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THE STUDY AND OPTIMIZATION OF FINGERPRINT VERIFICATION USING SIFT APPROACH ON PORES AND RIDGES OF FINGERPRINTS

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Abstract— -***Today's modernization and advancement in the area of information and telecommunications technologies that comprises for a fully automated computerized process through which human efforts were decreases and working of information exchange takes place, however, systems where the authenticity is require related to the access an account of user can improve identification process by utilizing biometric recognition which provides more security. Fingerprint based personal identification is becoming more and more popular in day uses of life. An accurate real time automatic fingerprint identification system designing is of great importance in many circumstances, and because this circumstances many scholars put their interest on this. The aim is to propose a approach using pores and ridges feature to extract and match it conveniently to increase or optimize the verification quality in term genuine acceptance rate. Image normalization is done using Gaussian blurring and sliding window contrast adjustment. Pores are extracted and estimated. Using these estimated pores, matching is done from template database to stored database using SIFT algorithm.***

Key words— *Bio-metrics, SIFT, fingerprint verification, pores and ridges*

I. INTRODUCTION

In an advancement of digital world, dependable personal authentication considere as an important human computer interface activity.It is used as National security consern, e-commerce issues, and access to computer networks where establishing a person's identity is essential for verification to succeed. Existing security consern are based on knowledge-based approaches like passwords or approaches which are token based examples are swipe cards and passports to control access to physical and virtual spaces. Biometrics system is the automated recognition of individuals identification based on their biological and behavioral characteristics.

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Biometric recognition means measuring an individual's suitable behavioral and biological characteristics in a particular recognition inquiry and comparing these data with the biometric system reference data which had been stored at the time learning procedure, so that the identity of a specific user is determined. As known fingerprint is the friction ridges impression, from the surface of a fingertip. Fingerprints have been used for identification for many decades of human , more recently becoming fingerprint recognition is one of the most prior and famous biometric technologies mainly because of the inherent ease in acquisition the numerous sources available for a group of prints, and the established use and collection by law enforcement agencies

In this paper we are using SIFT pores matching technique for the fingerprint verification. The work provides various issues of competition (discussed in previous section) in fingerprint matching. The aim is to decrease the error rates, namely False Acceptance Rate (FAR) and False Rejection Error (FRR) in the earlier fingerprint matching algorithms. The proposed approach utilizes Level 3 features on ridges and pores mainly for matching fingerprints at 500ppi.

II. ISSUES

Fingerprint recognition is a complicated pattern recognition aspect. It is awkward to form an accurate algorithm which is capable of extracting salient features and matching them in a strong way, particularly in low quality fingerprint images and when use of low-cost acquisition devices with small area are adopted. There is a famous believe that is not based on correct information that automatic fingerprint recognition is a fully solved problem since it was one of the first applications of machine pattern recognition. On the other side, fingerprint recognition is even more a competitive and important pattern recognition problem.

The challenge when matching fingerprints were affected by:

i) Whenever is High rotation/displacement which results in less quantity overlap between template and expressing doubt of fingerprints (this case can be treated as similar to matching partial fingerprints).
ii) Non-linear distortion caused by the finger plasticity.
iii) Different pressure and skin condition
iv) Feature extraction errors which may result in spurious or missing features. The vast majority of contemporary automated fingerprint authentication systems (AFAS) are minutiae (level 2 features) based [1]. Minutiae-based systems generally rely on finding correspondences between the minutia points present in "query" and "reference" fingerprint images.

