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WAVELET ENERGY FEATURES FOR FINGERPRINT IDENTIFICATION

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ABSTRACT

Fingerprints are the most prevalent and mulled over biometrics characteristics. Their soundness and uniqueness make the unique mark recognition proof system to a great degree dependable and helpful for Security applications. Fingerprints are the most seasoned and most broadly utilized type of biometric recognition proof. Everybody is known to have interesting, unchanging fingerprints. Customary security frameworks utilized either learning based systems like passwords or PIN, and token-based routines, for example, travel permit, driver permit, ID card and were inclined to extortion in light of the fact that PIN numbers could be overlooked or hacked and the tokens could be lost, doubled or stolen. To address the requirement for hearty, dependable, and secure particular recognition proof, verification frameworks will essentially oblige a biometric part. Fingerprints have been being used for biometric recognition This paper manages the issue of choice of an ideal calculation for unique mark matching in request to outline a framework that matches obliged determinations in execution and exactness using wavelet energy features and Euclidean Distance for fingerprint identification.

Keywords: Wavelet Energy Features, Fingerprint Recognition, Security.

1. INTRODUCTION

Pattern recognition is a day machine intelligence problem with numerous applications in a wide field, including Face recognition, Character recognition, Speech recognition as well as other types of object recognition [2]. The field of pattern recognition is still very much in it is infancy, although in recent years some of the barriers that hampered such automated

pattern systems have been lifted due to advance in computer hardware providing machines capable of faster and more complex computation. Fingerprints are accepted to be remarkable crosswise over people and crosswise over fingers of same single person. Indeed indistinguishable twins having comparable DNA, are accepted to have distinctive fingerprints. Customary security frameworks utilized either learning based systems like passwords or PIN, and token-based routines, for example, travel permit, driver permit, ID card and were inclined to extortion in light of the fact that PIN numbers could be overlooked or hacked and the tokens could be lost, doubled or stolen. To address the requirement for hearty, dependable, and secure particular recognition proof, verification frameworks will essentially oblige a biometric part. Fingerprints have been being used for biometric recognition. In an as of late distributed World Biometric Market Outlook (2005-2008), examiners foresee that the normal yearly development rate of the worldwide biometric business sector is more than 28%, by 2007. The innovations that would be incorporated in this are finger impression innovation by 60%, facial & iris by 13%, keystroke by 0.5% and computerized mark checks by 2.5%. Since finger impression ID system is a productive strategy to perceive human personality, it persuades to recover the secret data of an individual [1][3].

The Concept

(National Science and Technology Council, NTSC) A fingerprint usually appears as a series of dark lines that represent the high, peaking portion of the friction ridge skin, while the valleys between these ridges appears as white space and are the low, shallow portion of the friction ridge skin. Fingerprint identification is based primarily on the minutiae, or the location and direction of the ridge endings and bifurcations (splits) along a ridge path[2][3].

The Importance

(Gordon H. Dechman President, FingerPrint USA)

Well established: fingerprint identification has been used in law enforcement applications over the past 100 years, and has become the de facto international standard for positive identification of individuals.

Proven: AFIS (Automated Fingerprint Identification System) technology has been designed developed, defined and proven in demanding law implementation applications in the course of the most recent two decades.

Legally accepted: The legitimate points of reference which have been built in the U.s. court framework make fingerprints the main biometric confirmation of recognizable proof which is promptly acknowledged in lawful incidents.

Mature: Finger impression recognizable proof advances are well past the Research and Development stage, as proved by the way that various reasonable makers produce contending items for a far reaching well established commercial center. In most different biometrics, the engineering is just accessible from a solitary merchant, making any extensive scale long haul application exceptionally unsafe.

Hardware

A variety of sensor types optical, capacitive, ultrasound, and thermal are used for collecting the digital image of a fingerprint surface. Optical sensors take an image of the fingerprint, and are the most common sensor today.

Software

The two main types of finger impression matching techniques are minutiae-based matching and pattern matching. Pattern matching usually compares two images to see how similar they are. Pattern matching is usually used in fingerprint systems to detect duplicates. The most widely used recognition technique, minutiae-based matching, relies on the minutiae points described above, specifically the location and direction of each point.

