COMSATS Institute of Information Technology
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Design and Implementation Report of

Hand Vein Biometric Based Recognition System

Submitted By

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Rameela Almas **(CIIT/ FA08-BCS-58/LHR)**

Session 2008-2012

Submitted To

Department of Computer Sciences

COMSATS Institute of Information Technology Lahore

A dissertation submitted to fulfill the Requirements for the Degree of

Bachelors in Computer Sciences

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APPROVED

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UNDERTAKING

The project titled **Hand Vein Biometric Based Recognition System** developed by **Saleha Ahmed & Rameela Almas** is dissertation as the partial fulfillment of the requirements for the degree of Bachelors in Computer Sciences (Session 2008-2012) from COMSATS Institute of Information Technology Lahore.

The candidates confirm that the work submitted is their own and appropriate credit has been given where reference has been made to work of others

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EXECUTIVE SUMMARY

A reliable personal identification system is important now days using a person's physiological and behavioral features. The identification of a person through his/her physiological and behavioral features prevents data forgery, data theft and identification theft. The proposed identification system is especially designed for the ladies who observe Hijab and cover their faces. Many different methods of identification are already in use such as fingerprint scanning, eye retina scanning, signatures and many more. The hand vein biometrics is gaining popularity and has emerged as a new technology in biometric system. This project aims at developing a very low cost and efficient identification system using Hand vein Patterns. A specially designed infrared sensitive camera captures the Hand vein image and then it is further processed for identification and verification. The whole process consists of four modules; image acquisition, image processing, feature extraction and matching module. After the image is acquired, the algorithms designed for extracting the patterns of the vein collects the template and pre-process it. This preprocessed template is stored in to a database and when the person is to be verified the new template is matched with the already stored one for identification.

DEDICATED TO OUR PARENTS & TEACHERS

ACKNOWLEGMENTS

We are grateful to Almighty Allah and our loving parents whose prayers were always with us throughout the project. We are thankful to Sir Imran Raza for providing us a great opportunity to design this system. As supervisor his support and guidance has been a very valuable asset for our project. His keen interest and discussion over the work have been very helpful in the difficult times. We are really thankful to his worthless contributions in our project work.

1 INTRODUCTION

1.1 A VERY BRIEF INTRODUCTION OF PROJECT WORK

This report proposes the Hand Vein Biometric Recognition System. This is designed to take image from a modified webcam, performs the image processing and then extracts features from the image for verification.

Nowadays, as technology is advancing very fast, public are getting more and more conscious and aware towards information safety. Often we hear in news about bank accounts are hacked into, credits cards are stolen and etc. In order to preserve information safety, security access system has to be employed. Traditional security access systems based on passwords, personal identification numbers (PINS), swipe-cards, keys, and so on offers limited security and usually unreliable. These methods can be compromised and breached very easily where these methods can be hacked, duplicated or forged. This breaching of security happens when password is divulged to an unauthorized user or a badge is stolen by an impostor. The key to overcome the disadvantages of traditional methods is to use biometric system.

Biometric is science of identifying a person by using their physiological or behavioral features. These features are such as face, fingerprint, iris, voice, palm print, retina, hand geometry, facial thermograms, signature, and hand vein. These features possess the properties of universality, uniqueness, permanence, collectability, acceptability and circumvention. Thus, a biometric technique has become a new face for authentication in security access system. Biometric

system provides more reliable feature because these features cannot be forgotten. Apart from that, these features are difficult to duplicate and most importantly it requires the person to present there for authentication.

Currently, hand vein is gaining popularity and has become new technology in biometric system. This is because hand vein pattern is unique for every individual. Many researches have been done to improve this hand vein system in order to produce a reliable, robust, faster and low-cost system.

Embedded systems have become increasingly popular as advances in IC-technology and processor architecture allow for flexible computational parts and high-performance modules integrated on a single carrier. Embedded system interacts with the physical world. It executes on machines that are not computers. They are cars, airplanes, telephones, audio equipment, robots, appliances, toys, security systems and so on. These embedded systems perform functions that are carefully partitioned in software and hardware to strike a fine balance between flexibility, reusability, performance and cost. Embedded system provides a medium of secure communication, secure information storage, and tamper resistance which protect from both physical and software attacks.

The Hand vein biometrics is gaining popularity now days as a person has unique vein pattern of the back of the hand. The system proposed is designed for the identification and verification of a person. The identification of the user is done by acquiring images from the camera and after performing the image processing techniques on it, the image templates are then stored in a database. We are using the back of the hand vein pattern as the biometric feature of a person for his/her identification and verification.

The system is designed in a way that it is divided into four basic modules like Image Acquisition, Feature extraction, Matching and then decision making. All these steps complete our system. Two matching techniques have been used to identify the person i.e. The Hamming Distance Matching and Minutiae Point extraction.

1.2 OUTCOME OF YOUR WORK

In the software part we have taken images of the back of the hand vein pattern of different subjects and compiled a database their patterns with the existing images of their vein pattern. We also designed a very compact prototype design of the hardware in which we installed the webcam and the Infrared source where the images are taken.

The Webcam is attached to the computer from which the images are taken and the Infrared source is placed at the back of the webcam to illuminate the surface and make the image clearer. The subject places the hand on the rod and the image acquisition is done. Further techniques that we have used to extract features are done by the software and the identification and verification process is done.

1.3 TOOLS

For developing the software part of the project we used MATLAB. MATLAB was used to create the design and the GUI of the system.

1.4 METHODOLOGY USED

The whole system is divided into four major modules

- The Image Acquisition Module
- The Feature Extraction Module
- The Matching Module
- The Decision Making Module

1.4.1 The Image Acquisition Module

It works on acquiring the data under consideration from the person's physiological features. In the Image Acquisition module the webcam is fixed in the hardware prototype and the infrared source is fixed at the back of it to make the image clearer and brighter. The camera used for this purpose is a specially designed webcam which doesn't block infrared light.

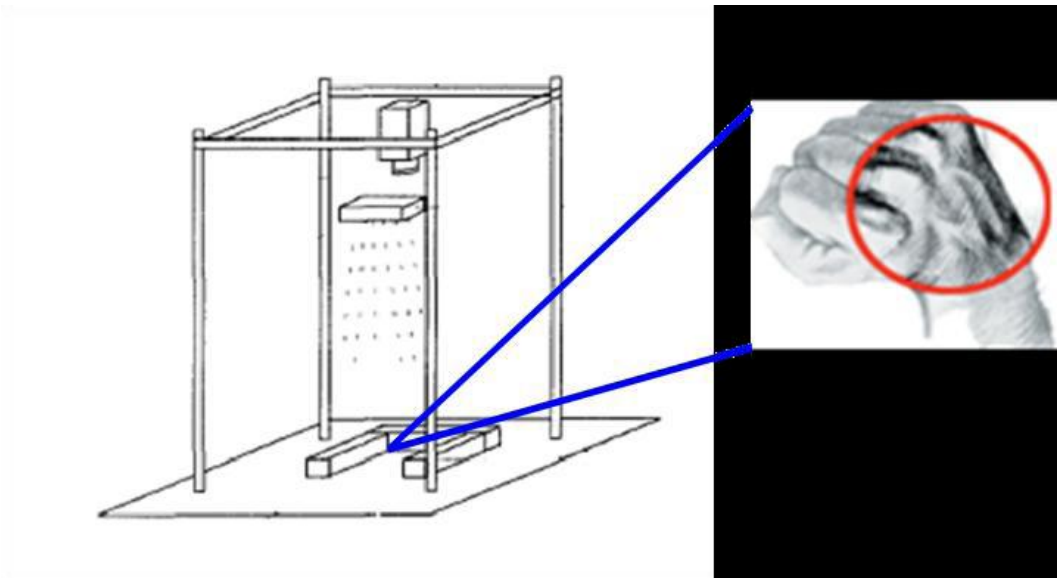

Figure 1.0 Image Acquisition [4]

1.4.2 The Feature Extraction Module

It works on extracting the feature vectors from the acquired data. When the image is taken in the first module it is then pre processed to extract the features out of the image. The pre-processing techniques that we used in the system were Median Filtering, Histogram Equalization, Resizing, Thresholding, Opening and Closing and then skeletonization.

