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CS 559 ASSIGNMENT 3

Evaluation of Face Recognition System

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1) FACE RECOGNITION :

Face is the most common biometric characteristic used by humans for recognition. Here we use Face Recognition based on Eigenface. using PCA. Eigenfaces are the principal components of the initial training set of face images and Recognition is performed by projecting a new image into the subspace spanned by the eigenfaces ("face space") and then classifying the face by comparing its position in face space. with the positions of individuals using Euclidean distance.

2) DATA - SET

-> The Face Recognition data sets were given to us and images were classified into training and testing data.

-> we give a path of our folder for training the database

-> And the training database say size MxN

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is converted to a 2D matrix containing all 1D image vectors and so the length of 1D column vectors is MN.

(ie) The code takes 2D images of the training database into 1D column vectors, Then it's put these 1D column vectors in a row to construct 2D matrix 'T'.
In our code for each Test image, there are two or more corresponding training image.

3) DESIGN:

→ We use face Recognition based on Eigenface using PCA System.

→ It decomposes the face images into a small set of characteristic feature images called eigenface, which may be thought of as the principal components of the initial training set of face images and Recognition is performed by projecting a new image into the subspace spanned by eigenfaces ("face spaces") and then classifying the face by comparing its position in face

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space with the positions of known individuals.

1) First we get a 2D matrix, containing all training image vectors and returns 3 outputs from training database
2) It returns the eigenfaces which are calculated using Principle Component Analysis to determine the most discriminating features between images of face.
3) It also returns the mean of training database, Eigenvectors and matrix of centered image vectors
4) Euclidean distance between the projected test image and the projection of all centered training images are calculated

The test image is supposed to have minimum distance with its corresponding image in the training database.

And the corresponding score matrix is found and curves and other findings are found out.

ie) Lesser the distance the closer is the similarity between the test and training image.

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example.m | roc.m | EigenfaceCore.m | Recognition.m | CreateDatabase.m

```
38      %%%%%%%%%%%%%%%%%%%%%%%% Extracting the PCA features from test image
39 -    InputImage = imread(TestImage);
40 -    temp = InputImage(:,:,1);
41
42 -    [irow icol] = size(temp);
43 -    InImage = reshape(temp',irow*icol,1);
44 -    Difference = double(InImage)-m; % Centered test image
45 -    ProjectedTestImage = Eigenfaces'*Difference; % Test image feature vector
46
47      %%%%%%%%%%%%%%%%%%%%%%%% Calculating Euclidean distances
48      % Euclidean distances between the projected test image and the projection
49      % of all centered training images are calculated. Test image is
50      % supposed to have minimum distance with its corresponding image in the
51      % training database.
52
53 -    Euc_dist = [];
54 -    for i = 1 : Train_Number
55 -        q = ProjectedImages(:,i);
56 -        temp = ( norm( ProjectedTestImage - q ) )^2;
57 -        Euc_dist = [Euc_dist temp];
58 -    end
59
60 -    [Euc_dist_min , Recognized_index] = min(Euc_dist);
61 -    d1=(Euc_dist);
62 -    OutputName = strcat(int2str(Recognized_index),'.jpg');
63 -    d = strcat(int2str(d1));
64
```

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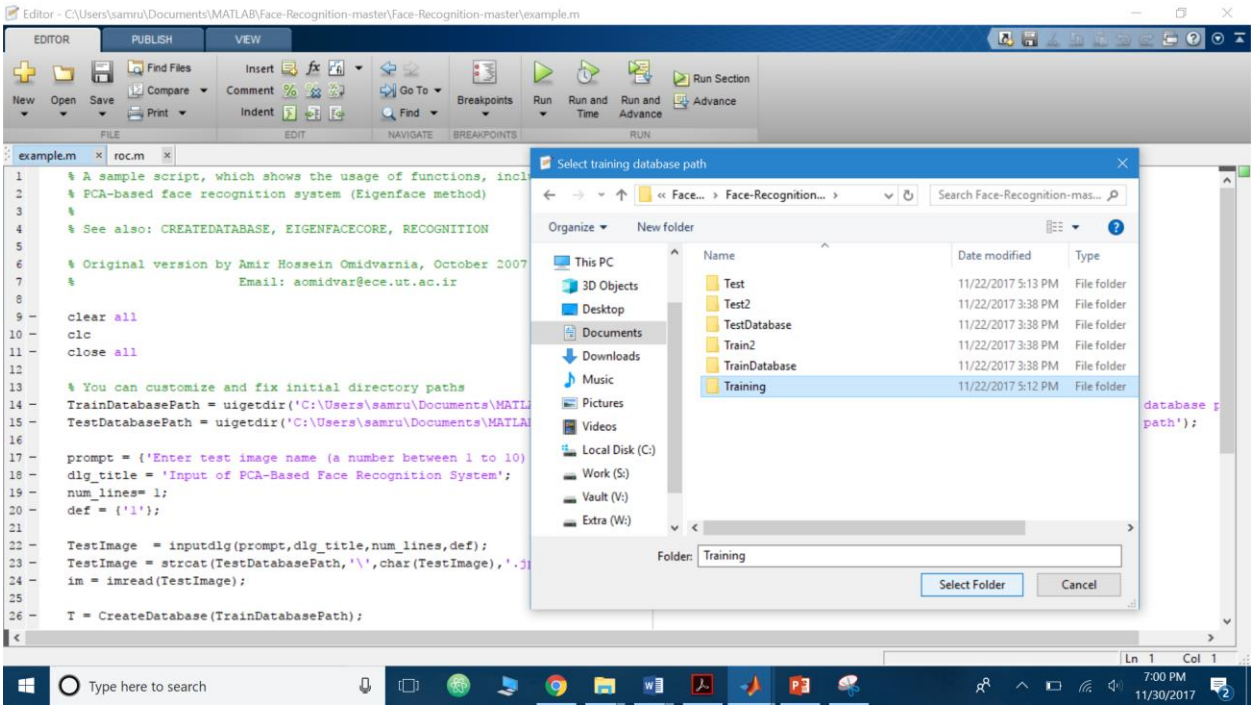

