DEVELOPMENT OF TOUCHLESS FINGERPRINT RECOGNITION SYTEM

Project report submitted in partial fulfilment of the degree of

Bachelor of Technology

In

Electronics and Communication Engineering

Under the supervision of

Dr. Rajiv Kumar

By

SAHIL BHASIN (101013)

SHIVANI GARG (101014)

SONALI GUPTA (101033)

To

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

JAYPEE UNIVERSITY OF INFORMATION AND TECHNOLOGY, WAKNAGHAT, 2010-2014

CERTIFICATE

This is to certify that the project report entitled "**Development of Touchless fingerprint recognition System**" , submitted by "Sahil Bhasin (101013), Shivani Garg (101014), Sonali Gupta (101033)" in partial fulfillment for the award of degree of Bachelor of Technology in Electronics and Communication Engineering to Jaypee University of Information Technology, Waknaghat, Solan has been carried out under my supervision.

This work has not been submitted partially or fully to any other University or Institute for the award of this or any other degree or diploma.

Date: 25th May, 2014 **Dr. Rajiv Kumar**

Assistant Professor

ACKNOWLEDGEMENT

We owe a great thanks to many people who have been helping and supporting us during this project. Our deepest thanks to Dr. Rajiv Kumar, Asstt. Professor, ECE Department, Jaypee University Of Information Technology, Waknaghat for guiding and correcting us at every step of our work with attention and care. He has taken pain to go through the project and make necessary correction as and when needed. Thanks and appreciation to the helpful people at college for their support. We would also thank our university and my faculty members without whom this project would have been a distant reality.

Date: 25th May, 2014

Sahil Bhasin (101013)

Shivani Garg (101014)

Sonali Gupta (101033)

Table of Contents

TOPICS:	PAGE NO.
Certificate	II
Acknowledgement	III
List of Figures	VII
Abstract	VIII-IX
Chapter 1: Introduction	**1**
1.1General	**2**
1.1.1 Touch-less Fingerprint Recognition	**2**
1.1.2 Current Applications for Fingerprint Recognition	**2**
1.1.3 Advantages of Fingerprint Recognition	**2**
1.1.4 Use of touch-less fingerprint recognition system in Airline industry	**3**
1.1.5 Advantages of the touchless fingerprint technology	**3**
Chapter 2: LITERATURE REVIEW	**4**
2.1 History of Fingerprints	**5**
2.2 Fingerprints	**7**
2.2.1 Definition	**7**
2.2.2 Fingerprint Pattern	**8**
2.2.3 Types of Fingerprint characteristic	**8**
2.2.4 Minutia feature	**9**
2.2.5 Patterns	**10**
Chapter 3: Methodology	**12**
3.1 Phases of Touchless Fingerprint Recognition System	**13**
3.2 Pre-processing	**13**

3.2.1 Normalization **13**

3.2.2 Fingerprint Segmentation **14**

3.2.3 Fingerprint Enhancement **15**

3.3Feature Extraction **15**

3.4Matching **15**

Chapter 4 : ANALYSIS, DESIGN AND MODELING **17**

4.1 Overall Description of the project **18**

4.2 Specific Requirements **19**

4.2.1 External Interfaces **19**

4.2.2 Functions **19**

4.2.3 Performance Requirements **19**

4.2.4 Design Constraints **19**

4.2.5 Software System Attributes **20**

4.3 Design **20**

4.4 Modeling **21**

Chapter 5 : RESULTS **24**

5.1 RGB to Grayscale conversion **25**

5.2 Normalisation of Gray Image **25**

5.3 Skin Colour Detection **26**

5.4 Conversion of an Image to Binary **26**

5.5 Morphological Processing **27**

5.6 Combining of two images **28**

5.7 Cropping of an image **29**

5.8 Enhancement of an image **30**

5.9 Feature Extraction **30**

5.10 Matching **31**

5.11 Conclusion

32

REFERENCES **33**

APPENDICES **35**

APPENDIX A: Tools Description **36**

APPENDIX B : Quality Assurance

List of Figures

FIGURE	PAGE NO.
Fig. 2.1 Ridges and valleys in a fingerprint	8
Fig. 2.2 Fingerprint patterns	9
Fig. 2.3 Different minutiae features	10
Fig. 2.4 Patterns of fingerprint ridges	11
Fig.4.1 Block diagram of biometric system	20
Fig.5.1 Original image	25
Fig.5.2 grayscale image	25
Fig.5.4 Normalisation image	26
Fig.5.5: Skin Colour Detection	26
Fig.5.6: Conversion of an Image to Binary	27
Fig 5.7: Morphological Processing	28
Fig.5.8: Combining of images	29
Fig5.9 : Cropping of image	29
Fig.5.10: Image Enhancement	30
Fig.5.11: Feature extracted image	31

ABSTRACT

Objective

To develop a reliable touch-less fingerprint recognition system in order to overcome the limitations of touch based fingerprint technology for better security purposes.

Capturing a 3D image of the finger, recognizing the ridge-valley pattern of the finger and performing different algorithms to extract the basic features like minutiae and then matching it with an already created database. This complete process after capturing an image using a digital camera will take place in three phases, namely, Pre-Processing phase, Feature-Extraction Phase and Matching phase.

Why we chose this topic?

Rapid growth in computer vision and image processing applications has been evident in recent years. One area of interest in vision and image processing is biometrics. Fingerprint recognition identifies people by using the impressions made by the minute ridge formations or patterns found on the fingertips. Finger printing takes an image of a person's fingertips and records its characteristics - whorls, arches, and loops are recorded along with patterns of ridges, furrows, and minutiae. Information is processed as an image and further encoded as a computer algorithm.

Biometric technologies are becoming the foundation of an extensive array of highly secure identification and personal verification solution. As the level of security breaches and transaction fraud increases, the need for highly secure identification and personal verification technologies is becoming apparent.

Advances in automatic fingerprint recognition are driven by improved fingerprint sensing and advancements in areas such as computer architecture, pattern recognition, image processing and computer vision. In addition to the new developments in science and technology, several recent social and political events have increased the level of interest in fingerprint recognition for the purpose of positive person identification. This highlightened interest in fingerprint technology and its promise to deliver cost-effective solutions have prompted us to undertake the endeavour to take up this project and work on it and deliver high accuracy rate than found earlier.