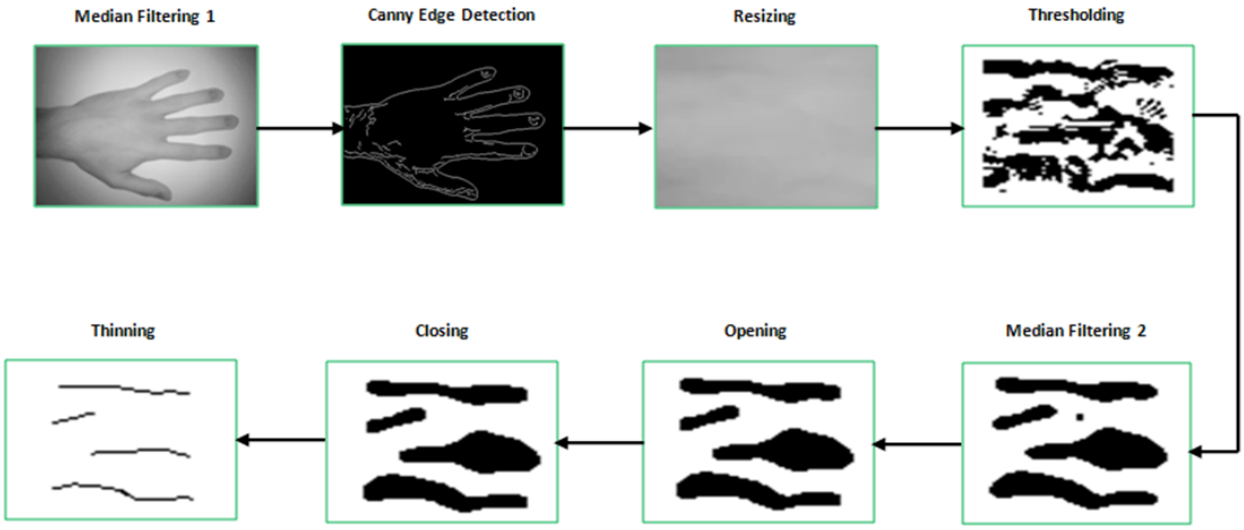

Figure 2 Feature Extraction [4]

After the pre processing of the image is done the features are extracted from that image. The feature extraction technique utilizes the minutiae point extraction. The minutiae points include bifurcation points and ending points. These feature points are used as a geometric representation of the shape of vein patterns. From this minutiae point a template was generated and from this template the threshold is determined.

1.4.3 The Matching Module

It works on matching the features with the already acquired images in the database. The matching process is done in the way that different algorithms can be followed to do image matching depending upon the nature of the database. The most common matching techniques used for hand vein biometric recognition is the hamming distance matching and hausdorff distance matching.

1.4.4 Decision-Making Module

It works with establishing and claiming the user's identity as it is accepted or rejected. So, this module actually identifies and verifies a person.

1.5 HIGHLIGHTS OF DISCUSSIONS IN VARIOUS CHAPTERS OF REPORT

The report consists of ten chapters, the first chapter is consisting the Introduction, Tools, Background of the Project, the Literature Review and its analysis plus the software lifecycle.

Chapter 2 will be containing a detailed discussion of the problem and how it was solved, what types of development requirements were needed and the feasibility of the new system.

Chapter 3 contains the already existing Hand Vein Biometric System Details

Chapter 4 will include the Requirement specification of the projects including its functional and nonfunctional requirement and the system Architecture and Design.

Chapter 5 will consist of the System Architecture and Design plus the implementation of the system.

Chapter 6 will include the Implementation explained with the help of Component Diagram, User Interface detail.

Chapter 7 will be the Testing and Evaluation Chapter that will include the Module Testing, Hardware Configuration testing and the Usability testing.

Chapter 8, 9 and 10 will be of the Deployment, Maintenance and Conclusion of the whole report.

1.6 RELEVANCE TO COURSE MODULES

In the system we designed it is related to our Digital Image Processing course and the Database course we studied. As the project does the image processing on the subject's hand, extract features from the image and does the image matching process for a person's identification and verification. The database is used to store the images and required detail about the person. So, the courses of Digital Image Processing and Database have a great part in our project.

1.7 PROJECT BACKGROUND

Safety is one of the most important needs of today, the reason behind proposing this system is to have some security system designed for females who wear hijab and cover their faces with veil. As there are already security systems available like the retina scanning and finger print detection, but to build a system that is very cheap and reliable is the major purpose of the project.

There are different methods used now days for security purposes like passwords, swipe cards, keys and so many other but they are very unreliable and give very limited security. So, to

develop a system that is reliable and valid to ensure security and can be used for a person's identification and verification is the major reason behind this system.

Biometric features are a person's physiological and behavioral features that are permanent, universal, unique, collectable and acceptable. These features are used widely for a person's identification and verification like fingerprints, retina, iris, voice, face, and signature and hand vein. Due to the properties of biometric features in a person the authentication is very much easy and reliable.

Other biometrics such as face, fingerprint and iris images have been studied very extensively for a person's verification, but verifying a person by his/her hand vein pattern is less developed.

There is a lot of work been done on other biometric systems and hand vein pattern biometric feature is now days in the spot lights as every individual has a very unique hand vein pattern of his/her back of the hand and hence the system which is to be designed will no doubt be producing very reliable, faster and valid results.

This hand vein biometric recognition system can give very high performance, as it can be integrated to be an embedded system which can not only work with other systems but can be used as a stand-alone system.

1.7.1 BIOMETRICS

Biometrics is derived from two ancient Greek words "bios" that means LIFE and "metron" that means "Measure", so it is defined as an "automated method of identifying or authenticating

the identity of a living person based on a physiological or behavioral characteristics" [1]

There are different biometric features in a human body that can be used for a person's identification and verification like Fingerprints, Retina, Iris, Gait, Signature, Face, Hand Geometry and many more.

All of the above mentioned systems use three basic methods to work on.

* A scanning Machine to capture or scan the image of the person's living personal characteristic

* Processing on the acquired image and to store into some database.

* Interface with the application systems.

The Biometric features of a person are the permanent, easy to obtain, universal and unique.

Figure 3 Biometric Features

This physiological or behavioral characteristic used for identification actually follows some requirements.

- Universality: Every person must have the characteristic.

- Uniqueness: Two distinct people cannot have the same characteristic.

- Permanence: This characteristic cannot change according to the time.

- Collectability: This characteristic can be measured quantitatively.

- Performance: The identification process must present an acceptable result.

- Acceptability: Indicates to what extent people are willing to accept the biometric system.
- Circumvention: Refers to the ability to get destroyed.

1.7.2 Biometric Systems

Biometric Systems are the pattern recognition systems that are based on recognizing a person by his/her biometric feature that he possesses. The feature is acquired through some scanner and the images are stored in a database after processing. The biometric systems that are based on a person's physiological characteristics are more reliable and are very easy to integrate. The major Biometric system's tasks are the Identification and Verification of a person.

Identification is done in a manner that it involves the comparing of acquired biometric information of a person with all the templates stored in the database where as the Verification process involves the matching of the exact template with the one in database and producing exact result.

1.8 LITERATURE REVIEW

Literature review had been going on throughout the project process in order to gain knowledge about the system to be developed. We studied different books, research papers and material we obtained from the internet regarding the system.

In [1] authors propose an efficient hand vein based recognition system using Fast Correlation of Near Infrared Hand Vein Patterns. Initially a data set of 50 persons was proposed with FAR of 0.02% and FRR of 3.00% at threshold 80. The efficiency rate of this proposed system was 99.95%, acceptance rate 97% and Reject Rate of 99.98%. The system used thermo graphic imaging in the near infrared spectrum and CCD camera (1100 nm) was used with a solid state infrared source. The matching ratio was 81.87% (Same person) and 48.27% (different persons). The system was used for medium to low level security level.

In [2] authors propose a recognition system using hand vein biometric was implemented in MATLAB and was tested on WASET hand vein image database. This proposed system has a very high verification accuracy rate of 99.5% by direct image comparison and FAR upto 2.3% which is very high. This system had an Equal Error Rates of 0.0145%.

In [3] the authors tested 108 images of 12 persons (9 from each) and on 9 threshold the FAR was 0% and RR was also 0%. As this system was a thermal hand vein pattern verification system the major draw backs of the systems were the atmospheric conditions which affected the quality of the images taken from a thermo-graphic camera.

In [4] the authors proposed a hand vein verification prototype that tests the performance and patterns similarity. A CCD video camera was installed with an infrared filter to capture the images of hand vein patterns of different subjects. The maximum efficiency rate of the testing set was reported as 99.888% at threshold 78 and the sensitivity was 92.16%, Specificity was 99.966%, FAR was 0.03% and FRR was 7.84%.

In [5] the authors designed a verification system by using the images a person's back of the hand and identifying a person by the knuckle tips this method has an EER of 1.77%. as a dataset of 100 users was taken with FAR and FRR of 1.14%.

In [6] the author has taken dorsal hand vein pattern using Quadratic Interference Function and a total database of 100 users have been tested FAR of 0.02% and FRR 0f 0.03%.

1.9 ANALYSIS FROM LITERATURE REVIEW

Ref. No	Method	Dataset (persons)	FAR	FRR	EER	Efficiency	Accuracy
1	vein based recognition system using Fast Correlation of Near Infrared Hand Vein Patterns	50	0.02%	3.00%	0.25%	99.95%,	97%
2	Hand Vein Rec Sys using WASET Database		2.3%	2.3%	0.0145%		99.5%
3	thermal hand vein pattern verification system	108	0%	0%	-	99.5%	
4	hand vein verification prototype		0.03%	7.84%		99.888%	99.76%
5	knuckle tips recognition system	100	1.14%	1.14%	1.77%.		
6	dorsal hand vein pattern using Quadratic Interference Function	100	0.02%	0.03%			

Table 1 Comparison of Vein Recognition technoques

CHAPTER 2

PROBLEM DEFINITION

2. PROBLEM DEFINATION

This section discusses the precise problem to be solved. It should extend to include the outcome.