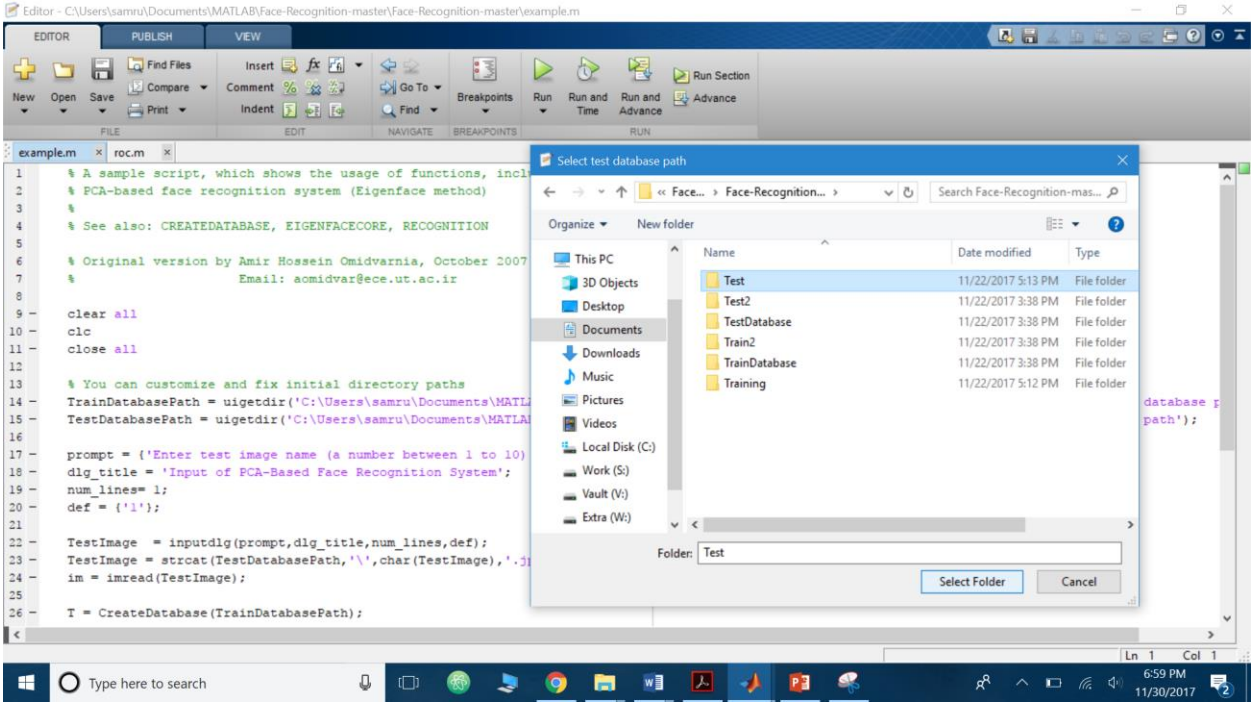

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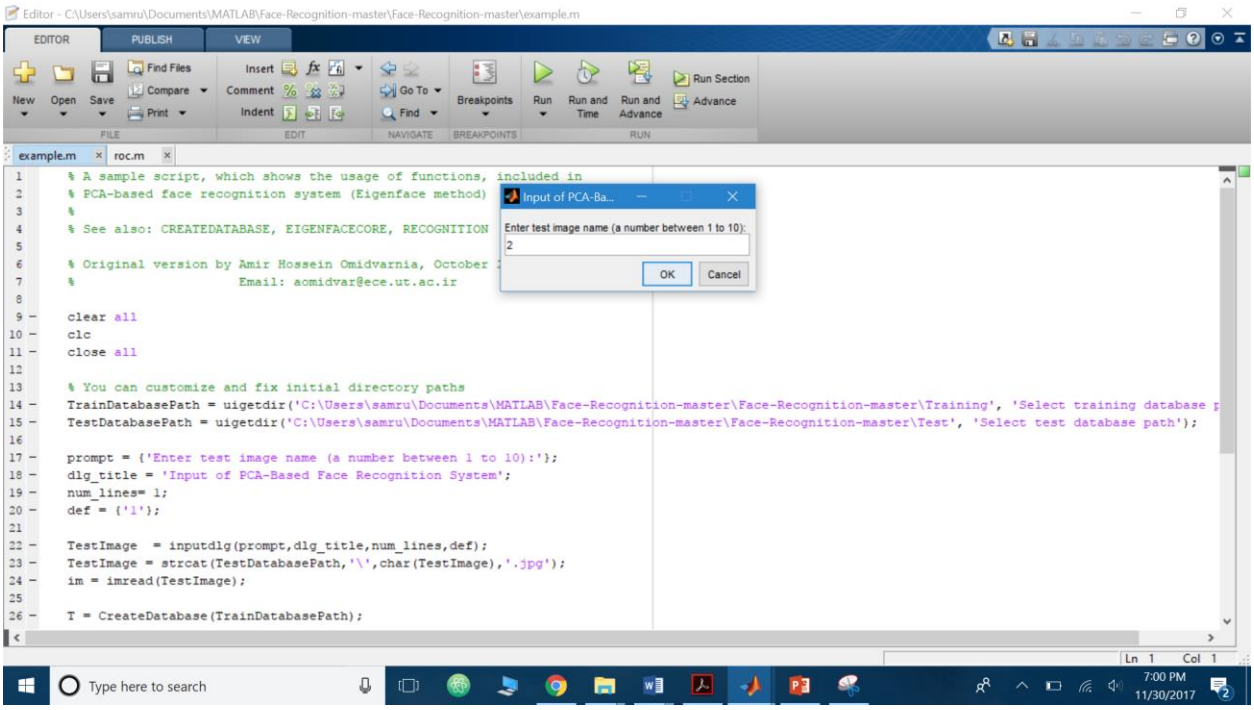

