terms of error rate in percentage (%). The performance of the proposed face recognition approach is given using the blue line. The performance of the proposed human face classification using BPN is effective and efficient during different execution and reducing with the amount of faces increases. Thus the presented technique is more efficient and accurate for recognizing human face ID.

V. CONCLUSION AND FUTURE WORK

A. Conclusion

The human face plays an important role in our social interaction, conveying people's identity. Using the human face as a key to security, biometric face recognition technology has received significant attention in the past several years due to its potential for a wide variety of applications in both law enforcement and non-law enforcement. Face recognition is a very interesting quandary. Ideally a face detection system should be able to take a new face and return a name identifying that person. The face recognition is a subject of machine learning and pattern recognition. That is frequently used for various different applications for authentication and secure access control due to their uniqueness. In the work direction, this project aims at comparative analysis and implementation of two novel techniques namely LDA and neural network based back propagation network (BPN) that have found immense application in the field of object recognition. The proposed work is dedicated to design and implement a face recognition model that accept the partial or complete face images in order to recognize the face class. In this context the three step process is proposed to work where in first phase the face images are partitioned into multiple face parts this step is termed here as the pre-processing of images. Secondly the images are processed for feature extraction thus the LDA algorithm is proposed to implement. Finally the neural network is proposed to perform training on extracted face features and classes and the trained model is used for recognizing the faces.

B. Future Work

The general experimental evaluation of the face expressional system guarantees better face recognition rates. The proposed technique is implemented successfully and their performance in different parameters are estimated, according to results the performance of the proposed technique is adoptable and efficient thus the following expected extensions are possible with the proposed method .

- ✓ Size of database is to be increased with illumination variation, pose variation, expression variation and occlusion variation conditions must be considered while capturing the dummy face of the subjects.
- ✓ Two or more classifier can be combine to improve the system for large huge amount of images.
- ✓ Using Soft Computing, neural network can be combined with fuzzy logic to enhance the performance of face recognition.

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