A NOVEL APPROACH FOR FACE VERIFICATION AND AGE ESTIMATION USING LOCAL BINARY PATTERN, ELASTIC MATCHING AND BACK PROPAGATION NEURAL NETWORK

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ABSTRACT

In this paper we propose a methodology based on back propagation approach to estimate human age using face features. The recent technology of image processing forms the basic principles of project entitled “A Novel Approach for Face Verification and age estimation using Local Binary Pattern, elastic matching and Back propagation Neural Network” has been developed to overcome the inconveniences faced by the organizations in recognizing the exact person and to estimate the age of a human. In this research is to propose a face detection algorithm for color images in the presence of varying lighting conditions as well as complex backgrounds. Based on a novel lighting compensation technique and a nonlinear color transformation, new method detects skin regions over the entire image and then generates face candidates based on the spatial arrangement of these skin patch. The proposed method is evaluated by extensive experiments on the FG-NET dataset and MORPH dataset, and compared with two widely used facial expression recognition approaches using Local Binary Pattern. To estimate the age is automatically via facial image analysis has lots of potential real-world applications, such as human computer interaction and multimedia communication.. We found surprisingly that the added difficulty of verification produced by age gaps becomes saturated after the gap is larger than four years, for gaps of up to ten years. The face boundary can be differing from different age groups. Identify the age groups of a human based on the edges and stored in the database. Compare the input image and the existing database image.

Key words: Image processing, LBP pattern, Age estimation, Morph dataset, Discriminative approach, BPN

I. INTRODUCTION

The objective of our system is to recognise and identify faces, not previously presented to or in some way processed by the system. There are many datasets involved in this project. Some of them are the FG-NET, MORPH dataset which consisting of a large set of images of different people. The database has many variations in pose, scale, facial expression and details. Some of the images are used for training the system and some for testing. The test set is not involved in any part of training or configuration of the system, except for the weighted committees as described in a section later on. The purpose of research work is to use of elastic matching, and local binary pattern for face recognition Also to estimate the age of a human using automatic age estimation and back propagation neural network.

II. RELATED WORK

Human age estimation can be identified with the reference paper (1) using easy NN(neural network)and the FG-NET dataset and MORPH dataset for the age varying from 1 to 70 years. Training and testing was performed using Easy Neural network. Age can be classified into 1-12, 13-25, 26-45, and 46-63.The Advantages are it can identify the human age of 84%, easy neural network concept is implemented for training and testing. The limitations are it cannot find the face recognition also the system outperforms with the human observations compared with the system output

In the existing research work is used to find the face verification and age progression of the image using GOP and discriminative method using FG-NET database. It is not easy to find the unauthorized persons (criminals) in the passport terminals, airports and in the public place. The images were retrieved from the passport database of different subjects such as illumination, facial expression etc are uncontrolled in this dataset.

III. PROPOSED SYSTEM

The proposed system is mainly classified into three stages. Using back propagation network algorithm we have classified into three stages.The face images in different databases are captured under different conditions, such as various lighting conditions, facial expressions, perspectives, etc. The respective eye locations of each image are detected and used for normalization and alignment. All images are cropped to a size of 64 ’ 64 based on the eye locations. In each database, one frontal-view image for each subject with normal illumination and neutral expression is selected as a training sample, and others form the testing set. In the proposed research work is used to find the face verification and age progression of the image using GOP and discriminative method using MORPH database.. Our proposed method uses the Back Propagation Network.