These systems normally perform well with high definition or resolution fingerprint images and as much as fingerprint surface area. These states, however, it may not always be a lot of skill. In many ases, only a short portion of the "query" fingerprint can be compared with the "existed" fingerprints. As per the result, the number of

minutiae (Level 2 feature of fingerprint) connection between points might be significantly decreases and the matching algorithm would not be able to make a decision with high certainty. The description of minutiae is given in background. This show is even more noticeable on intrinsically low resolution fingers, where only a part of the minutiae can be take out and used with plenty of reliability. Although minutiae may carry most of the fingerprint's discriminating information, they do not always posses the best trade-off between robustness and accuracy.
This has influenced the designers of fingerprint recognition techniques to search for different fingerprint evaluating features, beyond minutiae, which may be used as combination with minutiae (and not as an alternative) to increase the system stiffness, accuracy and rigidity. It is a known fact that the presence of Level 3 features in fingerprints provides minutiae detail for matching and the potential for increased accuracy. The experts of forensics department often make use of Level 3 features, example sweat pore sand ridges to match fingerprint samples when inadequate minutia points are present in the fingerprint image or bad or blunt image hinders minutiae analysis. i.e., experts take advantage of an extended feature set in order to conduct a more effective matching

III. GENRAL FEATURE OF FINGERPRINTS AND VERIFICATION

3.1 fingerprint features

Fingerprint feature are into following 3 levels are as follows

- Level 1 feature comprises these global patterns and morphological information. They alone do not contain sufficient information to uniquely identify fingerprints but are used for broad classification of fingerprints.
- Level 2 features or minutiae refer to the many ways that the ridges can be discontinuous. These are essentially Galton characteristics, namely ridge endings and ridge bifurcations. A ridge ending is defined as the ridge point where a ridge ends abruptly. A bifurcation is defined as the ridge point where a ridge bifurcates into two ridges. Minutiae are the most prominent features, generally stable and bold to fingerprint impression conditions.
- Level 3 features refer to pores and contour to ridges. These are purely the sweat pores and ridge contours. Pores are the openings of the sweat glands and they are distributed along the ridges. A pore can be either open or closed, based on its perspiration activity

The pore information (position, number and shape) are considered to be permanent, immutable and highly distinctive but matching techniques use pores since their reliable extraction The figure 1 shows the different levels of finger very few automatic print. Our focus of point is on the pores feature which comes under level 3 which is shown bellow.

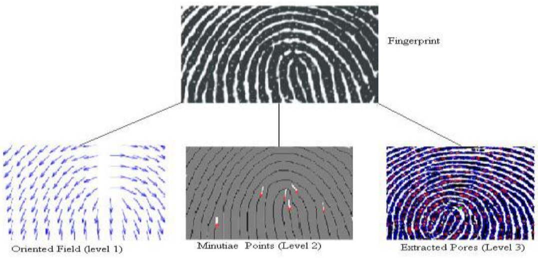

Fig 1: different levels of fingerprints

3.1.2 Pores extraction techniques

The level-3 feature extraction algorithm uses curve evolution with the fast implementation of Mum-ford–Shah functional [4]. Mumford–Shah curve evolution efficiently segments the contours present in the image. In this approach, feature boundaries are detected by evolving a curve and minimizing energy based segmentation model as given in the following equation

$$Energy(C,c1,c2)=\alpha\iint \phi|C'|\,dx\,dy+\beta\iint |I(X,Y)-C1|^2\,dx\,dy+\iint|I(X,Y)-c2|^2$$

………... (I)

Where $\bar{C}$ is the evolution curve such that $\bar{C}=\{(x,y):\varphi(x,y)=0\}$, C is the evolution curve parameter, φ is the weighting function or stopping term, Ω represent the image domain, *I(x, y)* represent fingerprint image, c_1 and c_2 are the average value of pixels inside and outside $\bar{C}$, respectively, and α, β, and γ are positive constant such that $\alpha + \beta + \gamma = 1$ and $\alpha < \beta < \gamma$. Further, Chan and Vese [6] parameterize the energy equation (Eq. 1) by the artificial time $t \geq 0$ and deduce the associated Euler-Lagrange equation and that leads to the following active contour model deduce the associated Euler-Lagrange equation and that leads to the following active contour model,

$$\psi_t' = \alpha\phi(v' + \varepsilon_k)|\nabla\Psi'| + \nabla\phi\Psi' + \beta\delta(1-c1) + \gamma\delta\Psi'(1-c2)^2$$

…….(II)

Where $\bar{v}$ the advection is term and ε_k is the curvature based smoothing term. ∇ is the gradient and $\delta=0.5/(\pi(x^2+0.25))$. The stopping term ϕ is set to

$$\phi=\frac{1}{1-(|\nabla I|)^2}$$

……………..(III)

This gradient based stopping term ensures that at the strongest gradient, the speed of the curve evolution becomes zero and therefore it stops at the edge of the image.

