Face Recognition Based Security System

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We accept the work in this report as a confirmation to the required standard for the partial fulfilment of the degree of BS(CS).

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Internal Examiner External Examiner

Dedication

This project is dedicated to our teachers who guided us throughout our Computer science tenure. We believe in whatever we are, wherever we are, is only the benefaction of Allah and prayers of our parents and our teachers.

Acknowledgements

All praises be to almighty Allah the beneficent and the merciful, who blessed me the courage to complete this project successfully against all odds and adversities. We feel highly privileged in taking the opportunity to thank our supervisor, Dr.Shahzad Khalid, for his valuable suggestions, constructive criticism, and polite behaviour. Without that it would have been almost impossible for us to accomplish the task successfully. Last but not the least we would like to thank our families whose invaluable praise, salutary advices and encouraging attitude kept our spirit alive to strive for knowledge and integrity which enable us to reach this milestone.

Abstract

Face recognition based security system works automatically to detect faces and recognizes them, providing the user with a detailed information of the subject. Previous systems requires constant vigilance whereas the proposed system will not be in need of human assistance to monitor security, it works automatically once started. This security system differs from others in various aspects, images are stored in the database in greyscale which consume less space as compared to others. The system is able to detect, recognize and stores information regarding the facial image detected.

Live monitoring and effective recognition makes the system stand out than the rest. Cameras used are of high quality that maintains stability and is void of fuzziness images, this system can be used in institutions, official buildings, centres that require efficient security system.

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Chapter No. 1

Introduction

1.1 Background

With the advancement of information technology, security is one of the most significant issues in the restricted zones. Every organization uses computer and different applications for security purposes. Security comes in different shapes and techniques like thumb impression, card swiping, security passwords etc. CCTV cameras are additionally used to monitor areas. It falls in the category of biometrics which means face recognition of different persons, like fingerprinting and retina scans. There are two types of dimensionalities for face recognition which are being briefly explain as follows:

In 2D Face Recognition, a face is represented by intensity variation or colour features of a given face. It is a 2D structure and Principal Component Analysis (PCA) is used on a set of images to extract a lower dimension. It is a speedy and efficient technique for recognizing faces. It works better if the illuminating light is moderate and is influenced by posed changes.

In 3D Face recognition, a face is represented by shape variation. The 3D images use a more reliable base for recognition. They are said to be more accurate however there is a considerable improvement required in this field. The 3D images have a 3D structure which is better than 2D in capturing the face and can easily handle the variations of the face and it's expressions. The combination of 2D Face Recognition and 3D Face Recognition give us a better result.

1.2 Problem Description

The system will recognize faces through a camera, therefore the camera should be of very high resolution and the system should be very efficient so that it can recognize faces from the database immediately. Moreover, changes in faces can cause hindrance in recognizing the face from the database. People may have very similar appearance. Complexity may occur when faces are viewed from different angles that may alter the image fed into the database.

1.3 Objectives

The proposed developed system is suitable for and will recognize faces from the images fed into the database of the surveillance system present in any environment. To perform this task EMGU CV library will be used. EMGU CV library provides trained classifiers to detect any object. By using this classifier we will detect the faces from the human bodies.

1.4 Scope

The scope of the system will be efficient in detecting the faces in real time and it will verify it from the database. This system can be used for Criminal Identification, Bank's restricted areas and so forth. The area we have chosen for it is Bahria University Labs .The purpose of choosing this area is to detect any person stealing something from the lab.

Chapter No. 2

Literature review

2.1 Introduction

Face detection is a technique to identify the faces on the body. Face recognition is a procedure to identify the patterns and match the features of the person to the image in order to recognize the faces. Face recognition process is involves the face detection technique. First of all face detection algorithms detect the faces from the body and after that face recognition process will perform the recognition method to recognize faces. In the past few years there has been a lot of work done on automated face recognition. There are many algorithms for face detection and recognition process. They are discussed below with brief review.

2.2 Face Detection

It is a computer vision technology that determines the locations and sizes of human faces in digital images. There are different algorithms available for face detection, the system which is integrated with the vision based human computer interaction should able to provide fast and accurate facial detection. Many researchers extensively used open source implementation. A good example is of object detection framework that is especially used in facial image processing. The EMGU CV contributed a collection of open source classifiers for the facial detection series of context.

2.2.1 Viola Jones

Viola Jones is an algorithm for detecting the visual objects and it is a very fast method for detecting the objects.

The cascade classifier of viola jones is used which is trained from a lot of positive and negative pictures. Cascade allows the background regions of the image to be immediately discarded while using more processing on promising object like regions. The configurations of cascade are saved in a XML file that is provided within the EMGU CV package for detecting the frontal face images.

Integral image made the extraction faster in detecting the faces through pixels and finding out face edges. Every component of the integral image contains the sum of all pixels located on the upper-left region of the original image.[1]

Viola Jones calculations are easy to calculate. In Viola Jones the white area is subtracted from the black area. The features of Voila Jones are as follows:

- Edge Features
- Line Features
- Four-Rectangle Features

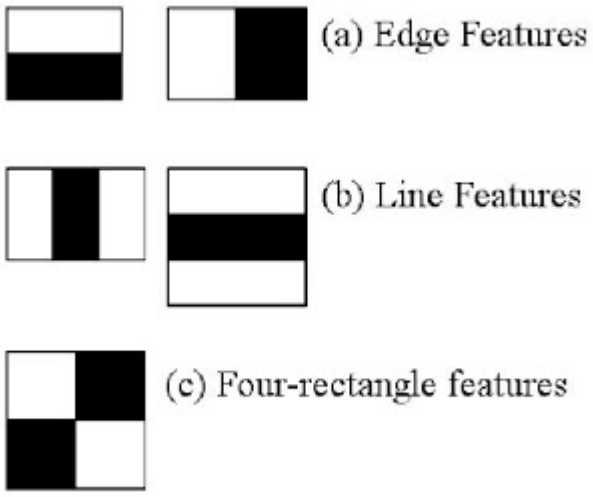

Figure 2.1 Haar Features [2]

Adaboost algorithm is used to increase the detection performance and is used to reduce computation time dramatically. It is an algorithm which constructs a strong classifier with the support of a weighted combination of weak classifiers. There are training sets which chooses the best features to be used on actual images to detect faces.

Figure 2.2 Haar Cascade feature classifier [3]

2.2.2 Skin Color Segmentation

Skin Color Segmentation is an algorithm for face detection. It is a technique through which we detect the faces through skin color. Skin segmentation is very important as it is not effected by variation in face angles. The commonly used colour model for the skin colour segmentations are RGB, HSV and YCbCr color models.

There are three primary colors used in RGB color model: red (R), green (G), and blue (B). In this model Red, Green and Blue colors are mixed together to create distinctive colors on the computer display. The three attributes of this color is hue (color-depth), saturation (color-purity) and intensity value (color-brightness). The variation between RGB color model and HSV color model is non linear. The major drawback of RGB is that it does not consider the changes caused by light on the color of the face hence this model can give faulty results.

The three attributes of HSV model are, Hue (color-depth), Saturation (color-purity) and intensity value (color-brightness). The variation between RGB color model and HSV color model is non linear. The major drawback of RGB is that it does not consider light effect on face color hence this model can give wrong information so HSV model is better than the RGB model.

In YCBCR color model, colors are specified in terms of luminance information which are in the Y channel and chrominance information which is in Cb and Cr channels. The variation between YCbCr and RGB is linear. YCbCr color model is better than HSV and RGB model.[4]

2.3 Face Recognition

Face recognition is a system which is for verification of a person. The method for doing this is to compare facial images with the images store in the data base. Nowadays, face recognition is very important for ensuring security of any organization, law enforcement areas and government sectors. It will reduce crime rate. There are two types of comparisons for face recognition which are as follow.

- Verification: It is a one to one matching. The system identifies an unfamiliar face and provides with their identity that has been saved in the database. It also verifies the identity provided by the individual at the security check.

- Identification: It is one to many matching. The image of an unknown person is compared with all the images stored in the database and gives a list of accurate matches.

There are four stages of identification which are as follow:

- Capture: The image of the person is captured.
- Extraction: The image is extracted and a template is made of that image.
- Comparison: The template is compared with the images from the database.

- Matching: The system will recognize the images, whether it is a match or a mismatch.

2.3.1 Principal Component Analysis:

Principal component analysis is a approach through which we can find out the differences and similarities among the faces. It is comparatively simple and a faster algorithm. The resolution of the image is in high definition which makes it difficult to analyse, so it reduces the resolution of the image in low definition called eigenfaces [5]. Due to this reason the computational process is sped up. It works on the principal of generating and representing average face sum of and differences of all others in Eigen face so it works on two dimensional data by converting RGB colour image into grey scale image in the first step. A matrix of nxn dimension will be formed once the values of the pixels are given in a row. By taking an average of each row and deducting the dimension from it a data set with a mean of zero is generated.

The representation obtained as a matrix will have elements which will display the images in rows, the first image will be set in the first row , the second image will be in the next row and so on. The vector will hold the values of the images according to their intensity, greyscale value is the most probable value in the vector.

Shown below is the large covariance matrix:

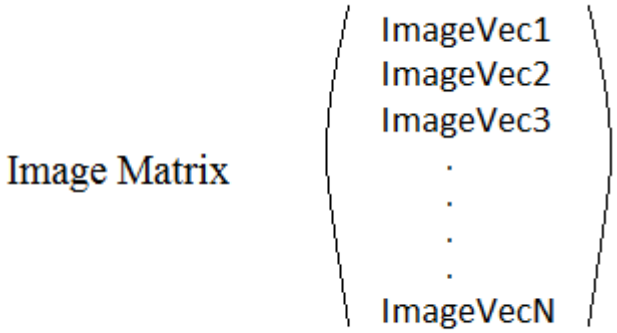

Figure 2.3 PCA Covariance General Formula

Hence, the data is formed from the covariance matrix in provisions of the eigenvectors. This data is helpful in carrying out facial recognition; the problem faced here is that any new image will not be available in the original set. Computer Vision works by calculating the differences among the new images and the original images but fails to measure them along the original axes. These axes perform in a much better way in terms of facial recognition, since the PCA analysis creates a difference and similarities between the original images and the new images.

The covariance matrix created will help in computing the values of eigenvectors and eigenvalues. Projection of these values into the face space will be carried out next. The usage of PCA in terms of facial recognition is for the expression of 1-D vector of pixels generated from 2-D images into the feature space. This is hence known as the eigenspace projection.

In the training set, PCA generates least possible squares decomposition. The algorithm input in the training set is t1..... tn of N facial images. The computation of each image in the PCA representation uses R nxm as an image point. In which each image includes nxm pixels. The eigenvectors will be equalled to the ith eigenvector, hence there are larger variations in the eigenvectors of low order and lesser variations in the higher order. Due to this hypothesis, the eigen vectors of higher order are not included in the representation [6].

2.3.2 Linear Discrimination Analysis

LDA is a method used in the field of statistics, pattern recognition and machine learning for the sake of obtaining knowledge in linear combination of features. These features characterizes more than two objects or events. the result obtained can be used for dimensionality reduction as a linear classifier before classification. LDA and PCA are inter-related along with factor analysis, in terms that these both ask for linear combinations which best suits the data obtained. LDA overtly shows the differences

among the classes. PCA differs in terms of not considering or taking into account differences in the class. On the other hand, factor analysis, provides combinations based on the differences. Similarly, discriminant analysis follows suit by being different from factor analysis and PCA in terms of not being an interdependent technique. A proper division between dependent and interdependent variables must be carried out. The prime dissimilarity among PCA and LDA is that the former carries out feature classification and the latter does data classification. The shape and location of the original data set changes in PCA, as compared to LDA, which provides more class separately [7].

Chapter No. 3

Requirement Specification

3.1 Existing System

The work related to the existing system is brefily explained below. As our system is for Bahria University, so keeping this in mind we will discuss existing system and the drawbacks of the existing system.

