International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 3 Issue 5, August 2019 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Face Recognition System using Self-Organizing Feature Map and Appearance-Based Approach

Thaung Yin, Khin Moh Moh Than, Win Tun

Faculty of Computer Systems and Technologies Computer University, Myitkyina, Myanmar

How to cite this paper: Thaung Yin | Khin Moh Moh Than | Win Tun "Face Recognition System using Self-Organizing Feature Map and Appearance-Based Approach" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-3 | Issue-5, August 2019, pp.1598-1603, **https://doi.org/10.31142/ijtsrd26691**

IJTSRD26691

ABSTRACT

Face Recognition has develop one of the most effective presentations of image analysis. This area of research is important not only for the applications in human computer interaction, biometric and security but also in other pattern classification problem. To improve face recognition in this system, two methods are used: PCA (Principal component analysis) and SOM (Self-organizing feature Map).PCA is a subspace projection method is used compress the input face image. SOM method is used to classify DCT-based feature vectors into groups to identify if the subject in the input image is "present" or "not present" in the image database. The aim of this system is that input image has to compare with stored images in the database using PCA and SOM method. An image database of 100 face images is evaluated containing 10 subjects and each subject having 10 images with different facial expression. This system is evaluated by measuring the accuracy of recognition rate. This system has been implemented by MATLAB programming.

KEYWORDS: *PCA (Principal component analysis), SOM (Self-organizing feature Map), DCT (discrete cosine transform)*

INTRODUCTION

Face recognition has grown much consideration in current years and has become one of the most effective applications of image evaluation and understanding. Although people can easily identify and recognize the human faces, it is difficult for computer to do these tasks. Face recognition is used in security system, credit-card verification and criminal identification, teleconference and so on.

The last decade has shown in this area, with emphasis on such presentations as human-computer interaction (HCI), biometric analysis, content-based coding of images and films, and supervision. Although a small task for the human brain, face recognition has showed to be tremendously difficult to reproduce artificially, since commonalities do exist between faces, they differ considerably in terms of age, skin, color and gender. Face recognition is a very interesting problematic and up to date. The problem is complex by opposing image abilities, facial appearances, facial furniture, contextual, and illumination situations. There are four simple approaches for face recognition: Appearance Based, Rule Based, Feature Based, and Quality Based. In this system, Feature Based approach is used.

Since human individuals vary in the tone of their skin, research has revealed that intensity rather than chrominance is the main distinguishing characteristic. The recognition stage typically uses an intensity (grayscale) representation of the image compressed by the DCT for further processing. This grayscale form comprises intensity standards for skin pixels. In this system, one of the unsupervised learning methods SOM, introduced by Teuvo Kohonen is used to learn the distribution of a set of patterns without any class information. As a neural unsupervised learning algorithm, Kohonen's Self-Organizing Map (SOM) Has been widely utilized in pattern recognition area.

This system proposes face recognition system using image processing in DCT and artificial neural network in SOM. First, the input image is necessary to pass the image preprocessing steps until the original image is transformed into 64x64 pixel matrix. Second, the DCT is used to compress the values of preprocessing step. The compressed image pixels are reshaped as 64x1 feature vector. Third, reshaped vector is used as training data set in SOM, one of the unsupervised learning methods. Then optimal weight value or winning neuron is saved after many iteration in SOM Neural Network. Finally, the unknown image is tested using optimal weight values from training dataset. Then the system is classified by face recognition or not.

RELATED WORKS

There are many possible research directions and challenging problems involved in further improving the approach to face recognition introduced in this paper. One such area is improving the invariance of the system to changes in lighting. The present study has some limitations. So further work should be done on the application to very large databases, looking into how the problem scales with size and at what size individual identification becomes unreliable and the input image is not only restricting the taken position of the human but also any group photo without fix the camera position. Face recognition system will be developed for the real time images. The person identification system is developed based on this approach.

APPEARANCE-BASED APPROACH TO FACE RECOGNITION

One of the appearance-based method is principal component analysis (PCA).PCA is a subspace projection technique widely used for face recognition. It finds a set of representative projection vector such that the project simples retain most information about original samples. Principal component analysis is a technique to proficiently represent a gathering of a examples points, decrease the dimensionality of the explanation by prediction the points into the main axis, where the orthogonal set of axis point in the direction of maximum covariance in the data. These vectors greatest account for the delivery of face images within the whole image space, PCA reduces the mean formed projection error for specified dimensions and deliver portion of important for each axis.