2. RELATED WORK

(Mark Sanderson and W. Bruce Croft)a Brief history of innovative work of data recovery framework beginning with formation of electro-mechanical seeking gadgets, through to the early reception of workstation quest for things that are pertinent to client's solicitation is portrayed. (Christos Faloutsas and D. W. Oard) Traditional routines for Information Retrieval are depicted in [1], and its suggestions are full content examining is proposed just for little database, reversal is the business work-horse, for bigger database. (Amit Singhal, Google Inc)different demonstrates that are utilized as a part of Modern Information Retrieval framework are clarified in [3], and IR frameworks to do positioned recovery. (David Robins Louisiana State University) Introduction to Interactive Information Retrieval System is described in [4]. It is study of human interaction with information retrieval system. (Anil Jain, Arun Ross and Salil Prabhakar) fingerprint matching utilizing particulars and composition peculiarities is clarified in [6]. It is a mixture matching calculation that uses both details point data and composition (area) data for fingerprints. An alternate critical utilization of grinding edges is individual identification. (Trupti S. Indi and Suhas D. Raut)a novel-based unique mark matching calculation is proposed in [7]. Details matching calculation need to take care of two issues: (i) Correspondence processing: Assign every particulars with two descriptors: content based and details based. (Ferdous Ahmed Sohel and M. Amiruzzaman, Microland (Iice))fingerprint matching by utilizing Back Propagation is portrayed within [11]. Finger impression matching is a testing issue in view of the complex mutilation included in two impressions of a same finger. It tries to discover the ideal conversion between two separate fingerprints.[8][9]

(S.adebayo Daramola, Tola Sokunbi and A.u Adoghe, Ota, Nigeria((ijcse)) fingerprint matching strategy utilizing Support Vector Machine [10]. This paper proposes hearty confirmation framework focused around gimmicks separated from human fingerprints and an example classifier called Support Vector Machine (SVM). Vijaya Sathiaraj, Bharathidasan University, Trichirappalli-23) fingerprint matching utilizing Artificial Neural Network is clarified in [12][16] In ANN there are numerous systems techniques are accessible. (Sangram Bana and Dr. Davinder Kaur, 2011) have introduced a strategy on Fingerprint Recognition utilizing Image Segmentation. The methodology chiefly includes Minutiae Extraction and Minutiae matching. (Le Hoang Thai and Ha Nhat Tam, 2010) proposed Fingerprint recognition utilizing institutionalized unique mark display as Fingerprint Recognition is one of most well known and correctness biometric advances. (Rakesh Verma, Anuj Goel, 2011) exhibited Wavelet Application in Fingerprint Recognition, Fingerprint confirmation is a

standout amongst the most solid particular recognition proof techniques and it assumes an extremely vital part in measurable applications like criminal examinations, terrorist ID and National security issues. (Tien-Tsin Wong and Chi-Sing Leung) proposed Discrete Wavelet Transform (DWT) has been vigorously contemplated and created in different experimental and designing fields. Its multi determination and area nature encourages applications obliging progressiveness and catching high recurrence points of interest[13].[14][15][16]

3. THE PROPOSED METHODOLOGY

The proposed method uses wavelet energy features for fingerprint identification in order to achieve authenticated information access. The proposed method contains various phases such as pre-processing, feature extraction, training, testing and connecting Matlab to database. The block diagram of the proposed model is given in figure 1. The detail description of each phase is given in the following subsections.