3.1.1 Traditional:

In every university the security is the very first priority. Security of a university comes in different forms like campus security, faculty, students, and employee's security. Security guards are always there for them but the main issue is the security of belongings like laptops, projectors, computer labs and so forth.

3.1.2 Surveillance Camera

The existing system which is implemented in Bahria University are surveillance cameras for security. They record videos (live streaming) to monitor the university areas like computer labs, class rooms, faculty and admin offices.

3.1.3 Imperfection

The existing surveillance system in Bahria University is not sufficient to monitor the premises. The imperfection of using this methodology to video surveillance is that it is immensely after the fact. Surprisingly if the person who have done crime can be recognize through the recorded video, it might be difficult to find them and at the point of damage, crime is already done.

3.1.4 Video Storage

The existing system of Bahria University is using surveillance cameras for security that stores recorded videos in the server or external storage. The drawback of this system is that it requires space and takes up archival storage places. Due to lack of

space the system stores a low quality video which produces a pixelated result. Furthermore, high quality video would call for more space.

3.1.5 System Failure (Damage)

System failure (damage), can cause a loss in data . Storage point is going to be damaged hence there will be no more source for storing data. The system will stop working. By considering the situation that there is only one point where the data is coming from and if it stops functioning properly it will cause the system to fail or lead to data damage.

3.2 Proposed System

By considering the security system of Bahria University our proposed system is very authentic, low cost and minimum storage requirement. This security system allows us to take facial images of the students and faculty members. After that it will send it to system software for processing (detection and recognition), along with date and time. Moreover, this system also processes(detect and recognize) faces through images which are already stored in the database.

3.2.1 Area Selection

The area which is assigned for the task is OC-Lab-05. Working in that area will require us to establish a system where it can easily find, detect and recognize faces and return authentic results. In the assigned area IP cameras are already installed which are of high resolution so it will make our work more easy and efficient.

3.2.2 Imperfection to Perfection

The damage caused by the culprit in a less secure area which lacks surveillance is considered to be as imperfection. Converting it to perfection is to capture the culprit while he/she is carrying out his/her activity. Capturing him/her at the spot will be easier, moreover the system will make it effortless to find the culprit in the premises.

3.2.3 Advantages

The following are the advantages of imperfection to perfection.

- **Low cost:**

  Most of the security systems are costly due to its heavy wiring, control room system and maintenance problem but the security system we are proposing is of low cost since it's functionality is more effective. This system requires only one computer system along with the appropriate number of cameras required to cover an area.

- **Efficiency**

  Due to its self detection and recognition capability this system will not require the assistance of human resource to watch over the surveillance system. It saves ample amount of time.

- **Less Memory Storage**

  Normally the systems which are used in different organizations have video storage issues, these systems require more storage space to perform effectively which hinders the functional capacity of the servers. In our proposed system, image capturing and detection allows us to use less memory and provides effectual system functioning.

- **Easy Detection**

  The detection of our system is concerned with the crime or any other activity performed by anyone in an organization present in front of the surveillance cameras. Such activities will be detected on the spot and captured, the system will receive the data and identify the person whose record will be already existing in the database.

- **Ease of Maintenance**

  Maintenance setbacks frequently occur in most of the systems. The proposed System does not require heavy maintenance since it has it's own software and a standalone database, which needs to be updated on timely basis.

3.3 Requirement Specification

A software and hardware requirement are those which can be designed for the development of any system and its function. Requirement specification is basically an idea through which we can find our outputs by giving the inputs technically that can be in a form of (input = process = output). That can be in form of functional and non-functional specifications for both software and hardware.

3.3.1 Hardware Specification

The following are the hardware specification of the project which are required for the completion of the project.

- **Camera**

  Cameras used must have image capturing speed of 30fps (Frames per seconds), moreover the shutter speed along with the focusing must be effective to provide with high quality images that are void of haziness. The recommendation for the device will be a 360 high resolution or a DSLR(Digital Single Lens Reflective).

- **Risks:**

  The risks for using camera devices are linked with the capability of zooming and focusing. If either of them are not functioning properly the result will be blurred or unrecognizable to the system. Which will ultimately cause failure of the system to detect and produce an exact match with the recorded database.

- **Computer System**

  The system must be fast for the proposed purpose, the minimum requirements are: PROCESSOR core i5 2.5 GHz , RAM 4GB to 8GB DDR3, HARD DISK 500GB.

- **Risks**

  Risks linked with the computer system are, if the system used does not match the minimum requirements of the software and processing speed, the system may crash or take time in returning results.

3.3.2 Software Specification

The following are the software specification of the project which are required for the completion of the project.

- **Microsoft Visual Studio 2012**

  By using this tool firstly creation of GUI (Graphical User Interface) of the software is for the purpose of friendly interface that can help make things easy on the screen for the user, Secondly, the programming being done is for the creation of the functions which will be performed by the software.

- **Microsoft Access 2007**

  This tool is used for creating tables, storing records as database. Moreover it is being used for the creation of personal details related to students and faculty members as image database, by which the output is given when the system or the software performs the function.

- **Language**

  The language we are using for software development is C#.

- **Operating System**

  The operating systems being used are Windows 7 and windows 8.

3.3.3 Functional Requirements

The following are the functional requirements which our software system must do to perform this project.

- **Image Sources**

  The software will get the images from different sources for face detection and recognition purpose. There are two types of sources which are as given below:

  - Image from video source: Images coming to the system from the surveillance camera.
  - Image from the other sources: Images coming from any portable device or from the working computer system.

- **Face Detection**

  In face detection process while the camera is running it take frames from the video and send it to the system then the system will process that picture. The system will locate the face in the whole frame and after that the face will be detected. Same process will be repeated if the picture is browsed from the computer system.

- **Issue**

  Issue occurs when the image is not complete, the face is not properly visible or the subject is looking in another direction. This will obstruct the system from properly recognizing the face.

- **Risks**

  Considering the condition when the face is not properly recognized by the software, it will stop the processing of the picture.

- **Face Recognition**

  In the face recognition process after the detection of the image it will match the result with the existing database, if the results match with the database the system will give us the whole information about the person and if the system

will not match the result with the existing database the system will show that the person is unknown.

- **Issue**

  The issue in this process is that if proper lighting is not available, the picture will not be properly examined.

- **Risks**

  The risks involved in this process is that a person's picture stored in the database is not recognized due to change in facial structure like moustache, facial hair, sun glasses or make-up.

3.3.4 Non-Functional Requirements

The following are the non functional requirements that how our system will perform to complete our task (project).

- **Performance**

  By considering the performance if our software/hardware requirements are not met as per given requirements, the system will not perform accurately.

- **Scalability**

  It means that the device or the system cannot perform the function in a situation where proper lightening is not available for the device. The system will not perform its function properly. Any change in the face structure or change in physical condition may cause it to stop functioning.

- **Maintainability**

  Maintainability refers to the proper conditions within the system for the software i.e. according to time variation and system requirements we can easily bring changes into our software coding.

- **Compatibility**

  There are so many systems which have no compatibility but in regards to the proposed system the compatibility criteria is valuable because platform of the system is independent and does not require server involvement, the software is highly dependent on a single operating system, it is possible in one condition if we try to run our software with a third party operating system it will be more risky for the software.

- **Usability**

  The GUI which we have created for the software is user friendly and very easy to use so any person who is familiar with a computer he/she can use it easily.

- **Reliability**

  If the system stops functioning due to some technical reasons, minimum time will be required to recover the damages.

- **Availability**

  The system will be available 24/7. Location of the operation will be that area where our system will be functioning.

3.4 Use Case Diagram

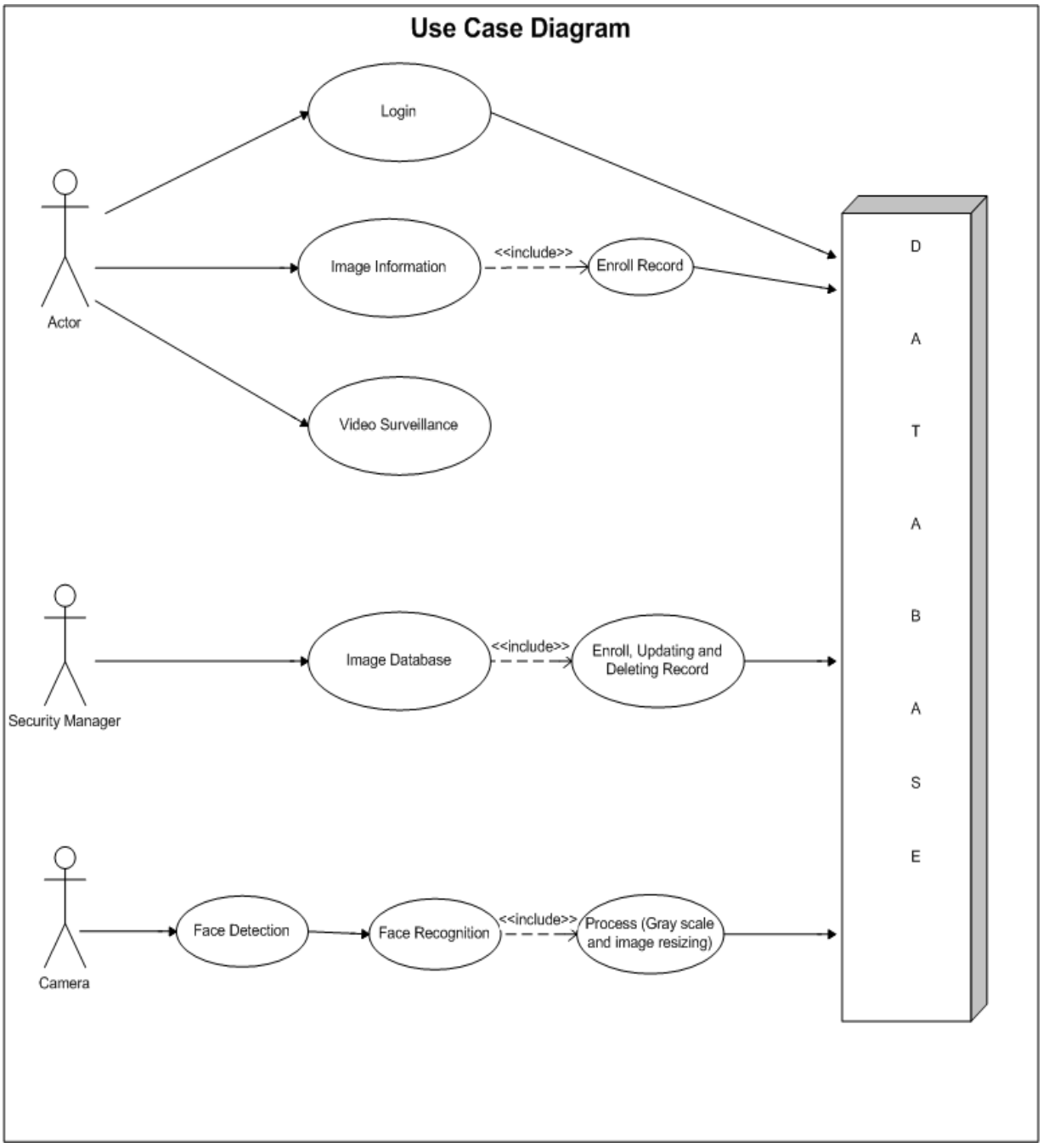

Figure 3.1 Use Case Diagram

3.4.1 Use Case #1

Title	Login	
Version No.	1.0	
Actors	User	
Description	This Use Case is for login to the application.	
Trigger	The application displays the GUI main screen.	
Main Success Scenario	Step	Action
	1.	Username : Bahria University by default
	2.	Type Password
	3.	Press Login Button
Alternate Flows	Step	Action
	1a.	If user enters the wrong password then the application will not open.
Special Requirements	Any Special Requirements	
Assumptions	The password of the application already exist.	
Pre-conditions	The Password is already saved on the system database and username is Bahria University by default.	
Post-conditions	The Application will open.	
User interface	The Login field contains Password and login button. The application's login user name is Bahria University by default.	
Issues	Invalid Password	

Table 3.1 Use Case #1

3.4.2 Use Case # 2

Title	Image Information	
Version No.	1.0	
Actors	User	
Description	This Use Case is for uploading image from computer system for matching or adding into the database.	
Trigger	The user will press the Image information button for accessing upload and add image process.	
Main Success Scenario	Step	Action
	1.	By pressing upload button image will be displayed on a picture box for matching from database.
	2.	By pressing upload button image will be displayed on picture box for adding image and its details into database.
Alternate Flows	Step	Action
	1a.	If user enters the wrong image format then the pop up error message displays that format is wrong.
	2a.	If user enters the wrong syntax then the pop up error message displays.
Special Requirements	User must enter the correct image format and fill up all details with correct syntax.	
Assumptions	The Image and its details already exist in the database.	
Pre-conditions	The user get access to image analyse screen.	
Post-conditions	The user will enter into the uploading, matching and adding process through the image analyse button.	
User interface	1: The main application has image analyse button. 2: Image analyse contains uploading and adding buttons.	
Issues	1: Wrong image format. 2: Wrong image detail syntax.	

