



Fingerprint Reconstruction from Ridge Endings-Bifurcations

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Abstract— *The set of distinct features are extracted from the fingerprint that is ridge endings and bifurcations called as (minutiae). Each fingerprint has unique pattern so it is strong biometric in the forensic department. Various apparatus are used in fingerprint science like video spectral comparator, Laser print finder, microscope, comparison projector, latent print kit box, magnifying glass and Iodine fuming chamber etc.,. Novel technology introduced to extract most distinct feature as ridge endings and bifurcations. Minutiae are local discontinuities in the fingerprint pattern, mainly terminations and bifurcations. Curved Gabor filters are applied to the curved ridge and valley structure of poor-quality fingerprint images. The Region of Interest (ROI) is that part of the image which catches our attention instantly than the other. Recognize the pattern with fingerprint in database and matching the pattern. Clustering the similar pattern and extract minutiae points (ridge endings and bifurcations) then validate with the original image. These methods show improvement in the (ridge endings and bifurcations) detection process in terms of time required and efficiency.*

Keywords— *minutiae curved Gabor Filter, bifurcations, ROI.*

I. INTRODUCTION

Fingerprint is most distinct features in the forensics department early stages the fingerprint is used only for salary issues and arts. In 18th century only the scientist proved fingerprint has distinct features and its more unique even same person have 10 distinct fingerprints so it is easy method to find the personality who involved in crimes. The ridge doesn't change over the life time and if any skin diseases after some days it will create the same pattern ridges. We can extract minutiae points until the epidermis damage. In crime area we cannot get the whole fingerprint, some partial fingerprint may be available, after the pre-processing we can extract the feature. In pre-processing technique the fingerprint must be analysed and improve the quality of the fingerprint if it is latent. In early stage ink method is used to get the fingerprint now the technology are improved and population increased exponentially so that computerized is introduced and more algorithm and techniques followed to improve the accuracy of finding criminals. Minutiae extraction is challenging technique and removing false minutiae is improved the accuracy of input image. Curved Gabor filters are applied to the curved ridge and valley structure of poor-quality fingerprint images. Curved Gabor filters used to locally adapt their shape to the direction of flow. Edge detection is a general way of automatically segment image by some method. Here canny edge detection method is used to segment the image because it provides the internal part of the data that is ridges must be shown at high quality.

II. OBJECTIVE

The main goal is fingerprint reconstruction, improving poor quality images into high quality to extract the minutiae points. One fingerprint cannot be matched with another fingerprint of same hand so minutiae are distinct feature it is easy to identify the personality.

III. STEPS IN MINUTIAE EXTRACTION

- Canny edge detection
- Segmentation
- Normalization
- Cs filter
- Binary image
- Skeleton image
- Minutiae extraction

Canny Edge Detection

Edge detection technique is used to remove the noise from the image. Canny edge detection is familiar technique to remove the noise and produce the smoothed fingerprint. Filter is applied to find the edge gradient and direction of the each pixel (minutiae points). according to the gradient magnitude and direction, eliminate the unwanted pixels within the edge. Sobel operator is used in existing, it extract only the boundaries of the object but canny edge detection extract the internal structure of the object including the boundaries. In medical application bone structure can be identified by canny edge detection method. Fingerprint also has ridges as internally so canny is suitable method to extract the features.



Figure 1: canny edge detection image

Segmentation:

Segmentation is used to locate the objects and boundaries in the image. This method Convert the grey scale image into black. The ridges are cleared and it is easy to recognize the pattern. Segmenting the fingerprint as foreground region and background region and filtering is applied at foreground region because the background region has noise.



Figure 2: segmenting the fingerprint image

Normalization:

Normalization technique is used to remove the redundant pixel and overwrite ridges, it produces the clear quality images. Normalization is also called as contrast stretching and histogram stretching because changing the pixel intensity values due to glare The moisture and scars of a finger as well as the pressure due to a fingerprint sensing could distort the quality of the acquired fingerprint image.

Curved gabor Filter:

Curved Gabor filter is for fingerprint image quality enhancement. Curved gabor filter is used to detect the edge or boundaries in the fingerprint image in terms of frequency and orientation similar to human visual system. It is effective fingerprint image enhancement method.

