FINGERPRINT ENHANCE RECOGNITION SYSTEM FOR BIO-METRIC AUTHENTICATION

A Project and Thesis submitted in partial fulfillment of the requirements for the Award of Degree of Bachelor of Science in Electrical and Electronic Engineering

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Certification

This is to certify that this project and thesis entitled "**Fingerprint Enhance Recognition System For Bio-Metric Authentication**" is done by the following students under my direct supervision and this work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering of Daffodil International University in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering. The presentation of the work was held on 18 October 2020.

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Dedicated to

Our Parents

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ABSTRACT

Human fingerprints are rich in details called minutiae, which can be used as identification marks for fingerprint verification. The goal of this thesis to develop image quality through improves PSNR, MSE & SSIM for fingerprint verification through extracting and matching minutiae. Measurement of image quality is important for many image processing applications. Image quality assessment is closely related to image similarity assessment in which quality is based on the differences (or similarity) between a degraded image and the original, unmodified image.

There are two ways to measure image quality by subjective or objective assessment. Subjective evaluations are expensive and time-consuming. It is impossible to implement them into automatic real-time systems. Objective evaluations are automatic and mathematical defined algorithms. Well-known objective evaluation algorithms for measuring image quality include mean squared error (MSE), peak signal-to-noise ratio (PSNR), and structural similarity (SSIM). MSE & PSNR are very simple and easy to use.

Various objective evaluation algorithms for measuring image quality like Mean Squared Error (MSE), Peak Signal-To Noise Ratio (PSNR) and Structural Similarity (SSIM) etc. have been studied and their results are compared.

CHAPTER 1

INTRODUCTION

1.1 Introduction

The fingerprint verification system was one of the most effective and well-known forms of biometrics, usually used to automatically verify or authenticate a person's identity through automated systems. This is achieved by comparing the fingerprint features of two people with match power. It helps in verifying the identity claimed by an individual and is closely related to the techniques used in applications such as access control systems. Scientific research has shown that fingerprints are surprisingly unique; There are no two people in the whole world with the same kind of details, not even identical twins. Fingerprints are permanent, integral to a person, except that they are damaged by fear, fingerprints remain the same from birth to death. This unique fingerprint feature used to identify individuals helps provide instant biometric solutions to existing problems with traditional security access control systems of locks and keys that could be stolen or forged, PIN codes or passwords that can be forgotten or heard, and RFID cards without any forged identification. Can use an intruder. Fingerprint analysis for matching purposes usually requires a comparison of some important features of the fingerprint pattern. These include fingerprint patterns such as arches, loops, and vortices that are a combination of Chavez and Minutia points. Scientists have discovered that each family member often bears the same fingerprints. Patterns can be inherited This is the basis of common belief.

This chapter provides a brief overview of the study, including the historical background of the study, the research issues, and the key contributions presented.

1.1.1 Historical Background Of Research

The history of fingerprinting began its use in criminal activities. Consistent with historians, the Babylonians pressed their fingers into the wet soil to record business transactions. This Chinese custom-made strategy, however, works with its profits as a single mark as an abusive ink on paper to conduct business transactions and determine their youth. Even many years later, the application was still in use once, in 18, AN English, then known as Sir William Herschel, the then Chief Justice of Hooghly District, Jangipur, India, required residents to record a fingerprint once in the language of their business documents. It was on this basis that Henry Faulds, a Scottish physician, came up with the idea. Physicians, while operating in Japan, discovered fingerprints on ancient clay items. In 1880, Fouldes wrote a letter to Darwin to facilitate his organization. Darwin refused at the time but sent the request to Sir Galton. Galton was a young scientist, the World Health Organization gathered a great deal of knowledge on the physical characteristics of individuals so that the mechanics behind the inheritance of genetic traits could work. After collecting 7,000 fingerprint samples, Galton revealed that his book "Fingerprints" would become the earliest fingerprint company in history throughout 1982. The system may not look stylish at the time, but its flaw survives. At the same time, others around the world had the same idea when the cep released "Fingerprints", a Frenchman named Bartillon was performing on his own system, involving hands, feet and other sutures. This practice, called mastication, was adopted by the British people in the nineties by the Indian police in Argentina. Once known for helping to investigate the murder of 2 boys in a passing village near the Argentine capital, his system competes with a pole half. Once samples were verified from the crime scene, she was identified as the killer, Francisca Rojas, the son's mother, she confessed to the crime and was born comparative dactyloscopy

1.1.2 Overview

The word "biometrics" comes from the Greek words "bio" (existence) and "matrix" (to measure). Some of the best biometric structures have come on the market quite a long time ago, a way of making significant progress in computer systems. Several of these new gadget-driven strategies, however, supported the concept of rectangular degree support that was originally planned much earlier than the whole. The concept of bioscience has changed as a gift for many years now. Within the Ordnance Century, China practiced fingerprinting to separate merchants and their children from others. Fingerprints are used nowadays.

- In the nineteenth century, Anthropologist Alphonse Bertilion, an associate degree sociologist, developed a technique for measuring the bodies of individuals (known as Bertiliones). Stays. This technique has declined rapidly because it has been found that people with the same body measurements are often mistakenly taken together. Then, Richard Edward Henry of Scotland Yard developed a strategy for the process.
- The retina detection plan was devised in 1935 by Dr. Carlton Simon and Dr. Isador Goldstein. In 1976, a research and development effort was conducted at the postgraduate INC. The primary industrial retina scanning system was created in 1981.
- Iris recognition was invented in 1993 by John Dogman at Cambridge
- In 2001, a biometric automated toolset (BAT) was introduced in Kosovo, offering a concrete detection.

Today, biometric has got to return up as an independent field of study with precise technologies of building personal identities. [3]

1.2 Problem Statement

Reliable personal authentication schemes are required to verify or determine the identity of individuals requesting their services across a wide variety of systems. The purpose of such schemes is to ensure that the render services are accessed by a legitimate user, and no one else. Examples of these systems include secure access to buildings, computer systems, laptops, cellular phones and ATMs. In the absence of robust authentication schemes, these systems are risky for an impostor type. Dition has traditionally been used to restrict access to passwords (knowledge-based security) and ID cards (token-based security) to the system. The main advantages of this traditional thematic personal identification are (i) they are very simple (ii) they can be easily integrated into different systems at low cost. However, this method is not based on a person's inherent qualities to create a personal identity, so tokens can be lost, stolen, forgotten, or misplaced; PIN forgotten or hypocrites can guess. Disclosure of a password to an unauthorized user or theft of a card by an impostor can easily violate security on these systems; Further, simple passwords are easy to guess (by an incorrect person) and hard passwords (by a legitimate user) are difficult to retrieve. So they are unable to meet the security requirements of our Electronic Connected Information Association. The rise of biometrics has solved the problem of sorting out traditional theoretical verification.

1.3 Objectives

On the bases of those ideas the goal of this thesis work is to match objective image quality matrices for image assessment and their analysis which will automatically predict image quality. Image quality assessment is closely associated with image similarity assessment. So, the emphasis during this thesis are on image fidelity, i.e., however shut a picture to given original or reference image. Some commonly used ways to evaluate image quality.

1.4 Research Methodology

The new image quality metric has been designed to be exploited in the MATLAB software package. Matlab is a powerful, all-purpose, mathematical software package. Matlab has great graphics and matrix handling capabilities. It integrates mathematical computing over powerful languages to provide a versatile environment for technological computing. The main options of Matlab Square measure its built-in mathematical toolbox and graphic functions. Also, external routines that are written in different languages such as C, C ++, Fortran and Java can be integrated with Matlab applications. Matlab supports importing files and data from various external devices. Most of the functions of Matlab Square are matrix-based measurements and can work in arrays of any acceptable dimensions. Matlab also includes a separate tool chest for image processing applications, which provides simple solutions to a number of problems compared to this analysis, complete step-by-step objective image matrix.

Step 1: Several algorithms have already been developed for measuring image quality. Among the average Square Error (MSE), Peak Signal to Noise Ratio (PSNR), Average Difference (AD), Maximum Difference (MD), Universal Image Quality Index (UIQI), and Structural Harmony Index Metric (SSIM) The initial step is to review the metrics. This is done through a literary survey. This step is to analyze their significance. It is an in-depth study of the advantages and disadvantages of their individual contributions and methods in the formulation of parameters used

Step 2: The second step is to simulate the methods (MSE, PSNR).

Step 3:Execute the methods with some standard images. The images are first corrupted with different kind of noise.

CHAPTER 2

BIOMETRICS AUTHENTICATION

2.1 Introduction

Biometrics authentication refers to techniques that believe in measurable physiological and distinctive features that will be automatically verified. In a nutshell, each or all of us have individual characteristics that will be used for specific identification, as well as a fingerprint, a membrane pattern, and voice features. Visual or 2-Quality Authentication - 1 of the 1 things you recognize is characterized by two of its own features (for example, a password), (for example, a swipe card), or it (for example, a fingerprint) - is becoming secure A truly common addition to the computing environment. The computer analyzes your fingerprint to determine who you are and, based on your identity followed by a pass code or pass phrase, allows you different levels of access. Access levels can include the ability to open sensitive files, to use credit card information to make electronic purchases, and so on.

2.2 Techniques Of Biometrics Authentication

Biometric authentication is truly a pattern-recognition that creates a personal identification determined by the belief in a specific physiological or behavioral trait held by the user. A personal matter is understandable but is being raised with an intelligent approach to determining whether a personal is understood. Authentication is often divided into 3 modules:

a.) Enrollment module

b.) Verification module

c.) Identification.