2.1 PROBLEM STATEMENT

Security has been the major issue of today's world, as it is very important to have a reliable personal identification system. There are already many Hand Vein biometric based identification systems available but the major problems with those hand vein biometric based identification systems were that they were more prone to data forgery and information theft. A thermal or CCD cameras were used to acquire image of a person's hand but in this proposed system a specially designed camera is used to capture the images of hand vein and are processed through computer. In the already existing hand vein biometric based identifications systems there was not any registration part involved like adding a user from database and deleting an unwanted user. Those systems used the folders of images like for adding a new user they had to rename the existing images and removing the user was even more complicated like the entire folders were deleted and it was very much complex. This system uses a database for registering the users and users can be added and deleted very easily from the database.

2.2 DELIVERABLES & DEVELOPMENT REQUIREMENTS

The Tangible and Intangible parts of the project are the hardware prototype and the software part for image processing.

2.2.1 Hardware

The hardware part consists of a very compact and a specially designed prototype for taking images of the hand vein in a suitable environment. The hardware is shown in the below

figure 5, it was ensured that the hardware should be able to fulfill the project requirements and should be very cost effective.

2.2.1.1 The Setup

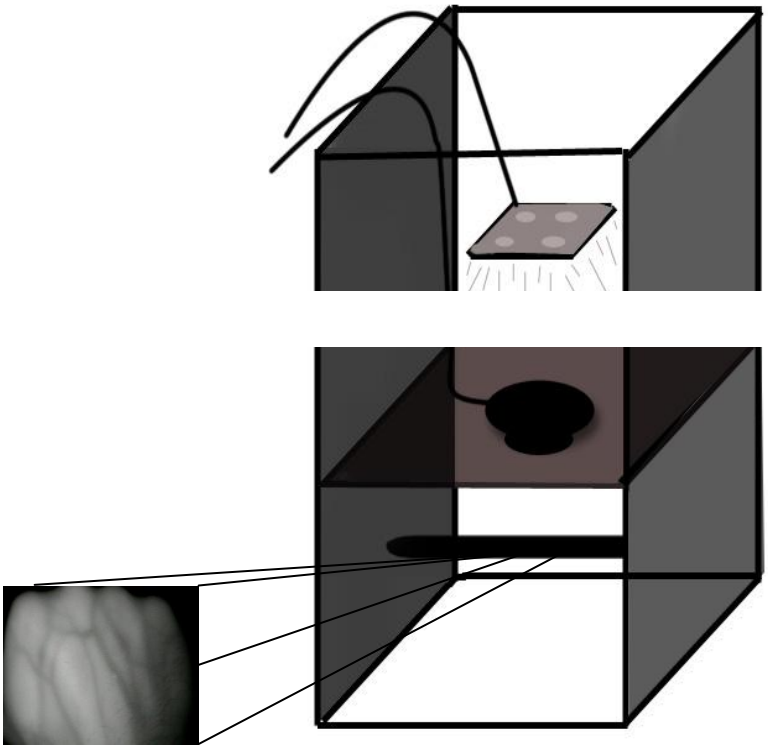

Figure 4 Hardware [8]

The image acquisition part of the system was to be done in a very confined environment. It was to make sure that different physical conditions like temperature, humidity and light etc. should

least alter the database images. These factors affect immensely the image acquisition. The setup was made of Black Acrylic, as we wanted the setup to be opaque and darkening of the inner surface was required to ensure minimum reflection takes place. The dimensions of the setup ware 12*10*18 inches. Another Acrylic sheet was used as a base to mount the camera and to paste the diffusion paper over it.

At the bottom there is a space left open for the hand insertion and a bar is placed there so that a person's hand should be at the same place probably. He is to hold that bar so he hand remains there.

2.2.1.2 Camera Modification

As one of the goals of this project was to make it cost effective, so a simple webcam was taken and modified to make it IR sensitive. The modification process is done by simply opening the camera carefully and the filter is removes and the camera is closed again and hence it starts detecting IR rays. Most of the cameras have an infrared filter just before the lens which stops the IR rays to enter the lens, so it was removed for the project to make it IR sensitive. The modification process of the camera was read and understood carefully by internet and some technicians. The fig 5 and 6 shows how we modified the camera to make our system.

Figure 5 Camera Modification

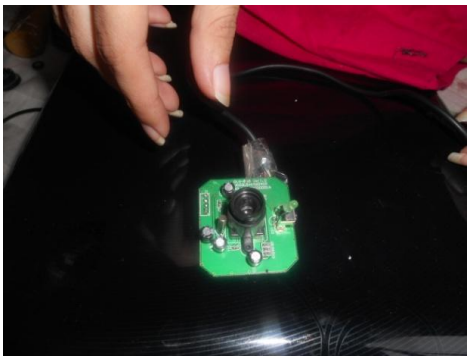

figure 6 Camera Modification

2.2.1.3 Infrared Source

The Infrared Source is used shown in figure 7, which is a circular array of concentric LED's that operates in near IR region (750 nm) and it works on 12 V. This IR source is fixed on the top of the glass base and the LED light falls on the glass base with diffusion paper and then the light falls on the hand.

Figure 7 Infrared Source

2.2.1.4 Light Diffusion

A diffusion paper of length slightly longer than the width of the box is used and pasted over the Acrylic sheet (fig 8, fig 9). This paper is used to evenly distribute the light on the person's hand.

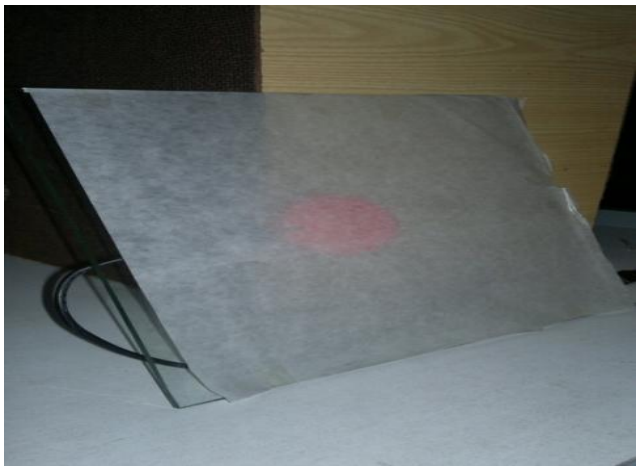

Figure 9 Diffusion paper

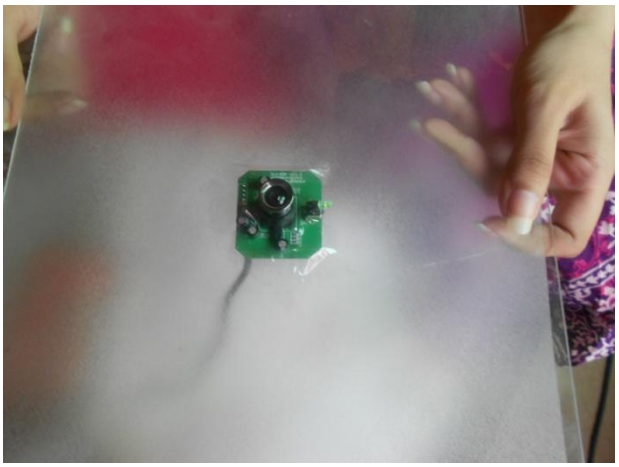

Figure 8 Light Diffusion

2.2.2 Software and Feature Extraction Techniques

The techniques used for extracting features from the hand vein image are the Median Filtering, Histogram Equalization, Adaptive Thresholding, Image Erosion, Image Dilation and Skeletonization.

2.2.2.1 Median Filtering

Median Filtering is a type of Noise reduction (Fig 10); it is one of the best pre-processing techniques that is done to enhance the image quality for later processing. It does preserve edges but removes noise from the image and is used greatly in Digital Image Processing.

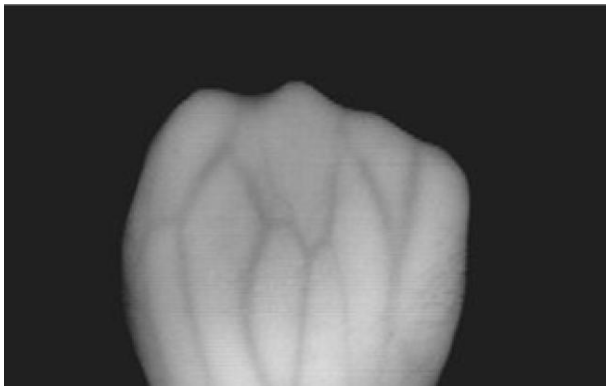

Figure 10 Median Filtering

2.2.2.2 Histogram Equalization

Histogram Equalization is a method used for making the contrast adjustment. By applying this adjustment the intensities are distributed equally. For the images having background and foreground colors this type of adjustment is very much good. The below figure 11 and figure 12 shows the histogram equalization on a normal image with a light background n foreground colors.

Figure 11 Histogram Equalization [5]

Figure 12 Histogram Equalization [5]

2.2.2.3 Adaptive Thresholding

Thresholding is used for image segmentation from a gray scale image to create a binary image. In thresholding an individual pixel is marked as "object" pixel and a value is set to know whether the image's pixels are below the threshold or above the threshold. Hence the images are segmented. In our project we have used this technique for segmenting the image and converting it into binary image Figure 13.