A. FACE SPACE

A two dimensional image T(x,y) of size m x n pixels can be viewed as a vector in high dimensional space. Each pixel of the image then corresponds to a coordinate in N-dimensional space as image space. Such a space has huge dimensionality and recognition there would be computational inefficient. In an image of an object is a point un image space, a collection of M images of the same sort of an object represents a set of points in the same subspace of the original image space. All possible images of particular object define a lower-dimension image space is face space.

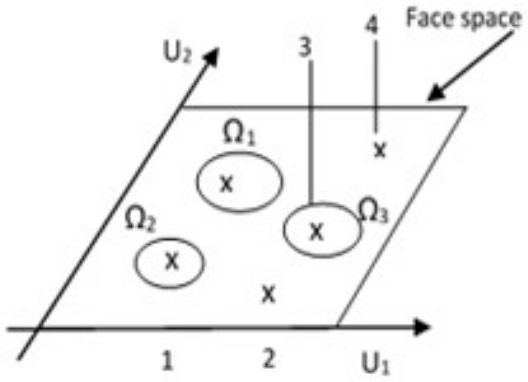

Figure1. Face space and the three expected images on it.

SELF-ORGANIZING FEATURE MAP

Self-organizing feature maps signify a special class of artificial neural networks built on inexpensive unsupervised learning. The output neurons of the network play among themselves to be stimulated (fired), with the product that only one output neuron, or one neuron per group, is at several one time. The output neurons that success the race are called winner-takes-all neurons. One way of inducing a winner-takes-all competition among the output neurons is to use lateral inhibitory connections between them. In a self-organizing feature map, the neurons are placed at the nodes of a lattice that is usually one- or two-dimensional; higher-dimensional maps are also not as common. The neurons developed selectively adjusted to many input patterns or classes of input patterns in the development of a competitive learning process. The positions of the winning neurons incline to develop ordered with respect to each other in such a way that an expressive coordinate system for dissimilar input features is created over the lattice. A self-organizing feature map is characterized by the construction of a topographic chart of the input patterns, in which the spatial positions (coordinates) of the neurons in the lattice correspond to essential features of the input patterns. The Kohonen self-organizing map (SOM) performs a mapping from a continuous input space to a discrete output space, preserving the topological properties of the input. This means that points close to each other in the input space are mapped to the same neighboring neurons in output space [13]. SOMs can be one-dimensional, two-dimensional or multidimensional maps. The number of input connections in a SOM network depends on the number of attributes to be used in the classification.

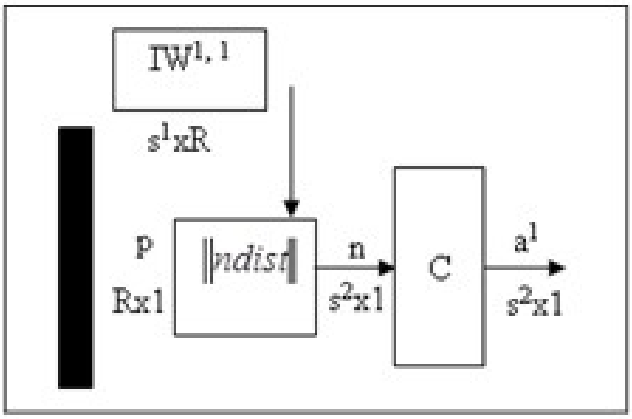

Figure2. Architecture of a simple SOM

PREPROCESSING STEPS FOR FACE RECOGNITION

The important parts of a face recognition system are the discrete cosine transform and self-organizing feature map methods. Firstly is the image preprocessing. In the preprocessing steps are used to apply the purpose for data reduction, removal of data redundancies and speed-up of parameter searches. The key to the recognition is feature extraction and it reduces redundant information. Functions of filtering, RGB to Grayscale Conversion and Image Resizing are used to preprocess the pixel of original image into the desired pixel range in this system. This section briefly explains the steps of image preprocessing for this system.

A. FILTERING IMAGES

The color input face image may certainly contain the additional unwanted pixel areas of noises. These noises are canceled or removed by size filtering method because these noises are very small in size compared to the size of the image. The averaging filter is used when these noises are removed. After the noise cancelling step of the system has been done, the noise-free image is accomplished.

