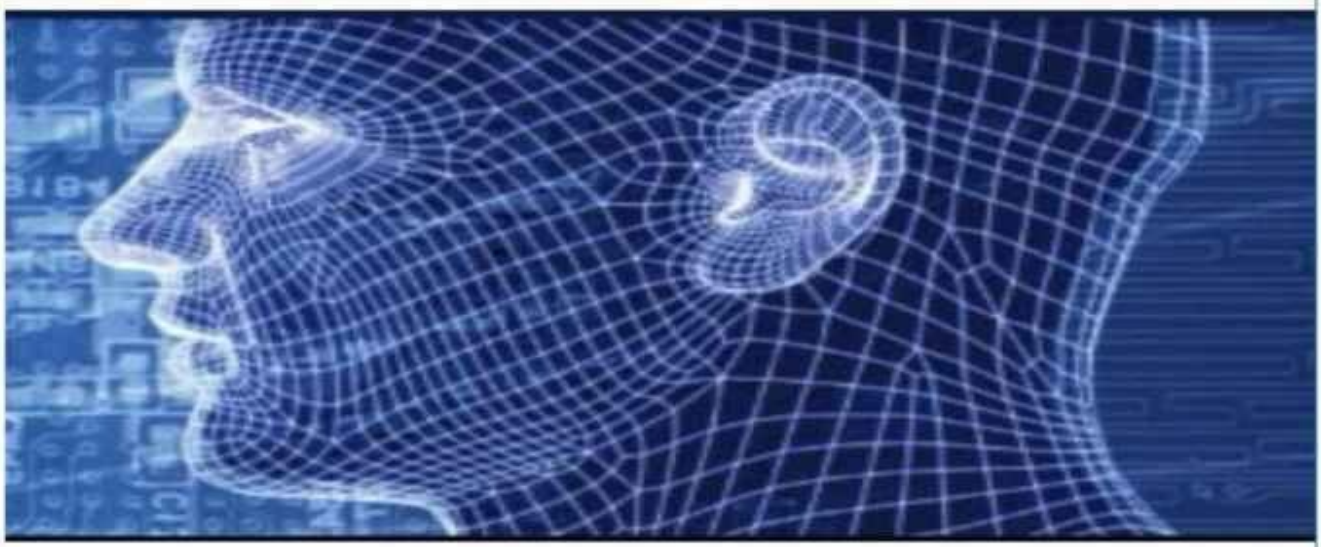

FACE RECOGNITION TECHNIQUE

(A LITERATURE SURVEY ON FACE RECOGNITION AND INSIGHT ON MACHINE RECOGNITION USING SOFTWARE)

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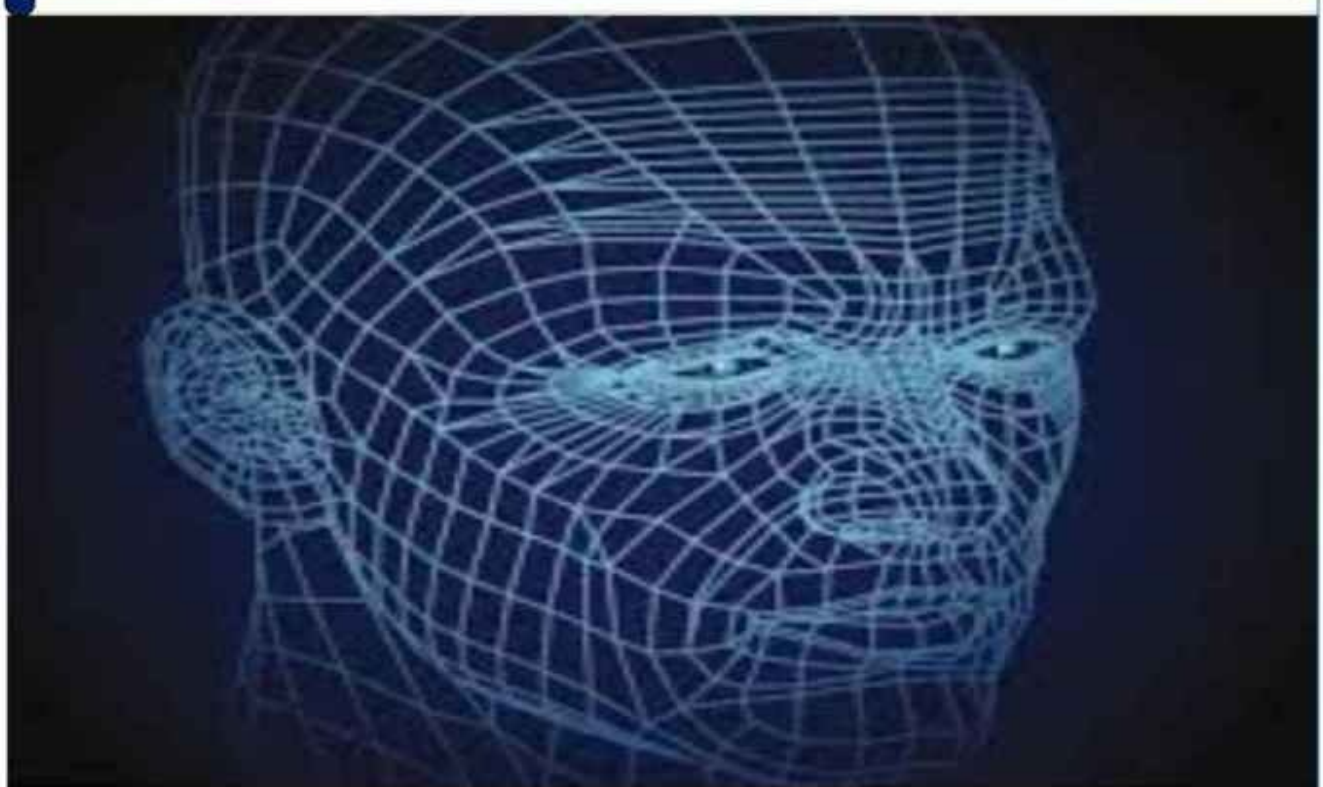
Dr. S. B. Kishor
Dr. S.G. Naranje



Dedicated to
Late Mr. Deorao M.Urkude

In loving memory of my father

(The fountain of inspiration)

ACKNOWLEDGEMENT

We are thankful to Dr. K. R. Dixit, (Principal, RCERT, Chandrapur) and
Hon. Shri. Shantaramji Potdukhe, (Ex Minister of Finance) they allow us to do
the research work.
We are equally grateful to all RCERT, Professors for the constant encouragement and support they have been extending all those days. We never
forgot their friendly behaviour during research work.
Special thanks to family members who support during course of work.
We would also like to thanks everyone who helps us to complete this research
book.

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ABSTRACT

Abstract of the entire research, gives clear idea of the research work before studying the depth of the research. Face recognition become very interesting topic of research because of lot of unsolved parameters. From past few decades number of researchers work on the topic to solve the problem of face recognition but still successful face recognition system is not yet implemented hence we proposed face recognition algorithm that match face matrix. As discuss face is nothing but a matrix so using MATLAB software we do matrix manipulation and try to find best possible features for face recognition. In law enforcement and lot of commercial applications, such as in the area of access control systems, national identity, video surveillance, user authentication and retrieval of identity from a data base for criminal investigations face recognition play very important roll but due to challenging problem in real time applications it is not so user friendly.

We take look on many unsolved parameters, such as face illumination, expression, pose, scale, low resolution, partial face (occlusion) and other environmental conditions, night video footage and day video footage. However, different pose and occlusion remains as major challenges in face recognition and these two problems affect the performance of face recognition in access control, authentication, and surveillance applications. To meet these challenges, the present study proposed a face recognition system using the analytical approach in which centre of two eye i;e forehead used for feature extraction.

In existing methods of analytical face recognition systems, features like eyes, nose, mouth where used as feature point but in proposed system we used forehead region maximum face recognition rate is 80% using Lab view software. In proposed analytical approach of face recognition, no any work has been done using above mention features but by using different features very little work had done.

In literature study maximum recognition rate of analytical, holistic and hybrid approach is below 84 % using different face database. In proposed SKM forehead feature work enhancement in recognition rates to 86% and require less time and also solve two big challenges half occlusion and different pose.

Facial recognition system is a most useful computer application or device that

can identify individuals based on their unique facial characteristics. Unlike many other biometric identification methods (e.g., fingerprints, voiceprint, speech), this can be advantageous in clean environments, for surveillance or tracking, and in automation systems. Because the system keeps a reference model of the individual, and captures their image for identification. They may also be more error-prone when identifying individuals, due to the fairly recent development of the technology.

As we know lot of literature available on websites, books, journal etc, we consider international and national paper survey for primary source of data. Various algorithm studies is done from this information collected analysis will be done using various parameters to achieve the basic objective. Study of most popular appearance based face recognition projection methods and detailed descriptions of each module are studied.

Our ID cards, passwords can be lost but face is connected part of our body so he/she can be verified with the help of their face. Due to resources constraints up till the last years face recognition has not successfully implemented but now but due to the development of new software and hardware technology it is possible to logging into systems with our face. Recently face recognition is attracting much attention in the society of network multimedia information access & also for security purpose. We are providing an up-to-date critical survey of image - and video-based face recognition research. There are two things for us to write this thesis first is to provide an up-to-date review of the existing literature available on net, and the second is to offer some insights into the studies of machine recognition of faces using software. We conclude the thesis with proposed KSM algorithm that helps the government and private sector for security purpose.

TABLE OF CONTENTS

LIST OF FIGURES

Fig. No.

Description

Page No.

The paragraph shows the percentage of other existing authentication

71

methods
Fig.3.3.1

Comparison of MATLAB and LABVIEW software

72

Fig 3.3.1.1

Comparison of KSM and RoBM algorithm

78

Fig 3.3.1.2

Comparison of KSM and RBM algorithm

79

Fig 3.3.1.3

Comparison of KSM and Eigenface algorithm

80

Fig 3.3.1.4

Comparison of KSM and LDA algorithm

81

Fig 3.3.1.5

Comparison of KSM and Pixel algorithm

82

Fig 3.3.1.6

LIST OF TABLES

Table No.
Description

[v]

PCA

Principal Component Analysis

ABBREVIATIONS

PCA Principal Component Analysis
LDA Linear Discriminate Analysis
ICA Independent Component Analysis
KPCA Kernal Principle Component Analysis
AAM Active Appearance Model
LLE Local Linear Embedding
EBG Elastic Bunch Graph
SVM Support Vector Machine
ANN Artificial Neural Networks
T3FRD Texas 3-D Face Recognition Database
3DWW 3-D “weighted walkthroughs”
KCFA Kernel Correlation Feature Analysis
FERET Face Recognition Technology
MLNN Multi-Layer Neural Networks
SSS Small Sample Size
AFR Automatic Face Recognition ORL Olivetti Research Laboratory

CHAPTER – 1

INTRODUCTION

Face recognition is very important research topic because of various applications in today's environment that's why researcher in various field like electronics, computer science, information technology, psychologist and neurologist too do research in this area, but still problem remain problem, to find solution we use analytical technique for face recognition, feature base technique use different region of face, that feature components of face is used for face recognition. Introduction covers the basic background of the topic. The chapter covers aim and objective of the research, by motivation do detailed study of existing literature, various face parameters are not predictable so still there are grand challenges for face recognition, by knowing different opinion formulate the problem, show block diagram of propose face recognition technique and proposed an KSM algorithm, explain experimental setup require for our work, show overview of face recognition system and finally put light on recent applications of face recognition.

To know the current capabilities of latest advances in face recognition technology and to understand advantages and disadvantages of various approaches like holistic, analytical and hybrid approach do literature survey in that survey it is found that analytical approach is better than holistic approach, various researcher used both approaches in combination and term as hybrid approach as the name indicated combination of two approach is nothing but hybrid approach.

In our research work we use best of two i:e is analytical approach so we presents a new innovative machine vision KSM algorithm using feature base approach. Face recognition model require software program that is used to identify persons whose facial ID'S are stored in a face bank databank. A face is digitized and matched against the face database to determine if the person is authorized to enter a facility or use a system. Proposed work provides an up-to-date critical survey of image - and video-based face recognition research.

The primary aim of our research is to develop an automatic face recognition algorithm that help us for security in all sectors like school, college, hospitals, low enforcement ,police, shops, public places like cinema hall, mol, bank, bus stand, railway station, airport *etc.* To achieve objective of research we do

literature survey and reach to conclusion that MATLAB is nothing but matrix laboratory is very efficient for matrix manipulation, we know that any image is nothing but matrix hence we select MATLAB software for implementation of our algorithm.

The program focus on feature extraction, each individual look different because of their face, each face has distinct features and lot of mathematics involve in face feature extraction. To retrieve specific part of face is nothing but feature selection. Face has not fix size, length, width so radius of each face is totally different so in such case retrieving any part of face and focus on desire part is very challenging, during literature survey it is found that the work on features like eye, nose, mouth had been done but still automatic face recognition is not so popular because of many drawback is existing algorithm.

In literature we found three approaches of face recognition we select best of two that is analytical approach because in holistic approach global face is used for manipulation hence size of matrix is too large to handle such large face matrix in face database and during matching procedure it will take long time to display result of comparison likewise in hybrid approach select global as well as local feature of face same thing due to size it will take long time to recognize any face. But we select analytical approach, in this approach only local feature of face is used.

Automatic searching of any face image by their forehead feature is very interesting for us; God is supreme that made each individual with unique forehead face feature. Though forehead has same structure to each person but the matrix value of each forehead region is different for all which help us to recognize face form gallery images.

Black and white face recognition were implemented in existing study but still no satisfactory work on color face recognition so in our face bank database we use color face. Various color face database is available on net but it is not possible to cover challenges like occlusion and pose hence we use our own color face bank database in our proposed KSM algorithm. Face bank is design in such a way that it contains five pose of each individual so we can able to recognize any face from any five directions. Face bank database is also helpful for half face occlusion.

1.1 AIM OF THE THESIS

Tough many algorithms are implemented using a various software's available, but still problem of face recognition remain unsolved so the aim of this research is to create an algorithm for fast and accurate face recognition. The KSM algorithm can be implemented, in DSP platform using MATLAB software.

1.2 OBJECTIVES OF THE THESIS

To achieve objective, study various face recognition algorithm with different parameters. And also study various existing software available for image processing like SCILAB, MATLAB, LAB VIEW, VHDL, FPGA, *etc.*

The objective of the study is how MATLAB is best software for implementation of face recognition algorithms and show how miniature systems software model helpful for authentication in various applications.

In today's environment applications of face recognition increased day by day because of failure of other authentication techniques like finger, eye, *etc.* So in various applications like, daily attendance, ATM cards, passports, driver's licenses, ADHAR card and photo ID in banking will may helpful such miniature systems for correct authentication of any person.

1.3 MOTIVATION

Any work is successfully done by motivation so put light on need of research in various application areas like school, college, hospital, government sector used latest finger print mode of authentication but while survey it is found that in some institution the fingerprint system failure and daily attendance register systems is also not so efficient, various people do illegal method in daily attendance hence to avoid such type of behaviors of people need best authentication system.

Disadvantages of other identification methods are
The finger prints of those people who are working in chemical industries are getting
affected. Therefore these companies may not use the finger print mode of authentication.

The first recorded use of fingerprints was by the ancient Assyrians and Chinese (Google). Henry established the first British fingerprint files in London in 1901.

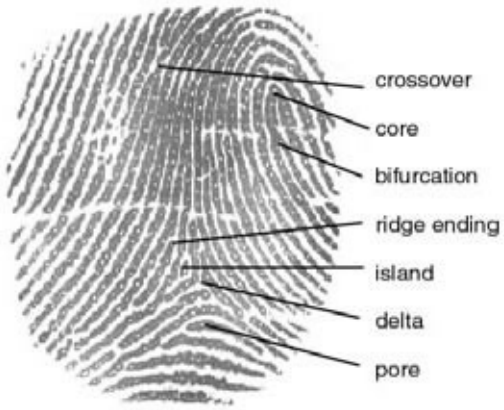


Fig. 1.3.1 Finger Imaging

It is found that with age, the voice of a person differs. Also when the person has flu or throat infection the voice changes or if there are too much noise in the environment this method may not authenticate correctly. Therefore this method of verification is not workable all the time.

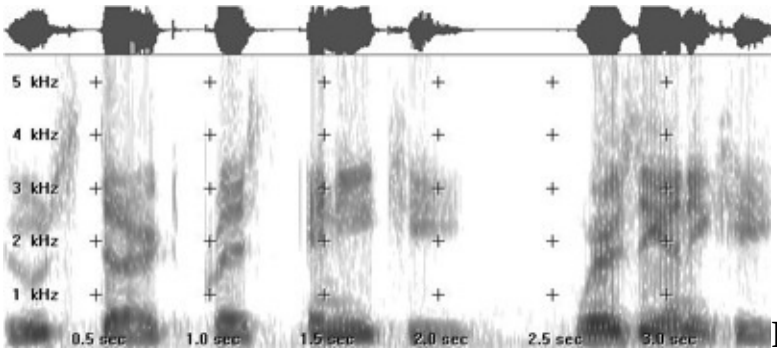


Fig. 1.3.2 Voiceprints

For people affected with diabetes, the eyes get affected resulting in differences. It is found that iris scanning is also failure technique.

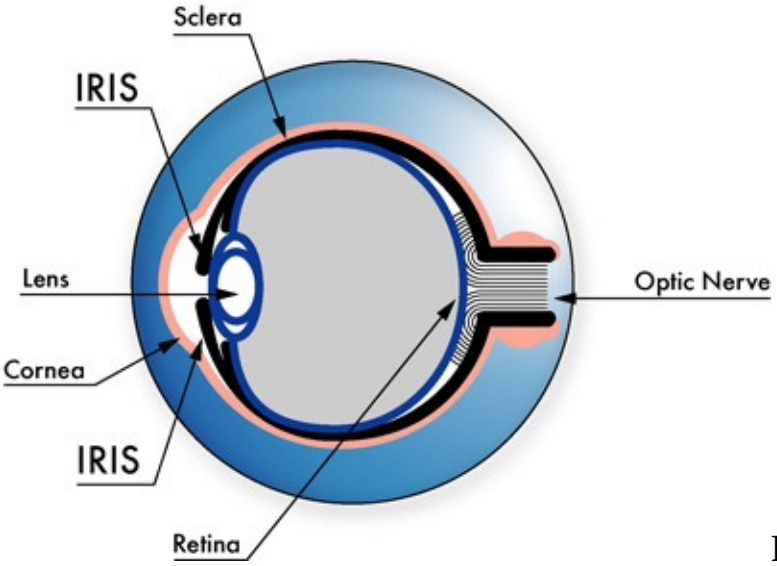


Fig. 1.3.3 Iris Scanning

Ridgelines of nail get change day by day by its structure and size hence it is found that fingernail ridgelines is also failure technique.

__Fig.1.3.4 Fingernail ridgelines

Today's widely used face recognizer model found during literature survey, it detect gray scale image and recognize it, but on color image it is failure system, so we developed an KSM algorithm that recognize gray and color image too. The model for face recognition is available on Google picks.

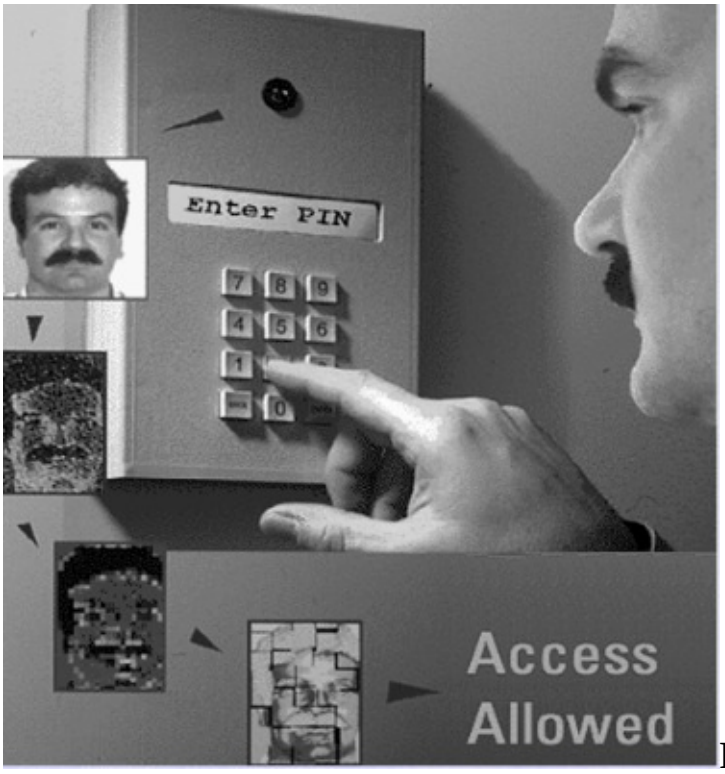


Fig. 1.3.5 Existing hardware

model of black and white face recognition (Google Search)
_Fig.1.3.61.3.6 Face Matrix (Google Search)

During survey it is found that too many applications of face recognition like ADHAR card for national identity, law enforcement, prevention of child molestation, residential **security, voter verification, banking, identity** verification **in the field and intelligence** gathering, crime prevention and investigation, checking for criminal records, enhancement of **security by using surveillance cameras in conjunction with face recognition system, finding** lost children's by using the images received from the cameras fitted at some public places, **knowing in advance if some VIP is entering the hotel, detection of a criminal at public place, can be used in different areas of science for comparing a entity with a set of entities, pattern** recognition, just look attendance, anti terrorist activities. Prevention of fraud in the market place, inquiry, identification of student in school & colleges during examinationduring examination by enrolment no as well as face *etc.*

To know which authentication is best we do literature survey, in literature literature (Lu, May 2003), various biometric authentication methods are given andvarious biometric authentication methods are given and how face recognition is better than other authentication methods isan other authentication methods is show in fig 1.3.7

Face Finger Hand Voice Eye Signature 99% 70% 50% 45% 69% 45%

Table .1.3.1 Percentage of existing authentication methods

The graph given below show that face has 99% as compare to other authentication. For finger , hand, eye recognition person must be in contact with machine it is very essential but for face the individual can be recognize without machine contact that means ones the image is registered it can be easily recognize from distance.

120%
100%99%
80% 70% 69%
60% 50% 45% 45% 40%
20%
0% Face Finger Hand Voice Eye Signature

Fig. 1.3.7 Percentage of existing authentication methods

1.4 GRAND CHALLENGES OF FACE RECOGNITION

The face is a dynamic structure that changes its shape non-rigidly since muscles deform soft tissue and due to bones movement. Another key challenge for face recognition is the effect of facial expressions on the appearance of the face. However, the appearance of the face also changes due to aging and people's different lifestyles. For example, if grow skin becomes less elastic and get loose with age, the lip and hair-line often faint recedes, the skin color changes, people become fat may gain or lose weight, grow a beard on face, change their hairstyle *etc.* This can lead to dramatic changes in the appearance of faces in images. Challenge for face recognition is related to the problem of occlusions. Such occlusions can happen for a number of reasons, *e.g.* part of the face maybe occluded with cloth and not visible when images are taken from certain angles. (Urkude, June 2013)

A. The Changes In Illumination B. The Changes In Pose
C. The Half Face Portion Occlusion D. The Age

A) The Changes In Illumination

Face recognition was found to be sensitive to the presence of cast shadows and to changes in illumination. Person face was slower and less accurate at matching and naming faces when there was a change in illumination direction. Ambient lighting changes greatly within and between days and among indoor and outdoor environments. As we know human face structure is 3D that's why, a direct lighting source can cast strong shadows that accentuate or diminish certain facial features. (RAMESHJAIN, (1989))

Change detection algorithms take two digitized images as input and return the locations in the field of view where differences between the images are identified. These differences may be caused by the motion of an object in the field of view (Ridha M. Hamza, Mar 23, 2004), the addition or removal of an object from the scene, slight changes in illumination , or environmental noise from the digitization process. (RAMESHJAIN, (1989)) (Ridha M. Hamza, Mar 23, 2004)The goal of such an algorithm is to locate only the changes that are due to structural changes in the scene, i.e., an object moving or the introduction or removal of an object in the scene. Many different types of techniques for change detection exist in the literature. Changes may be detected either at the iconic or pixel intensity level or after identifying features various entities such as fine

lines , spots, corners, or some other interesting change. At the pixel level various diverse techniques exist for detecting changes.

These range from simple differencing methods to complex modeling processes. In some technique individual pixels taken or in others technique look at blocks of adjacent pixels. But, besides the specific technique used for measuring changes, this change detection process is generally the same. (RAMESHJAIN, (1989)) The input images are first divided up into defined regions. A metric f, is then computed for a region in the field of view for both input images.

By comparing the measurements computed for the two images, one determines a quantity corresponding to the difference (or similarity) between the two locations. A simple equation for this matrix may appear as follows (E.Wood)

D (x,y)=f1(x,y) - f2(x,y)……(1)

In this equation D(x, y) is the calculated difference, and f, is the matrix computed for the particular region in question in image i. , then compares this "difference matrix" to a threshold to determine if a change is to be indicated at that location.

B) The Changes In Pose

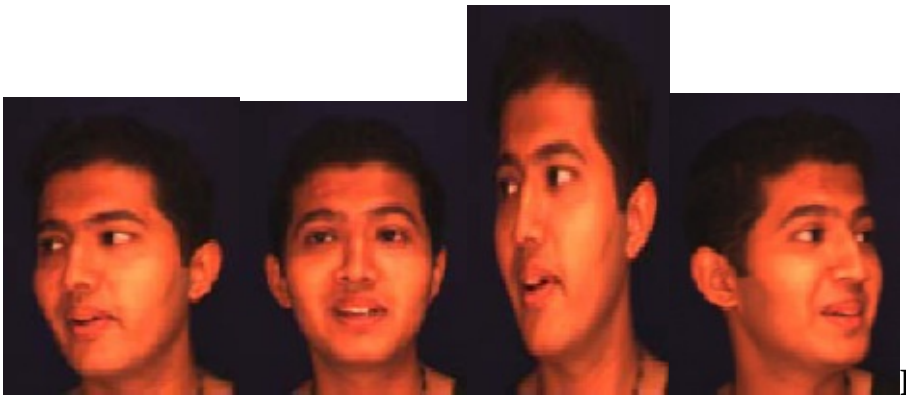
In many face recognition scenarios the pose of the probe and existing gallery face images is different. For example, the gallery image may be a frontal ''mug-shot'' and the probe image may be a 3/4 view captured from a camera in the corner of a room. Approaches addressing pose variation can be classified into two main categories depending on which type of gallery images they apply for testing. Multiview face recognition is a direct extension of frontal face recognition in that the algorithms require all different pose gallery images. In previous work linear subspaces have been extended in order to deal also with the problem of pose changes.

In literature study it is found that Indeed Okada and Von Der Malsburg (2002) present a framework for recognizing faces with large 3D pose variations, by means of parametric linear subspace model for representing each known person in the gallery. The authors investigate two different linear the LPCMAP model, that is a parametric linear subspace model, combining the components (PCs) of training samples linear subspaces spanned by principal

and the linear transfer matrices, which associate projection coefficients of training samples onto the subspaces and their corresponding 3D head angles the PPLS model, that extends the LPCMAP by using the piecewise linear approach, that is a set of local linear models, each one providing continuous analysis and synthesis mappings, enabling to generalize to unknown poses by interpolation. The experimental results show that the recognition system is robust against large 3D head pose variations covering 50 rotations along each axis. It is found significantly compressing the data size, the PPLS system performed better than the LPCMAP system. Hence, the number of known people is relatively small and the samples included some artificiality which may accidentally increase the performance.

All people have different face so another drawback is that the recognition systems uses pixel-wise landmark locations for representing facial shape and deriving head pose information, but finding and mark locations in static facial images with arbitrary head pose is an ill-posed problem. Then, again further study it is observed that Gross *et al.* (2002) proposed to use the light-field to achieve a greater robustness and stability solving the problem of pose variation in face recognition. The light-field is a 5D function of position (3D) and orientation (2D), which specifies the radiance of light in free space.

In particular, the authors apply the PCA to a collection of light-fields of faces of different subjects, obtaining a set of eigen light-fields, while the mean light-field could also be estimated and subtracted from all of the light-fields. Since, any face image of the object corresponds to a curve in the light-field. Way to look at this curve is as a highly occluded light-field, from which the Eigen coefficients can be calculated yet, especially for objects with simple reflectance properties such as Lambertian. Then input face images are vectorized in light-field vectors, next used for training and testing the system. They test the eigen light-field method on the CMU (PIE) database and the FERET database, showing that it outperforms both the standard Eigenfaces algorithm and the commercial Facet system. Overall, it is observed that the performance improvement of eigen light-fields over the other two algorithms is more significant on the PIE database than on the FERET database but on different database it is difficult. We include all five pose in our face bank database that solve pose problem.

 Fig.1.4.1 Changes in pose

C) The Occlusion

Most probably if one grew a beard on their face or is wearing sun glasses or a hat on their head , rap cloth etc then it is difficult to recognize occluded region of face . A disguise can be anything which conceals or changes a person's physical appearance, including a packing with wig, sun glasses, dark makeup, costume or some other ways. Various disguise for people, animals and objects. Different hats or cloth, scarf, sun glasses, change in hair style or apply wigs, color, plastic surgery, and make-up are also used. One of the main drawbacks of the appearance-based paradigm (e.g., PCA), is its failure to robustly recognize partially occluded objects. One way to deal with partially occluded objects (such as faces) is by using various local approaches. In general, face divide into various parts and then use a voting space to find the best match.

 Fig.1.4.2 Images from the four categories image, glasses, sunglass, hat, disguise. (Google Search)

A voting technique can easily misclassify a test image because it does not take into account how good a local match is. In (Martinez, 2002) in order to cope with this problem, each face image is divided into k different local parts. Each of these k local parts is modelled by using a Gaussian distribution (or, equivalently, with a mixture of Gaussians), which accounts for the localization error problem. Given that the mean feature vector and the covariance matrix for every local subspace are drawn out and the probability of a given match can be directly associated with the sum of all k Mahalanobis distances.