Security is the most important aspect of Technology. To reach the goals of security, every business or industry have their own security systems. So, the airline industry is no behind the others. Till date the airline reservations and airplane boarding were done examining the identity cards such as License, PAN Card or Passport. But these can be manipulated and security can be breached. To avoid this, some airports have used the concept of biometrics. In this, the authentication of the boarders can be done by using some biometric techniques like Finger Print Recognition, Face Recognition, etc. For fingerprint recognition, fingerprint sensors are used. Most of the sensors available today use "touch" method since it is simple and little training is required. But there are some drawbacks of touch base fingerprints. To overcome the above limitations, touch-less fingerprint technology came into existence.

Sahil Bhasin

Shivani Garg

Sonali Gupta

Dr. Rajiv Kumar

Assistant Professor, ECED

25th May, 2014

Chapter1 : INTRODUCTION

1.1 General

1.1.1 Touch-less Fingerprint Recognition

Fingerprint recognition system is a biometric system that uses fingerprint as biometric input to this system. A fingerprint consists of patterns of ridges and valleys on the surface of a fingertip. Each individual has fingerprint which is different from the other. Actually this biometric system is a computer vision system which performs following functions: Image acquisition, Pre-processing, Feature Extraction, High-level processing or verification or matching. Basically, Fingerprint recognition system is an identification system that can be an Automated Fingerprint Identification System (AFIS) or a Non-automated Fingerprint Recognition System. Fingerprint recognition is a biometric method of verifying a match between two human fingerprints. Fingerprints are one of the many forms of biometrics used to identify individuals and verify their identity. A touch-less fingerprint recognition technology is a remote sensing technology to capture the ridge-valley pattern which provides essential information for recognition. Since there is no contact between finger and any rigid surface, the skin does not deform during capture.Digital camera is used to capture the image of the fingerprint.

1.1.2 Current Applications for Fingerprint Recognition

Fingerprint recognition has primarily been used to secure entry devices for building door locks and computer network access. A small number of banks use fingerprint recognition systems for authorization at ATMs. Grocery stores are experimenting with a fingerprint scan checkout that automatically recognizes and bills a registered user's credit card or debit account. More recent applications of finger recognition include use of fingerprints for voter registration.

1.1.3 Advantages of Fingerprint Recognition

- Fairly small storage space is required for the biometric template, reducing the size of the database required.
- Each and every fingerprint including all the fingers are unique, even identical twins have different fingerprints.
- Sound potential for forensic use as most of the countries have existing fingerprint databases.

1.1.4 Use of touch-less fingerprint recognition system in Airline Industry:

There are a number of steps that can be taken immediately to improve our capacity to properly identify people who are arriving at the airport. Most of the airports use optical card and finger image readers. In this, the finger image of the card bearer can be extracted from the card by an optical card reader, and compared to the "live" image of the person applying for boarding the airplane by using a low-cost finger image reader. With touch-based fingerprint technology, input images fromthe same finger can be quite different and there are latentfingerprint issues that can lead to forgery and hygienicproblems. Touch-less fingerprint technology provides a near perfect solution to the problems in terms of hygienic, maintenance and latent fingerprints.

1.1.5 Advantages of touchless fingerprint technology:

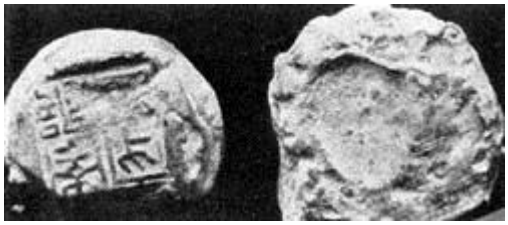
- **No Latent Fingerprints:** The touchless recognition system leaves a fingerprint. So it is not possible for the sensor to make errors due to latent fingerprints.
- **No restriction on number of users:** As the technology is touch-less.
- **Identification accuracy:** The ridges on the fingers are produced in high quality, independent of the finger's appearance, condition, pressure applied or ambient conditions. There are no problems like false minutiae or bad contact.
- **Large Clear Image:** The capturing area for image is not limited to a small contact surface but, to a certain extent, wraps around the finger. The touchless technology allows for clear, correct pictures not influenced by movements on a contact surface.
- **Robust and Reliable:** Dirt or dust on the protective glass has no influence on the quality of image and function of the sensor.
- **Maintenance free and durable:** The complete sensor is protected behind a glass screen and never is touched when in use. Therefore it cannot be worn, damaged or affected by environmental factors, nor can the sensor be influenced by any substances or chemicals attached to the finger.
- **User comfort:** The assembly is extremely easy to use. Touchless fingerprint identification allows the highest standard of hygiene.

Chapter2 : LITERATURE REVIEW

2.1 History of Fingerprints

- **BC 200s China**

Clay seals having friction ridge impressions were used during both the Qin and Han Dynasties (221 BC - 220 AD).



- **1858- Herschel**

The English first began using fingerprints in July of 1858, when Sir William James Herschel, Chief Magistrate of the Hooghly district in Jungipoor, India, first used fingerprints on native contracts.

- **1863 - Coulier**

Professor Paul-Jean Coulier, of Val-de-Grâce in Paris, published his observations that (latent) fingerprints can be developed on paper by iodine fuming.

- **1882 – Bertillon**

Alphonse Bertillon, a Clerk in the Prefecture of Police of at Paris, France, devised a system of classification, known as anthropometry or the Bertillon system, using measurements of parts of the body.

- **1892 – Vucetich & Galton**

Sir Francis Galton published his book, "Fingerprints", establishing the individuality and permanence of fingerprints. The book included the first classification system for fingerprints.

- **1905**

U.S. Army begins using fingerprints.U.S. Department of Justice forms the Bureau of Criminal Identification in Washington, DC to provide a centralized reference collection of fingerprint cards.

- **2014 - World's Largest Database**

As of March 2014, the Unique Identification Authority of India operates the world's largest fingerprint (multi-modal biometric) system, with over 560 million fingerprint, face and iris biometric records. UIAI plans to collect as many as 600 million multi-modal record by the end of 2014. India's Unique Identification project is also known as Aadhaar, a word meaning "the foundation" in several Indian languages. Aadhaar is a voluntary program, with the ambitious goal of eventually providing reliable national ID documents for most of India's 1.2 billion residents.

With a database many times larger than any other in the world, Aadhaar's ability to leverage automated fingerprint and iris modalities (and potentially automated face recognition) enables rapid and reliable automated searching and identification impossible to accomplish with fingerprint technology alone, especially when searching children and elderly residents' fingerprints.

2.2 Fingerprints

2.2.1 Definition

A **fingerprint** is an impression left by the friction ridges of a human finger. It is made up of a number of ridges and valleys on the surface of a finger.

Ridges are the upper skin layer segments of the finger and valleys are the lower segments.