Figure 13 Thresholding

2.2.2.4 Image Erosion

Erosion is used in digital Image processing as it shrinks the size of the object and when we use erosion on gray objects it reduces the brightness by taking the minimum neighborhood. Whereas when the Erosion process is used for a Binary image it completely removes the objects which are smaller than the structuring element. As in the figure 14 below you can see how it has worked in our project.

Figure 14 Image Erosion

2.2.2.5 Image Dilation

Image dilation actually increases the size of the object and as we mentioned above in the process of erosion that the objects below the structuring element is removed, while in dilation the size of the object is doubled. After the erosion process we have used the image dilation in our system for feature extraction Fig 15

Figure 15 Image Dilation

2.2.2.6 Skeletonization

Skeletonization is also known as “Thinning”. It is a very common pre-processing technique used normally in raster to vector conversion. It extracts are region based shape that re[resents the general form of an object Fig 16.

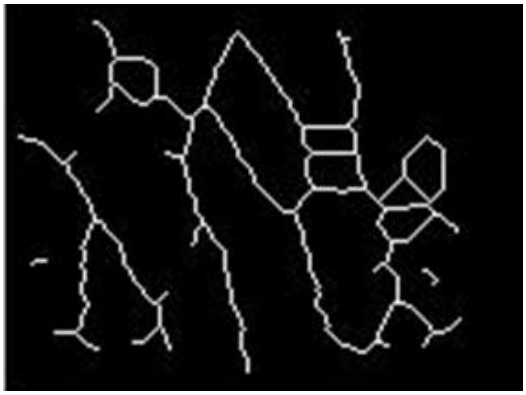

Figure 16 Skeletonization

2.2.3 Image Matching

2.2.3.1 Hausdroff Distance

Hausdroff distance is named after the person Felix Hausdroff, it is also known as Hausdroff metric or Pompeiu0Hausdroff distance. It measures how far two subsets of a metric space are from each other. This method works in the way

"Two sets are close in the Hausdroff distance if every point of either set is close to some point of the other set"

In other words you can say that it is the farthest point of a set that you can be to the closest point of a different set.

Definition: If *X* and *Y* are two non-empty subsets of a metric space (M, d), so the Hausdroff distance can be $d_H(X, Y)$ by

$$d_{\mathrm{H}}(X,Y) = \max\{\sup_{x\in X}\inf_{y\in Y} d(x,y), \sup_{y\in Y}\inf_{x\in X} d(x,y)\}, \quad \text{------ (i)}$$

Where sup is the supremum and inf the infimum

So,

$$d_H(X,Y) = \inf\{\epsilon > 0;\ X \subseteq Y_\epsilon \text{ and } Y \subseteq X_\epsilon\} \text{ ----------(ii)}$$

where

$$X_\epsilon := \bigcup_{x\in X}\{z \in M;\ d(z,x) \le \epsilon\}$$

,

That is, the set of all points within ε of the set X (sometimes called a generalized ball of radius ε around X).

Hausdroff distance is used in different ways in different fields of Computer Sciences, like in Computer Vision it is used to find a template in an arbitrary target image. A binary image is given via edge detector the image or template is pre-processed. Every point of a binary image is treated as a point in a set. So the whole image is treated as set of points, this algorithm then tries to minimize the hausdroff distance between the template and some are of the target image. And the image with minimal hausdroff distance to the template is considered the best candidate.

CHAPTER 3

CURRENT SYSTEM

3. CURRENT SYSTEM

As this system is designed especially for the ladies who cover their faces and are not comfortable with getting themselves identified by their face as they have to remove the veil, so let us discuss some currently used biometric recognition systems that do not require face exposure but other biometric features to identify a person like signature, Gait, Keystroke, Odor, Hand vein pattern, ear shape, Hand geometry, fingerprints, retina, Iris, Palm print and voice.

So let us explain all the other current biometric systems used for identification and verification of a person without taking the veil off of the ladies.

These Biometric features have been proposed and some are in use at many different levels but there are some problems mentioned in these systems like some of them are not acceptable, some are expensive and so many other issues.

- **Gait**

Gait is a person's peculiar way of walking and it is one of the newer systems used for a low-security application. But it is not yet reliable way of identifying a person as with age and change in the weight of the body or serious brain damage a person's gait changes, but there are different video-sequence techniques used for measuring different movements but are expensive. Figure 17 shows the complex spatio-temporal biometrics of the gait of a person.

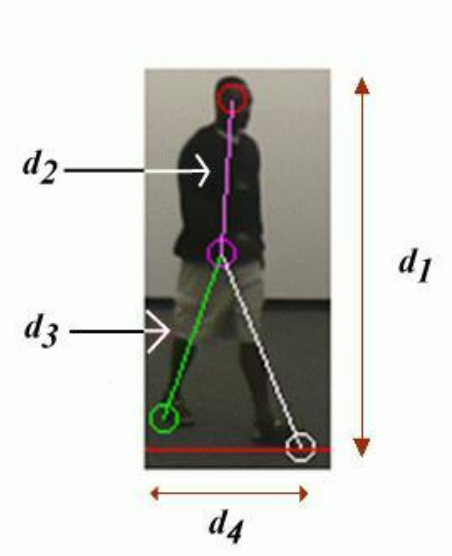

Figure 17 Gait [4]

- **Keystroke**

Keystroke dynamics is a behavioral biometrics and you can differentiate a person by his typical typing patterns. In figure 18 it is shown that each person types in a characteristic way, while observing a person's keystroke only there is a privacy issue but the good part is that it can be monitored very easily.

Figure 18 Keystroke[8]

- **Ear Shape**

Ear shape and the structure of cartilaginous tissue of pinna are distinctive but its is one of the suggested methods of recognition but is not believed to be distinctive.

- **Hand Geometry**

The dimensions of a person's joints, fingers, shape and size of palm are the characteristics in which a person is compared due to his/her hand geometry. The technique is very simple, cheap and easy to use. But as the hand geometry of people are not distinctive so it cannot be used for identification. If you have arthritis or you are wearing jewelry then the correct information about your hand geometry cannot be extracted

- **Finger Print**

Finger prints scanning is a very efficient and accurate way of identification and has been used widely for centuries. Fingerprint recognition for identification acquires the initial image through live scan of the finger by direct contact with a reader device that can also check for validating attributes such as temperature and pulse. Since the finger actually touches the scanning device, the surface can become oily and cloudy after repeated use and reduce the sensitivity and reliability of optical scanners. Solid state sensors overcome this and other technical difficulties because the coated silicon chip itself is the sensor. Solid state devices use electrical capacitance to sense the ridges of the fingerprint and create a compact digital image. Today, a fingerprint scanner costs about 20 USD and has become affordable in a large number of applications (laptop computer). In real-time verification systems, images acquired by sensors

are used by the feature extraction module to compute the feature values. The feature values typically correspond to the position and orientation of certain critical points known as minutiae points [4]. The matching process involves comparing the two-dimensional minutiae patterns extracted from the user's print with those in the template. One problem with the current fingerprint recognition systems is that they require a large amount of computational resources.

- **Retina**

Retinal recognition actually creates an “eye signature” from the vascular configuration of the retina which is supposed to be a characteristic of each individual and each eye, respectively. As it is protected by the eye itself so it is very easy to replicate. It works in the way as the person is supposed to look through a lens at an alignment target and the eye is scanned. This method is not so acceptable by the public as it reveals some medical conditions.

- **Palm Print**

Like fingerprints, palms of the human hands contain unique pattern of ridges and valleys. Since palm is larger than a finger, palm print is expected to be even more reliable than fingerprint. Palm print scanners need to capture larger area with similar quality as fingerprint scanners, so they are more expensive. A highly accurate biometric system could be combined by using a high-resolution palm print scanner that would collect all the features of the palm such as hand geometry, ridge and valley features, principal lines, and wrinkles.

Voice

The features of an individual's voice are based on physical characteristics such as vocal tracts, mouth, nasal cavities and lips that are used in creating a sound. These characteristics of human speech are invariant for an individual, but the behavioral part changes over time due to age, medical conditions and emotional state. Voice recognition techniques are generally categorized according to two approaches:

1) Automatic Speaker Verification (ASV) and 2) Automatic Speaker Identification (ASI). Speaker verification uses voice as the authenticating attribute in a two-factor scenario. Speaker identification attempts to use voice to identify who an individual actually is. Voice recognition distinguishes an individual by matching particular voice traits against templates stored in a database. Voice systems must be trained to the individual's voice at enrollment time, and more than one enrollment session is often necessary. Feature extraction typically measures formants or sound characteristics unique to each person's vocal tract. The pattern matching algorithms used in voice recognition are similar to those used in face recognition.

- ## Signature

Signature is a simple, concrete expression of the unique variations in human hand geometry. The way a person signs his or her name is known to be characteristic of that individual, Figure 19. Collecting samples for this biometric includes subject cooperation and requires the writing instrument. Signatures are a behavioral biometric that change over a period of time and are influenced by physical and emotional conditions of a subject. In addition

to the general shape of the signed name, a signature recognition system can also measure pressure and velocity of the point of the stylus across the sensor pad.