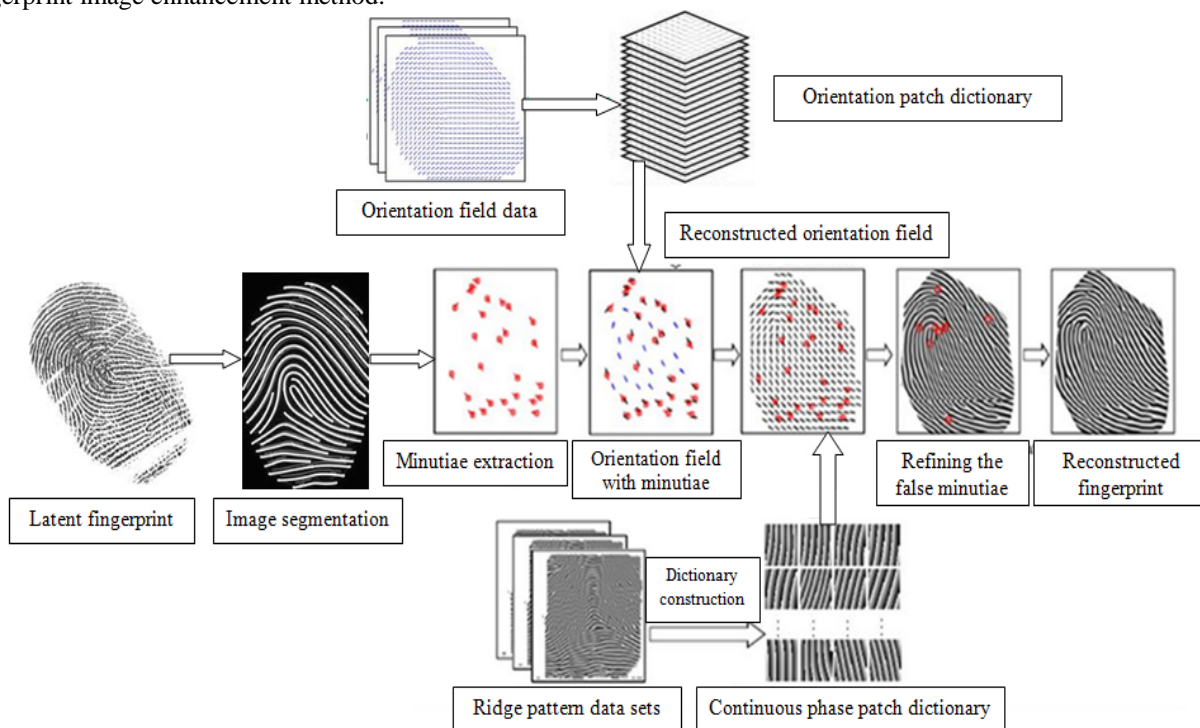


Figure 3: Architecture diagram for reconstructing fingerprint from minutiae

Binary Image:

The fingerprint image is converted 8 bit greyscale image into 1's and 0's for computer readable. Binarization technique is used to get the good quality image from latent image because the latent fingerprint does not clear ridges and furrows in fingerprint so we need to binarize the image by specify the ridges as 0's and furrows as 1's. The most important steps to fingerprint recognition is binarization and thinning process it is called pre processing technique to extract the feature.

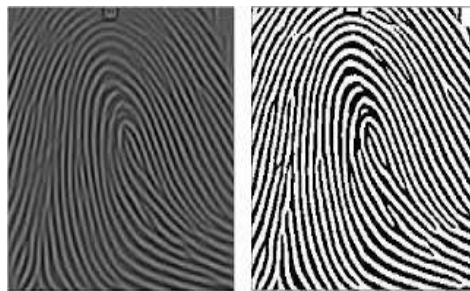


Figure 4: greyscale image and binary image

Skeleton Image:

Skeleton image extraction is difficult task when the fingerprint has poor quality. Skeleton structure of the fingerprint image is obtained at the thinning stage. Skeletonization is a process for reducing foreground regions in a **binary image** to a skeletal remnant that largely preserves the extent and connectivity of the original region while throwing away most of the original foreground pixels is called skeleton.



Figure 5: skeleton image

Minutiae Extraction:

Ridge endings (the abrupt end of a ridge) and bifurcations (a single ridge that divides into two ridges) are called minutiae points. These minutiae are distinct feature to each person so identifying the personality by extracting the minutiae is novel approach. Minutiae feature reduces the fingerprint recognition problem and pattern matching problem. Latent fingerprint has nearly 20 -30 minutiae points.

Spurious minutia pixels include:

- Ridge ending lies on the border of ROI (Region of Interest).
- Adjacent ridge endings with the same ridge orientation.
- Ridge endings and bifurcations are connected closely and more than one bifurcation too close.

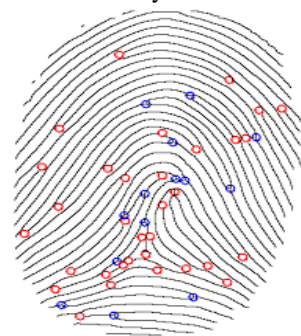


Figure 6: minutiae points

Refinement:

Refinement is the process of removing noise by good binarization technique. Broken ridges may cause the miss classification type. This process is final stage of fingerprint reconstruction, removing false minutiae from the reconstructed fingerprint.