A Ridge- is a high.

A Valley- is a depression or low.

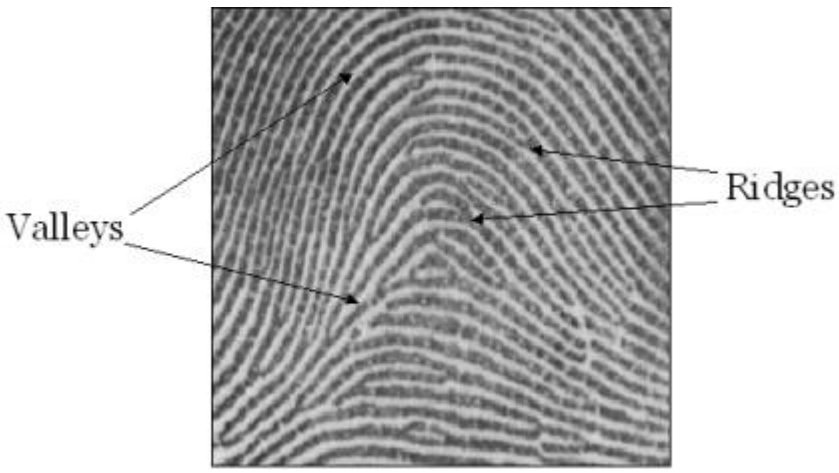


Fig. 2.1 Ridges and valleys in a fingerprint

2.2.2 Fingerprint Pattern

The pattern is the unique characteristic of ridges and valleys that make up the fingerprint. It is defined by the spatial relationship of lines with each other, their beginning and terminating points, and the unique patterns they make.

2.2.3 Types of Fingerprint characteristics:

These are the points of identification:

5 Ending ridges

6 Bifurcations

7 Dots

8 Enclosures

9 Short ridges

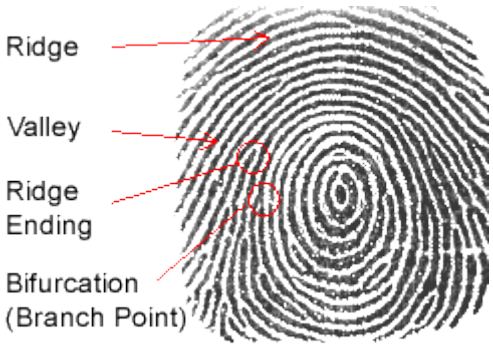


Fig. 2.2 Fingerprint patterns

The ridges form minutia points: ridge endings (where a ridge end) and ridge bifurcations (where a ridge splits in two). Many types of minutiae exist, including dots (very small ridges), islands (ridges slightly longer than dots, occupying a middle space between two temporarily divergent ridges), ponds or lakes (empty spaces between two temporarily divergent ridges), spurs (a notch protruding from a ridge), bridges (small ridges joining two longer adjacent ridges), and crossovers (two ridges which cross each other).

2.2.4 Minutia features

The major minutia features of ridges are ridge ending, bifurcation, and short ridge (or dot). The point at which a ridge terminates is a ridge ending. The points at which a single ridge splits into two ridges are Bifurcations. Short ridges (or dots) are ridges which are shorter than the average ridge length. Minutiae and patterns are very important in analysis of fingerprints since no two fingers have identical minutiae and patterns.

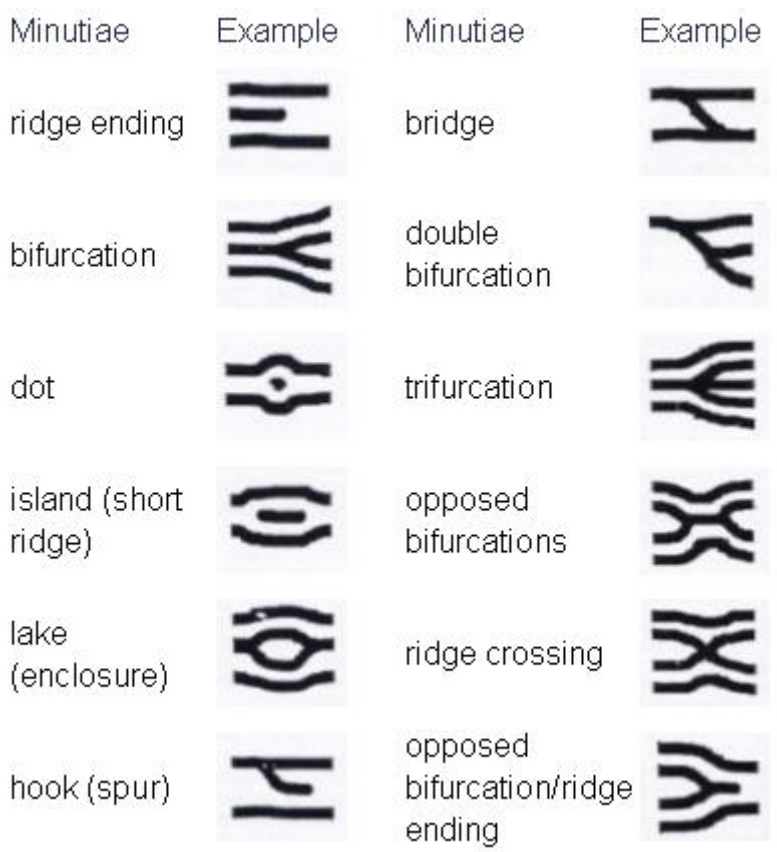


Fig. 2.3 Different minutiae features

The uniqueness of a fingerprint can be determined by the pattern of ridges and valleysas well as the minutiae points.

There are five basic fingerprint patterns: arch, tented arch, left loop, right loop and whorl. Loops make up 60% of all fingerprints, whorls account for 30%, and arches for 10%.

2.2.5 Patterns

The three basic patterns of fingerprint ridges are the arch, loop, and whorl:

- **Arch:** These are the ridges that enter from one side of the finger, rise in the center forming an arc, and then exit the other side of the finger.
- **Loop:** Theses are the ridges that enter from one side of a finger, form a curve, and then exit on that same side.
- **Whorl:** These are the ridges that form circularly around a central point on the finger.

