AN ADAPTIVE TECHNIQUE FOR FINGER CODE GENERATION USING SEGMENTATION WITH SPFB BASED TECHNIQUE

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Abstract:

Fingerprint recognition and retrieval is a widely used biometric application for identification and security purpose. Various methods has been proposed for fingerprint identification and recognition and each methods has advantage as well as disadvantages that makes the system partially efficient. The complexity in process and other issues affects performance of the existing system and make the system inefficient. In this paper we presented a Singular Point Feature Block [SPFB] based segmentation of fingerprint in the generation of finger code for better recognition. The feature set is generated based on the singularity points such as core point, delta point and reference point and the global feature entropy. In the first phase the orientation field is estimated, singular points are detected and segment the image based on block generation around the singularity points. Hence a finger print code is obtained with singular point feature. In the next phase the feature set is generated and matching is done with various fingerprint images and this method produces an efficient result and cost effective. Euclidean distance is used for distance measure between two image features. The images from the standard image database FVC2004 of DB3 is considered for the experimentation; FRR and FAR has been compute for performance evaluation. This proposed approach is compared with the existing methods and it provides better results.

Keywords: Core Point, Delta Point, Delta Points, SPFB, BP network

1. INTRODUCTION

Today, the security and authentication system is a challenging task in all fields due to the rapid development in the information technology. The functionality of the security system is based on the hardware, software and the combination of both. In earlier days text, numbers and other characters are used as secret codes for security and authentication purpose. Recently, the biometric feature has entered into the security system to make the system more efficient and secure. These biometric features such as fingerprints recognition, IRIS, gait, palm print, voice, Signatures etc., are used for the identification and recognition.

Fingerprint recognition is the most widely used biometric system for human identification. Generally, fingerprints are the pattern of human fingers which are called as minutiae i.e. ridges and valleys. The fingerprint acquisition can be classified into two major techniques (i) Automatic Fingerprint Recognition using online sensors or other devices. (ii) Latent prints are obtained by various Medias such as ink, powder, paper etc, there are mostly used in the crime departments.

There are various types of fingerprint are available such as whorl, left loop, right loop, trend arch, arch etc and the minutiae can be classified as ridge ending and ridge bifurcation. Feature extraction is one of the major processes in fingerprint recognition. To make the recognition process more efficient there is a need for segmentation and to generate a standard finger code with standard feature such as Core Point and Delta. Segmentation can be done with various techniques such as, Morphological operations, linear classification; Region of Interest, Block based approaches, graph based approaches etc. The various methods used for
image segmentation are discussed in the following sections.

2. RELATED WORKS

Askar M. Basin [1] used a method with three pixel features, being the coherence, the mean and the variance. An optimal linear classifier is trained for the classification per pixel, while morphology is applied as post processing to obtain compact clusters and to reduce the number of classification errors. But, this method cannot classify in low quality images. A fingerprint segmentation algorithm [2] based on three new features which are coherence, contrast and main energy ratio was proposed. The classification is take place from a classifier which is a SVM (Support Vector Machine). In order to get an accurate result in classification, a preprocessing is adopted to reduce the influence of noise. This method can classify foreground, back ground and blurred area. Another method [3] used the computational geometry algorithms in the fingerprint segmentation that the extracted feature (characteristic polygon) may be used as a secure and accurate method for fingerprint-based verification This method allows very small false acceptance and false rejection rates, as it is based on specific segmentation. Ratha’s algorithm is used for verification. In this method the images are partitioned into non overlapping blocks.

A linear Classifier model [5] is used for fingerprint image segmentation to evaluating the block features The segmentation uses three block features: the block clusters degree, the block mean information, and the block variance. An optimal linear classifier has been trained for the classification per block and the criteria of minimal number of misclassified samples are used. Morphology has been applied as postprocessing to reduce the number of classification errors and this method supports the high quality images. Xiaosi Zhan et al. [5] used MCMC & GA method for image segmentation. This method generates random sequence of closed curves boundary between fingerprint regions and back ground; the genetic algorithm is used to accelerate the speed. In order to improve the speed and accuracy a Quadatic Surface Model [6] is applied on fingerprint images and evaluate three parameters coherence, mean and Variance and the Back Propagation Neural Network (BPNN) are applied for experimentation.