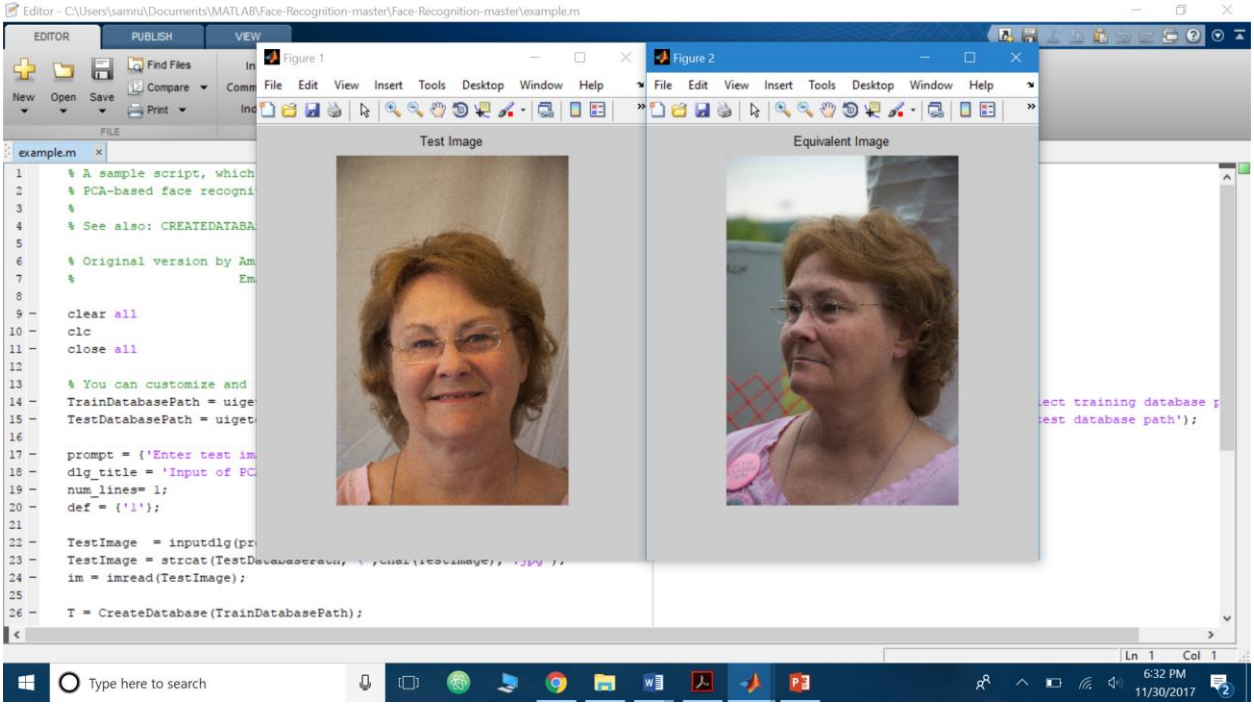

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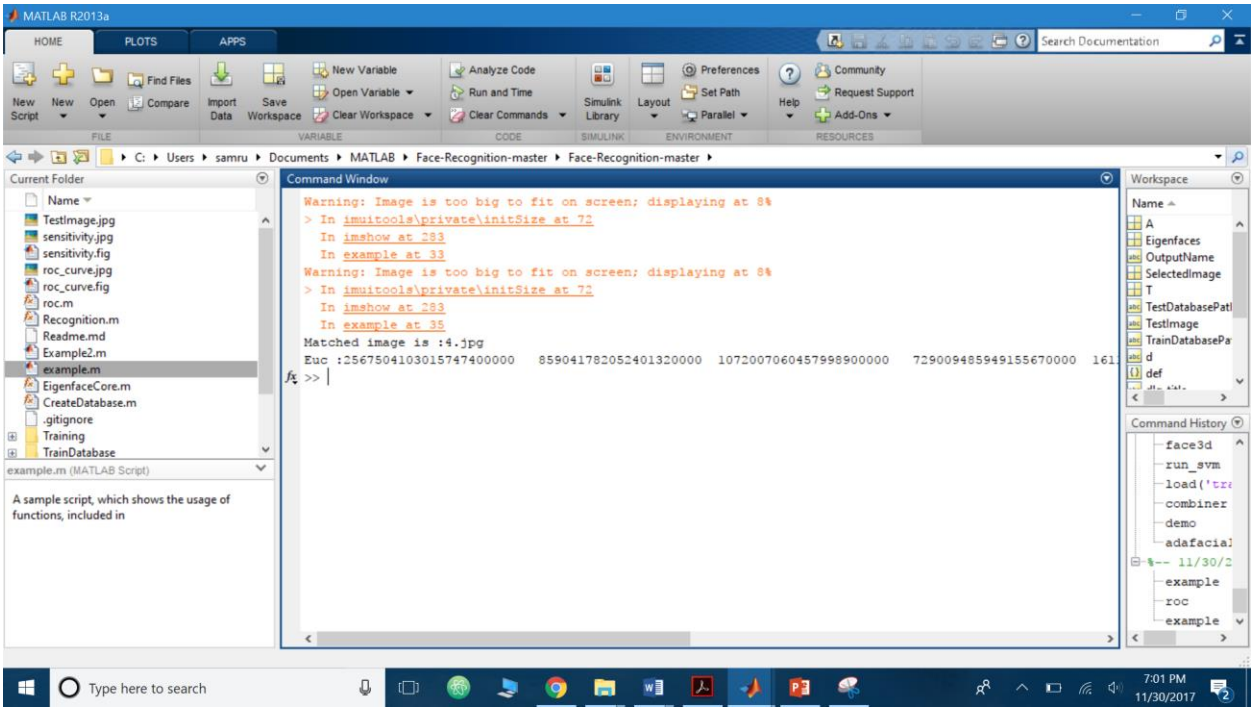
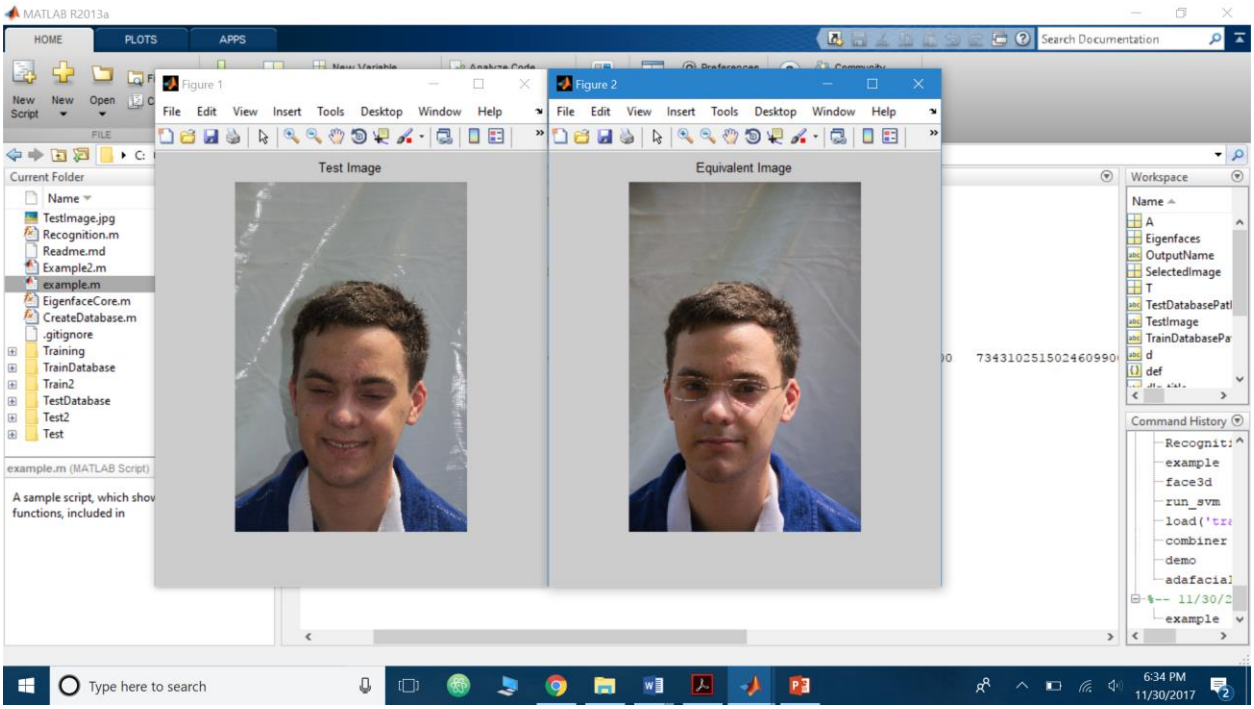