This approach differs from previous local PCA methods in that it uses a probabilistic approach rather than a voting space. Author Martinez demonstrated experimentally that the suppression of 1/6 of the face does not decrease accuracy, while even for those cases where 1/3 of the face is occluded, the identification results are very close to those obtained without occlusions. He also has shown that worse results are obtained when the eye area is occluded rather than the mouth area. The probabilistic approach proposed by Martinez is only able to identify a partially occluded face, while the Kurita *et al.* (2003) proposed a method that also reconstructs the occluded part of the face and detects the occluded regions in the input image, by means of an auto-associative neural network. At first the network is trained on the non-occluded images in normal conditions, while during the testing the original face can be reconstructed by replacing occluded regions with the recalled pixels. In the results the authors claim that the classification performance is not decreased even if 20–30% of the face images is occluded. On the other hand, this method suffers from two of the main problems of the NN based approaches the system retraining in case of new enrolments and the little availability of training samples. Moreover, a method, which is able to deal with both occlusions and illumination changes, has been proposed by Sahbi and Boujemaa (2002).

They presented a complete scheme for face recognition based on salient feature extraction in challenging conditions. These features are used in a matching process that overcomes occlusion effects and facial expressions using the dynamic space warping which aligns each feature in the query image, if possible, with its corresponding feature in the gallery set.

Once features have been extracted, they construct a binary image which is subdivided into regions describing shape variation between different faces. They model the statistical deviation of each feature in the face model with respect to its corresponding matched features in each candidate face of the gallery set, and they introduce a matching class for each extracted and matched feature from the face model. This matching class expresses the possible deviation of this feature (modeled using a Gaussian distribution) with respect to the gallery images.

Tests have been performed using the Olivetti and ARF public databases, noting that for little occlusion and rotation, the matching process succeeds, so the precision of recognition is guaranteed to be unchangeable with respect to small occlusions and rotation effects. But still the problem of occlusion remain unsolved, so we extract the unconcluded part of face that is forehead region and compare that part with face bank face get enhancement in results, we found that

compare that part with face bank face get enhancement in results, we found that mostly upper and lower part of face is occluded by scarp and eyes occluded with glasses or sun glasses so we easily retrieve forehead image from such occluded image and we think by matching only forehead region it is possible to recognize face of any person because we think God create that part unique for each individual.

D) The Age

As the face matures, it changes some of its most enduring properties (e.g., shape of cranium) and acquires new attributes (e.g., wrinkles, spot). These changes are the basis for information about the aging of the face. The time lapse between the training and testing images is not negligible. Many of the considered techniques ignore in performances, this makes clear that all the introduced methods do not take into account for problems due to the age variations.

Some strategies overcome this problem periodically upgrading the gallery or retraining the system. Nevertheless this not very suitable solution only applies to those systems granting services, which perform the person authentication, task frequently (Andrea F. Abate, 26 January 2007), while it is impractical in other situations, such as low enforcement. Alternatively the age of the subject could be simulated trying to make the system more robust with respect to this kind of variation.

Fig.1.4.3 Dramatic changes in the face as it ages

Several techniques for the age simulation are given in literature: Coordinate Transformations, Facial Composites, Exaggeration of 3D Distinctive Characteristics, but none of these methods has been investigated in the face recognition framework. In literature survey a recent work Lanitis and Taylor (2000) and Lanitis *et al.* (2002) proposed a new method based on age functions. Every image in the face database is described by a set of parameters b, and for each subject the best age function is drawn depending on his/her b. The greatest advantage of this approach is that different subject-based age functions allow taking into account for external factors which contribute towards the age

variations.

The above authors tested this approach on a database of 12 people, with 80 images in the gallery and 85 in the probe. They reported an improvement of about 4– 8% and 12–15% swapping the probe and gallery set. In both the experiments the mean age of the subjects has been simulated, before performing the recognition task. Notice that the number of the subject in the database is very small, emphasizing the absence of a standard FERET-like database, which systematically models the age variations. So to improve the robustness of the face recognition systems with respect to changes in age is an interesting and unsolved aspect in low enforcement applications, for the prediction of facial appearance of missing persons. Is there a more general way to state a technique better than others? Methods presented in previous sections have both advantages and drawbacks. State which one is the best is very difficult and strongly depends on what is required the system to do. Most of these approaches have been tested on different datasets. One way to make a more general evaluation is to pick a set of significant parameters, rather than considering the recognition rate only.

The parameter set includes several aspects that need to be taken into account when testing. Examples are number and database characteristics, probe dimension and gallery sets, input size *etc*. It is very interesting to analyze the way in which these parameters can drive a more accurate comparative study of face recognition algorithms. Obviously, the greater the number of used databases is, the thorough the assessment of the performances can be. In general, to speed up training/testing tasks, the higher the computational complexity is, the smaller the dimension of the input images can be. Most cameras used in video surveillance applications still provide low resolution images, making methods working on smaller images more suitable than others. However, low resolution research is also available but not satisfactory. In recent high resolution images and videos made possible by recent technologies and presented in the upcoming FRVT2005 confirm that the higher the resolution is the betterment in performances. The probe and gallery set size also has to be taken into account. It is well known that only one image is available for training in most real situations, while the identification is performed many times. They suggest that the smaller the gallery set is, the higher the capability of extracting discriminant features. This can be further improved by a large probe set. It makes sense then to minimize the ratio (gallery size)/(probe size).

Many research results show that several approaches are more sensitive to changes in high frequencies than to low ones. This is not a desirable property

changes in high frequencies than to low ones. This is not a desirable property, because low frequencies carry most of the invariant information about the identity of the subject, while high frequencies are often affected by changes in environmental conditions. Therefore, the usefulness of a time gap between sessions providing the images of the gallery and probe set becomes apparent. Important open questions still need to addressed. Thus, the larger the number of the addressed problems is, the higher the adaptability to real-world applications can be esteemed. Finally, all the methods exposed so far require some kind of input preprocessing and this could significantly reduce the usefulness of a face recognition algorithm suggesting that the system flexibility increases when normalization on input data is reduced. Based on these considerations is then possible to investigate which techniques provide a better approximation of pointed parameters.

The PDBNN based algorithm seems to provide the best experimentation. It addresses most of the problems, while experiments conducted on three different databases with a large number of images reported a high recognition rate. As further example, the LEM approach can be considered. The recognition rate is lower than other methods such as Th-Infrared (Buddharaju et al., 2004) or LDA (Lu et al., 2003), but it has been tested on more databases and it addresses three different problems this highlights the robustness of the method.

Thus today's challenges for color face recognition are the changes in illumination, changes in pose, occlusion and age variation *etc.* To enhance face recognition and to overcome these challenges need best face recognition algorithm. The proposed KSM forehead feature base face recognition algorithm overcome two challenges of above mention challenges i:e

• **The Changes In Pose**
The Occlusion (Half Face Portion)•

1.5 FORMULATION OF THE PROBLEM

Problem arises due to various unsolved parameters. Study how to formulate any problem for better result, which will helpful for betterment of society. To create a user friendly interface latest Graphical User Interface tools available in MATLAB is used & write function that contain formula of problem to display better result. The features chosen for recognition play a very important role in face recognition.

We know that full face difficult to recognize because of the size of matrix so we

chose selected part of face for recognition it will minimizes size so identification task get easy, by using our algorithm and our face bank database unnecessary part of face removed and only a selected useful part taken in to consideration for comparison.

In various algorithm different part of face is extracted as features and handle various vector of each feature like eyes, nose, mouth but we found it is difficult to maintain such features vectors in database so we select only single feature of face and maintain a single face vector Thus, we are able to avoid redundant face data so the result get enhance by our method. We give name to our algorithm as KSM Forehead Feature Face Recognition Algorithm.

1.6 BLOCK DIAGRAM OF PROPOSE FACE RECOGNITION TECHNIQUE

Rough sketch of proposed KSM forehead feature base face recognition system by means of blocks, so that working of face recognition system is easily understand to the reader.

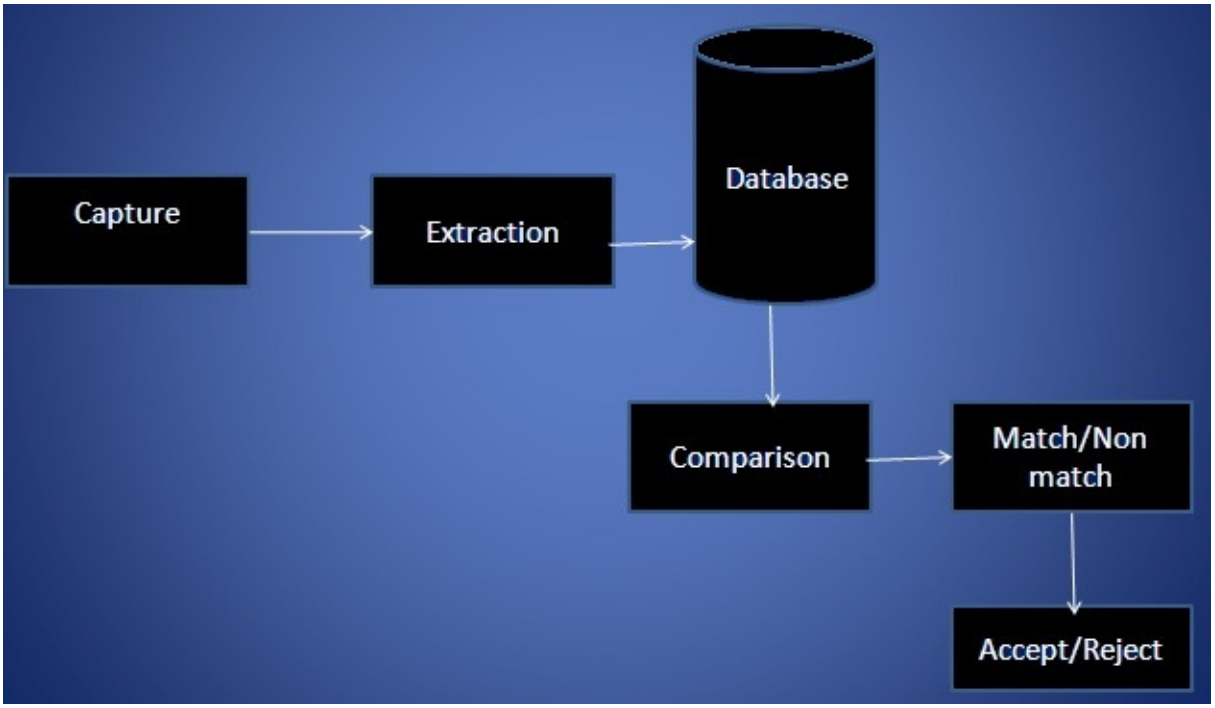


Fig. 1.6.1 Block Diagram of FRT

1.7 PROPOSED ALGORITHM

Identification stages covered in proposed KSM algorithm is given below

Capture: A sample face is captured from video preprocessed (frame, crop,

registered, intensity normalization, image filtering etc)
Extraction: Features from centre of two eyes i:e forehead region, data is extracted from the sample face. Retrieve feature and store it in face bank.
Comparison: Then extracted feature data is compared with stored face bank database sample. **Matching**: Match/Non match decides according to decision rule.

Main characteristic of our KSM algorithm are it verifies and identify person very efficiently, it require less time as compare to other algorithm because it retrieve only local feature of face. Easy to installed in any windows operating system. It requires low cost because of freely availability of MATLAB software.

1.8 EXPERIMENTAL SETUP

We used “face bank” database. All images used in this experiment were first preprocessed using standard steps (cropping, histogram adjusting). After this, image registration i:e all images were resized to the size of 256× 256 pixels. Every computer based system is made up of hardware and software.

Here hardware include laptop with webcam and MATLAB software is loaded on it. Commercially available Logitech, Sony, Micromax, web camera with HD quality was used for face database acquisition Fig.1.8.1 show how system looks. Face images in this face database are in same resolution, different pose face image are kept in face bank.

Face Bank Database description

We are trying to solve various unsolved face recognition issues. Distance has a large influence on face recognition results due to this problem, we fix the distance for capturing a face image different viewing angle at different distances.

Images are in JPEG format with the original size of 256 x 256 pixels, cropped according to desired input pixels. From entire population, sample 50 subsets of images used for training. Since we are used our own database face bank database, rather than available ORL, FERET.

Camera

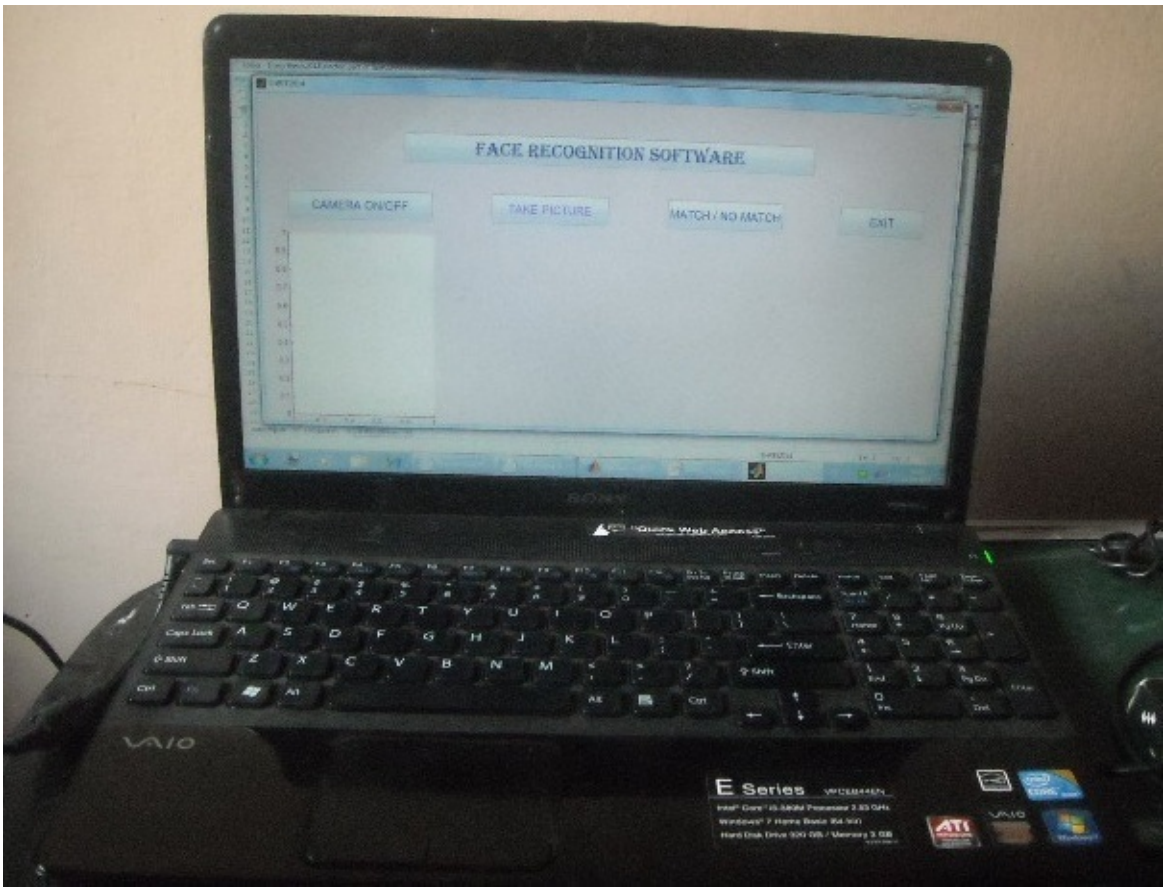


Fig.1.8.1 Laptop with inbuilt camera setup for data collection

1.9. OVERVIEW OF FACE RECOGNITION SYSTEM

Our KSM algorithm implemented using MATLAB software, face recognition model design by graphical user interface. Here we design a model for face recognition the overview of face recognition system is shown by figure 1.9.1.

Fig. 1.9.1 Graphical User Interface for FRT

1.10 APPLICATIONS OF FACE RECOGNITION

During literature study we found some applications of face recognition are as follows

• National Identity (ADHAR Card)

For National Identity face can be used because every human being can be uniquely identified with their fasces

• Just Look Attendance.

Daily attendance in every sector public and private mostly thumb recognition is used but by survey and observation it is found that it is failure in colleges , offices and also in chemical industries, fingers get affected by chemicals that's why it is difficult to recognize thumb. In future face may be used for daily attendance.

• Anti Terrorist Activities.

Anti terrorist attack can be control by using surveillance camera.

• Prevention of Fraud In The Markets.

Market is a place where all items are place so occurrence of misbehavior and fraud is quite common to control this CCTV camera is efficiently worked. With the help of CCTV footage fraud detection becomes easy.

• Automated Detection

Automated face detection and recognition of face in a crowded scene to find fraud. Surveillance camera is very helpful to find fraud in crowded place. From capture video frame any fraud person is identified by their behavior.

• Law Enforcement.

Low enforcement used face recognition algorithm to know depth of any case. During investigation details of video footage play very important roll.

• Residential Security.

Now a day residential security is very essential thing because every member of family is working anywhere so it is very essential to secure house from thief by using surveillance camera residential security can be enhance.

• Voter Verification.

Many time a single person vote in different vote center by different name and with different fraud identity proof but by using face as id it can be control and it

is very essential thing for betterment of society.

• Banking Security.
To enhance security system in bank face play very essential roll. In bank face id proof minimizes misbehaviors.

• In Intelligence Gathering For Identity Verification.
Face bank is useful for identity verification of known person. Human being can be identified by their face because of their unique face.
• Crime Prevention and Investigation.

For crime prevention face recognition software is used for detecting crime. For investigation police can use surveillance camera images details to find criminal in any case.

• Airport Security (VIPS),
Mostly VIP person security can be control by using surveillance camera in airport. The footage obtain from this camera is helpful for preventing occurrence of fraud.

• In Examination (Student verification)
Student identification can be enhancing using face bank is help to identify any software. Students face

examination hall.
recognition student in

• Mobile and Computer Security Face can play role of password in future because of unique characteristics in face, we observe that each face have a unique features that play very important role for identification.

• Medical Sector
In healthcare, many time wrong medicine is given to wrong person, patient record get mixed because of handling file manually, identity proof of any patient may change due to such file handling technique so it will help to recover such behavior, by using face as best identity proof of each patient. Doctor also used recognition algorithm for cell and tissue image comparison, it will help to find difference in original and infected tissue, and according to result of comparison he may take decision regarding disease.

Face logon provides identification of a user by biometric verification. Passwords

Face logon provides identification of a user by biometric verification. Passwords and fingerprints are past now, apply password every time you login to your PC or mobile is now past face recognition is the future login. New innovative machine vision algorithm will may provide capabilities to meet all of these requirements, though various biometrics such as signature scan, fingernail ridgelines, iris scanning, finger scan, vein, voice recognition are successfully implemented but still need some best option for authentication that is nothing but next generation identification face recognition.

Above application give birth to new invention in face recognition, thought face recognition can be done by various methods but still it is not successfully implemented in any above area so need to research such topic to provide best face recognition algorithm in the area given above. To overcome limitations, present a possible solution by providing best recognition algorithm.

Few studies focus on face recognition. In some studies correlation is given but due to dynamic structure of face that all thing are not sufficiently solve all parameters. In few work images are taken in control environment and use their algorithm but it is not so efficiently and timely recognize face. Still occlusion, pose, age, and illumination challenges not cover so we found scope in face recognition work.

Due to various unsolved parameters, such as face illumination, expression, pose, scale, low resolution, partial face (occlusion) and other environmental conditions night video footage and day video footage face recognition problem still not solved. But, different pose and occlusion remains as major challenges in face recognition and these two problems affect the performance of face recognition in, access control, authentication, and surveillance applications.

By using KSM algorithm, we are able to overcome these two challenges, the present study proposed a face recognition system using the analytical approach in which centre of two eye *i.e.* forehead is used for feature extraction. We formulate the problem and found better result than existing analytical approach. Colour face recognition is also one of the big challenge which is overcome by our algorithm.

During analysis we also check the performance of KSM algorithm on large gallery set. Recognition time for small and large set is near about same hence we conclude that our algorithm efficiently works.

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LITERATURE REVIEW

Detail literature study include research papers study, various face extraction methods take in to consideration image-based face & **video-based face detection** that include capturing image from video & converting it in to specific format (e.g. JPEG, GIF, Bitmap). Image enhancement, comparison of different algorithms, histogram equalization techniques, algorithms study, related articles study, observe different problem in face recognition, study of various methods of face recognition will be discussed.

In this chapter the detail survey of existing literature on face recognition using machine. Due to widely available of technologies today face recognition has several applications ranging from banking, static matching of photographs as in mug shots matching and credit card verification to surveillance video images. Mostly all face recognition system is depend on existing dataset(ex. ORL face set, Yale face set, PIE face set, FERT etc) but in this research new face bank dataset is design for testing.

2.1 THREE DIFFERENT APPROACHES FOR FACE RECOGNITION

I n literature survey it is found that face recognition is best applications of Gabor wavelets. The face image is convolved with a set of Gabor Wavelets and the resulting images are further processed for recognition purpose. There have been a great amount of researches on face recognition recently, and various proposed algorithm are created by different approaches like holistic, analytic and hybrid *etc.*

2.1.1 Holistic Approaches

In the holistic approach, the complete face region is taken into account as input data into face detection system. Examples of holistic methods are

Eigen faces (most widely used method for face recognition) Fisher faces (most widely used method for face recognition) Linear Subspaces
Support vector machines
Template Matching
Geometrical Feature Matching
Nearest feature lines (NFL)

Principal component analysis (PCA)
Linear discriminant analysis (LDA)
Independent component analysis (ICA)
A) Eigenfaces: Eigenface is one of the old investigated approaches for face recognition. According to (Pentland, 1991)improvements can be achieved by first mapping the data into a lower dimensionality. eigenfaces are the principal components of the

While in mathematical terms, distribution of faces, or the eigenvectors of the covariance matrix of the set of face images. Turk and Pentland applied principal component analysis to face recognition and detection. PCA finds the eigenvectors, called “EigenFaces”, of the covariance matrix corresponding to the generic training images.

The eigenvectors are ordered to represent different amounts of the variation, respectively, among the faces. Each face can be represented exactly by a linear combination of the eigenfaces. It can also be approximated using only the “best” eigenvectors with the largest eigenvalues. The best M eigenfaces construct an M dimensional space, the “face space” (Pentland, 1991)

Author L. Sirovich and M. Kirby (Kirby, Mar 1987)used principal component analysis to efficiently represent pictures of faces. They also say that any face images could be approximately reconstructed by a small collection of weights for each face and a standard face picture (eigenpicture). The weights describing each face are obtained by projecting the face image onto the eigenpicture.

Fig. 2.1.1 Black & white Feature Vector are obtain from standard Eigenface (Council, 7 August 2006)
PCA projections are optimal for reconstruction from a low dimensional basis, but they may not be optimal from a discrimination standpoint

B) Fisher faces : Developed by Robert Fisher in 1936 for taxonomic classification. (Peter N. Belhumeur, July 1997.) Generally Fisher's Linear Discriminant is a \classical" technique in pattern recognition. Cheng *et al.* presented a method that used Fisher's discriminator for face recognition where features were obtained by a polar quantization of the shape (Y. Cheng, 1991) Fisher's Linear Discriminant (FLD) is an example of a class specific method, in the sense that it tries to \shape" the scatter in order to make it more reliable for classification. Most Discriminating Feature (MDF) method used for recognizing

hand & gestures Cui, Swets, and Weng applied Fisher's discriminator (using different terminology. Though no implementation is reported, they also suggest that the method can be applied to face recognition under variable illumination.

In above algorithm eigen faces based principal component analysis (PCA) and the fisher face based on linear discriminant analysis (LDA) are two most important subspace method of the well-know holistic approaches. To simplify a dataset into lower dimension while retaining the characteristic of dataset the above methods are used. The eigenface based on Template Matching, Geometrical Feature Matching are also holistic approaches (P.A.Khandre)

In contrast to using information only from key feature points, holistic approaches extracts features from the whole face image i:e global image . Normalization on face size and rotation is a really important pre-processing to make the recognition robust.

2.1.2 Analytic approaches (Component based Face Recognition)

Some feature points are detected from the face, especially the important facial landmarks point such as eyes, nose, and mouth. These detected points are called the fiducial points, and the local features extracted on these points, distance and angle between these points, and some quantitative measures from the face are used for face recognition. The main advantage of analytic approaches is to allow for a flexible deformation at the key feature points so that pose changes, different angles of view can be compensated for. In component based face recognition methods though automatic extraction of face components and its validation without human intervention is difficult task.

In feature based approaches, local features on face such as nose, and then eyes are segmented and then used as input data for structural classifier. Generally, key point features provide more accurate and consistent representation for alignment purposes than region based features, with lower complexity and computational burden than contour feature extraction.

Types of feature extraction methods can be distinguished:

Generic methods based on edges, lines, and curves
Feature based methods that are used to detect facial features such as eyes
Structural matching methods that take into consideration geometrical constraints on the features (P.A.Khandre)

2.1.3 Hybrid Approach

Meaning of hybrid is nothing but combining both techniques. In face recognition methods using Hybrid approaches, both holistic and analytical approaches are used. Some examples of hybrid approach are

• A modular eigenfaces approach was proposed where both global eigenfaces and

local eigen features are used. Note that the concept of Eigen faces may be extended to eigen features, such as eigeneyes, eigenmouths, eigenchin *etc.*

Hybrid idea comes from how human vision system perceives both local feature and complete face. There are modular eigen faces, hybrid local feature, shape normalized, and component based methods in hybrid approach. Human facial features play a significant role in identifying faces. Different research like neurophysiologic research studies have declared that eyes, mouth, and nose are amongst the most important features for recognition.

When a human face is represented as an image, it is very natural for these features to depict distinguishing characteristics not present in other facial components such as cheeks and chin. The eyes, the mouth, and the nostrils are the local minima of a facial image, whereas, the tip of the nose is a local maximum.

However, for the purpose of compression herein, the facial features of interest are only the eyes and the mouth. When a facial intensity image is represented as a surface, the brightness values form deep valleys in the facial feature regions (P.A.Khandre)

2.2 METHOD FOR FACE RECOGNITION

Various methods for face recognition are implemented in literature put light on that. As we know one picture is far better than theory so this tree diagram give better information regarding face recognition. Image based face recognition methods covered in this tree diagram (Lu, May 2003).

–

Fig. 2.2.1 Image based Face recognition methods (Lu, May 2003)

Image Based Face Recognition Today interest in biometric authentication growing day by day and image based face recognition take vital role, in literature it was shown that there are two types of image based face recognition appearance based face recognition and model based.

2.2.1 Appearance Based Face Recognition

This include face feature analysis, graph matching, appearance-based face recognition is of two types linear method and non linear

2.2.1.1 Three linear method detailed explanation is given as

- **PCA**
- **ICA**
- **LDA**

(A)Principal Component Analysis (PCA): (Muller, December 1996)PCA is a powerful technique for extracting structure from possibly high dimensional data sets, an *s*-dimensional vector representation of each face in a training set of images, Principal Component Analysis (PCA) (Turk and Pentland, 1991) tends to find a *t* dimensional subspace whose basis vectors correspond to the maximum variance direction in the original image space. This new subspace is normally lower dimensional ($t << s$).If the image elements are considered as random variables, the PCA basis vectors are defined as eigenvectors of the scatter matrix.

Let us consider a set of N image samples, {x1,x2…….x_N}taking values in n-dimensional image space. Then, PCA finds the best set of projection vectors in the sample space that will maximize the total scatter across all images. The objective function of PCA is written as the following W_{PCA}=argmax $_{W| |}$,

……(1) Where

$_{ST}$ $\sum^{N}$xi μ_{xi} μ_{T}……..……(2)

is the total scatter matrix and μ is the total mean of the whole training set. The columns of W_{PCA},{W_{E1}, W_{E2}…….W_{EM}} are the projection vectors, which are called eigenfaces.

The main steps in finding the principal components can be summarized as follows:

- Collect xi of an n dimensional data set x, i=1,2, ……, m
- Mean correct (center) all the points: Calculate mean mx and subtract it from each data point, xi – mx

• Calculate the covariance matrix: $C = (xi - mx)(xi - mx)^T$
• Determine Eigen values and eigenvectors of the matrix C.
• Sort the Eigen values (and corresponding eigenvectors) in decreasing order.
• Select the first $d \leq n$ eigenvectors and generate the data set in the new representation.

• The projected test image is compared to every projected training image by using a similarity measure. The result is the training image which is the closest to the test image. (ACAN2, 2003)

***(B)Independent Component Analysis (ICA)* :** (Bartlett et al., 2002) minimizes both second-order and higher-order dependencies in the input data and attempts to find the basis along which the data (when projected onto them) are -statistically independent. Bartlett *et al.* provided two architectures of ICA for face recognition task. Architecture I– statistically independent basis images (ICA1 in our experiments), and Architecture II – factorial code representation (ICA2 in our experiments).