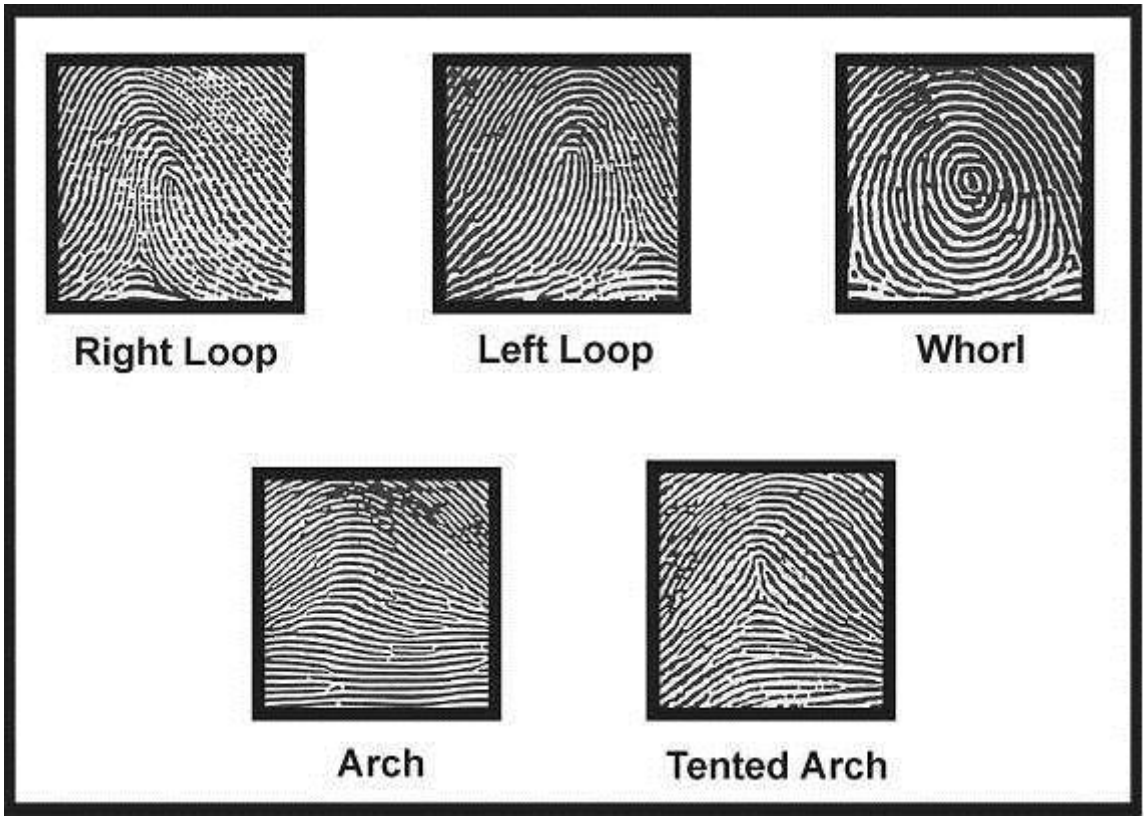


Fig. 2.4 Patterns of fingerprint ridges

Chapter 3: Methodology

3.1 Phases of Touchless Fingerprint Recognition System

The touchless fingerprint recognition system consists of three phases. Each phase itself has some blocks. Each block carries out a special function on the input image. The three main phases of touchless fingerprint recognition system are: Pre-processing, Feature Extraction and Matching.

3.2 Pre-processing

Pre-processing is an important step before fingerprint feature extraction and matching in detecting minutiae from the fingerprints. It is used to reduce the noises and increase the contrast between ridges and valleys. This step is important because they are captured using digital camera.

Pre-processing is further divided into three blocks:

- Normalization
- Fingerprint Segmentation
- Fingerprint Enhancement

3.2.1 Normalization

It is the first pre-processing block. It is done for two reasons.

- **To minimize the non-uniform lighting problem.**

  This is done by changing the dynamic range of pixel intensity values by calculating mean and variance of the image and therefore reduces illumination.

  $$g(x,y) = \frac{f(x,y) - m_x(x,y)}{\sigma_f(x,y)}$$

  Where

  $f(x,y)$: The original image

  $m_f(x,y)$: An estimation of a mean $f(x,y)$

  $\sigma_f(x,y)$: An estimation of the standard deviation

- **To pre-specify mean and variance.**

  Firstly, the RGB fingerprint image is converted to gray scale which has 256 different gray levels which are enough for recognition. Then it is normalised as follows:

$$= \begin{cases} M_o + \sqrt{\dfrac{V_o(I(i,j) - M)^2}{V}} & if\ I(i,j) > M \\ M_o - \sqrt{\dfrac{V_o(I(i,j) - M)^2}{V}} & otherwise \end{cases}$$

Mo is desired value of image

Vo is variance value of image

3.2.2 Fingerprint Segmentation

Segmentation is donein parallel with normalization. It is necessary to reduce the size and undesired background of input image which is noisy. It focuses on the favourable central area of the fingerprint. It has three blocks: the skin color detection, adaptive thresholding and morphological processing.

- **Skin color detection**

  It is used to detect human presence in an image by detecting skin pixels in an image. The image is converted from RGB to YCbCr color space. The brightness component(Y) is eliminated and chrominance component is used.

- **Adaptive thresholding**

  In this the image is thresholded into a binary image. Thresholding is used to segment an image by setting all pixels whose intensity values are above a threshold to a foreground value and all the remaining pixels to a background value.The Adaptive Threshold module is used in uneven lighting conditions when you need to segment a lighter foreground object from its background. In many lighting situations shadows or dimming of light cause thresholding problems as traditional thresholding considers the entire image brightness. Adaptive Thresholding will perform binary thresholding (i.e. it creates a black and white image) by analyzing each pixel with respect to its local neighbourhood. This localization allows each pixel to be considered in a more adaptive environment.

- **Morphological processing**

  It is applied to remove the skin color content from the background. It is basically a noise removal process. The main purpose is to smooth, fill in, and remove objects in a binary image.

  The normalized image is multiplied with the binary mask obtained. Consequently, the resulting image is cropped and enhanced.

3.2.3 Fingerprint Enhancement

The main purpose is to enhance the image by improving the clarity of the ridge structure and increasing the consistence of ridge orientation. It can be used to eliminate noise between ridges, connect broken ridges or improving ridge contrast. First of all, the undesired background of the image is calculated and deleted. Then the intensity values of image are adjusted. This increases the contrast of the output image. After this global threshold is calculated for the image which is used to convert an intensity image to a binary image. Finally the pixels having lower values (noise) are removed.

3.3 Feature Extraction

The feature vectors are extracted from the images after pre-processing. Minutiae are used as fingerprint features. In this phase, firstly thinning is done. Thinning is done to remove pixels so that an object without holes shrinks to a minimally connected stroke, and an object with holes shrinks to a ring halfway between the hole and outer boundary. This is basically a noise removal process. Now, minutiae are extracted by creating a small window through which ridges and bifurcations are identified. Finally image with ridge and bifurcations is displayed by combining all the windows obtained above.

