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Study of enhancement of quality of Finger print using fuzzy set and neural network

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Abstract : In biometric identification, fingerprint recognition is most popular and widely used method Fingerprints were used as a means of positively identifying a person as an author of the document and are used in law enforcement. Fingerprint recognition has a lot of advantages, a fingerprint is compact, unique for every person, and stable over the lifetime. A predominate approach to fingerprint technique is the uses of minutiae. This dissertation presents an investigation and comparative study to extract minutiae points in fingerprint image. In most cases, fingerprint images available are not of good quality; they may be corrupted and degraded due to variation in skin and effective condition. So first a fuzzy logic based image enhancement method has been applied to obtain a more reliable estimation of minutiae points and their location and then a different algorithm used to extract them. Neural network is used to give the training to the location of these minutiae point and to improve the performance of the system.

Key Words : biometric identification, fingerprint recognition, fuzzy set and neural network

Introduction : The quality of the input fingerprint image affects the performance and fingerprint matching methods. The quality of a fingerprint image measured corresponds to the clarity of the ridge structure in the fingerprint image. A fingerprint that contain high contrast and well defined ridges and valleys, are called as good quality image while a poor quality fingerprint is marked by low contrast and ill- defined boundaries between the ridges. There are several reasons that may degrade the quality of a fingerprint image.

- There may be creases, bruises or wounds present in fingerprint image that may cause of ridge discontinuities.
- Excessively dry fingers lead to fragmented and low contrast ridges.
- Sweat on fingerprints leads to smudge marks and connects parallel ridges.

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The main objective of the paper work is to develop a new idea to extract minutiae point and there location by using fuzzy set and neural network.

Methodology

The step-by-step methodology to be followed for finding minutiae point and there location using fuzzy theory and neural network are as follows:

- Different step in fingerprint minutiae point extraction (such as image enhancement, image binarisation, image thinning etc) have been done.
- Based upon above analysis a program is developed for extracting minutiae point.
- Results achieved after the execution of program are compared with the earlier outputs.

The process to extract fingerprint minutiae points contains five steps. First step is image acquisition step to obtained fingerprint image from different sensor. The second step is to enhance the contrast of image by using fuzzy logic. Image binarisation step is done after enhancement of image. Fourth step is to convert the binary image into thinned image and then minutiae point extraction method has been implemented in step five. Neural network training are describes in step six.

Step 1 Image Acquisition

The first step is to acquire fingerprint image. The fingerprint image acquire either by offline or by an online process. The fingerprint acquired by online is called “live- scan” whereas offline fingerprint image are known as “inked” fingerprint

Step 2 Image Enhancement by Using Fuzzy Logic

Fingerprint is the pattern of ridges and valleys. Every individual has a unique fingerprint. This uniqueness is determined by the local ridge characteristics. Minutiae points are the prominent ridge characteristic. A good quality fingerprint typically contains about 40 - 100 minutiae points

Some of fuzzy rule for image enhancement are such as

- If pixel level is dark then output is darker.
- If pixel level is gray then output is gray.
- If pixel level is bright then output is brighter.

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Step3 Image Binarisation:

Binarisation is the process to convert gray image into binary image. Most minutiae extraction algorithm operates on binary image in which there are only two level of interest 0 (for black level) and 1 (for white level). After the operation, ridges in the fingerprint are highlighted with black colour while valleys are white. The binarisation process involves examining the grey-level value of each pixel in the enhanced image, and if the value is greater than the global threshold, then the pixel value is set to a binary value one otherwise, it is set to zero. The outcome is a binary image containing two levels of information, the foreground ridges and the background valleys. Figure5.4 shows the binary image.

Step 4 Image Thinning

Ridge thinning is to eliminate the redundant pixels of ridges till the ridges are just one pixel wide. Thinning is the morphological process to remove the foreground pixel until they are one pixel wide. So in the first step morphological process apply to reduce the width of the ridge. Morphological is a means of changing a stem to adjust its meaning to fit its syntactic and communicational context.