As compared with the other statistical methods, ICA provides a more powerful data representation than PCA because PCA considers the second order moments only and it uncorrelated data, while ICA accounts for higher order statistics and it identifies the independent source components from their linear mixtures.
The main steps to derive the independent components are as follows:

• Collect xi of an n dimensional data set x, i=1,2, …, m
• Mean correct all the points: Calculate mean mx and subtract it from each

data point,
xi – mx

• Calculate the covariance matrix: $C = (xi - mx)(xi - mx)T$
• The ICA of x factorizes the covariance matrix C into the following form:

$C = F \Delta F^T$ whereΔ is a diagonal real positive matrix.
• F transforms the original data x into Z such that the components of the

new data Z are independent: $X = F Z$

ICA transformation F can be derived by the algorithms such as FixedPoint Algorithm, Natural Gradient Algorithm, Extended Bell-Sejnowski Algorithm

and EASI Algorithm (ACAN2, 2003)

C)Linear Discriminant Analysis (LDA) **:** (Bel humeur et al., 1996) finds the vectors in the underlying space that best discriminate among classes. For all samples of all classes the between-class scatter matrix *SB* and the within-class scatter matrix *SW* are defined. The goal is to maximize *SB* while minimizing *SW*, in other words, maximize the ratio det|*SB*| / det|*SW*|. This ratio is maximized when the column vectors of the projection matrix are the eigenvectors of (*SW-1· SB)* (P.A.Khandre). In fig. 2.2.1.1 given below each block represent class and also observe that there is large difference between classes but little difference within classes.
The objective function of LDA can be written as follows:

W_{PCA}=argmax $_{W\ ,}$ …….(1) Let the training set contain c classes and each class ci have Ni samples. Then, S_b and S_w are defined as:

Where$_{S\ \sum\ xi}$ μ_{xi} μ_{T}…….(2) $_{N}\sum_{xk\ ci\ xk}$ μ_{xk} μ_{T}……...…….. (3)$_{S\ \sum}$
Whereμi is the mean of class, ci and xk is a sample belonging to class. (GuMin Jeong, © ICROS, KIEE and Springer 2010)
_____Fig.2.2.1.1 Six Classes using LDA (Council, 7 August 2006) The main steps in LDA are as follows:
• Calculate within-class scatter matrix, Sw
$S\ \sum^{C}\ \sum^{N!}\ _{xi!}$ $\mu_{j\ xi!}$ $\mu_{j\ T}$…….(i)$_{J}$
where x
$_{j}$

$_{i}$ is the ith sample of class j,
$\mu_j$is the mean of class j,
C is the number of classes,
$N_j$is the number of samples in class j.

• Calculate between-class scatter matrix, Sb
$S\ \sum!\ xj$ μ_{xj} μ_{T}…….(ii) whereμ represents the mean of all classes.
• Calculate the eigenvectors of the projection matrix
W = eig (Sw –1 Sb)

• Compare the test image's projection matrix with the projection matrix of each

training image by using a similarity measure. The result is the training image which is the closest to the test image. (ACAN2, 2003)

2.2.1.2 Non linear detailed explanation is given as
KPCA
ISOMAP
LLE

***(A) Kernel principal component analysis (KPCA)*:** A new method for performing a nonlinear form of principal component analysis is proposed. (Jukka Kortelainen, APRIL 2011)The use of integral operator kernel functions, one can efficiently compute principal components in highdimensional feature spaces, related to input space by some nonlinear map-for instance, the space of all possible five-pixel products in 16× 16 images. Polynomial kernel PCA to extract nonlinear principal components from the training and test set. The kernel principal component analysis thus is computationally comparably better than a linear PCA. (Muller, December 1996)

1. Linear PCA :

Let xi, i = 1 , 2 , - . . , N , be n x 1 dimensional training sample vector, and a centered training sample set can be obtained by subtract the mean vector

%& ' ∑'%(…….(1)$_{)}$

%)*%(%&…….(2)

Covariance matrix of the samples can be defined as

' ∑ ' %)*%)* …….(3)$_{)}$

Linear PCA diagonalizes the covariance matrix S by using a linear orthogonal transformation, which can be done by solving the Eigen value problem

+w w…….(4)

Where λ and w are Eigen values and eigenvectors of S, respectively. Assume the Eigen values are sorted in decreasing order, that is,λ i λ i+1, then PCA is to select the first m < n eigenvectors (that is, components) as the basis vector of a lower dimensional subspace, forming the n x m dimensional transformation matrix P = [wl,w2,'",wm]. Then the projection of a new vector x into the mdimensional subspace is computed as (Qingshan, Sept. 2003)

y. %…….(5)

2. Nonlinear PCA:

The idea of KPCA seeks to find nonlinear principal components in the input

data. At first, the kernel trick is used to map the data from the input space to a high dimensional implicit feature space F by using a nonlinear mapping Φ: x R^n X F and then linear PCA is performed in F. In computation, it does not demand to computeΦ explicitly, while just need to compute the inner product of two vectors in F by using a kernel function (Qingshan, Sept. 2003)

k(x, y) =Φ (x).Φ (y)…….(1)
The same as linear PCA, the corresponding eigenvalue problem in F should be solved

$_{+w}{}^{\Phi}{}_{S}{}^{\Phi}{}_{w}{}^{\Phi}$ ……..…… .(2)
where$_S{}^{\Phi}$is the covariance matrix in F. Because all solutions$_w{}^{\Phi}$with $_{+0}$ lie in the span ofΦ (x1),Φ (x2)……..Φ (x_N) there exist coefficientsαi such that

0
$^{\Phi}{}_{)}{}_{\sum}\ \alpha_i\Phi_{xi}$ ……..…….(3)

Defining an N x N matrix K by
$\Phi_{\%(\ .}\Phi_{\%3}$ ……(4)$_{1(,\ 3\ 4\ \%(,\ \%3}$
the eigenvalue problem Eq.(2) can be converted into

$_{6+}\alpha_{1\ 7}$…….(5)

for nonzero eigenvalues. Let$_{+(\ -\ +(\ 8\ 1\ :\ 0}$and select the first$_{;\ <\ =}$,usually $_{;\ >\ =}$,eigenvectors to span a subspace in F, then the projection of a new vector x onto a kernel eigenvector$_0{}^{\Phi}$ is calculated as

?
0
$^{\Phi}{}_{)}{}_{.\ \Phi\ x\ \sum}\ \alpha_{i\ k\ xi,\ x}$ ……(6)

(B)Isometric Map (ISOMAP): The algorithm, called ISOMAP, seeks to preserve the intrinsic geometry of the nonlinear data by utilizing the geodesic manifold distances between the data points. The algorithm can be divided into three steps.
1) Construction of neighborhood graph. Two data points are considered to be

neighbors if they satisfy a predefined condition. The condition can be either that their distance in the original space is shorter than a constant or that one of the points belongs to the K^{th} nearest neighbors (KNN)of the other point. Based on this neighborhood information, a weighted graph containing all data points is constructed. Neighboring points are connected with edges of weight equal to the distance of the points in the original space.
2) Computation of shortest paths. The geodesic distance on the manifold is estimated between all pairs of points by computing their shortest path distances in the neighborhood graph. This can be done using various methods, such as Dijkstra's algorithm.
3) Construction of embedding. After calculation of the shortest paths, the data can be represented with a matrix expressing the geodesic distance of each pair of points on the manifold. Applying classical MDS to this matrix constructs an embedding of the data that best preserves the manifold's estimated intrinsic geometry. (Jukka Kortelainen, APRIL 2011)

***(C) Local Linear Embedding (LLE)*:** It tries to unfold the manifold by preserving the local relationship of data. Many areas of science depend on exploratory data analysis and visualization. The need to analyze large amounts of multivariate data raises the fundamental problem of dimensionality reduction: how to discover compact representations of highdimensional data. Here, introduce locally linear embedding (LLE), an unsupervised learning algorithm that computes low-dimensional, neighborhood-preserving embeddings of highdimensional inputs. Unlike clustering methods for local dimensionality reduction, LLE maps its inputs into a single global coordinate system of lower dimensionality, and its optimizations do not involve local minima. By exploiting the local symmetries of linear reconstructions, LLE is able to learn the global structure of nonlinear manifolds, such as those generated by images of faces. (Saul, Dec. 22, 2000)

2.2.2 Model based face recognition is divided in to two types

- **2D Model**
- **3D Model**

Faces are no rigid and their images have a high degree of variability in shape, texture, pose, and imaging conditions. A comprehensive survey on face detection methods can be found in (Low, 2001.), (M. H. Yang, Jan. 2002.). A huge research effort has been devoted to detecting and tracking of facial features in two-dimensional (2-D) and three-dimensional (3-D) (Ahlberg, fast and reliable active appearance model search for 3-D face tracking, AUGUST 2004)

reliable active appearance model search for 3-D face tracking, AUGUST 2004)

A. 2D Elastic Bunch Graph
B. Active Appearance Model

(A)2D Model Elastic bunch graph (EBG): Face recognition by elastic bunch graph matching recognition is based on a straight forward comparison of image graphs, stored model graphs can be matched to new images to generate image graphs, which can then be incorporated into a gallery and become model graphs. Model graphs can easily be translated, scaled, oriented or deformed during the matching. Representative set of individual model graphs into a stack-like structure, called a face bunch graph (FBG) process, thus compensating for a large part of the variance of the images. Each model has the same grid structure and the nodes refer to identical fiducial points. A set of jets referring to one fiducial point is called a bunch. An eye bunch, for instance, may include jets from closed, open, female, and male eyes *etc.* (Wiskott, April 18 ,1996)

There are three phases in the EBGM algorithm. First, important landmarks on the face are located by comparing Gabor jets extracted from the new image to Gabor jets taken from training imagery. Second, each face image is processed into a smaller description of that face called a Face graph. The last phase computes the similarity between many Face graphs by computing the similarity of the Gabor jet features. The Face graphs with the highest similarity will hopefully belong to the same person. (David S. Bolme)

Fig. 2.2.2.1 Elastic bunch showing face graph (Council, 7 August 2006)

(B) 3 D Model Active Appearance Model (AAM): It searches for real-time face and facial feature tracking. The main contribution is a novel search scheme whose computing time is not dependent on the dimension of the face space, i.e., the number of the texture modes. By modifying the criterion search, that not only CPU time can be earned but also the search can be very accurate compared with the basic search 3-D face model, 3-D shape is directly recorded in coordinate form. The shape is given by a set of vertices and triangles. The 3-D face model is given by the 3-D coordinates of the vertices Pi i=1, ……..…η whereη is the number of vertices. Thus, the shape up to a global scale can be fully described by the 3 η vector g the concatenation of the 3-D coordinates of all vertices Pi. The latter property results from the fact that the dimension of the face space plays a major role in avoiding the degradation of the tracking performance. This is successfully used for tracking the 3-D face pose

(Ahlberg, Fast And Reliable Active Appearance Model Search For 3-D Face Tracking, August 2004)

Three Dimension Face Recognition (3DFR)

Latest Texas 3-D Face Recognition Database (T3FRD) which is the largest publicly available database of co-registered 2-D and 3-D face images acquired using a passive modality (i.e. optical stereo ranging). Literature study of 3-D face recognition algorithm in which range images are segmented into equal width iso-geodesic stripes at increasing distance from the nose tip. Next, the face is compactly represented by an attributed relational graph where each node represents a stripe, and each edge of the graph is annotated by 3-D "weighted walkthroughs" (3DWW) between two stripes. The 3DWW between each pair of stripes captures the relative spatial displacements between all pairs of points of the input stripes. Two given faces are compared by comparing their corresponding annotated graphs. Iso-geodesic contour based surface representation is combined with statistical learning techniques and region ensemble approaches to construct a face recognition model with competitive performance and robustness against pose and facial expression variations. This model embodies several unique contributions to the fields of 3-D face recognition, 3-D surface representation, and object detection. (Bovik, 11 May 2013)

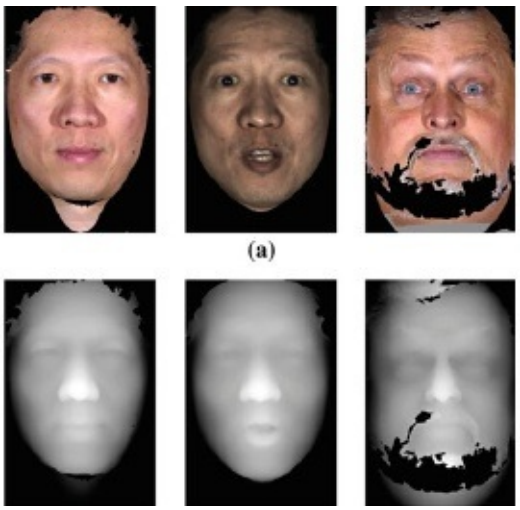

Fig. 2.2.2.2 Face Image from Texas 3-D Face Recognition Database (T3FRD) (Bovik, 11 May 2013)

In the BU-3D FE databases come in two versions, one with the static data and the other with dynamic data. The static database includes still color images, while the dynamic database contains video sequences of subjects with

expressions.

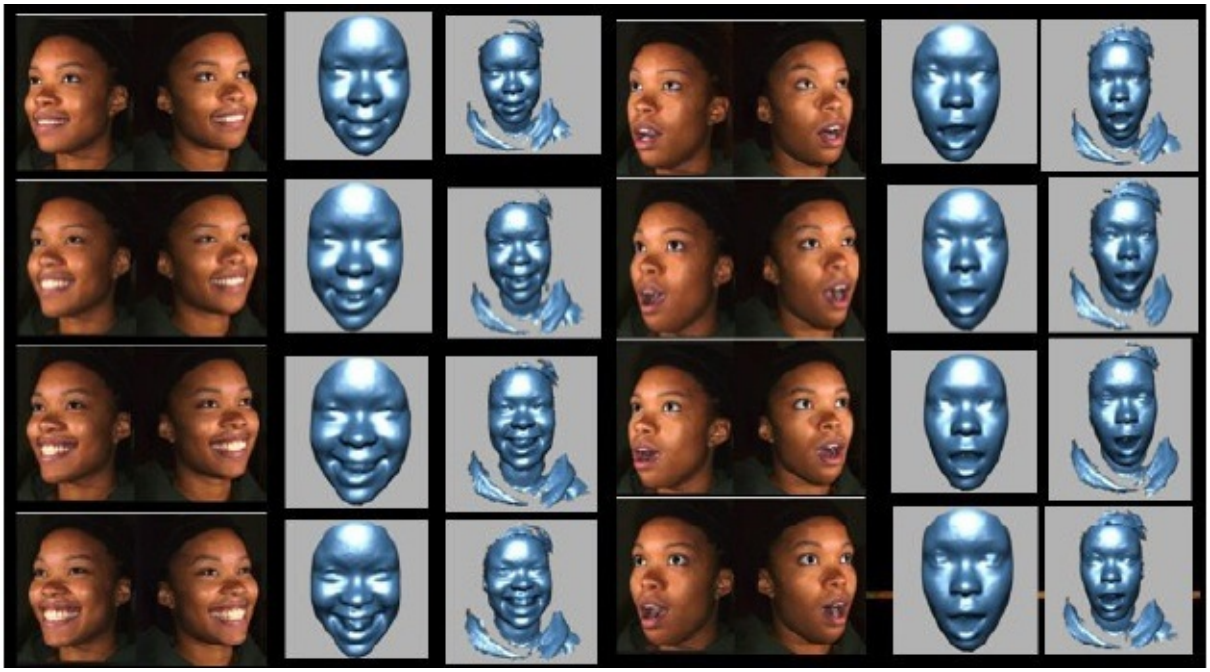

Fig. 2.2.2.3 Face Images from BU-3D FE database(Binghamton University, State University of New York Lijun Yin lijun@cs.binghamton.edu)

We also study the result of existing algorithm like PCA, LDA, ICA their success rate is given on table 2.3.1.

Table 2.3.1 Experiment I Results: PCA, LDA and ICA Performance (ACAN2, 2003)

Table 2.3.2 Experiment II Results: R,G, B Variations

with 25 and 50 Training Faces (ACAN2, 2003)

Table 2.3.3 Experiment III Results : Estimates with Partial Occlusions (ACAN2, 2003)

In above table face images of six partial occlusion cases are mention by author.

Case I : The left part of the image is cut vertically until the left ear of the face is lost. Case II : The upper part of the image is cut horizontally until the hairs are lost, but the forehead will be included.

Case III : The bottom part of the image is cut horizontally until the bottom edge of the chin is reached.

Case IV : The right part of the image is cut vertically until the right edge of the right eye is reached.

According to author (ACAN2, 2003) A comparative performance analysis of Principal Component Analysis, Linear Discriminant Analysis and Independent Component Analysis techniques was conducted on face recognition using colored images. The performances were obtained using different number of training images and three sets of experiments were employed for relative performance evaluations of PCA, LDA and ICA methods.

We observe the performance of each experiment and make decision according to their results. In the first set of experiments, the recognition performances of PCA, LDA and ICA were demonstrated on the original colored images.

The effect of illumination variations were demonstrated in the second set of experiments by increasing the R, G, B color component values. The input images were partially occluded in the third set of experiments.

The results of the experiments show that PCA is better than LDA and ICA in general and under different illumination variations. It is also demonstrated that LDA is more sensitive than PCA and ICA on partial occlusions, but PCA is less sensitive to partial occlusions compared with ICA sensitivity. That is, PCA's success rates are better than that of LDA and ICA on partial occlusions, and ICA is better than LDA on partial occlusion results.

On the other hand, increasing the number of training images does not have a great impact on PCA and LDA in general, but for ICA, the performance decreases. For the illumination changes and partial occlusions, increasing the number of training images decreases the performance rates. The reason of this performance decrease may be because of the abundance of the training images or the difference between the samples of the training and test images.

2.3 CURRENTLY AVAILABLE FACE RECOGNITION WEBSITES AND DATABSE WEBSITES.

2.3.1 Face Recognition Websites

Recently on internet various face recognition software's are available but they are bulky, and expensive so during survey it is found that still face recognition technique is not so user friendly though these commercial product available on net today, their website are given below

- Passfaces from ID-arts http://www.id-arts.com/
- ImageWare Sofware http://www.iwsinc.com/

• Eyematic Interfaces Inc. http://www.eyematic.com/
• BioID sensor fusion http://www.bioid.com
• Visionsphere Technologies
http://www.visionspheretech.com/menu.htm
• Biometric Systems, Inc. http://www.biometrica.com/
• FaceSnap Recorder
http://www.facesnap.de/htdocs/english/index2.html
• SpotIt for face composite http://spotit.itc.it/SpotIt.html
• FaceIt from Visionics http://www.FaceIt.com
• Viisage Technology http://www.viisage.com
• FaceVACS from Plettac http://www.plettac-electronics.com
• FaceKey Corp. http://www.facekey.com
• Cognitec Systems http://www.cognitec-systems.de
• Keyware Technologies http://www.keywareusa.com/

2.3.2 Databases from Websites

For image based and video based face recognition currently available face recognition database given on this website (http://www.face-rec.org/databases/) are as follows, detail description of some database is given in appendix.

Sr. No. Face Databases

1. The Color FERET Database, USA
2. SC face - Surveillance Cameras Face Database
3. Multi-PIE
4. The Yale Face Database
5. The Yale Face Database B
6. PIE Database, CMU
7. Project - Face In Action (FIA) Face Video Database, AMP, CMU
8. Cohn-Kanade AU Coded Facial Expression Database
9. Image Database of Facial Actions and Expressions - Expression Image Database
10. Face Recognition Data, University of Essex, UK
11. NIST Mugshot Identification Database
12. NLPR Face Database
13. M2VTS Multimodal Face Database (Release 1.00)
14. The Extended M2VTS Database, University of Surrey, UK
15. The AR Face Database, Purdue University, USA
16. The University of Oulu Physics-Based Face Database
17. CAS-PEAL Face Database

18. Japanese Female Facial Expression (JAFFE) Database
19. BioID Face DB – Human Scan AG, Switzerland
20. Psychological Image Collection at Stirling (PICS)
21. The Sheffield Face Database (previously: The UMIST Face Database)
22. Face Video Database of the Max Planck Institute for Biological Cybernetics
23. Caltech Faces
24. EQUINOX HID Face Database
25. VALID Database
26. The UCD Color Face Image Database for Face Detection
27. Georgia Tech Face Database
28. Indian Face Database
29. VidTIMIT Database
30. Labeled Faces in the Wild
31. The LFWcrop Database
32. Labeled Faces in the Wild-a (LFW-a)
33. 3D_RMA database
34. GavabDB: 3D face database, GAVAB research group, Universidad Rey Juan Carlos, Spain
35. FRAV2D Database
36. FRAV3D Database
37. BJUT-3D Chinese Face Database
38. The Bosphorus Database
39. PUT Face Database
40. The Basel Face Model (BFM)
41. Plastic Surgery Face Database
42. The Iranian Face Database (IFDB)
43. The Hong Kong Polytechnic University NIR Face Database
44. The Hong Kong Polytechnic University Hyperspectral Face Database (PolyU HSFD)
45. MOBIO - Mobile Biometry Face and Speech Database
46. Texas 3D Face Recognition Database (Texas 3DFRD)
47. Natural Visible and Infrared facial Expression database (USTC-NVIE)
48. FEI Face Database
49. ChokePoint
50. UMB database of 3D occluded faces
51. VADANA: Vims Appearance Dataset for facial Analysis
52. MORPH Database (Craniofacial Longitudinal Morphological Face Database)
53. Long Distance Heterogeneous Face Database (LDHF-DB)
54. PhotoFace: Face recognition using photometric stereo

55. The EURECOM Kinect Face Dataset (EURECOM KFD)
56. YouTube Faces Database
57. YMU (YouTube Makeup) Dataset 58. VMU (Virtual Makeup) Dataset
59. MIW (Makeup in the "wild") Dataset
Table 2.3.4 Existing Face Database
From literature study four face-recognition algorithms performance obtain is observe as follows (Pranab Mohanty, DECEMBER 2008)

Algorithms	**PCA**	**LDA**	**ICA**	**EBGM**
Accuracy in %	94	90	87	91

Table 2.3.5 Similarity of the local manifold structure between the original algorithms and the linear model as captured by the nearest neighbor agreement metric using the FERET probe set.

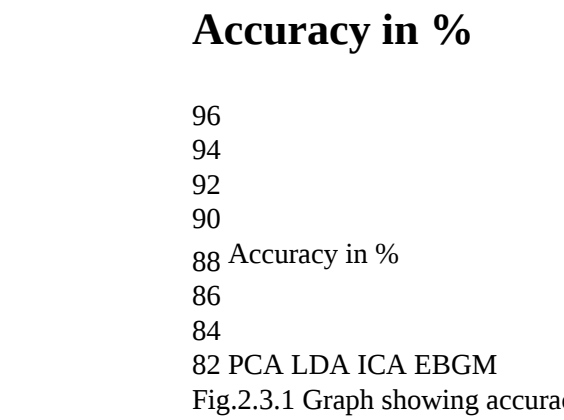

Fig.2.3.1 Graph showing accuracy of face recognition algorithm using FERET probe set

Some camera of different company like (Artech Group, HCL, Sony) model available in market. This camera has single USB wire, having logical access control using programs, clearly verify user by their face matrix.
Gray face image recognition software available is market but still color face

recognition software not effectively used each everywhere. In this research we create an algorithm for face recognition, the algorithm implemented using MATLAB software. In the Proposed KSM forehead feature base face recognition algorithm, performance of pattern recognition systems that use statistical features depends on a specific feature extraction technique. This technique is used to represent an image by a set of features and to reduce the dimension of the image space by removing redundant data.

Some Biometric camera of different company like (Artech Group, HCL, Sony)model available in market : This camera has single USB wire, having logical access control using programs , clearly verify user by their face matrix


Fig.2.3.2 3D Camera for User Verification (Design by Artech Group)

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CHAPTER – 3

RESEARCH METHODOLOGY

In this chapter, actual method of research, steps involve in research is mention. Chapter theme is given as, planning include research plan, analysis, organizing include facial database handling, comparison include software, algorithm, database, system design, system implementation, controlling is discussed.

In any research first we have to define problem, so our problem is thought various software and hardware available but still problem of face recognition remain unsolved we are trying to find solution by making GUI in MATLAB. For this we review a literature and after finding no any satisfactory solution of problem take a topic for study that is nothing but need for study. Aim of our research is to create an algorithm for race recognition and Objective of our research is to prove MATLAB is best tool for implementing face recognition algorithm.

Objective of our research is univarient, study is quantitative, we used finite population of 50 samples, primary source of data collection tool is international and national journal papers, IEEE papers, web source and secondary data is experimental result. In data processing we use data coding, data classification, data tabulation, data manipulation it include data cleaning: missing data, improper code, outlier, category merging *etc.* In data analysis we use data comparison tool using Z test software.

Research methodology refers to a system of models, procedure and techniques to find the results of a research problem. It facilitates smooth and better running of various task and operations, thereby making research efficient and yielding maximum information with minimum expenditure of effort, time and money. If a method/algorithm producing a quick response, then the user's task will be completed by consuming less energy.

Before doing research we read some research methodology book from available literature. In literature research can be define by various way by various author

• Research is an original contribution to the existing stock of knowledge making for its advancement. (C.R.Kothari)
• Research is a structured enquiry that utilizes acceptable scientific methodology to solve problems and create new knowledge that is generally applicable to

to solve problems and create new knowledge that is generally applicable to society. (Khare)
• Dictionary meaning of research is “a careful investigation or inquiry especially through search for new facts in any branch of knowledge.”
• Research can be also defined as scientific and systematic search for pertinent information on a specific topic.
• Research is an art of scientific investigation.
(http://www.slideshare.net/technomgtsood/introduction-to-research-2886846)
• Research in common parlance refers to a search for knowledge.
• Redman and Mory define research as a “systematized effort to gain new knowledge”. (Dawson)
• Research as a movement, a movement from the known to the unknown. Attain full and fuller understanding of the unknown (C.R.Kothari)

In short, the search for knowledge through objective and systematic method of finding solution to a problem is research. (www.slideshare.net/wanju/reasearch-methodology-2)
Research Methods versus Methodology (C.R.Kothari)

Research methods may be clarified as all those methods/techniques that are used for conduction of research. Research methods or techniques use in performing research operations. Research methods can be put into the following three groups:

1. In the first group author include those methods which are concerned with the collection of data. These methods will be used where the data already available are not sufficient to arrive at the required solution (http://www.slideshare.net/wanju/reasearch-methodology-2) 2. The second group consists of those statistical techniques which are used for establishing relationships between the data and the unknowns.
3. The third group consists of those methods which are used to evaluate the accuracy of the results obtained.
According to author research methods falling in the above stated last two groups are generally taken as the analytical tools of research.
(http://www.slideshare.net/wanju/reasearch-methodology-2)

Whereas research methodology is a way to systematically solve the research problem. It may be clarify as a science of studying how research is done scientifically.

So according to author it is necessary for the researcher to know not only the research methods/techniques but also the methodology. Researchers is process that not only need to know how to develop certain indices or tests, but also how to calculate the arithmetic mean, the mode, the median or the standard deviation or test like chi-square, also how to apply particular research techniques, they also need to know which of these methods or techniques are suitable for our analysis and which are not, and what would they mean and indicate and why. (http://blog.reseapro.com/2012/05/research-methodology/)

So according to author (C.R.Kothari) that it is necessary for the researcher to design his methodology for his problem as the same may differ from problem to problem. Research methodology is not only talk of the research methods but also consider the logic behind the methods that use in the context of our research study and explain why we are using a particular method or technique and why we are not using others so that research results are capable of being evaluated either by the researcher himself or by others.

Research design stands systematic planning of the methods adopted for collecting the relevant data and technique to be used in analysis keeping in view the objective of the research. Before doing any research we must know the opinion of each author about research.

3.1 PLANNING

For any system development efficient planning is always necessary for that we prepared research plan. Goal is set from starting of work so various stages of work was decided earlier this criteria is very important for achieving goal.

• **Research Plan**
As research comprises of lengthy processes and required to be plan in advance for successful completion.
Approximate Duration of the Project:
• Gathering information : 3 months
• Analyzing and formulating the data : 2 months
• Gathering secondary data from sources : 3 months
• Compiling secondary data : 6 months
• Categorizing secondary data : 6 months
• Preparing the written document or research report : 4 months

3.1.1 System Analysis

3.1.1.1 Study Customer Needs

Customer needs means finding user requirement from our system. For that survey of existing system their drawbacks taken in to consideration while designing new system so that the new system become very efficient, by this method the objective of user should be satisfactorily achieved. Graphical user interface is design in such a way that, they should be understandable.

3.1.1.2 Feasibility Study

a) Technical Feasibility -Software/ HardwareIs existing technology sufficient for development of project. Database-The existing memory can handle face database. Flexible system-System is design in such a way that it can be change easily.
b) Operational Feasibility -The proposed system will not cause damage to other existed system. Operator objective can be achieved very easily so that capability can enhance.
c) Economical Feasibility-Available Resources can sufficient for this project. By conducting cost benefit analysis decide that aim of project can be achieved with in available resources.

3.1.2 Requirement Analysis

Study of available resources that can be hardware, software require for project development. Is system require more resources than available, is comparatively study so that goal can be achieved with available resources.

3.1.3 Risk Analysis

Identification of risk is always good process to create successful system without any error. Any type of software system have various failure attack due to virus or any other reason, if that can be identified before system implementation and find alternative solution to overcome such problem is better for avoiding risk in future. The list of risk and set solution is given as.

Risk
System Failure due to virus
Manpower
Development environment
System Size

Hardware

Solution Antivirus is install on system System analyst to handle any risk
Latest version of MATLAB software
Sufficient RAM & Hard disk capacity Flexible to handle different available hardware

In this way if risk can be monitor occurrence of system failure can be avoided. Understanding problem and finding solution to that problem is very good task for efficient software system development.

3.2 ORGANIZING

Very important stapes of management is organizing. Kept new face in facial database in best possible manner need best organization so that face handling becomes effective. In literature study based on figure of market report the growth of face recognition goes on increasing from 1998 to 2014, for that various facial database handling techniques were developed by various author.

Face Bank Organization

A very close relationship exists between the advancement of today face recognition algorithms and the latest available face databases, different factors that affect facial appearance in a controlled manner that's why we are organized our face bank in best possible manner so that it can be utilized effectively. During 5 shots for each person, in each shot, people have been asked to take front, left, right, up down poses. The face bank consist high quality colour face images with different poses and also include occluded face (sun glasses and scarf). The laptop was used for capture also we test our algorithm by mobile phone images. The mobile phone used to capture the face bank database images was a micromax HD. The number of male and female subjects are exactly the same size. As our population is finite we chose 10 sample image, study sample, give unique address to each respondent that is our sampling frame let's take look on sample face bank.