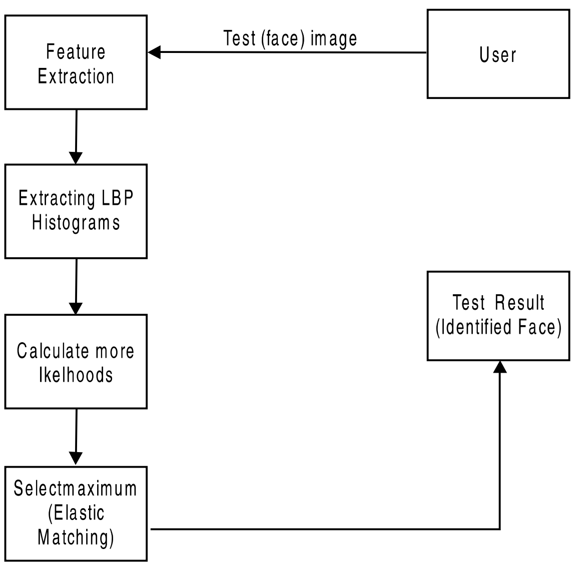

Fig. 1. Face verification Flow Chart

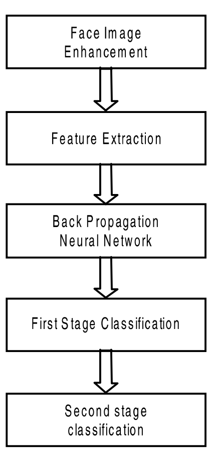

Fig. 2. The stages of the proposed system

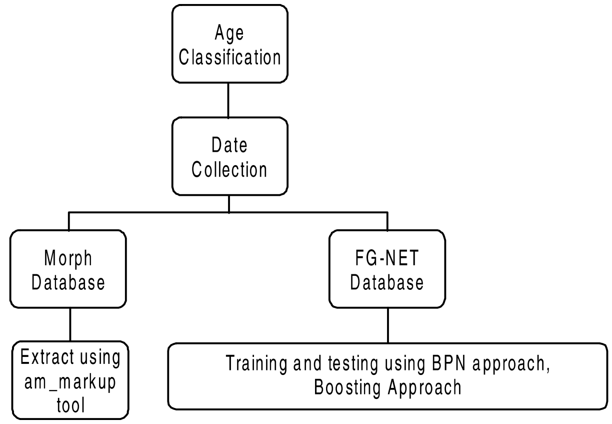

Fig. 3. The Process of the Proposed Model

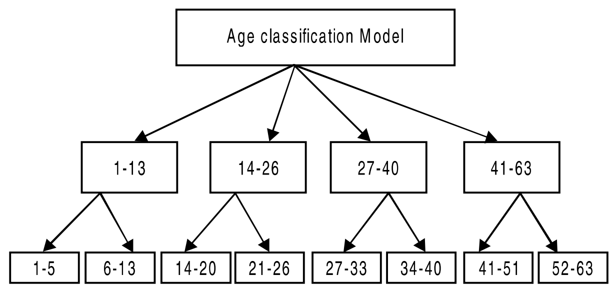

Fig. 4. Age Classification using proposed model

Advantages:

- The experimental results on standard face databases show that this algorithm performs better than traditional methods.
- It can obtain a higher recognition rate and is robust to posture, lighting and expressions
- It can reduce the dimension greatly and preserve the main information with a high recognition rate in a wide range of resolution.
- Maintains good edge strength.
- It can estimate the age and also face recognition.

IV. FUNCTIONAL REQUIREMENTS

- Modeling a face and feature extraction
- Extraction of LBP histograms and Elastic matching
- PCA for Eigen faces.
- Recognition and Verification
- Face Boundary Estimation

- Gradient Orientation and Gradient Orientation Pyramid
- Age Progression using Back Propagation Network

A Modeling a face and feature extraction:

The "coded" image is divided into sub-images and the overlap between successive sub-images is allowed to be up to 5 pixels less than the total height of the sub-image.