Euclidean Distances – Match with least distance



High accuracy as person with closed eyes and without glasses is identified

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4) Imposter & Genuine Distribution.

The corresponding image of the test and training should give us the closest identification value which would be diagnol. With this the matrix is drawn and distributions are plotted.

Training Class

Test Class	A	B	C	D	E
F	[0.107]	0.156	0.552	0.666	0.134
G	0.859	[0.107]	0.729	0.235	0.256
H	0.734	0.2949	[0.411]	0.297	0.166
I	0.666	0.893	0.165	[0.146]	0.327
J	0.756	0.413	0.368	0.154	[0.121]

The euclidean distance for the test and training image is calculated. Since the ~~genuine~~ Diagnol. corresponds to the same test and training folders. Since the diagnols has less MD, they are genuine scores.

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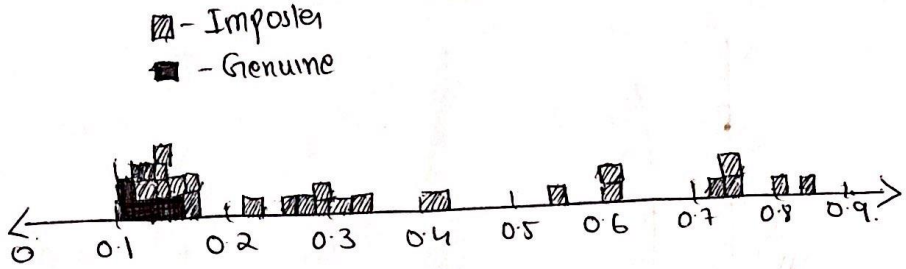

5) ROC curve,

To plot the ROC, we vary the threshold and plot graph between FMR and TMR.

$$FMR = \frac{\text{No. of false Match}}{\text{No. of false identity claims}}$$

$$TMR = 1 - FNMR = 1 - \frac{\text{No. of false non-match results}}{\text{No. of True identity claims}}$$

Varying threshold.

① $t = 0.1$
FMR = 0.09
TMR = 0.1

② $t = 0.2$
FMR = 0.4
TMR = 0.8

③ $t = 0.3$
FMR = 0.45
TMR = 0.8

④ $t = 0.39$
FMR = 0.5
TMR = 0.9

⑤ $t = 0.55$
FMR = 0.2
TMR = 0.4

⑥ $t = 0.7$
FMR = 0.5
TMR = 0.8

⑦ $t = 0.8$
FMR = 0.9
TMR = 0.25

⑧ $t = 0.4$
FMR = 0.7
TMR = 0.2

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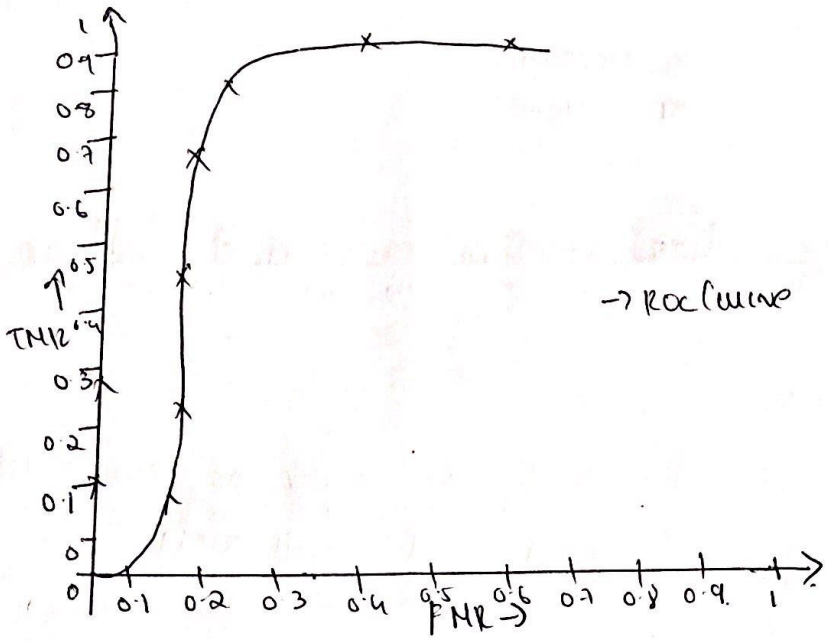

We have also plotted in MATLAB.