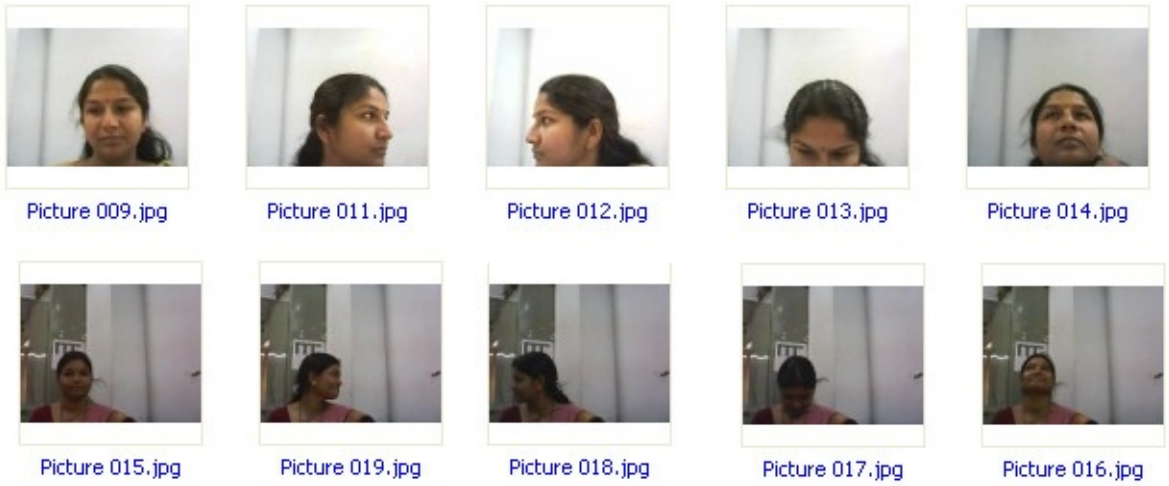

Fig.3.2.1 Sample Face Database

3.3 COMPARISONS

Hypothesis testing is also called confirmatory data analysis. Method of making decisions using data is nothing but statistical hypothesis test . If result is according to a pre. If result is according to a predetermined threshold probability then it is statistically significant.ity then it is statistically significant. A result that was found to be statistically significant is also called aso called a positive result. By this hypothesis we conclude that face is best for authentication

Percentage of existing authentication methods (Lu, May
45, 12% 99, 26% Face 69, 18%$_{\text{Finger}}$
Hand 45, 12% 70, 19%$_{\text{Voice}}$ **50, 13%**$_{\text{Eye}}$
Signature

Fig. 3.3 The pi graph shows the percentagpi graph shows the percentage of other existing authentication methods

Software
Database Image Size

Recognition Rate LAB VIEW (Dr. Alex **50 images from the publicly available Database of Faces** 80% See Kok Bin)
MATLAB 50 images of 10 people from Face bank database 86%

Table 3.3.1 Comparison of MATLAB and LABVIEW software
Recognition Rate
86% 87%
86%
85%
84%
83%

% 82%80%
81%
80%
79%
78%
77% **LAB View** MATLAB **Software**

Fig 3.3.1 Comparison of MATLAB and LABVIEW software Test : We calculate Z ratio test for above comparison with the help of online Z ratio calculator

Sample A (MATLAB) Sample B(LABVIEW) Ka=43 Kb=40
Na=50 Nb=50
Pa=0.86 Pb=0.8 Pa-Pb=0.06
Z=0.799
Probability
One tail Two tail 0.2121 0.4243

Table 3.3.2 Table show z ratio of two samples (MATLAB with LABVIEW) software comparison (http://vassarstats.net/propdiff_ind.html)

Sample A show 43% face recognition and sample B show 40% among 50 sample face respectively. Thus the proportion is Pa=43/50=0.86 and Pb=40/50=0.8, the difference between two proportion is 0.06 and Z ratio is 0.799, Z-test checks whether the 2 proportions are significantly different.

In C and C++ matrix manipulation is so tedious and time consuming as compare to MATLAB software. As the name MATLAB is nothing but Matrix Laboratory Biometric performance is easily enhance using MATLAB. The benchmark includes three different software C and C++ and MATLAB. Any face is nothing but Matrix, to manipulate that matrix various easily available function present in MATLAB software as compare to C , C++ , LABVIEW. Various experiment were conducted to test robustness of different approaches using different software. We select LABVIEW Software for Benchmark. All the software details included in this comparison have been obtain from papers on web author mention percentage details regarding description of face recognition so the remaining data collected by coding available on net .

Many built in functions available in MALTAB software relevant to engineering and computer science and because of good GUI capabilities it is very user-friendly than other open source software .

Many open source software version require many function to do simple task but in MATLAB only single function do the task very effectively. Scilab is just like MATLAB but it is also not so good for face recognition that's why we select MATLAB software for face recognition.

Due to various command available in MATLAB Face can be recognize using different way by MATLAB software we study recognition rate of different methods like Neural Network MATLAB, Bunch Graph and also most important Feature Extraction using MATLAB, in all case recognition rate is good, MATLAB can recognize color , blur , occluded image with the help of different algorithm available and also by proposed algorithm. Comparison feature extraction algorithm with proposed algorithm is shown in table 3.3.1.2

3.3.1 Comparison of different algorithm for face recognition.

Proposed FRT System Parameters

By using face feature parameter improvement in recognition experiments. Feature vector includes center points between two eyes, extract the maximum or minimum reference points (coordinate).The same faces can appear completely different at two different pose, in order to resolve this fact we use five different pose vector of single person for matching (Front face, Left side face, right side face, face up , face down) and calculate probability with them face identification accuracy is depend on probability of matching.

Though various existing face recognition algorithm available but still use of face recognition is not so user friendly hence we show comparative analysis of existing algorithm with our algorithm using different parameters like color image, occluded image, image with various pose.

Algorithm
PCA (Kresimir Delac, 27
Database Color / Half Different Pose Gray Occluded Images Image
FERET database Gray No No
February 2006)
ICA (Kresimir Delac, 27 FERET database Gray No No
February 2006)
LDA (Kresimir Delac, 27 FERET database Gray No No
February 2006)
Feature base CBCL database Color No No

SFV-FR (Zhengya Xu,
DECEMBER 2011)
Proposed KSM forehead Own Face bank Color Yes Yes
feature base face recognition
algorithm
Table 3.3.1.1 Table show different algorithm with different database for face recognition

Analytical Approach

ShapeFeature-VectorBased Face
Recognition System (Zhengya Xu,
DECEMBER 2011)

Featurebased face recognition using
mixturedistance
(Featurebased face recognition using
recognition using
20 Jun 1996)
Proposed KSM
Forehead Feature base face recognition approach

Database Recognition Rate The data sets include a subset of the Massachusetts
79.10% Institute of Technology-CBCL face recognition
database which consists of ten individuals ,they use
several database FRAV3D of 106 peopleall face
images were acquired under controlled lighting
conditions and without glasses, hats,or
scarves.JAFFE to test facial expression and large
variation in pose, age, and lighting and for an aging
FG-NET database is used
By comparison, nearest neighbor search 84% using Euclidean distance

FACE BANK of 10 people with five different pose, 86% with fix measured distance
FACE BANK of 10 people with five different pose 86% of occluded image with fix measured distance

Table 3.3.1.2 Comparison of three different algorithms using analytical approach

Using analytical approach we found two papers showing their result first

ShapeFeature-Vector-Based Face Recognition System (Zhengya Xu, DECEMBER 2011) ,the data sets include a subset of the Massachusetts Institute of Technology-CBCL face recognition database which consists of ten individuals ,they use several database FRAV3D of 106 people all face images were acquired under controlled lighting conditions and without glasses, hats,or scarves.JAFFE to test facial expression and large variation in pose, age, and lighting and for an aging FG-NET database is used their recognition rate 79.10%. Second Featurebased face recognition using mixturedistance (Featurebased face recognition using mixturedistance, 18-20 Jun 1996) they used two face database first one 685 people in which each face is represented by 30 measured distances give 95% and second one by comparison, nearest neighbour search using Euclidean distance give 84%. We compare our Proposed Feature base Approach with above two approaches and found result as 96% using FACE BANK of 10 people with five different pose, with fix measured distance and result 85%, 90%, 96% vary using occluded FACE BANK of 10 people with five different pose image with fix measured distance .

For comparative statement we used different papers available on web site. For all significant occlusion category recognition rates using AR Face Database, (In AR database they used a subset of 114 people each with 8 images for a total of 912 training images).and Face bank (subset of 10 people each with 5 images of different pose total 50 training images) are shown in table 3.3.1.3 . RoBM 84.50 using sunglass and 80.70 using scarp ,like wise RBM , Eigenfaces , LDA, Pixel show less recognition rate (Yichuan Tang) as compare to our algorithm that show 86% using sunglass 86% using half scarf all this shown in table given bellow.

Algorithms Occlusion

Sunglasses Scarf[**Database**] RoBM
RBM
Eigenfaces LDA
Pixel
Proposed KSM Forehead Feature 84.50% 80.70%

61.70% 32.90% AR Face Database66.90% 38.60% (Yichuan Tang)56.10% 27.00%
51.30% 17.50%
86% 86% Face Bank (O)
Table 3.3.1.3 Comparison of different algorithm for face recognition under

occlusion category.

Occlusion by sunglasses

KSM Algorithm RoBM Algorithm 86% 84.50%

Table 3.3.1.4 Recognition rate of KSM and RoBM algorithm

87% **86%**
86%
86%
85% 84.50%
85%
84%
84% KSM Algorithm RoBM Algorithm

Fig 3.3.1.1 ComparisonComparison of KSM and RoBM algorithm

KSM Algorithm RBM Algorithm 86% 61.70%

Table 3.3.1.5 Recognition rate of KSM and RBM algorithm

90% 86%
80%

70% 61.70%
60%
50%
40%
30%
20%
10%
0% KSM Algorithm RBM Algorithm

Fig 3.3.1.2 ComparisonComparison of KSM and RBM algorithm

KSM Algorithm Eigenface Algorithm 86% 66.90%

Table 3.3.1.6 Recognition rate of KSM and Eigenface algorithm

90% 86%
80% 70% 66.90%
60%
50%
40%
30%
20%
10%
0% KSM Algorithm Eigenface Algorithm

Fig 3.3.1.3 ComparisonComparison of KSM and Eigenface algorithm

KSM Algorithm LDA Algorithm 86% 56.10%

Table 3.3.1.7 Recognition rate of KSM and LDA algorithm

90%86%
80%
70% 60% 56.10%

50%
40%
30%
20%
10%
0% **KSM Algorithm** LDA Algorithm
Fig 3.3.1.4 ComparisonComparison of KSM and LDA algorithm
KSM Algorithm Pixel Algorithm 86% 51.30%
Table 3.3.1.8 Recognition rate of KSM and Pixel algorithm
90% 86%
80%
70%
60% 51.30%
50%
40%
30%
20%
10%
0% **KSM Algorithm** Pixel Algorithm
Fig 3.3.1.5 ComparisComparison of KSM and Pixel algorithm
Occlusion by sunglasses

Sample A (KSM) Sample B(RoBM) Ka=43 Kb=770
Na=50 Nb=912
Pa=0.86 Pb=0.8443 Pa-Pb=0.0157
Z=0.299
Probability
One tail Two tail 0.3825 0.7649

Table 3.3.1.9 Z ratio of KSM and RoBM algorithm

Sample A (KSM) Sample B(RBM) Ka=43 Kb=563
Na=50 Nb=912
Pa=0.86 Pb=0.6173 Pa-Pb=0.2427
Z=3.46
Probability
One tail Two tail 0.0003 0.0005

Table 3.3.1.10 Z ratio of KSM and RBM algorithm

Sample A (KSM) Sample B(Eigenface) Ka=43 Kb=610
Na=50 Nb=912
Pa=0.86 Pb=0.6689 Pa-Pb=0.1911

Z=2.818
Probability
One tail Two tail 0.0024 0.0048

Table 3.3.1.11 Z ratio of KSM and Eigenface algorithm

Sample A (KSM) Sample B(LDA) Ka=43 Kb=515
Na=50 Nb=912
Pa=0.86 Pb=0.5647 Pa-Pb=0.2953
Z=4.119
Probability
One tail Two tail <.0001 <.0002

Table 3.3.1.12 Z ratio of KSM and LDA algorithm

Sample A (KSM) Sample B(Pixel) Ka=43 Kb=469 Na=50 Na=912

Pa=0.86 Pb=0.5143 Pa-Pb=0.3457
Z=4.771
Probability
One tail Two tail <.0001 <.0002

Table 3.3.1.13 Z ratio of KSM and Pixel algorithm
(http://vassarstats.net/propdiff_ind.html)

Occlusion by Scarf

KSM Algorithm RoBM Algorithm 86% 80.70%
Table 3.3.1.14 Reco1.14 Recognition rate of KSM and RoBM algorithm
87% 86%
86%
85%
84%
83%
82% 80.70%
81%
80%
79%
78% **KSM Algorithm** RoBM Algorithm
Fig 3.3.1.6 ComparisonComparison of KSM and RoBM algorithm
KSM Algorithm RBM Algorithm 86% 32.90%

Table 3.3.1.15 Recognition rate of KSM and RBM algorithm

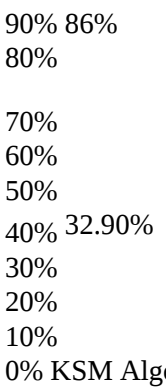

Fig 3.3.1.7 ComparisonComparison of KSM and RBM algorithm

KSM Algorithm Eigenface Algorithm 86% 38.60%

Table 3.3.1.16 Recognition rate of KSM and Eigenface algorithm

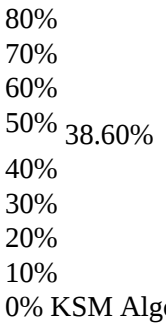

Fig 3.3.1.8 ComparisonComparison of KSM and Eigenface algorithm

KSM Algorithm LDA Algorithm 86% 27.00%

Table 3.3.1.17 Recognition rate of KSM and LDA1.17 Recognition rate of KSM and LDA algorithm

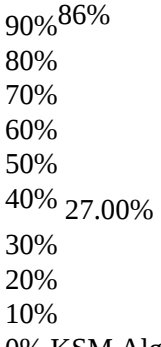

Fig 3.3.1.9 ComparisonComparison of KSM and LDA algorithm

KSM Algorithm Pixel Algorithm 86% 17.50%

Table 3.3.1.18 Recognition rate of KSM and Pixel algorithm

90%86%

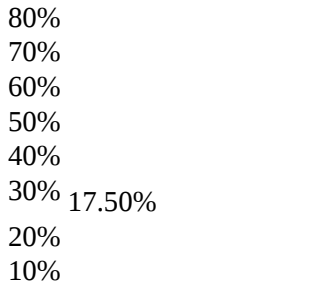

Fig 3.3.1.10Comparison of KSM and Pixel algorithm

Sample A (KSM) Sample B(RoBM) Ka=43 Kb=730
Na=50 Nb=912
Pa=0.86 Pb=0.8004 Pa-Pb=0.0596
Z=1.032
Probability
One tail Two tail 0.151 0.3021

Table 3.3.1.19 Z ratio of KSM and RoBM algorithm

Sample A (KSM) Sample B(RBM) Ka=43 Kb=300
Na=50 Nb=912
Pa=0.86 Pb=0.3289 Pa-Pb=0.5311
Z=7.633
Probability
One tail Two tail <.0001 <.0002

Table 3.3.1.20 Z ratio of KSM and RBM algorithm

Sample A (KSM) Sample B(Eigenface) Ka=43 Kb=350
Na=50 Nb=912
Pa=0.86 Pb=0.3838 Pa-Pb=0.4762
Z=6.67
Probability
One tail Two tail <.0001 <.0002

Table 3.3.1.21 Z ratio of KSM and Eigenface algorithm

Sample A (KSM) Sample B(LDA) Ka=43 Kb=250
Na=50 Nb=912
Pa=0.86 Pb=0.2741 Pa-Pb=0.5859

Z=8.765
Probability
One tail Two tail <.0001 <.0002

Table 3.3.1.22 Z ratio of KSM and LDA algorithm

Sample A (KSM) Sample B(Pixel) Ka=43 Kb=160 Na=50 Na=912

Pa=0.86 Pb=0.1754 Pa-Pb=0.6846
Z=11.551
Probability
One tail Two tail <.0001 <.0002

Table 3.3.1.23 Z ratio of KSM and Pixel algorithm
(http://vassarstats.net/propdiff_ind.html)

Occlusion by Sunglasses

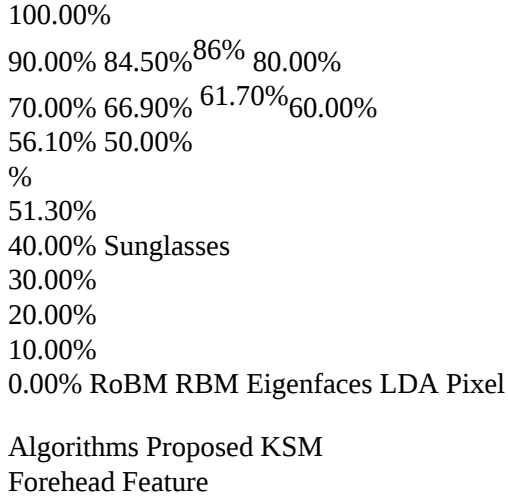

Fig.3.3.1.11 Line graph for comparison of different algorithm for face recognition under occlusion by sunglasses category (Yichuan Tang)

Occlusion by Scarf

40.00%38.60%
30.00%32.90% Scarf27.00%
20.00%17.50%
10.00%
0.00% RoBM RBM Eigenfaces LDA Pixel

Algorithms Proposed KSM
Forehead Feature

Fig.3.3.1.12 Line graph for comparison of different algorithm for face recognition under occlusion by scarf category (Yichuan Tang)

3.3.2 Different face data base for face recognition

All the data included in this comparison have been obtain from internet as all author not mention percentage details regarding description of face recognition so the remaining data collected by coding available on net.

Year / University

April 1992 and April 1994 Speech, Vision and Robotics Group of the Cambridge
University Engineering
Department.
(http://www.freedownloadmana ger.org/download/orl-database569675.html)
(http://www.cl.cam.ac.uk/Resea rch/DTG/attarchive:pub/data/att _faces.tar.Z)
1996 George Mason
University, USA
(http://face.nist.gov/)

1998 Psychology
Department, Kyushu
University, Japan (Lyons)
2006 Max Planck Institute for Biological Cybernetics, Tubingen, Germany
(http://faces.kyb.tuebingen.mpg. de/index.php)
2006 Binghamton University, State University of New York (Yin)
2014 Face Bank Database
RTM, Nagpur University

Facial database No. of Images
ORL database 400

Color/ Resolution/ Gray No. of subjects Gray 112×92
10
FERET database 14,051 Gray 256x384 1199
JAFFE 213 Gray 256x256 10

MPI for 5600 Biological
Cybernetics
database

Color 256x256 200

BU-3D FE 2500 database
Color, 1040x1329 3D models 100

Face Bank 50 Color 256x256 Images 10
Table 3.3.2.1 Various currently available face database and our Face Bank

3.4 SYSTEM DESIGN

Diagrammatic representation of an algorithm i:e flow chart of the proposed face recognition system is given. Every algorithm can understand very easily if flow of work is diagrammatically explained that's why proposed system work flow is show by this flow chart.

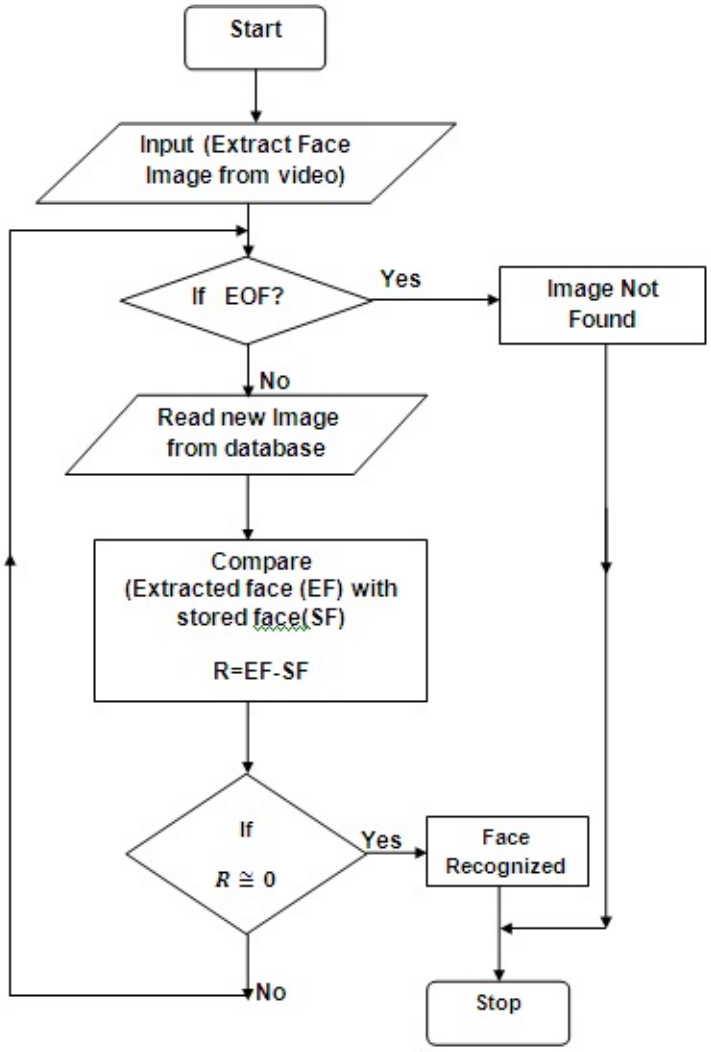

Fig.3.4.1 Flow chart for the proposed face recognition

3.4.2 Sketch of Steps of Face Recognition Process

Steps of face recognition process sketch is shown because picture can be easily understands than theory.

Capture Face Image

Extract Face Feature (Forehead Feature)

Register Face

Compare

Fig.3.4.2 Steps of face recognition process

Steps covered in proposed algorithm are, Capture-A sample of face is captured from video. Extraction features -From center of two eyes i:e forehead region, data is extracted from the sample face(frame crop). Registered-convert extracted feature in same size. ComparisonExtracted feature data is compared with stored face database sample match/non match decides according to decision rule.

3.5 IMPLEMENTATION OF PROPOSE ALGORITHM USING MATLAB

3.5.1. FRT System Parameters

Feature vector includes center points between two eyes, extract the maximum or minimum reference points (coordinate).The same faces can appear completely different at two different pose, in order to resolve this fact we use five different pose vector of single person for matching (front face, left side face, right side face, face up, face down) and calculate probability with them face identification accuracy is depend on probability of matching.

In preprocessing phase, take color images enhance that image, apply automatic cropping algorithm, register image and then match that image with other images after that testing is carried out. This technique is not only computationally less extensive as compared to other recognition techniques but also provides best recognition results images with various constraints like with or without glasses, sad, happy, sleepy, surprise.

3.5.2 Model Design

Fig.3.5.2 MATLAB Graphical User Interface provide help to create model for face recognition

3.6 CONTROLLING

Controlling involve monitoring of proggramme activities to make sure that the end objective are being met. The process of controlling involve setting standard, measure performance according to standard, take desire action, when required. Thus by knowing drawback corrective actions can be done and decision is taken for achieving desire goal. for control over sketch collect the test data, administer the test, and analyze the results must be in proper manner.

Thus research design is very intellectual technique, so to achieve desire objective we follow following steps

Research Question
(Hypothesis)
Literature Survey (Collect Data)
Research Methodology
Design and Implementation in MATLAB
(Flow chart and programme code)
Results and
Conclusion
Fig. 3.6.1 Control over research design process

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FACE RECOGNITION TECHNIQUES

In this chapter we discuss actual face recognition techniques. Face image of an individual's face, is matched to a pre-existing image on-file "face bank" associated with the claimed identity (the verification task). In face-recognition systems, images captured by digital camera are simplified down to the salient features and turned into strings of numbers. As the computer captures new images and simplifies them it can compare them against the strings in inventory.

The chapter describes technique used in face recognition. Now expensive web cameras are widely available in market so face capturing task become very easy but any human faces are no rigid thing also variability in their shape, texture, gesture ,pose, lightning condition etc so detecting actual face from video is challenging task. Various function describe below for doing different task, image registration function work to convert each captured face image into same coordinate system. As name indicate create database function create image database. Image verification function match input image with stored image, quit function exit from GUI window.

What is digital image representation -An image may be defined as a two dimensional function f(x,y) where x and y are spatial(plane) coordinates, and the amplitude of *f* at any pair of coordinates is called the intensity of the image at

that point. (E.Wood).

What is color image representation in MATLAB-An RGB color image is an MXNX3 array of color pixels, where each color pixel is a triplet corresponding to the red , green, and blue components of an RGB image at a specific spatial location . An RGB image may be viewed as a “stack” of three gray scale images that, when fed into the red, green, and blue inputs of color monitor, produce a color image on the screen.

By convention, the three images forming an RGB color image are referred to as the red, green and blue component images. If all the component images are identical, the result is gray scale image.

4.1 CAPTURING FACE IMAGE

A) Image Acquisition

The starting step of all digital image processing is images are fed into the software environment to be processed. Basically, this task is about transforming the JPEG, BITMAP, PNG, image into the matrix form a matrix given below (E.Wood)

$$A = \begin{matrix} f(1,1) & f(1,2) & \cdots & f(1,n) \\ f(2,1) & f(2,2) & \cdots & f(2,n) \\ \vdots & & & \\ f(m,1) & f(m,2) & \cdots & f(m,n) \end{matrix}$$

Where (x, y) are the spatial coordinates of the image and the function f returns the intensity of that particular pixel. The values of m and n depend on the resolution of the camera used, where m and n increases as the resolution increases. The capture image is RGB (colored) format.

Blue Component Image Green Component Image Red Component Image

Fig.4.1 RGB image from three component Red, Green, Blue

B) Face Detection

Face can be used to differentiate one person from another person, though face detection and recognition is most challenging task but still in recent years so many algorithm are developed, In literature various method for face detection are implemented. Very important and first step of face recognition is accurate face detection, in survey face detection is of two type feature-based and image-based. We use feature based face detection for that we conduct feature analysis and searching desire feature i:e fore head feature(center of two eyes). Various algorithms are implemented for both technique let us diagrammatically see evolution of face detection research.

i) Feature-Based Approach

Low-Level Analysis
• Edges
• Gray information.
• Color
• Motion
• Generalized measures

Feature Analysis
• Feature searching
• Constellation analysis

Active Shape Models
• Snakes
• Deformable template
• Point distribution model ii) Image-Based Approach

Linear subspace methods Neural Networks Statistical approaches

In this research , we used feature-based approach while doing feature analysis it is found that mostly mouth, eye, nose points consider for feature extraction but in the proposed algorithm the most known part i:e center part of two eye (forehead region) used for face recognition. In order to capture specific region

we select desire two points by mouse and remove unnecessary background in the image. This background increases the size of the matrix, that's why in this research crop selected feature from entire face image. Specific function does this task very easily. Redundancy is avoided by proposed KSM forehead feature base face recognition algorithm due to small size of matrix.

Fig.4.1.1 Original Image

Fig.4.1.2 Sample Automatic Crop Image

4.2 FEATURE EXTRACTION PROCESS

To create low cost face recognition device we select features form forehead and create a vector of such selected features. Feature vector includes center points between two eyes, extract the maximum or minimum reference points (coordinate).The same faces can appear completely different at two different pose, in order to resolve this fact, we use five different pose vector of single person for matching (front face, left side face, right side face, face up, face down) and calculate probability with them face identification accuracy is depend on probability of matching.

4.3 FACE FEATURE REGISTRATION PROCESS

In preprocessing of face image, quality of face image is enhanced and in registration processes all images covert in to same dimension.
Matching criterion involves preprocessing of face image, for face registration facial region is converting in to same coordinate. Any face image can be identify after registration because matching process important process for require same size images that's way face registration is an face recognition. Based on input face feature vector F=(F1,F2,F3,F4,……Fn) when decision rule is apply on input image, generate one of P symbol I1, I2 ,I3,I4 …..IP as an output that is identified person.

r1c1	r1c2	r1c3	r1c4	r1c5	r1c6
r2c1	r2c2	r2c3	r2c4	r2c5	r2c6
r3c1	r3c2	r3c3	r3c4	r3c5	r3c6
r4c1	r4c2	r4c3	r4c4	r4c5	r4c6
r5c1	r5c2	r5c3	r5c4	r5c5	r5c6
r6c1	r6c2	r6c3	r6c4	r6c5	r6c6

Fig.4.3.1. Sample of face image matrix having rows & columns number

Same size image can be compare. Image registration is process of transforming one image in to the coordinate system of another image (E.Wood). For that purpose create a separate program (function) that perform image registration task. Crop registered images are store in face bank by creating cell array of face, the cell array of front face is given below

vec={f1; l1; r1;u1;d1; f2; l2; r2;u2;d2; f3; l3; r3;u3;d3; f4; l4; r4; u4; d4; f5; l5; r5;u5;d5};

f1-Front Face l1-Left Face r1-Right Face u1 -Face Up
d1-Face Down

Thus five different pose of same person is stored in vec cell array, and then calculate probability of face occurrence, each face is likely to be found five times. To produce manageable dataset sample of 5 subjects data set are created. In this way face bank database contain 50 sample images of 10 persons.