3.4 Matching

The matching is done by edge detection and then matching black points and white points of the two images. The edge detection is done on both the images. It finds edges in a binary image. Prewitt method is used to find edges in which edges are returned at those points where the gradient of image is maximum. Now, the white points and black points are counted in the first edge detected image. These are compared with the second edge detected image. The matching

percentage is then calculated. If the percentage is more than 90, the images are same else they are different.

Chapter 4 : ANALYSIS, DESIGN AND MODELING

4.1 Overall Description of the project

a) Product perspective

The project is an attempt to use techniques for fingerprint recognition for real time and classification of the minute differences. For this purpose we have studied various algorithms and experimented with various libraries available.

b) Product Functions

The product helps in capturing of an image of the tip of the fingers and performs each algorithm step by step to figure out the ridge-valley pattern of an individual. This feature distinguishes one individual from the other. Then matching of the patterns is done with the stored database and if found, the result displayed is either match found or fingerprint does not match the database.

c) User characteristics

The project does not have any constraints on who can use it; it can be used by anyone and everyone, from researcher, teacher and student to developer, anyone can use the product in accordance to his needs or build application on it. The user can be any human finger facing the digital camera with his finger facing towards the camera and must be straight and uncovered. The background can be of any colour other than skin colour.

d) Design and Implementation constraints

- All the programming code is written in Matlab using its inbuilt functions.
- A decent digital camera is required and can be used in darkness.
- The project is supposed to run both on windows and Mac.

e) Assumption and Dependencies

- The background should be of any colour other than skin colour.
- The fingers should be uncovered for detection.
- The camera should of decent quality.

4.2 Specific Requirements

4.2.1 External Interfaces

Hardware Interface: There is a digital camera + computer interaction. The only hardware used is digital camera.

Software Interface: We have used Matlab for programming.

Communication Interface: Digital camera is the only communication interface.

4.2.2 Functions

- Digital camera captures the image.
- Then the image is implemented through the Matlab.
- Image will go through three phases one by one.
- And then testing is done.

4.2.3 Performance Requirements

The basic requirement for running of the application is

- Digital camera
- Matlab

Dynamic Requirements:

- Memory Available

4.2.4 Design Constraints

- The results are better on more efficient computers as the search process is faster.
- A still hand can give better results in recognition of the accurate ridge-valley patterns.
- A dark background gives better results.

4.2.5 Software System Attributes

a) **Reliability:** Result should be as the application, further working depends on it. Feature vector points have to be accurate for best working of the application.

b) **Robust:** As it takes a lot of computation and memory resources its necessary that software must be a robust one and free memory resources used and gradually degrade there by annoying the user.

c) **Maintenance:** Matching is an important phase for classification of better and efficient results. One needs to have a rich database so that it covers nearly all the possible users of the system, so that at any point of time it does not fail to recognition anyone.

d) **Portability:**The software is portable, i.e. can be installed anywhere.