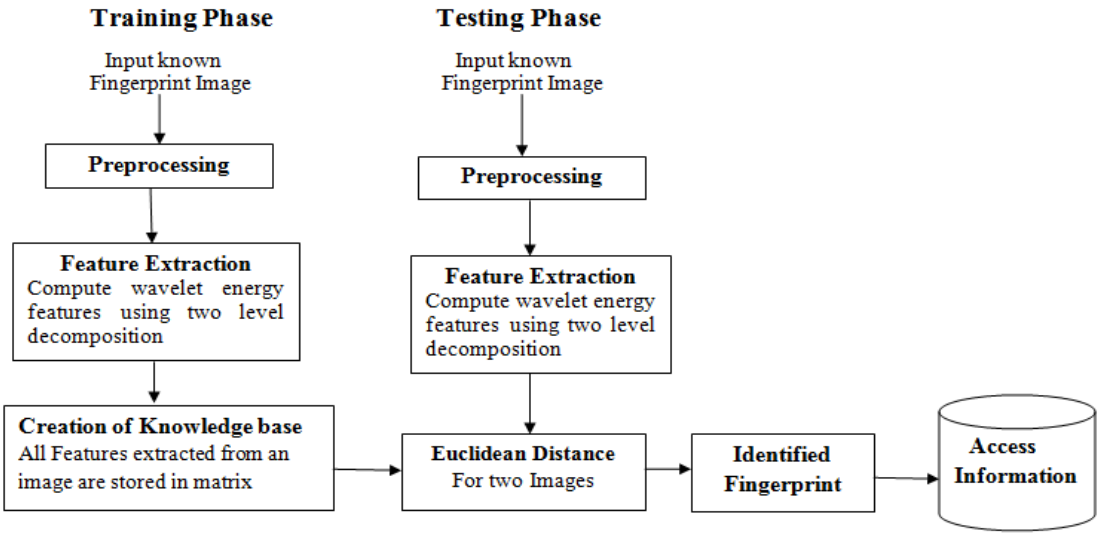


Figure 1: Block diagram of proposed model

3.1 Pre-Processing

The fingerprint images obtained have issues like blur images, colour degradation, size etc. The purpose of this is to make the images to be of standard size, remove complex backgrounds and makes them easier for further processing in identification of fingerprint. Preprocessing consists of several steps, which are detailed below.

- **Binarization**

This stage of preprocessing converts the image into binary image where each pixel is represented by either 0 or 1. It allows reducing image information by removing background so that the image is of black and white type .This type of image is easier for further processing.

- **Image Resize**

Image is resized to fixed size 120X120 pixels.

3.1.1 Feature Extraction

Features are extracted from preprocessed image, each image is divided such that there are 3 blocks in each row and 3 blocks in each column with every block of size 40*40 pixels. We use dwt2 command to perform a single-level two-dimensional wavelet decomposition with respect to 'haar' wavelet.

$$[cA, cH, cV, cD] = dwt2(C, 'haar') \quad (1)$$

The above function computes the approximation coefficients matrix cA and details coefficients matrices cH, cV, and cD, horizontal, vertical, and diagonal, respectively, obtained by wavelet decomposition of the each block of the image C.

Then the Wavelet energy features for each block are computed using the following equations:

$$eH = sum(abs(cH(:)))/(m \times n) \quad (2)$$

$$eV = sum(abs(cV(:)))/(m \times n) \quad (3)$$

$$eD = sum(abs(cD(:)))/(m \times n) \quad (4)$$

where, eH, eV, eD are energy features corresponding to the horizontal, vertical, and diagonal details, respectively.

- m is number of rows in each block
- and n is number of columns in each block.

The procedure is repeated to perform second level wavelet decomposition and to compute corresponding energy features. Energy features for all the fingerprint images are computed using same steps.

Extracted features of each image are stored into feature vector. The Knowledge base is constructed by placing feature vectors all training samples of each image in a row.

$$Fv = [B_i] \;\; 1 \le i \le 9 \quad (5)$$

$$B = [f_1 f_2 f_3 f_4 f_5 f_6] \quad (6)$$

$$KB = [Fv_j] \;\; 1 \le j \le N \quad (7)$$

Where

- $f_1 f_2 f_3$, are the energy features corresponding to the horizontal, vertical, and diagonal details for first level decomposition.
- $f_4 f_5 f_6$ are the energy features corresponding to the horizontal, vertical, and diagonal details for second level decomposition.
- N is the number of training samples.

3.1.2 Euclidean Distance

- The Euclidean Metric (and distance magnitude) is that which corresponds to everyday experience and perceptions. That is, the kind of 1, 2, and 3-Dimensional linear metric world where the distance between any two points in space corresponds to the length of a straight line drawn between them. After calculating the distance between two pair of points, for which there is minimum distance those will be matched. Figure 2 shows the scores of three individuals on two variables (Variable 1 is the x-axis, Variable 2 the y-axis)

