Fingerprint Based Gender Identification Using SVM

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Abstract- *Fingerprint is an impression left by human finger. Due to the secretion of sweat, the fingerprints are easily imprinted on to the surface of the objects Example: Glass or metal. Human fingerprints are rich in details called minutiae, which can be used as identification marks for fingerprint verification. This project develops a complete system for fingerprint verification through extracting and matching minutiae. To achieve good minutiae extraction in fingerprints with varying quality, pre-processing in form of image enhancement and binarization is first applied on fingerprints before they are evaluated. An alignment-based elastic matching algorithm i.e., SVM(Support Vector Machine) has been developed for minutiae matching. This algorithm is capable of finding the correspondences between input minutia pattern and the stored template minutia pattern without resorting to exhaustive search.*

Keywords- Fingerprint, Ridge, Gender identification, SVM, Minutiae.

I. INTRODUCTION

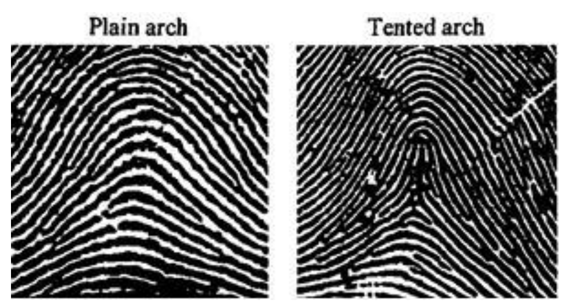
A **Fingerprint** recognition is one of theoldest and most reliable biometric used for personal identification. Fingerprint recognition has been used for over 100 years now and has come a long way from tedious manual fingerprint matching. The ancient procedure of matching fingerprints manually was extremely cumbersome and time-consuming and required skilled personnel.

Finger print in its narrow sense is an impression left by the friction ridges of a human finger. The fingerprint is an epidermis of the finger and consists a pattern of ridges and valleys. The endpoints and bifurcation points of ridges are called minutiae. The uniqueness of a fingerprint is due the minutiae pattern. A fingerprint is something that remains same over the time and is independent of all the body changes that takes place over the years. This is why it is often referred as the permanent identification mark for a human and is used in many applications like: civilian, industrial, commercial, forensic application and as unique Id of nation as AADHAR with the help of a biometric scanner. It is also used to authenticate access to devices like laptops, smartphones, employee attendance, etc with the use of a fingerprint scanner.

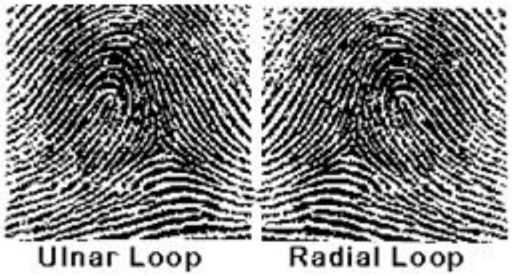
The hidden data in the fingerprints gives information about gender, origin, face sketch, environment, age, genetic diseasesetc.

Gender identification of person can be done based on the fingerprints, with the help of ridges of fingerprints which serves as the main feature. It is found that the average ridge density is higher in women than men. There are three main fingerprints patterns: arches, whorls and loops which constitutes about 5%, 30-35% and 60-65% of the total fingerprint pattern respectively.

In arches, the ridges run from one side to the other side of the pattern making no backward turn. A wave-like pattern is created. There are two types in this: plain arches and tented arches.



In loops, one or more of the ridges enter on either side of the impression, re-curves, touches or crosses the lineand terminatesin the direction of the ridge entered. There are two types: radial loops and ulnar loops.

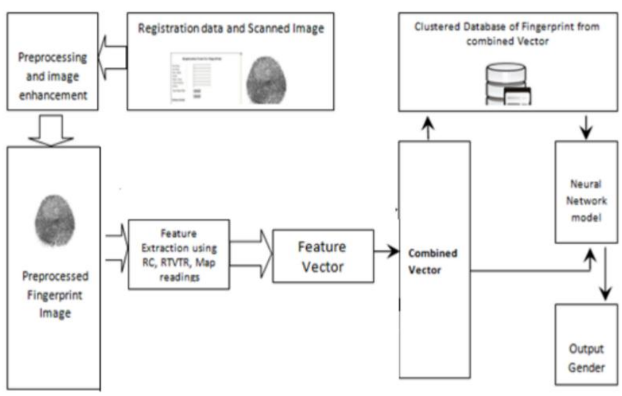


In whorls, a spiral or a circular pattern is formed. There are four types in this: plain whorl, double loop whorl, central pocket whorl and accidental whorl.

