Fingerprint Matching of Normalized Image based on Euclidean Distance

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ABSTRACT
Euclidean distance is one of the oldest methods for mapping distance between two points. It is highly demandable for matching process. Recently there are many techniques for matching fingerprints. Using Euclidean distance, minutiae based fingerprint matching gives accurate matching results. Euclidean Distance is a distance matching technique which is broadly perusal in computational geometry, image processing, computer graphics and pattern recognition. According to the Euclidean distance formula, simply in the plane the distance between two points is map, and the resulting distance is match with the resulting distance of reference fingerprint for matching. Normalization is significant enhancement technique that applied to renovate the contrast in an image. In the case of noisy fingerprint images, normalization is quite important technique for better and accurate outcomes. This paper deals with to perform Euclidean distance between minutiae points for provide robustness of our algorithm for matching fingerprints to reference fingerprint. The process of determining Euclidean distance is done by a tool of Image processing i.e. Matlab.

Keywords
System Design, Fingerprint Enhancement, Normalization, Euclidean distance, Whorl,Arch, Loops.

1. INTRODUCTION
Biometrics is a science of establishing the identity using physical and behavioral characteristics of an individual. No two people have exactly the same fingerprint. Even two identical twins, with identical DNA, have different fingerprints. This essential character permit fingerprint to be used in all kind of ways, including for background checks, biometric security, mass disaster identification and also in criminal situation. A fingerprint is a representation of ridges patterns present of the epidermis of a finger.

Generally Fingerprint is used in most of the identification and authentication process areas. It is one of the extremely improved biometrics techniques, with more history research, and design. Fingerprint recognition identifies people by using the impression made by ridges and valleys texture or patterns found on the fingertips. Fingerprinting analyzes the basic pattern characteristics like whorls, arches, and loops are recorded along with patterns of ridges, furrows, and minutiae points.

There are many methods, which can be used for accurate results of fingerprint matching. Euclidean distance is a common distance between two points which is measure by ruler. It can be effectively applied for matching in fingerprint recognition system. Minutiae is the basic points in a fingerprint image, these points are the small details in a fingerprint, which are the most important for the fingerprint recognition.

2. CHARACTERSTICS OF FINGERPRINTS
Fingerprints contains its own characteristics like types , patterns, minutiae points and secondary features are shown below.

2.1 Types of Fingerprint
Fingerprints are broadly classified into 3 categories like

- Live scan Fingerprint
- Latent Fingerprint
- Patent Fingerprint

2.2 Patterns of Fingerprint
Patterns of fingerprints are broadly classified into 3 categories that are shown below in figure 1.

- Archs
- Loops
- Whorls

Fig 1: Patterns of fingerprint

2.3 Minutiae Points
Minutiae points of fingerprints are broadly classified into following categories that are shown below in Table 1 and this paper describes only 2 type i.e. Ridge ending and Ridge bifurcation shown in fig.2.

Table 1. Different types of Minutiae points

Types of Minutiae Points	Pattern
Ridges-end Point	
Bifurcation Point	
Independence ridges	
Dot Or Island	
Lake	
Spur	
Crossover	

2.4 Secondary Features

Secondary features are Euclidean distance and Oriental Estimation. These are the two major types of minutiae features: the ridges ending points, the bifurcation points shown in fig.2. The ridges ending is, as the name implies, the spot where a ridges end and a bifurcation is the spot where a ridges splits into two ridges. After extracting minutiae points, the distance in between all minutiae points are mapped for provide robustness of algorithm of fingerprint matching system [1].