Figure 19 Signature [8]

- **Hand Vein Pattern**

The vein patterns are the vast network of blood vessels underneath a person's skin. The vein pattern in the back of the hand is unique for each individual [2]. Every individual has their own vein pattern and this also applies to identical twins as they also have different vein patterns [3]. Because of this uniqueness of vein pattern, it provides a good distinction between individuals. In addition to that, vein patterns also differ for each hand. Right hand and left hand has different vein patterns [3].

Vein patterns are large robust internal patterns where it does not change with time except for the size of the hand. This causes the vein pattern in the back of the hand remains stable over a long period of time [4]. Apart from that; veins are hidden underneath the skin. This makes the vein patterns not easily observed as it is invisible to human eyes [3]. Hand vein is not affected by situation of the outer skin (e.g. dirty hand) and less vulnerable to attacks. Intruders will find it hard to forge, duplicate, replicate or reproduce the vein patterns as compared to other biometric features.

Vein patterns are not easily observed, damaged, obscured or changed. The properties of uniqueness, stability and strong immunity to criminal tampering, makes it a potentially good biometric which offers secure and reliable features for authentication system.

Currently there are different systems on hand vein biometrics are in use like the personal verification system by using the thermal-imaged vein pattern of the back of the hand and uses the Hausdorff distance method by recognizing the shapes of the and vein pattern and measuring the line segment. There are different flaws in this current system for example we have the images captured of the vein pattern in a normal office environment.

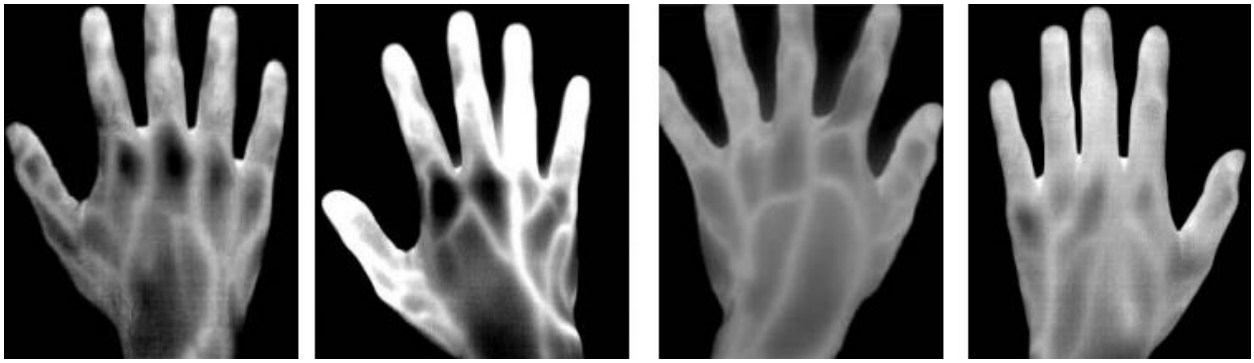

Figure 20 Thermal Hand Vein Image [2]

The above figure 20 is the image taken in an office environment where the temperature and humidity are lower than the outside environment. You can see that the vein patterns are easily distinguishable.

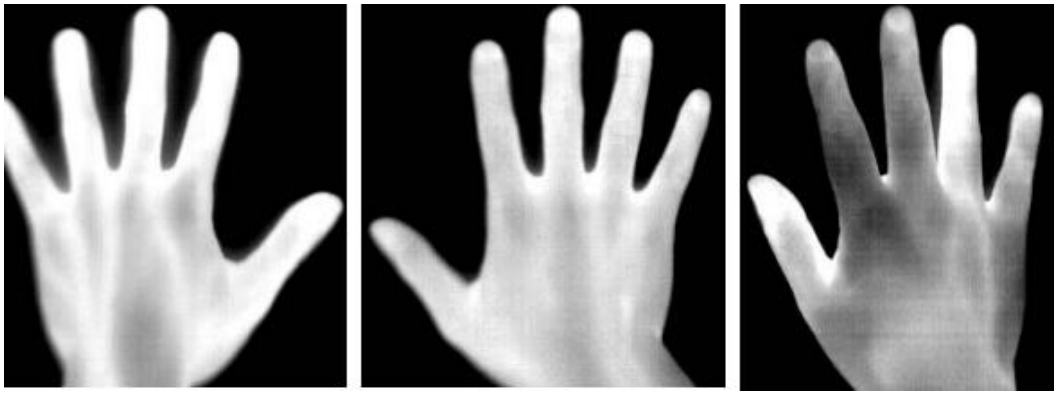

Figure 21 Thermal Hand vein image [2]

Now if you see the figure 21, we see that temperature and humidity have a very negative effect on the image quality, as these images were taken in an outdoor environment for the better performance of the system. So, we see that by using a thermal camera we had to stick with one environment and the image acquisition was a problem.

