Malik e*t al.LGU (IJECI)* 2017

LGU (IJECI)
ISSN: 2522-3429

LGU International Journal for
Electronic Crime Investigation

Research Article Vol.1 issue1 Oct-Dec 2017

Using codes in place of Fingerprints images during image processing for Criminal Information in large Databases and Data warehouses to reduce Storage, enhance efficiency and processing speed

[1] Aftab Ahmad Malik Ph.D (University of Kent England) M.Phill, MSc, L.L.B; Professor Department of Computer Science, Lahore Garrison University (LGU) Lahore Pakistan
Email: dr.aftab.malik@yahoo.com
[2] Mujtaba Asad BS (EE),MS(Computer Science) MS (EE); Ph.D Scholar, Department of Electronics and Electrical Engineering, Shanghai Jiao Tong University, Shanghai Minhang Campus, Doram Building No 9, China;
Email: mujtaba.asad@live.com
[3]Waqar Azeem Lecturer, Department of Computer Science, LGU,Lahore Pakistan
Email: waqar.azeem@lgu.edu.pk

Abstract:

The purpose of this work is to assign codes to the fingerprints images stored in large databases / Data warehouses, the images require large amount of storage as compared to a numeric code. Moreover, when fingerprint images are compared to other fingerprint images, the process is more time consuming as compared to the numeric codes. It is proposed to keep up all fingerprint images in a separate database file along with their codes. This file may be a supplementary file with respect to Master database file. In addition to this, the codes of fingerprint images may be stored in Master Database/ Data warehouse for all records. The search queries can be processed using the numeric codes. In this manner, the Time Complexity and Space Complexity are reduced considerably. Whenever, any fingerprint image is received for searching its record, first its code is obtained by proposed algorithm and then this code is used to search the record from database/Data Warehouse making entire procedure faster and efficient.

Keywords: Forensic, Biometrics, Image processing, coding fingerprint images, criminal history, Numeric Codes, Database/Data Warehouse

1. Introduction

In criminal Information Systems, the particulars regarding physical appearance such as face prints, fingerprints, DNA code and Iris Code etc are of very important nature. In order to facilitate further discussion and background, following explanation is provided.

Digital Forensic is science related to retrieving and finding out the information found in digital devices related to crime or cybercrime. It helps to access information

available in mobiles, computers or any other storage media. This field is advancing and progressing rapidly. It also helps to uncover and interpret the information electronically. Its objectives are to process and store the information obtained from scene of offence or other sources for further analysis and use.

The Cloud Computing involves machines learning techniques and managed plate form and uses tools to build application with ease. It is called a subset of broad Network Forensic. The robustness and quality can be ensured with application of cloud computing. Cloud forensic plays a pivotal role in between Cloud Computing and digital cloud forensic.

The Elastic Bunch Graph Matching (EBGM) [9] algorithm is used in Computer Vision to recognize the objects of an image on a graph representation derived from other images. The Elastic Bunch Matching returns the similarity value, the positions of the nodes in image, which helps in creating an image graph. Gabor Filters [10] are used in image processing with Gaussian envelop function for texture analysis. The Gabor filters are extensively used in the situations where fingerprint matching and enhancement is processed. They are called band-pass filters and possess the following properties:

- frequency-selective
- orientation-selective

The Biometrics Technology is extensively and commonly used in forensic to analyse for measurement and examine the characteristics of humans like DNA, Irises, voices and face images. The related information can be converted into digital form, encrypted and stored in a database/data warehouse. This is thesis of this paper.

2. The applications of biometrics

There are mainly three categories in the field of biometrics:

- Commercial sector
- Government applications such as national ID card, driver's license, social security, welfare disbursement, border control, and passport control.
- Forensic applications such as corpse identification, criminal investigation, terrorist identification, parenthood determination, and missing children.