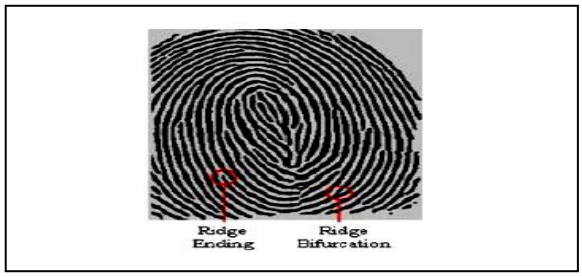

Fig 2: Minutiae matching types

3. SYSTEM DESIGN

The performance of any fingerprint recognition system is dependent on some features which are highly demanding in any algorithm. One of the features is image quality, because the fingerprint recognition system is fully dependent on the fingerprint images. In minutiae based fingerprint matching, the main section of the algorithm is minutiae extraction. If the fingerprint image (both input and template fingerprint images) are not clear, it is very difficult to extract real minutiae points. In noisy fingerprint images, there are many minutiae points like structure are generated, which is known as False Minutiae Points. So, for accurate fingerprint matching it is very important and necessary task to enhance and normalized the fingerprint images for clear vision before query and saving in a database [2].

Below fig.3 is the flow diagram of fingerprint matching system. In this there are two main operations for efficient recognition first one is to pre-process the fingerprint image using binarization, thinning and normalization for fingerprint enhancement and another one is the minutiae extraction for fingerprint matching. In this step Euclidean Distance is used for robustness of algorithm.

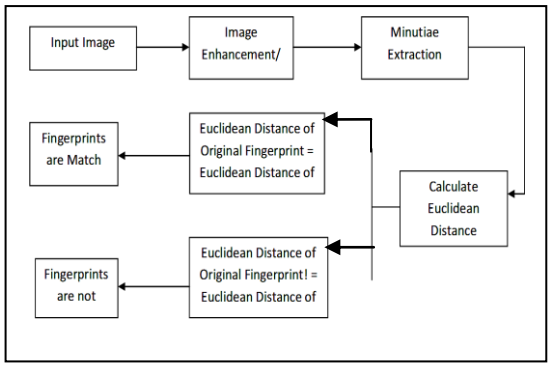

Fig 3: Flow Diagram of Fingerprint matching System

4. PREVIOUS WORK

Fingerprints are so vital application to forensic science. When we pressed finger on paper after being pressed on ink, the fingerprint image is generated, which is unique to each and every person. The pattern variation in the ridges is distinct for every person in the world; this is the reason which makes fingerprint, the most important technique for recognition. Fingerprint recognition is significantly used in restricted areas, forensic applications like investigation of criminals, identification of terrorist, national security issues, etc which requires a strong fingerprint database and dexterous recognition system.

In comparison with features of good and bad quality fingerprint images, extraction of minutiae based matching is must require from effective fingerprint recognition. S.A Daramola and C.N Nwankwo had analysed extraction of fingerprint characteristics based on ridges patterns. Robust features of fingerprint image like minutiae points, local and global features are extracted. The modification within various person fingerprints is established using main area of the fingerprint image as the context for effective classification. The performance of the proposed automatic fingerprint verification algorithm depends on the special ability of the fused feature vector, which is used to represent the image. Fused feature vector is extracted from the pre-processed low quality fingerprint image taking into thought the position and orientation of pixels using image main area as the reference point [3].

Shashi Kumar D R & K B Raja proposed a paper that deals with DWT based fingerprint recognition using Non-minutiae (DWTFR) algorithm where the middle area feature and Edge parameters are laid down on each DWT level by considering all four sub bands (LL, LH, HL and HH). The comparison of test fingerprint with template fingerprint is decided based on the Euclidean Distance of all the features [4].

Ms.Prajakta M Mudegaonkar and Prof. Ramesh P. Adgaonkar proposed a paper deals with filter based algorithm uses Gabor Filters to extract both local and global details in a fingerprint image. The Fingerprint identification is based on the Euclidean Distance between the two corresponding finger codes generated after extracted both local and global features and hence is much fast and accurate than the minutiae matching [5].

Muhammad Umer Munir and Dr. Muhammad Younas Javed present a fingerprint matching design that utilizes a ridges feature map to match fingerprint images. The proposed scheme uses a set of 16 Gabor filters, whose spatial

frequencies conform to the average inter-ridge spacing in fingerprints, is used to generate the ridge strength at equally spaced orientations [6].