4.4 FACE DATABASE CREATION TECHNIQUE

Face Bank :
After registration processes all same size images are kept in cell array such cell array
is act as face database i.e “Face bank”
Face bank is nothing but vector of extracted feature of face image. Face bank database
is design in such a way that each collected videos frames of 5 subjects using the laptop with
webcam.
Each user was asked to perform the following set of actions while seated in front of the
webcam.
frame 1: look stretch towards webcam (front face) frame 2: turning head to the left;(left side of face) frame 3: turning head to the right;(right side of face) frame 4: turning head up (face up)
frame 5: turning head down;(face down)

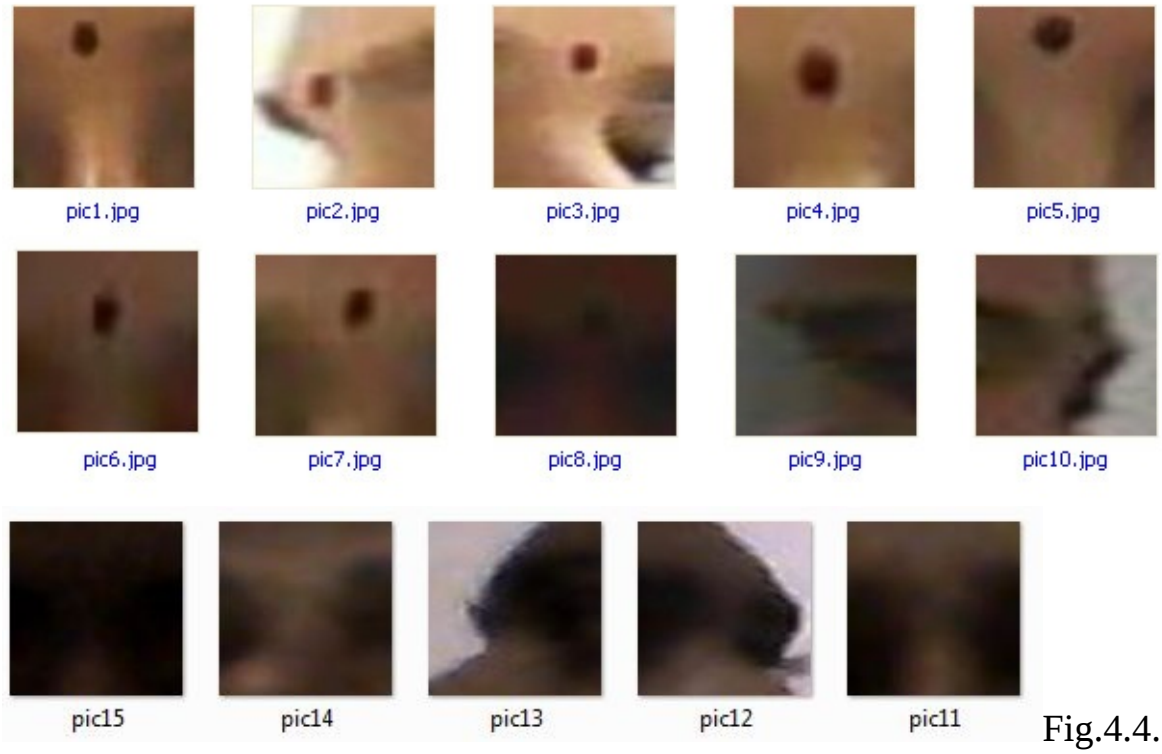

Fig.4.4.1 Sample registered ‘FACE BANK’ database

First we capture full face then we extract selected portion by following commands that are given in MATLAB help menu. Thus with the help of ginput we extract only two points , In figure 4.4.1 extracted portion of face image is given. (Matlab help) (Attaway)

```
im=imread('E:\my thesis2014\fullfacebank\Picture.jpg');
p=ginput(2)
sp(1)=min(floor(p(1)),floor(p(2)));
sp(2)=min(floor(p(3)),floor(p(4)));
sp(3)=max(ceil(p(1)),ceil(p(2)));
sp(4)=max(ceil(p(3)),ceil(p(4)));
mm=im(sp(2):sp(4),sp(1):sp(3),:);
s=imresize(mm,[256 256], 'bilinear');
figure; image(s);
imwrite(s,'E:\my thesis2014\facebank\pic16.jpg');
save(pic16.jpg)
>> help ginput. (Matlab help) (Attaway)
```

GINPUT Graphical input from mouse.
[X,Y] = GINPUT(N) gets N points from the current axes and returns the X-and Ycoordinates in length N vectors X and Y. The cursor can be positioned using a

mouse. Data points are entered by pressing a mouse button or any key on the keyboard except carriage return, which terminates the input before N points are entered. [X,Y] = GINPUT gathers an unlimited number of points until the return key is pressed. . (Matlab help)
[X,Y,BUTTON] = GINPUT(N) returns a third result, BUTTON, that contains a vector of integers specifying which mouse button was used (1,2,3 from left) or ASCII numbers if a key on the keyboard was used. (Matlab help)

>> help floor. (Matlab help)
FLOOR Round towards minus infinity.FLOOR(X) rounds the elements of X to the nearest integers towards minus infinity. (Matlab help)

>> help ceil . (Matlab help)
CEIL Round towards plus infinity.CEIL(X) rounds the elements of X to the nearest integers towards infinity. (Matlab help)

 Fig.4.4.2 Extracted blur face portion without red circle mark

Fig. 4.4.3 Extracted face portion with red circle mark To check whether our KSM algorithm is work for blur and red mark image or not we conduct an experiment for that we select two different image of same person first image is without mark and second in with mark and extract two point by ginput command. In above two fig.4.4.2 and fig. 4.4.3 when we calculate result of two face matrix, difference is zero, hence it is concluded that face is recognized by our software. Likewise same experiment is conducted for different lightning conditions and blur image it also give better result.

Occlusion is one of the challenge for face recognition, generally people occlude their face to protect them self from sun light and dust so they occlude the upper and lower part of face because center part of two eye remain un occluded though eye is occluded with sun glass, we can easily extract two point form center of two eye.

Fig. 4.4.4 Lower half occluded face Fig. 4.4.5 Captured two points of occluded

Fig. 4.4.4 Lower half occluded face Fig. 4.4.5 Captured two points of occluded face

Mostly face half portion is occluded by scarf or cloth, upper and lower portion of forehead is occluded but the portion require for matching i:e center of two eyes that is forehead region is not occluded, in example given below the lower portion of face is occluded.

We extract two point by ginput command and verify the extracted part with stored face part the difference is zero so person wearing scarf can be easily identified with the help of KSM algorithm.

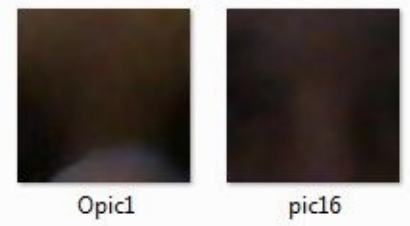

Fig. 4.4.6 Captured two points of occluded face and normal face Image normalization play very important role, image restoration, histogram, noise removal techniques, image filtering, image sharpening, color image smoothing, transformation, image registration, image segmentation are very important process mention in digital image processing using MATLAB, so here we show some techniques apply on image before they process.

Image Restoration: Restoration is process of improve image in some predefined form. It helps in recovering image in original form. (Rafael C. Gonzalez)

Geometric Image Transformation: It modify the special relationship between pixels in an image, it is also called rubber print. In MATLAB imtransform does this task very effectively. (Rafael C. Gonzalez)
Adding noise by imnoise command, imnoise change the input image into class double in the range [0, 1] before adding noise to it, the syntax for this function is

g=imnoise (f, type, parameters)
Where ‘ f ‘ is input image, Gaussian, salt and pepper noise types, parameter like density, frequency *etc.*

Histogram Equalization : When we deals with discrete quantities we work with histogram ,and call the preceding techniques histogram equalization. In

MATLAB histeq function does this task.
RGB image can be converted in to gray image here we show command for reading image,after reading RGB image it is converted in to gray image. (Rafael C. Gonzalez) >> I = imread('E:\fullfacebank\Picture 009.jpg')
>>imshow(I)
Fig.4.4.7 RGB face image

>>a=rgb2gray(I)

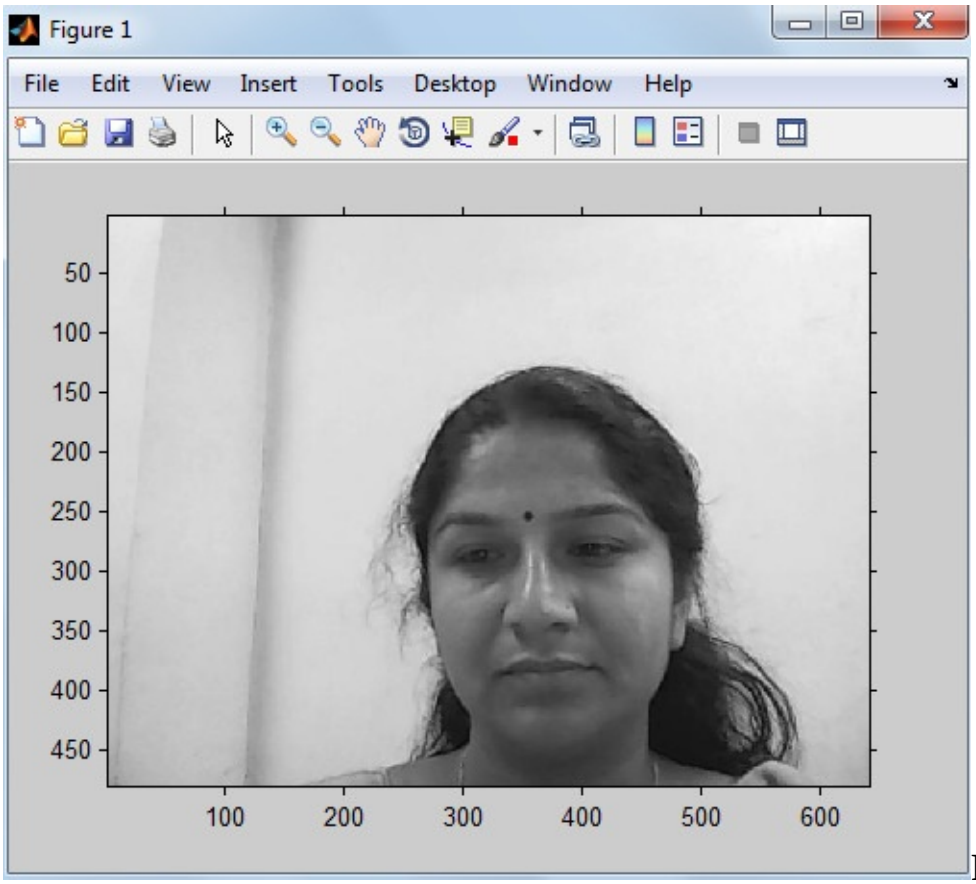

Fig.4.4.8 Gray face image
>>imhist(a)

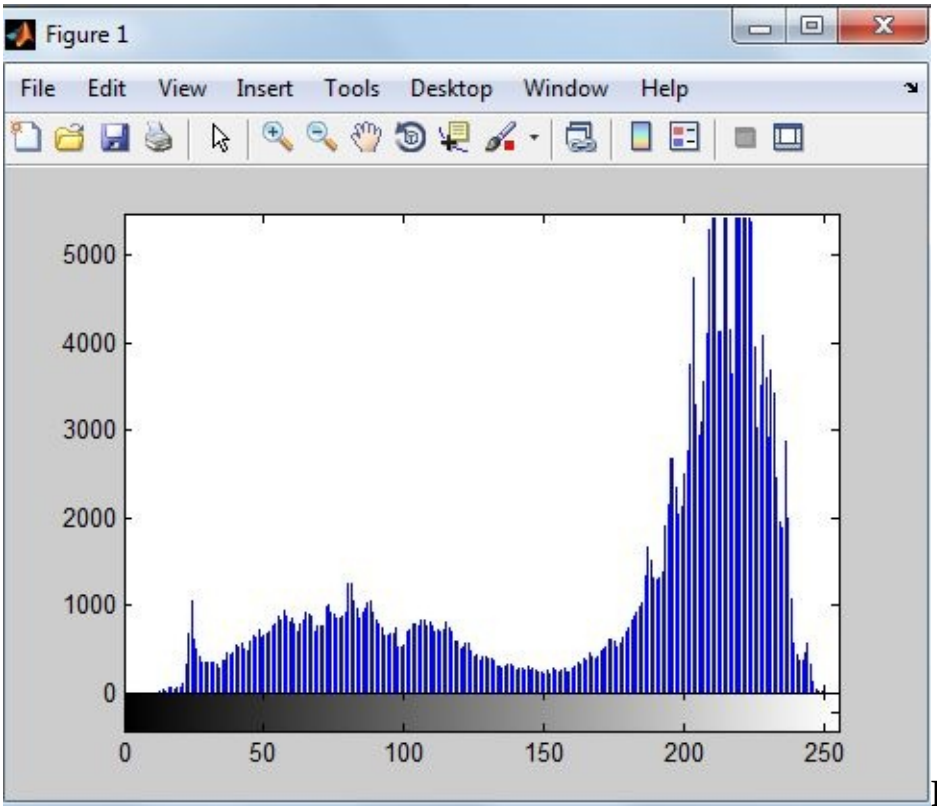

Fig.4.4.9 Histogram of gray face image

>>v=histeq(a)

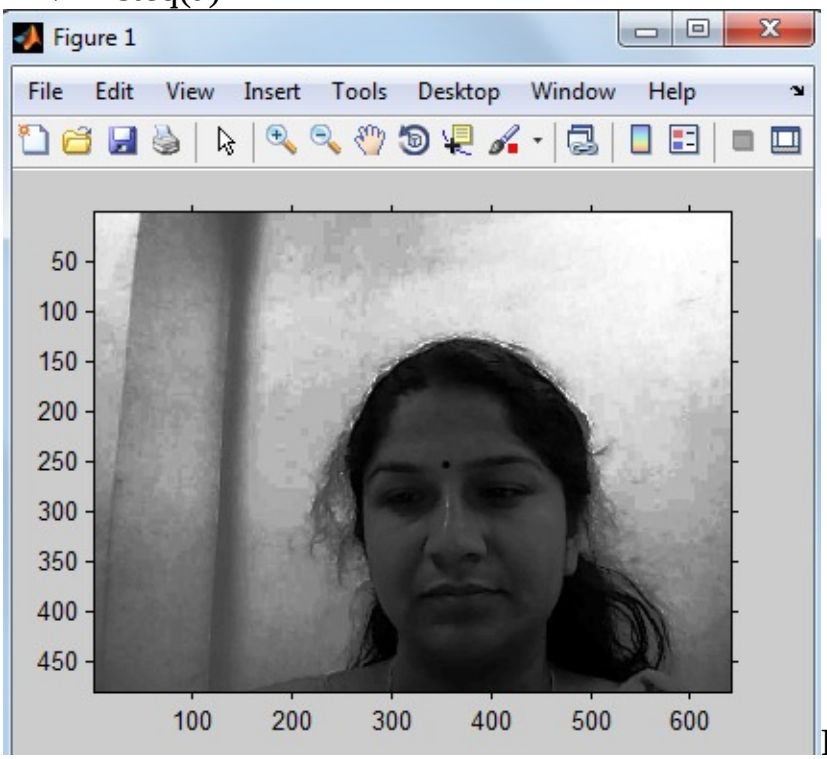

Fig.4.4.10 Histogram equalized gray face image >>imhist(v)

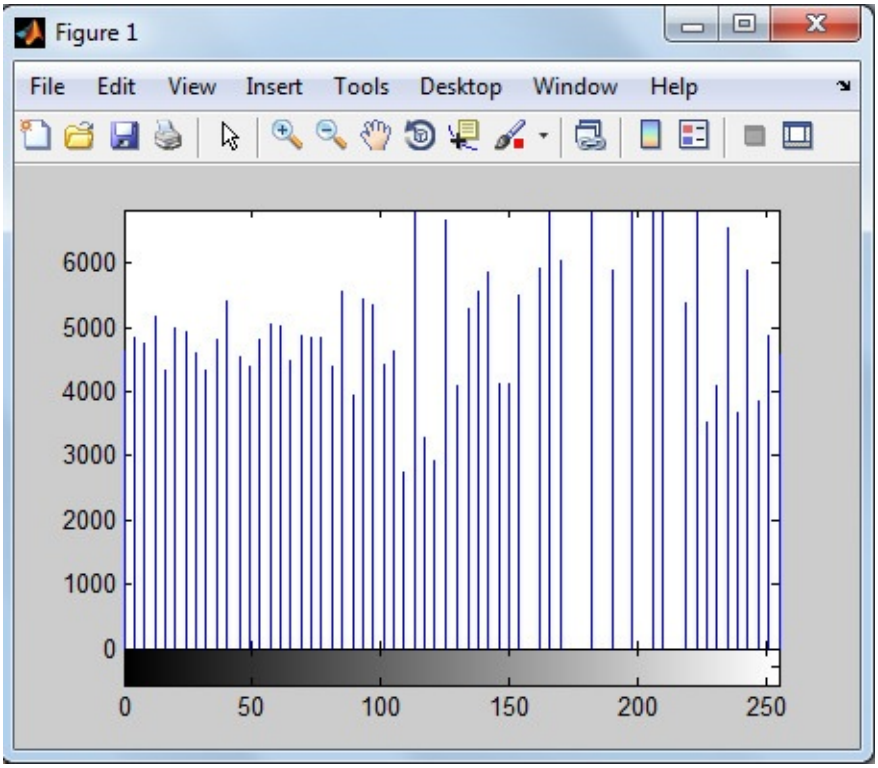

Fig.4.4.11 Histogram equalization of gray face image

Spatial Filtering of Color Image: In MATLAB color image smoothing, sharpening functions are available we use some of them for image preprocessing

YCbCr color space is used widely in digital video, Y is luminance information and color information is stored as two color-difference components Cb, Cr. Here Cb is difference between the blue component and a reference value and Cr is difference between the red component and a reference value. (Rafael C. Gonzalez)

```
>>b=rgb2ycbcr(I)
>> imshow(b)
```

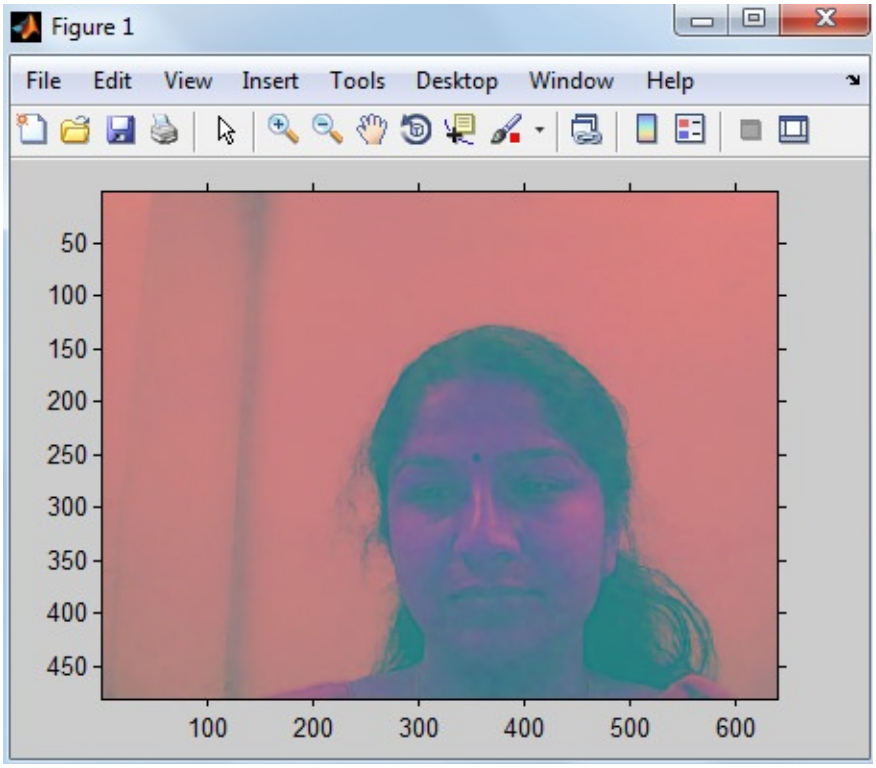

Fig.4.4.12 YCbCr color face image

Image blurring can be enhancing by above techniques. Thus ycbcr2rgb converting image in to its RGB color space the original image.

```
>> c=ycbcr2rgb(b)
>> imshow(c)
```

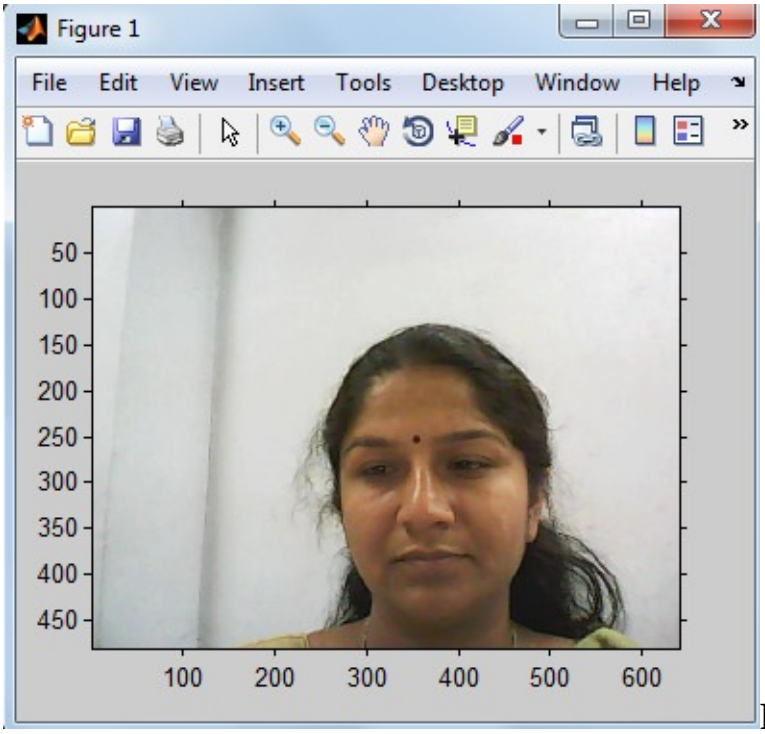

Fig.4.4.13 YCbCr to RGB color face image

4.5 FACE IMAGE VERIFICATION

Capture face is first registered and then compare with stored face database if match found then face is verified otherwise face not found in database. MATLAB Software provide platform for reading and writing image. We can read standard image files TIFF, JPEG, BMP, etc using the imread function. Which type of image reading by imread returned that type of data . We can write MATLAB data to a variety of standard image formats using the imwrite function. Handle Graphics objects are MATLAB objects that implement graphing and visualization functions. Because objects have a type property that identifies which type of object, you can find the handles of all occurrences of a specific type of object. Finds the handles of all patch objects, for example, h = findobj('Type','') (Rafael C. Gonzalez)

By using MATLAB software we are trying to enhance color face recognition. A face is digitized and matched against the face database “face bank” to determine if the person is authorized to enter a facility or use a system. Thus face verification has various applications like law enforcement, prevention of child molestation, residential security, voter verification, in banking for person authentication, identity verification in the field and intelligence gathering, crime prevention and investigation, checking for criminal records, just look attendance,

prevention of fraud in the markets *etc.*

Face Matching

Matching is done by finding difference of matrix suppose matrix A is subtracted from matrix B if the result is zero that means matrix is of same type. We use subtraction in our algorithm. Decision rule for matching is intersection of two matrices must be null for high identification accuracy.
f (1, 1) f (1, 2) · · · f (1, n) f (2, 1) f (2, 2) · · · f (2, n).

A = . . .
. . .
f (m, 1) f (m, 2) · · · f (m, n)
f (1, 1) f (1, 2) · · · f (1, n) f (2, 1) f (2, 2) · · · f (2, n). B = . . .
. . .
f (m, 1) f (m, 2) · · · f (m, n)

On the basis of above concept temporary face is match with stored face i:e face vector. For accurate face recognition face vector contain all same size and registered face images.

4.6 EXIT FROM GRAPHICAL USER INTERFACE

Terminate the programme i:e exit from GUI. User can easily quit from current GUI window by using exit. To perform exit task we write separate coding and later on that coding of exit function included in graphical user interface to perform above mention task.

Exit()

4.7 MODULAR PROGRAMME CODING AND RESULTS

Face recognition algorithms try to solve the problem of both verification and identification. Due to low cost our algorithm is used as effective solution. Result of comparison between two images is find out by calculation difference of extracted face image with stored face image vector , If it is approximately equal to zero that means the face is recognized.

Results:
Actual output of each function is given below that means result of each module is given hear.

fig.4.7.1 Video Sequence

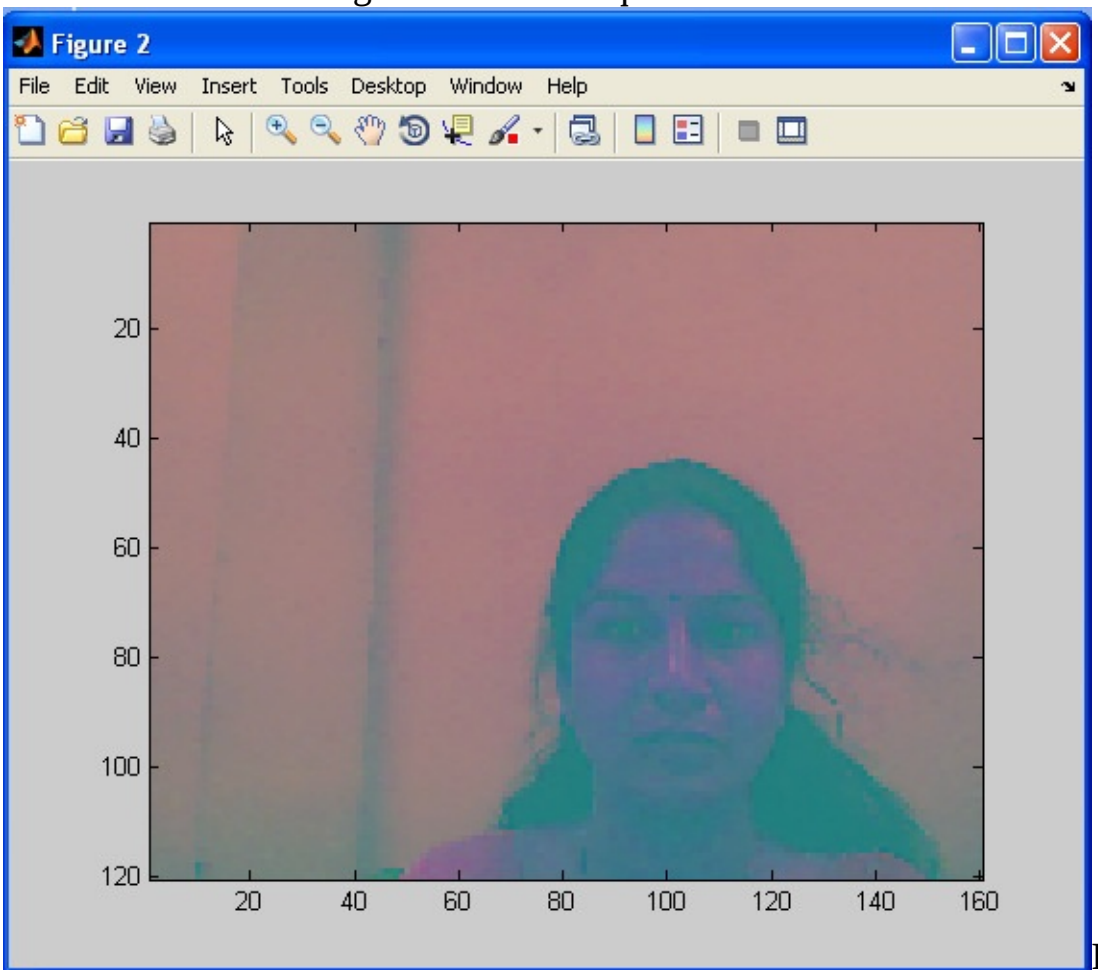

Fig.4.7.2 Image Frame

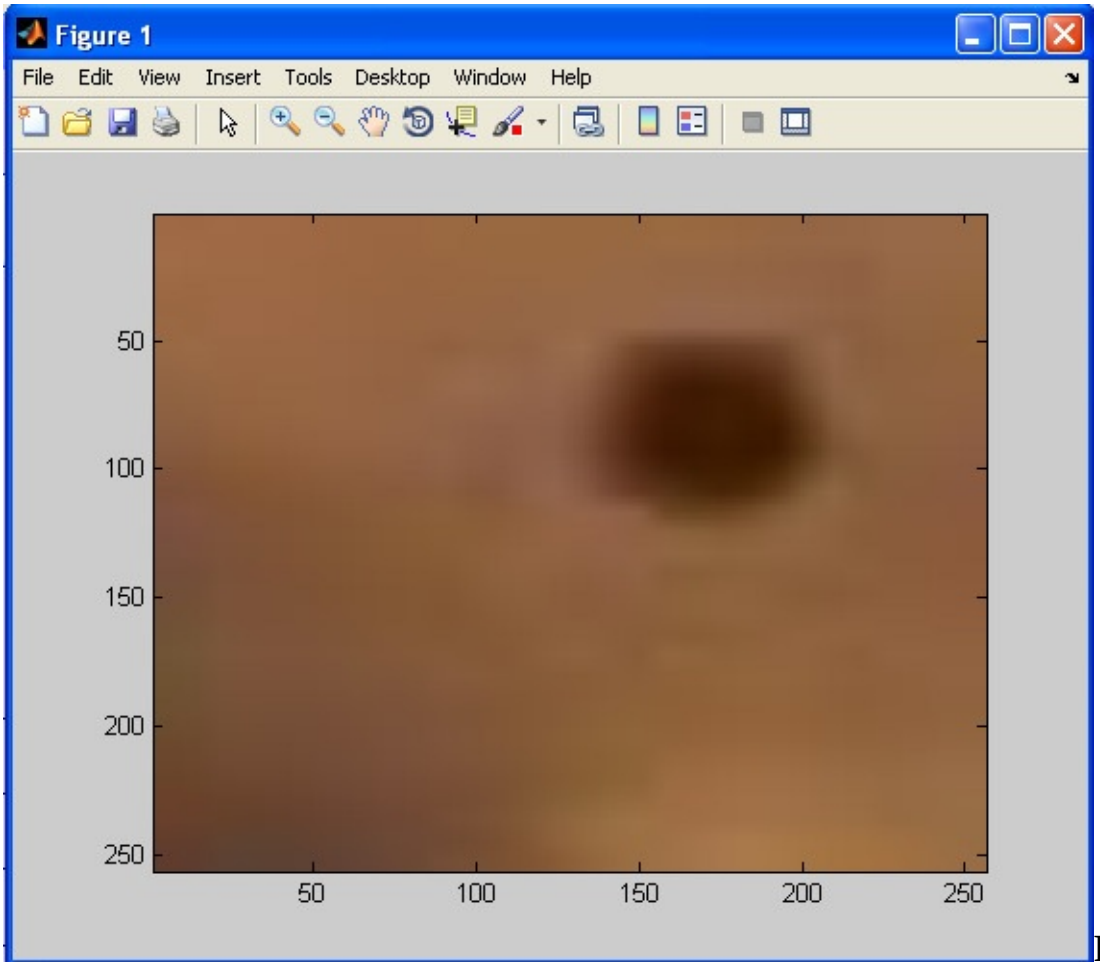

Fig.4.7.3 Selected feature of face image

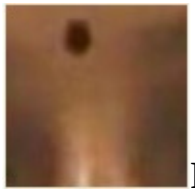
Fig.4.7.4 Registered image

Fig.4.7.5 Registered image compare with stored registered face, display result match found