Figure3. Original image

When the filtering function is used, the results are following:

221	221	222	222	222	222	222	222
220	221	221	221	220	221	221	222
220	221	221	220	220	220	220	221
220	221	221	221	220	220	220	221
220	220	221	220	220	220	220	220
220	220	220	220	220	220	219	220
219	219	220	220	220	219	220	220
219	219	220	220	220	220	220	220

Figure4. Filtering matrix of original image (8x8 pixels)

B. CONVERTING TO GRAY

To reduce the complexity of the proposed system, original image is changed to grayscale. For the purpose of defect detection, a grayscale image with 0~255 intensity value is sufficient. Therefore converting the color image to grayscale before performing any image processing is needed for reducing processing time. The color conversion formula is as follow.

Gray= Red* 0.299 + Green *0.587 + Blue * 0.114

When the color conversion function is used, the result is in the following.

214	214	214	214	214	214	214	215
213	214	214	214	213	214	214	215
213	214	214	213	213	213	213	214
213	214	214	214	213	213	213	214
213	213	214	213	213	213	213	214
213	213	213	213	213	213	213	214
213	212	213	213	213	213	212	213
212	212	213	213	213	213	213	213

Figure 5.Grayed matrix of original image (8x8 pixels)

PROPOSED SYSTEM DESIGN

The system design for face recognition is shown in figure6.

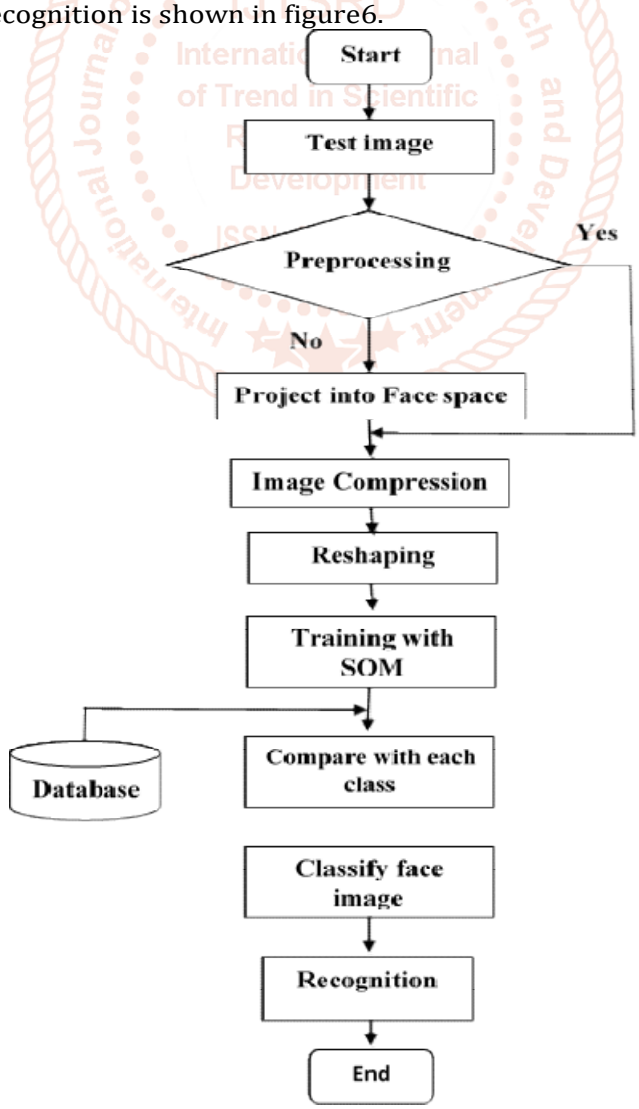

Figure6. System design for face recognition

To develop the face recognition system, most images in the above database are some Myanmar students. Each person having ten images takes in different facial expressions. To ensure and to be detecting precisely, it has some limited constraint. The image acquisition must be taken from the camera and then the image must be RGB color or gray. The images in the database has dimensions are 230x230 pixels. This constraint is typical in face recognition. In the database all of the image are necessary to analysis to train with SOM method. If the input test image has been finished preprocessing then go to image compression. If the input test image is not preprocessing then filtering images, converting to gray and resizing the image. The test image is then go to image compression.