6) CMC Curve :-

→ In CMC Curve each biometric template is compared to all the training image

→ The resulting score based on the Euclidean distance is found out

→ TPIR-

Probability of observing the correct identity with top k ranks

→ Ri is the rank number of observation xi and i indicates the several number in the range of ascending data $P_c = R_i/(N+1)$

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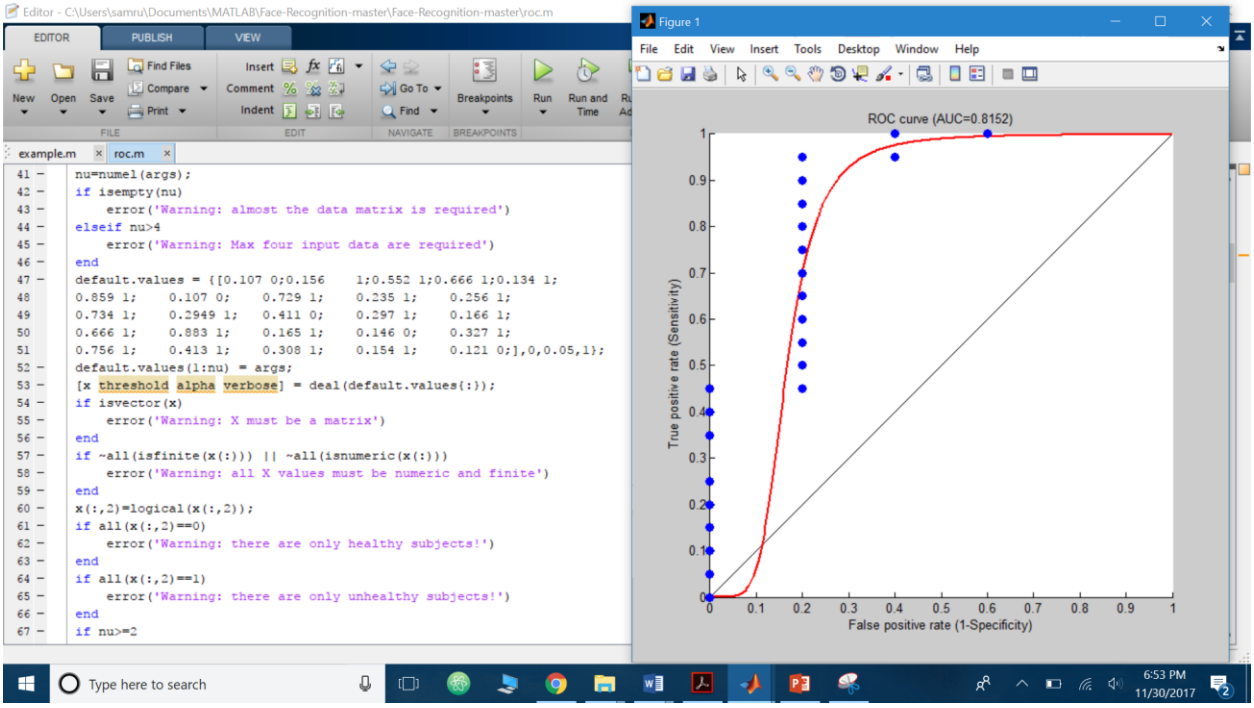

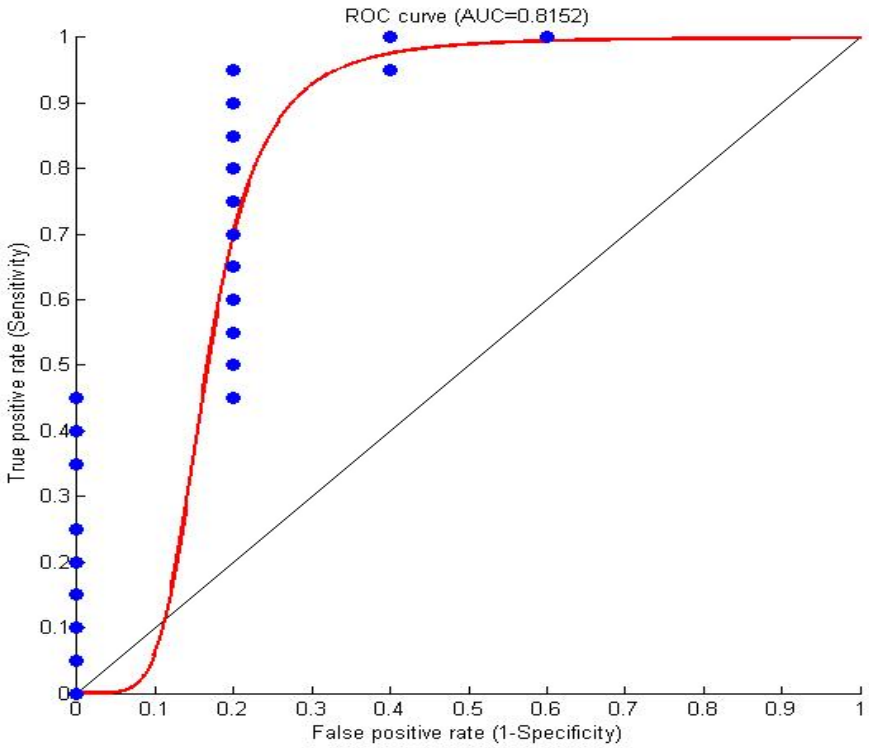

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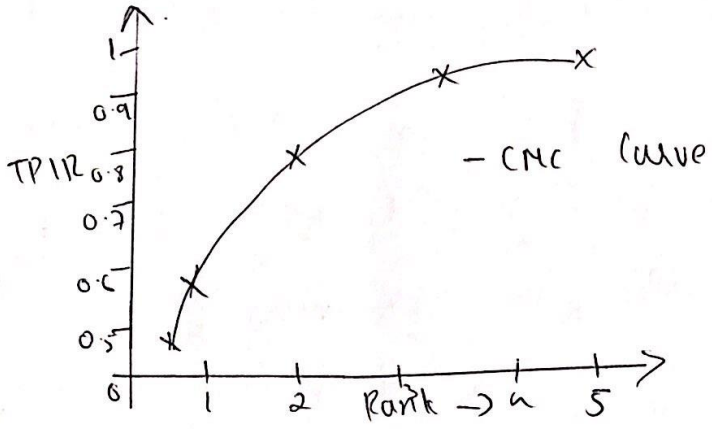

7) CONCLUSIONS AND FINDINGS

→ Here the test and training database were created and each test image is compared and recognized with training images.

→ From the above experiment, we know that the test showed good ROC and CMC curves

→ It also has good AUC (Area of Under Curve)

AUC=

→ And the standard error which is shows that it's a really good system.

→ Confidence interval = , which is also a good system

→ Also the sensitivity, specificity and efficiency, PLR, NLR is calculated by varying threshold.