2.3 **Working Process Of Biometric Technology**

The registered module is responsible for enrollment in the biometric system. Throughout the enrollment, a person's biometric feature is scanned by a biometric reader to provide a raw digital image of the feature. Thus for the convenience of the mill, the raw digital image is usually more processed by the feature extractor but returned with a more compact image than the one referred to as a model. Depending on the instrument, the model also puts in the central data. Depending on the application, Bioscience is going to be employed in one of 2 modes: verification or detection. Verification - also referred to as authentication - is used to verify the identity of a person - to prove that people are the unit of the World Health Organization they say they are. Identification is used to establish a person's identity—that is, to determine who a person is. Although biometric technology resides in completely different features, all biometric systems start with a collaborative enrollment stage and follow a uniform stage that will use verification or identification.

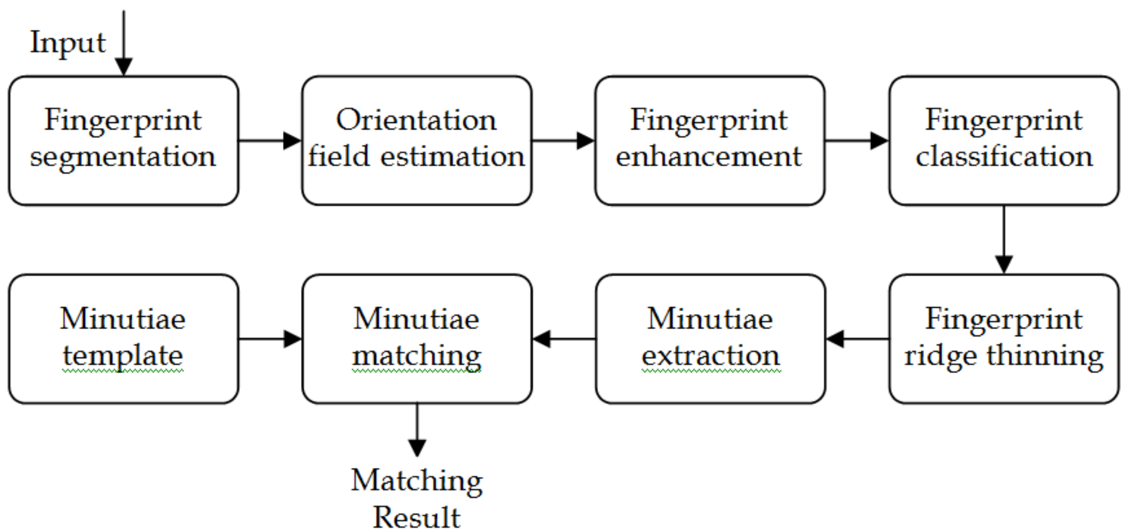

Figure2.1: Fingerprint authentication process

2.3.1 ENROLLMENT

In enrollment a biometric system is trained to identify specific individuals. The 1st person provides an identifier like the card. Biometric identification is attached to the identity according to the document. He then presents the biometric (e.g., finger tips, hand or iris) on a purchasing device. Individual alternative zone units are stabilized and one or more sample zone units are lifted, encoded and kept as a reference guide for future comparisons. Depending on the technology, biometric sample images can also be collected as a recording or a record of attached dynamic measurements. However biometric systems extract options and provide inscriptions and information in the guide in the system vendor-owned algorithm or the size of the template depends on the vendor and therefore differs in technology. Templates are often placed remotely within a central data or biometric reader device; Their small size allows them to be stored on extra sensitive cards or tokens. Minute changes in position, distance, pressure, atmosphere, and alternative factors affect the generation of the guide. As a result, every time a person's biometric data area unit is captured, the new template is probably going to be unique. Calculating on a biometric system, biometric data may often have to be gifted to enroll someone's name. Either the reference guide can present a combination of information captured later or many listed templates can also be placed. The value of guides or templates is important to the overall success of biometric applications. Biometric options will improve over time, forcing individuals to re-enroll to update their reference guides. Some technology will update the reference guide to match activities. The method of enrollment also depends on the quality of the symbol that the soul represents. The reference guide is linked to an identity to the identification document. If the identification document does not specify the real identity of the person, the reference guide is going to be attached to a false identity.

2.3.2 VERIFICATION

The final outline of this chapter goes here.

In the verification system, the step during enrollment is that anyone or he claims (e.g., the name registered) he verifies the UN agency when the person provides the associate symbol, the biometric is provided, the biometric system captures, supports an evolving algorithm Effort creates templates. The system then compares the test biometric template with this person's reference template, which is listed in the system to determine if a person's judgment is tested and if the templates match. Verification is usually referred to as a 1: 1 (one-to-one) match. The verification system will have databases ranging from dozens to logged registered temples but the field unit was predicted to be matched with the biometrics provided along with its collaborator as opposed to his or her reference template. Almost all verification systems will make a match-no-match call but render in a second. One of the most common applications of verification as a whole may be a system that requires employees to reveal their claimed identities before they can secure buildings or access computers.

2.3.3 Identification

In the detection system, the step after enrollment is that person is Unlike the spot verification system, no identifier is provided. To find a match, the person identifies the reference template and compares the test template with all the individual reference templates registered in the system instead of comparing it with the biometrics presented. The region of the detection system matches the unit as 1: M (one-to-M, or one-to-many) because individual biometrics are compared to multiple biometric templates in the system's database. There are 2 forms of detection system: positive and negative. Identification system area unit designed to ensure that a person's biometric information is registered. The expected results in attendance can be a match. A common positive identification system controls access to a secure building or secure computer by checking anyone seeking access through the WHO, in contrast to information received from registered staff. The goal is to determine if anyone seeking access can register with the system. The Negative Identification System Area Unit is designed to ensure that a person's biometric information is not present at any time. No description matches the expected result. Comparing a person's biometric data with all WHO data registered during the public benefits program will ensure that the person is not "double-dipped" by documentation of exploitative fraud for registration under multiple identities. Another form of negative identification system is the watch list system. Such systems are designed to spot people on the surveillance list and alert the authorities for acceptable action. For all people, the system allows them to see that they are not on the watch list and allows them to pass normally. Those who have biometrics in the data on this system cannot voluntarily provide them. For a surveillance system, for example, biometrics can be captured from mug shots provided by law enforcement agencies.

2.4 Existing Biometric Technology

There are many biometric technologies that have been planned over the past few years, but in the last five years alone the leading ones have turned out to be a lot wider deployments. Some technologies are more suitable for specific applications than others and are acceptable to a few users. We can describe seven top biometric technologies:

- Facial Recognition
- Fingerprint Recognition
- Hand Geometry
- Iris Recognition
- Signature Recognition
- Speaker Recognition

2.4.1fingerprint Recognition

Fingerprint recognition is one of the most effective known and most used biometric technologies. Automated systems have been commercially acceptable since the early nineteen seventies and during our study, we have a tendency to find there are seventy-five fingerprint recognition technology companies. Until recently, fingerprint recognition was used primarily in applications. Fingerprint recognition technology extracts the feature from impressions created by distinct widths above the fingernail. Fingerprints will be flat or rotated. Captures the effect of a completely central location between a flat print tip and the 1st knuckle; A rotating print captures the capture on either side of the finger. An image of the fingerprint is captured by the scanner, enlarged and reproduced into a template. Scanner technologies will be optical, silicon or ultrasound technology. Ultrasound, where it is probably the most accurate, is not uncommon in wide use. In 2002, we discovered that optical scanners were commonly used. Throughout the improvement, dirt, cuts, stains and creases or dry, wet or worn fingerprints have decreased, and the definition of agility has also increased. Vendors base their algorithms on the extraction of points of trivial matters related to breaks in the holes of their fingerprints. Different algorithms support square measurement extracting ridge patterns.

2.4.2 Fingerprints In Biometric Authentication

The area unit of fingerprints is considered to be unique to people and to the fingers of the same person. Even identical twins having the same DNA, the region unit is believed to possess completely different fingerprints. Historically, fingerprint patterns are extracted by creating a degree of ink print associated with the fingerprint on the paper. The electronic age introduced various compact sensors that provided digital images of these patterns. These sensors can only be integrated into existing PC peripherals such as a mouse or keyboard (figure), making this mode of detection a highly attractive proposition. This has led to an increase in the use of fingerprint-based authentication systems automatically in every civilian and applicable application.

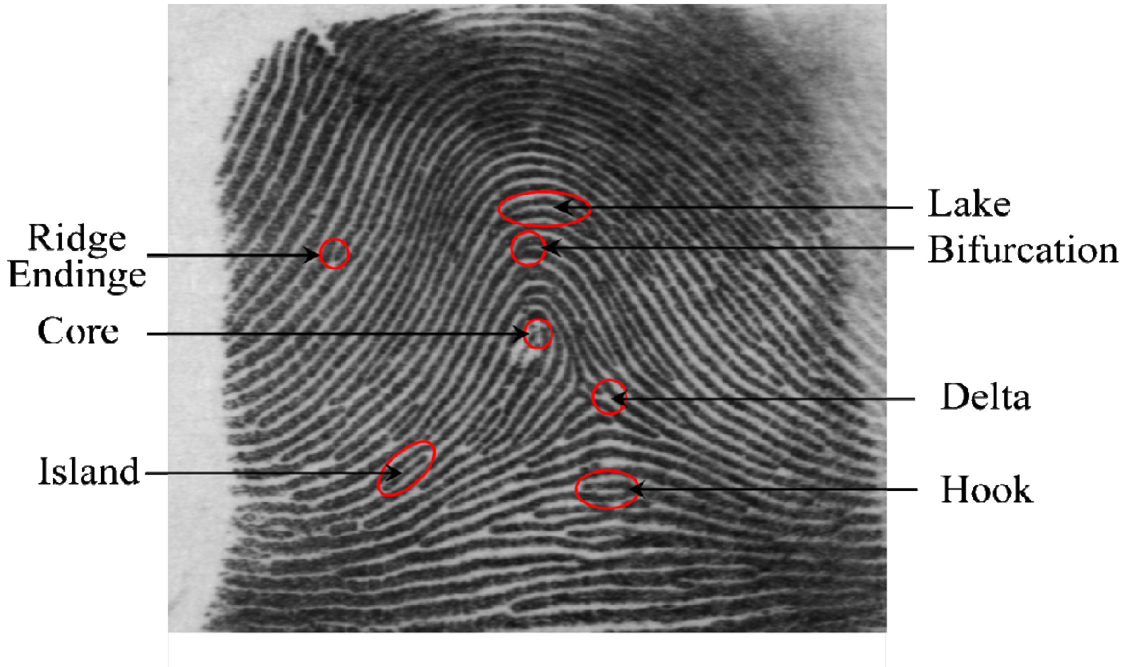

Figure2.2: Regions of fingerprint

Typically, the global configuration described by the ridge structure is assigned to work in the Fingerprint section, where the distribution of Mintia points is assigned to find and match between 2 fingerprints. Automatic fingerprint identification systems, which match a query print with huge print data (this will carry it with millions of prints), think about the patterns inside the query image (fingerprint indexing) and a specific match (finger) to slide their search into the database Imprint Matching) The pattern of on-ridge flow in minute points to work never matches fingerprints by itself. [4]