Image Compression layer is to compress the values of preprocessed image by using DCT transform matrix in equation (1)

$$T(u,v) = \begin{cases} \sqrt{\frac{1}{N}} & u = 0, \quad 0 \le v \le N-1 \\ \sqrt{\frac{2}{N}} \cos\frac{\pi(2v+1)u}{2N} & 1 \le u \le N-1, \quad 0 \le v \le N-1 \end{cases} \qquad (1)$$

For an 8x8 block its result in this matrix T

0.3536	0.3536	0.3536	0.3536	0.3536	0.3536	0.3536	0.3536
0.4904	0.4157	0.2778	0.0975	-0.0975	-0.2778	-0.4157	-0.4904
0.4619	0.1913	0.1913	-0.4619	-0.4619	-0.1913	0.1913	0.4619
0.4157	-0.0975	-0.4904	-0.2778	0.2778	0.4904	0.0975	-0.4157
0.3536	-0.3536	-0.3536	0.3536	0.3536	-0.3536	-0.3536	0.3536
0.2778	-0.4904	0.0975	0.4157	-0.4157	-0.0975	0.4904	-0.2778
0.1913	-0.4619	0.4619	-0.1913	-0.1913	-0.4619	-0.4619	-0.0975
0.0975	-0.2778	0.4157	-0.4904	0.4904	-0.4157	0.2778	-0.0975

Figure7. Result of DCT transform matrix (8x8 pixels)

The compressed image pixels are reshaped as 64x1 feature vector by using reshaping function. Then training with SOM layer is carried out by the reshaped vector used as training dataset in SOM, one of the unsupervised learning methods. Then optimal weight value (or) winning neuron is repeatedly calculated by using the equation (2).

$$h_{ji(x)}(n) = \exp\left(-\frac{d^2 j,i}{2\sigma^2(n)}\right) \qquad (2)$$

To recognize a face image, calculate the matrix from the image want to recognize and then subtract the average face from the image matrix, and compute its projection onto face space to obtain the vector. This vector Ω is compared with each vector Ωi (face classes) stored in the database. If the distance found among Ω and any Ωi is inside the threshold of the class and it is the smallest found distance, then there was the facial recognition of Ω belonging to the class i and then classify the face. If the testing image is recognized, the system responds as "Present", otherwise "Not Present".

THRESHOLD

The proposal is to fine one threshold for each class looking for the better acting to face recognition. The thresholds define the maximum allowed distance among the new face submitted to recognition and each class. If the distance found inside the thresholds of the class and it is the smallest found distance, then there was the facial recognition belonging to this class. This distance was calculated by the square minimal method. If the distance found between the new face and one of the classes is inside the class thresholds. Then face recognition is found.

IMPLEMENTATION AND RESULT

In the implementation of the system, face recognition consists of two phases, training and testing. The training phase is containing all of the images in the database. The test phase is concerned with identifying a person from a new image. Any transformation applied on the training images is also applied on the testing images. The first experiment is to take input test image and compare with each class of stored faces in the database and then classify the face image. The system cam Also recognize most representative pose. Pose are taken by rotating the face to the left, right, up and down. We test our system with ten images of different facial expressions, some degree of rotation, different poses from each person of our own constructed database. Then the result in table 1, prove that the system can recognize different facial expressions images and with glasses images is 100%.

TABLE I EXPERIMENTAL RESULT OF IMAGES CLASSIFICATION OF OUR SYSTEM

Test image	Accuracy
Frontal view	100%
Side view	88%
Averted eye	100%
With glasses	100%
No glasses	100%
Sad	85%
Happy	99%
Surprised	80%
Wink	88%

The main interface of this system is shown in figure 8.

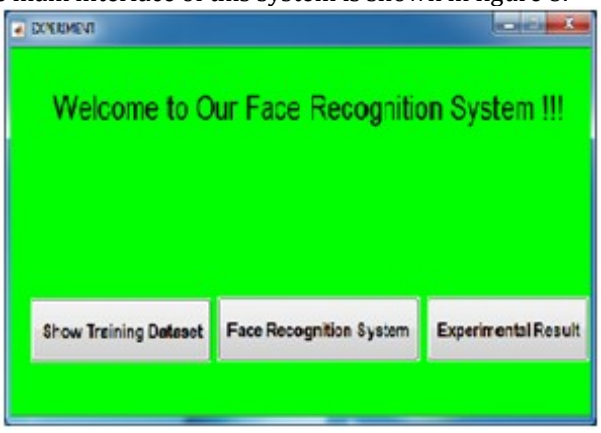

Figure8. The main interface of this system

In this graphical user interface has three button, firstly is face recognition system. This button is the main page of this system. Second button is show training dataset. In this database having ten images takes in different facial expressions. Third button is show experimental result in bar chart.

IMAGE CAPTURING MODULE

The color input face image is captured by using digital camera in the dimension of 230x 230 pixels. The color captured images is saved in JPEG format with RGB values. The example for captured image is described in figure 9.