→ All of the above data are attached as Screenshots below

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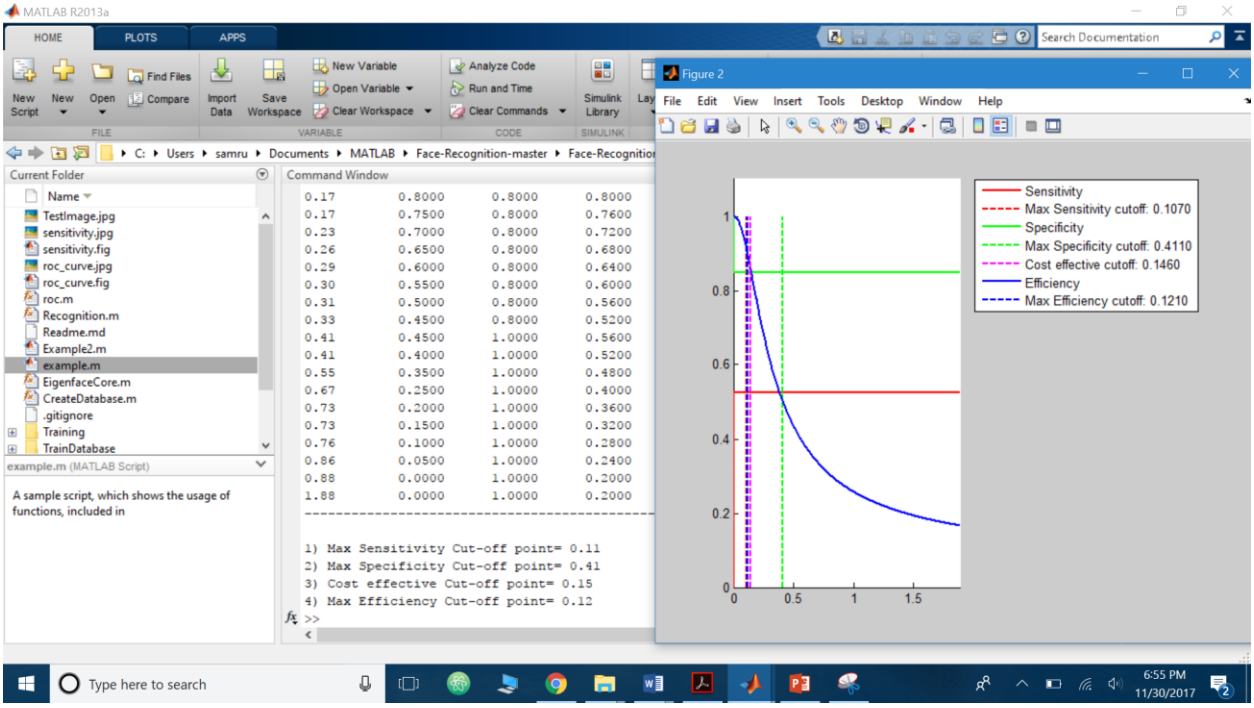

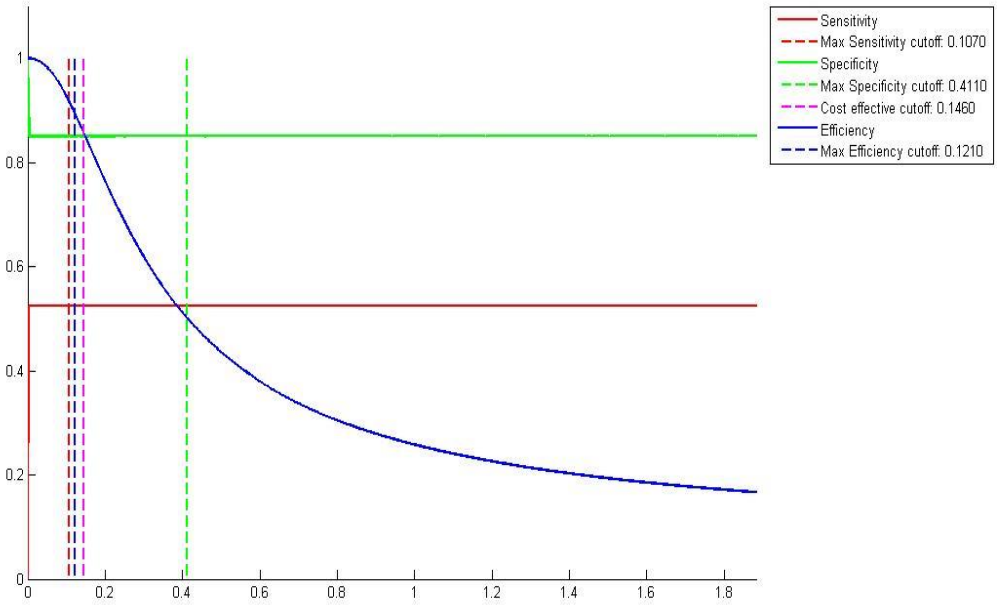

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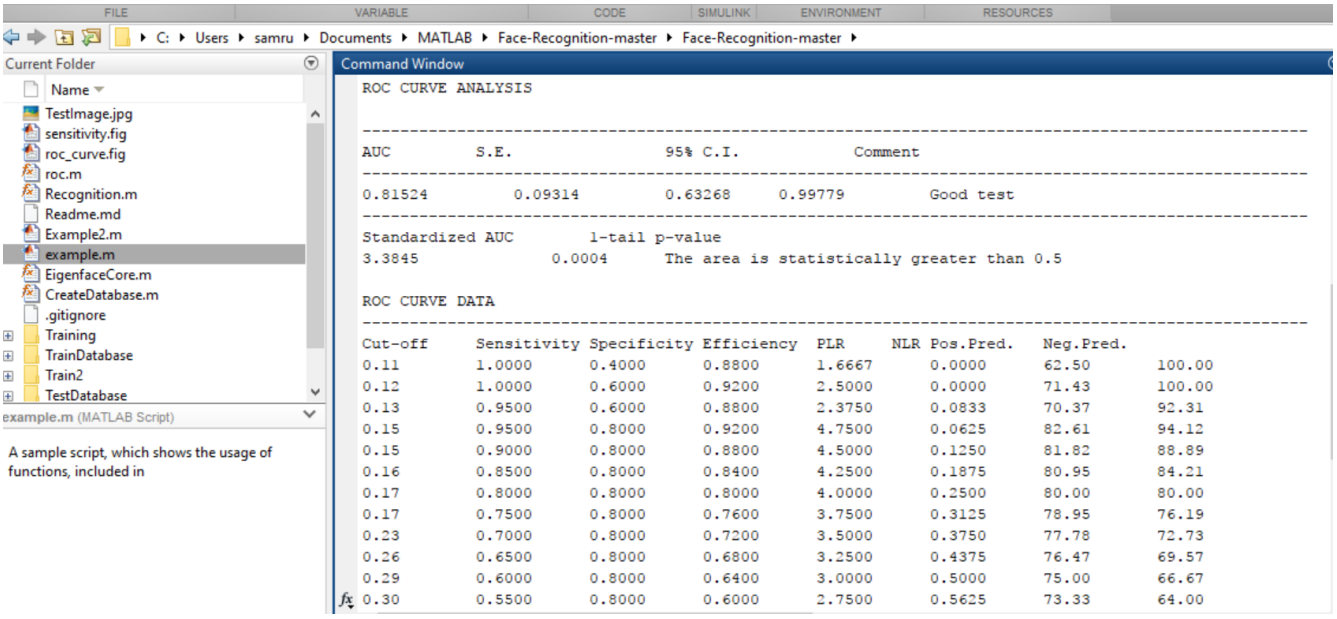