Step 5: Minutiae Points Extraction:

Extraction minutiae point and their location is an important step of the process. There are many algorithms have been developed for minutiae point extraction. An algorithm based on Tico and Kuosmanen method [29] and Crossing Number (CN) methods is used for extract minutia points. This method extracts the ridge endings and bifurcations from the skeleton image by examining the local neighbourhood of each ridge pixel using a 3x3 window.

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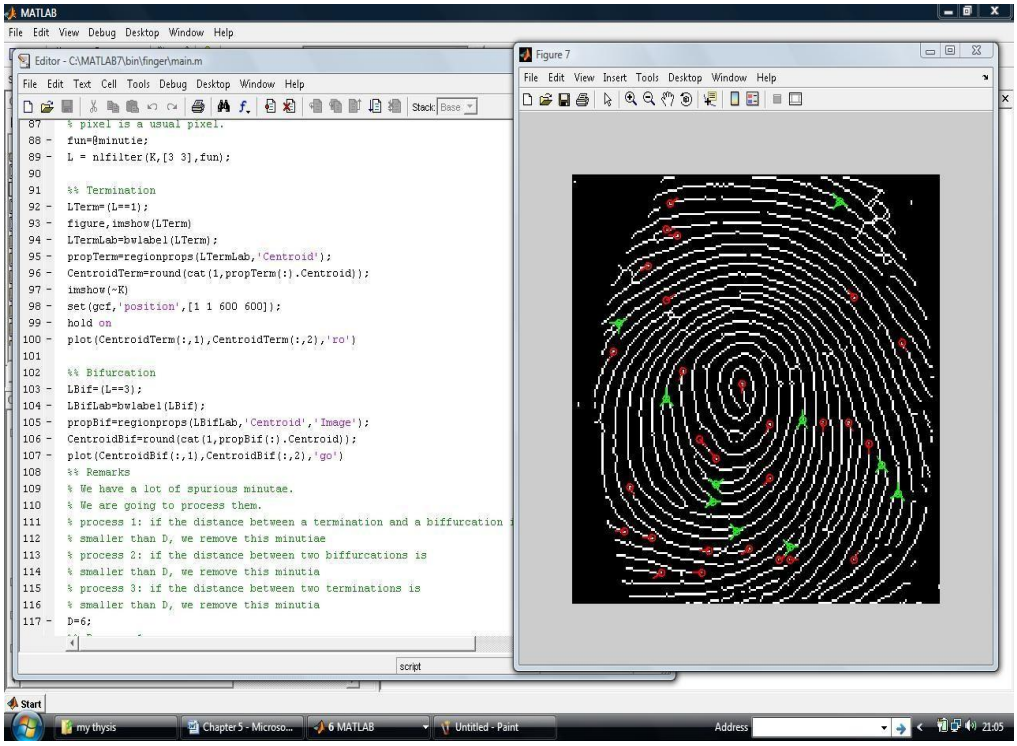

Figure : Minutia Point Extraction

Step 6 Training : The last step is to train minutiae point location by neural network using backpropagation algorithm. All detail about neural network has been given in chapter 2. Backpropagation is most popular supervisor learning algorithm used to training in various systems.

Result

Experiments were done in around 50 images and some of the results of them being shown below. Result are based upon two fingerprint images, Finger1 and Finger2 is shown. Table 1.2 and Table 1.4 are show the bifurcations points while Table 1.3 and Table 1.5 shows termination points location Finger1 and Finger2 respectively.

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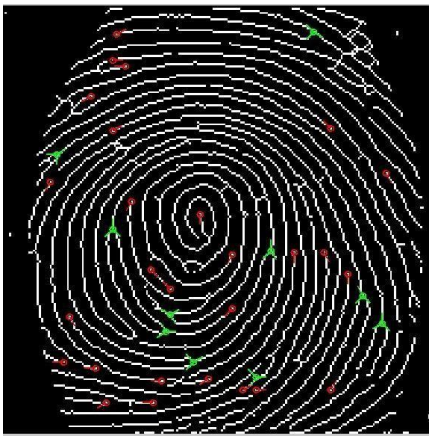
Finger1