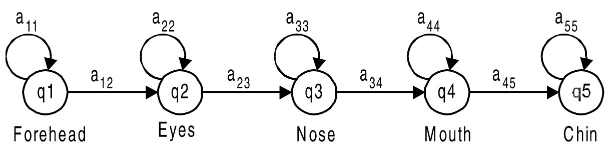

Fig. 5. One-dimensional discrete top-to-bottom

To generate the observation vector from each sub-image, the two dimensional sub-images are converted into a vector by extracting the coefficients column-wise. The number of features (NF) selected was varied to see its effect on the recognition ability of the system. The coefficients of the sub-images are stacked to form a vector, therefore a face image is represented by a vector which is () in length, where Q is the number of states. Figure 5(a) shows the original image form the AT&T database while Figure 5(b) shows the gray-scale of the approximation coefficient of the same image with the sampling strip for segmenting the image into allowable states

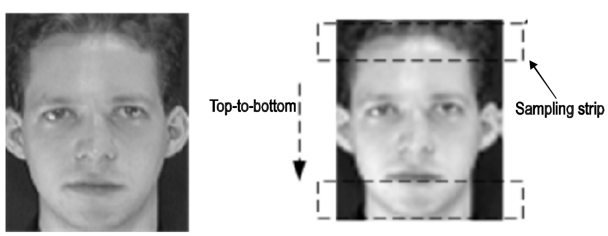

Fig. 6: Grey-scale version of the approximation coefficients of an image and segmentation into states.

The method extracts the part of a face that includes eyes, eyebrows, nose and mouth, based on the detected features of the face. The database consists of faces such as depends upon the weight gain of the human, facial hair changes and the presence of glasses, illumination conditions, wearing headscarf and without wearing headscarf. A face detection algorithm for color images in the presence of varying lighting conditions as well as complex backgrounds is implemented. Based on a novel lighting compensation technique and a nonlinear color transformation, our method detects skin regions over the entire image and then generates face candidates based on the spatial arrangement of these skin patches. The input will be coming from any sensor devices like camera, robotics, GPS (global positioning system) .It is noticed that, among these applications, only a few facial features such as eyes and mouth are frequently addressed for fine extraction. The face boundary is one of the most important but difficult facial features to be extracted. The image can be extracted from the sensor device and placed in the stable space. The noises can be identified in the extracted image and suitable filters can be applied to detect the original image. To identify the morph dataset and calculate the edge of the morphed images, when the input is taken from the sensor device first the edge will be calculated and it can be compared from the static information. The edge can be calculated after converting the original image into the binary scale image. Identify the face of a human based on the edges and stored in the database. Compare the input image and the existing database image.

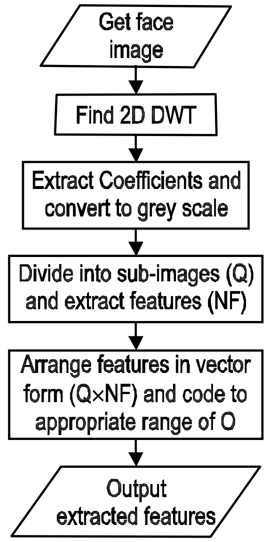

Fig. 7. Algorithm for feature extraction

B Extraction of LBP histograms:

It extracts LBP histogram from non-binary edge map in order to maintain the edge strength information and meanwhile extract the texture information. The face area is divided into small regions, from which local binary pattern(LBP) histograms are extracted and concatenated into a single vector efficiently representing the facial image.

The method divides the query and database images into equally sized blocks from which LBP histograms are extracted. Then the block histograms are compared using a relative dissimilarity measure based on the available distances. It sums up the database histograms according to the size of the query image and finds the best match by exploiting a sliding search window. The approach is based on the simple local binary patterns (LBP) for representing salient micro-patterns of face images in which the image pixels are labeled into binary class.

LBP operator

The local binary pattern (LBP) operator is defined as a gray-scale invariant texture measure, derived from a general definition of texture in a local neighborhood. It labels the pixels of an image by threshold the 3'3 neighborhood of each pixel with the center value and considering the result as a binary number. It employs the elastic matching to weaken the negative impact from translation. The process of elastic matching is as following: given a test block in the testing image, then search its neighborhood in the training image to find the best match that a block with the minimum distance to it each face is normalized to a size of 64'64 pixels.

