An Approach For Fingerprint Image Verification

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Abstract

In recent scenario, security is very important so they make use of biometric system in which fingerprint recognition/ verification is popular. Matching feature is the most popular verification algorithm. In order to obtain perceptional information histogram equalization is done. FFT enhancement is followed by histogram equalization in order to improve the form of ridges and bifurcation. Minutiae extraction algorithm proposed by Rathal et al is implemented due to its faster and more reliable approach. Reo's algorithm efficiently helps to locate the ridges in the fingerprint image. Then morphological thinning operation is applied for minutia detection. Smoothing algorithm is used to differentiate between ridges and bifurcation. Matching is done between the input image and the stored template with the help of the triplet based minutiae matching algorithm is used. The algorithm consists of three components: clockwise arranged minutiae without central minutiae, local minutiae matching and global minutiae matching. This algorithm achieves higher accuracy.

1. Introduction

The term bio metric is derived from the Greek word bio meaning life and metric meaning measurement. With the advancement of science and technology, biometric is widely used in uniquely identifying a person based on his/her physiological characteristics such as signature, voice, keystroke, gait, etc. The term verification is defined to find the identity of the user by matching his/her fingerprint against the fingerprint stored in the data base. Of these various biometric identifiers fingerprint recognition/verification is most popular biometric system used for security and forensic applications. [1]

2. Overview of the technologies

Verification and identification are the two types, matching one to one matching is called verification. This helps the person enrolment against the fingerprint in the database and this will be stored with the person name (or) other identity in the compressed format. For matching the fingerprints there is the necessary to compare several features of the print pattern.[2] The pattern consist characteristics of ridges, minutia points. These are the unique features found in fingerprint patterns. The fingerprint ridges consist of arch, whorl, and loop. Ridge ending, bifurcation and short ridge (or) dot is the major minutia features of the fingerprint ridges. The minutia will be unique for different person.

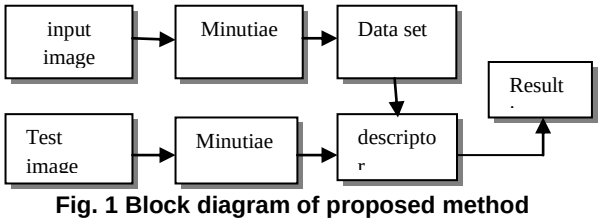

Fig. 1 Block diagram of proposed method

3. Image senor

Fingerprint sensors make use of capacitive, optical, pressure or thermal technologies to obtain an image of a fingers feature. Fingerprint sensors include an analogy to digital converter to translate the analogy information into a digital data. Once the image is captured the digital information is transferred to digital signal to generate a match.[4]

4. Feature extraction

In the feature extraction stage the minutia can be identified with the help of the morphological operation called thinning.[3] Both ridge ending and bifurcation

can be found out, the minutiae feature can either be obtained by binarized image (or) direct gray scale image. Due to the noise, scar or a dry finger the ending can be shortly isolated in order to avoid these problem valid minutiae is found by the feature attributes. bifurcation type, the (x,y) location, and the direction of the ending (or) bifurcation are the attributes. Minutia template is produced from the feature extraction stage. [1]

5. Finger print matching

Minutiae based and correlation based is the two categories of the fingerprint matching technique. Finding the minutia points and mapping their relative placement on the finger comes under the category of minutia-based technique. Fingerprint with low quality minutia cannot be obtained. So the correlation based matching method will overcome with it. This method helps to find out the global pattern of ridges and furrows. But the image translation and rotation will affect the precise location of a registration point. The most advantageous is minutia-based technique and will be helpful to find out the local ridge structure easily.[1]

6. Techniques

6.1 Histogram equalization

Histogram equalization is used and distribution of an image to inflate the pixel value and 0 to 255 is the range. [11]