CHAPTER 4

DESIGN & ARCHITECTURE

4. DESIGN & ARCHITECTURE

4.1 SYSTEM ARCHITECTURE

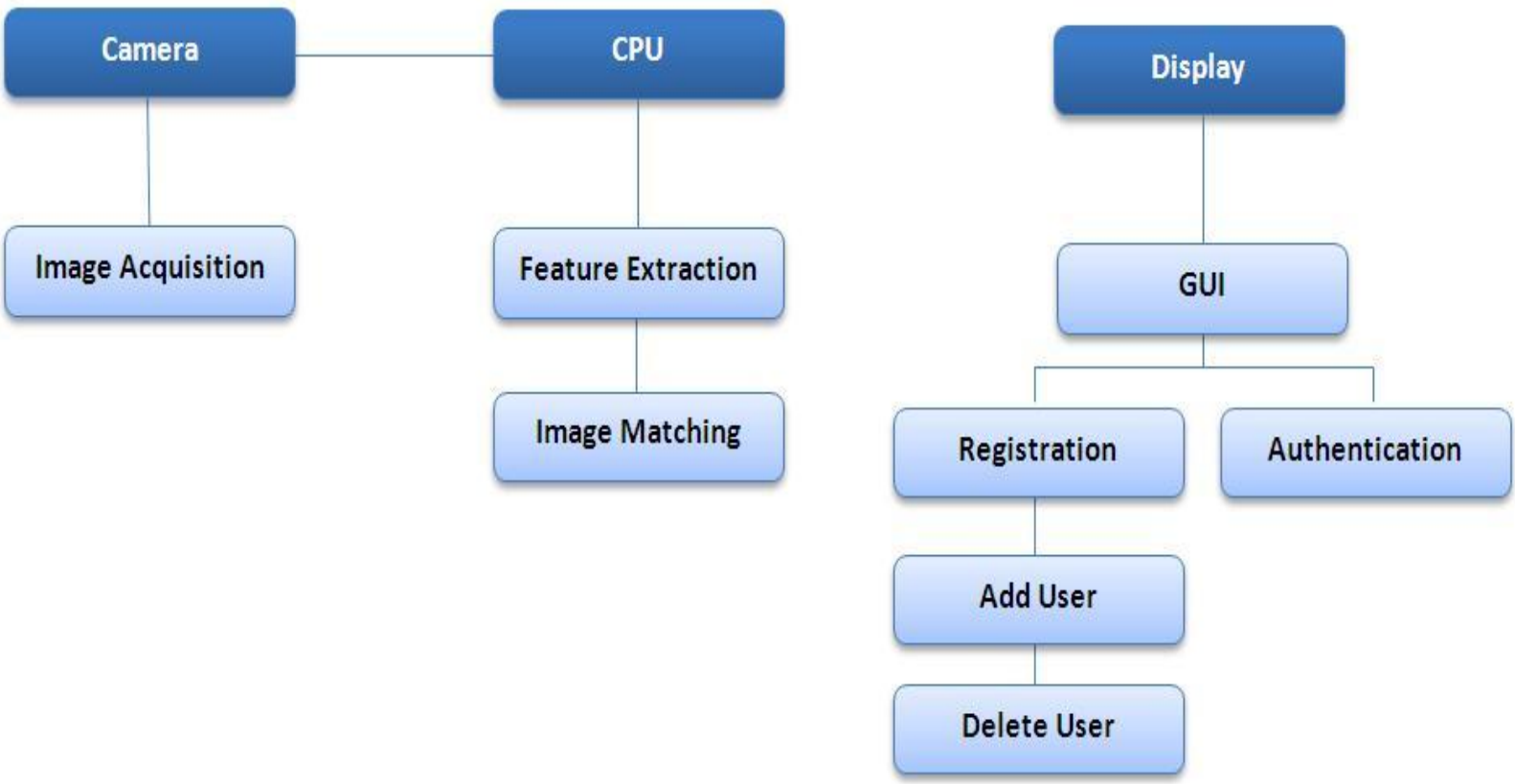

Figure 22 System Architecture

4.2 SYSTEM DESIGN

4.2.1 System Flow Chart

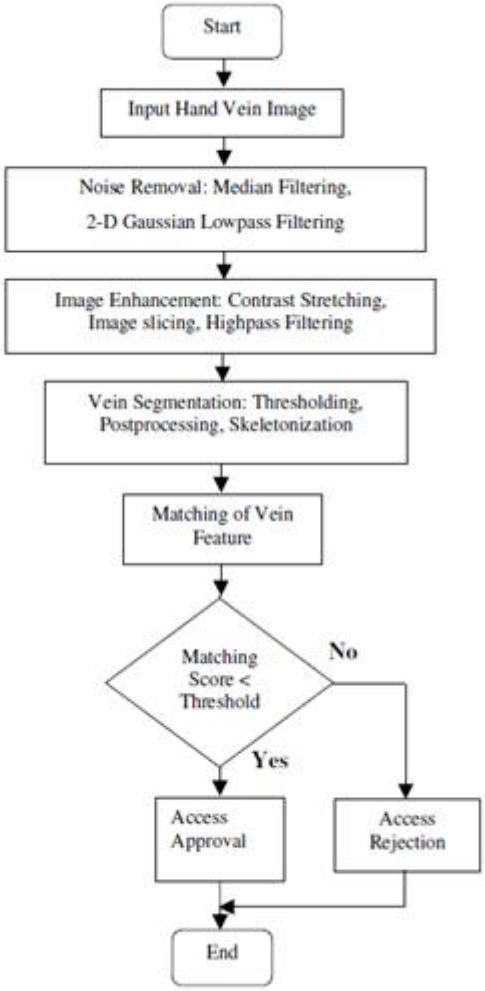

Figure 23 System Flow chart

4.2.1.1 MODULAR FLOW CHART

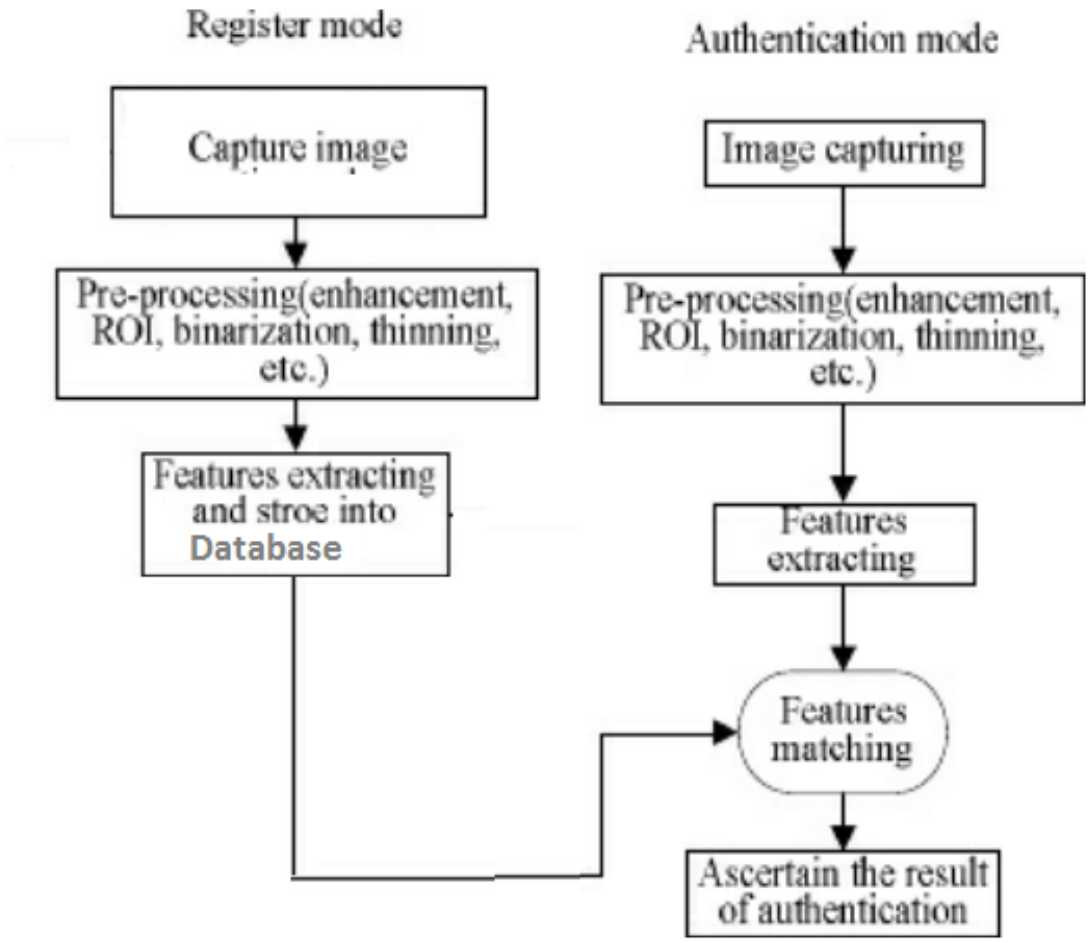

Figure 24 Modular Flow chart

CHAPTER 5

TESTING

&

EVALUATION

Revision History

Date	Version	Description	Author
06/06/12		Hand Vein Biometric Based Recognition System	Saleha Ahmed Rameela Almas

5. Test Plan

5.1 Introduction

5.1.1 Purpose

This Test Plan document for the Hand Vein Biometric based Recognition System supports the following objectives:

Software components that require testing in the project are

5.1.1.1 Image Acquisition

In the image acquisition we test whether the modified camera is taking the proper image as we have re-defined. The camera we used is a modified webcam and is made Infrared sensitive to capture images in a closed environment with infrared radiations around.

5.1.1.2 Pre-Processing

Image pre-processing module is very much important in our system as after the image acquisition the features are extracted from the image of the person's hand. The following functions need to be tested in the pre-processing phase

Median Filtering

Histogram Equalization

Thresholding

Image Erosion

Image dilation

Image skeletonization

Hausdroff Distance matching

Minutiae point extraction

5.1.1.3 Matching

5.1.1.4 User Registration

5.1.1.5 User Deletion

5.2 Background

The Hand Vein Biometric Based System proposed is designed incorporates a complete system that can receive image from specially designed infrared webcam and perform image processing, extraction of the biometric feature from the image and authenticate the template stored in database.

Biometric hand vein system involves four stages. The stages are image acquisition, image pre-processing, feature extraction and image matching [1]. Image acquisition is done by the modified webcam while image pre-processing, feature extraction and image matching is done on the PC.

5.2.1 Scope

As we have divided the project into modules so we will be performing 4 types of testing in our project

5.2.1.1 Unit Testing

The system consists of four modules:

5.2.1.1.1 Image Acquisition

In image Acquisition Module the hand image of different persons were taken from the modified camera, the veins of the persons were visible.