Elastic matching

A human face is treated as a combination of a sequence of small and flat Facets adopt an even distribution of feature points and a uniform block size, and all of the blocks employ square structure. Adjacent blocks also allowed overlapping. After the image is divided into blocks, the next step is calculating the distance between two blocks. Blocks to be compared will not be accurate in the same position because of some partial distortion. Such as a side face, or a face with expression or the key points (such as the eyes) are not located precisely, then there will exist translation of some face parts. And these translations will bring about a certain negative impact to face recognition. So, in order to reduce these effects, we employ elastic matching to compare two blocks.

The process of elastic matching is as following: given a test block in the testing image, then search its neighbourhood in the training image to find the best match that a block with the minimum distance to it. In our method, each face is normalized to a size of 64'64. And Regarding the computation and performance, feature points located at the nodes of a 21'21 grid, i.e. the distances between the feature points in the vertical and horizontal directions are both equal to 3. And the size of block and search range are both 5'5.

C PCA for Eigen faces

Principal Component Analysis is based on the Karhunen-Loeve (K-L), or Hostelling Transform, which is the optimal linear method for reducing redundancy, in the least mean squared reconstruction error sense. The idea of principal component analysis is based on the identification of linear transformation of the co-ordinates of a system. "The three axes of the new co-ordinate system coincide with the directions of the three largest spreads of the point distributions."

Face recognition, given dataset of N training images, we create N d-dimensional vectors, where each pixel is a unique dimension. The principal components of this set of vectors are computed in order to obtain a $d \times m$ projection matrix, W. For the comparison we are going to use two different PCA algorithms. The first algorithm is computing and storing the weight of vectors for each person's image in the training set, so the actual training data is not necessary. In the second algorithm each weight of each image is stored individually, is a memory-based algorithm. For that we need more storing space but the performance is better. By extraction the sample pattern's algebraic feature, the human face image's Eigen values, the neural network classifier is trained for recognition.

D Recognition and verification

Facial recognition utilizes distinctive features of the face - including the upper outlines of the eye sockets, the areas surrounding the cheekbones, the sides of the mouth, and the location of the nose and eyes - to perform verification and identification. Most technologies are somewhat resistant to moderate changes in hairstyle, as they do not utilize areas of the face located near the hairline. When used in identification mode, facial recognition technology generally returns candidate lists of close matches as opposed to returning a single definitive match (as do fingerprint and iris-scan technologies).

Given a face to be tested or recognized, feature (observation vector) extraction is first performed as described in section 3.1. Model likelihoods (log-likelihood) for all the models in the training set (given the observation vectors) is calculated and the model with the highest log-likelihood is identified to be the model representing the face. Euclidean measure is used to test if a face is in the training set or database. If the log-likelihood is within the stated distance, the model (face) is recognized to be in the training set or in the database. However, in areas of applications such as access control, it is desired to know the exact identity of an individual, therefore the need to verify the correctness of the faces recognized.

$$\text{if } \| {}^{test} - {}^{min} \| < \text{ constant}$$

accept
face
reject face

For classification or verification, the Viterbi recogniser is used as shown in Figure 6. The test (face) image is converted to an observation sequence and then model likelihoods $P\left(O_{test}/\lambda_1\right)$ are computed for each. λ_i, $i = 1, 2, \ldots c$. The model with highest likelihood reveals the identity of the unknown face. $v = \text{argmax}_{isisc}\left[P\left(0_{test}/\lambda_i\right)\right]$

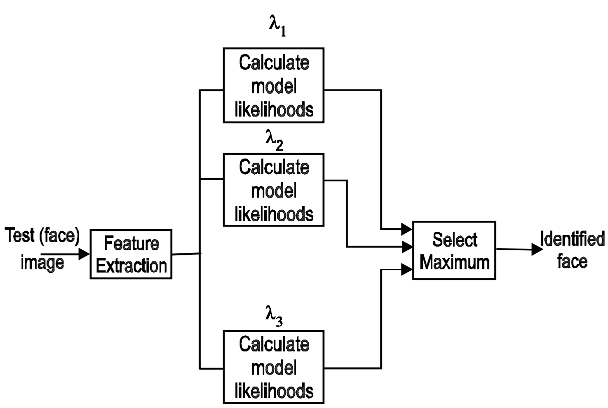

Fig. 8. Recognizer

E. *Face boundary estimation*

The image can be extracted from the sensor device and placed in the stable space. The noises can be identified in the extracted image and suitable filters can be applied to detect the original image. To identify the morph dataset and calculate the edge of the morphed images, when the input is taken from the sensor device first the edge will be calculated and it can be compared from the static information.