3. Review

There exist several techniques to analyse and synthesise the fingerprint images. The fingerprint images are analysed for quality; then sometimes may be improved. [1] Proposed & devised an efficient algorithm for Coding Person's Names in large Databases/ Data warehouses to enhance Processing speed, Efficiency and to reduce Storage Requirements. [1] Allocates numeric codes to Names (First name, Middle name, Last name) using three numeric characters for each, instead of 40 Alpha-Characters, which are normally reserved for one complete name.

A similar approach has been employed for facial image coding by first author of this paper [2] describes how to generate code for facial prints and to use them in databases and data warehouses to reduce Time and Space Complexity and to make the image processing more efficient. In this paper, the philosophy of [1] and [2] is applied to fingerprint images to reduce Time Complexity and Space Complexity. The images [2] also

clarify the points of measurements of distances in case of facial image processing figure 1; similar strategy can be applied to fingerprint at minutiae point as shown in Figure 1.

[3] Describes uses and procedures of OpenCV. It provides built in Library functions for real time image processing. The module imgproc provides basic and important image processing Techniques/Algorithms for filtering, image transformations and conversions.

Figure 1

Voila Jones Algorithm is discussed in

[4], which identifies and detects various parts of the facial image, the eyes, nose and mouth using common characteristics of the face. [5] Claims that 99% accuracy in image processing can be achieved in front-pose face image.

Different patterns to code the fingerprints have been presented in [6] in order to use these codes in the software for storage and retrieval of criminal information. [7] Discusses the techniques for Software for Storage and Retrieval of Criminal Information for Police based on physical data.

There are several biometric systems designed to identify humans by matching the characteristics from the database or Data warehouse. The employee's roll call system is one such example; others in daily life are computer login and internet access. The ATM forensic applications such as used in Criminal Information system are elaborated and designed in [6] and [7]. The Face Recognition by Elastic Bunch Graph Matching has been discussed in [11]. A grid of points is launched as shown, then a bunch graph is constructed for recognition, it works with Instructions on getting FERET database. The purpose of FERET is to design automatic Face Recognition System. For Enhanced Security of Digital Images [13] and [14] have been used and developed by the second author of this paper.

4. Brief Analysis of Finger Prints

The relevant algorithms can translate the given image (facial image or fingerprint) into a digital code. The minutiae are important features in fingerprint used to make comparison between 2 images; it has Ridge ending and sudden end of ridge dividing it into

two ridges. The following figure 2 shows the split of ridge in Figure 2(a), (b):

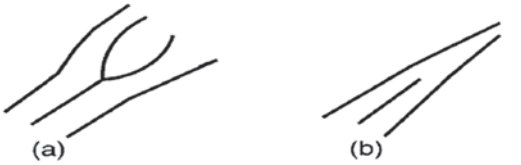


Figure 2

The Minutiae Points

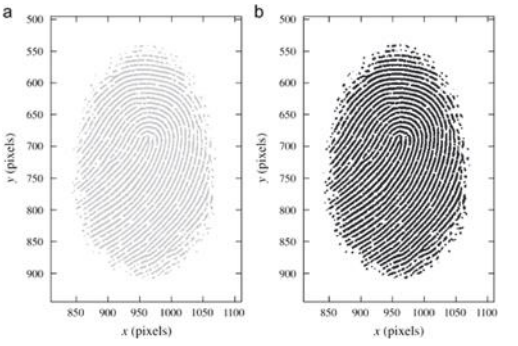


Figure 3a

To process the criminal information regarding storage and retrieval, Cloud Computing and digital forensic are of immense importance. Similarly, these two areas also apply to cyber–crime investigations.

In this paper, main focus will be on storage and retrieval of information based on fingerprints. The structure of fingerprints is unique. In fingerprint, there are spirals, whorls, parabolas, arches, ridges, tented arches, dots and dashes. All fingers have unique code. Therefore, fingerprints are used to retrieve human data from a Database or Data warehouse as unique key like Id-card Number or Employee Number.