3.2 General fingerprint verification

Friction ridges of the skin and thumbs forms the imprint called fingerprint. Identification takes place using them because of their immutability and individuality.we define Immutability as not changing character of pattern which is permanent each finger. Individuality is defined as the uniqueness of ridge details across individuals; probablity of too finger print is same as given by 1 in 2000. however the mannual process are tedous and tme consuming to give the performance evaluation task.. An automatic fingerprint identification system is widely adopted in many applications such as building or area security and ATM machines. The general approach will be described for fingerprint recognition:

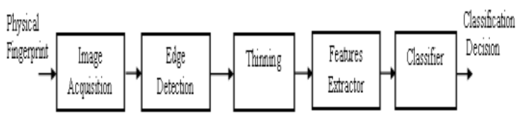

Fig 2 Fingerprint recognation system

- **Image Acquisition**:

There are number of methods used to acquire fingerprints.most used or famous is inked impression method in all which remains the most popular one. Today inkless fingerprint scanners are also present for eliminating the intermediate digitization process. Directly the minutiae extraction algorithm is effected by the fingerprint quality . Two types of degradation usually affect fingerprint images:

i) small breaks (gaps); the lines on the finger called ridges are not almost continuous since they sometimes include cuts.

ii) the presence of cluttering noise always well seprate the parallel ridge line.The resolution of the scanned fingerprints must be 500 dpi while the size is 300x300.

- **Edge Detection**:

An edge is the boundary between two regions with relatively distinct gray level characterstics. The idea behind the most edge ditection is on the computation of a local derivative operator such as 'Roberts', 'Prewitt' or 'Sobel' operators.genrally , the edge detection algorithm is used to collect theset pixel, seldom characterizes a boundary completely because of bondries consist of breaks noise, and other effects that introduce spurious intensity discontinuities. Thus, to assemble edge pixels into meaningful boundaries it uses edge detection algorithms typically are followed by linking and other boundary detection procedures designed.

- **Thinning**:

It a important approach to reduce to a grpah by the representing the structural shape of a plane region. Obtaining the skeleton of the region via thinning (also called skeletonizing) algorithm the reduction may be achived. The thinning algorithm while deleting unwanted edge points should not:

- Remove end points.
- Break connectedness
- Cause excessive erosion of the region

- **Feature Extraction**:

One of the most important tasks for a recognition system Extraction of sutable features. The feature extraction method used in [1] will be explained below. A multilayer perceptron (MLP) of three layers is trained to detect the minutiae in the thinned fingerprint image of size 300x300. The first layer of the network has nine neurons associated with the components of the input vector. The hidden layer has five neurons and the output layer has one neuron. The network is trained to output a "1" when the input window in centered on a minutiae and a "0" when it is not.

The networking will be trained using:

- The backpropagation algorithm with momentum and learning rate of 0.3.
- The Al-Alaoui backpropagation algorithm.

State the number of epochs needed for convergence as well as the training time for the two methods. Once the network is trained, the next step is to input the prototype fingerprint images to extract the minutiae.

- **Classifier**:

After scanning the entire fingerprint image, the result or output is a image with location of minutae revealing binary image the location of minutiae. it done to stop the falsy reported output and chose the correct minutae and two more rules are added to enhance the robustness of the algorithm:

- At those potential minutiae detected points, it can re-examine them by increasing the window size by 5x5 and scanning the output image.
- If two or more minutiae are to close together (few pixels away) we ignore all of them.