2.4.3 Minutiae

In fingerprinting terms, minutiae ar the points of interest during a fingerprint, like bifurcations (a ridge rending into two) and ridge endings.

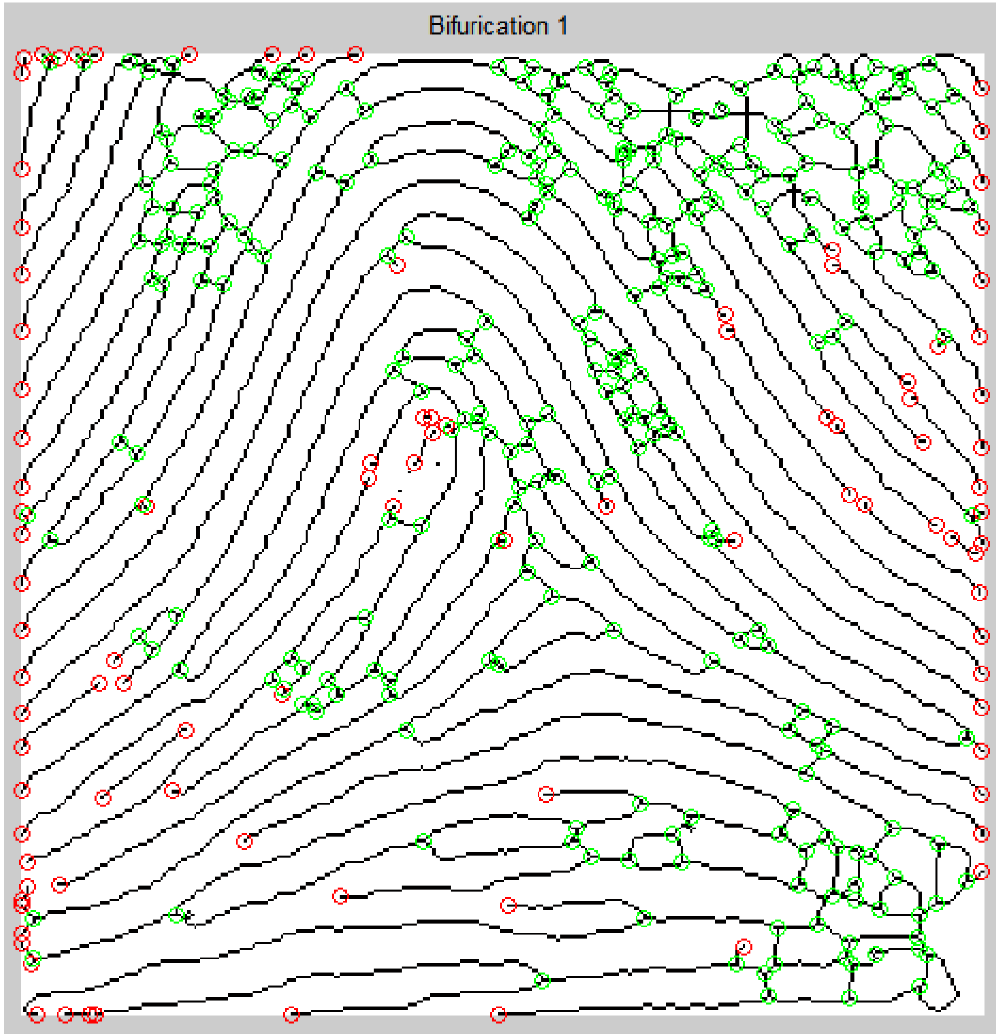

Figure2.3: Image with minutiae

Different types of ridges are:

a.) ridge endings – a ridge that ends short

b.) ridge bifurcation – one ridge that divides into 2 ridges

c.) short ridges, island or freelance ridge – a ridge that commences, travels a brief distance then ends

d.) ridge enclosures – one ridge that bifurcates and reunites shortly afterward to continue as one ridge

e.) spur – a bifurcation with a brief ridge branching off a extended ridge

f.) crossover or bridge – a brief ridge that runs between 2 parallel ridges

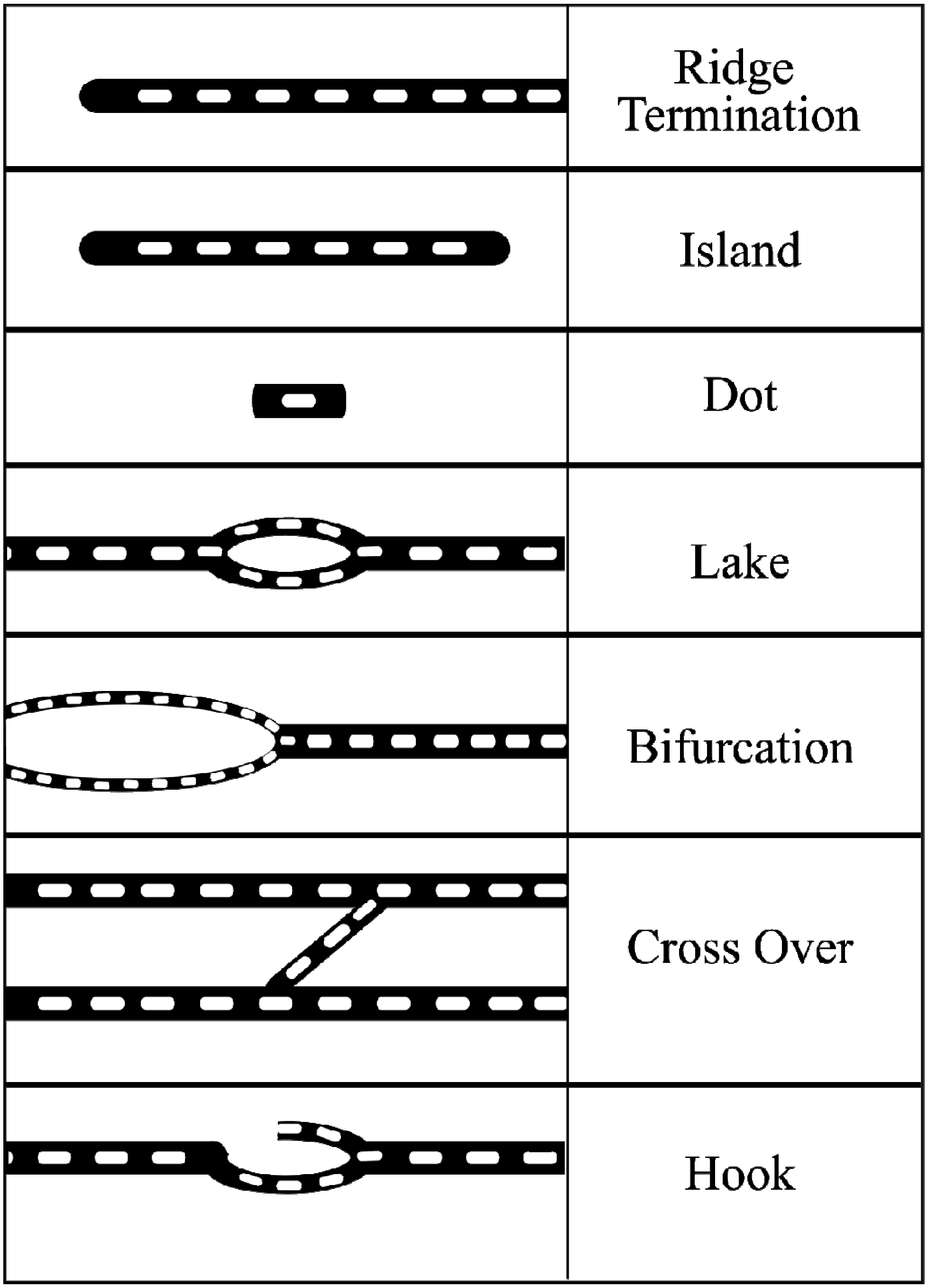

Figure2.4:Different types of ridges

CHAPTER 3

ANALYSIS AND SIMULATION

3.1 Introduction

Improving the fingerprint image is used to clear the image for more extra activity. Since fingerprint images obtained from scanners or other media are of excellent quality, they do not seem to be reassured with augmentation methods, due to insufficient amount of ink to widen the gap between ridals and valleys and to attach false broken points in canals. Very helpful. Originally, the advanced step was supposed to be done using clever edge identifiers. After examination, however, it is found that the result of an edge detector is an image with the boundary of the regidus. Filling sizes using edge detection requires the employment of additional steps that can take a lot of processing time and increase the complexity of the code.