5. Fingerprint Patters

The Fingerprint pattern recognition system is being extensively used in identity marching and access control. Most of the systems are designed to match fingerprints image with stored image of fingerprints for authentication using image processing algorithms. The design of the proposed system of the work of this paper depends on assigning fingerprints a unique code.

The usual patterns in fingerprints are whorls, loops and arches which are not sufficient for identification and coding. The important feature is ridge endings termed as “hooks” and “eyes” to determine the identity of a fingerprint. However, other features such as line shapes, pores and breaks plays an important role in shape of the fingerprint and hence the coding process. Following pattern indicate [16] minutiae image features (figure 3a and 3b):

Figure 3b

A live-scan sensor is required in case of digital image processing of fingerprints. In the Automated Fingerprint Identification Systems (AFIS), such devices have been used. The optical and solid state is also commonly used [15] ,[18].

Fingerprint Shapes and Patterns:

The figures 4a and 4b show arches, loops, whorls and composites of fingerprints.

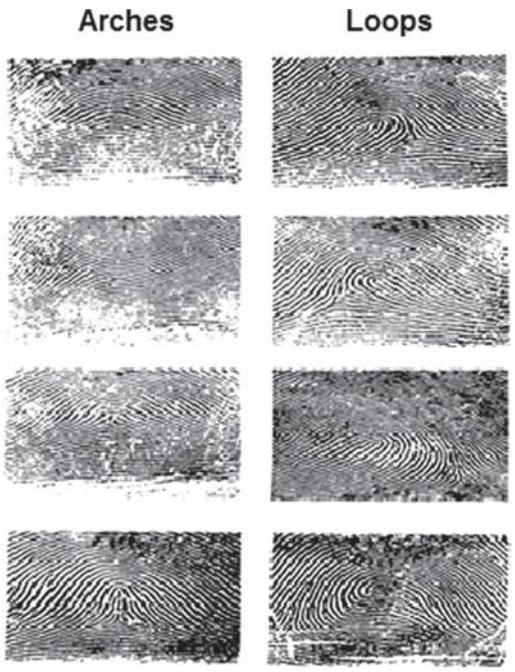
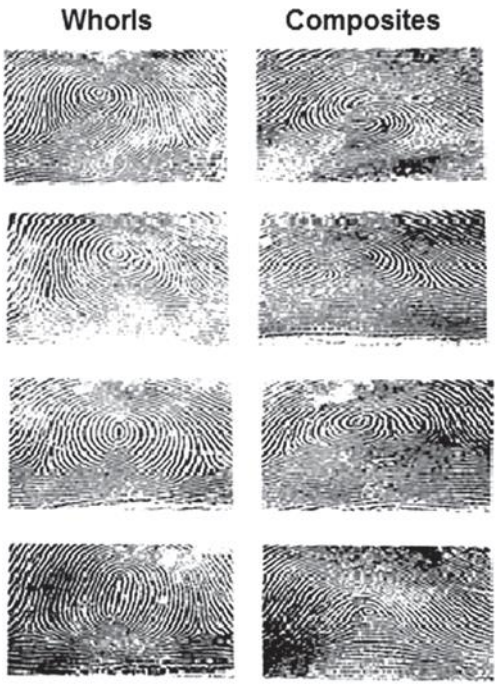


Figure 4a



Source: Sagem Morpho

Figure 4b

6. Assumptions

The assumptions for the proposed system are that only neat and visible images are considered. The damaged images are first repaired by image processing techniques before entry. Fake or severely damaged fingerprints are avoided.

Complete and well defined fingerprint images are used.

7 Biometric Requirements

The characteristics of biometric identifiers include Universality, Uniqueness, Permanence and Collectability.

The feature of collectability means that the characteristics can be measured quantitatively.

While, designing biometric system care must be taken regarding above characteristics, as well as, the verification system must be able to identify an individual by comparing the pre-stored characteristics and the one entered for verification.