Enhance Image of Finger1
by Fuzzy Logic



Minutiae Points in Finger1

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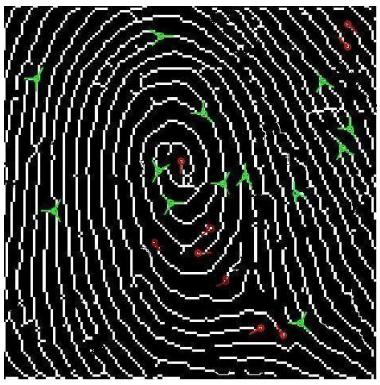
Finger2

Enhance Image of Finger2 by Fuzzy Logic



Minutiae Points in Finger2

Table 1.2 and Table 1.3 show the location of minutiae point corresponding to Finger1.

SNo	X	Y	Angle 1	Angle 2	Angle 3
1	146	13	2.46	-1.57	-0.52

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2	26	70	3.14	-1.57	0.52
3	52	105	-2.36	1.57	-0.79
4	126	115	-2.36	1.57	-1.05
5	169	136	-2.36	2.09	-0.79
6	79	145	2.62	-1.05	0.52
7	178	149	-2.62	1.57	-0.79
8	77	153	-2.62	2.09	0
9	90	167	2.36	-2.36	0.52
10	119	174	2.36	-2.09	0

Table 1.2: Bifurcations Points Location in Finger1

SNO	X	Y	Angle
1	54	14	0.52
2	52	26	0
3	58	29	3.14
4	42	43	-2.62
5	154	58	2.36
6	52	59	0.52
7	180	79	1.05
8	23	83	-2.09
9	61	92	-2.09
10	93	98	-1.57
11	137	116	-1.57
12	151	116	-1.05
13	108	117	-2.09
14	70	124	-0.79
15	162	126	-1.57
16	79	133	2.36
17	108	142	-2.36
18	32	146	-1.05
19	29	167	3.14
20	44	170	3.14
21	97	175	-2.92
22	75	176	3.14
23	113	180	0.52
24	119	180	0.00
25	154	180	1.05
26	49	186	-2.62
27	71	186	3.14

Table 1.3: Termination Points Location in Finger1

Table 1.4 and Table 1.5 show the location of minutiae point corresponding to Finger2.

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SNo	X	Y	Angle1	Angle2	Angle3
1	128	31	2.09	-2.09	-0.52
2	80	44	2.09	-2.09	-0.79
3	135	57	2.09	-1.57	0.00
4	63	66	2.36	-2.36	0.00
5	75	68	3.14	-1.57	-1.05
6	97	69	-2.36	1.57	-1.05
7	88	72	3.14	1.05	-1.05
8	32	120	-2.62	3.14	-1.05
9	36	139	3.14	1.05	-0.79
10	63	13	2.62	-1.05	-1.05
11	13	30	3.14	-1.57	-1.05
12	119	128	3.14	1.05	0.00
13	67	80	2.36	-2.09	0.00
14	20	83	3.14	1.05	-1.05

Table 1.4: Bifurcations Points Location in Finger2

SNO	X	Y	Angle
1	138	8	-0.79
2	138	17	2.36
3	55	17	2.36
4	71	63	-1.57
5	55	68	-1.05
6	89	111	1.05
7	55	116	-1.57
8	103	130	-2.62
9	14	132	-1.57
10	37	132	1.57
11	113	132	2.62
12	151	116	-1.05

Table 1.5: Termination Points Location in Finger2

Conclusion : The main focus of this research is enhancement of fingerprint image by fuzzy logic and then extraction of fingerprint minutiae points and their location. So before minutia point extraction, first a new fuzzy logic based method for image enhancement was implemented. Experiment was done on poor quality fingerprint image initially and is compared to the result by applying proposed method and without applying method. Experimental results show that enhanced image is obtained by using fuzzy logic gives better result rather then original fingerprint image (poor quality image). The Crossing Number method was then implemented to perform extraction of minutiae. Experiments conducted have shown that this method is able to accurately detect almost valid bifurcations and ridge endings from the thinned image. However, there are cases where the extracted minutiae do not correspond to true minutia points. To improve the performance of methods, training has been done by feedforward neural network.

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