3.2 Image Binarization

The binaryization move makes the most obvious statement, that the factual information obtained from the print is only bilateral; Elite vs. Valley prints are taken as grayscale images, so it is a very necessary step in the process of lifting ridges, so knowing that they are fraudulently differentiates sharply. Image that provides equivalent information. So, binarization transforms the image from a 256-level image to a 2-level image that gives the same information. Typically, an object's pixel is given a value of "1" while a background pixel is given a value of "0." The value is given Finally, a binary image is created by coloring each pixel white or black based on the label of the pixel (black for zero, white for 1) bin Threshold (Global Throholding) cannot be selected Image.in is performed to bifurcate, the image is divided into blocks (16x16), and the average intensity value for each board is calculated, then each pixel is converted to one if its intensity value is greater than the average intensity value of the current block relative to the pixel. [1]

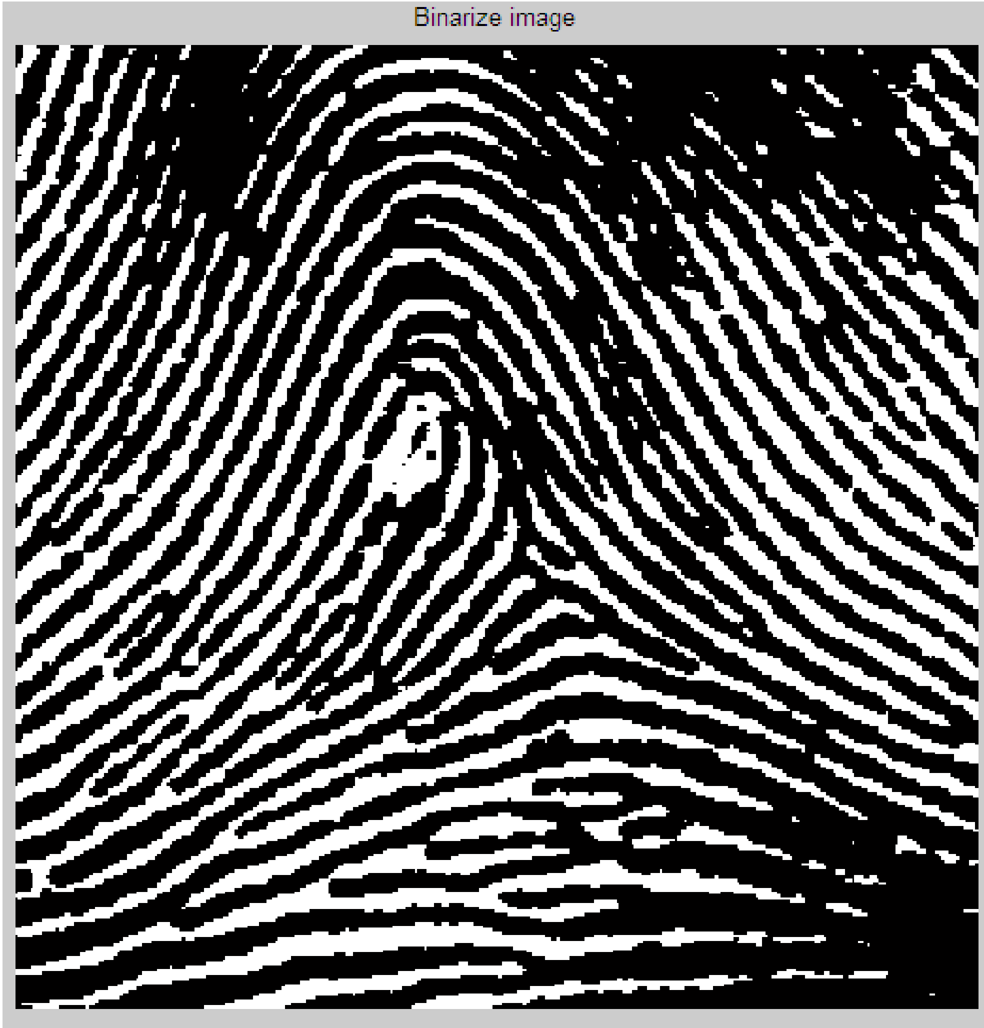

Figure3.1: Binarize image

3.3 Ridge thinning

Ridge thinning is the removal of useless pixels of ridges until the ridges are only one pixel wide. The associate degree is careless, parallel thin formulas are employed. In each scan of the total fingerprint image, the rule marks redundant pixels in each small image window (3x3) and finally removes all these marked pixels after a few scans. The thin ridge map is filtered by various sized activities to get rid of some H brakes, isolated points and spikes. During this step, any single points, be they single-point races or single point breaks during an episode, will be deleted and the process will be considered..[4]

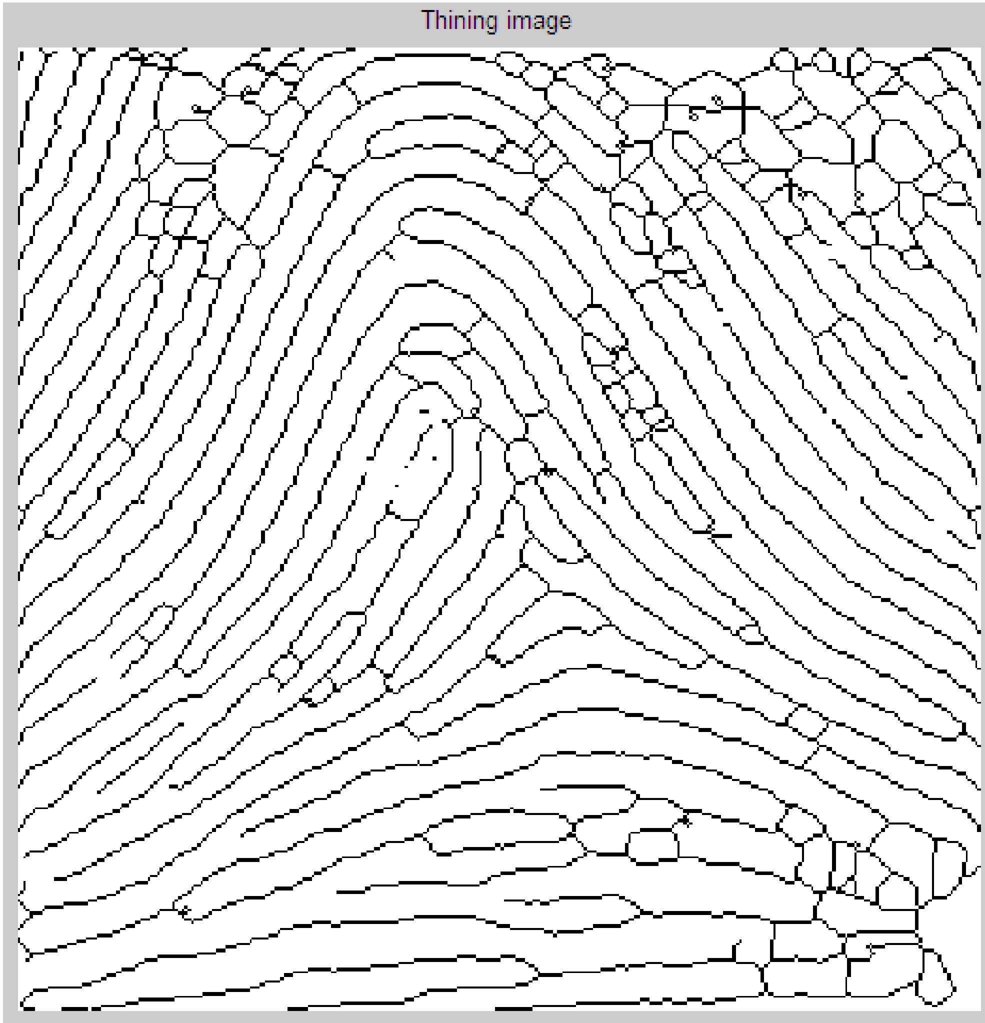

Figure3.2: Thining image

3.4 Minutiae Marking

After the fingerprint ridge thinning, marking minutiae points is comparatively simple.

The idea of a Crossing number (CN) is widely used for extracting the minutiae. In general, for each 3x3 window, if the central picture element is one and has specifically three one-value neighbors, then the. If the central pixel is 1 and has only 1 one-value neighbor, then the central pixel is a ridge ending, i.e., for a pixel P, if Cn(P) = = 1 it's a ridge end and if Cn(P) = = 3 it's a ridge bifurcation point.