6.2Fourier transformation

The image is divided into small blocks(32x32) pixels and Fourier transformation is applied to it. For experimental purpose we keep n=0.50 as the constant. The appearance of the ridge is measured by the higher ”n” . If the value of “n” is too high then it causes false joining of the ridges.[11]

6.3 Estimation orientation field

Rao’s algorithm is implemented[7]

1. The fingerprint image is divided into blocks (WxW)
2. Calculate the gradient for each pixels in each block G_x andG_y

$$V_x(i,j) = \sum_{u=i-w/2}^{i+w/2} \sum_{v=j-w/2}^{j+w/2} 2G_x(u,v)G_y(u,v)$$

$$V_x(i,j) = \sum_{u=i-w/2}^{i+w/2} \sum_{v=j-w/2}^{j+w/2} (G^2{}_x(u,v) - G^2{}_y(u,v))$$

$$\theta(i,j) = 1/2 \tan^{-1}(v_x(i,j)/v_y(i,j))$$

3. Local orientation of each block is estimated.

$$C(i,j) = 1/N \sqrt{\sum_{(i',j') \in D} |\theta(i',j') - \theta(i,j)|^2},$$

D represents the local neighbourhood around the block (i,j);N is the number of blocks within D; and are local ridge orientations at blocks ,separately.

4. If the steadiness level is above the threshold Tc, then the local orientations around this region are re-estimated at a lower resolution level until , C(i,j) is below a certain level.

6.4MinutiaeMarking

Once image thinning is completed it becomes simple to mark the minutia when the central pixel is 1 and surrounded by exactly 3 one-value neighbours, then the central pixel is called ridge branch. If the central pixel is 1 and has only 1 neighbour value, then the central pixel is called ridge ending.[5]

6.5Image segmentation

ROI is known to be recognized for each fingerprint image. The inter ridge width D average is estimated and the average between two neighbouring ridges. The way to find D value is simple.[8] First test the row of the thinned image and sum up the entire pixels in the row whose value is 1. In order to find out the inter-width ridge divide the row length with the summation value. To obtain more accuracy repeated row scan is performed.[5]

6.6Triplet based features [10]

6.6.1 Angles min, med, max are the three angles in the triangle. Let i=1,2,3
P1 is the point will be given to the vertex angle max.
P2 is the point will be given to the vertex of angle min.
P3 is the point will be given to the vertex of angle mid.

6.6.2Handedness

Let $Z_i=X_i +jy_i$ the complex number j= $\sqrt{-1}$ leads to the location (x_i , y_i) of point Pi i=1,2,3.[10]

6.6.3Triangle type

The minutiae in the finger either an end point or a bifurcation based on the form of the triangle.[10]

6.6.4Triangle direction

The minutiae in the image is searched in the image from top to bottom or left to right.[10]

6.6.5Maximum side

Let λ =max {Li},where L1=$|z_{21}|$, L2=$|z_{32}|$ and L3=$|z_{13}|$.[10]

7 Minutiae Triplet Similarity

A new minutiae triplet similarity concept is introduced. In order to provide difference between similar and non-similar minutiae triplet for two given minutiae triplet. In order to find the dissimilarity either any of the one triplet must be dissimilar. If all the components are similar, above 0 they tend to reach high. Rotation is avoided by the sensor during finger print verification.[10]

7.1Algorithm – M3GL

M3gl is the fingerprint verification algorithm proposed in order to find out the minutiae representation and similarity degree. Fingerprint consists of minutiae set P and compute minutiae triplet as follow. For every p ∈ P, build m-triplet that include p and find its c nearest minutiae in P this procedure can discard the similarity. Low quality fingerprint images can also be used for fingerprint verification. They make use of the length of the largest side during similarity process. This process consists of three steps. Local minutiae matching, global minutiae matching and score computation.[9]