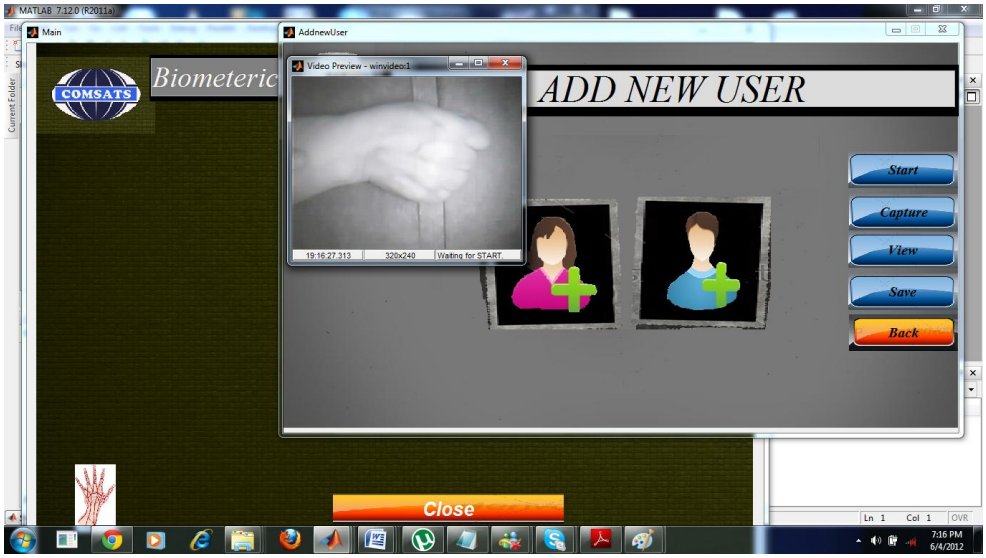

Figure 25 NEW USER

5.2.1.1.1 Image pre-processing

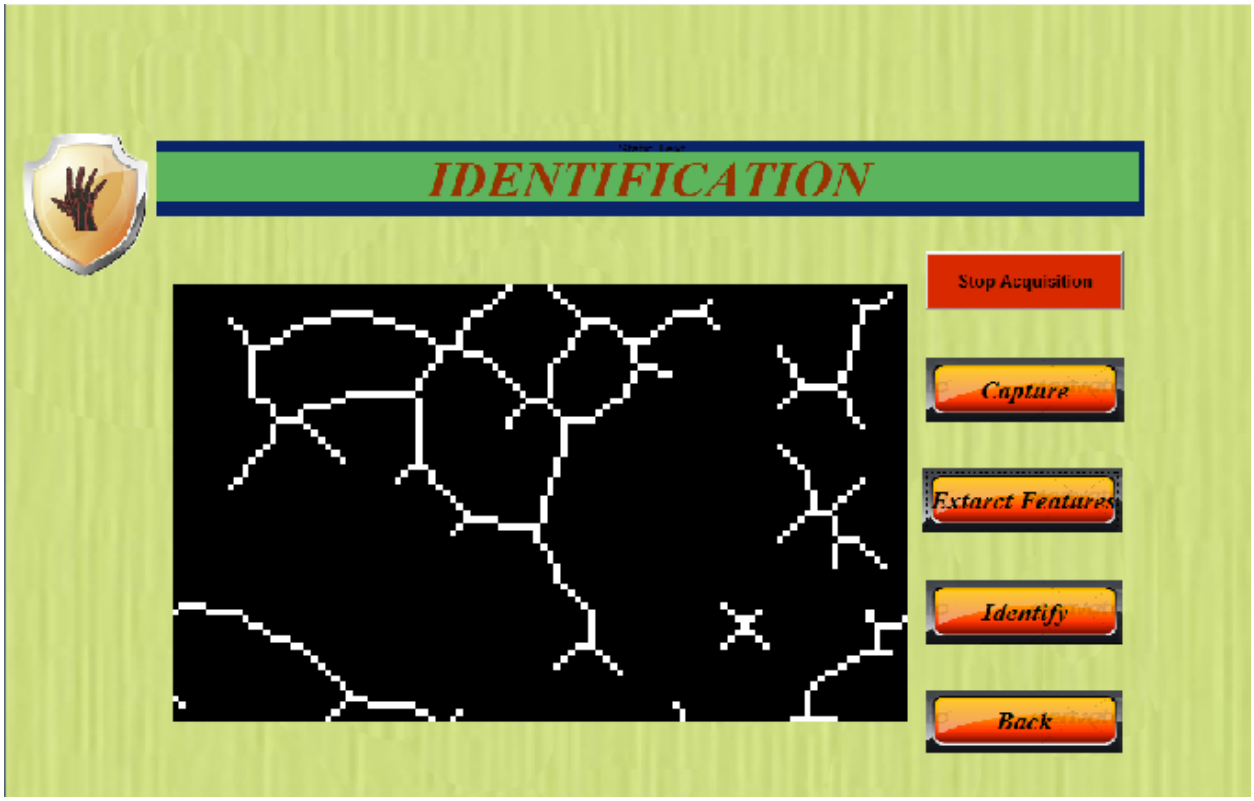

Figure 26 Identification

5.2.1.1.3 Matching

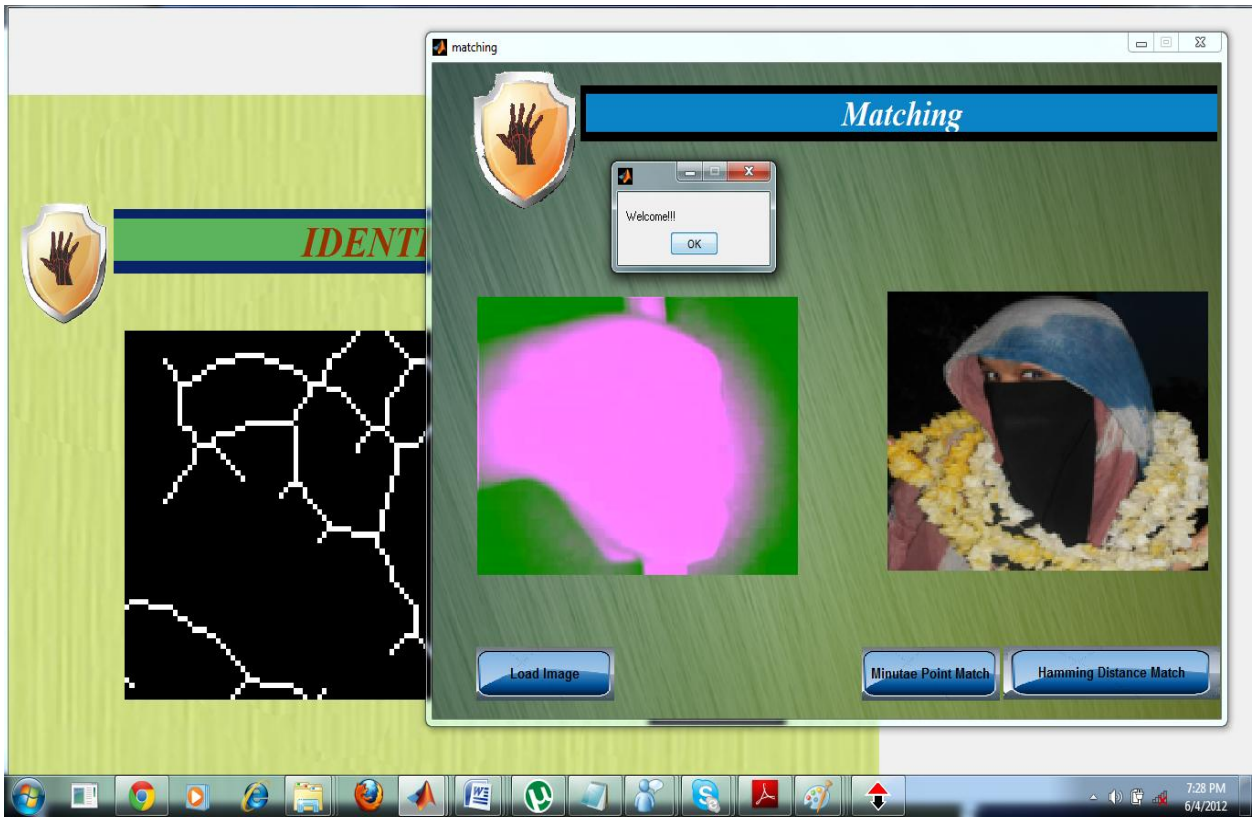

Figure 27 Matching

5.2.1.2 Function Testing

Each Function of the system is to be tested thoroughly like the major pre-processing functions of the system, Image Acquisition function and Matching function of the system.

5.2.1.3 Integration Testing

Integration Testing involves when all the modules of the system are integrated and tested.

5.3 Project Identification

The table below identifies the documentation and availability, used for developing the test plan:

Document (and version / date)	Created or Available	Received or Reviewed	Author or Resource	Notes
Requirements Specification	☑Yes ☐ No	☑ Yes ☐ No		
Use Case Reports	☐ Yes ☑ No	☐ Yes ☑ No		
Design Specifications	☑ Yes ☐ No	☑ Yes ☐ No		
Prototype	☑ Yes ☐ No	☑ Yes ☐ No		
Users Manuals	☑ Yes ☐ No	☑ Yes ☐ No		
Project Plan	☑ Yes ☐ No	☑Yes ☐ No		

5.4 Requirements for Test

For testing the Hand Vein Biometric based Recognition System certain predefined requirements need to be fulfilled.

1. The camera

The camera has to be made Infrared Sensitive to enhance the visibility of the hand vein pattern of a person.

Figure 28 Camera

2. Hardware setting

The hardware should have a closed and dark interior for capturing the image of the hand

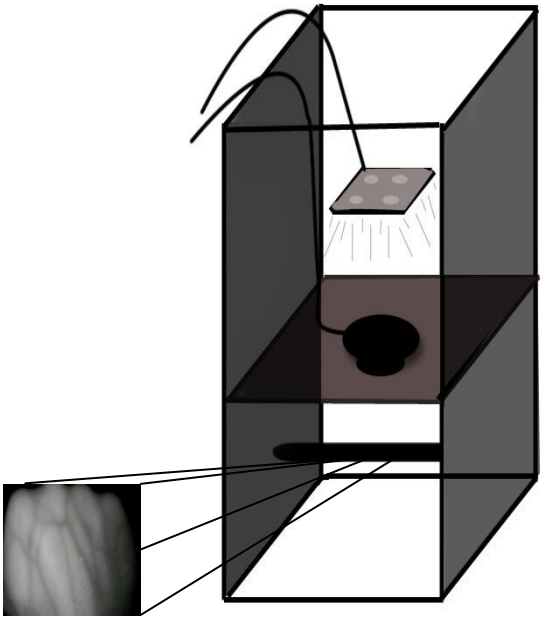

Figure 29 Hardware Setup

Figure 30 Hardware

3. Hand Placement

Hand should be placed rightly under the camera to acquire a fine image of the back of the hand.