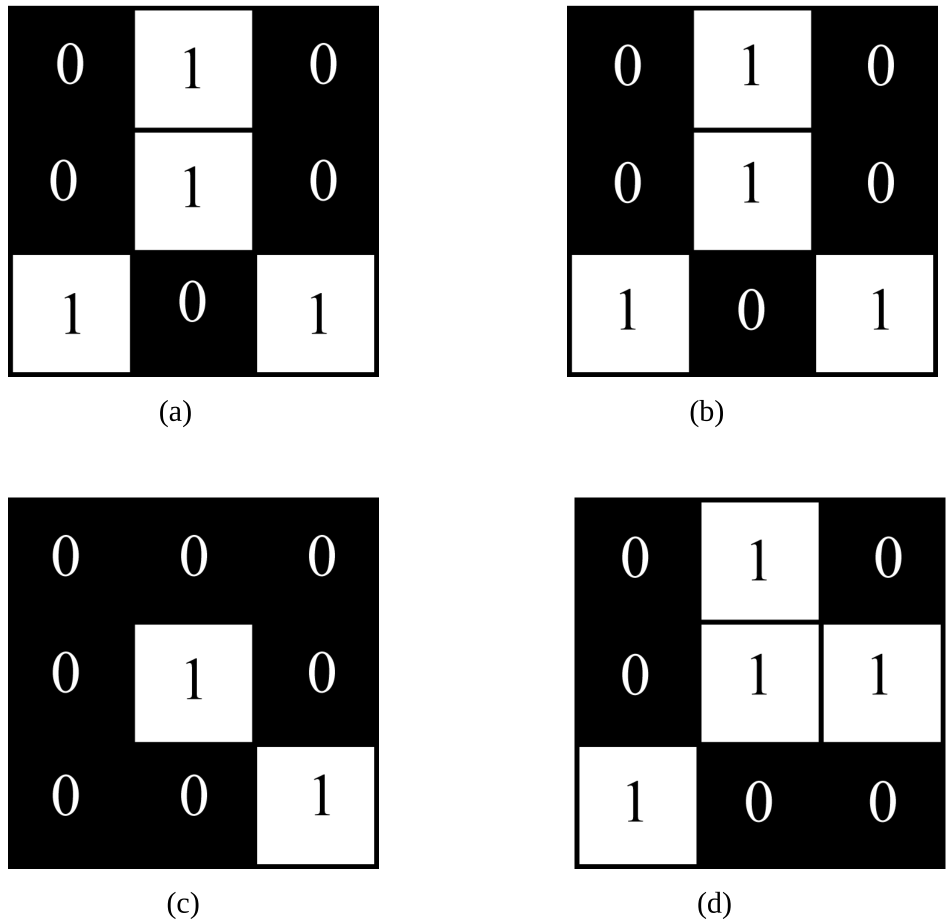

Figure3.3: (a), (b), (c), (d) minutiae marking process

The value of both the top pixel is 1 and at the same time there is another neighbor outside the 3x3 window of the right pixel which is marked as a branch, but in reality only 1 branch is located in a small area so check routine does not add value to both a branch and the branch neighbors. Also, the average intermediate width D is the easiest way to estimate the common D value calculated at this level. Scan a row of thin ridge images and add all the pixels in a row with one of the values. Then divide the length of the row by the shortest edge to get an interstitial width. For more accuracy, this type of row scan is performed in a variety of rows and column scans, finally, all the inter-drawing widths together Minutia identifies, there is no labeled unique ID for all the thin ridges of the fingerprint image operation. [4]

CHAPPTER 4

IMAGE QUALITY ASSESSMENT

4.1 Introduction

Image quality can be compromised in most systems of understandable importance. Digital images underwent massive disasters throughout acquisition, processing, storage, transmission, and copying, all of which could lead to a deterioration of visible quality.

4.2 Importance Of Quality Measure

We know the importance of the quality of pictures and videos and the price-quality balance associated with it, the apparent question that arises is why we want to measure quality. The solution is simple and will be illustrated by a few examples. If a designer plans this high-end TV and is interested in understanding what the value curve looks like, he or she clearly wants a style to determine the quality of the output video after running his or her style at a certain configuration cost for a particular company's accounting. In other situations, the designer of a medical imaging device may want to conclude that 2 different X-ray devices give higher results. He also wants some way to scientifically compare the values of the 2 methods. Basically, qualitative evaluation algorithms are basically required for 3 types of applications:

1. For optimization purpose, where one maximize quality at a given cost.
2. For comparative analysis between different alternatives.
3. For quality monitoring in real-time applications.

4.3 Methods To Evaluate Image Quality

Some commonly used methods to evaluate image quality are given below:

(i) Mean Squared Error (MSE)
(ii) Peak Signal to Noise Ratio (PSNR)
(iii) Structural Similarity (SSIM)

4.3.1 Mean Squared Error (MSE)

An obvious method of measuring this similarity is to calculate the error signal by subtracting the check signal from the reference and calculating the average strength of the error signal. Average-Squad-Error (MSE) is the simplest and therefore the most widely used, full-reference image quality mascara. This metric is usually utilized in signal process and is outlined as follows:

MSE=

$$MSE = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}(x(i,j) - y(i,j))^2$$

Where $x(i, j)$ represents the original (reference) image and$y(i, j)$ represents the distorted (modified) image and i and j arethe pixel position of the M×N image. MSE is zero when $x(i,j) = y(i, j)$.[5,9]

4.3.2 Peak Signal To Noise Ratio (PSNR)

Peak ratio, commonly abbreviated to PSNR, is an engineering term for the ratio between the maximum achievable strength of a signal and the strength of the transmitted sound that affects the fidelity of its image. While several signals result in truly broad dynamic variations, PSNR is usually expressed in terms of the index DB scale. The PSNR is assessed in decibels and is inversely proportional to the average square error. This is given by the equation:

$$PSNR = 10\log_{10}\frac{256 * 256}{MSE}$$

4.3.3 SSIM

The difference between the various technologies of previously mentioned relevance, such as MSE or PSNR, is that these methods assume absolute error; Conversely, SSIM may be a perception-based model that treats image degradation as perceived change in structural information, yet incorporates the activity of sensory activity, masking each brightness level and contrasting mask conditions. Structural information is the concept of the interdependence of pixels, especially after the concept is clearly closed. This dependence carries important information about the structure of the object within the visual scene. Brightness level masking can be one where image distortions (in this context) are less visible in bright areas, while contrast masking is a matter where visible activity or "texture" in the image is visible where distortion is seen.

The inspiration behind the structural matching method for measuring image quality is that HVS images are not designed to detect imperfections and "errors". Instead, HVST has evolved in such a way that it recognizes visual patterns so as to be able to find structures or connections to natural images. Based on this observation, it is realized that a helpful perceptible quality metric will emphasize the visual structure over lighting effects. The idea that image metrics would be created based on this philosophy was initially explored and so it was modified, applied, evaluated and improved in contrast to struct and an image. Conversely, the structural approach is sensitive to distortions that break down natural spatial relationships such as blasts, the art of block compression, and noise in an image. As described, the structural philosophy can be applied by employing a set of equations of the SSIM standard metric in place of the figure. Illumination, contrast and structure are measured individually. Given the comparison of two images (or image patches) with x and y, the average luminance of each image is estimated.

$$\mu_x = \frac{1}{N}\sum_{n=0}^{N} x_n \mu_x = \frac{1}{N}\sum_{n=0}^{N} x_n$$

Contrast is estimated using standard deviation as

$$\sigma_x = \sqrt{\frac{1}{N-1}\sum_{n=1}^{N}(x_n - \mu_x)^2}\sigma_x = \sqrt{\frac{1}{N-1}\sum_{n=1}^{N}(x_n - \mu_x)^2}$$

and structureis estimated from the image vector x by removing the mean and normalizing by the standard deviation

$$\delta_x = \frac{X-\mu_x}{\sigma_x}\delta_x = \frac{X-\mu_x}{\sigma_x}$$

Then, the measurements µx; µy; αx; αy; &$^{\sigma\sigma}$x; &$^{\sigma\sigma}$y are combined using a luminance comparison function l(x; y), a contrast comparison function c(x; y), and a structure comparison function s(x; y) to give a composite measure of structural similarity

$$\mathrm{SSIM}(x,y) = l(x,y)^{\alpha}.c(x,y)^{\beta}.s(x,y)^{\gamma}\mathrm{SSIM}(x,y) = l(x,y)^{\alpha}.c(x,y)^{\beta}.s(x,y)^{\gamma}$$

Where α; β; &$^{\gamma\gamma}$ are positive constants used to weight each comparison function.

The comparison functions are given as:

$$l(x,y) = \frac{2\mu_x\mu_y + C_1}{\mu_x^2 + \mu_y^2 + C_1} l(x,y) = \frac{2\mu_x\mu_y + C_1}{\mu_x^2 + \mu_y^2 + C_1}$$

$$c(x,y) = \frac{2\upsilon_x\upsilon + C_2}{\sigma_x^2 + \sigma_y^2 + C_2} c(x,y) = \frac{2\upsilon_x\upsilon + C_2}{\sigma_x^2 + \sigma_y^2 + C_2}$$

$$s(x,y) = \frac{(\delta_x.\delta_y) + C_3}{\upsilon_x.\upsilon_y + C_3} = \frac{\sigma_{xy} + C_3}{\upsilon_x\upsilon_y + C_3} s(x,y) = \frac{(\delta_x.\delta_y) + C_3}{\upsilon_x.\upsilon_y + C_3} = \frac{\sigma_{xy} + C_3}{\upsilon_x\upsilon_y + C_3}$$

Where () is the inner-product operator defining the correlation between the structure of the two images.

$$SSIM(x,y) = \frac{(2\mu_x\mu_y + C_1)(2\sigma_{xy} + C_2)}{(\mu_x^2 + \mu_y^2 + C_1)(\sigma_x^2 + \sigma_y^2 + C_2)} SSIM(x,y) = \frac{(2\mu_x\mu_y + C_1)(2\sigma_{xy} + C_2)}{(\mu_x^2 + \mu_y^2 + C_1)(\sigma_x^2 + \sigma_y^2 + C_2)}$$.[6 ,8]

4.5 FILTER

Filters are data processing techniques that can smooth out high-frequency fluctuations in data or snatch specific frequency periodic trends from data. The filter function in Matlab filters a vector of data x according to different equations.

The filter is driven by a moving-average filter implementation strategy, which is a common data smoothing technique.

Different types of MATLAB function:

Imfilter

N-D filtering of multidimensional images

Syntax

B = imfilter(A, H)

B = imfilter(A, H, option1, option2,...)