8. Steps in Fingerprint coding Scheme

The fingerprint is the query point which can be taken directly from database, if already stored; otherwise it is entered through the scanner.

Step 1: Enrolment and identification of fingerprint

Step 2: Conversion of image into digital form

Step 3: Process of marking and extraction of unique minutiae points

Step 4: Saving minutiae information regarding location and direction

Step 6: Storing the criminal history, physical data, modus operandi and Personal or criminal information is stored along with fingerprint in Database.

Step 7: The match score between the query print and stored image is compared which must be high for same fingerprint low for different prints.

Step 8: Process of conversion of fingerprint image into a (numeric) / digital code and fingerprint image. There is also provision for the 14 Digit code returned by the Algorithm.

9. Graphical User Interface

The Graphic User Interface contains personal information about the person whose image is being processed such as First Name, Middle Names, Last name, gender, occupation, Date of Birth, face image.

10. Sequence of operation on fingerprint

The fingerprint image passes through the following operation upon entry:

- Resizing
- Lightening
- Smoothing
- Edge detection
- Binarisation
- Thinning
- Final code generation

2. Design:

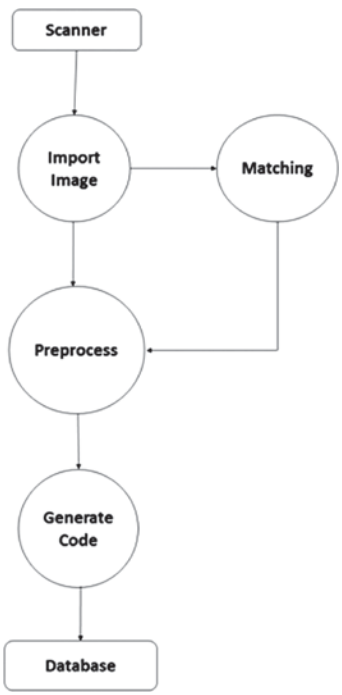


Figure 5

11. Calculation Methodology

Using direction vectors, the orientation image is calculated in the form of a matrix. Its vectors represent ridge orientation at every location. The gradient based approach is employed to determine the gradient, because the orientation vector is orthogonal to gradient.

The Fingerprint image is divided into square-blocks. This is how the gradient is calculated for every pixel. For every block, the orientation vector is computed leading towards averaging procedure using Sobel operator horizontally and vertically.

MATLAB provides bwmorph function to 'Thin" the image. The example of matrix so formed is shown in Figure 7.

