ENHANCING THE PERFORMANCE OF THE FINGERPRINT IDENTIFICATION BY INCORPORATING SINGULAR AND MINUTIAE POINTS

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Abstract: Fingerprints are the most reliable human characteristic that can be used for person identification. The non-changeability of Fingerprints during human life span and the uniqueness of each individual fingerprints are the basis for fingerprint recognition. A fingerprint pattern is composed of singular points and minutiae points. Although significant improvement in fingerprint recognition has been achieved, many challenging tasks are still remaining. This enhances the accuracy of the existing system in terms of False Acceptance Rate (FAR) and False Rejection Rate (FRR).

I. INTRODUCTION

The concept of Fingerprint identification system is in use since 400AD [1]. Before the introduction of Galton points in 1890 person identification was based on Fingerprint patterns which were mainly loops, whorls and arches. The minutiae points were then used to identify a person uniquely [2]. The core point is the uppermost of the innermost curve and is unique to every individual. There are about 100 ridge characteristics found in the human fingerprint. The ridge termination and the bifurcation are common among those. We are considering only these two minutiae points. There are numerous existing systems that use only the core point or only the minutiae points. Some systems have a combination of these two features. A hybridized form of such a system is discussed here. This system is an enhanced version of the existing systems that uses the core point [4] and the minutiae features [7] simultaneously. The Fingerprint has many advantages which makes the system simple, flexible and cost-effective. Some of these advantages are Ease of use, Uniqueness, Reliable and High accuracy.

Section II deals with the basic processes in the fingerprint identification systems. The Section III involves the existing system and some of its limitations. In the Section IV the proposed module is discussed. Section V deals with the results and discussions of proposed system. Section VI is the conclusion. The need and the method of the proposed module is explained with the algorithm. The results obtained are presented in the final section.

II. BASICS OF FINGERPRINT RECOGNITION

The Fingerprint identification system will have the basic modules of sensing, binarization and thinning. The core point detection and the minutiae feature extraction methods vary based on different criteria. The different modules involved are as follows.

(A) Fingerprint Sensing

The fingerprint image is sensed by the sensor and the image is loaded to the program. The loaded image is now stored as an array.

(B) Binarization

The input image is segmented to ensure the removal of noise. For this, the image is divided
into blocks of size 16×16 and the variance of each block is computed. The variance is then compared with the threshold value. If the variance of a block is less than the threshold value, then it is deleted from the original figure. This process is carried out for the whole image.

### (D) Core Point Detection

Core point is the uppermost of the innermost curving ridge [3]. The core point is found using the Poincare Index Algorithm. If the value of Poincare index is equal to 360 degree (threshold), it is core point. If the value of Poincare index is greater than 180 degree (threshold) [2], it is delta point The Poincare index is represented as

\[ P_{(G,C)}(i,j) = \sum_{k=0}^{2} \text{angle}(d_k, d_{(k+1)\mod 8}) \]  

### (E) Minutiae Extraction

The minutiae points such as the ridge endings and bifurcations are extracted using the crossing number of pixels algorithm [7]. The crossing number of a pixel in a binary image is defined as half the sum of the differences between pairs of adjacent pixels in the 8-neighborhood. Its value is 1 for termination minutiae, 2 for an intermediate ridge pixel and 3 for a bifurcation or more complex minutiae. Crossing Number of pixels (CN) is calculated using the following formula

\[ cn = 0.5 \sum_{i=0}^{n} | P_i - P_{i+1} + 1 | \]
(F) Region of Interest
This module is improvised from the existing systems so as to reduce the complexity in performance. We take a particular region of interest, different for each image, with reference to the density of the minutiae points around the core point. The region of interest can be made in two ways; either automatic or manual. The second one is based on the end users desire whereas the former is done by the system by analyzing the image and the density and the clarity of the minutiae points.

(Figure 6: Region of Interest)

(G) Orientation
This module comprises of two phases namely, core point axis [10] and Angular normalization. The first phase involves finding the farthest point by measuring the distance of every ridge point from the core point and drawing a line between them. The second phase involves rotating the image such that the core point axis coincides with the Y-axis. The Fig. 3.7a shows the core point axis drawn in the image.