Usman Akam et al., proposed a method [7] based on boundary gray values and a modified traditional gradient based segmentation technique.

The images are located into blocks and compute the gray values on those blocks with threshold by direction based method. A Vector Field Model [8] for Image segmentation is an approach that performs an object-based rather than a pixel-based analysis of high-spatial resolution image. A multiscale approach for segmenting the pan-sharpened multispectral image based on vector field model. The edge features are obtained using the Gabor bank filtering of each band is fused as multiscale texture features. A robust segmentation algorithm [9] which utilizes the strength of Harris Corners for segmentation. The algorithm employs dynamic thresholding and simple binary operations to provide highly accurate segmentation of the image. It also works effective in segmenting out corrupt areas within the fingerprint image.

Point feature based finger print image segmentation model [10] is used for segmentation. Two kinds pixel features, being the coherence of direction and the variance of gray level are used in the segmentation and fuzzy c-means clustering algorithm is used to select threshold. Morphology technology is applied as post processing to obtain a smooth contour line. The results demonstrate the effectiveness of the method, especially in low quality images, in terms of including less background and excluding less foreground and capable of filtering spurious boundary. It can eliminate the smudged regions separated by meaningful boundary in the segmented fingerprint image. An Ada Boost Classifier [11] is applied for the fingerprint segmentation and in this method two new features, block entropy and block gradient entropy, are computed. Then, an AdaBoost classifier is designed to discriminate between foreground and background blocks based on these two features and five other commonly used features. The problem exist in this method is the segmentation of background and foreground regions is ambiguous and the criteria of classification are only based on visual inspection. A four slap fingerprint segmentation method [12] used a segmentation algorithm to extract multiple fingerprints from a four slap fingerprint image. This algorithm divides each slap image into non-overlapping square blocks and identifies foreground and background blocks using average pixel intensity in that block. Blocks are joined to find the foreground block's connected components. Finally clusters containing finger-tips are selected using geometric characteristics of a finger.
Krzysztof Mieloch et al., [13] proposed a method for reconstructing the low quality areas of the fingerprint image used and a structural information is applied for improving the segmentation and connecting the disrupted fingerprint lines to recover the missing minutiae. An Enhanced Gabor filtering method [14] is used for area detection and extraction of minutiae and a semantic conformance testing for minutiae data. In this method the segmentation in of fingerprint is less effective. An improved automated labelling based linear neighbourhood propagation method [15] is used for segmentation by combines the variance with the gradient magnitude to exactly label partial block of LNP. IALNP provides a more robust automatic labeling mechanic, which combines the variance with gradient magnitude to exactly label partial blocks for LNP learning.

An enhanced active contour based segmentation [16] for finger print extraction with region growing and active contour process. Region growing algorithm is used as a preliminary segmentation process to obtain initial seeds for active contour algorithm. These results are then used by the active contour model to segment the fingerprint image from its background. As active contours always provide continuous boundaries of sub-regions, they can produce more reasonable segmentation results than traditional segmentation methods. Due to the various issues in the existing system in complexity in the process, more process time and low accuracy. In order to overcome the issues in the existing system, we proposed Singular Point Feature Block based technique for fingerprint image segmentation in the generation of finger code for fingerprint recognition

3. METHODOLOGY

Various methods have developed for fingerprint recognition; especially for segmentation of fingerprints is one of the important tasks in the fingerprint recognition system. The existing methods have merits and demerits in the segmentation process. Mostly, the segmentation process is done to segment the foreground and background, it leads to the loss of features. In some methods the segmentation take place on block based, region based, graph based and pixel based approaches. Hence, to fulfil the drawbacks in the existing system, we propose a Singular Point Feature Block based technique for fingerprint image segmentation in the generation of finger code with the singular features such as Reference point, Core point and Delta point. A global feature Entropy is computed as an additional feature which supports in the matching process in the absence of core point and delta point. The block diagram of the proposed technique is presented in the following figure.