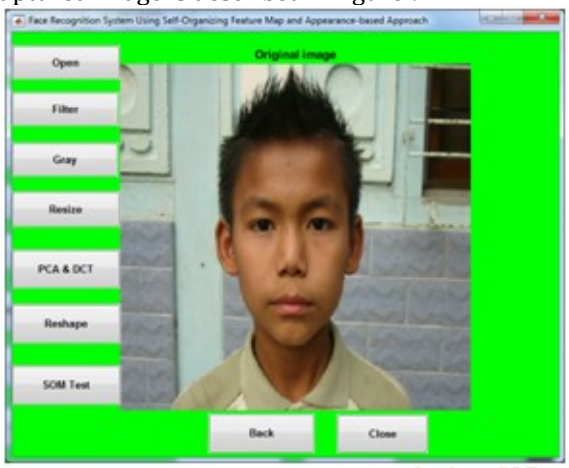

Figure9. Captured image

Then filter the captured image, and make the gray image shown in figure 10.

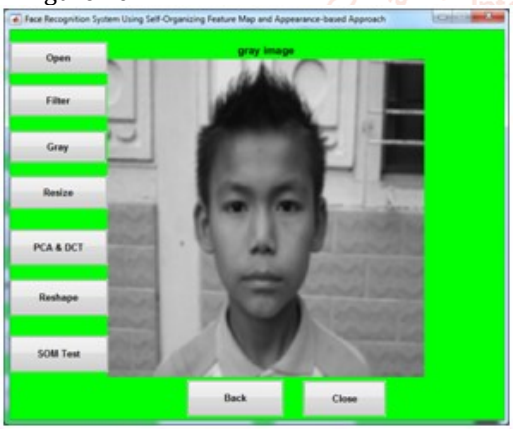

Figure10. Gray image

Then Resized the gray image shown in figure 11.

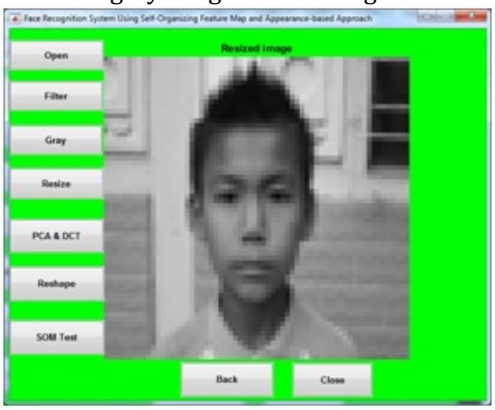

Figure11. Resized image

The preprocessed image is compressed using principal component analysis and discrete cosine transform compression. The compressed image is shown in figure 12.

Figure12. Compressed image

The compressed image is reshaped to obtain 64x1 feature vectors. This vector can be seen in left hand side of the whole block, the remaining block area is discard portion of the block. The reshaped image is shown in figure 13.

Figure13. Reshaped image

The 64x1 reshape vector is calculated by using the SOM algorithm. Then optional weight value or winning neutron id got after many iteration in SOM Neutral Network. The testing image is matched from the training dataset.Then the system is classified by face recognition or not. Ten training figure is shown in figure 14.

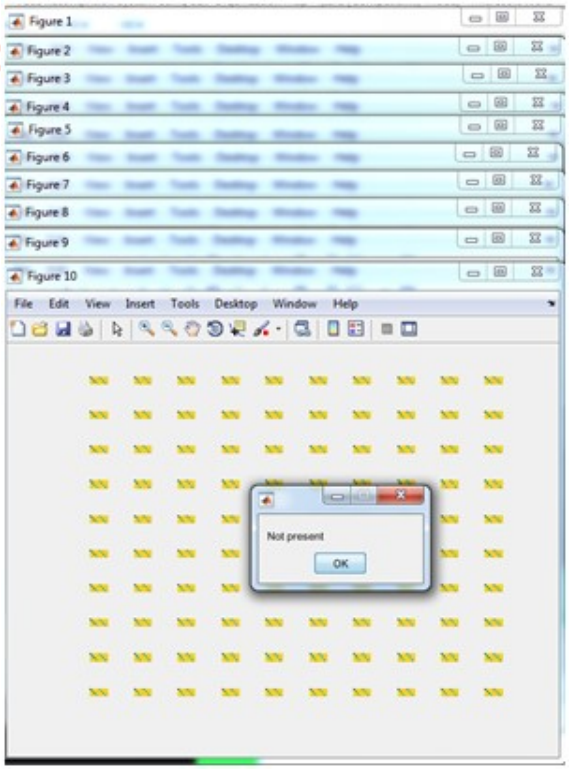

Figure 14 Result image

Figure 15 Training images in the dataset

The following figure 16 show the experimental result of accuracy rate on testing images. When the user clicks the "Show Result" button, the system shows port accept rate at the left hand side and port reject rate at the right hand side. The testing images are being tested increasingly by 50 images. So, the port accept rate are above 80% at the left hand side. Other side, the system port reject rate reach up to 19.5 % at last.