The edge can be calculated after converting the original image into the binary scale image. The face boundary can be differing from different age groups. Compare the input image and the existing database image. To analyze the image that can be fall on which age group. Morphing describes the action taking place when one image (in this case a digital image) gets transformed into another or, in a more technical way, Morphing describes the combination of generalized image warping with cross-dissolve between image elements.

The advantage of this problem is that it does not require many images for each subject, which is often difficult for collections across aging. Furthermore, this problem directly relates to the passport renewal task that is important for the passport datasets in our experiments. In the task, a newly submitted photo needs to be compared with an old one, to ensure that the request is valid.

F. *Age Progression using Back Propagation Network*

Back Propagation Algorithm:

The following steps summarize the back propagation algorithm:

- Propagate the input forward through the network to the output.
- Propagate the partial derivatives of the error function backward through the network.
- Update the weights and biases of the network.
- Repeat until stop condition is reached.

In the case the inputs are not fully connected as usually assumed by the algorithms. The weights corresponding to missing connections can be simply ignored in the updating step, and when included in the calculation of the error they can be considered of zero value. If the weight values are too large the net value will large as well; this causes the derivative of the activation function to work in the saturation region and the weight changes to be near zero. For small initial weights the changes will also be very small, which causes the learning process to be very slow and might even prevent convergence.

V. TRAINING AND LEARNING FUNCTIONS

Training and learning functions are mathematical procedures used to automatically adjust the network's weights and biases. The training function dictates a global algorithm that affects all the weights and biases of a given network. The learning function can be applied to individual weights and biases within a network. Neural Network Toolbox supports a variety of training algorithms, including several gradient descent methods, conjugate gradient methods, the Levenberg-Marquardt algorithm (LM), and the resilient back propagation algorithm (Rprop). The toolbox's modular framework lets you quickly develop custom training algorithms that can be integrated with built-in algorithms. While training your neural network, you can use error weights to define the relative importance of desired outputs, which can be prioritized in terms of sample, time step (for time-series problems), output element, or any combination of these. You can access training algorithms from the command line or via a graphical tool that shows a diagram of the network being trained and provides network performance plots and status information to help you monitor the training process.

A. Training

Features extracted from faces of individuals are used to train a model for each face using the algorithm shown in Figure 5. The initial parameter were generated randomly and improved using Baum-Welch re-estimation procedure [15] to get the parameters that optimise the likelihood of the training set observation vectors for the each face.

State transition probability (A) is defined as,

$$a_{ij} = 0, \qquad j < i$$
$$a_{ij} = 0, \quad j > i + \Delta$$

where $\Delta = 1$ i.e. the model is not allowed to jump more than a state at a time. Since each face was divided into five sub-images, the resulting matrix is

$$\begin{bmatrix} a_{11} & a_{12} & 0 & 0 & 0 \\ 0 & a_{22} & a_{23} & 0 & 0 \\ 0 & 0 & a_{33} & a_{34} & 0 \\ 0 & 0 & 0 & a_{44} & a_{45} \\ 0 & 0 & 0 & 0 & a_{55} \end{bmatrix}$$

$$a_{NN} = p$$

while $a_{Ni} = 0$ for $i < N$ and $i > N + 1$

and the initial state probability (π) is defined as

$$\pi_i = [1, 0, 0, 0, 0, 0]$$

Maximum number of iteration for the re-estimation is set to 5 or if the error between the initial and present value is less than , then the model is taken to have converged and the model parameters are stored with appropriate class name or number $\left(A_c, B_c, \pi_c \right)$.