7.2Local matching

The matching procedure followed with the help of the binary search between the template and the query.
Let Q be the query and P be the template fingerprint minutiae sets. Let R be the minutiae triplet query and T be the minutiae triplet query. The set which contains local minutiae pair set be A$\leftarrow\{\}$. Binary search is performed for every query minutiae triplet set $\{t_1, t_2 ...., t_u\} \subset T$ through the similarity value higher than 0 then add the pairs $(r_i, t_1)(r_i, t_2)..(r_i, t_u)$, to A. According to the similarity sort all the pairs of A using descending order. The local minutiae matching pair is been placed in the set $M \leftarrow \{\}$. For every (r,t) do the following.[9]

- Let $B \leftarrow \{(q_1, p_1), (q_2, p_2), (q_3, p_3)\}$ be the matching minutiae where $q_1, q_2, q_3 \in Q$ and $p_1, p_2, p_3 \in P$ they maximize $s_{inv}(r,t)$.

When every $(q_i, p_i) \in B$ do the following

- no pair $(q_j, p_j) \in M$ then $q_j = q_i$ or $p_j = p_i$ then $M \leftarrow M \cup \{q_i, p_i\}$.

7.3 Global Matching

The step uses each minutia and performs query minutiae transformation for every reference pair. The amount minutiae matching maximize the selected transformation. This procedure overcomes the demerits of the single alignment based matching. They achieve three criteria; first the Euclidean distance should not exceed the threshold t_g. Second minutiae direction must not exceed threshold t_a . Third, the directions differences relative to reference minutiae pair must not exceed threshold t_a .[9]

7.4 Similarity Score Computation

The formula for computing similarity value is $\frac{n^2}{|P||Q|}$

where P and Q are the query and template of the minutiae sets respectively and n is the amount of matching minutiae pairs.[9]

8 Experimental Results

A fingerprint database FVC2000 is used to test the experiment performance. Once the image undergoes histogram equalization to precede the process either 0 or 1 has to be pressed. If 0 is pressed matching is done with the use of the noise image. If 1 is pressed noise is been removed and single alignment based matching is performed.

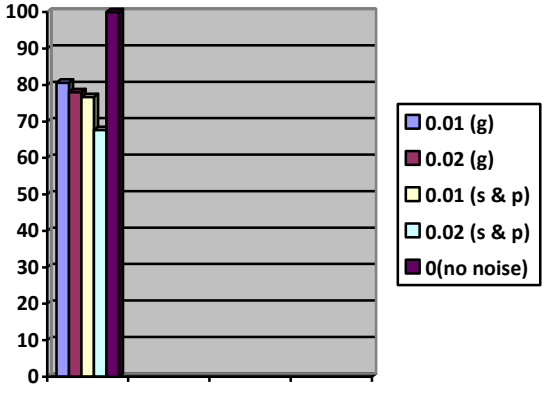

Fig. 2 Graph for noise removed images

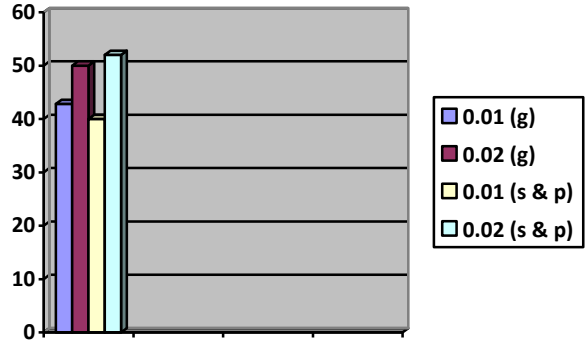

Fig. 2 Graph without noise removed images

In this paper fft enhancement is used to highlight the bifurcation and ridge ending and combined several methods from different sources. In this paper we simulated external noise to the fingerprint images and verified the matching process such as Gaussians and salt & pepper noise to the fingerprint image and up to 80% rate of successful matching is completed. As illustration we make use of the m3gl algorithm and found out that they produce more accuracy than the single alignment based matching algorithm. They make use of index approach than that of classification.

9. References

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