Figure 31 Hand Placement

4. Features Matching

Features should be extracted properly from the defined algorithm to make the matching process accurate

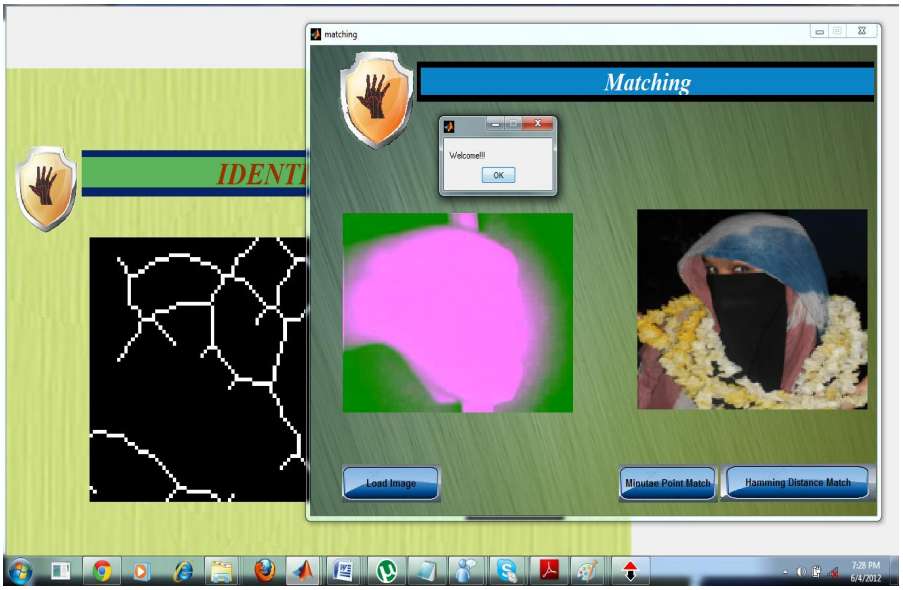

Figure 32 Matching

5.5 Test Strategy

5.5.1 Testing Types

5.5.1.2 Function Testing

Median Filtering

Test Objective:	Remove Noise from the image
Technique:	Median Filtering Function • When valid image is taken the noise is removed • Image is ready for further pre-processing techniques
Completion Criteria:	• All planned tests have been executed.
Special Considerations:	Hand Placement and Image capturing should be taken in consideration

Histogram Equalization

Test Objective:	Image enhancement
Technique:	Median Filtering Function • When valid image is enhanced, fore ground and background colors are differentiated
Completion Criteria:	• All planned tests have been executed.
Special Considerations:	Hand Placement and Image capturing should be taken in consideration and Noise should be removed from the image

Thresholding

Test Objective:	Image Segmentation
Technique:	Thresholding Function Used to convert the image into binary form for further pre-processing
Completion Criteria:	• Image is segmented into black and white
Special Considerations:	Foreground and background colors should be differentiated properly

Image Erosion

Test Objective:	Erode image
Technique:	• Erosion Function used for reducing the size of the vein pattern for minor details
Completion Criteria:	• Reduced details of hand veins
Special Considerations:	Image should be segmented

Image Dilation

Test Objective:	Enlarge the necessary details
Technique:	• Dilation function is used for enhancing the details of required data for feature extraction
Completion Criteria:	• Size of the vein pattern must be enhanced and enlarged
Special Considerations:	Image should be segmented and erosion process should be done

Skeletonization

Test Objective:	Thinning of the vein pattern
Technique:	• Image thinning to find the minutiae points for person's identification
Completion Criteria:	• Thin Hand Vein Pattern

Hausdroff Distance Matching

Test Objective:	Image Matching
Technique:	• Compare the Template with a target template for matching the two image templates
Completion Criteria:	• Identifying a person
Special Considerations:	Hand Placement and image taking

User Registration

Test Objective:	Adding a new user in the database
Technique:	• Addition of new user • Person's image • His Hand vein pattern image • Necessary Details
Completion Criteria:	• Addition of person's details in database
Special Considerations:	Fulfillment of necessary details

Delete User

Test Objective:	Deleting the user from database
Technique:	• Deleting the already existing user from database
Completion Criteria:	• User's record should not be in database
Special Considerations:	User should be registered

User Interface Testing

Test Objective:	Verify the following: • Navigation through the target-of-test properly reflects business functions and requirements, including window to window, field to field, and use of access methods (mouse movements, clicks) • Window objects and characteristics, such as buttons conform to standards.
Technique:	Create / modify tests for each window to verify proper navigation and object states for each application window and objects.
Completion Criteria:	Each window successfully verified to remain consistent with benchmark version or within acceptable standard
Special Considerations:	Not all properties for custom and third party objects can be accessed.

Data and Database Integrity Testing

Test Objective:	Ensure Database access methods and processes function properly and without data corruption.
Technique:	Invoke each database access method and process, seeding each with valid and invalid data (or requests for data). Inspect the database to ensure the data has been populated as intended, all database events occurred properly, or review the returned data to ensure that the correct data was retrieved (for the correct reasons)
Completion Criteria:	All database access methods and processes function as designed and without any data corruption.
Special Considerations:	Testing may require a DBMS development environment or drivers to enter or modify data directly in the databases. Processes should be invoked manually. Small or minimally sized databases (limited number of records) should be used to increase the visibility of any non-acceptable events.

Load Testing

Test Objective:	Verify performance behaviors time for no. of users varying workload conditions.
Technique:	Use addition of number of users into database and then checking the performance
Completion Criteria:	Multiple transactions / multiple users: Successful completion of the tests without any failures and within acceptable time allocation.
Special Considerations:	Load testing should be performed at a dedicated time. This permits full control and accurate measurement. The databases used for load testing should be either actual size, or scaled equally.

Volume Testing

Test Objective:	Verify that the target-of-test successfully functions under the following high volume scenarios: • Maximum (actual or physically capable) number of users registered • Maximum database size has been reached (actual or scaled) and multiple queries / report transactions are executed simultaneously.
Technique:	Use tests developed for Performance Profiling or Load Testing. Multiple users should be used, either running the same tests or complementary tests to produce the worst case transaction volume Maximum database size is created (actual, scaled, or filled with representative data) and multiple users used to run queries / report transactions simultaneously for extended periods.
Completion Criteria:	All planned tests have been executed and specified system limits are reached / exceeded without the software or software failing.
Special Considerations:	What period of time would be considered an acceptable time for high volume conditions (as noted above)?

Tools

The following tools will be employed for this project:

	Tool
Test Management	MATLAB
Project Management	MATLAB
Functional testing	MATLAB
Performance testing	MATLAB

CHAPTER 6

DEPLOYMENT & WORKING

6. DEVELOPMENT AND WORKING

➢ Main Menu

The Main Menu of the system consists of different objects i.e. Create a New user, Verify the existing user and delete the user.

For registering the new user a new user is added to the database and his/her hand vein image is taken and stored in the database along with his own image and necessary details for a person's identification. For a person's verification the hand vein image of a person is taken again for verification as the matching process is done with the already existing template.

Figure 33 Main Menu

➢ ADD NEW USER

Figure 34 Add New User

➢ IDENTIFICATION

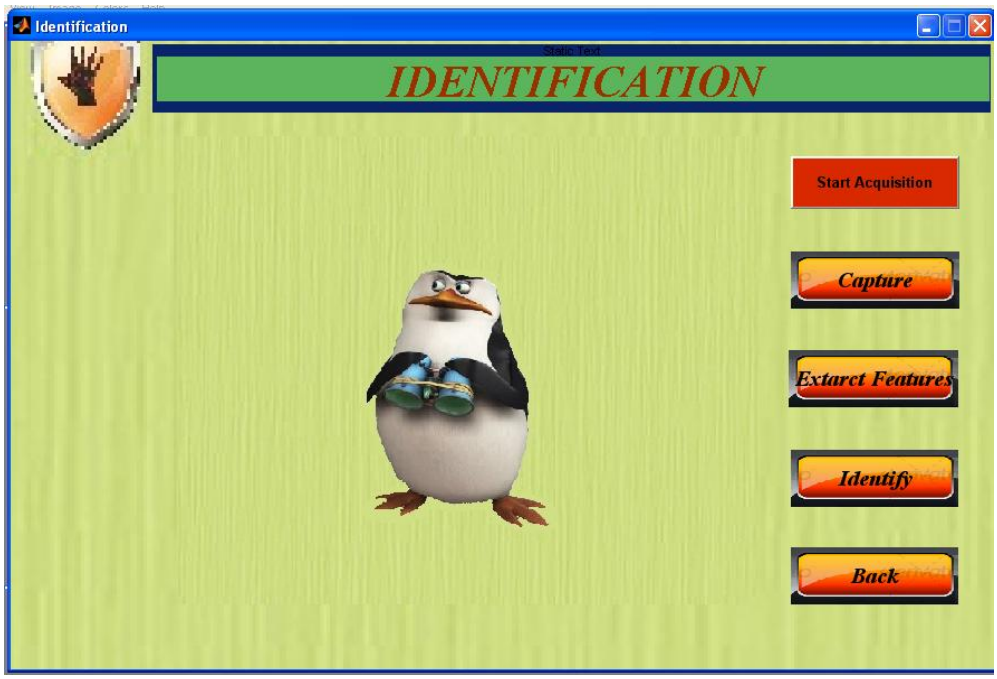

Figure 35 Identification Window

MATCHING

Figure 36 Matching Window

7. CONCLUSION

A biometric identification system is developed that recognizes the shape of the vein pattern by capturing the vein pattern using a specially designed camera. The system is designed and developed targeting woman wearing veil. Unlike other approaches, the system directly recognizes the shapes of the vein pattern using line segment hausdroff distance and Minutiae point. Preliminary testing results show that all the vein pattern images in the database have been correctly recognized and it demonstrates the potential usefulness of such a system.

We describe how we design and implement the infrared sensing web camera without the use of expensive infrared device.

8. FUTURE WORK SUGGESTIONS

Below are some of relevant future recommendations for this research:

i. Hardware language can be written to accelerate the time taken for image to be processed. By doing so, time to process a hand vein image can be consumed
ii. A script file can be written in order to execute front end and back end. At the moment, front end and back end are executed separately. And execution of front end and back end separately is really troublesome sometimes
iii. It can be implemented on a embedded system like FPGA board to make it real time and more efficient.

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