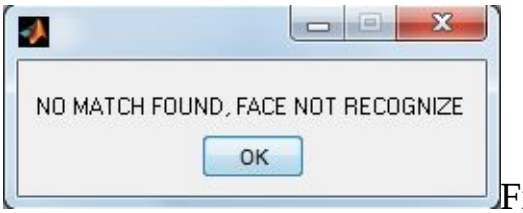

Fig.4.7.6 Registered image compare with stored registered face, display result no match found

4.9 GUI PROGRAMME CODING AND RESULTS

The implementation and performance evaluation of face recognition system using MATLAB (Pratab, 2004)

```
function varargout = SHREE2014(varargin)

% SHREE2014 M-file for SHREE2014.fig
% SHREE2014, by itself, creates a new SHREE2014 or raises the existing
% singleton*.
% H = SHREE2014 returns the handle to a new SHREE2014 or the handle to
% the existing singleton*.
% SHREE2014('CALLBACK',hObject,eventData,handles,...) calls the local
% function named CALLBACK in SHREE2014.M with the given input
arguments.
% SHREE2014('Property','Value',...) creates a new SHREE2014 or raises the
% existing singleton*. Starting from the left, property value pairs are
% applied to the GUI before SHREE2014_OpeningFcn gets called. An
% unrecognized property name or invalid value makes property application
% stop. All inputs are passed to SHREE2014_OpeningFcn via varargin.
% *See GUI Options on GUIDE's Tools menu. Choose "GUI allows only one
% instance to run (singleton)".
% See also: GUIDE, GUIDATA, GUIHANDLES
% Edit the above text to modify the response to help SHREE2014
% Last Modified by GUIDE v2.5 13-Apr-2014 14:11:54
% Begin initialization code - DO NOT EDIT
gui_Singleton = 1;
gui_State = struct('gui_Name', mfilename, ...
'gui_Singleton', gui_Singleton, ...
'gui_OpeningFcn', @SHREE2014_OpeningFcn, ...
'gui_OutputFcn', @SHREE2014_OutputFcn, ...
'gui_LayoutFcn', [] , ...
'gui_Callback', []);
if nargin && ischar(varargin{1})
```

```
gui_State.gui_Callback = str2func(varargin{1});
end
if nargout
[varargout{1:nargout}] = gui_mainfcn(gui_State, varargin{:});
else
gui_mainfcn(gui_State, varargin{:});
end
% End initialization code - DO NOT EDIT
% --- Executes just before SHREE2014 is made visible.
function SHREE2014_OpeningFcn(hObject, eventdata, handles, varargin)
% This function has no output args, see OutputFcn.
% hObject handle to figure
% eventdata reserved - to be defined in a future version of MATLAB
% handles structure with handles and user data (see GUIDATA)
% varargin command line arguments to SHREE2014 (see VARARGIN)
% Choose default command line output for SHREE2014
handles.output = hObject; % Update handles structure
guidata(hObject, handles);
% UIWAIT makes SHREE2014 wait for user response (see UIRESUME)
% uiwait(handles.figure1);
% --- Outputs from this function are returned to the command line.
function varargout = SHREE2014_OutputFcn(hObject, eventdata, handles)
% varargout cell array for returning output args (see VARARGOUT);
% hObject handle to figure
% eventdata reserved - to be defined in a future version of MATLAB
% handles structure with handles and user data (see GUIDATA)
% Get default command line output from handles structure
varargout{1} = handles.output;
% --- Executes on button press in pushbutton1.
function pushbutton1_Callback(hObject, eventdata, handles)
% hObject handle to pushbutton1 (see GCBO)
% eventdata reserved - to be defined in a future version of MATLAB
% handles structure with handles and user data (see GUIDATA)
% --- Executes on button press in radiobutton1. function
radiobutton1_Callback(hObject, eventdata, handles)
% hObject handle to radiobutton1 (see GCBO)
% eventdata reserved - to be defined in a future version of MATLAB
% handles structure with handles and user data (see GUIDATA)
% obj = videoinput('winvideo', 1,'YUY2_160x120');
```

```
% preview(obj)
% obj = videoinput('winvideo', 2,'YUY2_160x120');
% preview(obj)
% t = getsnapshot(obj);
% image(t);
% imwrite(t,'E:\fullfacebank\twof.jpg');
% save(twof.jpg)
im=imread('E:\fullfacebank\Picture 015.jpg');
imshow(im)
% Hint: get(hObject,'Value') returns toggle state of radiobutton1
% --- Executes on button press in pushbutton3.
function pushbutton3_Callback(hObject, eventdata, handles)
% hObject handle to pushbutton3 (see GCBO)
% eventdata reserved - to be defined in a future version of MATLAB
% handles structure with handles and user data (see GUIDATA)
im=imread('E:\fullfacebank\Picture 015.jpg');
p=ginput(2)
sp(1)=min(floor(p(1)),floor(p(2)));
sp(2)=min(floor(p(3)),floor(p(4))); sp(3)=max(ceil(p(1)),ceil(p(2)));
sp(4)=max(ceil(p(3)),ceil(p(4)));
mm=im(sp(2):sp(4),sp(1):sp(3),:);
s=imresize(mm,[256 256], 'bilinear');
figure; image(s);
imwrite(s,'E:\facebank\j.jpg');
save(j.jpg)
% --- Executes on button press in pushbutton4.
function pushbutton4_Callback(hObject, eventdata, handles)
% hObject handle to pushbutton4 (see GCBO)
% eventdata reserved - to be defined in a future version of MATLAB
% handles structure with handles and user data (see GUIDATA)
s1=imread('E:\facebank\pic1.jpg');
s2=imread('E:\facebank\pic2.jpg');
s3=imread('E:\facebank\pic3.jpg');
s4=imread('E:\facebank\pic4.jpg');
s5=imread('E:\facebank\pic5.jpg');
s6=imread('E:\facebank\pic6.jpg');
s7=imread('E:\facebank\pic7.jpg')
s8=imread('E:\facebank\pic8.jpg');
s9=imread('E:\facebank\pic9.jpg');
```

```
s10=imread('E:\facebank\pic10.jpg');
vec={s1;s2;s3;s4;s5;s6;s7;s8;s9;s10};
for i=1:length(vec) %disp(length(vec{i}))
dif=s-(vec{i});
if dif<=0
msgbox('MATCH FOUND,FACE RECOGNIZE')
hold
break
else
disp('NO MATCH, FACE NOT RECOGNIZE')
hold
end
end
% --- Executes on button press in EXIT.
function EXIT_Callback(hObject, eventdata, handles)
% hObject handle to EXIT (see GCBO)
% eventdata reserved - to be defined in a future version of MATLAB
% handles structure with handles and user data (see GUIDATA)
exit
```

Results :

Result of proposed work is represented diagrammatically. With the help of MATLAB software we are trying to find out solution of face recognition problem.

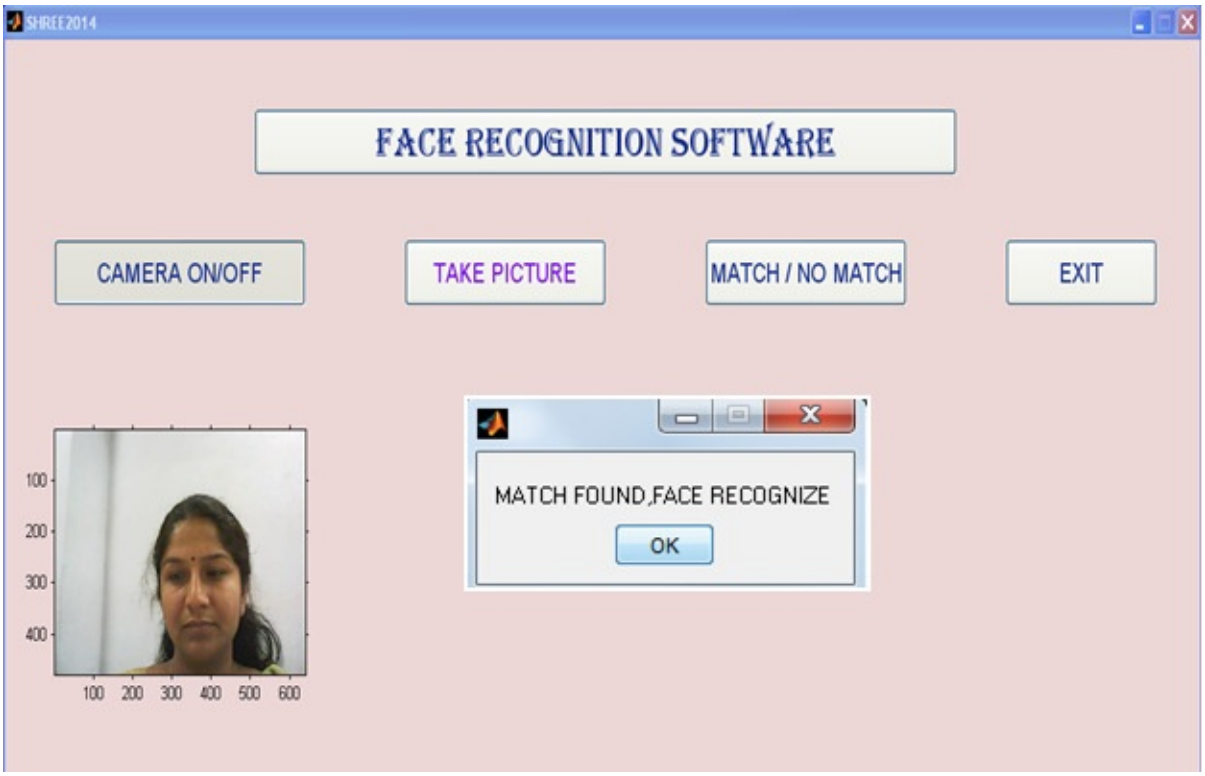

Fig.4.9.1 Output of face recognition software though GUI

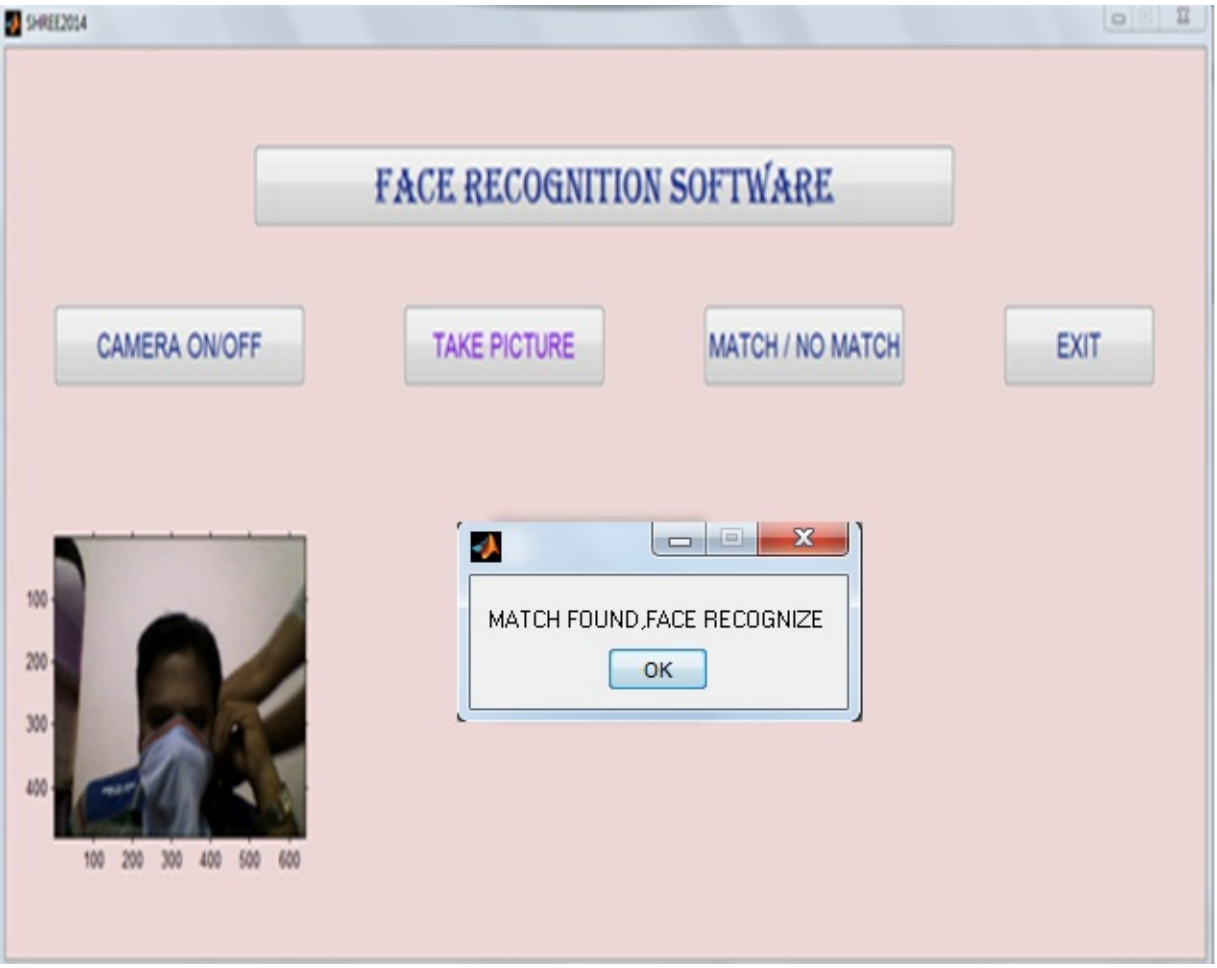

Fig.4.9.2 Output of occluded face with face recognition software though GUI

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[1]. A Practical Introduction to MATLAB. (n.d.). Retrieved from www.math.mtu.edu.
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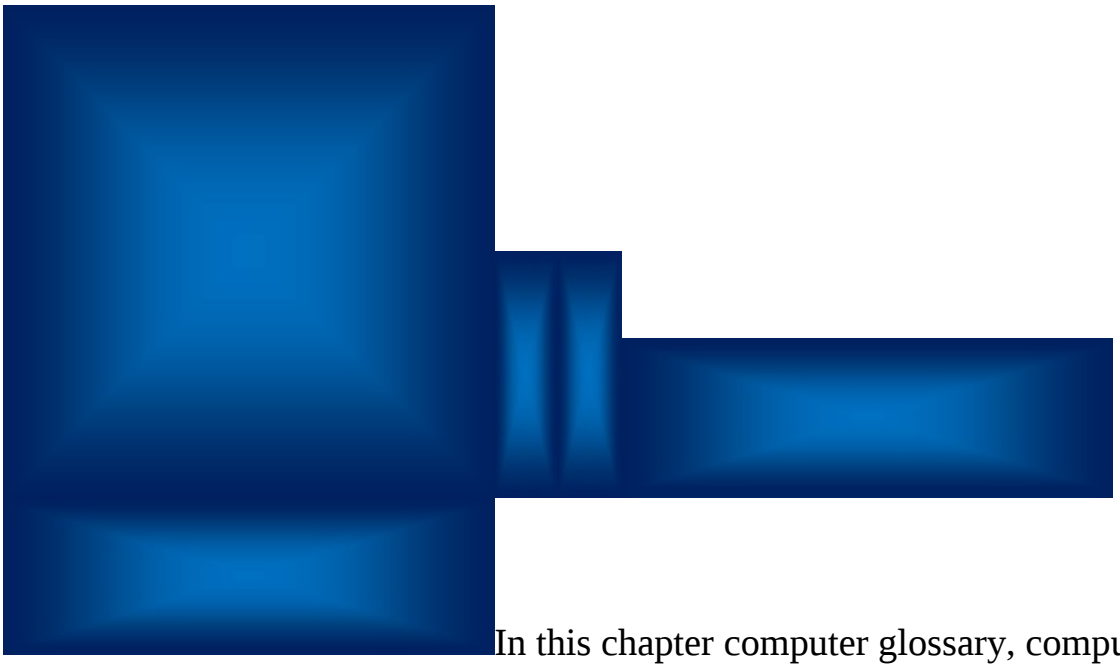
[7]. MATLAB You Tube. (n.d.). Retrieved from www.youtube.com.

CHAPTER – 5

INFORMATION TECHNOLOGY TERMINOLOGIES

 In this chapter computer glossary, computer terms are discussed. Some terminology are used in this thesis are as follows

5.1 COMPUTER TERMINOLOGY

Computer: Computer is a programmable electronic devise for processing data at high speed.

Program (application) : Set of instruction that you use to tell the computer what to do.

Algorithms: In simple words an algorithm is a step-by-step procedure for calculations. It is used for calculation, data processing, and automated reasoning.

Flowchart: Pictorial representation of an algorithm

Software : Collection of programs to achieve specific task. Software is a general term for the various kinds of programs used to operate computers and related devices.

Software Programs: a series of instructions that tell the computer hardware what to do; can also be the interface between the user and the computer system.

Hardware : The term hardware describes the physical aspects of computers and related devices.

Hardware: The physical components of the computer system eg keyboard, mouse, speakers *etc.*

Variables : Variable is a name given to memory location.

Concatenation: Concatenation is the process of joining small matrices to make bigger ones
Home Page: The main or introductory Web page for a site.
Cells: The rectangles created at the intersection of columns and rows
Field: A single category of data in a database.
Field Name: Label used to identify the data stored in a field.
Formula: An equation that performs operations on worksheet data.
Object: A table, form, or report that can be selected and manipulated as a unit.
Organization: A group of people working together to accomplish a goal.
Primary key: One or more fields in a table that uniquely identify a record
Standard: An approved model.
World Wide Web: documents that reside on computers on the Internet.
Data: A collection of pieces of information.
Information: Data that has been processed and is meaningful.
Data type: The attribute for a field that determines what type of data it can contain.
Database: An organised collection of related information.
Entity: The subject of the database or table.
System: System is orderly grouping of inter dependant component link together according to plan to achieve desire task.
Function: A predefined formula that performs calculations by using specific values, called arguments

5.2 IMAGE PROCESSING TERMINOLOGY

MATLAB: The MATLAB is nothing but a Matrix laboratory (Attaway)
GUI: GUI is a Graphical User Interface (Attaway)
GUI: Graphical User Interface - combines text, graphics and other visual cues to make software easier to use.
Intensity: The amplitude of *f* at any pair of coordinates is called intensity of the image at that point.

Gay Level Image : Term gray level is used to refer to the intensity of monochrome image. (Rafael C. Gonzalez, 2004/ REPRINT 2005)
Color Image : Color image is formed by combination of three individual images for ex. In RGB color system a color images consists of three monochrome images referred to as the red(R) green (G) and blue (B) primary or component images. (Rafael C. Gonzalez, 2004/ REPRINT 2005)

Sampling: Digitizing the coordinates values is called sampling (Rafael C. Gonzalez, 2004/ REPRINT 2005)

Quantization: Digitizing the amplitude values is called quantization (Rafael C. Gonzalez, 2004/ REPRINT 2005)

Digital Image : Converting any image to digital form required that the coordinates as well as the amplitude , be digitized thus when x, y and amplitude value of *f* are all finite , discrete quantities , then call the image a digital image. (Rafael C. Gonzalez, 2004/ REPRINT 2005)

Binary Image: A binary image is logical array of 0s and 1s.
Digital Image Processing: Digital image processing refer to processing digital image by means of digital computer. (Rafael C. Gonzalez, 2004/ REPRINT 2005)
Resolution (screen resolution) : It shows you pictures and stuff by making little dots glow in different colors. (Rafael C. Gonzalez, 2004/ REPRINT 2005)

Pixel : The smallest element of an image that can be individually processed in a video display system. Pixel is also referred to a picture element , image element , pels. (http://dictionary.reference.com/browse/pixel).Any digital image is composed of finite number of elements, each of which has a particular location and value. (Rafael C. Gonzalez, 2004/ REPRINT 2005)

Image Registration: It is process of converting one image in to coordinate system of another image because same size image can be compared with each other. (Rafael C. Gonzalez, 2004/ REPRINT 2005)

Histogram: Histogram is a graph of a frequency distribution in which rectangles with bases on the horizontal axis are given widths equal to the class intervals and heights equal to the corresponding frequencies. (http://dictionary.reference.com/browse/histogram+?s=t) **Histogram Equalization**: Dealing with discrete quantities, work with histogram and call the preceding techniques histogram equalization. In general, The histogram of any image will not be uniform, due to discrete nature of the variable. Histogram associated with the intensity level of given image. Default value in histeq is nlev=64. For the most part generally use the maximum possible number of levels 256for nlev value because this is true implementation of histogram equalization method. (Rafael C. Gonzalez R. E., 2010)

g=histeq(f,nlev)
ex . g=histeq(f,256)

Where f is the input image and nlev is a number of intensity levels specified for the output image

Cell array : A cell array is a kind of data structure that stores values of different types. Cell arrays can be vectors or matrices; the different values are stored in the elements of the array. One very common use of a cell array is to store strings of different lengths.
For example, reate a cell array in which one element will store an integer, one element will store a character, one element will store a vector, and one element will store a string. Just as with the arrays we have seen so far, this could be a 1 X 4 row vector, a 4X1 column vector, or a 2X2 matrix. The syntax for creating vectors and matrices is the same as before. Values within rows are separated by spaces or commas, and rows are separated by semicolons. curly braces are used rather than square brackets. (Attaway)

>>cellrowvec = {23, ‘a’, 1:2:9, ‘hello’}
=
[23] ‘a’ [1x5 double]… ‘hello’
To create a column vector cell array, the values are instead separated by semicolons:
>> cellcolvec = {23; ‘a’; 1:2:9; ‘hello’}

cellcolvec = [23]
‘a’
[1x5 double] ‘hello’

This method creates a 2 2 cell array matrix: >> cellmat = {23 ‘a’; 1:2:9 ‘hello’}

cellmat =
[23] ‘a’ [1x5 double] ‘hello’

by using cell array we design face bank with different pose
vec={f1; l1; r1;u1;d1; f2; l2; r2;u2;d2; f3; l3; r3;u3;d3; f4; l4; r4; u4; d4; f5; l5; r5;u5;d5};

5.3 IMAGE EXTENSIONS

JPEG : Joint Photographic Experts Group. It is easily compressed and is used for color images. JPEG compressed images are usually stored in the JFIF(JPEG file interchange format) file format. That’s why we select JPEG format for face bank images.

JPEG 2000: Joint Photographic Experts Group 2000. It is used in professional movie edition because of improvement in quality and compression ratio than JPEG.

BMP: Windows Bitmap.This is most commonly used in windows, It support 256 colors but does not support transparency. Widely used windows environment because of their simplicity.

GIF: Graphics Interchange Format. Compresses image files and supports only an 8-bit palette, or 256 colors.GIF format supports animation and provides image animation effects.
BMP: Windows Bitmap. More commonly used in windows environment, support 256 colors.BMP are uncompress so size is large.
PNG: Portable Network Graphics. The PNG format support true color(16 million colors. It is designed to work in online viewing applications.
TIFF: Tagged Image File Format. It is flexible format that saves 8 bit or 16 bits per color(RGB).TIFF images are widely used in photographs.
HDF: Hierarchical Data Format
ICO: Icon File
PBM: Portable Bitmap
PCX: Windows Paintbrush
PGM: Portable Graymap
PPM: Portable Pixmap
RAS: Sun Raster
XWD: X Window Dump
CUR: Cursor File

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CASE STUDIES

6.1 CONCLUSION OF CASE STUDY

In our thesis we explain how to recognize any face image by our algorithm but for recognizing images from CCTV footage require enhancement in picture quality. As we know in private and government sector various surveillance cameras are used but due to low quality of web camera, image are not recognized correctly, so we conclude in our case study that there should be proper enhancement in footage, so that image frame quality get enhance.

From video facial images are extracted due to uncontrolled condition of CCTV the images are not in clear condition for that purpose it is very essential to enhance CCTV video footage. By latest available technology video must be enhance so that the picture quality get improved. In video footage multiple images are in varying angles for this face bank must contain each and every angle of facial images. Face image must be enrolled.

Fig.6.1.1 CCTV Detecting Face

In our case study it is fond that video footage taken by Chandrapur Police are not by night vision camera that's why we are not able to detect thief so it is very essential to ensure that the surveillance camera is of both type night vision as well as day and place in proper position with varying angles.

In case study Jain Temple burgled in Bhadrawati (Dist. Chandrapur) on dated 25 July, 2011 is taken in to consideration , We are trying to convert some video clips in to jpeg format so that image obtain from that video clip is enhance by using MATLAB program to get better result. (Gonzalez, Jul 2008)

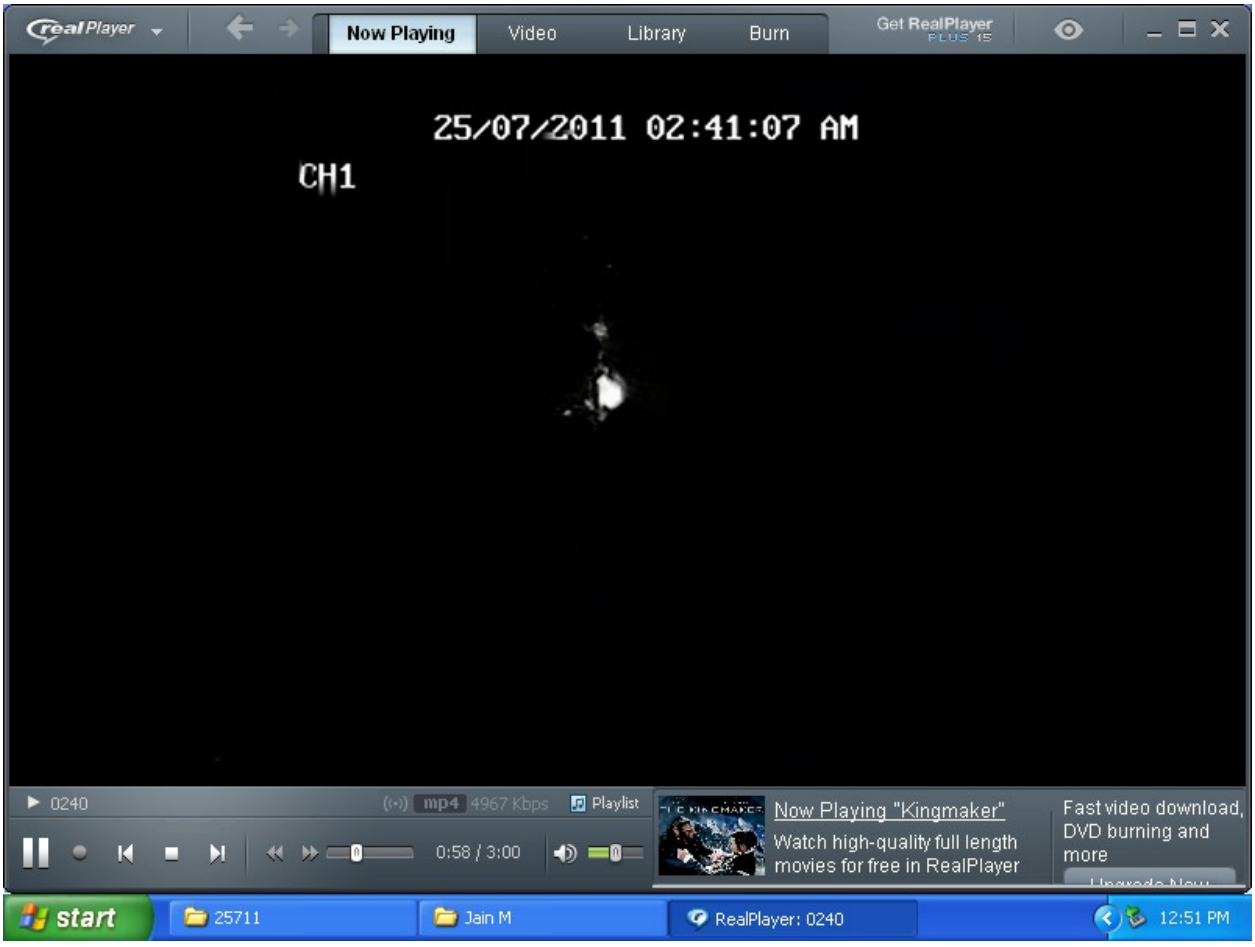

Fig. 6.1.2 Jain Temple burgled in Bhadrawati (Dist. Chandrapur) on dated 25 July, 2011

If the above video clips are taken by night vision camera or by latest infrared illuminator surveillance camera than it is very easy to find thief, but the footage is day vision that why the picture not identified. For best result we require latest enhance quality footage and face bank gallery contain samples of known thief face images.