4.3 Design

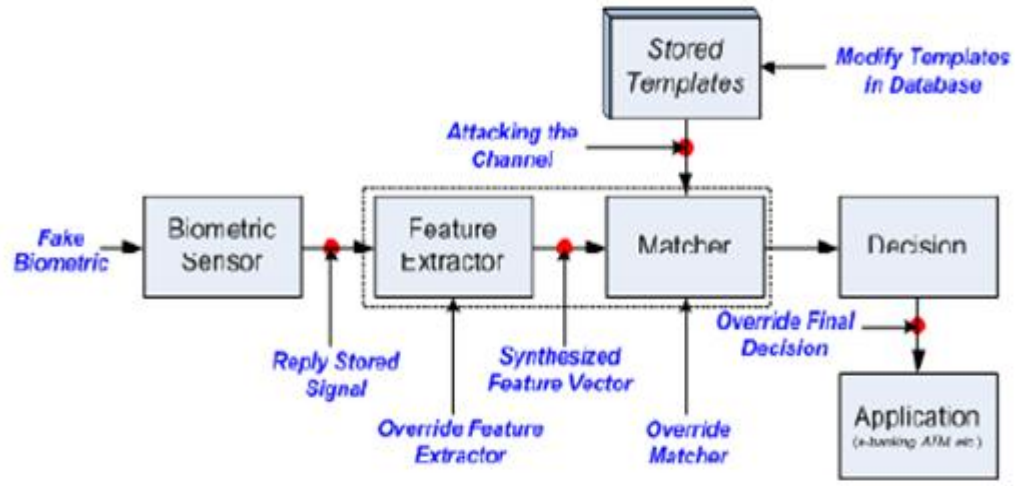
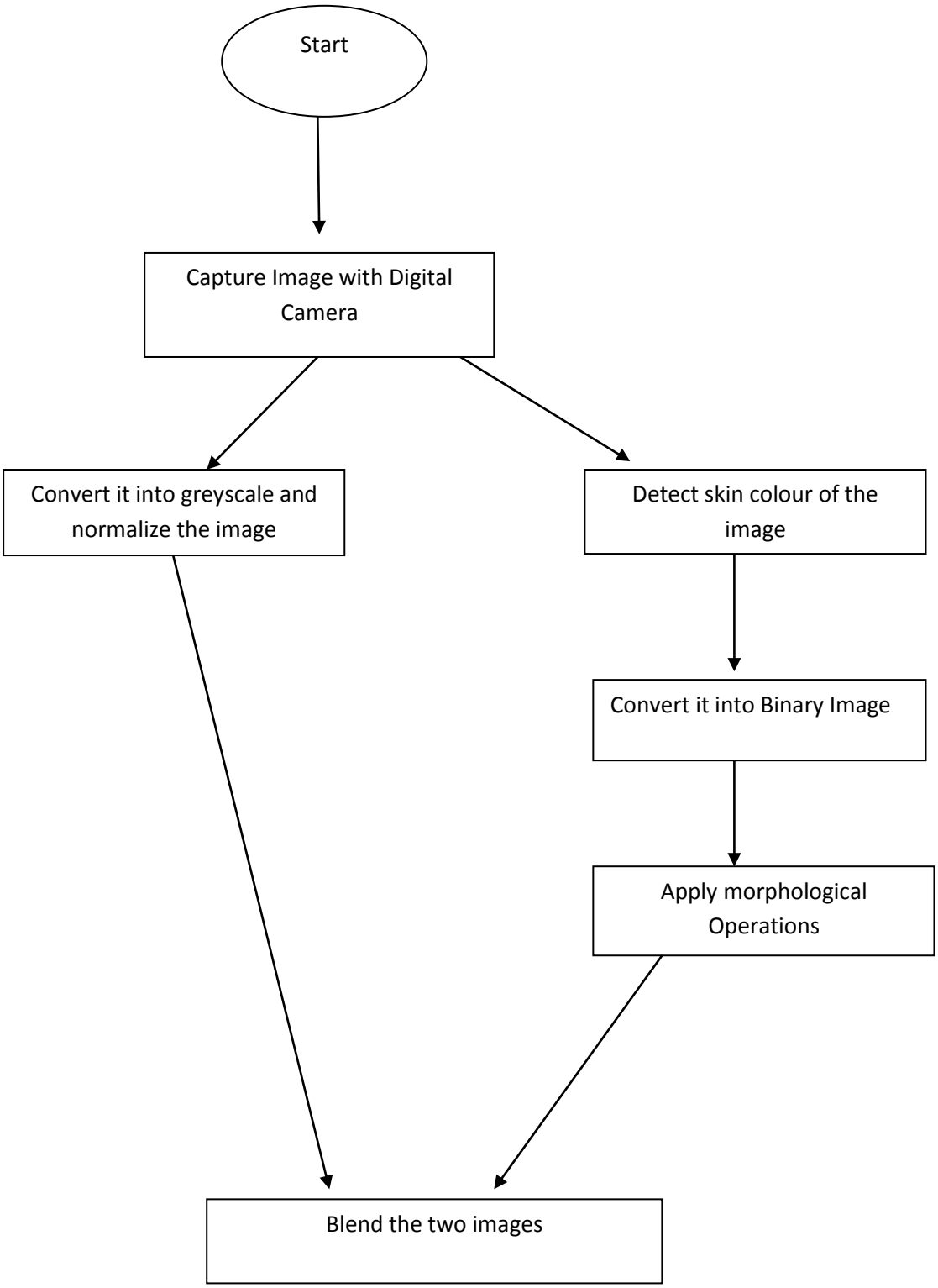
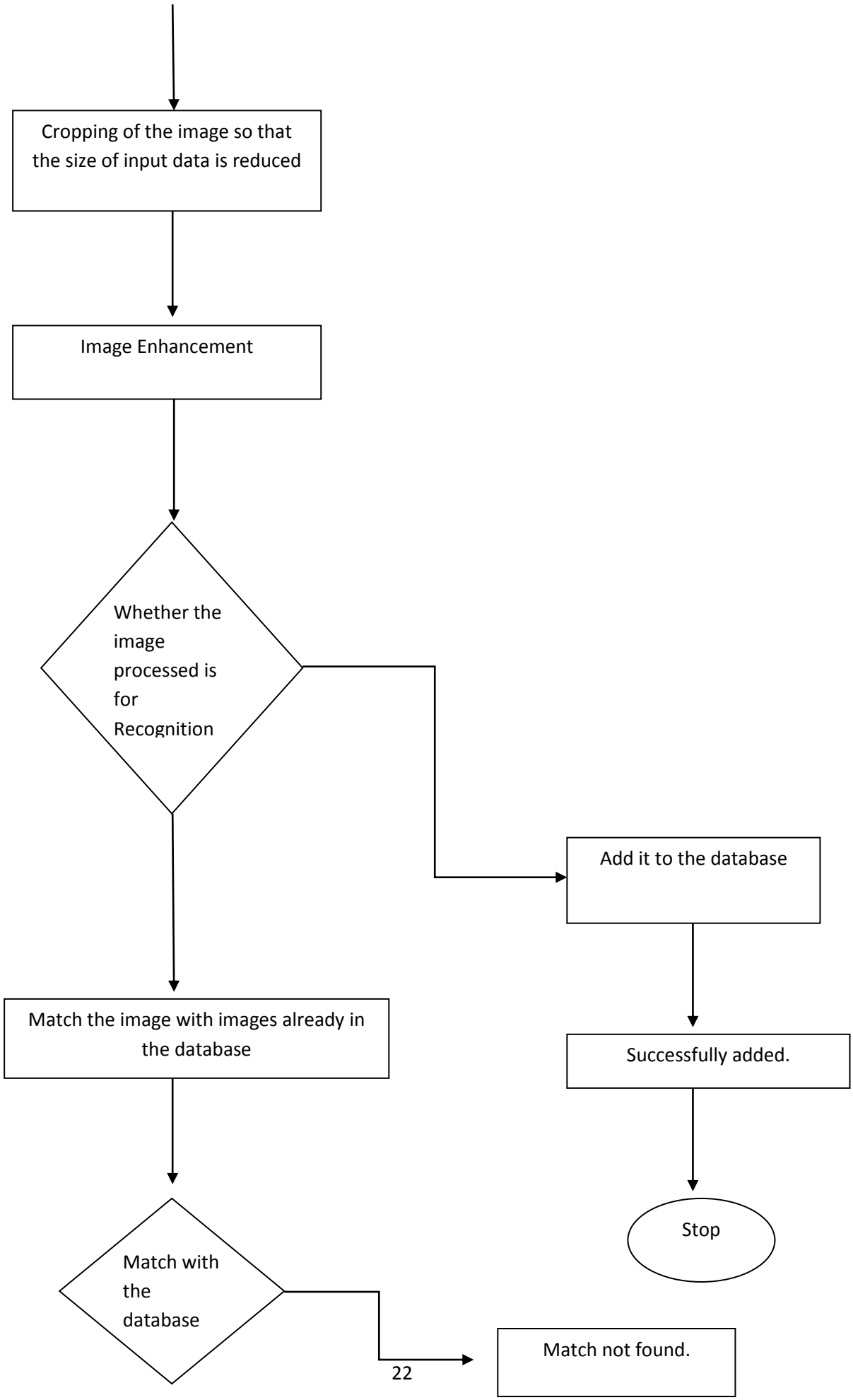


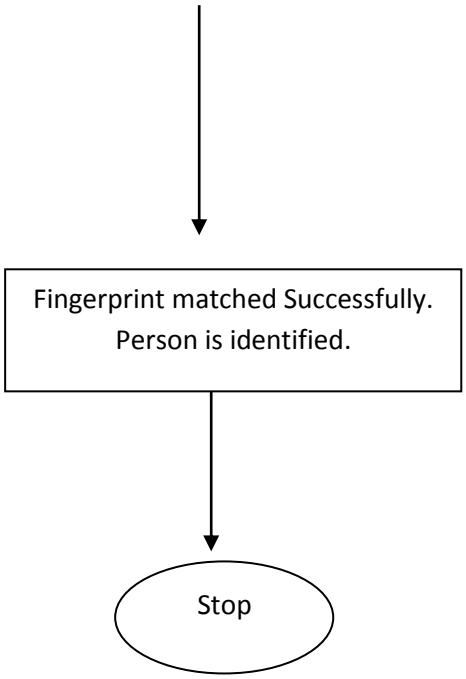
Fig.4.1 Block diagram of biometric system

4.4 Modeling

The model of the touchless fingerprint recognition system is represented in a flow chart.