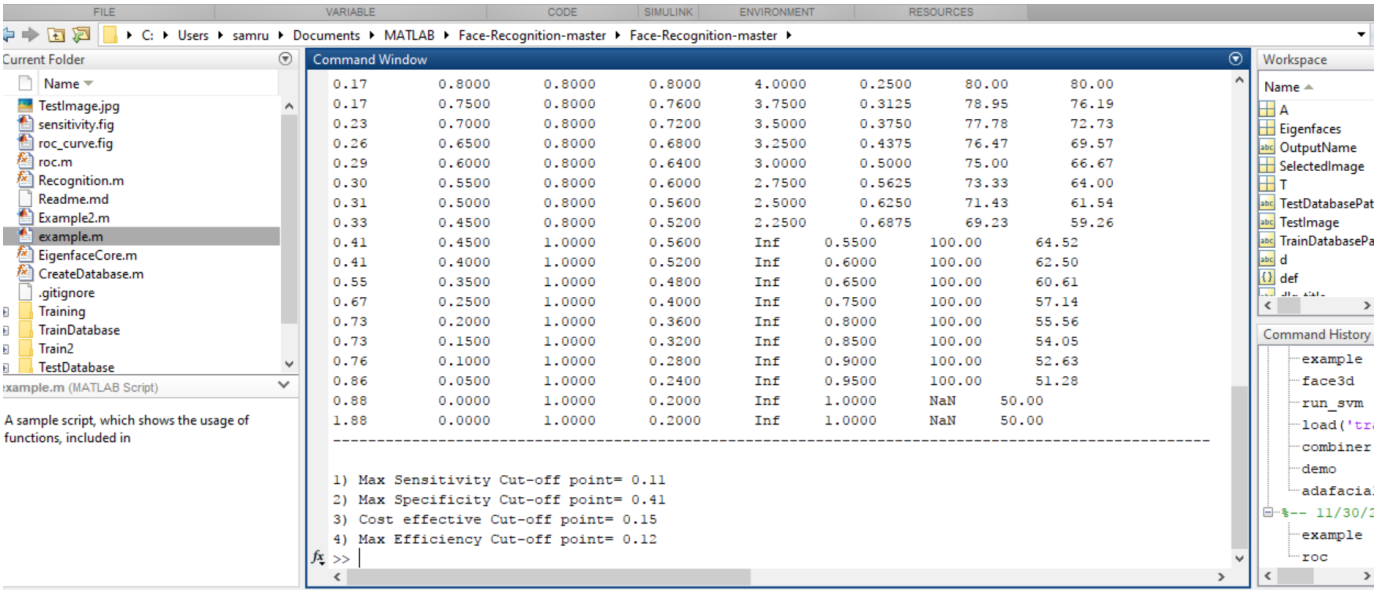

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Face recognition's prototype enhancement and its implementation

8) Automated Facial Expressions Recognition System :-

a)

-> Our Prototype to push the boundary of face recognition and finding the human facial Expressions and Recognising the facial Expressions.

-> Usually in our previous system we compared two images (face) using eigen values and we recognized them using ~~hamming~~ Euclidean distance.

-> Here we ~~dete~~ not only recognize the images, but we also detect their expressions as disgust, fear, Anger, Sad, Supuse and happiness.

-> We train the images into Expressions of categories and then we recognize any image and their expression.

-> The paper that we referred was.

"Automated Facial Expression Recognition System" by Andrew Ryan (NCLS)

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b) DESIGN :-

→ The Automated Facial Expression Recognition System not only detects and recognize the face but also tells the expression of the face image

→ The images are loaded in the form of matrix to the input for PCA process

→ To prepare for PCA, the loaded images are all subtracted by mean image and its constructed and face space is created

→ Face Detection is the next step in the design where only one face in scene and its primary object.

→ face space is created using the face images which has the higher values of eigenvalues

→ And using this PCA, the eigenvalues and vectors are calculated

→ Training images are trained with different expressions and whenever any different input test image is given, the system would detect the Facial Expression

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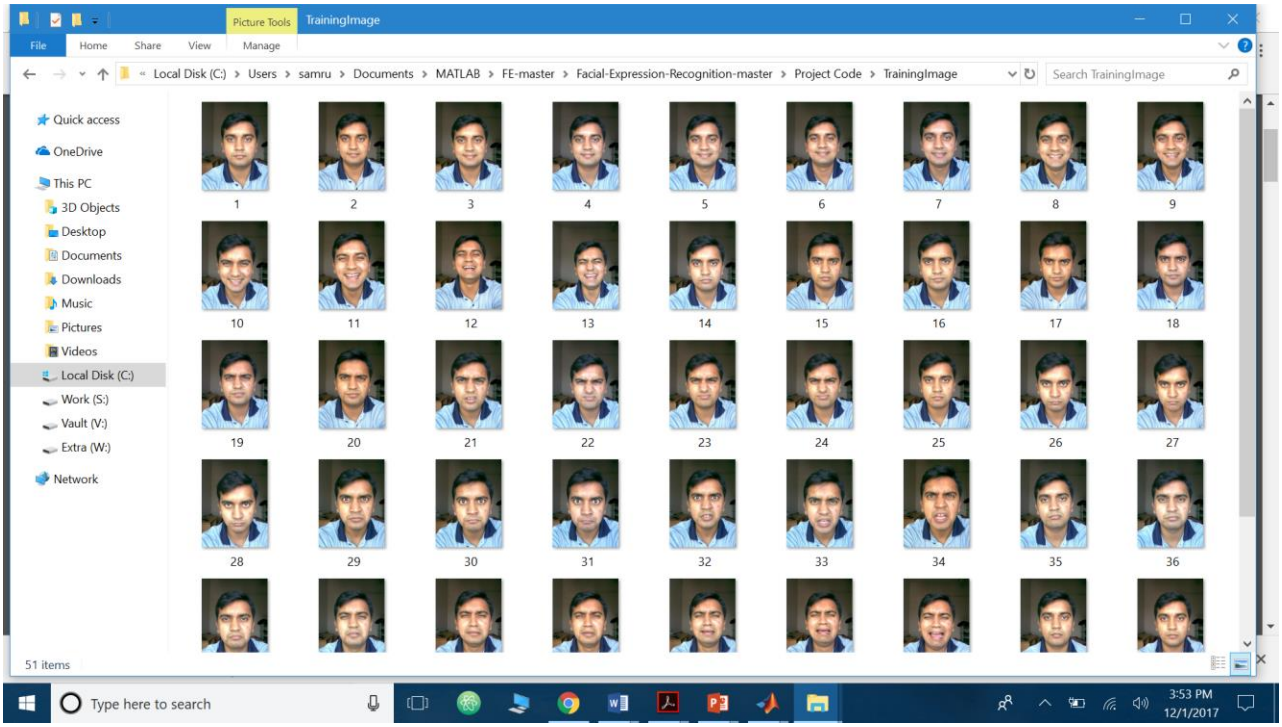