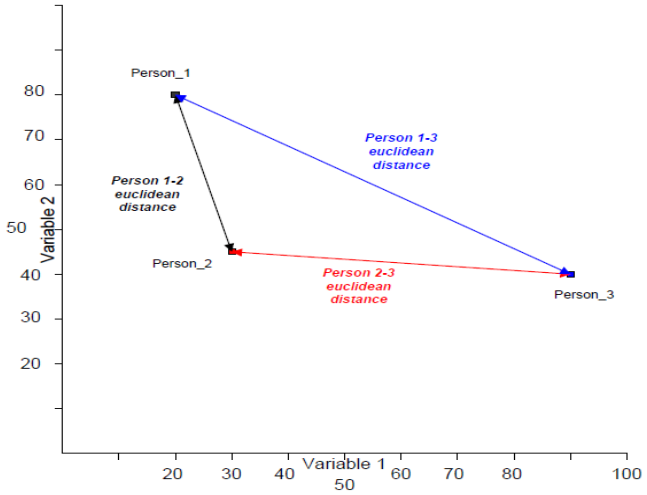


Figure 2: The scores of three individuals on two variables

The straight line between each "Person" is the Euclidean distance. There would this be three such distances to compute, one for each person-to-person distance. However, we could also calculate the Euclidean distance between the two variables, given the three person scores on each as shown in figure 2.3.

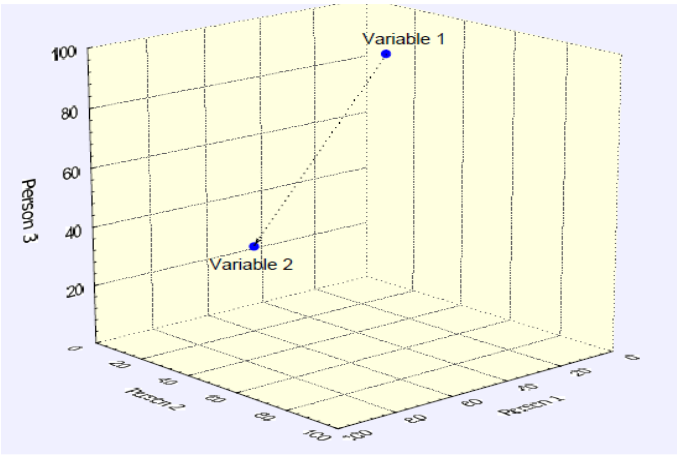


Figure: 2.3: The Euclidean Distance between 2 variables in the 3-person dimensional score space

The formula for calculating the distance between each of the three individuals as in equation.(8)

$$d = \sqrt{\sum_{i=1}^{v} (p_{1i} - p_{2i})^2} \quad \textbf{(8)}$$

where the difference between two persons' scores is taken, and squared, and summed for v variables (in our example v=2). Three such distances would be calculated, for p1 – p2, p1 – p3, and p2 - p3.The formula for calculating the distance between the two variables, given three persons scoring on each as shown in equation is:

$$d = \sqrt{\sum_{i=1}^{p} (v_{1i} - v_{2i})^2} \quad \textbf{(9)}$$

where the difference between two variables' values is taken, and squared, and summed for p persons (in our example p=3). Only one distance would be computed – between v1 and v2. Let's do the calculations for finding the Euclidean distances between the three persons, given their scores on two variables.

Equation 1 is used where say we are comparing two "objects" across a range of variables – and trying to determine how "dissimilar" the objects are (the Euclidean distance between the two objects taking into account their magnitudes on the range of variables. These objects might be two person's profiles, a person and a target profile, in fact basically any two vectors taken across the same variables.

Equation 2 is used where we are comparing two variables to one another – given a sample of paired observations on each (as we might with a person correlation), In our case above, the sample was three persons.

3.1.3 Fingerprint Identification Model

Test image is processed to obtain the horizontal, vertical, diagonal profile based features, which is further fed to Euclidean distance algorithm for recognition.

3.1.4 Algorithms

The proposed methodology consists of following algorithms.

Algorithm1: Algorithm for feature Extraction

Description: Extracting the features of an image from the database

Input: Preprocessed image

Output: Extracted features

Begin

Read the pre-processed image

Step1: Divide the image into blocks each of size 40 × 40 pixels.

Repeat

- Compute the approximation and detail co-efficient matrices
- Calculate the corresponding wavelet energy features for each block

- Above steps are repeated to perform second level decomposition.

Until (all the blocks are processed)

Step2: Extracted features are stored in feature vector.