Description

B = imfilter(A, H) filters the multidimensional array A with the multidimensional filter H. The array A can be logical or a nonsparse numeric array of any class and dimension. The result B has the same size and class as A.

Each component of output B is calculated using a double-precision floating-point. If A is an integer or logical array, the output elements are truncated beyond the integer type limit and the values of the fraction are rounded.

Imnoise

Add noise to image

Syntax

J = imnoise(I,type)

J = imnoise(I,'gaussian',m,v)

J = imnoise(I,'poisson')

J = imnoise(I,'salt&pepper',d)

J = imnoise(I,'gaussian',m,v) adds Gaussian white noise of mean m and variance v to the image I. The default is zero mean noise with 0.01 variance.

J = imnoise(I,'poisson') generates Poisson noise from the data instead of adding artificial noise to the data. If I is double precision, then input pixel values are interpreted as means of Poisson distributions scaled up by 1e12. For example, if an input pixel has the value 5.5e-12, then the corresponding output pixel will be generated from a Poisson distribution with mean of 5.5 and then scaled back down by 1e12. If I is single precision, the scale factor used is 1e6. If I is uint8 or uint16, then input pixel values are used directly without scaling. For example, if a pixel in a uint8 input has the value 10, then the corresponding output pixel will be generated from a Poisson distribution with mean 10.

J = imnoise(I,'salt&pepper',d) adds salt and pepper noise to the image I, where d is the noise density. This affects approximately d*numel(I) pixels. The default for d is 0.05.

The mean and variance parameters for 'gaussian', 'localvar', and 'speckle' noise types are always specified as if the image were of class double in the range [0, 1]. If the input image is of class uint8 or uint16, the imnoise function converts the image to double, adds noise according to the specified type and parameters, and then converts the noisy image back to the same class as the input.

Gaussian filter

In the physical sciences and signal processors, a Gaussian filter may be a filter whose emotional response may be a Gaussian performance (or an approximate to it). Gaussian filters have the feature of not getting any overshoot for performing any action while increasing and decreasing the reading time. This behavior is closely linked to the actual truth with the least possible cluster delay of the Gaussian filter. It is concerned about the best time-domain filters, even the standard frequency-domain filters such as sinc. These units are important in regions such as oscilloscopes and digital telecommunication systems.

Mathematically, a Gaussian filter modifies the input by compromising by a Gaussian function; This recording is additionally referred to as Wearstrass Transform.

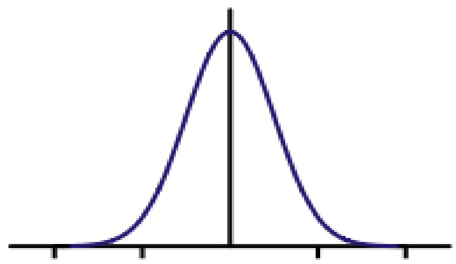

Fig: Shape of the impulse response of a typical Gaussian filter

Definition:

The one-dimensional Gaussian filter has an impulse response given by

$$g(x)g(x)=\sqrt{\frac{a}{\pi}}.e^{-a.x^2}\sqrt{\frac{a}{\pi}}.e^{-a.x^2}$$

and the frequency response is given by the Fourier transform

$$\hat{g}(f)=e^{-\frac{x^2.f^2}{a}}\hat{g}(f)=e^{-\frac{x^2.f^2}{a}}$$

with f the ordinary frequency. These equations can also be expressed with the standard deviation as parameter.

And the frequency response is given by

$$\hat{g}(f)\hat{g}(f)=e^{-\frac{f^2}{\sigma_f^2}}$$

By writing $a\,a$ a function of $\sigma\sigma$ with the two equations for g(x) and as a function of $\sigma_f\sigma_f$ with the two equations for g(f) it can be shown that the product of the standard deviation and the standard deviation in the frequency domain is given by

$$\sigma.\sigma_f=\frac{1}{2\pi}$$

where the standard deviations are expressed in their physical units, e.g. in the case of time and frequency in seconds and Hertz.

In two dimensions, it is the product of two such Gaussians, one per direction:

$$g(x,y)=\frac{1}{2\pi\sigma^2}\frac{1}{2\pi\sigma^2}.\ e^{-\frac{x^2+y^2}{2\sigma^2}}e^{-\frac{x^2+y^2}{2\sigma^2}}$$

where *x* is the distance from the origin in the horizontal axis, *y* is the distance from the origin in the vertical axis, and σ is the standard deviation of the Gaussian distribution.[7]

4.6 Database

Fig: Image1

Fig: Image2

Fig: Image3

Fig: Image4

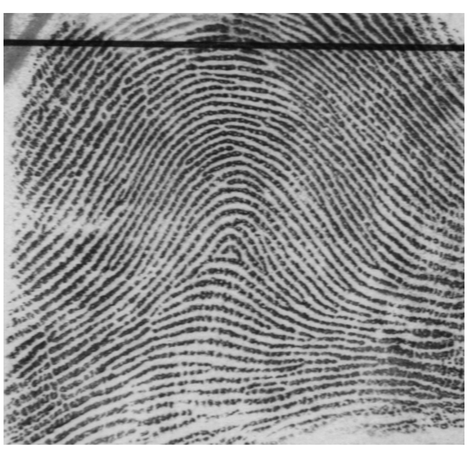

Fig: Image5

Fig: Image6

Fig: Image7

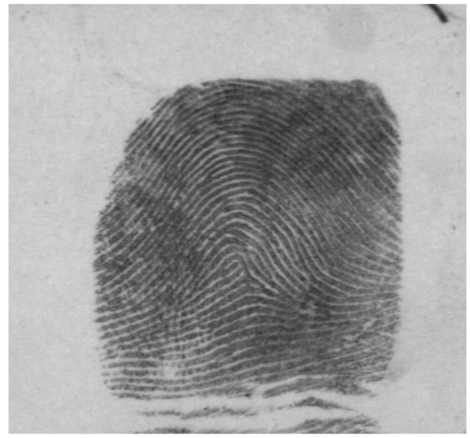

Fig: Image8

Fig: Image9

Fig: Image10

Fig: Image11

Fig: Image12

Fig: Image13

Fig: Image14

Fig: Image15

Fig: Image16

Fig: Image17

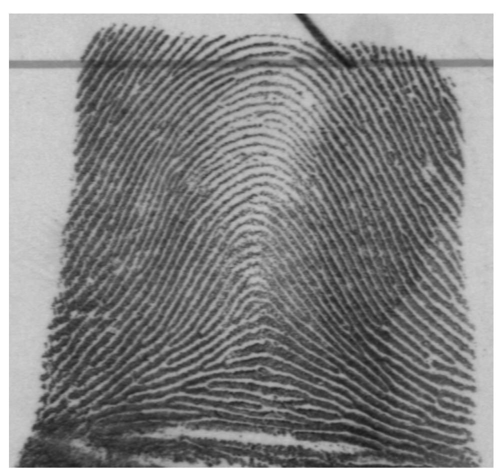

Fig: Image18

Fig: Image19

Fig: Image20

Fig: Image21

Fig: Image22

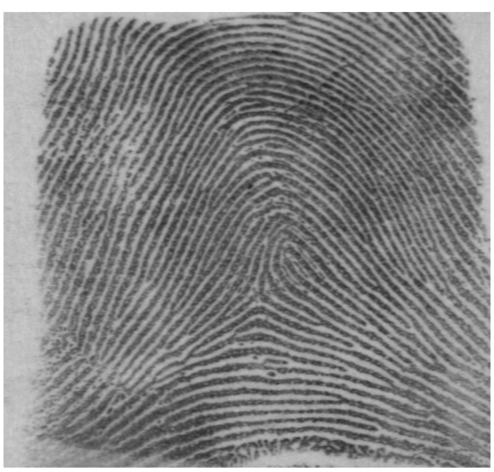

Fig: Image23

Fig: Image24

4.7 Program

Input image read:-

```
functionfingerprintdemo()

clear all
close all
clc

I=imread('J:\20.png');
%I=image read

I1=I([130:440],[130:440]);
figure(1), subplot(2,2,1),
 imshow(I1)

clear I
```

Figure4.1: Reference image

Image Binarization:-

```
I=I1;
H = fspecial('gaussian',[9 9],0.5);
I = imfilter(I,H);

figure(1), subplot(2,2,2), imshow(I)
set(gcf,'position',[1 1 600 600]);


J=I(:,:,1)>100;
figure(1),         subplot(2,2,3),
imshow(J)
set(gcf,'position',[1 1 600 600]);
```

Image Thining:-

```
K=bwmorph(~J,'thin','inf');
%K=bwmorph(~J,'skel');
figure(1),         subplot(2,2,4),
imshow(~K)
set(gcf,'position',[1 1 600 600]);
```