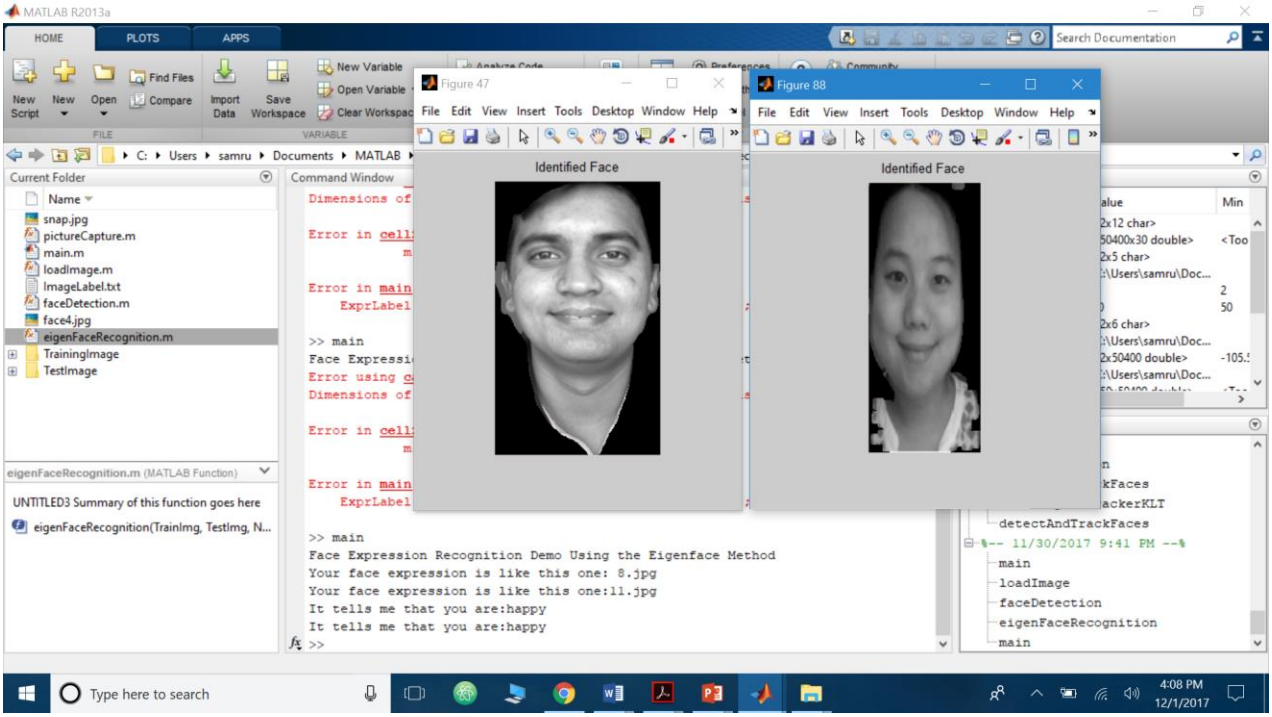

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→ The training of the image is done by obtaining the different facial parameters

→ For each facial expressions, the particular facial features will be prominent and those values are extracted and compared to detect the facial expression

→ * Read the I/p image from database

→ We crop the face image

→ Extract features from cropped image (each expression will have different face characters)

→ Find facial vectors

→ Recognize expression and classify as happy, sad, anger, surprise.

c) EFFICIENCY

Compared to other methods, this gives better accuracy. The table of comparison is given below.

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Comparative Study				
Title	**Technique**	**Database**	**Performance (%)**	**Remarks**
Statistical Moments based Facial expression Analysis	**Feature Extraction:** Zernike moments **Classification:** Naive Bayesian classifier	JAFFE (Japanese Female Facial expression) database 60 images used for experiment.	Average accuracy for six emotions is 81.66% in time less than 2 seconds.	Emotion accuracy graph shows highest recognition rate of happiness and lowest recognition rate of sadness.
Facial expression recognition with Auto-Illumination correction	Expressions on the face are determined with Action Units (AU's)	Single and Multiple face image	60% recognition rate for multiple face image	Illumination on image plays vital role.
Identification-driven Emotion recognition system for a Social Robot	Hybrid approach used for personalized emotion recognition,	MUG facial expression database used. More than 50 people frontal face database used aged between 20-25 years.	82% performance achieved with KNN Classifiers.	3D model facial image used.KNN classifier gives good performance for emotion recognition.
The application study of learner's face detection and location in the teaching network system based on emotion	SVM(Support Vector Machine) classifier based Adaboost algorithm used	PIE face image database used	Detection and Correction rate 95% or more.	Presents application of face emotion recognition with of E-learning system.

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4) CONCLUSIONS AND FINDINGS

→ This experiment uses different facial expressions of a same person in the training database and it can correctly detect the different test images of any person and can identify the expression of any new test image as there are more than 50 plus images in training set

→ This ensures greater Accuracy and automatically when a face is Recognized using PCA and Eigenface Recognition, the facial expressions are also detected.

5) REFERENCES

1) Automated Facial Expression Recognition System by Andrew Ryan

2) Automatic Emotion Recognition. Using Facial Expression by Monika Dubey, Lokesh Singh

3) Facial Feature extraction and Expression Recognition based on Neural Network by S.P Khandait, Dr R.C. Thool.

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