B. Algorithm for model re-estimation

(n is the maximum number of iteration allowed)

$k = 1$

initialise $\lambda = (A, B, \pi)$

compute $P(0/\lambda^k)$

while $k < n$ do

estimate $P(0/\lambda^{k+1}$

if $| P(0/\lambda^{k+1}) - P(0/\lambda^k) | <$ error

quit

else

$P(0/\lambda^k) \Leftarrow P()/\lambda^{k+1})$

end

end

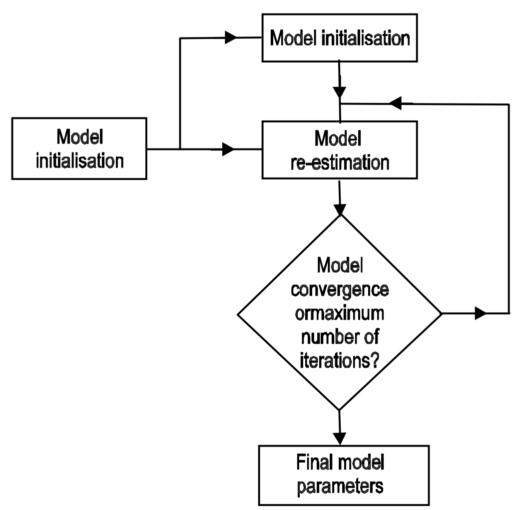

Fig. 9: Algorithm for training

VI. PREPROCESSING AND POST PROCESSING FUNCTIONS

Preprocessing the network inputs and targets improves the efficiency of neural network training. Postprocessing enables detailed analysis of network performance. Neural Network Toolbox provides preprocessing and post processing functions and Simulink blocks that enable you to: Reduce the dimensions of the input vectors using principal component analysis Perform regression analysis between the network response and the corresponding targets Scale inputs and targets so that they fall in the range [-1,1] Normalize the mean and standard deviation of the training set Use automated data preprocessing and data division when creating your networks

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This simple type of network is interesting because the hidden units are free to construct their own representations of the input. The weights between the input and hidden units determine when each hidden unit is active, and so by modifying these weights, a hidden unit can choose what it represents.

We also distinguish single-layer and multi-layer architectures. The single-layer organization, in which all units are connected to one another, constitutes the most general case and is of more potential computational power than hierarchically structured multi-layer organizations. In multi-layer networks, units are often numbered by layer, instead of following a global numbering.

Image Processing Toolbox provides reference-standard algorithms for preprocessing and postprocessing tasks that solve frequent system problems, such as interfering noise, low dynamic range, out-of-focus optics, and the difference in color representation between input and output devices.

Image enhancement techniques in Image Processing Toolbox enable you to increase the signal-to-noise ratio and accentuate image features by modifying the colors or intensities of an image. You can:

- Perform histogram equalization
- Perform decor relation stretching
- Remap the dynamic range
- Adjust the gamma value
- Perform linear, median, or adaptive filtering

The toolbox includes specialized filtering routines and a generalized multidimensional filtering function that handles integer image types, offers multiple boundary-padding options, and performs convolution and correlation. Predefined filters and functions for designing and implementing your own linear filters are also provided.Image deblurring algorithms in Image Processing Toolbox include blind, Lucy-Richardson, Wiener, and regularized filter deconvolution, as well as conversions between point spread and optical transfer functions. These functions help correct blurring caused by out-of-focus optics, movement by the camera or the subject during image capture, atmospheric conditions, short exposure time, and other factors. All deblurring functions work with multidimensional images. Device-independent color management in Image Processing Toolbox enables you to accurately represent color independently from input and output devices. This is useful when analyzing the characteristics of a device, quantitatively measuring color accuracy, or developing algorithms for several different devices. With specialized functions in the toolbox, you can convert images between device-independent color spaces, such as sRGB, *XYZ*, xy^{Y}, $L^{*}\ a^{*}\ b^{*}$, *uvL*, and L^{*}ch. For more flexibility and control, the toolbox supports profile-based color space conversions using a color management system based on ICC version 4. For example, you can import n-dimensional ICC color profiles, create new or modify existing ICC color profiles for specific input and output devices, specify the rendering intent, and find all compliant profiles on your machine.