![Block Diagram](image)

**Fig 3.1 Block Diagram**

From the above Figure 3.1 shows the entire segmentation process of the proposed technique and the main task this system is as follows:
- Estimation of Orientation field
- Singular point Detection
- Finger code generation
- Feature Extraction

The detailed description of the entire segmentation process is presented in the following sections.

3.1 Direction and Orientation Field Estimation.

An important task in the singular point detection is the estimation of orientation field for fingerprint segmentation. Let \( \theta \) be defined as the orientation field of a fingerprint image. \( \theta(i, j) \) represents the local ridge at pixel \((i, j)\). Local ridge is specified for a block rather than that of every pixel. An image is divided into a set of non-overlapping blocks of size \( w \times w \) and each block holds a single orientation. The estimation of orientation field is computed based on least square mean square algorithm is summarized as follows [19][20]. The local ridge is specified for a block rather than that of every pixel. An image is divided into a set of non-overlapping blocks of size \( w \times w \) and each block holds a single orientation. The estimation of orientation field is computed using the following equations.

\[
V_x(i,j) = \frac{\sum_{u=-w/2}^{i+w/2} \sum_{v=-w/2}^{j+w/2} 2\partial_x(u,v)\partial_y(u,v)}{\sum_{u=-w/2}^{i+w/2} \sum_{v=-w/2}^{j+w/2} \partial^2_x(u,v)\partial^2_y(u,v)} \quad (3.1)
\]

\[
V_y(i,j) = \frac{\sum_{u=-w/2}^{i+w/2} \sum_{v=-w/2}^{j+w/2} 2\partial_x(u,v)\partial_y(u,v)}{\sum_{u=-w/2}^{i+w/2} \sum_{v=-w/2}^{j+w/2} \partial^2_x(u,v)\partial^2_y(u,v)} \quad (3.2)
\]
Subsequently,
\[
\theta(i, j) = \frac{1}{2} \tan^{-1} \left( \frac{V_y(i, j)}{V_x(i, j)} \right) \quad \ldots (3.3)
\]
Here, the \( \theta(i, j) \) is the least square estimate of the local ridge orientation of the block centered at pixel \((i, j)\). The local ridge orientation varies slowly in a local neighborhood where no core point appears. The discontinuity of ridge and valley due to noise could be softening by applying a low pass filter. The smoothed orientation field (local ridge orientation at \((i, j)\)) can then be computed as follows:
\[
\theta'(i, j) = \frac{1}{2} \tan^{-1} \left( \frac{\theta_y(i, j)}{\theta_x(i, j)} \right) \quad \ldots (3.4)
\]

### 3.2 Reference Point Location

A point of a fingerprint as a point of maximum curvature of ridges in the fingerprint image and reference axis is defined to be the axis if local symmetry at the reference point as shown in fig.3.2 [17].

**Fig.3.2 Reference point representation**

Many previous approaches are used to determine the reference point \((x_c, y_c)\) critically relied on the local features like Poincaré index and some other similar properties of the orientation field. Reference point detection method [18] is based on the fact that the reference point is invariant to geometrical transformations. To locate a reference point in a real plane, as a point \((x, y)_{ref}\) that gives maximum value of closed contour integral over the vector field \(D\), viz.

\[
(x, y)_{ref} = \arg \max_{x_0, y_0} R_{x_0 y_0}(\bar{D}) \quad \ldots (3.5)
\]

Where \( \bar{D} = \frac{D}{|D|} = (-\cos 2\theta, -\sin 2\theta) \) estimated for a fingerprint image, and let the closed contour \(L\) be a boundary of \(D\), which is a real plane centered in the point \((x_0, y_0)\).