Cropping of the image so that the size of input data is reduced
Image Enhancement
Whether the image processed is for Recognition
Add it to the database
Successfully added.
Stop
Match the image with images already in the database
Match with the database
Match not found.


Fingerprint matched Successfully.
Person is identified.
Stop

Chapter 5 : RESULTS AND CONCLUSION

9.4 RGB to Grayscale conversion

When converting an RGB image to grayscale, we have to take the RGB values for each pixel and make as output a single value reflecting the brightness of that pixel. One such approach is to take the average of the contribution from each channel: (R+B+C)/3. However, since the perceived brightness is often dominated by the green component, a different, more "human-oriented", method is to take a weighted average, e.g.: 0.3R + 0.59G + 0.11B.

Fig.5.1 Original image

Fig.5.2 Grayscale image

9.5 Normalisation of Gray Image

Normalization is a process that changes the range of pixel intensity values. Applications include photographs with poor contrast due to glare, for example. Normalization is sometimes called contrast stretching or histogram stretching. In more general fields of data processing, such as digital signal processing, it is referred to as dynamic range expansion. It is done to remove the non-uniform lighting problem.

Fig.5.4 Normalisation image

9.6Skin Colour Detection

Skin detection is the process of finding skin-colored pixels and regions in an image or a video. This process is typically used as a preprocessing step to find regions that potentially have human faces and limbs in images. Several computer vision approaches have been developed for skin detection. A skin detector typically transforms a given pixel into an appropriate color space and then uses a skin classifier to label the pixel whether it is a skin or a non-skin pixel. A skin classifier defines a decision boundary of the skin color class in the color space based on a training database of skin-colored pixels.

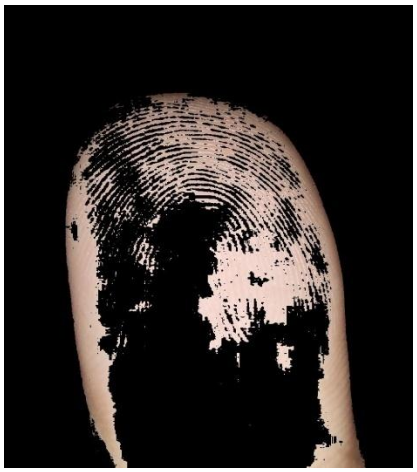


Fig.5.5: Skin Colour Detection

9.7 Conversion of an Image to Binary

A binary image is a digital image that has only two possible values for each pixel. Typically the two colors used for a binary image are black and white though any two colors can be used. The color used for the object(s) in the image is the foreground color while the rest of

the image is the background color. In the document scanning industry this is often referred to as bi-tonal.

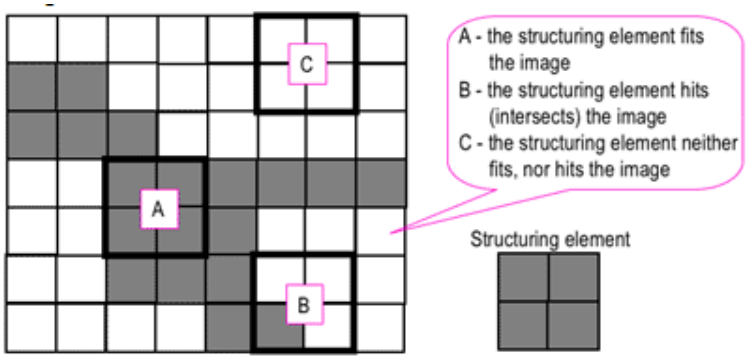
Binary images are also called bi-level or two-level. This means that each pixel is stored as a single bit (0 or 1). The names black-and-white, B&W, monochrome or monochromatic are often used for this concept, but may also designate any images that have only one sample per pixel, such as

Fig.5.6: Conversion of an Image to Binary

9.8Morphological Processing

Morphological image processing is a collection of non-linear operations related to the shape or morphology of features in an image. According to Wikipedia, morphological operations rely only on the relative ordering of pixel values, not on their numerical values, and therefore are especially suited to the processing of binary images. Morphological operations can also be applied to greyscale images such that their light transfer functions are unknown and therefore their absolute pixel values are of no or minor interest.

Morphological techniques probe an image with a small shape or template called a structuring element. The structuring element is positioned at all possible locations in the image and it is compared with the corresponding neighbourhood of pixels. Some operations test whether the element "fits" within the neighbourhood, while others test whether it "hits" or intersects the neighbourhood:



Probing of an image with a structuring element
(white and grey pixels have zero and non-zero values, respectively).

Fig 5.7: Morphological Processing

9.9Combining of two images

There are several types of blending functions. Here in this project we are multiplying the values of the normalized greyscale image and binary image.

Fig.5.8: Combining of images

9.10 Cropping of an image

Cropping refers to the removal of the outer parts of an image to improve framing, accentuate subject matter or change aspect ratio. Depending on the application, this may be performed on a physical photograph, artwork or film footage, or achieved digitally using image editingsoftware. The term is common to the film, broadcasting, photographic, graphic design and printing industries.

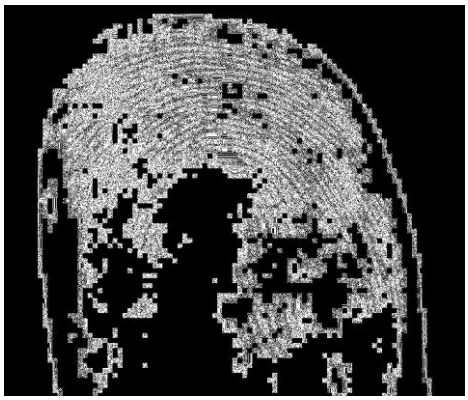


Fig5.9 : Cropping of image

9.11 Enhancement of an image

Image enhancement is the improvement of digital image quality (wanted e.g. for visual inspection or for machine analysis), without knowledge about the source of degradation. If the source of degradation is known, one calls the process image restoration. Both are iconical processes, viz. input and output are images.