Image transforms such as FFT and DCT play a critical role in many image processing tasks, including image enhancement, analysis, restoration, and compression. Image Processing Toolbox provides several image transforms, including Radon and fan-beam projections. You can reconstruct images from parallel-beam and fan-beam projection data (common in tomography applications). Image transforms are also available in MATLAB and Wavelet Toolbox™.

Image conversions between data classes and image types are a common requirement for imaging applications. Image Processing Toolbox provides a variety of utilities for conversion between data classes, including single- and double-precision floating-point and signed or unsigned 8 – ,16 – , and 32-bit integers. The toolbox includes algorithms for conversion between image types, including binary, grayscale, indexed color, and truecolor. Specifically for color images, the toolbox supports a variety of color spaces (such as YIQ, HSV, and YCrCb) as well as Bayer pattern encoded and high dynamic range images.

VII. SYSTEM IMPLEMENTATION

System implementation is the final phase of putting the utility into action. Implementation includes the final testing of the complete system to user satisfaction, and supervision of the initial of the new system.

A novel approach for face recognition using local binary pattern has garnered tremendous attention from governments for crime fighting as well as airport terrorism deterrence. However, there has been little attention towards consumer use of face recognition products. The aim of this project is to come up with a simple implementation for computer authentication to replace the popular pass-phrase based authentication on personal computers. The popularity of high-resolution cameras on market made the possibility of face recognition based computer authentication possible.

Facial recognition technology is expected to grow rapidly as customers deploy it for criminal and civil identification applications, including surveillance and screening. . Increased revenues will be primarily attributable to use in large-scale ID projects in which facial imaging already takes place and the technology can leverage existing processes, such as drivers' licensing, passport issuance applications, and voter registration. In addition, facial recognition technology's use in surveillance applications is expected to increase significantly in public and private sector applications.

7.1 Face Verification and Age estimation

System implementation is the final phase of putting the utility into action. Implementation includes the final testing of the complete system to user satisfaction, and supervision of the initial of the new system.

Age progression involves the modification of the shape and texture of a person's face in order to reflect cross-population age-related trends (i.e., changes in face shape and introduction of wrinkles), coupled with person-specific transformations. The main issue in this subject is the accurate prediction of the facial appearance of a person along the time .

The ability to produce accurate age-progressed images is important in several applications including the localization of missing people, the development of age invariant face recognition systems, and automatic update of photographs appearing in smart documents (i.e., smart id cards).

Test Data Set:

Trained Data Set:

VIII. CONCLUSION & FUTURE ENHANCEMENT

A face image is considered as a combination of many small blocks and local binary pattern histograms are extracted from them as features used for face recognition. Different from the traditional method, we use edge map substitute the gray image to extract local binary pattern. A face image per person was used for training while five other images per person were used for testing. Depending on the Euclidean distance, 100% recognition rate was achieved for images tested. For verification, 80% correct classification (Hit) occurred while 20% were misclassified. The rest of the images that were not in the training set were used to test the false acceptance rate (FAR) i.e. the ratio of the numbers of images falsely accepted to the total number of images tested and 0.02 FAR occurred. First of all, testing on a large public dataset will be conducted for deeper understanding of the proposed approaches. We plan to work on the MORPH dataset for this purpose. Second, we plan to apply other discriminative approaches (e.g., boosting) for simultaneous feature analysis and classification. We plan to work on the MORPH dataset for this purpose. Second, we plan to apply other discriminative approaches (e.g., boosting) for simultaneous feature analysis and classification. The effect of the aging process on verification algorithms is done empirically. In the experiments we observed that the difficulty of face verification algorithms saturated when the age gap is larger. We also implemented the effects of age related issues including image quality, and facial hair. we have used the Back propagation network (BPN) method to find the exact age of a person.