IV. GENRAL APPROCHES OF MATCHING

The purpose of the matching algorithm is to compare two fingerprint images or templates and returns a exactly like score that corresponds to the two prints probability of match between them, most of the algorithm extract features for the purpose bhind is simply of matching. Human experts also uses the minutae feature etraction which is moast popular and the matching on the basisis of it. local discontinuities and mark position are reprsented of the minutiae where the ridge comes to an end or bifurcates into two. There are 18 type of minutae in wamong them these two areimportant ypes have been identified so far . Each minutiae may be described by a number of attributes such as its position (x,y) its orientation θ, its quality.

Template selection techniques:

The goal of the new generation of fingerprint technique is to support the matching with pores and ridges, increasing the system security to the governmental and Police levels. Here there are three template criteria for selection, being on minutiae-based, and correlation-based, and coherence based.

a) Minutiae Acquisition Technique

There are too many technology which are bases on minutia. the fingerprint by its local features are represented in Minutia-based techniques, like terminations and bifurcations. This approach has been studied extremely thoroughly, and it is the base of current fingerprint recognition . This work also follows on the same approach. However a drawback of this technique is that it suffers from most of the fault of minutiae-based systems. Still, are un reliable in some aspect.

b) Correlation-Based Template Selection:

The second method satisfies the template requirements are straight forward. In this method, we chose the template as in way such that how they can be fit on other location of same fingerprint.. If a template fits almost as well at another location as it does at its original location, it is not a useful template. However, if a template fits much worse at all other locations in the fingerprint, then the template is distinct Therefore, the ratio of fit at a template's original location to the fit at the next best location can be used as a template selection criterion.

Since the correlation-based checking is carried out by means of template matching, the method use in this consumes a lot of computational power. This makes it a small attractive method to use. However, it may be used with the other two methods. In that case, possible template locations are extracted by one of the methods of the previous subsections. Then, the correlation characteristics of those locations are checked as an additional selection criterion.

c) Coherence-Based Template Selection

A measure that indicates how well the local gradients are pointing in the same directions is the coherence of an image at that area. the coherence is very high in the area where the structure of valley is parallel, and , the coherence is low at noisy area. Second fingerprint is not reliably matched on taking area of high coherence. However, at locations around minutiae, more grayscale gradient orientations are present, resulting in a significantly lower coherence. Therefore, the coherence can be used as an appropriate measure that indicates the presence of minutiae as well as a measure that indicates how well a template can be located in the secondary fingerprint.

.V. SIFT (SCALE INVARIENT FEATURE TRANSFORM)

Scale Invariant Features Transform (SIFT)[1 5] is an algorithm in computer vision to detect and describe local features in images.

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SIFT detects stable feature points in an image and performs matching based on the descriptor representing each feature point. SIFT technique describes image features that have many properties that make them suitable for matching differing images of an object or scene. The features are invariant to image scaling and rotation, and partially invariant to change in illumination and 3D camera viewpoint

It takes input as image provides key descriptor which further match with testing images as shown below

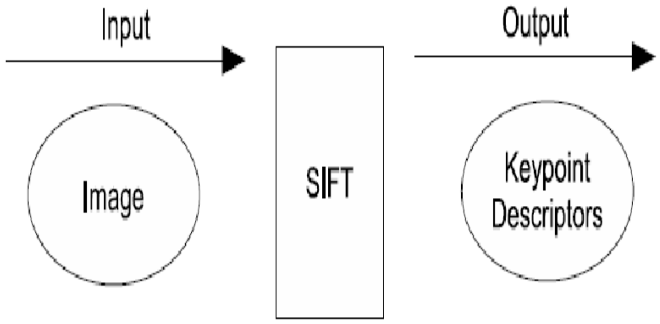

Figure 3 SIFT takes as input an image, and generates a set of key point descriptors [13]