5. FINGERPRINT ENHANCEMENT AND NORMALIZATION

Fingerprint Enhancement is a pre-processing technique which is used to remove noise in the image. There are many techniques in image processing for remove the blurriness in the image. Enhancement is used to make it easier for visual interpretation of imagery. Basically enhancement is the transformation of an image to alter its impact on the viewer. Image enhancement technique is useful tools to process an image so that the result is more suitable than the original image for a particular application.

Normalization is a process that changes the range of pixel intensity values; it is sometimes called contrast stretching. The normalization is a simple and crucial pre-processing step to improve the image quality by removing noise from image and correct the variations and deformation generated in an image caused by inaccurate image capture or other reasons. The opinion of image normalization consist the changing the intensity of each pixel so that means the whole image are changed to some pre-defined values. Normalization maintains the clarity and contrast of the ridges and valley structure. It is a pixel wise operation [7].

Suppose intensity range is x to y, and the desire range is q to z. So, in this condition first step of the algorithm is subtracting x from each of the pixel intensity.

For example, if the intensity range of the image is 80 to 180 and the desired range is 0 to 255 the process, subtracting 80 from each of pixel intensity, making the range 0 to 100, then each pixel intensity is multiplied by 255/100, making the range from 0 to 255. Linear normalization of a grey scale image is shown by following equations

IN= (I – Min) + newMin

Where,

I = old / original image

IN= new image

(Min,Max) = range of intensity values in original image.

(newMin, newMax) = range of intensity values in new image.

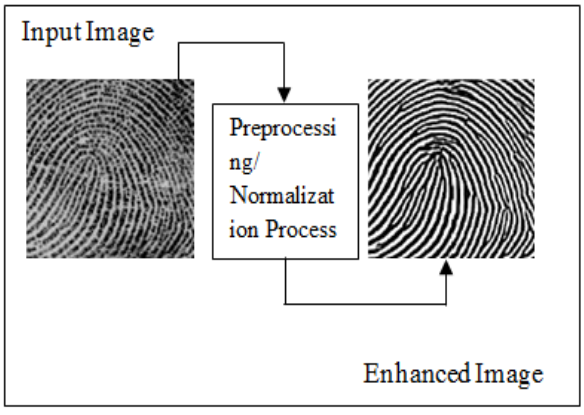

Fig. 4: Input noisy image and Enhanced image after Normalization Process

The normalization algorithm is based on the local property of the fingerprint image. A given fingerprint image I which is defined as an N*M matrix and (i,j) represents the intensity of the pixel at the ith row and jth column.

If I (i,j) > M then

$$G(i,j)=M_0+\sqrt{((VAR_0(I(i,j)-M)^2))/VAR}$$

otherwise

$$G(i,j)=M_0-\sqrt{((VAR_0(I(i,j)-M)^2))/VAR}$$

Where M0 and VAR0 are the desired mean and variance of the given image and M and VAR are the computed mean and variance of the given image [8].

6. EUCLIDEAN DISTANCE

In comparison of binary images distance play a very important role in the fields of local features, morphological operations and distance between two points in an image. Commonly Euclidean distance is a natural distance between two points which is generally mapped with a ruler. The distance between minutiae points in a fingerprint image is shown in following fig.3. Definition of Euclidean distance is shown in textbox which is the straight line distance between two points.

If P values are P1, P2 till Pn and values of Q are Q1, Q2 till Qn are the two points in Euclidean space then the distance from P to Q is given by:

$$x = \sqrt{(p1 - q1)^2 + (p2 - q2)^2 \ldots (pn - q1)^2}$$

For more simple the distance check-up the root of square differences between coordinates of a pair of objects.

$$\sqrt{\sum_{i=1}^{n}(qi - pi)^2}$$

Matlab has also inbuilt function for Euclidean distance which is "A=bwdist(BW)".

bwdist function is used for computing distance transform of binary image (BW). For each pixel in the image BW, the distance transform assigns a number that is the distance between that pixel and the nearest nonzero pixel of BW.