Figure 6 shows the minutiae points

Figure 6

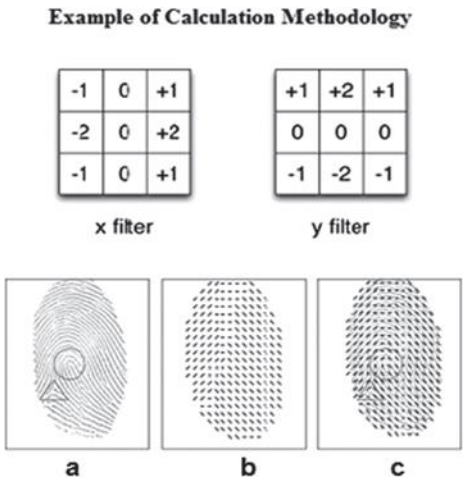


Figure 7

On the basis of proposed design diagram, the DFD is given in figure 8

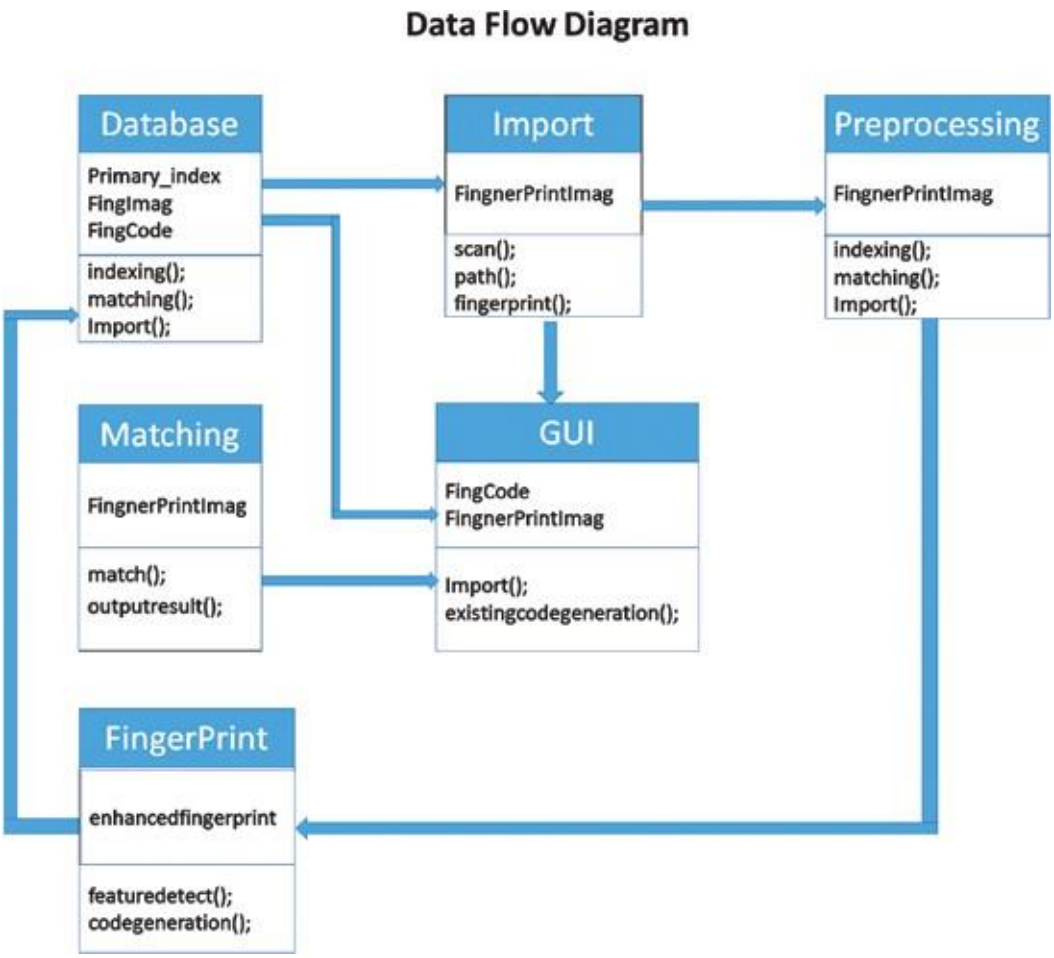


Figure 8

Use cases for Fingerprint images

Use case 1:

Enter or Import fingerprint Image from database.

Description:

- A prompt to either Enter image-file from a file path to import image from existing database.

Use case 2:

- Extracting minutia, ridge ending, bifurcation and all other features in order to produce initial pattern and generate Code
- pattern and generate Code

Use case 3: Conversion into numeric code

Description:

- Apply Thinning on binarised output.
- Extract Fingerprint features and an initial code block
- Secure code block

Use case 4:

Fingerprint code Matching

Description:

- Match the converted code attached to the images in Database.
- Extracting minutia and other features from fingerprint images.