IX. RESULTS

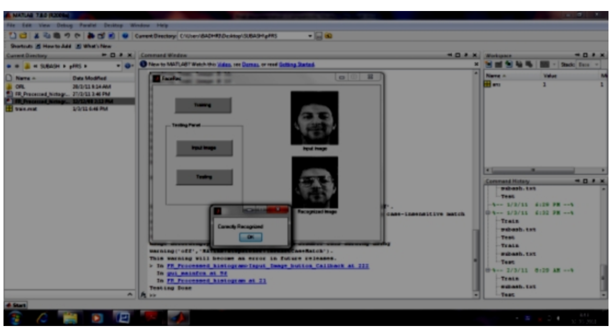

Fig. 10. Face Verification

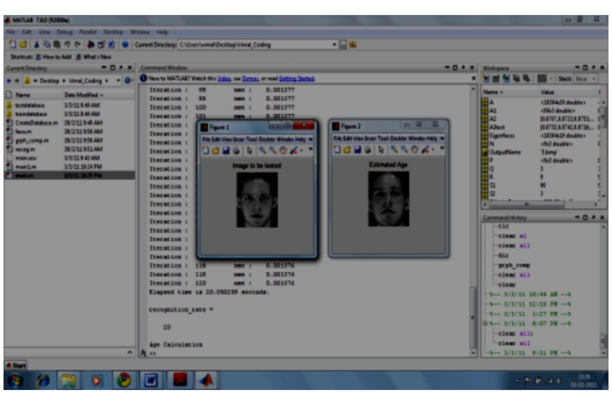

Fig. 11. Age Estimation

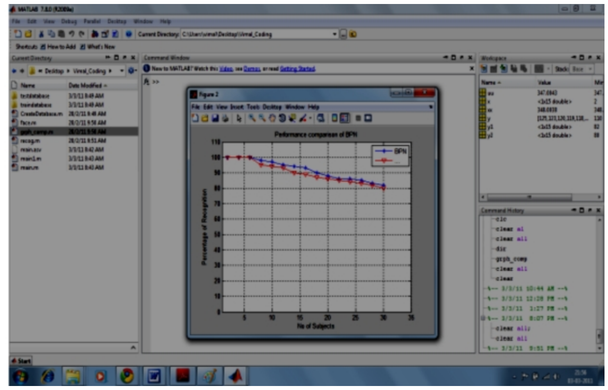

Fig. 12. Performance Comparision Using BPN and Easy NN

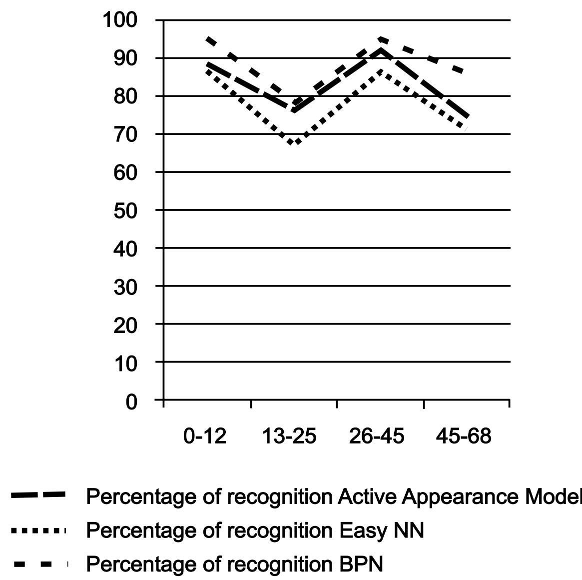

Fig. 13. Performance Comparision using Easy NN, Active Appearance Model and BPN

No of subjects	Percentage of recognition		
	Active Appearance Model	Easy NN	BPN
0-12	88	87	95
13-25	76	67	78
26-45	92	86.4	95
45-68	74	70.9	86

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