IV. EXPERIMENTAL EVALUATION

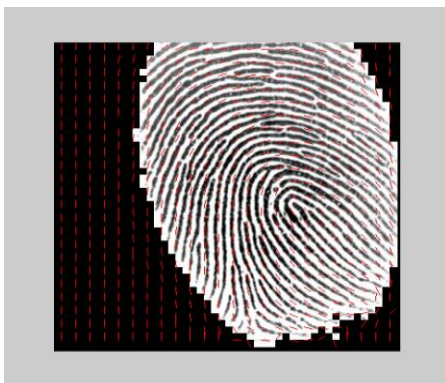
Extracting minutiae points is the challenging factor and structuring discontinues minutiae points into standard format then matched with rolled fingerprints. Minutiae extraction (x,y) represents the location of the minutiae point and angle represents direction of the flow. **(Images obtained in each step carried out).**



1. Original Fingerprint Image



2. Normalized Image



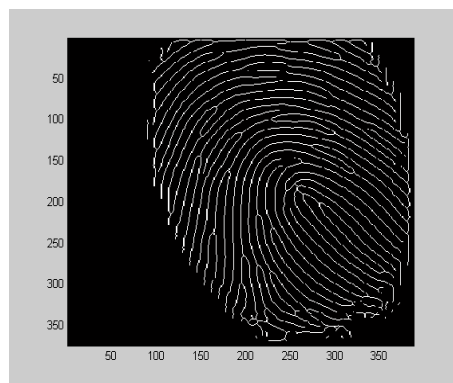
3. Segmented Image along with the orientation field



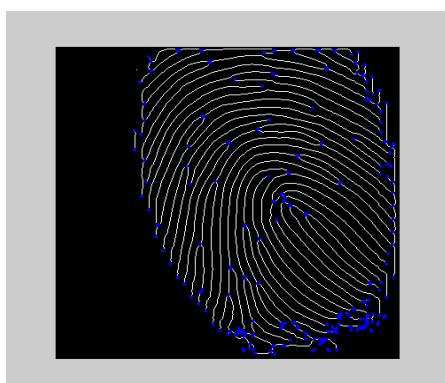
4. Enhanced Image after Gabor Filtering



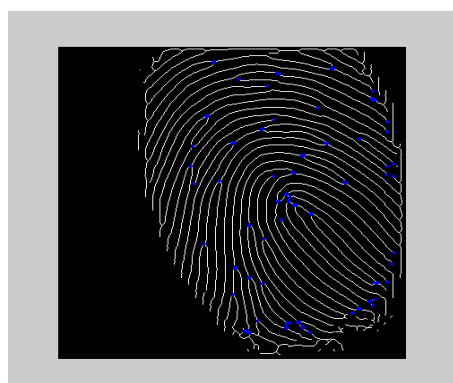
5. Binary Output



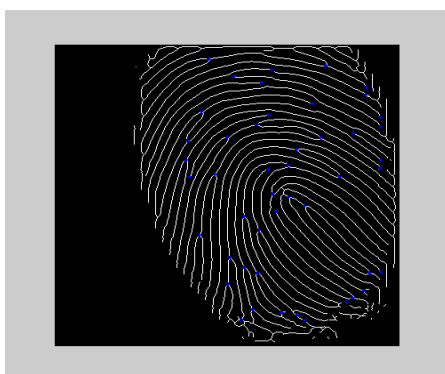
6. Thinned Binary Output



7. Thinned Binary along with all the minutiae



8. Minutiae obtained after deleting spurious minutiae at the borders



9. Final extracted Minutiae after applying the windowing technique

Number of Terminations: 95
 Number of Bifurcations: 23

Table 1 Minutiae termination

X	Y	ANGLE
3	7	25
105	25	124
27	112	29
244	31	90
34	77	35
123	37	257
38	266	40
64	40	116
41	250	41
285	45	55
45	276	48
220	50	43
50	295	63
28	64	64
56	87	96
65	255	67
16	72	40
73	279	74
5	75	22
79	38	83
20	85	2
87	43	93
137	99	234
102	202	106
185	106	279
107	300	113
299	118	17
118	198	124
17	131	260
137	163	138
83	138	147
139	293	146
262	148	2
153	27	159
163	211	164
300	168	270
170	282	181
252	186	24
189	296	193
25	205	2
205	174	206
126	207	248

221	2	226
13	227	173
228	300	229
44	230	86
232	16	232
268	243	187
244	300	254
72	257	261
258	77	262
71	268	300
270	118	271
57	277	286
279	222	279
230	281	78
283	300	284
159	287	167
289	223	289
234	290	101
291	119	291
173	292	135
294	156	300

Table 2 Minutiae Bifurcation

X	Y	Θ1	Θ2	Θ3
38	105	50	75	66
46	78	157	88	101
116	229	118	217	130
95	135	249	189	172
197	17	200	11	219
20	237	40	240	34
245	26	246	36	250
30	250	20	253	204
256	33	257	43	266

V. CONCLUSIONS

Fingerprint reconstruction based on ridge endings and bifurcations are most developed technique and used in forensics department. Day by day the crime and robbers are increased so the crimes are increased exponentially, need to find the correct personality who involved in crime by short time is challenging because the fingerprint sometimes poor quality and noise. The good preprocessing technique improved the quality of images by binarization. Filter used to remove the spurious minutiae. Canny Edge detection technique is to find the boundaries and internal structure of the object fingerprint image. In previous algorithm have some drawbacks such as reconstruct only skeleton image, partial fingerprint image, changing direction after reconstruction etc. novel approach reconstruct full fingerprint. by using minutiae extraction and matching with original database .

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