These are the following steps SIFT algorithm

- **Scale-space extreme detection**: it is the first stage where the computation searches takes over all scales and image locations on the image. Difference-of-Gaussian function is used for the implementation, through invariant to scale and orientation the potential point are identified.
- **keypoint localization**: At each applicant location, a detailed model is fit to determine location and scale. Keypoints are selected based on measures of their stability.
- **Orientation assignments**: One or more orientations are assigned to each keypoint location based on local image gradient directions. All future operations are performed on image data that has been transformed relative to the assigned orientation, scale, and location for each feature, thereby providing invariance to these transformations.
- **Keypoint descriptor**: The local image gradients are measured at the selected scale in the region around each keypoint. These are transformed into a representation that allows for significant levels of local shape distortion and change in illumination.
- **Assigning Descriptor**: A 16x16 window is used to generate a histogram of gradient orientation around each local extremum. To make the descriptor orientation invariant, all gradient orientations are rotated with respect to the major orientation of the local extreme.

VI. PROPOSED APPROCH

This unit converse the proposed approach and pores matching using SIFT algorithm. Figure 6.1 shows the block diagram of proposed approach. The basics of SIFT technique is described in the previous chapter. In this section, the proposed algorithm, its features and other various aspects has been described. Two type of database has been created; first one name samedb1 contains the 10 fingerprints of same person with some variations and other factors such as light, noise etc. Thus samedb1 contains 400 fingerprints of 40 different students. Second database namely diffdb2 contains 150 fingerprints of different students.

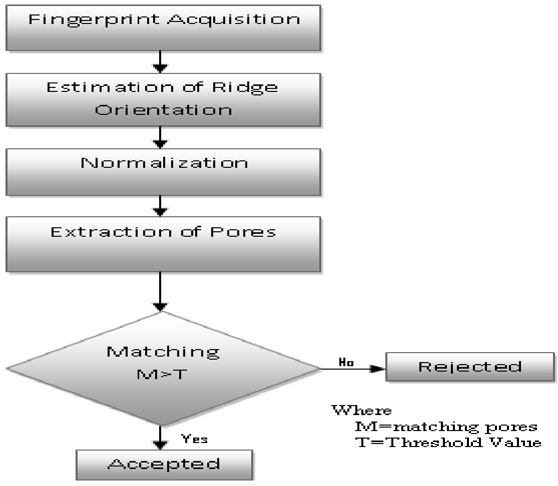

Figure 4 Block diagram of proposed approach

- **Fingerprint Acquisition and Database**

The first step in the proposed approach is to acquire fingerprint image of good quality. Thus, Hamster II is use for acquiring fingerprint image. Hamster II is optical fingerprint scanner and use for scanning the finger. Hamster II is used for creating fingerprint database. This database is use for analyzing the accuracy of proposed algorithm and execute the results on the basis of analyze. After acquiring fingerprint, store it in database and also use as input to proposed algorithm. Figure 6.2 shows the acquired fingerprint from optical scanner.

Figure 5 Acquired fingerprint from optical scanner

- **Estimation of ridge orientation**

Next process is the estimation of the ridge orientation. The local ridge orientation is determined by the least square estimate method. This data is utilized later in the representation of pores. Analysis of the developed fingerprint matching system has revealed a number of interesting conclusions. It can be stated that segmentation is the critical stage of fingerprint pores recognition, since areas that are wrongly identified as pores regions will corrupt biometric templates resulting in very poor recognition. Segmentation can be the most difficult stage of pores recognition because its success is dependent on the imaging quality of fingerprint images. 95% of the fingerprint database images segmented correctly. Another interesting finding was that the encoding process only required one Gabor filter to provide accurate recognition, since the open literature mentions the use of multi-scale representation in the encoding process.