Figure4.2: Binarize output image

Figure4.3: Thinning output image

```
fun=@minutie;
L = nlfilter(K,[3 3],fun);


LTerm=(L==1);
% make all value of '1' is 1, but all zero.
figure(2), subplot(2,2,1),imshow(LTerm)

%LTermLab=bwlabel(LTerm);
LTermLab=LTerm;
propTerm=regionprops(LTermLab,'Centroid')

CentroidTerm=round(cat(1,propTerm(:).Centroid));
figure(2), subplot(2,2,2), imshow(~K)
set(gcf,'position',[1 1 600 600]);
hold on
plot(CentroidTerm(:,1),CentroidTerm(:,2),'ro')

hold on
LBif=(L==3);
LBifLab=bwlabel(LBif);
propBif=regionprops(LBifLab,'Centroid','Image');
CentroidBif=round(cat(1,propBif(:).Centroid));
```

```
plot(CentroidBif(:,1),CentroidBif(:,2),'go')
D=3;
Distance=DistEuclidian(CentroidBif,CentroidTerm);
SpuriousMinutae=Distance<D;
[i,j]=find(SpuriousMinutae);
CentroidBif(i,:)=[];
CentroidTerm(j,:)=[];


Distance=DistEuclidian(CentroidBif);
SpuriousMinutae=Distance<D;
[i,j]=find(SpuriousMinutae);
CentroidBif(i,:)=[];
%Process 3

Distance=DistEuclidian(CentroidTerm
);
SpuriousMinutae=Distance<D;
[i,j]=find(SpuriousMinutae);
CentroidTerm(i,:)=[];
hold off
figure(2), subplot(2,2,3),imshow(~K)
hold on
plot(CentroidTerm(:,1),CentroidTerm(
:,2),'ro')
plot(CentroidBif(:,1),CentroidBif(:,2),'
go')
hold off
Kopen=imclose(K,strel('square',11));

KopenClean= imfill(Kopen,'holes');
KopenClean=bwareaopen(KopenClea
n,7);

figure(3), subplot(2,2,3), imshow(KopenClean)

KopenClean([1 end],:)=0;
KopenClean(:,[1 end])=0;
ROI=imerode(KopenClean,strel('disk',10));
Figure(2),
Subplot(2,2,4),imshow(ROI)

imshow(I)

hold on
imshow(ROI)
alpha(0.5)

hold on
plot(CentroidTerm(:,1),CentroidTerm(:,2),'ro')
```

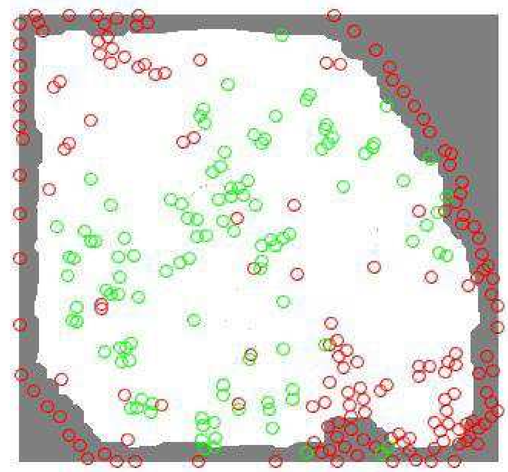

Figure4.4: Filtered image

```
plot(CentroidBif(:,1),CentroidBif(:,2),'go')
hold off
[m,n]=size(I(:,:,1));
indTerm=sub2ind([m,n],CentroidTerm(:,1),CentroidTerm(:,2));
Z=zeros(m,n);
Z(indTerm)=1;
ZTerm=Z.*ROI';
[CentroidTermX,CentroidTermY]=find(ZTerm);
indBif=sub2ind([m,n],CentroidBif(:,1),CentroidBif(:,2));
Z=zeros(m,n);
Z(indBif)=1;
ZBif=Z.*ROI';
[CentroidBifX,CentroidBifY]=find(ZBif);
figure(3), subplot(2,2,1), imshow(I)
```

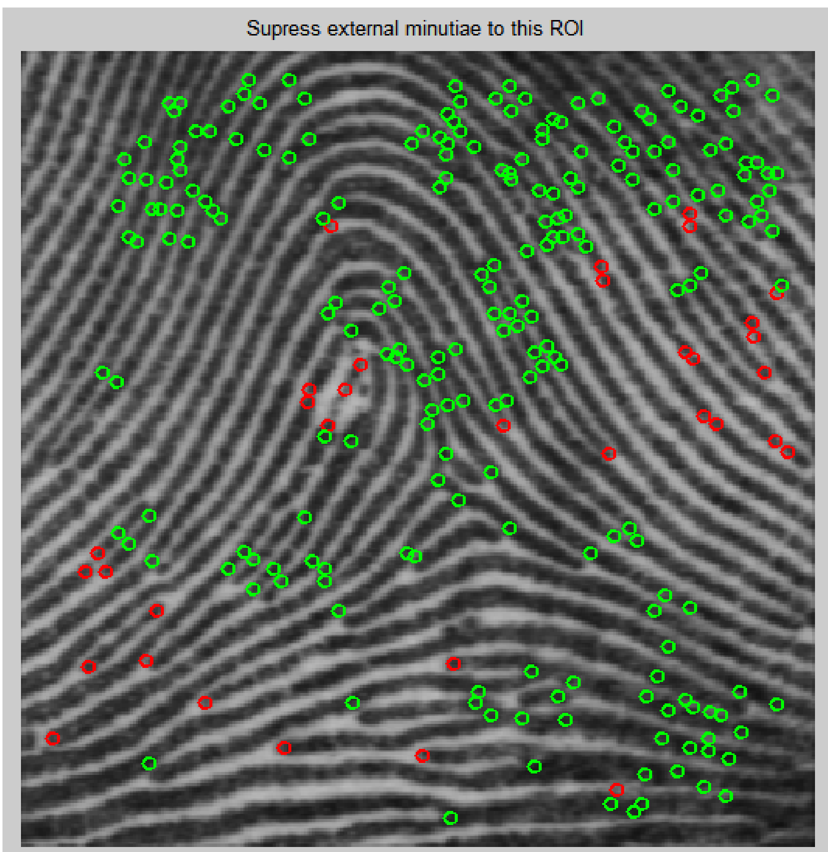

Figure4.5: Supressed image

```
hold on
plot(CentroidTermX,CentroidTermY,'ro','linewidth',2)
plot(CentroidBifX,CentroidBifY,'go','linewidth',2)
```

```
Table=[3*pi/4 2*pi/3 pi/2 pi/3 pi/4
       5*pi/6 0 0 0 pi/6
       pi 0 0 0 0
      -5*pi/6 0 0 0 -pi/6
      -3*pi/4 -2*pi/3 -pi/2 -pi/3 -pi/4];
%OrientationTerm=zeros(6,1);

forind=1:length(CentroidTermX)
    Klocal=K(CentroidTermY(ind)-2:CentroidTermY(ind)+2,CentroidTermX(ind)-
2:CentroidTermX(ind)+2);
Klocal(2:end-1,2:end-1)=0;

    [i,j]=find(Klocal);
OrientationTerm(ind,1)=Table(i(1),j(1));
end

dxTerm=sin(OrientationTerm)*20;
dyTerm=cos(OrientationTerm)*20;

figure(3), subplot(2,2,2),imshow(K)
set(gcf,'position',[1 1 600 600]);
hold on

plot(CentroidTermX,CentroidTermY,'ro','linewidth',2)
plot([CentroidTermXCentroidTermX+dyTerm]',...
    [CentroidTermYCentroidTermY-dxTerm]','r','linewidth',2)

forind=1:length(CentroidBifX)
    Klocal=K(CentroidBifY(ind)-2:CentroidBifY(ind)+2,CentroidBifX(ind)-
2:CentroidBifX(ind)+2);
Klocal(2:end-1,2:end-1)=0;
    [i,j]=find(Klocal);


if length(i)~=3
CentroidBifY(ind)=NaN;
CentroidBifX(ind)=NaN;
OrientationBif(ind)=NaN;
Else

for k=1:3

OrientationBif(ind,k)=Table(i(k),j(k));
dxBif(ind,k)=sin(OrientationBif(ind,k))*5;
dyBif(ind,k)=cos(OrientationBif(ind,k))*5;

end
end
end
```

```
plot(CentroidBifX,CentroidBifY,'go','linewidth',2)
OrientationLinesX=[CentroidBifXCentroidBifX+dyBif(:,1);
CentroidBifXCentroidBifX+dyBif(:,2);CentroidBifXCentroidBifX+dyBif(:,3)]';
OrientationLinesY=[CentroidBifYCentroidBifY-
dxBif(:,1);CentroidBifYCentroidBifY-dxBif(:,2);CentroidBifYCentroidBifY-
dxBif(:,3)]';
plot(OrientationLinesX,OrientationLinesY,'g','linewidth',2)

end
```