Table 3.2 Use Case #2

3.4.3 Use Case # 3

Title	Video Surveillance	
Version No.	1.0	
Actors	User	
Description	This Use Case is for live video streaming from surveillance cameras.	
Trigger	The user will press the video surveillance button for accessing surveillance cameras.	
Main Success Scenario	Step	Action
	1.	The user will press the video surveillance button to access available surveillance cameras.
Alternate Flows	Step	Action
	1a.	N/A
	2a.	N/A
Special Requirements	The surveillance cameras should be in active mode.	
Assumptions	Known faces and its details already exist in the database.	
Pre-conditions	The user get access to login before using video surveillance.	
Post-conditions	The user will activate surveillance cameras by pressing video surveillance button.	
User interface	Video surveillance main screen displays the available surveillance camera boxes and buttons to activate them.	
Issues	All surveillance cameras must be in working condition.	

Table 3.3 Use Case #3

3.4.4 Use Case # 4

Title	Image Database	
Version No.	1.0	
Actors	User : Security Manager	
Description	This Use Case is for updating and deleting image and its details from database.	
Trigger	The user (Security Manager) will press the Image database button for updating, deleting and view all record from database.	
Main Success Scenario	Step	Action
	1.	The user (Security Manager) will press the image database button to access updating, deleting and all record.
	2.	The User (Security Manager) will press the update button to make changes in the image details.
	3.	The User (Security Manager) will press the delete button to remove record from the database.
Alternate Flows	Step	Action
	1a.	N/A
	2a.	N/A
Special Requirements	Only Security Manager has password to get access into the image database for updating and deleting record from database.	
Assumptions	N/A	
Pre-conditions	The security manager gets his own login password to access image database.	
Post-conditions	The Security manager enters into image database main screen.	
User interface	1: The Main Application has image database button. 2: Image database contains updating and deleting buttons.	
Issues	Invalid security manager's password	

Table 3.4 Use Case #4

3.4.5 Use Case # 5

Title	Face Detection	
Version No.	1.0	
Actors	System	
Description	This Use Case is for detecting faces in pictures and surveillance cameras.	
Trigger	N/A	
Main Success Scenario	Step	Action
	1.	Automatically system detects faces from pictures and surveillance cameras.
	2.	N/A
	3.	N/A
Alternate Flows	Step	Action
	1a.	N/A
	2a.	N/A
Special Requirements	Surveillance cameras must be in proper place so the faces can be detected easily.	
Assumptions	Detect faces in video surveillance cameras and images.	
Pre-conditions	Login to the application	
Post-conditions	Displays the detected face on the screen with green rectangle mark.	
User interface	Video Box or Image Box	
Issues	Pose and lightening variation	

Table 3.5 Use Case #5

3.4.6 Use Case # 6

Title	Face Recognition	
Version No.	1.0	
Actors	System	
Description	This Use Case is for recognize (Matching) faces in video surveillance from the database.	
Trigger	N/A	
Main Success Scenario	Step	Action
	1.	System will convert the detected face into gray scale.
	2.	System will resize the image.
	3.	System will automatically recognize (Matching) faces in video from database.
Alternate Flows	Step	Action
	1a.	N/A
	2a.	N/A
Special Requirements	System must recognize faces from the database.	
Assumptions	System will display the recognition result.	
Pre-conditions	Login to the application.	
Post-conditions	Displays the recognition face result details.	
User interface	Video Box	
Issues	Pose and lightening variation	

Table 3.6 Use Case #6

Chapter No. 4

System Design

4.1System Architecture

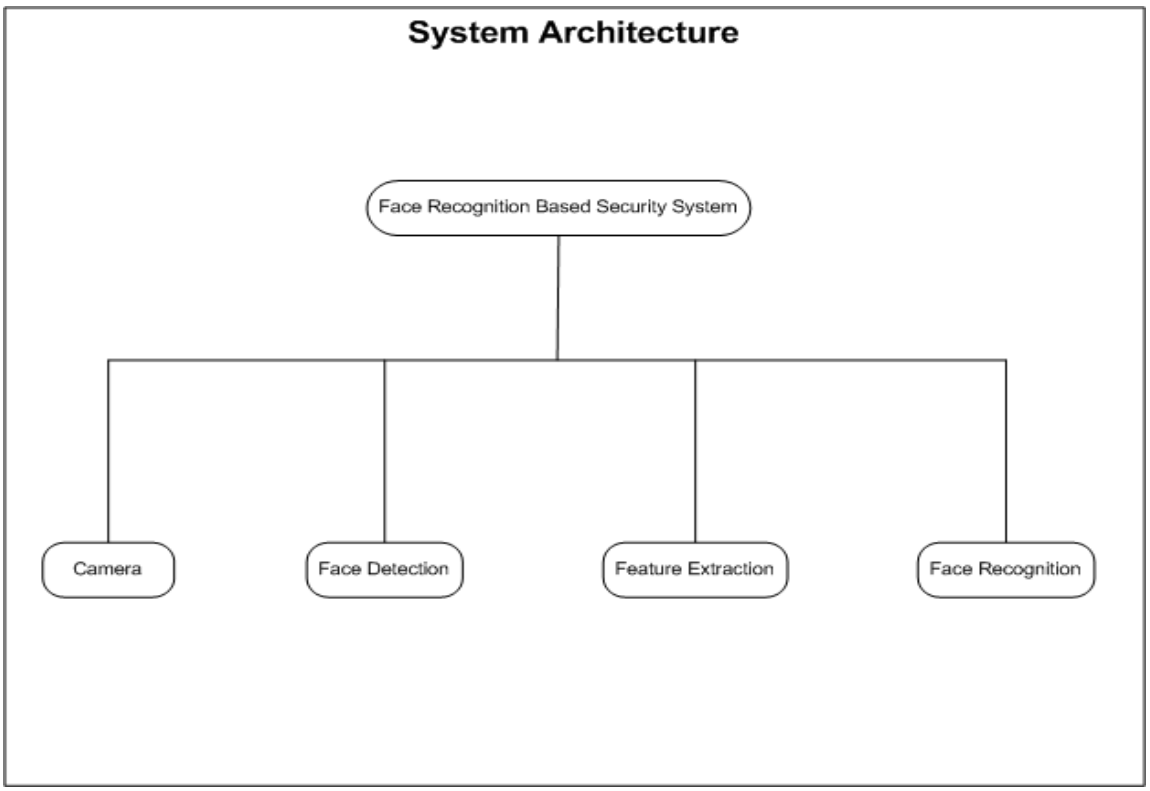

Figure 4.1 System Architecture

4.2 Design Constraints

The problem could be that the subject is not facing forwards due to which the camera will not detect the complete facial features, this will affect the result in recognizing the individual, furthermore, lack of proper lighting and low resolution may affect the output and cause hindrance in the process of identification.

4.3 Design Methodology

The methodology used in this project is that the facial features will be extracted through Haar Cascade classifier and the recognition process will be carried through Principal Component Analysis (PCA) algorithm.