Screenshort of Fingerprint Code Generation

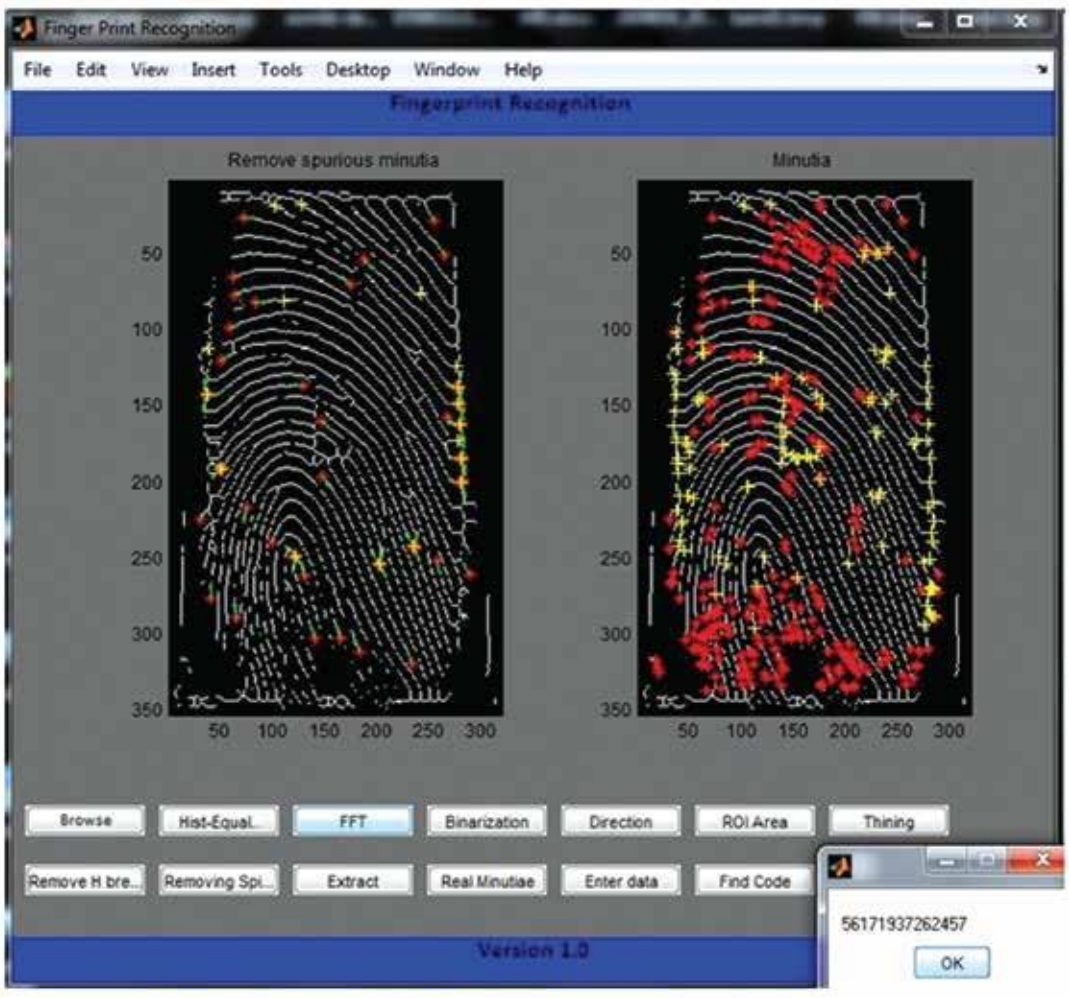


Figure 9

12. Conclusion

The searching the database / Data warehouse using a numeric unique key is faster as compared to searching by comparing images with images. In case of searching the large data base by entering image consumes excessively more time because the comparison of stored image with the entered image involves pixel to pixel and region to region comparison for which the Time Complexity and Space Complexity is very high. In case the database is sorted the relevant record is directly accessed by numeric key. In case the images are stored in an auxiliary file instead of Master Database file.

13.Acknowledgement

The authors acknowledge the encouragement from Mr Kaukab Zuberi Director DFRSC, Lahore Garrison University Lahore.