Many different, often elementary and heuristic methods are used to improve images in some sense. The problem is, of course, not well defined, as there is no objective measure for image quality. Here, we discuss a few recipes that have shown to be useful both for the human observer and/or for machine recognition. These methods are very problem-oriented: a method that works fine in one case may be completely inadequate for another problem.

Fig.5.10: Image Enhancement

5.9 Feature Extraction

The feature vectors are extracted from the images after pre-processing. Minutiae are used as fingerprint features. In this phase, firstly thinning is done. Thinning is done to remove pixels so that an object without holes shrinks to a minimally connected stroke, and an object with holes shrinks to a ring halfway between the hole and outer boundary. This is basically a noise removal process. Now, minutiae are extracted by creating a small window through which ridges and bifurcations are identified. Finally image with ridge and bifurcations is displayed by combining all the windows obtained above.

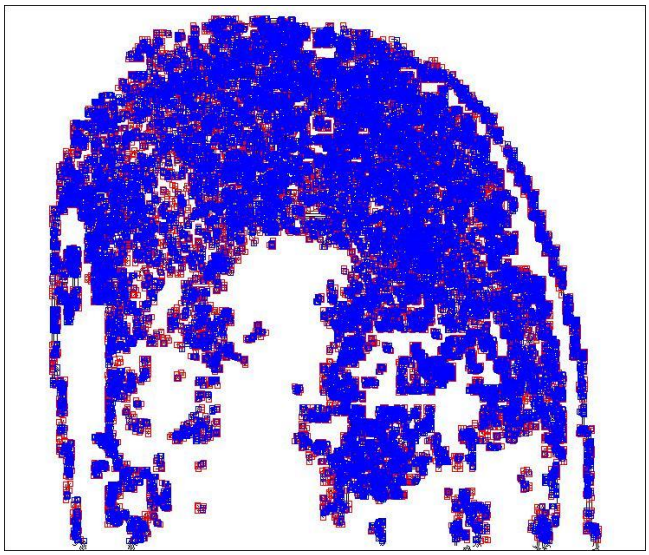


Fig.5.11: Feature extracted image

5.10 Matching

The matching is done by edge detection and then matching black points and white points of the two images. The edge detection is done on both the images. It finds edges in a binary image. Prewitt method is used to find edges in which edges are returned at those points where the the gradient of image is maximum. Now, the white points and black points are counted in the first edge detected image. These are compared with the second edge detected image. The matching percentage is then calculated. If the percentage is more than 90, the images are same else they are different.

Matching percentage = (matched data/total data)*100

Image1	Image2	Matching percentage(%)
Im_01	**Im_04**	**7.561**
Im_02	**Im_04**	**15.63**
Im_03	**Im_04**	**100**

Table depicting matching percentage

5.11 Conclusion:

In this report, all phases of touchless fingerprint recognition system are implemented. We also presented number of comparisons between touchless systems and the conventional fingerprint recognition systems. Further, this report presented a modeled system that comprised of preprocessing, feature extraction and matching. We have implemented various blocks of fingerprint system on images and found the results.

REFERENCES

1. http://onin.com/fp/fphistory.html
2. http://en.wikipedia.org/wiki/Fingerprint_recognition
3. http://www.griaulebiometrics.com/en-us/book/understanding-biometrics/types/enhancement
4. Pooja Gautam and Shubhra gautam Sharma: Touch-less Fingerprint Recognition System at Airports
5. T. Matsumoto, H. Matsumoto, K. Yamada, and S. Hoshino: Impact of artificial "gummy" fingers on fingerprint systems
6. Yeegahng Song, Chulhan Lee and Jaihie Kim: A New Scheme for Touchless Fingerprint Recognition System
7. B.Y. Hiew, Andrew B.J. Teoh and Y.H. Pang: Touch-less Fingerprint Recognition System
8. F.A. Afsar, M. Arif and M. Hussain: Fingerprint Identification and Verification System using Minutiae Matching
9. Chulhan Lee, Sanghoon Lee, and Jaihie Kim: A Study of Touchless Fingerprint Recognition System
10. Prabhjot Kaur, Ankit Jain, Sonia Mittal: Touch-less Fingerprint Analysis — A Review and Comparison
11. http://cherup.yonsei.ac.kr/research/research_touchless
12. Dr. Marios Savvides: Introduction to Biometric Recognition Technologies and Applications
13. B.Y. Hiew, Andrew B.J. Teoh, and *Y.H.* Pang: Digital Camera based Fingerprint Recognition
14. Om Preeti Chaurasia: An Approach to Fingerprint Image Pre-Processing
15. Jyotika Chopra and Dr. P.C. Upadhyay: Various Fingerprint Enhancements and Matching Technique
16. Mike Boldischar and Cha Poa Moua: Edge Detection and Feature Extraction in Automated Fingerprint Identification Systems
17. Vladimir Vezhnevets ∗ Vassili Sazonov Alla Andreeva: A Survey on Pixel-Based Skin Color Detection Technique
18. http://www.fbi.gov/about-us/cjis/fingerprints_biometrics/biometric-center-of-excellence/files/fingerprint-recognition.pdf
19. Chulhan Lee, Sanghoon Lee, Jaihie Kim, Sung-Jae Kim: Preprocessing of a Fingerprint Image Captured with a Mobile Camera

20. http://www.roborealm.com/help/Adaptive_Threshold.php
21. http://homepages.inf.ed.ac.uk/rbf/HIPR2/adpthrsh.htm

APPENDICES

APPENDIX A: Tools Description

MATLAB is a high-level language and interactive environment for numerical computation, visualization, and programming. Using MATLAB, you can analyze data, develop algorithms, and create models and applications. The language, tools, and built-in math functions enable you to explore multiple approaches and reach a solution faster than with spreadsheets or traditional programming languages, such as C/C++ or Java.

You can use MATLAB for a range of applications, including signal processing and communications, image and video processing, control systems, test and measurement, computational finance, and computational biology. More than a million engineers and scientists in industry and academia use MATLAB, the language of technical computing.

Add-on products extend MATLAB for:

- Math, Statistics, and Optimization
- Signal Processing and Communications
- Image Processing and Computer Vision
- Control System Design and Analysis
- C Code Generation

APPENDIX B : Quality Assurance

Quality assurance, or QA for short, is the systematic monitoring and evaluation of the various aspects of a project, service or facility to maximise the probability that minimum standards of quality are being attained by the production process. Two principles included in QA are " Fit for Purpose" – the product should be suitable for the intended purpose; and "Right first time"- mistakes should be eliminated.