4.4 Processing diagram

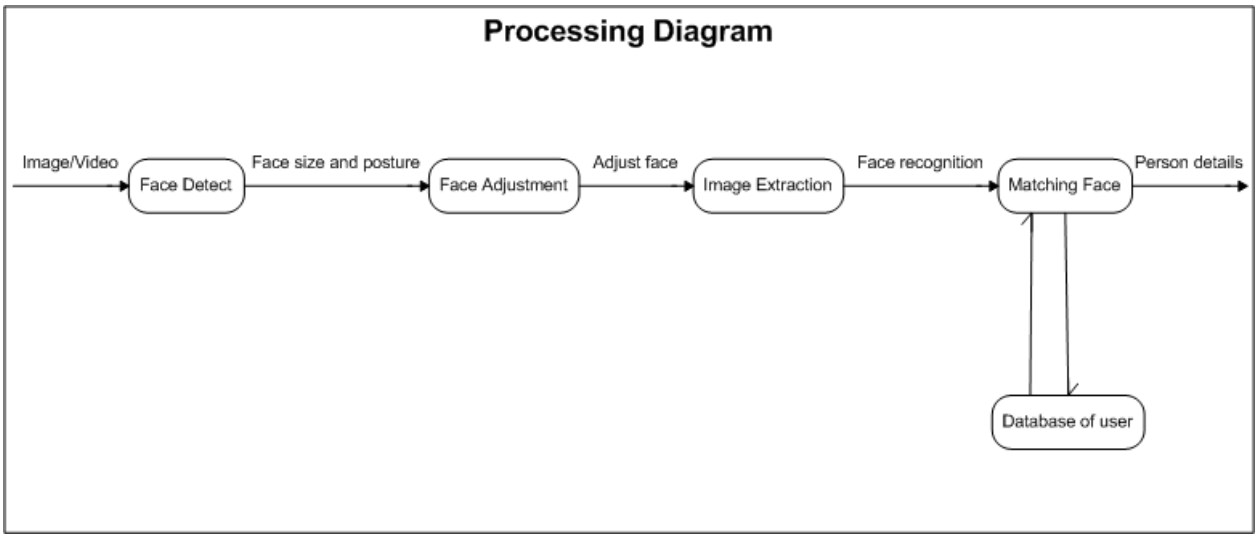

Figure 4.2 Processing Diagram

4.5 Data Flow Diagrams

4.5.1 Login Data Flow Diagram

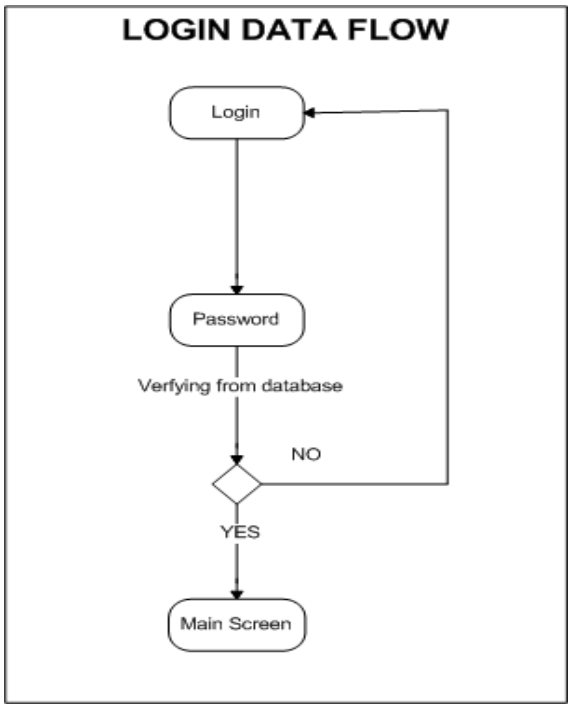

Figure 4.3 Login Data Flow Diagram

4.5.2 Image Information Data Flow Diagram

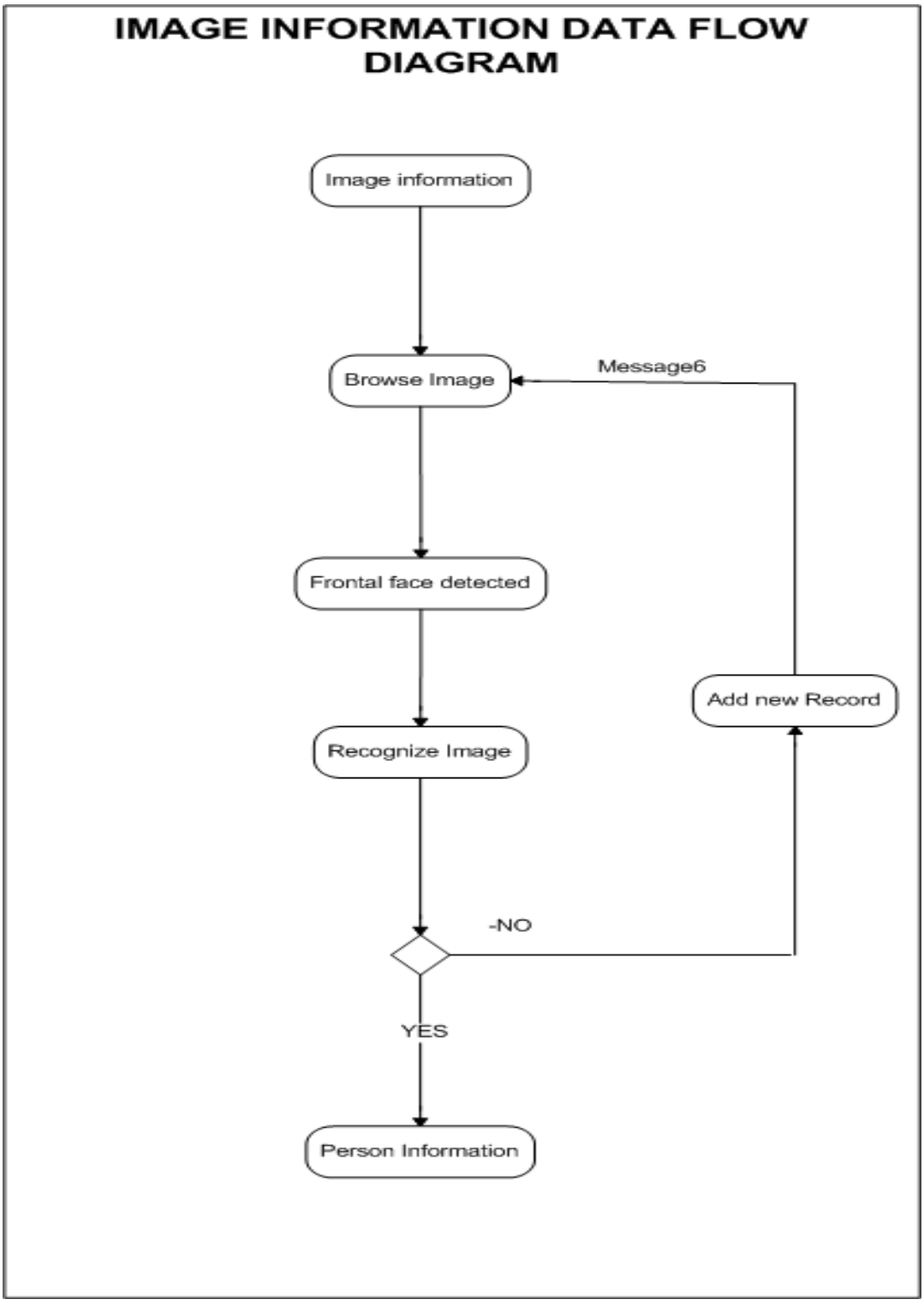

Figure 4.4 Image Information Data Flow Diagram

4.5.3 Video Surveillance Data Flow Diagram

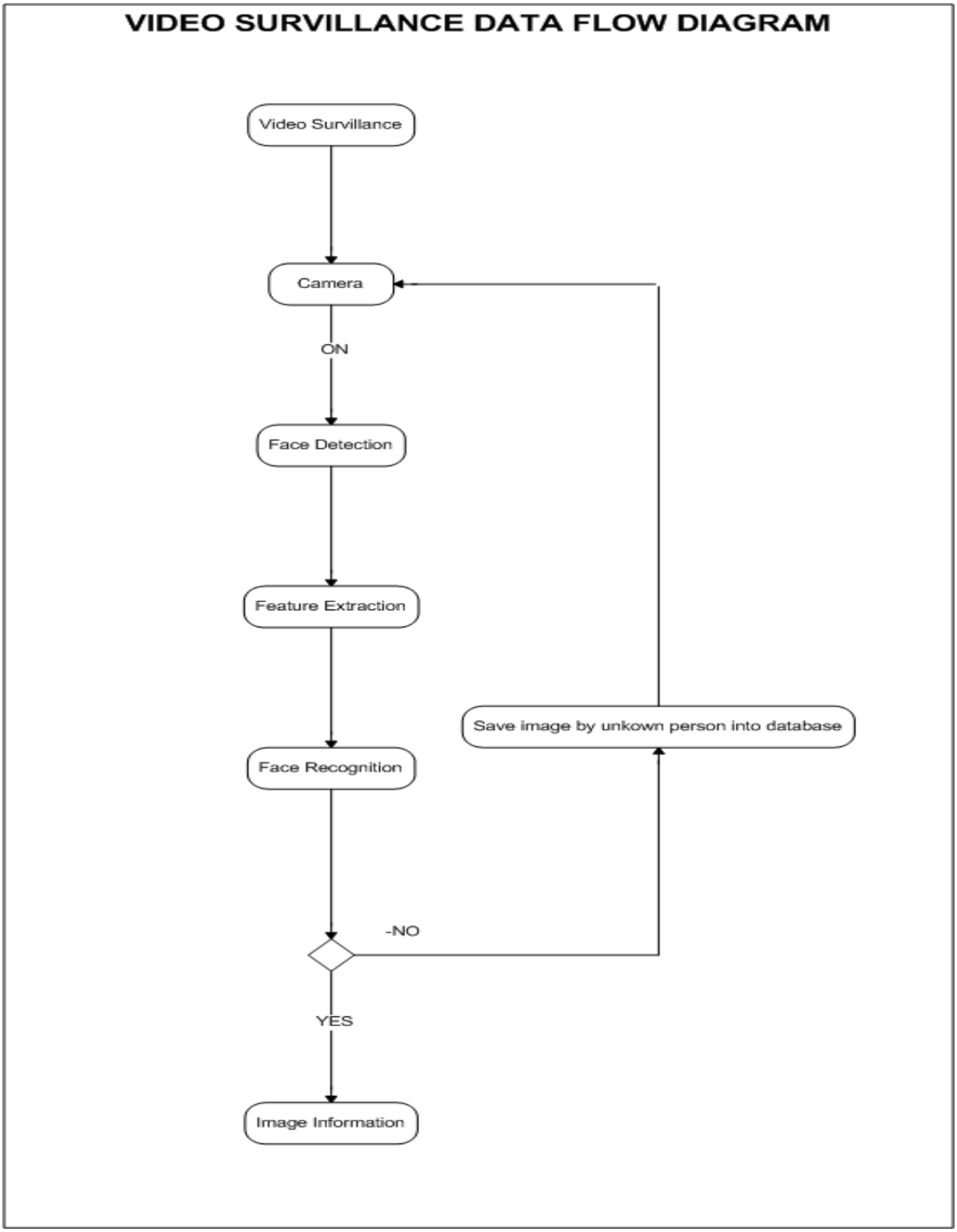

Figure 4.5 Video Surveillance Diagram

4.6 State diagram

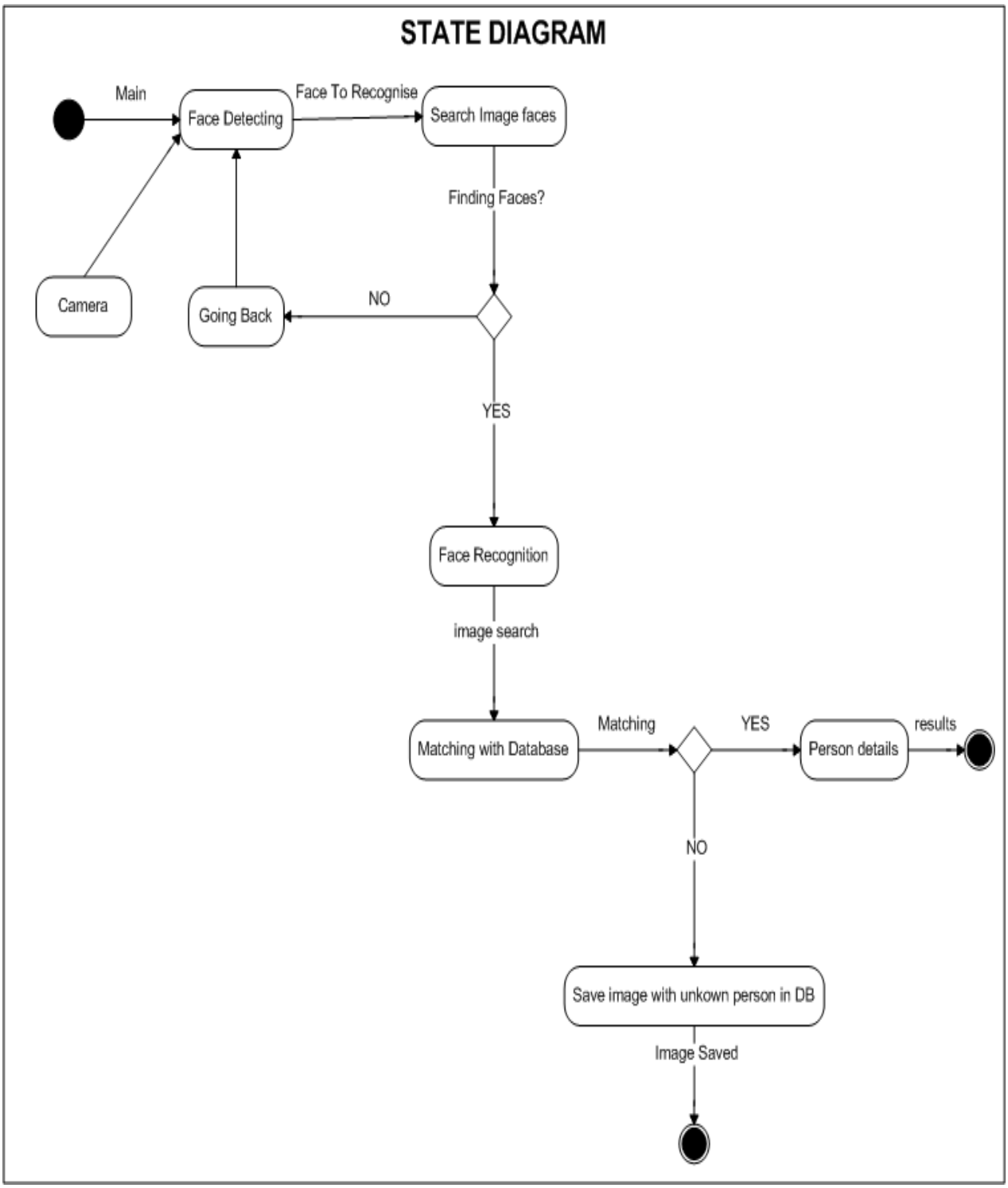

Figure 4.6 State diagram

4.7 Class diagram

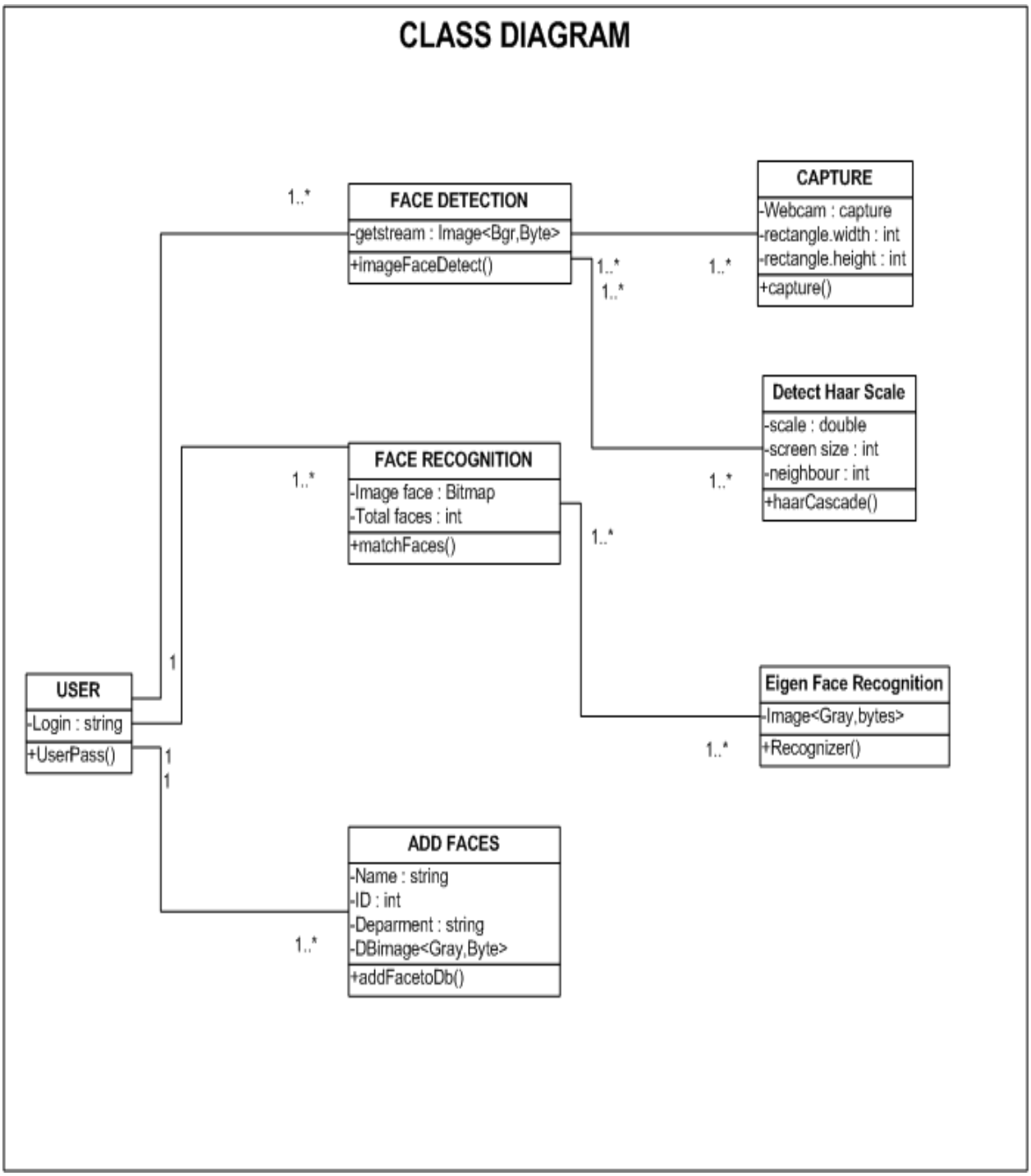

Figure 4.7 Class Diagram

4.8 Sequence Diagrams

4.8 .1 Login Sequence Diagram

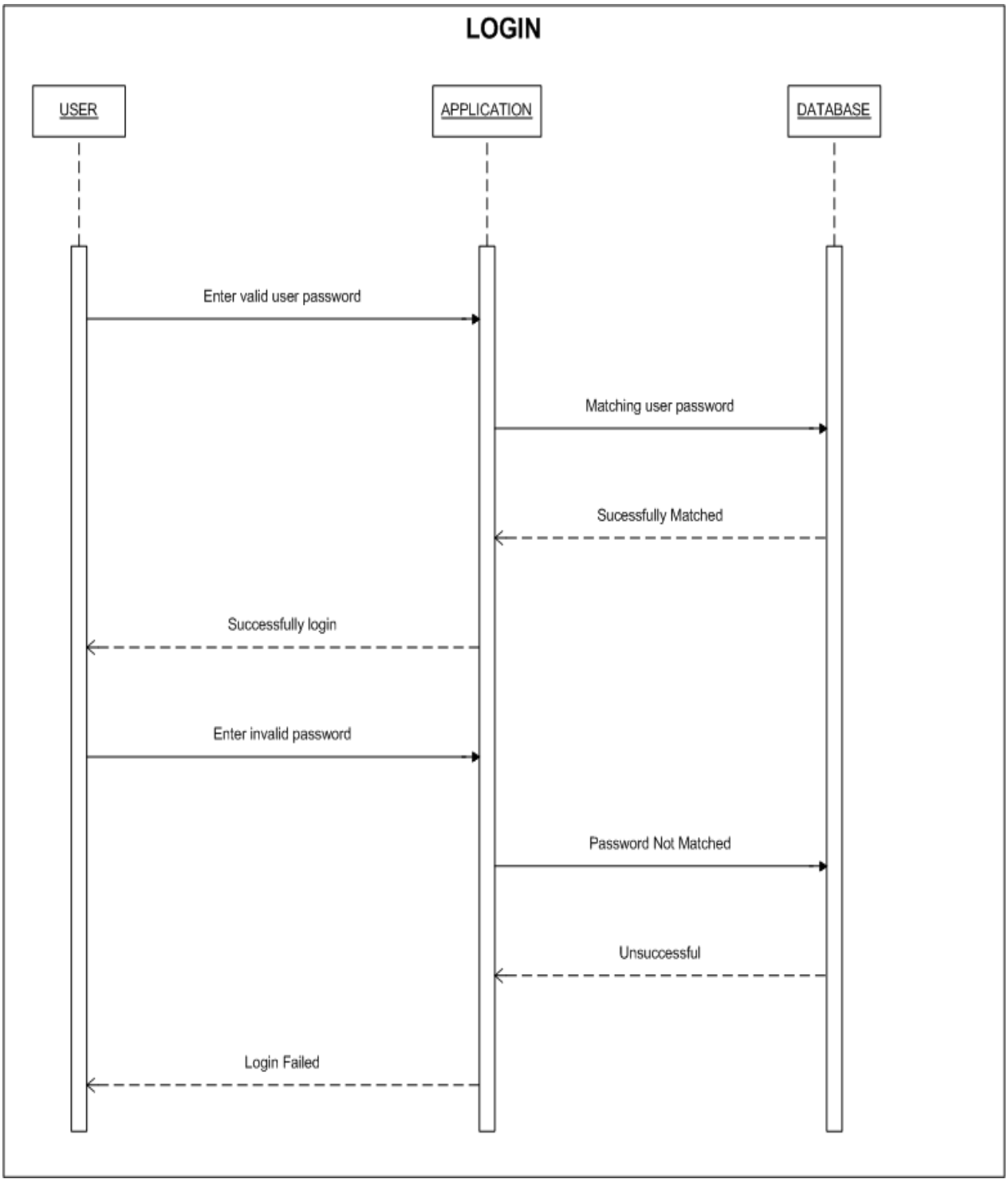

Figure 4.8 Login Sequence Diagram

4.8.2 Application Sequence Diagram

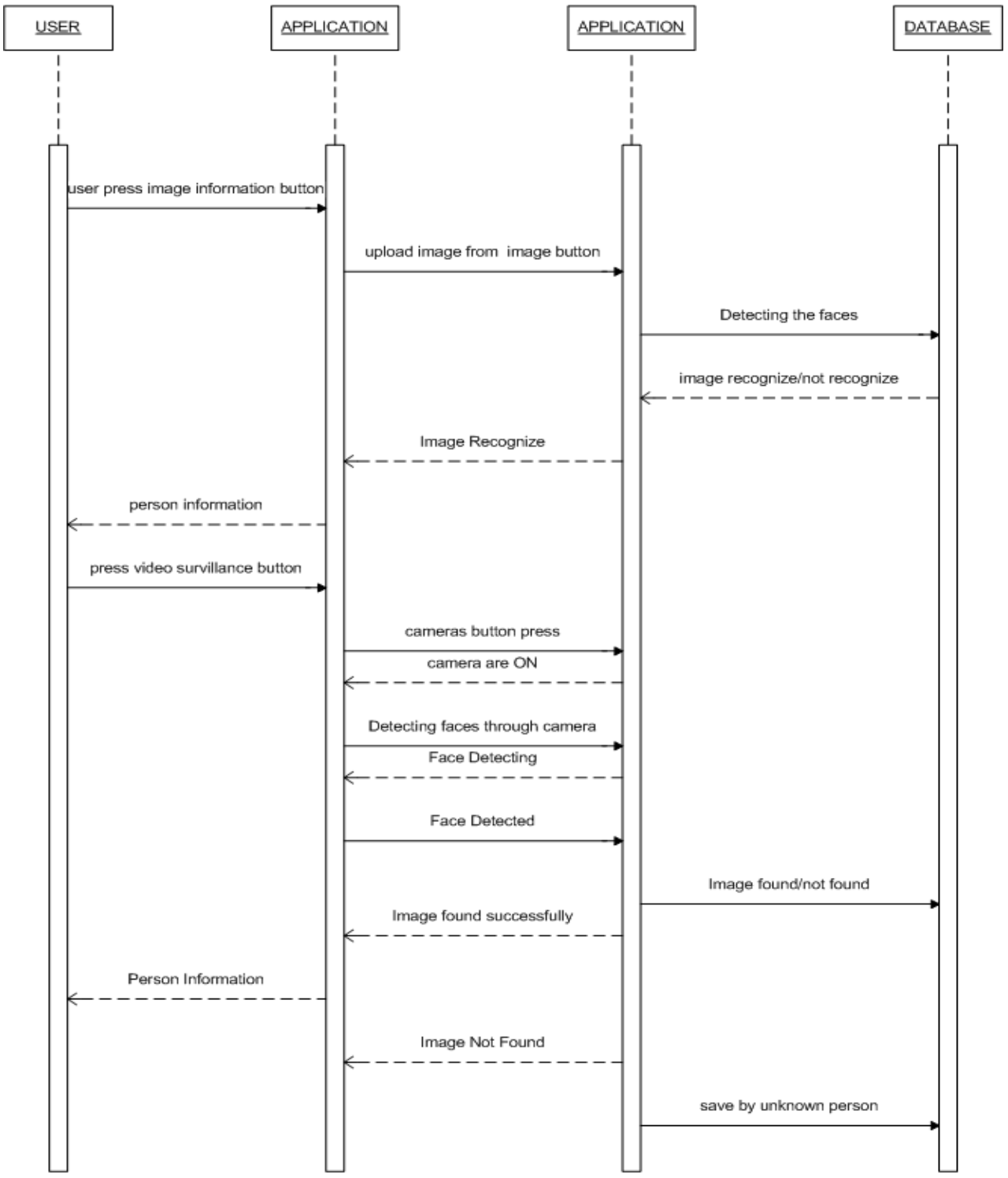

Figure 4.9 Application Sequence Diagram

Chapter No. 5

System Implementation

5.1 System Architecture

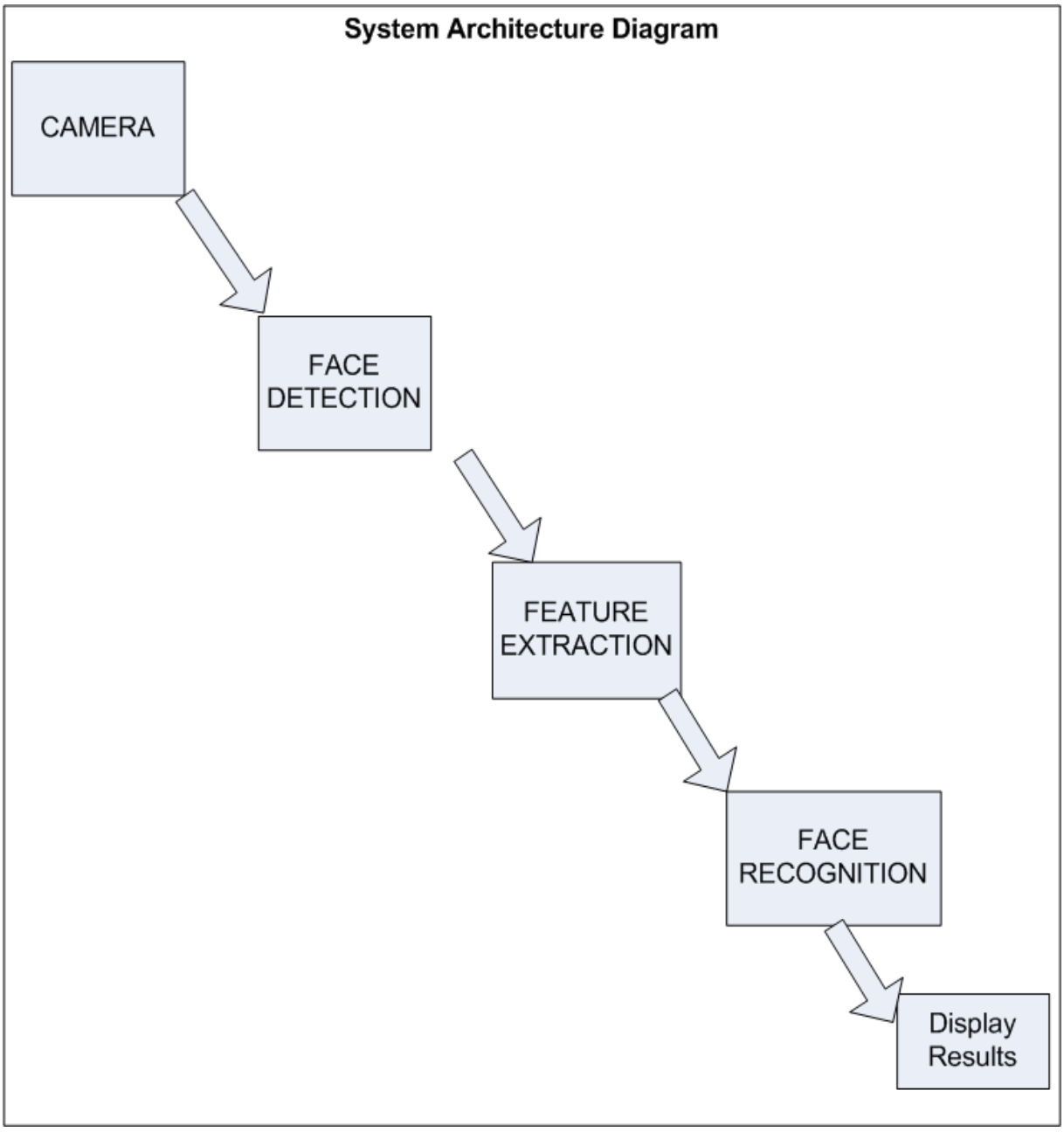

Figure 5.1 System Architecture

5.1.1 Camera