The reference point lies on the ridge that bends maximum and the bend is also characterized by the high circulation of the field \(d\) along this ridge \(L\) which is the boundary of \(D\) and is calculated using Green’s formula as follows.

\[
\oint_L \bar{v} dx + \bar{u} dy = \iint_D (\bar{u}_x - \bar{v}_y) dxdy \int_D k(d) dxdy
\]

The circulation is equal to the curvature sum of \(d\) in area \(D\) and the area of the maximum curvature the ridges bend at most and the vector field of a fingerprint is characterized by the parallel flow lines. The reference point is detected as per the equation (6) in which the point of maximum curvature is equal to the searching for point where integral \(R_{xy}(\bar{D})\) reaches its maximum. The reference point of the fingerprint image is defined as follows.

\[
(x, y)_{ref} = \max_{x_0, y_0} R_{x_0 y_0}(\bar{D}) = \oint L \bar{v} dx + \bar{u} dy = \iint_D (\partial_x \bar{U} - \partial_y \bar{V}) dxdy \quad \ldots (3.6)
\]

The discrete analog of the formula reads as

\[
R_{x_0 y_0} = \sum_D \nabla_y (\cos 2\theta_{xy}) - \nabla_x (\sin 2\theta_{xy})
\]

where \(D\) is \(N \times N\) window centered in the point \((x_0, y_0)\) and \(L\) its envelope.

### 3.3 Core point and Delta point detection

In the process of singular point detection such as Core point, Delta Point it is necessary to compute the Poincare index. The Poincare index [21] which is derived from continuous curves and a core point has a Poincare index value as 1/2 and a delta point as -1/2.

Let \(\theta(x, y)\) denote the direction of the pixel \((x, y)\) in a fingerprint image of size \(M \times N\). The Poincaré Index at pixel \((x, y)\) which is enclosed by a digital curve (with \(N\) points) can be computed as follows:

\[
Poincare(x, y) = \frac{1}{2\pi} \sum_{k=0}^{N-1} \Delta(k) \quad \ldots (3.7)
\]

\[
\Delta(k) = \begin{cases} 
\partial(k) & |\partial(k)| < \frac{\pi}{2} \\
\partial(k) + \pi & \partial(k) \leq -\frac{\pi}{2} \\
\pi - \partial(k) & \partial(k) \geq \frac{\pi}{2}
\end{cases}
\]

\[
\theta(x, y) = \theta (x_{(k+1) \mod N}, y_{(k+1) \mod N}) - \theta (x_k, y_k)
\]

and it goes in a counter-clockwise direction from 0 to \(N-1\). The Poincaré Index is computed at pixel in the \((i, j)\) with the Poincaré index and the corresponding value is \(Poincare(i, j)\). In order to calculate simply, the direction yards from 0 to 7 is used to compute the Poincaré Index.

\[
(k) = \begin{cases} 
\partial(k) & |\partial(k)| < \frac{\pi}{2} \\
\partial(k) + \pi & \partial(k) \leq -\frac{\pi}{2} \\
\pi - \partial(k) & \partial(k) \geq \frac{\pi}{2}
\end{cases}
\]

The core point is detected if the value of Poincare \((x, y) = +0.5\), and in case of delta point the value of
Where \( R \) as per following equation.

\[
\Delta \text{point} \text{, Similarly, } R \text{ coordinate of the reference point, core point and delta point. The minimum of } i \text{ and } j \text{ and maximum value of } i \text{ and } j \text{ are estimated to construct the block around the singular point. The SPFB Block is constructed by finding the } i_{\text{min}}, j_{\text{min}}, i_{\text{max}}, j_{\text{max}} \text{ of the singular point which are obtained and shown in the equation . The } i_{\text{min}}, j_{\text{min}}, i_{\text{max}}, j_{\text{max}} \text{ are computed as per following equation.}
\]

\[
i_{\text{min}} = \min\{R_{pi}, C_{pi}, D_{pi}\} \quad \text{if } i \geq 0
\]

\[
i_{\text{max}} = \max\{R_{pi}, C_{pi}, D_{pi}\} \quad \text{if } i \geq 0
\]

\[
j_{\text{min}} = \min\{R_{pj}, C_{pj}, D_{pj}\} \quad \text{if } j \geq 0
\]

\[
j_{\text{max}} = \max\{R_{pj}, C_{pj}, D_{pj}\} \quad \text{if } j \geq 0
\]