14. References

1 Aftab Ahmad Malik: "Algorithm for Coding Person's Names in large Databases/ Data Warehouses to enhance Processing speed, Efficiency and to reduce Storage Requirements"; Journal of Computer Science and Information Technology, LGURJCSIT, Volume 1 issue 1, January-March 2017; ISSN 2519-7991

2 Aftab Ahmad Malik & Asad Mujtaba: "Algorithm for using Codes in place of Facial images during Image Processing in large Databases/ Data Warehouses to reduce storage, Enhance efficiency and Processing speed; Journal of Computer Science and Information Technology, LGURJCSIT, Volume 1 issue 2, April-June 2017; pp 1-9; ISSN 2519-7991

3 Piyush Patel ""code to generate unique ID for face recognition using OpenCV "[closed] by Stack Overflow Community; which is a community of 6.6 million programmers ; http://stackoverflow.com/questions/16980195/code-to-generate-unique-id-for-face-recognition-using-opencv

4 Shahwar H and Adnan Khan : " Face and Face Parts detection in image processing"; LGURJCSIT: Journal of Computer Science and Information Technology, Vol 1 issue 1, January-March 2017; ISSN 2519-7991

5 Sarah A. Downey 2011, "Unique identity for Facial Recognition";

6 Aftab Ahmad Malik: "Software for Finger Prints Storage and Retrieval of Criminal Identification System for Police", Research Journal, University of Engineering Technology, Lahore, Volume 12; No. 4; PP: 1-18

7 Aftab Ahmad Malik: Software for Storage and Retrieval of Criminal Infor- mation for Police", Research Journal, University of Engineering Technology, Lahore, Volume 13 ; No. 1 PP: 1-28

8 Brandon McKinney." Face Patterns", https://www.pinterest.com/pin/512425263825056246/

9 Laurenz Wiskott 2014, “Elastic Bunch Graph Matching”, Scholarpedia, 9(3):10587, Revision #143316] doi:10.4249/scholarpedia.10587

10 Gabor Filters , “ The Computer Vision Lab at GET ,University of Paderborn ,Department of Electrical Engineering, Grundlagen der ElektroTechnik , HNI

11 Laurenz Wiskott, Jean-Marc Fellous, “Face Recognition by Elastic Bunch Graph Matching”, Book: Intelligent Biometric Techniques in Fingerprint and Face Recognition, CRC Press, ISBN 0-8493-2055-0, pp. 355-396, (1999).

12 Maurric Hess and Giovanni Martinez, “Facial Feature Extraction based on the Smallest Univalue Segment Assimilating Nucleus (SUSAN) Algorithm”, SUSAN (Smallest Univalue Segment Assimilating Nucleus), Image Processing and Computing Vision Research Lab (IPCV-LAB), Escuela de Ingenieria Electrics, Universidad de Costa Rica

13 Engineer Mujtaba Asad,” Enhanced Security of Digital Images using Discrete Cosine & Discrete Wavelet Transform”, MS (EE) Final Thesis, GC University Lahore, 2014.

14 J. Zafar, and Engineer Mujtaba Asad, “ Enhanced Security and Reinstatement Computing of Images Using Fragile Invisible Integer Wavelet Watermarking Scheme”, Proceedings of the World Congress on Engineering 2015 Vol I , WCE 2015, July 1 - 3, 2015, London, U.K.

15 A. K. Jain, J. Feng, and K. Nandakumar, "Fingerprint Matching", IEEE Computer Magazine: February 2010, pp. 36-44, Feb. 2010

16 D.Braggins, "Fingerprint sensing and analysis", Sensor Review, vol. 21, no. 4, pp. 272-277, 2001

17 John Edgar Hoover, “The Science of Fingerprints, Federal Bureau of Investigation”, John Edgar Hoover.html http://www.scientificlib.com/en/ Technoogy/Literature/FBI/TheScienceOf Fingerprints.html

18 T. Harris, "How Fingerprint Scanners Work", HowStuffWorks.c