The camera shows us the real world, live streaming of actual happenings. Cameras installed in the area will provide with constant surveillance and will play an important role in detection. As we were using visual studio 2012 that don't have live video streaming tool to capture the video from camera but now as we modify our toolbox options we import Emgu.CV.UI library which not only enhance the functionality of our toolbox but also make it more easy to work and user friendly. The library which we import for capture live streaming from camera is in the following figure:

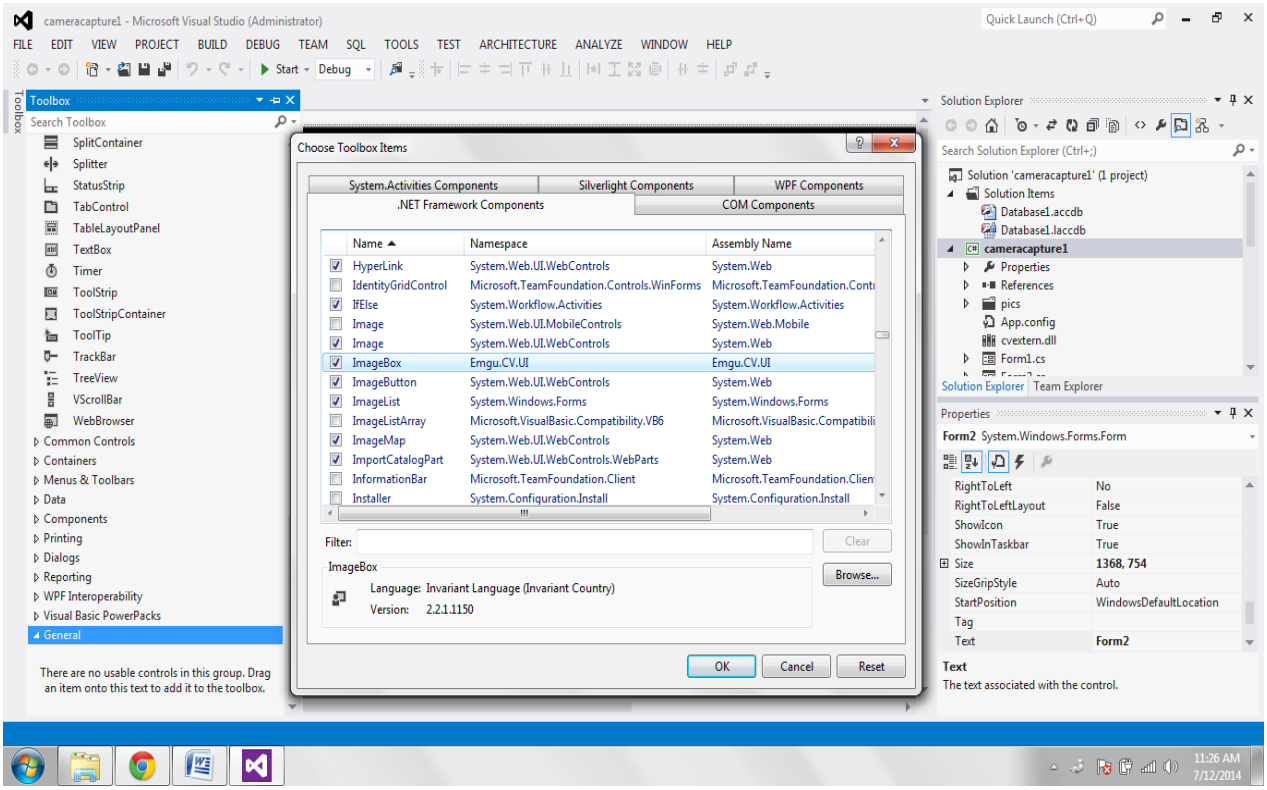

Figure 5.2 Emgu.CV.UI Library import

To show the functionality of our newly import tool for that purpose we have taken some of the references to use this tool which are as follows:

- Emgu.CV.dll
- Emgu.CV.ML.dll
- Emgu.CV.UI.dll

- Emgu.Util.dll

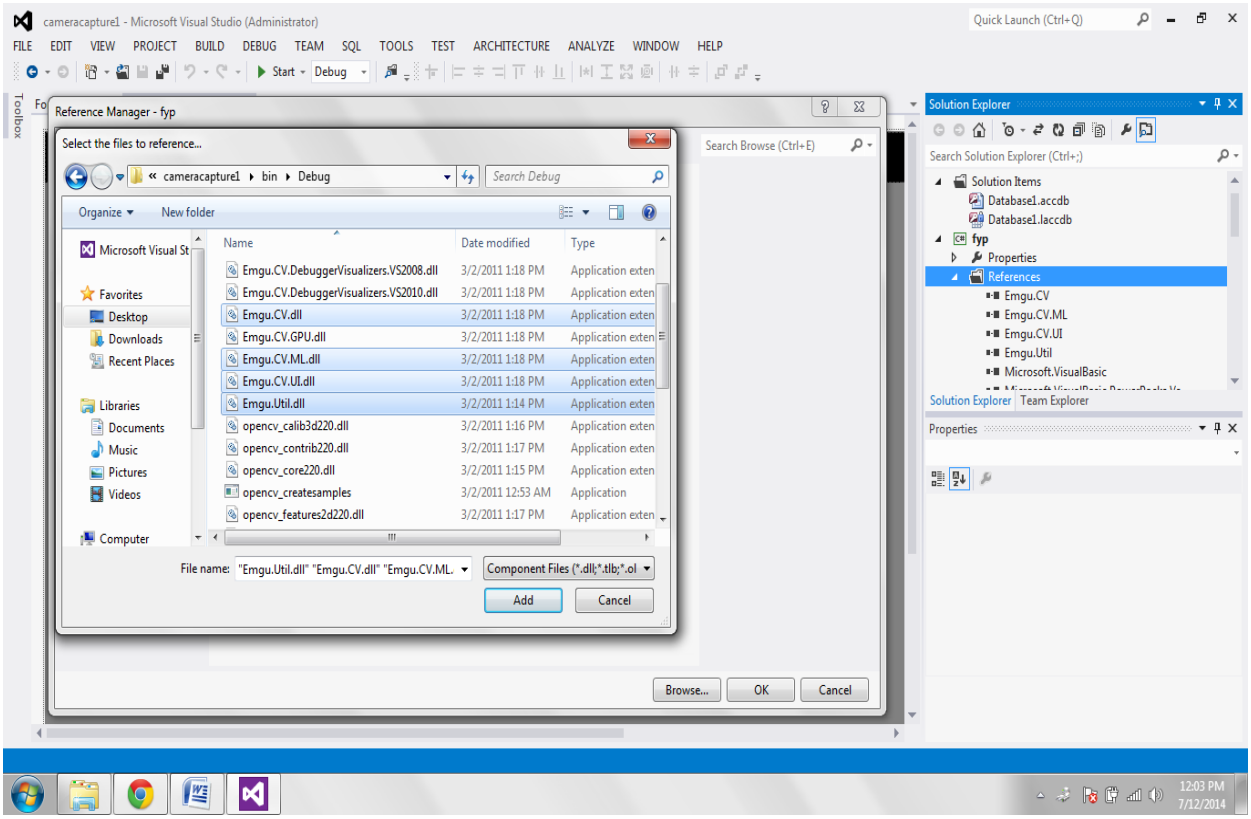

Figure 5.3 Import References

5.1.2 Face detection

The system will detect the subject's face by using Viola Jones Technique. The system is made to differentiate between facial features and other features, it will only detect the complete faces given that the subject is looking to the front.

Viola Jones HaarCascade Frontal Face API is being used to detect the faces. This API will detect the face while the person is coming straight in the angle of camera, so it will detect the face very clearly but if the person face is not straight in the angle of camera, the API will not detect the face and discard it. The function which we have created is named by **imageFaceDetect()** function either it is captured from the camera or browse from the system.

Moreover, the image detection is concern it will be easier for the API to detect the image because the image which we will browse from the computer could be in a straight position. The image which will be detected by the system it would be encircled. The detected faces example is in the figure 5.4 and 5.5 .

Figure 5.4 Detected Faces

Figure 5.5 Detected Faces

5.1.3 Feature Extraction

In this module the system will extract the image of the detected subject and send it to the image box for further processing and recognition.