Where \( R_{pi}, C_{pi} \text{ and } D_{pi} \) are the row value i.e x coordinate of the reference point, core point and delta point. Similarly, \( R_{pj}, C_{pj} \text{ and } D_{pj} \) are the column value i.e y coordinate of the reference point, core point and delta point. The minimum of i and j and maximum value of i and j are estimated to construct the block around the field and the singular points are marked. A singular point block is constructed by finding the minimum and maximum of row, column of the obtained singular points. The block is constructed round the extracted singular points a threshold constant k is used to increase the boundary of the block. The coordinate values are estimated with the min and max i,j value among the obtained features. The initial top most left and right point; bottom most left and right point. These points are initiated and pointed with the following equations. Let us consider the threshold value k for the boundary of the block and the block is constructed with the following equation 3.9.

\[
TL(i, j) = \{i_{\text{min}} - k, j_{\text{min}} - k\}
\]

\[
TR(i, j) = \{i_{\text{min}} - k, j_{\text{max}} + k\}
\]

\[
BL(i, j) = \{i_{\text{min}} + k, j_{\text{max}} - k\}
\]

\[
BR(i, j) = \{i_{\text{min}} + k, j_{\text{max}} + k\}
\]

Where k is the constant, TL, TR, BL, BR are the boundary marks of the block it shows the four corners which bounds the singular point features within the block.

### 3.4.2 Extraction of singular point features

A Local Triangle is constructed between the singular points and computed the angle of each singular points in the generation feature set. The block of the matching is the local triangle feature of the fingerprints.

\[
FT_k = \{d_{ij}, d_{ik}, d_{jk}, \psi_i, \psi_j, \psi_k\}
\]

where \( d_{ij} \) denotes the distance between singular points and i,j is the Reference point and core point i.k between reference point and delta point and j,k between core point and delta point \( \psi_i, \psi_j, \psi_k \) indicates the angle between the singular points. The angle values are estimated and stored in a feature set as in the following equation (3.11).

\[
F_{SP} = \{R_{p\theta}, C_{p\theta}, D_{p\theta}\}
\]

From the above mentioned equation for feature set generation Fs is not sufficient for the image matching or retrieval in the absence of core point or delta point, Hence we estimated feature entropy which is presented below.

**Entropy feature:**

The entropy is a measure of the average information of an image and the background regions of the fingerprint has lower entropy and the fingerprint with clear ridges and valleys has higher entropy. this features is used for feature extraction for more accuracy and it is defined in the equation 3.12.

\[
H_s = -\sum_{k=0}^{255} P_k \log P_k \quad \text{ ... (3.12)}
\]

where

\[
P_k = \frac{n_k}{\omega \times \omega} \quad \text{and } n_k \text{ is the number of all pixels whose gray value equals to } k. \text{ So } P_k \text{ indicates the probability that the gray level } k.
\]

The Singular point features and the entropy features are concatenate to establish a feature set for
fingerprint matching and retrieval as presented in the following Equation.

$$FS_{SP} = \{R_p, C_{\theta}, D_{\theta}, E_n\} \quad \text{... (3.13)}$$

Where $$R_p, C_{\theta}, D_{\theta}$$ are angular values of the singular points and $$E_n$$ is the entropy value of the image.

4. Similarity and Performance measures

To find the similarity measures between the images, various metrics are used to measure the distance between features of the images. Some of the well known distance metrics used in for image retrieval are presented below.