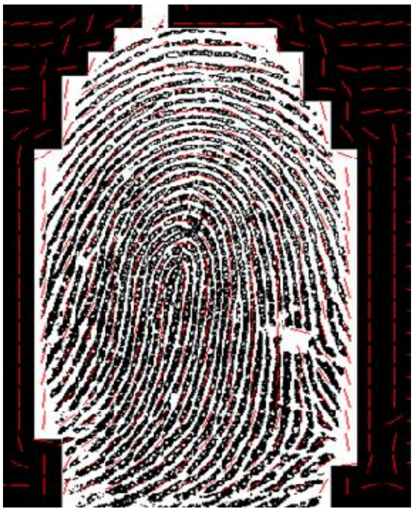

Fig 6: Ridge orientation of fingerprint

- **Normalization**

To compensate for the variations in lighting, contrast and other inconsistencies, three pre-processing steps are used: Gaussian blur, sliding window contrast adjustment, and histogram based intensity level correction. Gaussian blurring is used to remove any noise introduced by the sensor. Normalizes image values to 0-1, or to desired mean and variance. Offsets and rescales image so that the minimum value is 0 and the maximum value is 1. Result is returned in n. If the image is color the image is converted to HSV and the value/intensity component is normalized to 0-1 before being converted back to RGB.
The lighting inconsistencies are adjusted by using sliding-window contrast adjustment on the Gaussian blurred image. To further enhance the ridges and valley a final intensity correction is made by using Histogram-based Intensity Level Adjustment.
The image can divide into small processing blocks (32 by 32 pixels) and perform the Fourier transform according to:

$$F(u,v)=\sum_{x=0}^{M-1}\sum_{y=0}^{N-1} f(x,y)\times \exp\left\{-j2\pi\times\left(\frac{ux}{M}+\frac{vy}{N}\right)\right\}$$

.... (IV)

For u = 0, 1, 2... 31 and v = 0, 1, 2... 31.
In order to enhance a specific block by its dominant frequencies, multiply the FFT of the block by its magnitude a set of times. Where the magnitude of the original FFT = abs (F (u, v)) = |F(u, v)|.Get the enhanced block according to

$$g(x,y) = F^{-1}\{F(u,v)\times|F(u,v)|^{k}$$ ….(V)

Where $F^{-1}(F(u,v))$ is done by:

$$F(x,y)=\frac{1}{MN}\sum_{x=0}^{M-1}\sum_{y=0}^{N-1} f(x,y)\times\exp\{j2\pi\times\frac{ux}{M}+\frac{vy}{N})\}$$

…………(VI)

For x = 0, 1, 2... 31 and y = 0, 1, 2... 31.
The k in formula (6.2) is an experimentally determined constant, which can choose k=0.45 to calculate. While having a higher "k" improves the appearance of the ridges, filling up small holes in ridges, having too high a "k" can result in false joining of ridges. Thus a termination might become a bifurcation.
The enhanced image after FFT has the improvements to connect some falsely broken points on ridges and to remove some spurious connections between ridges. The side effect of each block is obvious but it has no harm to the further operations because resultant image after consecutive binarization operation is pretty good as long as the side effect is not too rigorous
For the fingerprint image preprocessing stage, Fourier Transform can be use to image enhancement. And then the fingerprint image is binarized using the locally adaptive threshold method. The image segmentation task is fulfilled by a three-step approach: block direction estimation, segmentation by direction intensity and Region of Interest extraction by Morphological operations. Most methods used in the preprocessing stage are developed by other researchers but they form a brand new combination in our project through trial and error. Also the morphological operations for extraction ROI are introduced to fingerprint image segmentation in this thesis.

Figure7 Normalized image

- **Pores estimation and extraction approach**

Extract level 3 features in ROI. The pores are distributed over ridges and using orientation detail can provide additional information for matching. During tracing, the algorithm classifies the contour information into pores and ridges.
A blob of size greater than 2 pixels and less than 45 pixels is classified as a pore. Therefore, noisy contours, which are sometimes wrongly extracted, are not included in the feature set. A pore is approximated with a circle and the center is used as the pore feature. The fingerprint image is threshold with a single-point threshold (T). After this step the pores have an intensity of 255. The pores are then extracted by a blob detector which locates groups of connected pixels (pores) with an intensity of 255 and with size within a pre-determined range. Each pore thus extracted is represented by the coordinates of the central pixel and an orientation, which is the ridge orientation at that particular location.
An edge of a ridge is defined as the ridge contour. Each row of the ridge feature represents x; y coordinates of the pixel and direction of the contour at that pixel. Here edges will remove by using morphological operation and extract only pores whose pixel value is greater than 15. In other words, there is assumption that pores can be classified as combination of 2 or more pixels. Using this assumption, we consider only those pores who are grouping of more than 15 but less than 45 pixels. Rest pixels will remove from

normalized image. Thus it is possible to remove the contour ridges and extract pores. Figure 6.4 shows the extracted pores from normalized image.