End //end of proposed algorithm

Algorithm2. Algorithm for Training phase

Description: Fingerprint identification for person authentication.
Input: Fingerprint images from the database.
Output: Feature vector of trained images

Begin

Repeat

Read the fingerprint image from database

Step1: Pre-processing

- Convert the gray-scale image into binary image.
- Resize the image.

Step2: Feature Extraction

Until (all the images in the database are read)

Step3: Knowledge Base is constructed by placing feature vector of each image in a row

End //end of proposed algorithm

Algorithm3: Algorithm for testing phase

Description: Fingerprint recognition for person authentication.
Input: Unknown fingerprint image.
Output: Person's unique id to which the input fingerprint belongs to.

Begin

Read the unknown fingerprint image

Step1: Pre-processing

- Convert the gray-scale image into binary image.
- Resize the image.

Step2: Feature Extraction

Repeat

Step3: Input the features of the test image to Euclidean Distance for recognition.

Until (all the features of Knowledge Base are compared)

End //end of proposed algorithm

Algorithm4: Algorithm for connecting Matlab to MySql database

Description: Retrieval of person's confidential data from database.
Input: Matched person's unique id
Output: Access of confidential data for matched person.

Begin

Step1: Connect to the database.
Step2: Write appropriate query using input.
Step3: Fetch and display the information in GUI.
End // end of proposed algorithm.

3.1.5 Tools and Techniques

Matlab

The basic data structure in matlab is the array, an ordered set of real or complex elements. This object is naturally suited to the representation of images, real-valued, ordered

sets of color or intensity data. This convention makes working with images in matlab similar to working with any other type of matrix data, and makes the full power of matlab available for image processing applications.

Single-level discrete 2-d wavelet transform

This proposed work uses the discrete wavelet transform function for extraction of fingerprint features. The syntax of the dwt function is as follows:

[ca,ch,cv,cd] = dwt2(x, '*wname*')

4. RESULTS AND DISCUSSIONS

The proposed method uses Euclidean distance to classify the fingerprint images. In this chapter the results of the proposed methodology have been discussed in detail considering several examples of the images. The databases FVC 2004, FVC 2002, are collected from the website [www.advancedsourcecode.com] and also real time databases from the scanner. The proposed methodology for fingerprint identification system has been evaluated for the above mentioned databases. We have used 75% of total samples for training and 25% for testing. The method is evaluated for all trained and test samples. The method achieves average recognition accuracy of 95.3%. The system is efficient and insensitive to the variation in size and font, noise, blur and other degradations. The experimental results of testing various character images with varying font styles, size and backgrounds are given below.