Thus by using face recognition for authentication chances of forgotten password minimizes as we know that face cannot be stolen, forgotten, lost anywhere, or given to any another person so it is best suitable option for verifying an individual with their unique face features.

FRT can successfully perform task if images taken in proper conditions. We do case study to understand strengths and weaknesses of currently available face recognition system. For that need to take picture during day time by surveillance camera and their recognition rate and picture taken during night time by night

vision camera and their recognition rate must be consider for better result. Need to do changes in surveillance security system for enhancing result of recognition. Now a day latest infrared illuminator surveillance camera create day like environment during night , it is also good for face recognition, may our government and privet sector use such system.


Fig. 6.1.3 Latest Infrared illuminator surveillance camera create day like environment during night (http://en.wikipedia.org/wiki/Facial_recognition_system)

To enhance an image various process like image normalization, image restoration, histogram, noise removal techniques, image filtering, image sharpening, color image smoothing, transformation, image registration, image segmentation process are mention in digital image processing hence here we apply some techniques on image before they process.(Gonzalez, R. C.)

In our investigations it is found that various issues like pose, occlusion, and resolution, age etc barrier to face recognition, so there have been significant advances made in face recognition technology to assist law enforcement agencies. Our algorithm perform best task of image base face recognition but for video base face recognition need enhancement, require low resolution database. In this work we present a case study in unconstrained facial recognition, using public domain images.

6.2 CASE SURVEY

Different face recognition case are studied, In literature various fact found on this topic, mostly all public domain images is difficult to recognize because of varying scenarios for efficient working of face recognition system surveillance camera must be kept in proper position with proper angle. Public domain images is of low resolution for that separate database of low resolution images required and camera used must be of high definition because by normal camera public domain images blur and difficult to recognize , due to blurring pixel value get changed and identification process become difficult. According to (Joshua C. Klontz, Technical Report MSU-CSE-13-4 Last Revised May 30, 2013) in their

experimental results show one instance where a commercial face matcher returns a rank-one hit for suspect Dzhokhar Tsarnaev against a one million mugshot background database. Though issues surrounding pose, occlusion, and resolution continue to confound matchers, there have been significant advances made in face recognition technology to assist law enforcement agencies in their investigations. Facial images and videos released by the FBI of the two suspects in the Boston Marathon bombings (Joshua C. Klontz, Technical Report MSU-CSE-13-4 Last Revised May 30, 2013)Suspect 1,Tamerlan Tsarnaev, is wearing a black hat. Suspect 2, Dzhokhar Tsarnaev, is wearing a white hat. Enhance images of both suspects given below

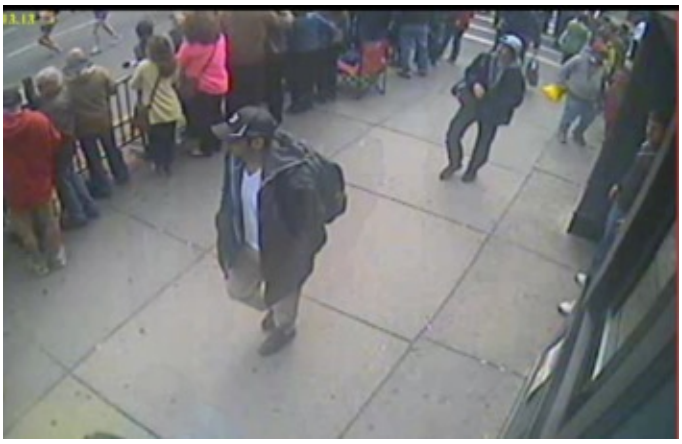

Fig. 6.2.1 CCTV Footage of Boston Marathon bombings (Joshua C. Klontz, Technical Report

MSU-CSE-13-4 Last Revised May 30, 2013)

Fig. 6.2.2 Two suspects caught on CCTV Camera, 1st wearing white hat and second wearing black hat (Joshua C. Klontz, Technical Report MSU-CSE-13-4 Last Revised May 30, 2013)

In published report mention that law enforcement published photographs of suspect caught on CCTV cameras they give news of footage with the quite hope that witnesses would come forward to identify the suspects. Because automated facial recognition technology was totally unsuccessful in providing positive identifications. For such issues necessity of best recognition system with availability of all possible criminal face images must be kept in face database for successful automatic face recognition. In UK CCTV is enhance and widely used (http://www.cctv.co.uk/)

Our algorithm may be useful to detect thief if we include criminal picture record in our face bank and for that it will must for government and private sector that they should use latest available CCTV for security purpose, by this method we can be definitely able to avoid crime. Our algorithm can recognize high as well low resolution image in very short time and low resolution image require less space as compare to high so definitely recognition of low resolution image is faster than high. Footage frame is generally of low resolution. MATLAB can perform very good task on low resolution image too. So by using MATLAB software our KSM algorithm perform enhancement in face recognition. (Pratab, R. (2004)).

At last we conclude that enhancement in CCTV footage is very essential in today environment. CCTV is a very efficient tool for finding crime. CCTV provides a fantastic footage that can be used to provide evidence against theft, burglary. CCTV in Business and Home provide safety monitoring system. Today environment require effective safety monitoring system for business and home too because of day time and night time fraud occurrence increases day by day. In business, loss due to consequence crime is increased to avoid such thing and finding thieves by using latest technology. Unauthorized person damaging other properties in that case need exact CCTV footage with the help of that police can easily do their task.

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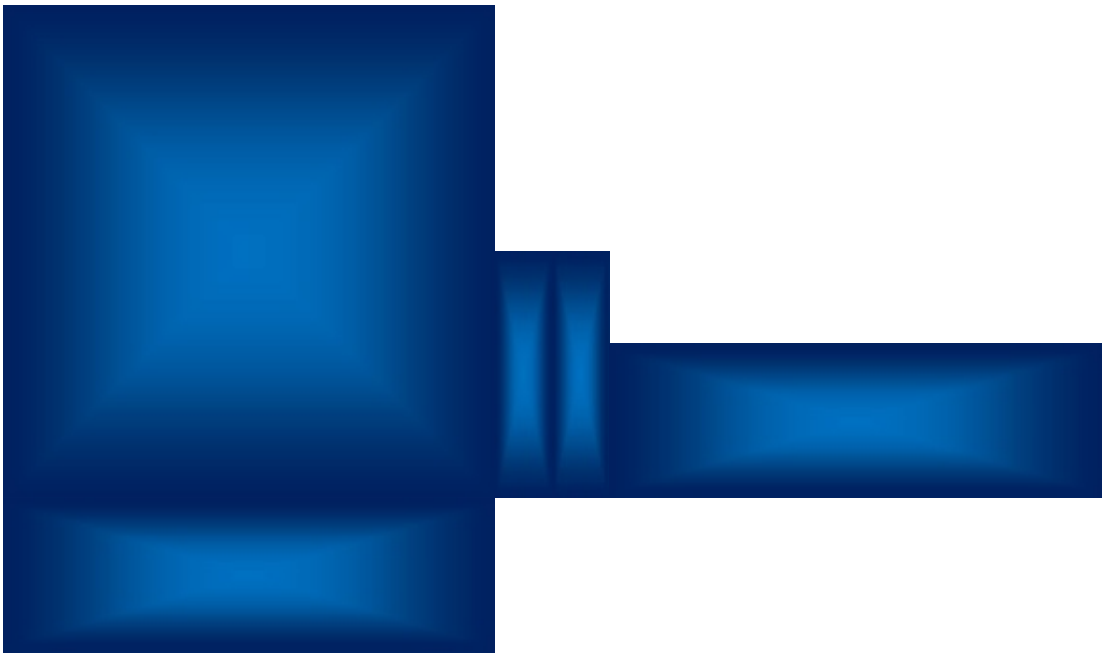
CHAPTER – 7

LIMITATIONS OF EARLIER RESEARCH



7.1 LIMITATIONS

• Resource constraint: Now a day various software's are available in market as well as latest hardware too. But unavailability of expensive software resources it couldn't be possible to cover all the aspects of face recognition.

Data reliability: Face database available on net is not so good for all. The data• collected may not be sufficient to identify any face picture.
• Data storage constraint.: Fata bank with all possible pose of face is must for identification

• Knowledge constraint: Differences opinion of various people regarding finger print recognition with face recognition. Consumer acceptance for new system is one of powerful constrain.

7.2 SCOPE

• Over the last ten years or so, face recognition has become a popular area of research in computer and successful applications of image analysis. Because of the nature of the problem, not only computer science researchers are interested

in it, but also neuroscientists and psychologists .

• Due to resource constraints there is scope for further research. There are many things which might have done differently if more time, money or technical assistance has been provided. Such limitations will enable the reader to understand how far the results of the research are dependable.

• This algorithm may be implemented for different applications using various software available.
• In today environment security is main thing for public as well as private sector so they may used such system to secure anything that is important.
• Verification of student during examination is possible by our algorithm.

CHAPTER – 8

CONCLUSION

Here we concluded that proposed algorithm can recognize face very effectively and also cover two main challenges of face recognition i:e the changes in pose and the half face portion occlusion. For security management government and private sector use lot of amount still there is weakness in security management. Recent terrorist attack exposed it very clearly so to enhance management and security infrastructure various digital signal processing tool used in this research method. By using digital image processing platform, MATLAB

software, implement proposed KSM algorithm and by using proposed KSM algorithm enhancement in recognition rate and minimizes redundancy. Low cost software and easy to handle (portable) is one of the advantages of our application software. For best result of our algorithm proper lighting and enrolling a face in face bank database. Thus our system recognize face in real time, we have verified our result with existing algorithm using LAB

view software. We show Z test for result analysis.

In this chapter, the chapter wise summary of the research work, future work for further research in various applications is mention.

As we know our Id cards, passwords can be lost but face is connected part of our body so he/she can be verified with the help of their face. Due to resources constraints over the last years or so far face recognition has not successfully implemented but now but due to the development of new software and hardware

technology it is possible to logging into systems and mobile with the help of our face. We are providing an up-to-date critical survey of image
- and video-based face recognition research.

Generally in any real life face recognition tasks, one should have to handle a huge amount of facial information but here processing every piece of information as a single feature vector is possible. Hence we tend to find match from single vector contain forehead features of each individual so the huge amount of unwonted information contained in any face is reduced. Hence redundancy of data can be avoided by this method.

Here we applied our algorithm in sample face bank database and found desire results.

If low resolution image database is used then also give better result, it is helpful for identifying any face taken by surveillance camera.

We use MATLAB software to implement KSM algorithm, because here many tools are available for image processing, like after image registration we can easily find size of each registered face image by simply typing size(variable name) also by length(vector name) display length of vector that means it give result as 50 as our database contain 50 face images.

By typing

>>vec command on command prompt it gives result as given below. For any type of matching all images must be in same size so we resize all images to 256/256 size.

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

[256x256x3 uint8]

In existing methods of analytical face recognition systems, features like eyes, nose , mouth where used as feature point but in our system we used forehead region. Maximum face recognition rate is 80% using Lab view software, our algorithm give enhance result than other. Likewise time require for recognizing face is also low as compare to other algorithm.

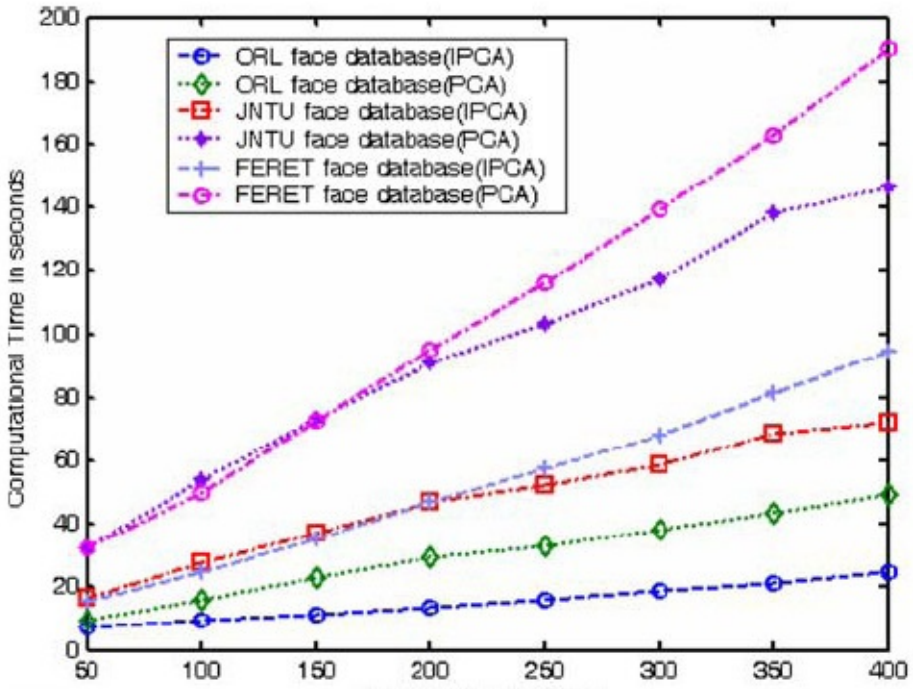


Fig. 8.1 Computation time for PCA and IPCA (Reddy, 2007)

Database size (50)

Computation Time in

(Algorithm)

Second

FACE BANK(KSM)

5
ORL (IPCA)

8
ORL(PCA)

9
JNTU(IPCA)

19

JNTU(PCA)

18

FERT(IPCA)

32

FERT(PCA)

33

Table 8.1 Computational time comparison of KSM, PCA and IPCA (Reddy, 2007)

Computation Time

Fig. 8.2 Computational time comparison of KSM, PCA and IPCA (Reddy, 2007)

We conclude the thesis with proposed KSM algorithm. The proposed algorithm require less computational time as compare to PCA and IPCA so the algorithm may useful in the government and private sector for security purpose. We implement the algorithm by MATLAB software, and result compare with LAB VIEW software. In literature study maximum recognition rate of analytical, holistic and hybrid approach is below 80 % using different face database. In our work enhancement in recognition rates to 86% and also require less time, we

also solve two challenges i:e occlusion and pose and give better result than existing algorithm. We show output of graphical user interface program.

8.1

CHAPTER WISE CONCLUSION OF RESEARCH WORK

INTRODUCTION

In introduction chapter

we

give

importance

of

face

recognition in today's

environment and mention our aim and objective of the research, show block diagram of propose face recognition technique and proposed algorithm, design flow chart for the proposed face recognition algorithm, features of our algorithm, overview of face recognition system, recent applications of face recognition and formulate of problem of the research by knowing challenges of face recognition.

LITERATURE REVIEW

For any research literature study is must we also **c**onduct literature survey on face recognition using machine. For that we refer IEEE papers, Google documents, conference proceedings and websites and books. Due to widely available of technologies today face recognition has several applications ranging from banking, static matching of photographs as in mug shots matching and credit card verification to surveillance video images. Mostly all face recognition system is depend on existing dataset(ex.ORL face set, Yale face set, PIE

face set etc) *etc*. In literature various face database are found but in this research

new face dataset is design for testing. As we mention in introduction we use feature base approach so our face bank contain only forehead features that's why we use our own database for tasting.

By observing existing percentage of face recognition algorithm, we developed an SKM

algorithm by using innovative ideas for feature selection, as we know face is dynamic but we study that some feature of face like centre of two eyes that is forehead region is stable matrix, so we retrieve only selected portion of face image and used for matching and it gives better results.

RESEARCH METHODOLOGY MANAGEMENT

Hear we mention meaning of research methodology, it is nothing but system of

models, procedure and techniques to find the results of a research problem. It facilitates smooth running of various operations, thereby making research as efficient as possible, yielding maximum information with minimum expenditure of effort, time and money. If a method/algorithm producing a quick response, then the user's task will be completed by consuming less energy.

Research design stands systematic planning of the methods adopted for collecting the relevant data and technique to be used in analysis keeping in view the objective of the research.
of work was decided earlier this criteria is very important for achieving goal. Actual method of research, steps involve in research is mention section wise. Chapter theme is given as, planning include analysis, organizing include facial database handling, comparison include software,

algorithm,

database,

system

design,

system

implementation

implementation,

controlling

is

discussed.

FACE RECOGNITION TECHNIQUES

How face recognition software work which techniques used for implementation and in which software is given in this chapter. Face image of an individual's face, is matched to a pre-existing image on-file "face bank" associated with the claimed identity (the verification task). In face-recognition systems, images captured by digital camera are simplified down to the salient features and turned into strings of numbers. As the computer captures new images and simplifies them it can compare them against the strings in inventory.

INFORMATION TECHNOLOGY TERMINOLOGIES

To understand any document one should know the terminology that's why we give sort of definitions to make our thesis easily understandable so in this chapter we mention various terminology used in this thesis we divide terminology in three part to make it clear first computer terminology second image processing terminology and third is long form of extension used in thesis.

CASE STUDY

In Bhadrawati (Dist. Chandrapur) Jain Temple burgled on dated 25 July, 2011

study is taken in to consideration, we are trying to convert some video clips in to jpeg format so that image obtain from that video clip is enhance by using MATLAB program to get better result. By this method, we are trying to recognize a face in that video clip.

We are analyzing, what types of tasks can earlier FRT successfully perform, and under what conditions? What are the known limitations on performance? For that we prepare frames on an image and after word process it but we concluded that due to unavailability of night vision camera we are not able to recognize picture very clearly, so government and privet sector must enhance video clipping for better results, it will help to minimize fraud occurrence in market

and any other public places.

Here we also study other case studies in their published report mention that law enforcement published photographs of suspect caught on CCTV cameras they give news of footage with the quite hope that witnesses would come forward to identify the suspects.

Because automated facial recognition technology was totally unsuccessful in providing positive identifications. Means they found that face recognizer software not able to recognize face due to low resolution image, but by using our algorithm it is possible to recognize blur, low resolution image too.

LIMITATION AND SCOPE OF THE RESEARCH
LIMITATIONS

Limitations of existing system give birth to new inventions as there are many thing that are not solved we are trying to solved the unsolved problems though due to various resource constraint like unavailability of resources it couldn’t be possible to cover all the aspects. We work on sort of data so data reliability is one of important limitation, sample data collected may not be sufficient to depict real picture. Data storage constraint means require more memory space to store large amount of data. It depends on machine and software.

Software

work is

not

independent

it

is

always

depend on electricity

and hardware.

Knowledge constraint is one the limitation opinion of various user is different with their personal interest. Now almost various sector and systems are user friendly with thumb recognition though it has various drawbacks to accept new system require understanding about new things.

SCOPE

The proposed algorithm can be used for various applications to enhance security system. Due to availability of latest technology research can be further extended. Hardware expert can design hardware model to implement proposed algorithm or may introduce new pattern in proposed work. Over the last ten years or so, face recognition has become a popular area of research in computer and successful applications of image analysis. Because of the nature of the problem, not only computer science researchers are interested in it, but also neuroscientists and psychologists. Due to resource constraints there is scope for further research. There are many things which might have done differently if more time, money or technical assistance has been provided. Such limitations will enable the reader to understand how far the results of the research are dependable. This algorithm may be implemented for various applications using different software's available. In today environment security is main thing for public as well as private sector so they may use such system to secure anything that is important by using our algorithm. The algorithm is very simple so one can easily make model for any type of system that require online security.

8.2

FUTURE WORK

•

Student identification will enhance using face recognition software. Students face bank will help to identify any student in examination hall.

•

For crime prevention face recognition software will help for detecting crime.

•

Our algorithm will enhance security system in bank. Face play very essential role because of unique face of each individual. In bank face id proof minimizes misbehaviors.

•

Many time a single person vote in different vote center by different name and with different fraud identity proof but by using face as id it will be control and it is very essential thing for betterment of society.
•

Now a day's almost all people have camera equipped mobile phone, they may use such software for their mobile security.
• In future by using our algorithm possible to design face identification software model,

it will help to find criminal. For the efficient working of software model, clips are taken by enhance quality day vision camera than it will very easy to find thief, but the face bank gallery must contain samples of known thief face images.
•

Daily attendance can be possible by using our algorithm.
• Various

systems

require

verification task

our

algorithm

also help in such

verification and identification task.
• In this work we use 50 sample faces in face bank database, it will be extended in future.
• Financial transaction security will be done using face recognition. Identity theft is big issue to avoid such matter every transaction can be secured with the help of face identity proof. In financial record or personal property record face play very important role your face used to show that you are you, the face results better than your finger prints authentication.

•

Resellers, in area where there is problem of reselling, with the help of electronics media then in such case face provide high security than others biometrics. In market face identification will be widely used for electronic media.

•

In healthcare, many time wrong medicine is given to wrong person , record get mixed because of manual identity proof, so it will help to recover such behavior by using face as best identity proof of each patient.

• Airport security: In future modern face biometrics algorithm provides reliability and ability to authenticate with powerful accuracy then existing methods.

• Police may use criminal database and use this algorithm for identification of suspect from crime video scene, due to explosion of available crime scene videos, because of availability of high definition mobile phone throughout the world hence in future our algorithm will be helpful in criminal investigations.

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APPENDIX

Appendices constitute supplementary material to the report. It includes Hardware and software requirements for research work, Introduction to MATLAB, Basic MATLAB command, review of available face database, our papers and conference details, workshop & seminar attended, glossary of terms used in the report which supports the contents of the research, course work on research methodology.

- Hardware and software requirement,
- Software details -Introduction of MATLAB
- Basic MATLAB command used for writing programme
- Face data bases
- Papers Details (National papers / International papers)
- Conference Details (National conference / International conference)
- Doctoral research meet report and their certificates
- Workshop & Seminar Details
- Other illustrative material and glossary of terms used in the report which supports the

contents of the research & course work on research methodology.

Hardware and software requirement

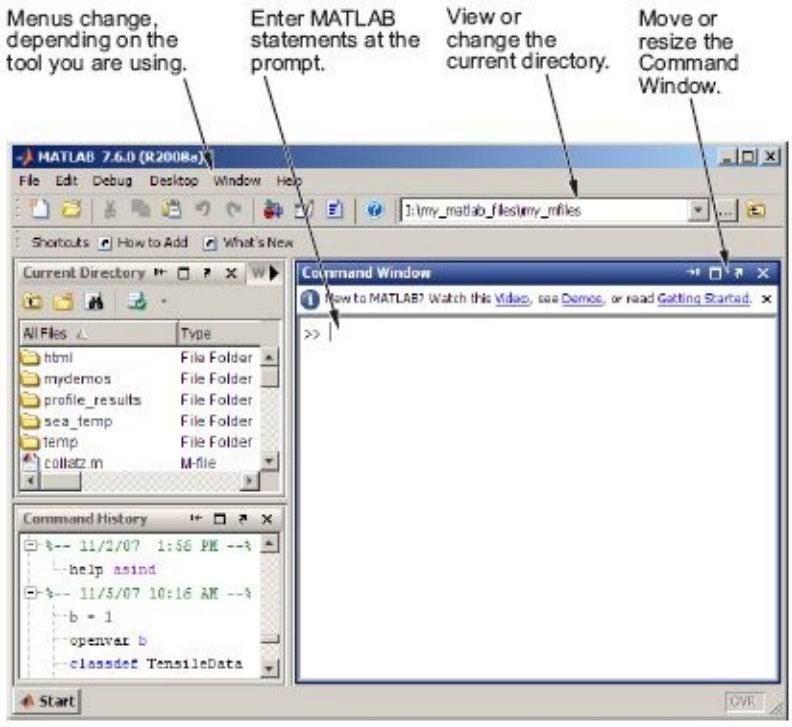
As this research requires analysis of huge data, the following equipments are required:

- Intel Pentium 4 processor based computer with color monitor
- Computer or Laptop with RAM 1Gb, Hard Disk 80 Gb
- Internet facility, Web camera.
- MATLAB Software
- Web camera software
- Ms-office software for excelling of data

• Media Player software (VLC, Real Player)

Hardware details
Laptop contain in build web camera of high configuration.
Software details

Introduction To MATLAB: (Attaway, Copyright © 2009, Elsevier, Inc. All rights reserved) The name MATLAB stands for matrix laboratory. MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. It allows us to solve many technical computing problems.
Let see basic of MATLAB



MATLAB Window

Basic MATLAB command used for writing programme

Clear window(clc)
>>clc
Directory Listing(dir)
>>dir('d:')
>>dir('d:\abhi')
Making Directory (mkdir)
>>mkdir dirname
Another directory in dirname directory

>>mkdir dirname abc

Print working directory(pwd)

>>s=pwd

s =

C:\Documents and Settings\Administrator\My Documents\MATLAB **Changing Directory(cd)**

>> cd('d:\abhi')

The directory pathname can also be stored in a string by putting output variable to cd >> pathstr=cd('d:\abhi')

pathstr =

d:\abhi

without any parameter , cd is equivalent to pwd

>> cd

d:\abhi

Copying files(copyfile)

>>copyfile('d:\abhi.txt' , 'd:\om\abhi.txt');

If we want to copy a file from root directory to subdirectory we use above command >>flg=copyfile('d:\abhi.txt' , 'd:\om\abhi.txt');

If flag has value 1 , the copy was successful.

Deleting file(delete)

>>delete('d:\ab\abc.txt')

Delete file from current directory

>>delete('abc.txt')

Use rmdir to delete directories.

>> rmdir('d:\ab')

If we familiar with DOS command then we can run them in MATLAB by prefixing ! before the **system command name**

>>!dir

Volume in drive D is Office Data

Volume Serial Number is D820-E250

Directory of d:\abhi

09/14/2012 10:22 AM 9,660 download (9).jpg

09/14/2012 10:20 AM 8,256 download.jpg ….

14 File(s) 129,273 bytes

2 Dir(s) 80,809,689,088 bytes free

Saving command of matlab session(diary) >> diary aug12.2005
>> diary on
>> diary off

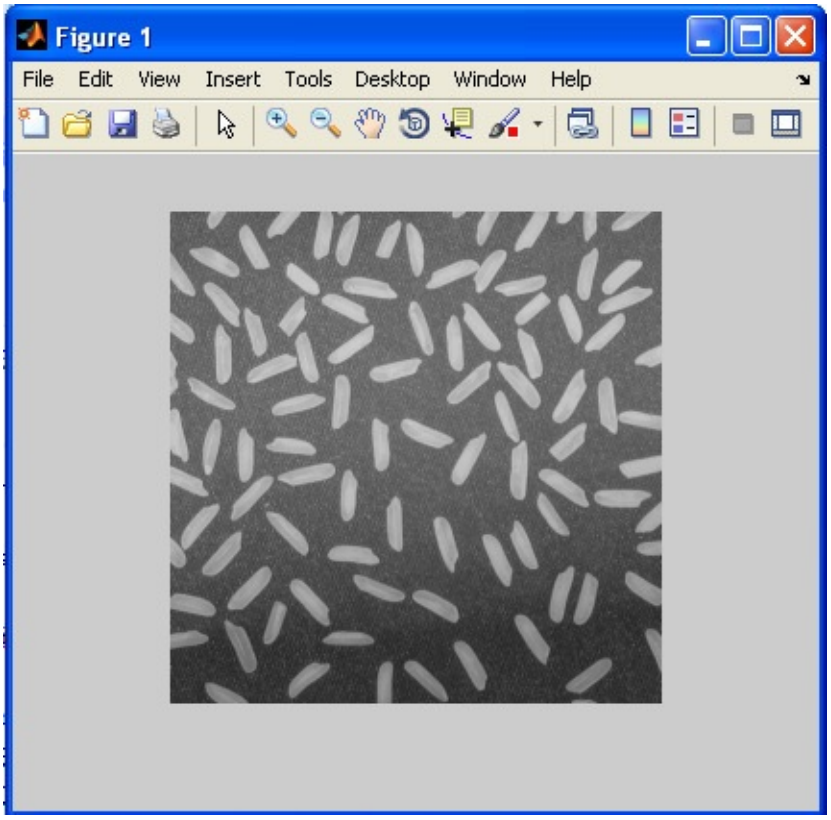
MATLAB Command for Image I/O and Display
Images are read into the MATLAB environment using function imread. Whose basic syntax is
Imread('filename')
>> f= Imread('abc.jpg');
Read the image from the jpg file abc into image array f
; for suppressing output
Images are displayed on the MATLAB desktop using function imshow,
Syntax
>>imshow(f)
To keep the first image and output a second image use fuction figure, as follows
>>figure, imshow(g)
Image are written to the current directory using function imwrite
Syntax
>> imwrite(f, 'filename')
For JPEG format
>> imwrite(f, 'filename.jpg', 'quality', q)

Where q is an integer bet 0 and 100 (lower the number the higher the degradation due to jpeg compression).
>> imwrite(g, 'filename.tif', 'compression ', 'parameter',…'resolution',[colres rowers])) Where ' parameter ' can have on of the following principle values:
'none' indicte no compression ;
'packbits'(the default for non binary image), 'lwz' , 'deflate',
'jpeg','ccitt'(binary images only; the default),'fax3'
colres column resolution
rowers row resolution
default value is [72 72]
Saving and loading a data file
>> save
Saving to: matlab.mat
>> load
Loading from: matlab.mat
Closing Matlab(quit)
>> quit

To Read Image

Example:
>> imdata = imread('ngc6543a.jpg');
To display image on matlab window
>>imshow(imdata)

Example
>> I = imread('rice.png'); >>imshow(I)