**Euclidean Distance**

The Euclidean Distance $$d_E(x_1, x_2)$$ is calculated as below

$$d_E(x_1, x_2) = \sqrt{\sum_{i=1}^{n} (x_1(i) - x_2(i))^2} \quad \text{... (4.1)}$$

where $$x_1(i)$$ is the feature vector of input image $$i$$, and $$x_2(i)$$ is the feature vector of the target image $$i$$ in the image database.

4.1.1 False Rejection Rate (FRR)

The False Rejection Rate is computed to evaluate the performance of the fingerprint matching in which the number of genuine fingerprints is rejected during the matching process with the genuine fingerprints images. The idea behind this parameter is if the system should accept the genuine and reject the false fingerprints and it is formulated as follows

$$FRR = \frac{\text{No. of genuine images rejected}}{\text{Total Number of genuine sets}} \times 100 \quad \text{... (4.2)}$$

4.1.2 False Acceptance Rate (FAR)

The False Acceptance Rate is computed to evaluate the performance of the fingerprint matching in which the number of imposter fingerprints is accepted during the matching process with the genuine fingerprints images. The idea behind this parameter is if the system should reject the imposter fingerprints and it is formulated as follows

$$FAR = \frac{\text{No. of imposter images accepted}}{\text{Total Number of imposter Tests}} \times 100 \quad \text{... (4.3)}$$

5. Algorithm

The segmentation process of the fingerprint images is take place in two phases and defined as Algorithm I and algorithm II. In algorithm I results in the singular point detection and in the generation of finger code. In algorithm II the fingerprint matching is take place and the FAR and FRR has estimated and are as follows.

5.1 Algorithm - I

**Input**: Fingerprint Image  
**Output**: Feature set

//Generation of finger code with Singular points//

**Step 1**: Select an input image $$I$$ of size $$M \times N$$

**Step 2**: Divide the input image $$I$$ into non-overlapping blocks with size $$w \times w$$.

**Step 3**: Compute the gradients $$\delta x(i, j)$$ and $$\delta y(i, j)$$ at each pixel $$(i, j)$$ which is the center of the block.

**Step 4**: Estimate the local orientation using the following eqn. 3.1 to eqn. 3.4 as discussed in the earlier section.

**Step 5**: Compute the reference point using the equation (3.6) as discussed in the earlier section.

**Step 6**: Compute the core point and Delta point using the equation (3.7) as discussed in the earlier section.

**Step 7**: Construct the finger code with the equation 3.9 as discussed in earlier section.

**Step 8**: Establish feature set with the equation 3.13

**Step 9**: Repeat step 1 to step 9 for all images in the Database

**Step 10**: Stop

Algorithm - II

**Input**: Target Image  
**Output**: Fingerprint Matching

// Fingerprint Matching//

**Step 1**: Select the target image $$L$$ of size $$M \times N$$ and divide into $$m \times n$$ block.

**Step 2**: Repeat step 3 to step 9 as in the algorithm 1

**Step 3**: Compute the Euclidean distance between the target image and the image set for matching using the equation 4.1

**Step 4**: Compute the FRR and FAR using the equation 4.2 and equation 4.3

**Step 5**: Stop

6. Experimentation and Results:

The proposed Singular Point Feature Block (SPFB) based technique is experimented with the images collected from the standard fingerprint data
base FVC 2004. The fingerprint images considered in this experiment are of size (M × N) with pixel values in the range 0 – 255. Some of the sample fingerprint images considered in the experimental part from the FVC2004 database is presented in the figure 6.1.

**Fig.6.1 Samples images of DB3 of FVC 2004 standard Database**

Each fingerprint code image is subjected to the above mentioned singular point feature extraction process with the proposed Singular Point Feature Block based technique. First, the image under analysis is partitioned into $k$ blocks, each block of size $(m \times n)$. Then the orientation field of the image is estimated with the algorithm – I to identify the directional flow of the image which is find the singular points. The Reference Point, Core point and Delta point are detected with the angular difference between them are computed in the generation of feature sets with the algorithms.