The pixel intensity values in the fingerprint image are typically non-invariant over the time of capture and there is need to determine salient feature of input fingerprint image that can be discriminate between identities as well as remain invariant for a given individual. Thus the problem of representation is to determine a measurement (features) space in which fingerprint image belonging to the same finger form a compact cluster and those belonging to the different finger occupy different portions of space.

The last step is to remove possible spurious pores. We apply the following constraints to post-processing the initial pore extraction results.

(i) Pores should reside on ridges only. To implement this constraint, we use the binary ridge image as a mask to filter the extracted pores.

(ii) Pores should be within a range of valid sizes. We measure the size of a pore by counting the pixels in its region.

(iii) The mean intensity of a true pore should be large enough. In our experiments, we discarded the last 5% pores (i.e. those with lowest intensity). Finally, we record the extracted pores' locations as the coordinates of their mass centers.

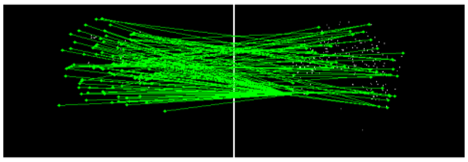

Fig 7: extracted pores and their matching

7. RESULT

We have taken here total 100 images, and consider two to eight images of each finger with respect to variations in images for analysis and key points detection same user, so it will become 500 fingerprint images are collected in a database.

We create two types of database; first one name samedb1 contains the 10 fingerprints of same person with some variations and other factors such as light, noise etc. Thus samedb1 contains 400 fingerprints of 40 different students. Second database namely diffdb2 contains 150 fingerprints of different students. These fingerprints acquire using Hamster II optical fingerprint scanner. Fingerprints are acquired after taking some interval of time. There is another database name fprintdb that was downloaded from FVC 2002 for analysis. The graph shows the result on taking pores and ridges for verification GAR Genuine Acceptance Rate much better than the other approaches on matching. FAR reduces on increasing threshold this result are better than existing level-2 [Jain *et al.*], [Jiang *et al.*] and
level-3 and of M Vatsa.

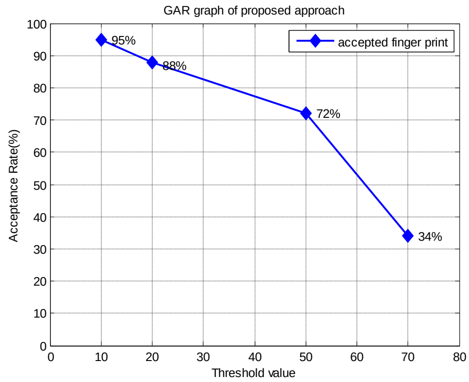

Fig 8 shows GAR on certain threshold

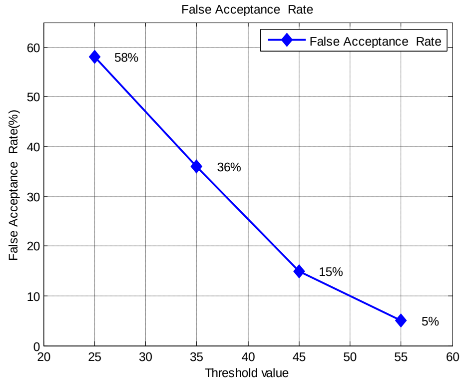

Fig 9 false acceptance rate with thresh hold

7. CONCLUSIONS

The experimental results demonstrate that the proposed approach and its associated pore extraction method can detect pores more accurately and robustly, and can help to improve the verification accuracy of pore based fingerprint recognition systems.on increasing level of octave it increases the recogination rate of image.sift work on high resolution more robustly with higher effect.

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