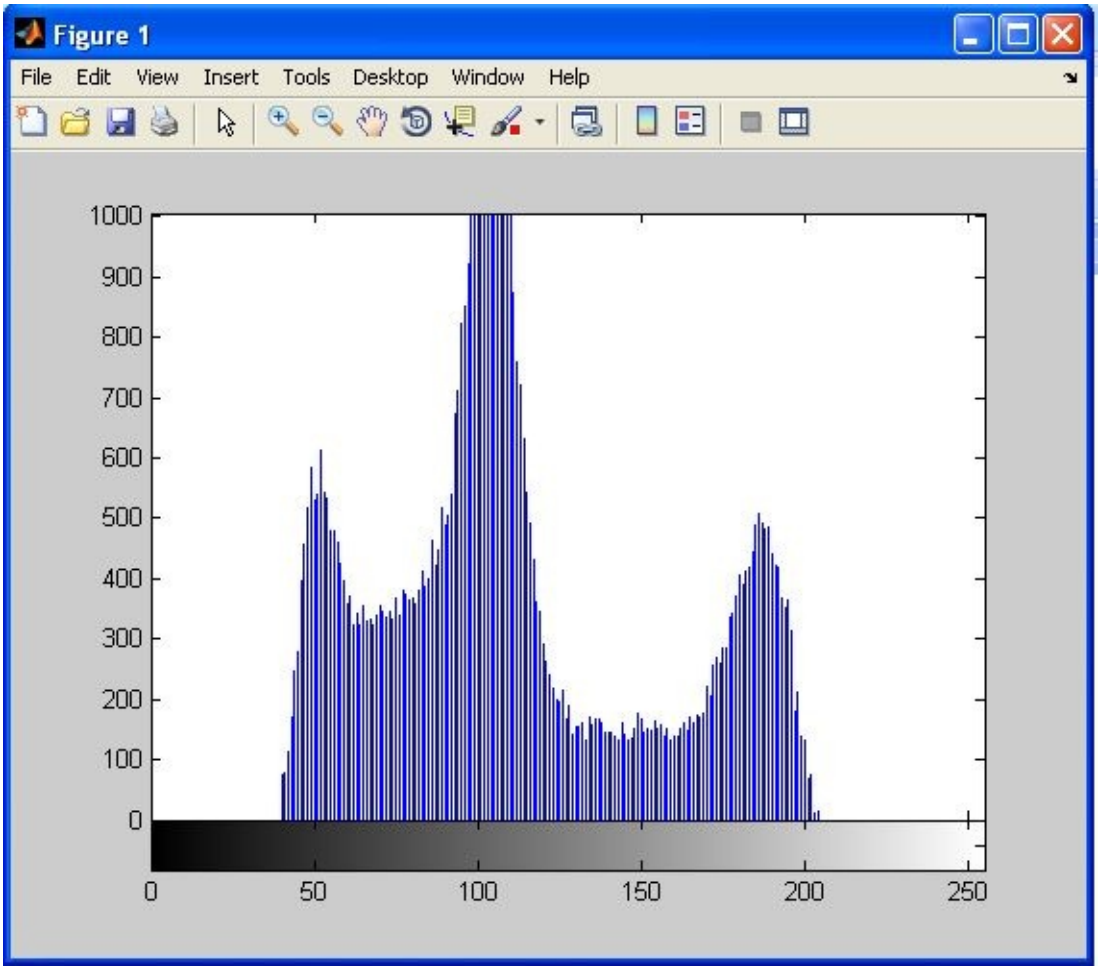
[...] = IMREAD(FILENAME) attempts to infer the format of the file

from its content.
[...] = IMREAD(URL,...) reads the image from an Internet URL. The

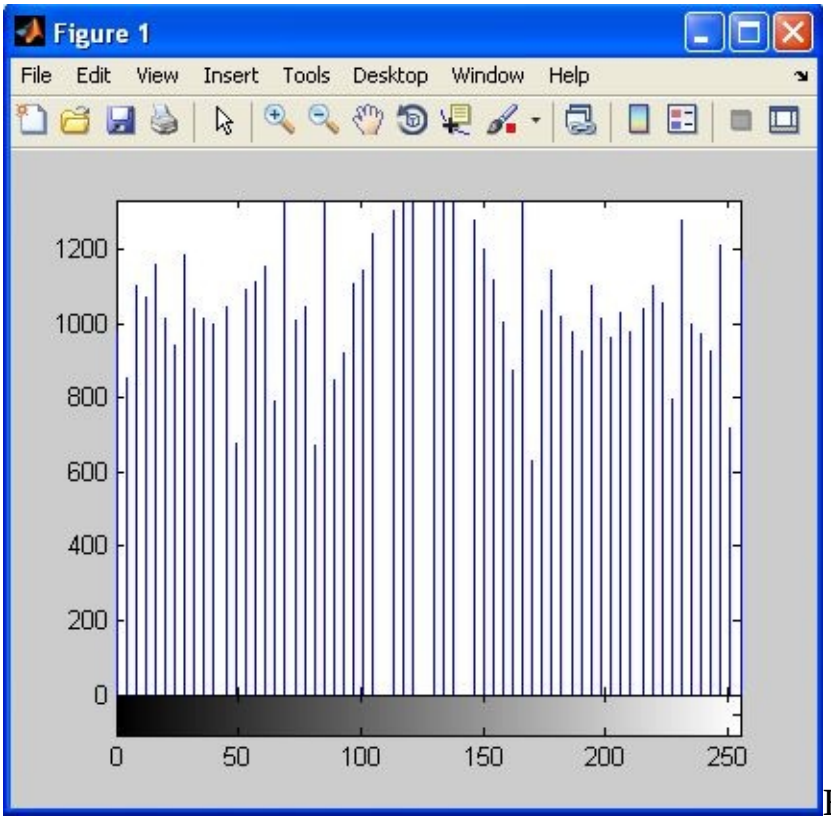
URL must include the protocol type (e.g., "http://").
Histogram is generally used for gray image hence to obtain histogram first we have to convert color RGB image to gray image by command
>>rgb2gray()

To show histogram command imhist

To show histogram command imhist
>>imhist(I)

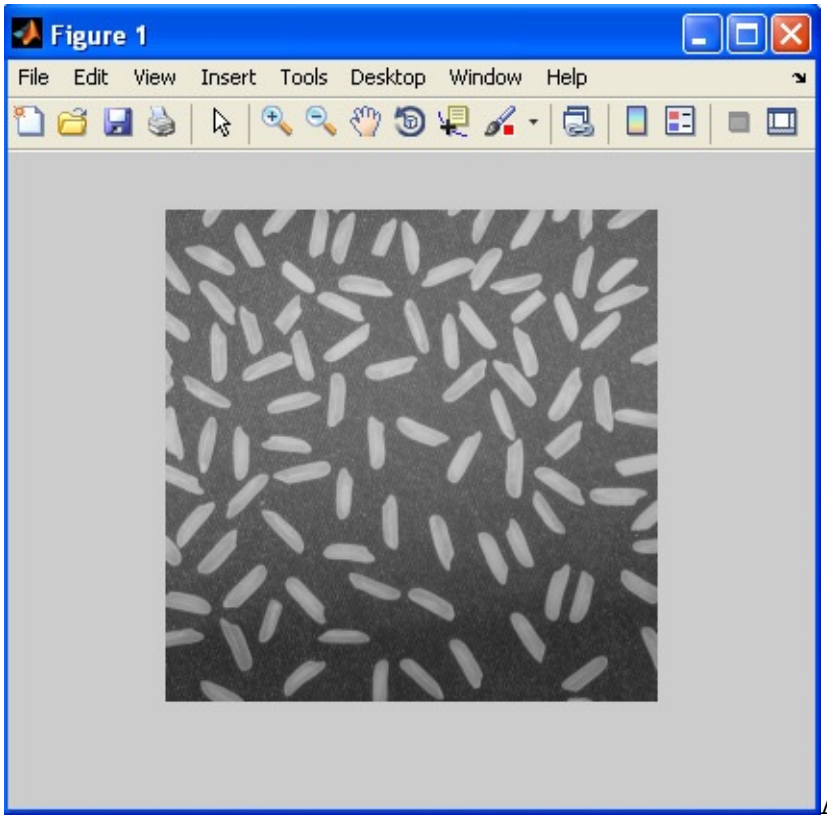


To show histogram equalization
>>J=histeq(I)



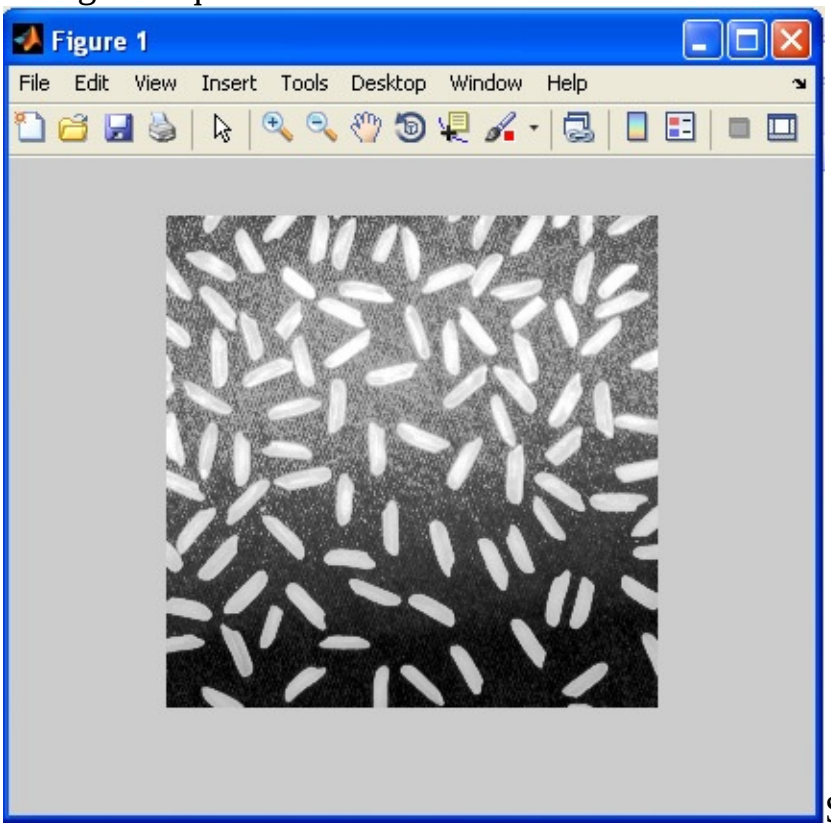
Before histogram equalization

>>imshow(I)



>>imshow(J) After

histogram equalization



Some Format-Specific Information (Listed Alphabetically by Format)

Data Types In Matlab

• SCALARS: This includes integers, complex number, floating point number
• CHARACTERS: Any alphanumeric symbol enclose in single quote ‘A’, ‘5’,’+’
• ARRAYS: An array is a list of similar data in a single row or column form. The

element of array can be all numeric or character or string but they cannot be mixed up.
An array in 2dimention is know as matrix
Array is written in square brackets enclosing its element separated by commas or spaces.
[2,4,5]
[‘abc’,’hjk’] etc

• STRING: String is basically array of character ‘ijk’ equivalent to [‘I’,’j’,’k’] . any two or more alphanumeric symbol enclosed in single quote is a string data
• CELL ARRAY: Cell array is a special type of arrays , where the element can

be of different data type. They are written using braces{‘teret’,45,’fsdgsdgs’}. A cell array can contain other cell arrays as its elements.
• STRUCTURES: A structure is also a different data type to store various related data types using meaningful field name
Ex: struct(‘village’ ,‘warora’ ,‘distance’, 45 ,location ,’road’)

VARIABLES : Name to represent a data is known as a variable
• Variable name begin with letter followed by other letters , digits and underscore
• Length of variable should be 1 to 32
• Variable name are case sensitive
• Keyword & program name should be avoided as variable name
• Variable name should not clash with the name of an already existing function
Ex : std_dev,avg1

To test variable existence
>>which what
What is a buld in function >>which when
When not found
You can use when as variable name
Keywors(iskeyword): display list of keywords
>>iskeyword

Ans= 'break' 'case'
'catch'
'classdef' 'continue' 'else'
'elseif'
'end'
'for'
'function' 'global'
'if'
'otherwise' 'parfor'
'persistent' 'return'
'spmd'
'switch'
'try'
'while'

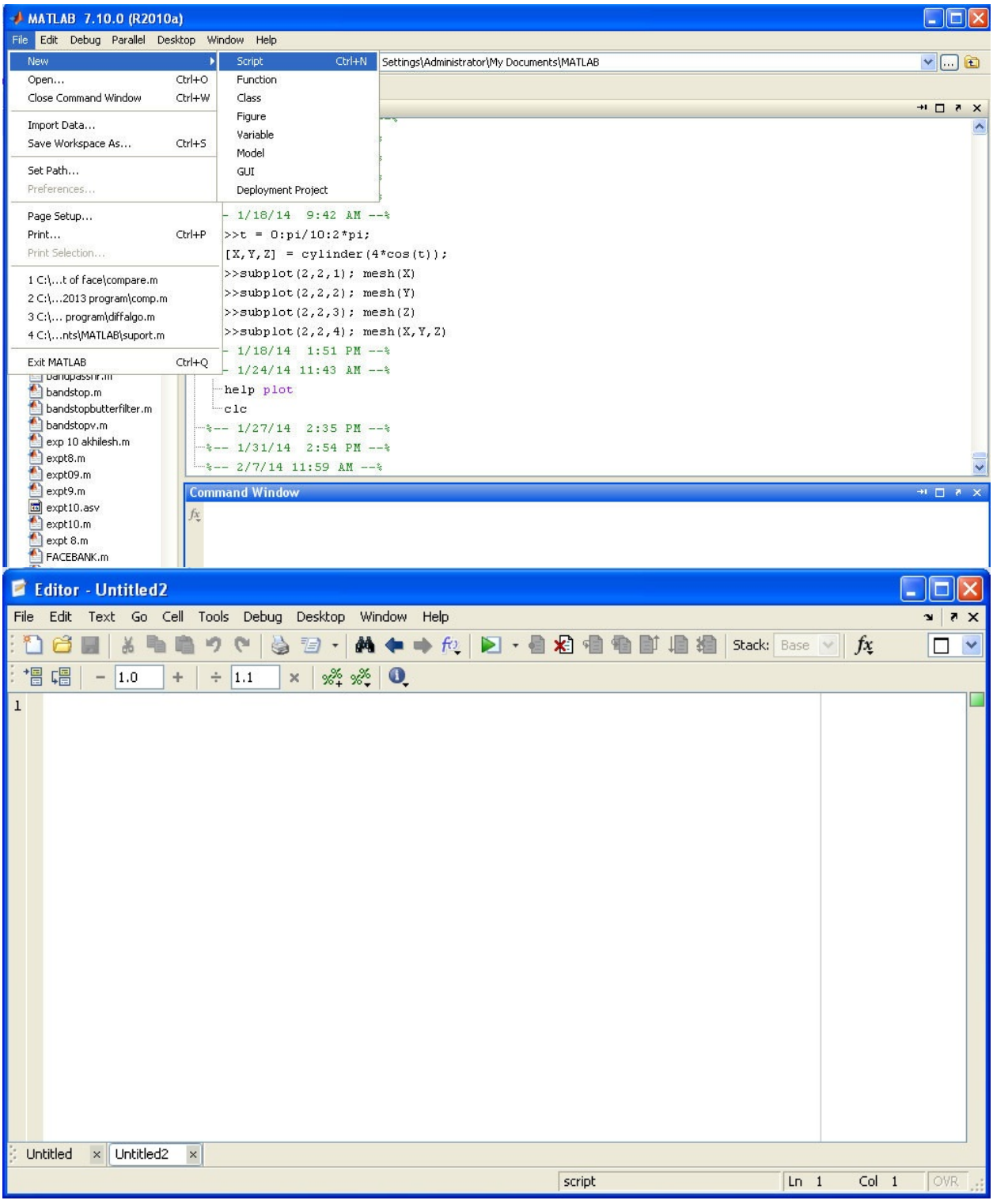


Fig. Editor Window for script writing i:e(MATLAB program) (file-new-script-.m)

Assignment statements

>> a=10
a =

10
>> disp (a)
10

semicolon ; is used to suppress its output >> a=10;
>>

Matrix Manipulation
>>A = [16 3 2 13; 5 10 11 8; 9 6 7 12; 4 15 14 1]

A =
16 3 2 13 5 10 11 8 9 6 7 12 4 15 14 1

>>sum(A)
ans = 34 34 34 34

MATLAB uses the variable ans, short for answer, to store the results of a calculation. MATLAB has two transpose operators. The apostrophe operator (e.g., A') performs a complex conjugate transposition. It flips a matrix about its main diagonal, and also changes the sign of the imaginary component of any complex elements of the matrix. The dotapostrophe operator (e.g., A.'), transposes without affecting the sign of complex elements. For matrices containing all real elements, the two operators return the same result. So
>>A'
produces
ans =
16 5 9 4 3 10 6 15 2 11 7 14 13 8 12 1 and

>>sum(A')'

produces a column vector containing the row sums ans =
34
34
34
34

The sum of the elements on the main diagonal is obtained with the sum and the

diag functions:
>>diag(A)
produces
ans =
16
10
7
1
Magic matrix and their subtraction same another magic matrix

>> magic(4)
ans =

16 2 3 13
5 11 10 8
9 7 6 12
4 14 15 1
>>b= magic(4) ans =
16 2 3 13
5 11 10 8
9 7 6 12
4 14 15 1

>> ans-b
ans =
0 0 0 0
0 0 0 0
0 0 0 0
0 0 0 0

Image is nothing but matrix contain different value for better identification of any image with gallery image it must be in same dimension. Thus by knowing magic in matrix manipulation using matlab we get encouragement to do further work. Hence we appreciated MATLAB is best software for image manipulation.

The Colon Operator
The colon, :, is one of the most important MATLAB operators. It occurs in several different forms. The expression
>>1:10

is a row vector containing the integers from 1 to 10: 1 2 3 4 5 6 7 8 9 10 To obtain nonunit spacing, specify an increment. For example,

```
>>100:-7:50
100 93 86 79 72 65 58 51
```

Subscripts
The element in row i and column j of A is denoted by A(i,j). For example, A(4,2) is the number in the fourth row and second column. For our magic square, A(4,2) is 15. So to compute the sum of the elements in the fourth column of A, type

```
>>A(1,4) + A(2,4) + A(3,4) + A(4,4)
```

This produces

```
ans =
34
```

but is not the most elegant way of summing a single column. It is also possible to refer to the elements of a matrix with a single subscript, A(k). This is the usual way of referencing row and column vectors. But it can also apply to a fully two-dimensional matrix, in which case the array is regarded as one long column vector formed from the columns of the original matrix. So, for our magic square, A(8) is another way of referring to the value 15 stored in A(4,2).
Use the value of an element outside of the matrix, it is an error:

```
t = A(4,5)
Index exceeds matrix dimensions.
```

On the other hand, if store a value in an element outside of the matrix, the size increases to accommodate the newcomer:

```
X = A;
X(4,5) = 17
X =
16 3 2 13 0
5 10 11 8 0
9 6 7 12 0
4 15 14 1 17
```

Subscript expressions involving colons refer to portions of a matrix: A(1:k,j) is the first k elements of the jth column of A. So sum(A(1:4,4)) computes the sum of the fourth column. But there is a better way. The colon by itself refers to all the elements in a row or column of a matrix and the keyword end refers to the

last row or column. So sum(A(:,end)) computes the sum of the elements in the last column of A:
ans =
34
Why is the magic sum for a 4-by-4 square equal to 34? If the integers from 1 to 16 are sorted into four groups with equal sums, that sum must be sum(1:16)/4 which, is
ans =
34
Below is the list of memory management functions.

1. clear - Removes variables from memory.
2. pack - Saves the existing variables to disk, and then reloads them contiguously.
3. save - Selectively persists variables to disk.
4. load - Reloads a data file saved with the save function.
5. quit - Exits MATLAB and returns all allocated memory to the system. Name the Basic Plots and Graphs of MATLAB.

Following table describes basic plots and graphs.
box - Axis border
errorbar - Plots error bars along curve
hold - Retains current graph while adding new graphs
line - Creates line object
LineSpec (Line Specification) - Syntax of Line Specification String loglog - Log to log scale plot
plot - 2-D line plot
plot3 - 3-D line plot
plotyy - 2-D line plots with y-axis on both left and right side polar - Polar coordinate plot
semilogx - Semilogarithmic plot
semilogy - Semilogarithmic plot
subplot - Creates axis in tiled positions
xlim - Sets or queries x-axis limits
ylim - Sets or queries y-axis limits
zlim - Sets or queries z-axis limits

Thus, Matrix laboratory (MATLAB) is a numerical computing environment various task like image enhancement, image deblurring, geometric transformations

transformations

segmentation, developed by feature detection, noise reduction, image generation programming language. It was

MathWorks. MATLAB allows implementation of algorithms, matrix manipulations, plotting of functions and data, creation of user interfaces and interfacing with programs written in other languages including C, C++, Java and Fortran. It also supports hardware for Linux, Mac OS X and Windows platforms providing extensive cross platform compatibility. MATLAB provides Image Processing Toolbox TM which provides a comprehensive set of reference-standard algorithms and graphical tools for image processing, analysis, visualization, and algorithm development.
Image registration, object tracking, recognition etc can be performed using the toolbox. Many toolbox functions are multithreaded to take advantage of multicore and multiprocessor computers.

FACIAL DATABASE

Human face is dynamic in nature due to variability in size, shape, color, and texture. The available face databases are extensively used for evaluation of various face recognition algorithms. During literature survey of face database different database available for use in research for evaluation purpose. Large amount of databases are available on net some of them consider for study, they are as follows

ORL database
FERET database
JAFFE database
MPI for Biological Cybernetics database BU-3D FE database
Our Database Face Bank

Year *University Facial No. of Color* database images Gray

April 1992 and April 1994
Speech, Vision and Robotics Group of the Cambridge University Engineering Department. http://www.freedownloadmanager.o rg/download/orl-database 569675.html
http://www.cl.cam.ac.uk/Research/ DTG/attarchive:pub/data/att_faces.t ar.Z
1996

George Mason
University, USA http://face.nist.gov/colorferet/reques t.html
1998
Psychology
Department, Kyushu
University, Japan
Michael J Lyons –
http://www.kasrl.org/jaffe_downloa d.html

ORL database 400 Gray

Resolution Number of subjects

112×92 10
FERET 14,051 Gray database
256x384 1199
JAFFE 213 Gray 256x256 10

2006
Max Planck Institute
for Biological
Cybernetics,
Tubingen, Germany
http://faces.kyb.tuebingen.mpg.de/in dex.php

MPI for 5600 Color Biological
Cybernetics
database
256x256 200 2006
Binghamton
University, State
University of New
York
Lijun Yin lijun@cs.binghamton.edu 2014
Own Database
RTM, Nagpur University BU-3D FE 2500 Color 1040x1329 100 database
Images,

3D
models
-

Face Bank 50 Color 256x256 10 Sample Images
images

Databases for face recognition
Databases from Websites
For image based and video based face recognition currently available face recognition database given on this website (http://www.face-rec.org/databases/)
Face Databases Detail description
By Dr. Wechsler and Dr. Phillips, FERET database was collected in 15
The Color FERET sessions between August 1993 and July 1996 on different dates. The database
Database, USA contains 1564 sets of images for a total of 14,126 images that includes 1199
individuals and 365 duplicate sets of images.

Database contains 4160 static images (in visible and infrared spectrum) of
SCface - Surveillance
130 subjects. Images from different quality cameras mimic the real-world
Cameras Face Database
conditions and enable robust face recognition algorithms testing, emphasizing

different law enforcement and surveillance use case scenarios.

The PIE database, collected at Carnegie Mellon University in 2000, has been very influential in advancing research in face recognition across pose and illumination. It contains 337 subjects, captured under 15 view points and 19 Multi-PIE illumination conditions in four recording sessions for a total of more than
750,000 images. Despite its success the PIE database has several shortcomings: a limited number of subjects, a single recording session and only few expressions captured. To address these issues researchers at Carnegie Mellon University collected the Multi-PIE database.
The Yale Face Contains 165 grayscale images in GIF format of 15 individuals. There are 11
Database images per subject, one per different facial expression or configuration:
center-light, w/glasses, happy, left-light, w/no glasses, normal, right-light, sad, sleepy, surprised, and wink.

Contains 5760 single light source images of 10 subjects each seen under 576 The Yale Face
viewing conditions (9 poses x 64 illumination conditions). For every subject Database B
in a particular pose, an image with ambient (background) illumination was

also captured.

A database of 41,368 images of 68 people, each person under 13 different PIE Database, CMU
poses, 43 different illumination conditions, and with 4 different expressions.

Plan to capture 200 subjects in 3 sessions in different time period. For one Project - Face In session, both in-door and out-door scenario will be captured. Capturing
Action (FIA) Face scenario mimics the real world applications, for example, when a person is
Video Database, AMP, going through the airport check-in point. Six cameras capture human faces
CMU from three different angles. Three out of the six cameras have smaller focus
length, and the other three have larger focus length. User-dependent pose and expression variation are expected from the video sequences.

Ten different images of each of 40 distinct subjects. For some subjects, the AT&T "The Database
images were taken at different times, varying the lighting, facial expressions of Faces" (formerly
(open *closed eyes*, *smiling* not smiling) and facial details (glasses / no "The ORL Database of
glasses). All the images were taken against a dark homogeneous background Faces")
with the subjects in an upright, frontal position (with tolerance for some side

movement).
Cohn-Kanade AU Subjects in the released portion of the Cohn-Kanade AU-Coded Facial
Coded Facial Expression Database are 100 university students. They ranged in age from
Expression Database 18 to 30 years. Sixty-five percent were female, 15 percent were AfricanAmerican, and three percent were Asian or Latino. Subjects were instructed
by an experimenter to perform a series of 23 facial displays that included single action units and combinations of action units. Image sequences from neutral to target display were digitized into 640 by 480 or 490 pixel arrays with 8-bit precision for grayscale values. Included with the image files are "sequence" files; these are short text files that describe the order in which images should be read.
The MIT-CBCL face recognition database contains face images of 10 subjects. It provides two training sets: 1. High resolution pictures, including frontal, half-profile and profile view; 2. Synthetic images (324/subject)

MIT-CBCL Face rendered from 3D head models of the 10 subjects. The head models were
Recognition Database generated by fitting a morphable model to the high-resolution training

images. The 3D models are not included in the database. The test set consists of 200 images per subject.
Image Database of 24 subjects are represented in this database, yielding between about 6 to 18
Facial Actions and examples of the 150 different requested actions. Thus, about 7,000 color

Expressions images are included in the database, and each has a matching gray scale
Expression Image image used in the neural network analysis.
Database
395 individuals (male and female), 20 images per individual. Contains

Face Recognition Data, images of people of various racial origins, mainly of first year
University of Essex, undergraduate students, so the majority of indivuals are between 18-20
UK years old but some older individuals are also present. Some individuals are

wearing glasses and beards.
NIST Mugshot There are images of 1573 individuals (cases) 1495 male and 78 female. The Identification Database database contains both front and side (profile) views when available.
Separating front views and profiles, there are 131 cases with two or more front views and 1418 with only one front view. Profiles have 89 cases with two or more profiles and 1268 with only one profile. Cases with both fronts and profiles have 89 cases with two or more of both fronts and profiles, 27 with two or more fronts and one profile, and 1217 with only one front and one profile.
NLPR Face Database 450 face images. 896 x 592 pixels. JPEG format. 27 or so unique people
under with different lighting/expressions/backgrounds.
Database is made up from 37 different faces and provides 5 shots for each person. These shots were taken at one week intervals or when drastic face

M2VTS Multimodal changes occurred in the meantime. During each shot, people have been asked
Face Database to count from '0' to '9' in their native language (most of the people are French
(Release 1.00) speaking), rotate the head from 0 to -90 degrees, again to 0, then to +90 and

back to 0 degrees. Also, they have been asked to rotate the head once again without glasses if they wear any.

The Extended Contains four recordings of 295 subjects taken over a period of four months.

M2VTS Database, Each recording contains a speaking head shot and a rotating head shot. Sets
University of Surrey, of data taken from this database are available including high quality colour
UK images, 32 KHz 16-bit sound files, video sequences and a 3D model.

The AR Face 4,000 color images corresponding to 126 people's faces (70 men and 56
Database, Purdue women). Images feature frontal view faces with different facial expressions,
University, USA illumination conditions, and occlusions (sun glasses and scarf).
Contains 125 different faces each in 16 different camera calibration and

The University of illumination condition, an additional 16 if the person has glasses. Faces in
Oulu Physics-Based frontal position captured under Horizon, Incandescent, Fluorescent and
Face Database Daylight illuminant .Includes 3 spectral reflectance of skin per person
measured from both cheeks and forehead. Contains RGB spectral response of camera used and spectral power distribution of illuminants.
The CAS-PEAL face database has been constructed under the sponsors of National Hi-Tech Program and ISVISION. The goals to create the PEAL face database include: providing the worldwide researchers of FR
CAS-PEAL Face community a large-scale Chinese face database for training and evaluating
Database their algorithms; facilitating the development of FR by providing large-scale
face images with different sources of variations, especially Pose, Expression, Accessories, and Lighting (PEAL); advancing the state-of-the art face recognition technologies aiming at practical applications especially for the oriental.
Japanese Female The database contains 213 images of 7 facial expressions (6 basic facial
Facial Expression expressions + 1 neutral) posed by 10 Japanese female models. Each image
(JAFFE) Database has been rated on 6 emotion adjectives by 60 Japanese subjects.
BioID Face DB The dataset consists of 1521 gray level images with a resolution

of 384x286
HumanScan AG, pixel. Each one shows the frontal view of a face of one out of 23 different
Switzerland test persons. For comparison reasons the set also contains manually set eye
positions.
Psychological Image This is a collection of images useful for research in Psychology, such as sets
Collection at Stirling of faces and objects. The images in the database are organised into SETS,
(PICS) with each set often representing a separate experimental study.

Glossary of Terms

MATLAB Description
Function
imread Read image from graphics file imshow Display image in handle graphics figure implay Play Video or image sequence imcrop Crop image
JPEG Joint Photographic Experts Group JPEG 2000 Joint Photographic Experts Group 2000 BMP Windows Bitmap
CUR Cursor File
GIF Graphics Interchange Format HDF Hierarchical Data Format
ICO Icon File
PBM Portable Bitmap
PCX Windows Paintbrush
PGM Portable Graymap
BMP Windows Bitmap
PNG Portable Network Graphics
PPM Portable Pixmap
RAS Sun Raster
TIFF Tagged Image File Format
XWD X Window Dump

.