(Figure 7: Core Point Axis)

(H) Matching
The matching phase defines the similarity (angle and centroid) metrics between two fingerprint representations and quantifies it. The quantified value is termed as a similarity or matching score between the two biometric measurements. The similarity metric is based on the concept of correspondence in minutiae-based matching. The proposed system has a separate module for authentication. This module involves getting two fingerprint templates and finding the match score between them. If the match score is greater than 95% then the two fingerprint templates are declared identical else the templates do not match with each other.

III. EXISTING WORKS
The commonly used fingerprint identification system is based on minutiae matching. Only ridge ending and ridge bifurcation minutiae types are used in those systems [6]. The traditional chain code contour chasing algorithm is used for feature extraction. The existing systems are based on the core point detection [3] and the singular point detections [5]. The presence of the singular points with respect to the core points is found. The x, y values of the points is noted. The singular points are thus indexed and the pattern is matched for identification of the Fingerprint [4]. Another existing system was based on the distance between the reference point and the minutiae points viz. ridge endings and ridge bifurcations. The reference point was calculated by the center point algorithm. The distance is stored in an array and this is used for matching.

The traditional algorithms resulted in high FAR and FRR values. Thus the systems did not provide the expected accuracy and security [7]. The system considering the core point and the singular points has a drawback that its complexity is very high and is time consuming. Improvised strategies can be laid to enhance accuracy and the performance.

IV. PROPOSED WORK
We have proposed an algorithm called “TRIANGULARISATION”. The main purpose of this algorithm in fingerprint identification system is to improve the matching accuracy and
performance of the fingerprints, thus providing the highly secured fingerprint identification system. This algorithm attempts in overcoming the drawbacks of the existing fingerprint identification system. The problems with the existing system are as follows:

1. When an image is considered for matching, unwanted region of interest is considered which are of no use while the matching process is done.
2. When the distances are taken into consideration, probability of errors occurs and also redundant values are taken to consideration increasing the complexity in performance wise.

The main objective of the Triangularisation algorithm is to improvise the accuracy as well as the performance of the system. We consider the parameters of the triangles formed from the minutiae and singular points, thus reducing the complexity.

1. The minutiae points and the core point are extracted from the fingerprint image.
2. A particular region of interest is analysed based on the density and clarity of the features with respect to the core point.
3. The orientation of the image is done based on the central axis.
4. The unwanted minutiae points are removed and triangles are formed with the nearest minutiae, having the core point has the common vertex for all triangles.
5. Now the angles formed with the vertex of all the triangles is taken and the matching process is carried out with these parameters.

V. RESULTS AND DISCUSSIONS

The proposed system was tested on Fingerprint database, namely the FVC 2000, FVC 2002, FVC 2004 and FVC 2006. These 4 databases consist of fingerprint images enrolled in TIFF format and the quality of the fingerprint varies. Every user consists of 3 different fingerprint trials included. Each fingerprint varies in position, orientation, quality and impression levels [9]. The proposed system yields 99.69% on an average when compared with every database. The system reduces the False Rejection Rate by normalizing the orientation of the input image and thus increasing the overall accuracy of the system.

<table>
<thead>
<tr>
<th>Databases</th>
<th>Existing System%</th>
<th>Proposed System%</th>
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<tbody>
<tr>
<td>FVC 2000</td>
<td>99.31</td>
<td>99.45</td>
</tr>
<tr>
<td>FVC 2002</td>
<td>99.39</td>
<td>99.47</td>
</tr>
<tr>
<td>FVC 2004</td>
<td>98.91</td>
<td>99.12</td>
</tr>
<tr>
<td>FVC 2006</td>
<td>99.46</td>
<td>99.63</td>
</tr>
</tbody>
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VI. CONCLUSION

The Fingerprint Recognition overcomes the traditional methods of authentication. The existing system has limitations in the complexity and matching performance. The False Rejection Rate is thus higher in those systems [4]. The proposed system overcomes these problems and provides a maximum accuracy.

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References