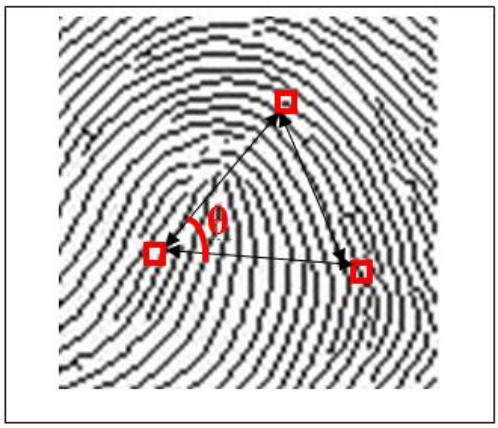

Fig. 5. Minutiae points with Euclidean Distance

Bydefault Bwdist uses the Euclidean distance metric. Binary images can have any number of dimensions where D is the

same size as Binary image (BW). Euclidean distance simply refers to the distance between two points as measured in a straight line. The advantage of using Euclidean distance in biometric recognition system is reportedly faster than most other means of determining correlation and it compares the relationship between actual ratings are for specific preferences or items [9].

7. CONCLUSION

It is very good practice to normalize fingerprint images and then process for identification. The fingerprint image itself includes multiple informatics properties such as, pattern and minutiae points. This research paper discussed about these properties as well as focuses on normalization techniques.

The normalization of digital fingerprint produce strength to the intensity values inside the image, after normalization process it is very easy to extract multiple features based on digital properties. Distance between two points can be classify to the standardize term i.e. Euclidean distance.

This calculation within the fingerprint image provides satisfactory result to identify the owner. The conclusion of this research paper is that the normalization makes easy retrieval of minutiae points and Euclidean distance to calculate the exact results for matching.

8. REFERENCES

[1] Jadhav S.D, Barbadekar A.B, Prof.(Dr.) Patil S.P, "Euclidean Distance Based Fingerprint Matching", Recent Researches in communications, Automation, Signal Processing, Nanotechnology, Astronomy and Nuclear Physics.

[2] Philippe Parra,"Fingerprint minutiae extraction and matching for identification procedure" department of computer science and engineering, university of California, San Diego La Jolla, CA 92093-0443.

[3] S.A Daramola, C.N Nwankwo, " Algorithm for fingerprint verification System",Journal of Emerging Trends in Engineering and Applied Sciences (JETEAS)2(2):355-359(ISSN: 2141-7016).

[4] Shashi Kumar D R, K B Raja, R.K Chhotaray, Sabyasachi Pattanaik," DWT Based Fingerprint Recognition using Non-Minutiae Features, IJCSI International Journal of Computer Science Issues, Vol. *, Issue 2, March 2011.

[5] Ms. Prejakta M. Mudegaonkar, Prof. Ramesh P. Adgaonkar, " A Novel Approach to Fingerprint Identification Using Gabor Filter-Bank", ACEEE Int.J. on Network Security, Vol. 02, No. 03, July 2011.

[6] Muhammed Umer Munir and Dr. Muhammad YounasJaved, "Fingerprint Matching using Gabor Filters", National Conference on Emerging Technologies 2004.

[7] Saadia Saddique, Malik Sikandar Hayat Khiyal, Aihab Khan, Memoona Khanum, "Modified sequential algorithm using Euclidean distance function for seed filling", Journal of Theoretical and Applied Information Technology.

[8] Arun Ross and Anil Jain "Biometric sensor interoperability" : A case study in Fingerprints"pp.134-145.

[9] Lin Hong,Yifei Wan, Anil Jain "Fingerprint Image enhancement : Algorithm and performance Evaluation" IEEE Transaction on pattern analysis and machine Intelligence ,Vol.20,No.8,August 1998.

[10] D. Maltoni, D. Maio, A. K. Jain, and S. Prabhakar. Handbookof Fingerprint Recognition. Springer-Verlag New York, Inc.,Secaucus, NJ, USA, 2003. 2, 3

[11] Dr. Neeraj Bhargava, "Performance Impact of user attempts on Fingerprint Recognition System (FRS)", Journal of Information, Knowledge and Research in Computer science and applications. ISSN: 0975-6728, Nov 12 to Oct 13, Volume-02, Issue-02.