Let us consider the image 101_2 and it is divided into block of size $3 \times 3$ then the orientation file has estimated with the equation 3.1 to 3.4 of the proposed algorithm-I. After the estimation of the orientation field the singular point features are extracted with the equation 3.6 for reference point and 3.7 for core point and delta point. Then the fingerprint code was generated by constructing the block and normalize the block using the equation 3.9. The feature set of the singular point feature are extracted with the equation 13 and the angular features of the image 101_2 is presented $(F_{SP})$.

$$F_{SP} = \{35, 135, 10\}$$

In addition to the above features, the entropy features are calculated and are given below:

$$E_n = \{4.0731\}$$

The extracted feature set $F_e = \{F_{SP}, E_n\}$ of the target image 101_2 is obtained as:

$$F_e = \{35, 135, 10, 4.0731\}$$

In Matching and recognition process the features of the image is compared with each images of the same finger in the standard image database FVC2004 DB3 and the results are shown in the table 6.1 and 6.2.

**Fig 6.2 Segmented finger code**

The experimented values of the fingerprints with the proposed model is tabulated in the following tables and the performance are evaluated with the existing the minutiae based model and correlation based model.

**Table 6.1 Matching Rate of Genuine Fingerprints**

<table>
<thead>
<tr>
<th>MODEL</th>
<th>MATCH</th>
<th>NON-MATCH</th>
<th>ACCEPTANCE %</th>
<th>REJECTION %</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPFB</td>
<td>264</td>
<td>56</td>
<td>82.50</td>
<td>17.50</td>
</tr>
<tr>
<td>MINUTIAE</td>
<td>175</td>
<td>145</td>
<td>54.69</td>
<td>45.31</td>
</tr>
<tr>
<td>CORRELATION</td>
<td>180</td>
<td>140</td>
<td>56.25</td>
<td>43.75</td>
</tr>
</tbody>
</table>

**Table 6.2 Rejection Rate of the Imposter Fingerprints**

<table>
<thead>
<tr>
<th>MODEL</th>
<th>MATCH</th>
<th>NON-MATCH</th>
<th>ACCEPTANCE %</th>
<th>REJECTION %</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPFB</td>
<td>136</td>
<td>364</td>
<td>27.20</td>
<td>72.80</td>
</tr>
<tr>
<td>MINUTIAE</td>
<td>192</td>
<td>308</td>
<td>38.40</td>
<td>61.60</td>
</tr>
<tr>
<td>CORRELATION</td>
<td>207</td>
<td>293</td>
<td>41.40</td>
<td>58.60</td>
</tr>
</tbody>
</table>

From the above table 6.1 the False Reject Rate for the genuine fingerprints and the genuine acceptance is 82.50 % for the proposed technique and 54.69 % and 56.25 % for minutiae and correlation model respectively. Similar, the False Acceptance Rate FAR the Rejection of imposter prints of the proposed technique provides 72.80%, 61.60 % and 58.60 % for the minutiae and correlation model. Compared to the table 6.1 and 6.2 the proposed technique provides less genuine rate and higher imposter rejection rate. The pictorial representation of the experimentation and its performance evaluation are presented in the fig.6.3 fig 6.4 and are presented below.

**Fig.6.3. Performance evaluation of FRR**
In this paper, a new Singular Point Feature Block (SPFB) based approach in the generation of finger code and the extraction of singular point feature has been proposed. The estimation of orientation fields has been computed for the detection of core and delta points. The reference is detected and then the core and delta points are detected with the Poincare index method. Finally, the finger code has generated with the proposed SPFB technique and the angular features of the singular point are extracted. In addition to that, the entropy feature has been computed for better recognition. The proposed model is experimented with standard fingerprint image database FVC 2004. The performance is evaluated using FRR and FAR and compared with the existing correlation and minutiae based models. Finally, the proposed model provides better accuracy among the existing ones. Hence, we conclude that the proposed model is a best one.

**REFERENCES**