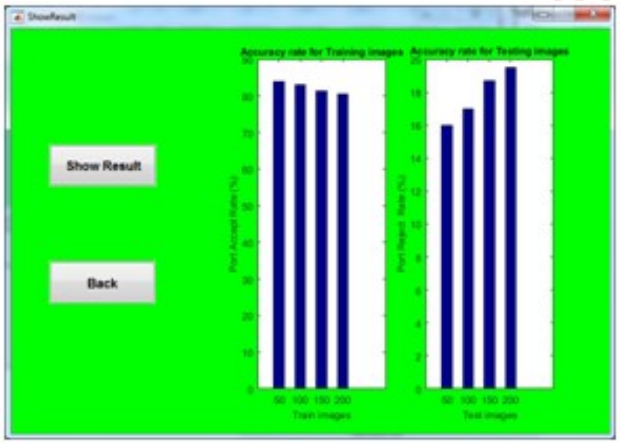

Figure 16 Experiment result of the accuracy rate

CONCLUSION

According to the result, not only DCT but also SOM is very useful for face recognition. This system is suitable for low cost hardware device. The main benefit of this system is that it can provision high-speed processing capability and little computational requirements, in term of both speed and memory utilization. This system can be used to compress other compression methods instead of DCT method. Besides, this system can be tested another unsupervised learning methods in neural network.

ACKNOWLEGMENT

The author would like to thank to all teachers, from Faculty of Computer Systems and Technologies, Computer University, Myitkyina, Myanmar, who gives suggestions and advices for submission of paper.

REFERENCES

[1] A. braham, "Artificial Neural Networks", Oklahoma State University, USA, 2005.

[2] H. R. Arabnia, "A Survey of Face Recognition Techniques", Department of Computer Science, University of Georgina, Athens, Georgia, U.S.A.

[3] K. Cabeen and P. Gent, "Image Compression and the Discrete Cosine Transform", Math45, College of the Redwoods.

[4] K. Delac, M. Grgic, "A Survey of Biometric Recognition Methods", HT-Croatian Telecom, Carrier Services Department, Kupska 2, University of Zagreb, Croatia.

[5] S. Dhawan, "A Review of Image Compression and Comparison of its Algorithms", Department of ECE, UIET, Kurukshetra University, Kurukshetra, Haryana, India.

[6] J. Ghorpade, S. Agarwal, "SOM and PCA Approach for Face Recognition - A Survey", Department of Computer Engineering, MITCOE, Pune University, India.

[7] M. Hajek, "Neural Networks", 2005.

[8] S. A. Khayam, "Discrete Transform: Theory and Cosine Application", Department of Electrical & Computer Engineering, Michigan State University, March 10th 2003.

[9] D. Kumar, C. S. Rai, and S. Kumar, "An Experimental Comparison of Unsupervised Learning Techniques for Face Recognition", Department of Computer Science &Engineering, G. J. University of Science & Technology, Hisar, India.

[10] F. Nagi, "A MATLAB based Face Recognition System using Image Processing and Neural Network", Department of Mechanical Engineering, University Tenaga Nasional, 2008, Kuala Lumpur, Malaysia.

[11] Mrs. D. Shanmugapriya, "A Survey of Biometric keystroke Dynamics: Approaches, Security and Challenges", Department of Information Technology Avinashilingam University for Women Coimbatore, Tamilnadu India.

[12] S. Sonkamble, Dr. R. Thool, B. Sonkamble, "Survey of Biometric Recognition Systems and their application", Department of Information Technology, MMCOE, Pune, India-411052.

[13] Kresimir Delac 1, Mislav Gric 2, Panos Liatsis 3, "Appearance-based Statistical Methods for Face Recognition" University of Zegreb, Faculty of EE & Comp, Unska 3/ xii, Zagreb, CROATIA.

[14] Author_A1, Author_B2, Author_C3, " Face Recognition Based on Symmetryzation and Eigenfaces".

[15] www.Digitalimageprocessing.html

[16] www.face-recognitiontechnology.php.write.html.