After the face detection is done the system will extract the face and convert it into the gray-scale image for this purpose we use gray-scale function **Image<Gray, byte> grayframe = ImageFrame.Convert<Gray, byte>();** ,after that extracted faces are converted into gray-scale and shifted to Picture-Box where we can see them one by one by clicking next and previous button.

The figure 5.6 and 5.7 shows that the only face is extracted from the original picture and the extracted face is converted into gray scale then it shifted into the picture-box.

Figure 5.6 Face Extraction

Figure 5.7 Face Extraction

5.1.4 Face recognition

In this module the system will match the image detected with the data that is saved in the database by using PCA eigenfaces . This recognition technique undergoes soon after detection and extraction of the image. The dummy workflow figure of PCA eigenfaces approach is given below:

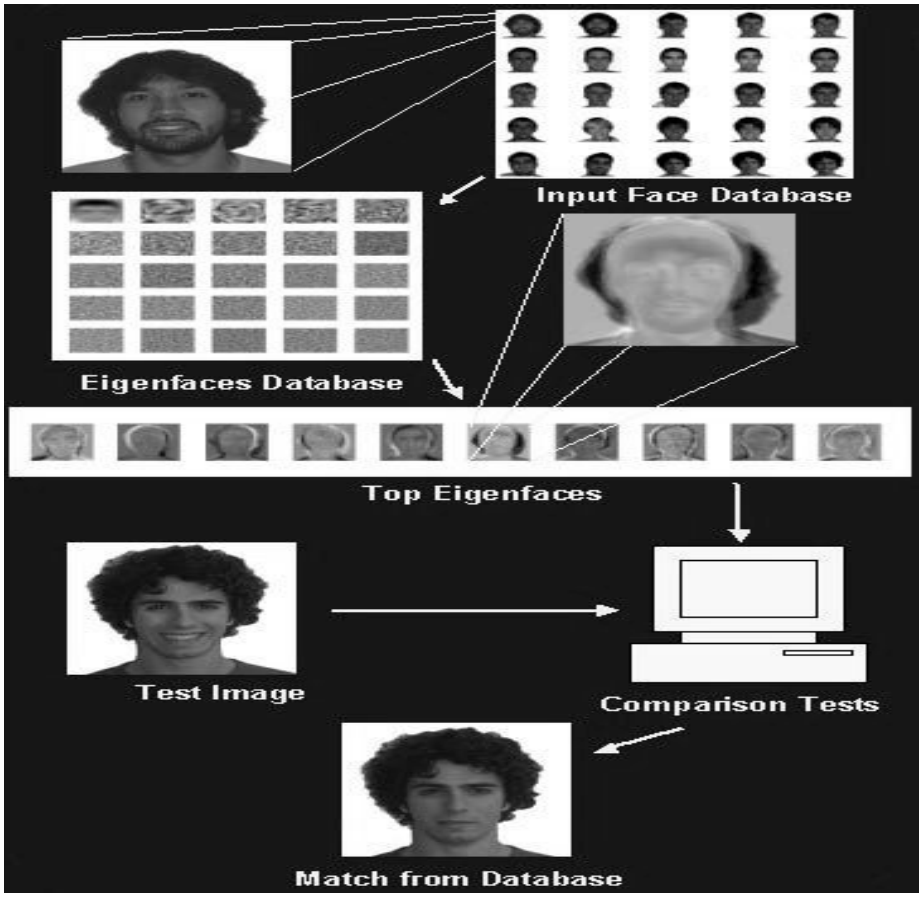

Figure 5.8 PCA Eigenfaces workflow approach [8]

PCA Eigenfaces approach works like it makes the eigenfaces database from the original database and low the dimensionality of the images as shown in the figure 5.9. Test image or any sample image came for recognition it matches with eigenfaces database and shows the result. Recognition process can be in the form of video surveillance as well as manually browse an image from computer or bootable device to recognize the person.

5.1.5 Display information

In this module, the system will show the result of whether the person is known or unknown. The system will show a detailed information of the known person and will show “Unknown” and “Date Time” for an unrecognized individual.

Figure 5.9 (A) Display results

Figure 5.9 (B) Display results

5.2 Tools and Technology

Tool that we are using is Visual studio 2012, MS Access 2007 and technologies are:

- EMGU CV
- Haar Cascade Classifier
- PCA Eigenfaces Algorithm

5.3 Development Environment/Languages

- The development environment where the software is being developed is visual studio 2012 and MS Access for Database.
- C# language is used for the development of the software.

5.4 Application Access Security

The main screen of the application will not be accessed until and unless the user enters the correct password of that application.

5.5 Database Security

The database of this application is very secured even the user cannot manipulate the database. User can only insert the information into the database and view information from the database only. Administrator can only have full access to the database.

5.6 Processing Logic/Algorithms

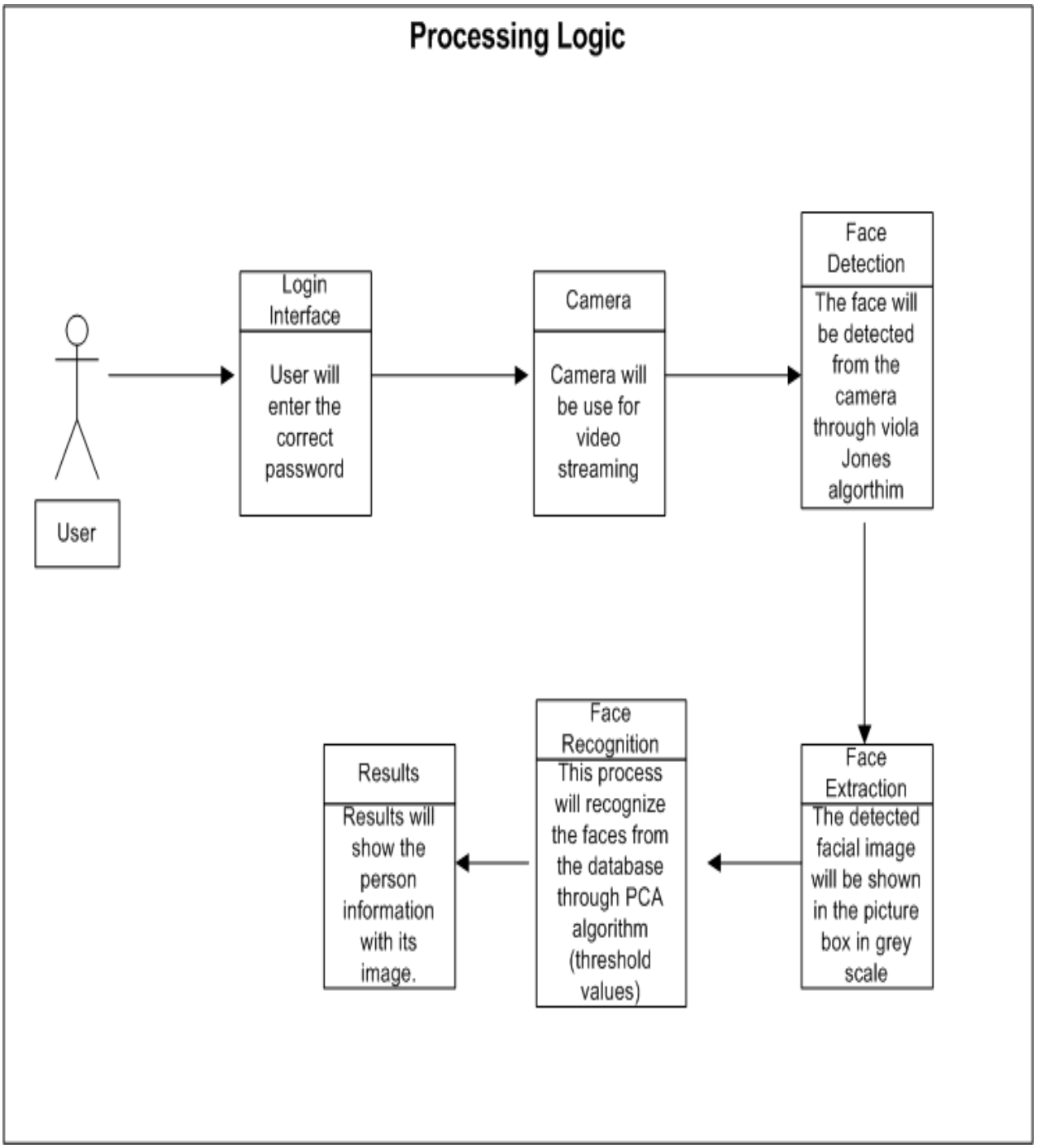

Figure 5.10 Processing Logic

Chapter No. 6

System Testing and Evaluation

6.1 Graphical User Interface

6.1.1 Test Case # 1

Test Case ID		TEST CASE_FUNCT_01	
Description		Tests the Login Screen	
Applicable for		Login Screen of the software in visual studio 2012	
Requirements		REQ_FUNCT_01	
Initial Conditions		Visual Studio 2012 should be install and properly working on the system.	
Step	**Full / Regr**	**Task & Expected Result**	
1		Open the login screen.	
2		Verify that the login screen is displayed on Visual Studio 2012.	**Pass** / Fail
3		User enter the valid application Password.	**Pass** / Fail
4		Verify that the password is masked and can be entered.	**Pass** / Fail
5		Verify that the Login button is displayed.	**Pass** / Fail
6		Verify that the application password is correct.	**Pass** / Fail

Table 6.1 Test Case #1

Comments:

The user will get access to the main screen of the application.

6.1.2 Test Case # 2

Test Case ID		TEST CASE_FUNCT_02	
Description		Tests the invalid password.	
Applicable for		Login Screen of the software in visual studio 2012	
Requirements		REQ_FUNCT_02	
Initial Conditions		Visual Studio 2012 should be install and properly working on the system.	
Step	**Full / Regr**	**Task & Expected Result**	
1		Open the login screen.	
2		Verify that the login screen is displayed on Visual Studio 2012.	**Pass** / Fail
3		User enters the invalid application password.	**Pass** / Fail
4		Verify that the password is masked and can be entered.	**Pass** / Fail
5		Verify that the Login button is displayed.	**Pass** / Fail
6		Verify that the application password is correct.	Pass / **Fail**

Table 6.2 Test Case #2

Comments:

The user will not get access to the main screen of the application because of invalid password.

6.2 Usability testing

6.2.1 Test Case # 3

Test Case ID		TEST CASE_FUNCT_03	
Description		Tests the Video Surveillance Button	
Applicable for		Entering into the Video Surveillance Screen.	
Requirements		REQ_FUNCT_03	
Initial Conditions		User should be in the main screen through login screen.	
Step	**Full / Regr**	**Task & Expected Result**	
1		Open the main screen.	
2		Verify that the Video Surveillance button is displayed.	**Pass** / Fail
3		User clicks the video surveillance button.	
4		The video surveillance screen is opened.	**Pass** / Fail

Table 6.3 Test Case #3

Comments:

The user gets access to the video surveillance screen and can use functionality of the video surveillance screen.

6.2.2Test Case # 4

Test Case ID		TEST CASE_FUNCT_04	
Description		Tests camera is running and start detecting faces from start button	
Applicable for		Accessing the cameras	
Requirements		REQ_FUNCT_04	
Initial Conditions		User should be in video surveillance screen through the main screen of the application.	
Step	**Full / Regr**	**Task & Expected Result**	
1		Open the video surveillance screen.	
2		Verify that the camera is selected and start button is displayed.	**Pass** / Fail
3		User Select the camera.	**Pass** / Fail
4		User clicks the start button.	**Pass** / Fail
5		Verify that the camera is working and showing video streaming.	**Pass** / Fail
6		Verify that the application starts detecting faces when the camera is ON.	**Pass** / Fail
7		Verify that the application automatically captures the faces and displays the faces in the picture box one by one.	**Pass** / Fail
8		Verify that the application automatically recognize faces from the database and display the details one by one.	**Pass** / Fail

Table 6.4 Test Case #4

Comments:

When user starts the camera then the application starts detecting faces from live streaming cameras, then displays detected faces in the picture box, one by one and sends images for recognition. After that recognition process starts running and matches faces from the database and shows the details one by one. If the images are not matching with the database images then that picture saved into the database automatically shows 'UNKNOWN' name with current date and time.