4.1 A Sample of an Image after loading

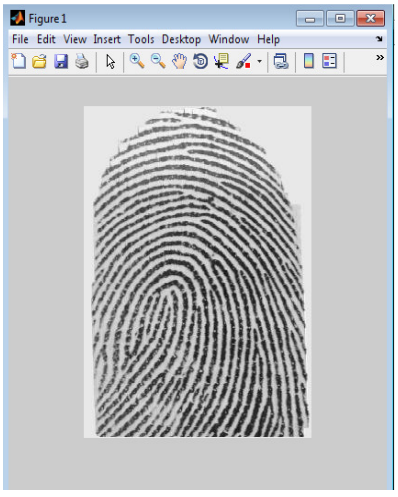


Figure 3: Fingerprint image

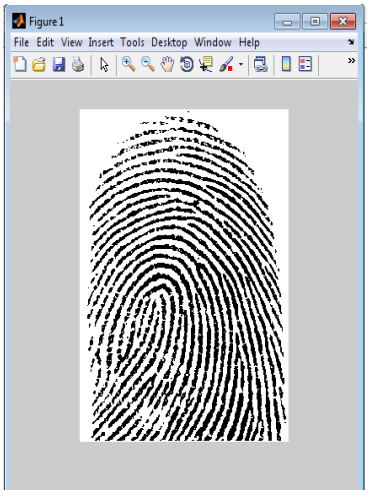


Figure 4: Resulting Binary image

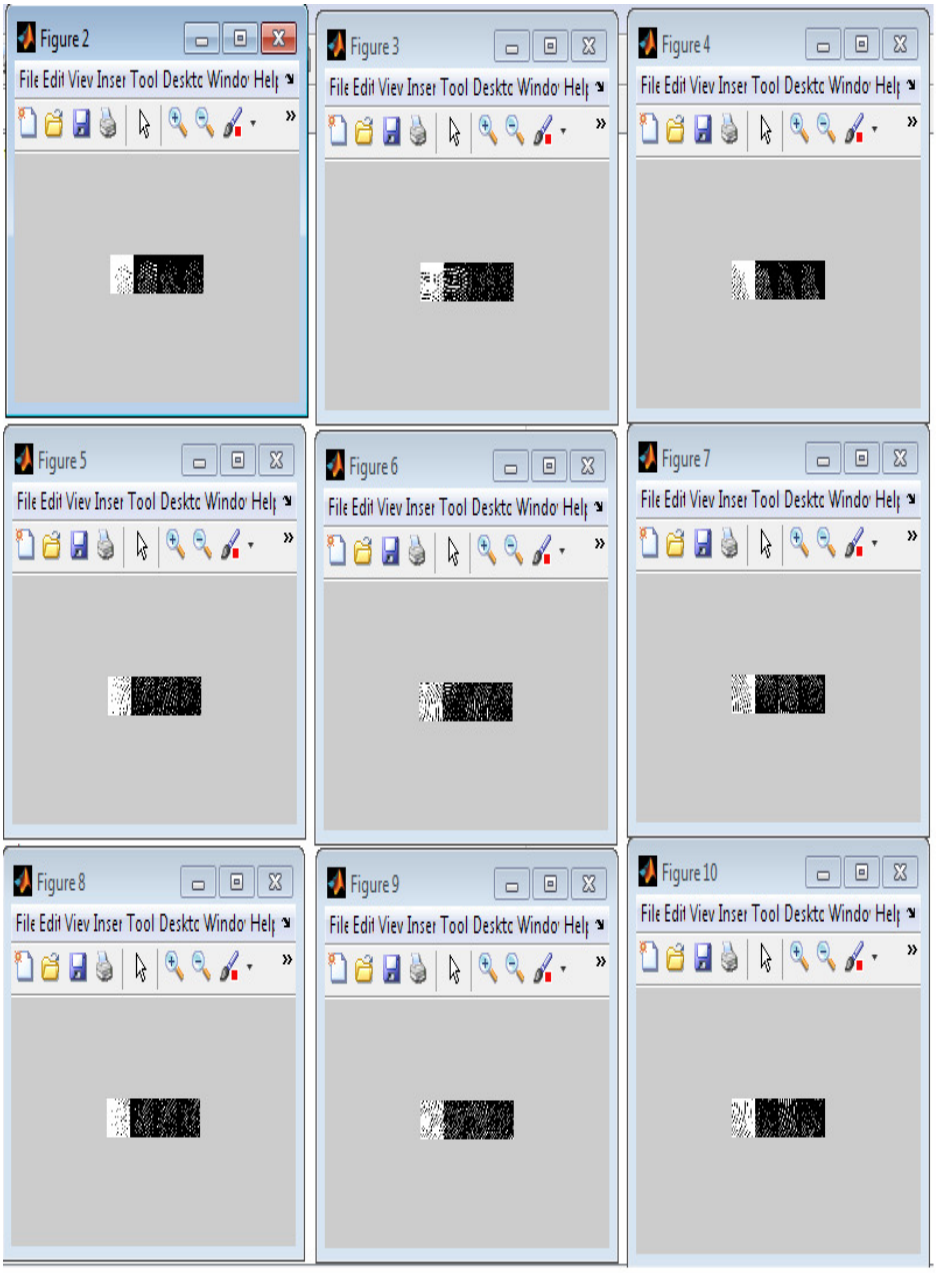


Figure 5: Blocks of image after applying dwt function

4.2 AN EXPERIMENTAL ANALYSIS DEALING WITH VARIOUS ISSUES

The proposed method has studied many of the techniques for identification of fingerprint like extracting the energy features, minutia points and applying the wavelet functions single time or twice as shown in the tables (1,2,3,4 and 5) and graphs (1….5). This proposed method also applied combination of these techniques for accurate matching of finger prints as listed in the table (1). After analyzing these combinations this proposed method came up with applying.