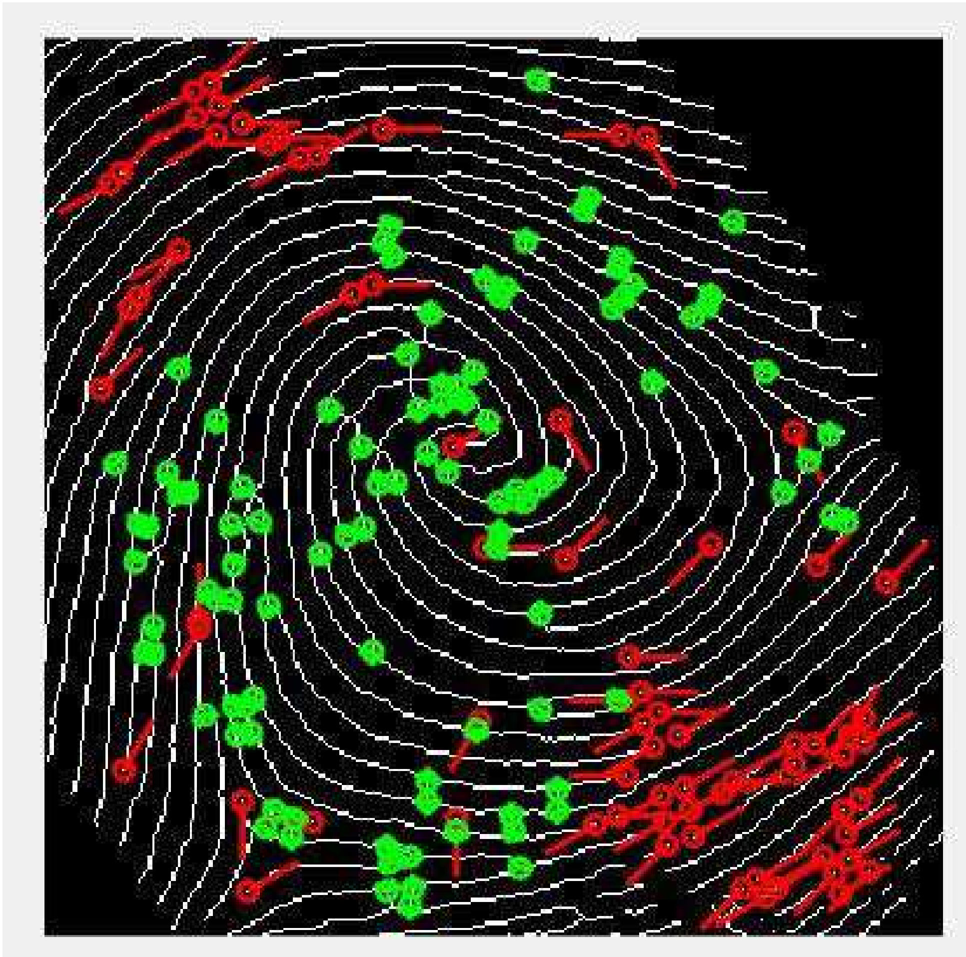

Figure4.6: Bifurecated image

```
function y=minutie(x)

i=ceil(size(x)/2);
if x(i,i)==0;
   y=0;
else
   y=sum(x(:)) - 1;
end
end
function D=DistEuclidian(dataset1,dataset2)
h = waitbar(0,'Distance Computation');
switchnargin
```

```
case 1
        [m1,n1]=size(dataset1);
        m2=m1;
        D=zeros(m1,m2);
fori=1:m1
waitbar(i/m1)
for j=1:m2
ifi==j
                    D(i,j)=NaN;
else
                    D(i,j)=sqrt((dataset1(i,1)-dataset1(j,1))^2+(dataset1(i,2)-dataset1(j,2))^2);
end
end
end
case 2
        [m1,n1]=size(dataset1);
        [m2,n2]=size(dataset2);
        D=zeros(m1,m2);
fori=1:m1
waitbar(i/m1)
for j=1:m2
                D(i,j)=sqrt((dataset1(i,1)-dataset2(j,1))^2+(dataset1(i,2)-dataset2(j,2))^2);
end
end
otherwise
error('only one or two input arguments')
end

close(h)
end
```

Program of SSIM, MSE, SSIM

```
clc
clear all
close all
image=(imread('E:\s1.png'));
image1=imresize(image,[128 128]);
figure,imshow(image1)
image0=(imread('E:\s2.png'));
image2=imresize(image0,[128 128]);


figure, imshow(image2)
peaksnr=psnr(image2,image1);
mse=immse(image1,image2);
similarity=ssim(image1,image2);


 fprintf('peaksnr= %f; similarity=%f\n; mse=%f\n',peaksnr,similarity,mse);
```

CHAPTER 5

RESULTS AND DISCUSSIONS

5.1 Introduction

Assessment of image quality is done either by subjective or objective evaluation. Subjective evaluations are expensive and time-consuming. It is not possible to apply subjective assessments within an automated period of time management. Objective assessments related to automated and mathematical outline algorithms are used for testing. well-known objective analysis algorithm is used for measurable image quality as Mean Square Error (MSE) and Size Ratio from Peak Signal (PSNR). Results of the program:

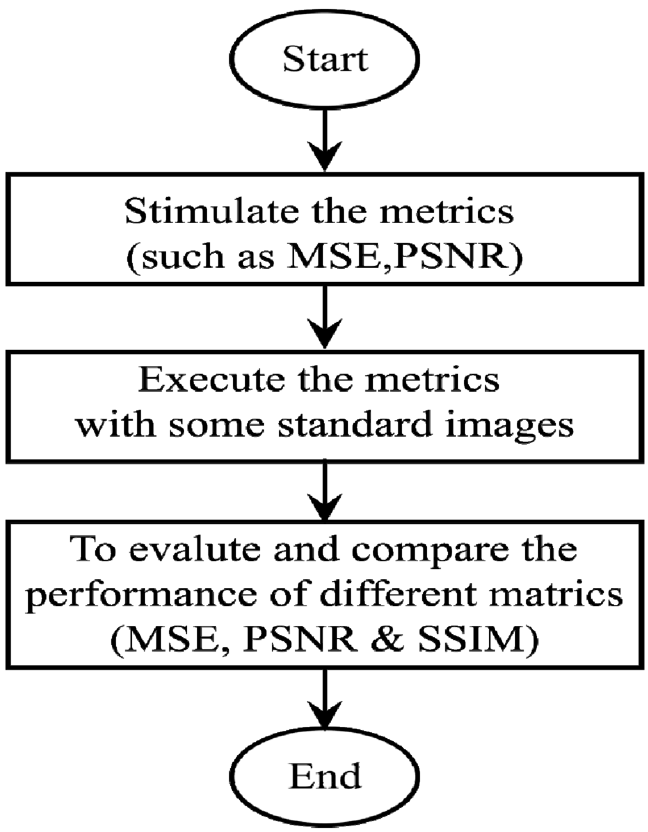

Figure5.1: Flow chart of evaluation image quality

5.2 Results

Table5.1: Values of MSE, PSNR& SSIM

Image	MSE	PSNR	SSIM
Image1	0.24	54.28	0.25
Image2	0.67	49.94	0.24
Image3	0.10	58.18	0.22
Image4	1.66	45.97	0.31
Image5	0.61	50.32	0.23
Image6	0.38	52.35	0.33
Image7	0.24	54.32	0.34
Image8	1.25	47.20	0.26
Image9	0.17	55.77	0.32
Image10	0.14	56.84	0.25
Image11	0.67	49.90	0.30
Image12	1.10	47.76	0.30
Image13	0.27	53.83	0.28
Image14	0.59	50.49	0.23
Image15	0.41	52.03	0.34
Image16	0.38	52.37	0.36
Image17	0.06	60.35	0.24
Image18	0.17	55.88	0.30
Image19	0.13	57.13	0.25
Image20	0.26	54.08	0.26
Image21	0.50	51.15	0.29
Image22	0.17	57.20	0.30
Image23	0.44	51.76	0.31
Image24	0.26	53.95	0.21

5.3 Summary

Simulation of the fingerprint verification system examines twenty-four live scan fingerprint pairs. The experiment was able to separate the funky Mintia pairing from the real Mintia pairing and will efficiently and efficiently verify the identity of any person supported by the data on the fingerprint template. The simulations produced subsequent results and steps taken to verify an unknown fingerprint.

CHAPTER 6

DISCUSSION AND CONCLUSION

6.1 DISCUSSION

Various image processes play an important role in measuring image quality. A good effort has been made in recent years to develop objective image quality metrics. Sadly, only limited success has been achieved. This thesis mentions the weakness of the method of measuring the quality of images that exists in the literature during this insight into why image quality is so difficult. Experimental results indicate that MSE and PSNR region units are very simple, easy to apply and have low processing complexity. However, these methods do not show smart results. MSE and PSNR images are acceptable for measuring the similarity of images only if the images disagree with a certain type of distortion. However, they will not be able to measure different types of distortions. SSIM is the most widely used method for measuring image quality. It will measure higher in different types of distortion than MSE and PSNR works correctly but it fails in the case of highly obscure images.

6.2 CONCLUSION

The MSE, PSNR and SSIM formulas still work accurately to measure the standard for black and white images, but this formula can be changed to measure the quality of color images and videos. This method focuses on evaluating the quality of the full-reference image, which suggests that a complete reference image is assumed to be known. In a number of intelligent applications, however, the reference image is not deserved and no reference or “blind” quality evaluation method is interesting. Thus, there may be one more strategy to support this type of assessment.

REFERENCES

[1] Adegbola Jamiu Sarumi, Badmus Abdulsamad Akinleye Okedola Akinyele, "Fingerprint Verification System Using Combined Minutiae and Cross Correlation Based Matching," *American Journal of Electrical and Computer Engineering*, vol. 2, no. 2, pp. 16-26, November 2018.

[2] By Darrin. (2013, November 26,) North American Investigations. [Online]. https://pvteyes.com/history-evolution-fingerprint-identification/

[3] Stephen Mayhew. (2012, july) Biometrics Research Group, Inc. [Online]. https://www.biometricupdate.com/201501/history-of-biometrics

[4] Zain S. Barham, "Fingerprint Recognition using MATLAB," in *Graduation project*., 2011, ch. 1.

[5] A.Jagan, Jaspreet Kaur, Divya Jyoti, Dr.D.S.Rao C.Sasi varnan, "Image Quality Assessment Techniques pn Spatial Domain," *International Journal of Computer Science and Technology* , vol. 2, no. 3, pp. 2229-4333, September 2011.

[6] Chengdong Wu and Yuan Gao Chunhe Shi, "Research on Image Adaptive Enhancement Algorithm under Low Light in License Plate Recognition System," pp. 5-18, September 2020.

[7] (2020, 17 September) wikipedia.org. [Online]. https://en.wikipedia.org/wiki/Mean_squared_error

[8] Wikipedia. (2020, 7 August 2020,) wikipedia.org. [Online]. https://en.wikipedia.org/wiki/Structural_similarity

[9] wikipedia. wikipedia.org/. [Online]. https://en.m.wikipedia.org/wiki/Gaussian_filter

[10] Aliyu Tukur, "Fingerprint Recognition and Matching using Matlab," *The International Journal Of Engineering And Science (IJES)*, vol. 4, no. 12, pp. 01-06, 2015.