6.2.3 Test Case # 5

Test Case ID		TEST CASE_FUNCT_05	
Description		Tests the Image Information Button	
Applicable for		Entering into the Image Information Screen.	
Requirements		REQ_FUNCT_05	
Initial Conditions		User should be in the main screen through login screen.	
Step	**Full / Regr**	**Task & Expected Result**	
1		Open the main screen.	
2		Verify that the Image Information button is displayed.	**Pass** / Fail
3		User clicks the image's Information button.	
4		The images information screen is opened.	**Pass** / Fail

Table 6.5 Test Case #5

Comments:

The user gets access to the Image Information screen. Image information screen contains several functionality like enroll/validate the detail of a person and also browse image from bootable device.

6.2.4 Test Case # 6

Test Case ID		TEST CASE_FUNCT_06	
Description		Test upload image button	
Applicable for		Upload image from computer/portable device to display on picture box.	
Requirements		REQ_FUNCT_06	
Initial Conditions		User should be in image information screen through the main screen of the application.	
Step	**Full / Regr**	**Task & Expected Result**	
1		Open the Image information screen.	
2		Verify that the upload button is clickable.	**Pass** / Fail
3		Verify that the selected picture is upload and displays on the picture box.	**Pass** / Fail
4		Verify that the current face image is already exist/not exist in the database.	**Pass** / Fail
5		Verify if the face image exists show its personal details from database.	**Pass** / Fail
6		Verify that if the face image is not exists nothing will be displayed.	**Pass** / Fail

Table 6.6 Test Case #6

Comments:

If the current upload face image is not exists in the database then user manually save the detail of the person by save to database button which test case is given below.

6.2.5 Test Case # 7

Test Case ID		TEST CASE_FUNCT_07	
Description		Test save to database button	
Applicable for		Adding the person image and its detail to the database	
Requirements		REQ_FUNCT_07	
Initial Conditions		User should be in image information screen through the main screen of the application.	
Step	**Full / Regr**	**Task & Expected Result**	
1		Open the Image information screen.	
2		Verify the save to database button is clickable.	**Pass** / Fail
3		Verify All the required details of the person is entered.	**Pass** / Fail
4		User clicks the save to database button.	**Pass** / Fail
5		Verify that the image and its details are successfully saved.	**Pass** / Fail
6		Verify that an ok and reset button is displayed.	**Pass** / Fail

Table 6.7 Test Case #7

6.2.6Test Case # 8

Test Case ID		TEST CASE_FUNCT_08	
Description		Tests view database button	
Applicable for		User can view the database.	
Requirements		REQ_FUNCT_08	
Initial Conditions		User should be in image information screen through the main screen of the application.	
Step	**Full / Regr**	**Task & Expected Result**	
1		Open the Image information screen.	
2		Verify the view database button is clickable	**Pass** / Fail
3		User clicks the view database button to view all the person details.	**Pass** / Fail

Table 6.8 Test Case #8

Comments:

User can only view the database but user cannot make changes in the database.

6.3 Software Performance Testing

6.3.1 Test Case # 9

Test Case ID		TC_FUNCT_09	
Description		Tests application detecting faces performance	
Applicable for		Detecting faces as per time	
Requirements		REQ_FUNCT_09	
Initial Conditions		User is on the main screen of the video surveillance and the camera is in ON state.	
Step	**Full / Regr**	**Task & Expected Result**	
1		Open the video surveillance screen.	
2		Verify that the camera is ON and working properly.	**Pass** / Fail
3		Verify that the camera is detecting faces quickly within seconds.	**Pass** / Fail
4		Verify that the detected faces displays on the picture box quickly within seconds.	**Pass** / Fail

Table 6.9 Test Case #9

6.3.1 Test Case # 10

Test Case ID		Test Case_FUNCT_10	
Description		Tests application Recognition faces performance	
Applicable for		Recognize faces as per time	
Requirements		REQ_FUNCT_10	
Initial Conditions		User is on the main screen of the video surveillance or Image Information screen.	
Step	**Full / Regr**	**Task & Expected Result**	
1		Open the video surveillance/Image Information screen.	
2		Verify that image is displayed on the picture box.	**Pass** / Fail
3		Verify that the application is recognize the image quickly from the database.	**Pass** / Fail
4		Verify that the results are displayed quickly.	**Pass** / Fail

Table 6.10 Test Case #10

6.4 Compatibility Testing

6.4.1 Test Case # 11

Test Case ID		Test Case_FUNCT_11	
Description		Test system hardware compatibility	
Applicable for		Application works properly and efficiently.	
Requirements		REQ_FUNCT_11	
Initial Conditions		Hardware should be efficient and high specification.	
Step	**Full / Regr**	**Task & Expected Result**	
1		Verify that the application is working properly with Pentium 4 system.	Pass / **Fail**
2		Verify that the application is working properly with core i3 system.	**Pass** / Fail
3		Verify that the application is working properly with core i5 system.	**Pass** / Fail

Table 6.11 Test Case #11

6.4.2 Test Case # 12

Test Case ID		Test Case_FUNCT_12	
Description		Test camera compatibility	
Applicable for		Application detects faces properly and accurately.	
Requirements		REQ_FUNCT_12	
Initial Conditions		The camera should be of high resolution.	
Step	**Full / Regr**	**Task & Expected Result**	
1		Verify the detected faces from web camera.	**Pass** / Fail
2		Verify the detected faces from the IP cameras.	**Pass** / Fail

Table 6.12 Test Case #12

Comment:

When we run the application for detecting the faces the performance of the application becomes low because of the low quality web cam result.

6.5 Exception Handling Testing

6.5.1 Test Case # 13

Test Case ID		TC_FUNCT_13	
Description		Test camera exception handling	
Applicable for		Camera is properly working or not	
Requirements		REQ_FUNCT_13	
Initial Conditions		User is on the main screen of the video surveillance.	
Step	**Full / Regr**	**Task & Expected Result**	
1		Open the video surveillance screen.	
2		Verify that the camera start button and camera selection button is displayed as well as clickable.	**Pass** / Fail
3		User selects the camera and clicks the start button.	**Pass** / Fail
4		Verify that the camera capture is ready to display streaming.	**Pass** / Fail
5		Verify that the camera capture is not ready exception handles not to crash/stuck the application.	**Pass** / Fail
6		Verify that the camera capture is not ready then creates it to display streaming.	**Pass** / Fail

Table 6.13 Test Case #13

6.5.2 Test Case # 14

Test Case ID		TC_FUNCT_14	
Description		Tests the database exception handling.	
Applicable for		Database properly working and view information.	
Requirements		REQ_FUNCT_14	
Initial Conditions		User is on the main screen of the image information or database.	
Step	**Full / Regr**	**Task & Expected Result**	
1		Open the main screen of database/image information.	
2		Verify that the update/delete/view database information buttons is displayed and clickable.	**Pass** / Fail
3		Verify that the exception handles the update/delete/view database button.	
4		Verify that the information save/delete/update/view information successfully.	**Pass** / Fail

Table 6.14 Test Case #14

6.6 Security Testing

6.6.1 Test Case # 15

Test Case ID		Test Case_FUNCT_15	
Description		Login security.	
Applicable for		Login security of the Application.	
Requirements		REQ_FUNCT_15	
Initial Conditions		User should have the correct password.	
Step	**Full / Regr**	**Task & Expected Result**	
1		Open the login screen/menu.	
2		Verify the login password to access the application.	**Pass** / Fail
3		User enters the valid application Password.	**Pass** / Fail
4		User enter the invalid application password	Pass / **Fail**

Table 6.15 Test Case #15

6.6.2 Test Case # 16

Test Case ID		Test Case_FUNCT_14	
Description		Admin can accessed to the Database	
Applicable for		Updating and deleting of the image from Database.	
Requirements		REQ_FUNCT_14	
Initial Conditions		Admin is on the main screen through the login screen.	
Step	**Full / Regr**	**Task & Expected Result**	
1		Open the main screen and enters into the Database.	
2		Verify the database password to access the application.	**Pass** / Fail
3		Verify Admin enters the valid database Password for accessing database .	**Pass** / Fail
4		Verify Admin enters the invalid database Password for accessing database.	Pass / **Fail**

Table 6.16 Test Case #16

Comment:

Database contains all information of the persons. Database main screen has functionality of update and delete information. Administrator who has the password of database can only accessed these functionalities.

6.7 TEST RESULT :

6.7.1 TEST RESULTS OF IMAGES:

Name Of Image	Total No. Of Faces In Database	No. Of Faces In Image	No. Of Detected Faces	Recognise Faces	Not Recognise Faces
Image 1	32	14	14	14	-
Image 2	32	6	6	6	-
Image 3	46	4	4	4	-
Image 4	46	7	7	7	-

6.7.2 TEST RESULTS OF LIVE VIDEO FOOTAGE

Camera	Total No. Of Faces In Database	Total No. Faces Detected in Camera	Recognise Detected Faces	Not Recognise Faces
Web Camera	50	3	2	1
Web Camera	50	3	3	-

Chapter No. 7

CONCLUSION

Conclusion

Now a days, Image processing is considered to be an important part of Information technology, since every other system is moving towards the automated system. Various fields regarding security purposes require image processing for detecting and capturing of images.

The proposed system as of now, works by detecting the faces, recognizes it through video streaming or manual image uploading. Face detection is a process in which the foreground and background is distinguished separately, image processing is applied to extract the facial features of the subject and recognizes the identity of the individual.

The use of .Net enabled us to use image processing in this field, and to understand neural networks in depth. Moreover, by using open CV's wrapper EMGU in .NET we came to know about its benefits and uses, along with that the use of open CV's wrapper EMGU in .NET assisted in the image processing system. Coding, designing, documentation and gathering required information have been a part of the project. Time management, team work and division of work has enabled us to meet our proposed objectives.

Chapter No. 8

References

References

[1] Viola, Paul, and Michael J. Jones. "Robust real-time face detection."International journal of computer vision 57.2 (2004): 137-154.

[2] http://utarcvis.blogspot.com/2007_09_01_archive.html Time: 12:20 Date: 25/10/2014

[3] https://camo.githubusercontent.com/6f76ef015bb78ea01359c22840f5d28699c8b4b6/687474703a2f2f6661726d372e737461746963666c69636b722e636f6d2f363035342f373033303435353834355f353139663532653332355f7a2e6a7067 Time: 3:00 Date: 25/10/2014

[4] Roy, Mrs Sunita, and Samir K. Bandyophadyay. "Face detection using a hybrid approach that combines HSV and RGB." International Journal of Computer Science and Mobile Computing 2 (2013): 127-136.

[5] Turk, Matthew, and Alex Pentland. "Eigenfaces for recognition." Journal of cognitive neuroscience 3.1 (1991): 71-86.

[6] Eleyan, Alaa, and Hasan Demirel. "PCA and LDA based face recognition using feedforward neural network classifier." Multimedia Content Representation, Classification and Security. Springer Berlin Heidelberg, 2006. 199-206.

[7] Eleyan, Alaa, and Hasan Demirel. "PCA and LDA based face recognition using feedforward neural network classifier." Multimedia Content Representation, Classification and Security. Springer Berlin Heidelberg, 2006. 199-206.

[8] https://camo.githubusercontent.com/6f76ef015bb78ea01359c22840f5d28699c8b4b6/687474703a2f2f6661726d372e737461746963666c69636b722e636f6d2f363035342f373033303435353834355f353139663532653332355f7a2e6a7067 Time: 6:00 Date: 27/10/2014