Table: 1 describes various techniques with their efficiency

1Number of persons	Techniques used	Efficiency
16 persons	Dwt function(twice) with minutia	87 %
16 persons	Dwt function(single) with projection features	85.02 %
16 person	Dwt function(twice) with projection features	85.54 %
16 person	Only dwt function	95.3 %

Table: 2 Dwt features with minutia points result for various databases

Number of persons	Trained images	Tested images	Efficiency
22 persons	132	176	84%
19 persons	114	152	86.30%
16 persons	96	128	87%
13 persons	78	104	87.5%
10 persons	60	80	88%

Table: 3 Dwt function applied for single time with projection features

Number of persons	Trained images	Tested images	Efficiency
22 persons	132	176	83%
19 persons	114	152	84.7%
16 persons	96	128	85.02%
13 persons	78	104	86.3%
10 persons	60	80	86.80%

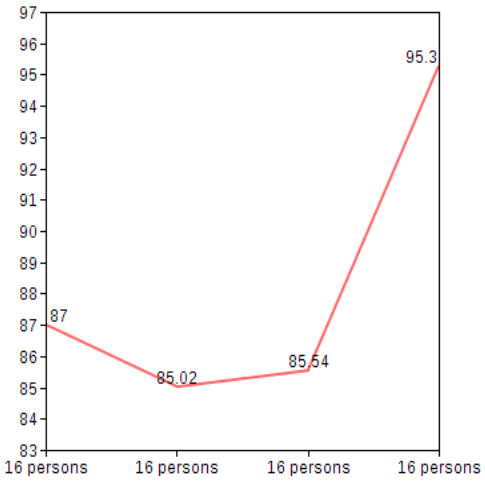
Table: 4 dwt applied double time with projection features

Number of persons	Trained images	Tested images	Efficiency
22 persons	132	176	83%
19 persons	114	152	84.7%
16 persons	96	128	85.54%
13 persons	78	104	86.3%
10 persons	60	80	86.80%

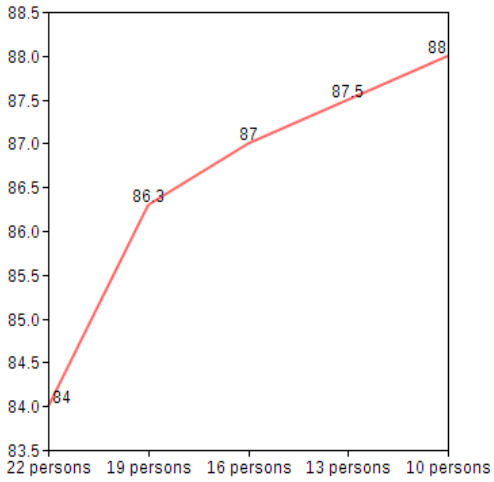
Table: 5 Dwt features without minutia point's result for various databases

Number of persons	Trained images	Tested images	Efficiency
22 persons	132	176	92.5%
19 persons	114	152	95.39%
16 persons	96	128	95.3%
13 persons	78	104	98.07%
10 persons	60	80	98.75%