To match the fingerprints, there are different fingerprint matching techniques. They are **1. correlation-based matching 2. Minutiae-based matching 3. Pattern-based (or image-based) matching.**

This paper deals with Minutiae-based matching technique.

II. SYSTEM DESCRIPTION



III. METHODOLOGY

Figure 1 shows the methodology for gender identification using fingerprint images. Each of the 15 fingerprints of a subject is collected. Pre-processing techniques like binarization and enhancement are performed on the fingerprints in the next stage. The relevant features that can distinguish gender from fingerprints are extracted by applying different image processing techniques.

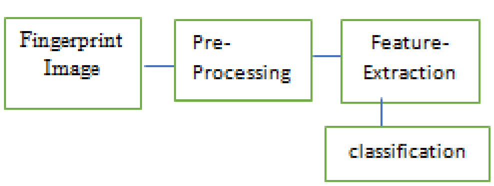


Figure 1: Block Diagram of system

The final step is to train the SVM classifier with the extracted known data values which later classify the unknown fingerprints as a male or female fingerprint. In pattern recognition and in image processing, Feature extraction is a special form of dimensionality reduction. Transforming the input data into the set of features is called features extraction. If the features extracted are carefully chosen it is expected that the feature set will contain relevant information from the input data in order to perform the desired task using this reduced representation instead of the full-size input.

The two major features that are significant for gender classification using fingerprint images are:

- Ridge Thickness to Valley Thickness Ratio (RTVTR).
- Ridge Density.

Theoretical overview of Ridge Orientation

Ridge orientation is the process of obtaining the angle of the ridges throughout theimage. Ridge orientations are calculated on a block-basis for a WxW block. W is generally equal to 16.

The first step in ridge orientation is the calculation of gradients at each pixel of the image. The gradients $G_{x(i,j)}$ and $G_{y(i,j)}$ are calculated using the Sobel Operator. The Sobel operator is given as follows:

$$G_{x(i,j)}=((A_2+KA_3+A_4)-(A0+KA7+A6))/(K+2)$$
$$G_{y(i,j)}=((A_0+KA_1+A_1)-(A_6+KA_5+A_4))/(K+2)$$

where K=2 for the Sobel Operator. The meanings of the pixels Ai are given as follows:

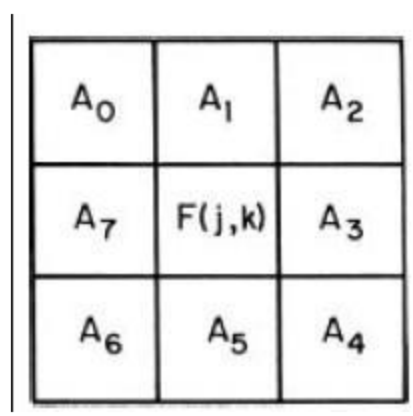


Fig. 2

The next step in ridge orientation involves using the gradient values of all these pixels to calculate the ridge angle for a W*W block as follows:

$$\theta_o = \frac{1}{2}\tan^{-1}\left(\frac{\sum_{i=1}^{W}\sum_{j=1}^{W} 2G_x(i,j)G_y(i,j)}{\sum_{i=1}^{W}\sum_{j=1}^{W}\left(G_x^2(i,j) - G_y^2(i,j)\right)}\right)$$

Due to the presence of noise, corrupted ridge and valley structures, minutiae, etc. in the input image, the estimated local ridge orientation, $q(i, j)$, may not always be correct. Since local ridge orientation varies slowly in a local neighborhood where no singular points appear, a low-pass filter can be used to modify the incorrect local ridge orientation. In order to perform the low-pass filtering, the orientation image needs to be converted into a continuous vector field, which is defined as follows:

$$\Phi_x(i, j) = \cos(2\theta(i, j)),$$

$$\Phi_y(i, j) = \sin(2\theta(i, j)),$$

This continuous vector field is passed through a low-pass Gaussian type filter in order to get the improved the orientation image. Finally, the local orientation is calculated from the filtered vector field by using the following formula:

$$O(i, j) = \frac{1}{2}\tan^{-1}\left(\frac{\Phi'_y(i, j)}{\Phi'_x(i, j)}\right)$$

Minutiae Extraction

Our implementation of fingerprint identification and verification is based the topological structural matching of minutiae points. We only consider two kinds of minutiae; ridge endings and bifurcations as shown in the following figure:

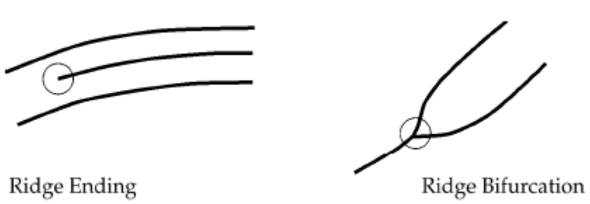
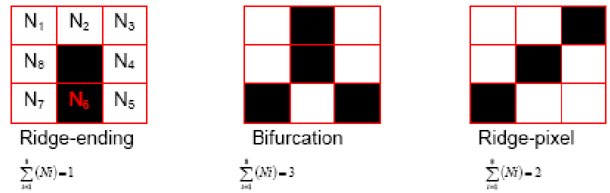


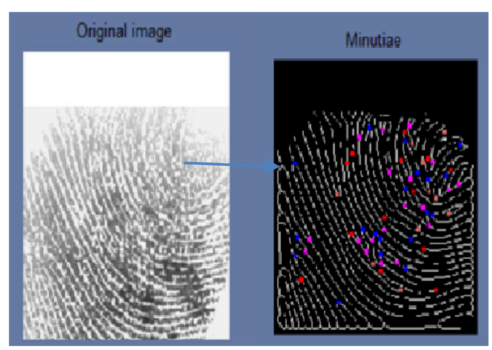
Figure. 3 Ridge endings and bifurcation

Minutiae extraction from a perfectly thinned ridge-map of a fingerprint image is a trivial task. All we need to do is to count the number of ridge pixels, every ridge pixel on the thinned image is surrounded by and depending on the following rule, and we can assign the minutiae points to those pixels:



However, due to noise, limitation on image acquisition, skin deformations etc the fingerprint image obtained is never ideal. As a result,there are a lot of spurious minutiae that crop up if we simply follow the above approach to minutiae detection. To solve the problem, various heuristics have been proposed and we have implemented the following rules to remove most of the spurious minutiae, resulting from noise in the thinned image:

- If several minutiae form a cluster in a small region, then remove all of them except forthe one nearest to the clustercenter.
- If two minutiae are located close enough, facing each other, but no ridges liebetween them, then remove both ofthem.



IV. EXPERIMENTAL RESULTS

The main features are extracted from male and female fingerprints and system was trained to identify the gender of that fingerprint using those features and ridge counts.

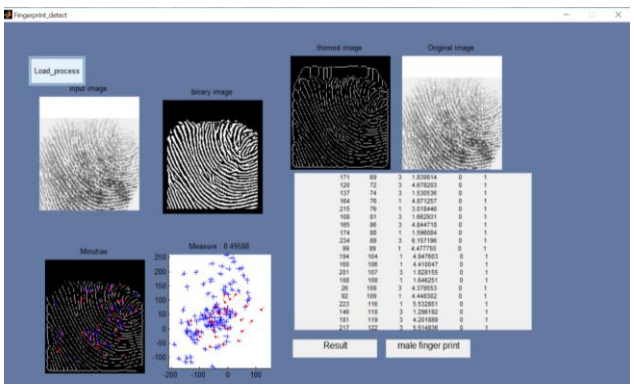
Some male and female fingerprints.

Figure 4: Female Fingerprints

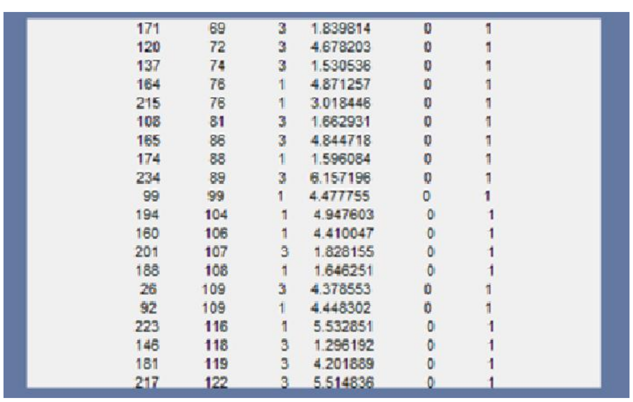
Figure 5: Male Fingerprints

Testcase 1: System has to identify the gender of the fingerprints from the **database**.

Result 1:



Features Extracted: RTVTR table.