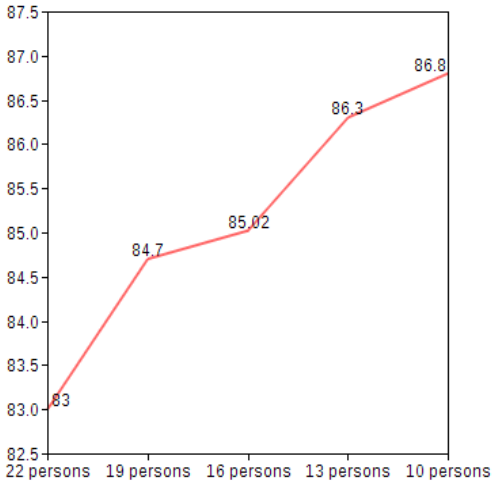
Graph for Table 1



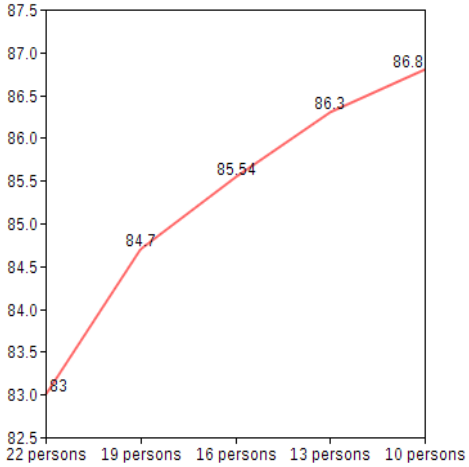
Graph for Table 2



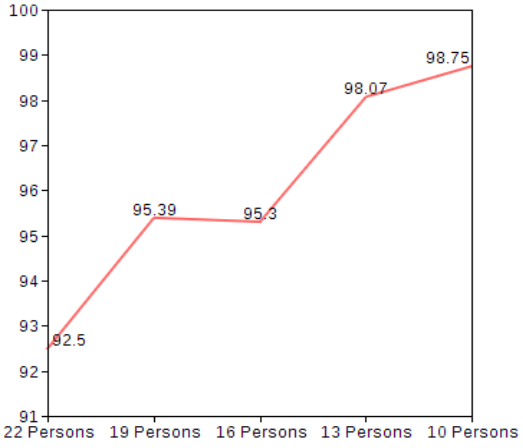
Graph for Table 3



Graph for Table 4



Graph for Table 5



CONCLUSION

In this work, a novel method for identification of fingerprint images is proposed. The proposed method uses wavelet energy features and Euclidean Distance for fingerprint identification. The system works in two phases, training phase and testing phase. Then connection of Matlab to database is made for information retrieval. Once the fingerprint is matched, person's unique id will be given in order to access his confidential information. And hence the authenticated access achieved. From the results obtained by considering wavelet energy features and Euclidean distance, it has been observed that the system is insensitive for several distortions like, variable lighting condition, noise, blur etc. The method is trained for 75% of total samples and tested for all samples. The method achieves average recognition accuracy of 95.3%. The proposed method can be extended for fingerprint identification considering new set of features and classification algorithms.

BIBLIOGRAPHY

[1] Mark Sanderson and W. Bruce Croft," School of Computer Science and Information Technology".
[2] Christos Faloutsos and Douglas W. Oard," A Survey of Information Retrieval and Filtering Methods ", Department of Electrical Engineering and Computer Science.
[3] Amit Singhal," Modern Information Retrieval: A Brief Overview", Google Inc.
[4] David Robins, "Interactive Information Retrieval: Context and Basic Notions", Louisiana State University.
[5] Christopher Mallow," Authentication Methods and Techniques".
[6] Anil Jain, Arun Ross and Salil Prabhakar," Fingerprint matching using minutiae and texture features Fingerprint matching using minutiae and texture features"
[7] Trupti S. Indi and Suhas D. Raut," A novel-based fingerprint matching algorithm using minutiae", Solapur University India.
[8] Ferdous Ahmed Sohel and M. Amiruzzaman," Fingerprint Authentication System Using Back-Propagation"Department of Computer Science and Engineering
[9] Vijaya Sathiaraj," A Study on the Neural Network Model for Finger Print Recognition" Bharathidasan University, Trichirappalli-23.
[10] Le Hoang Thai and Ha Nhat Tam," Fingerprint recognition using standardized Fingerprint model" University of Science Ho Chi Minh City, 70000, Viet Nam.
[11] Rakesh Verma, Anuj Goel, "Wavelet Application in Fingerprint Recognition".
[12] Tien-Tsin Wong and Chi-Sing Leung," Discrete Wavelet Transform on Consumer-Level Graphics Hardware", The Chinese University of Hong Kong.
[13] Hamzeh Khazaei, Ali Mohades," Fingerprint Matching and Classification using an Onion Layer algorithm of Computational Geometry".
[14] Sangram Bana and Dr. Davinder Kaur," A method on Fingerprint Recognition using Image Segmentation".
[15] Adebayo Daramola, Tola Sokunbi and A.U Adoghe, "Fingerprint matching method using Support Vector Machine", Ota, Nigeria((IJCSE)).
[16] Soukaena H. Hashem, Abeer T. Maolod and Anmar A. Mohammad, "Proposal to Enhance Fingerprint Recognition System", International Journal of Computer Engineering & Technology (IJCET), Volume 4, Issue 3, 2013, pp. 10 - 22, ISSN Print: 0976 – 6367, ISSN Online: 0976 – 6375.