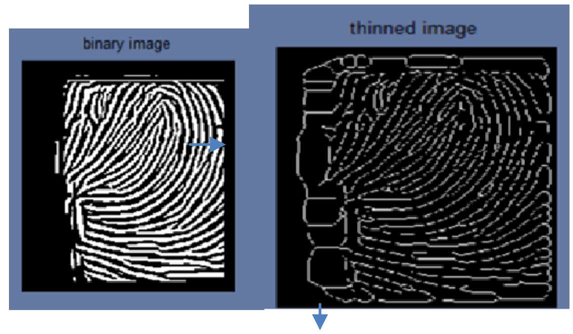


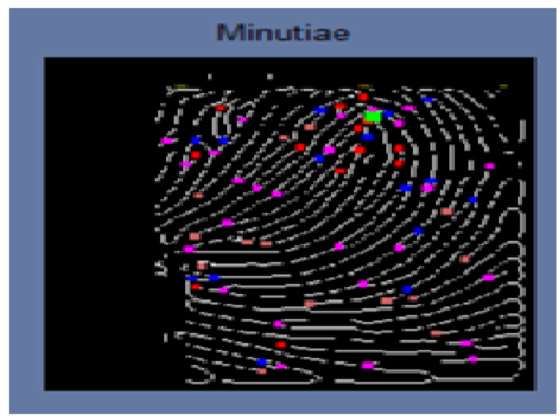
171	69	3	1.839814	0	1
120	72	3	4.678203	0	1
137	74	3	1.530536	0	1
164	76	1	4.871257	0	1
215	76	1	3.018446	0	1
108	81	3	1.662931	0	1
165	86	3	4.844718	0	1
174	88	1	1.596084	0	1
234	89	3	6.157196	0	1
99	99	1	4.477755	0	1
194	104	1	4.947603	0	1
160	106	1	4.410047	0	1
201	107	3	1.828155	0	1
188	108	1	1.646251	0	1
26	109	3	4.378553	0	1
92	109	1	4.448302	0	1
223	116	1	5.532851	0	1
146	118	3	1.296192	0	1
181	119	3	4.201889	0	1
217	122	3	5.514836	0	1

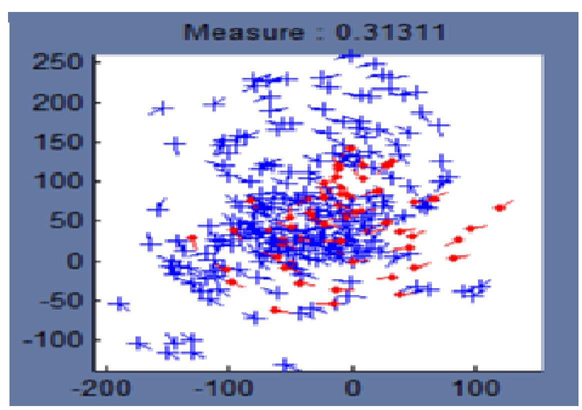
Test Case 2:

Live Demonstration

Fingerprint will be scanned from SYDemo fingerprint scanner and that will be stored in database and will be tested.

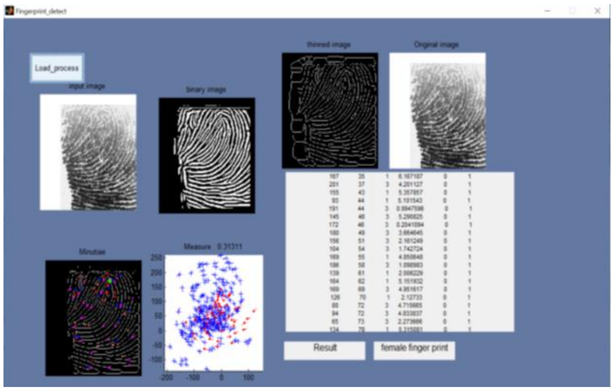






Expected Output: FEMALE FINGERPRINT

Final Result 2:



Obtained Output: FEMALE FINGERPRINT

V. CONCLUSION

The algorithm of the proposed system is written in MATLAB R2014. Here, this paper proposed a method for Gender Classification of fingerprints using SVM technique.

The success rate is **100% for database** and more than **70% for live demonstration.**Better result will be obtained for live demonstration with fingerprint scanners of great accuracy and large memory. An algorithm for compressing the huge database of fingerprints has to be developed and the database of the feature vectors have to be coded to provide a simpler database structure to reduce the complexity in calculations.

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