Effects of Segmentation and Tresholding on Fingerprint

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Abstract— **The segmentation techniques is spatial processing where it mainly used for cleaning the background. Basically there are various techniques for the pre processing but the segmentation techniques is one of the effective techniques. Similarly in fingerprint identification, the detection of ridges from the background is required which can be obtained with the help of thresholding in which we get binary image from the gray level .**

***Keywords*— segmentation, despeckle, thresholding, global median,local mean.**

I. Introduction

In the preprocessing, the segmentation is a spatial processing technique that primarily aims at cleaning up the background which makes the greyish non-signal areas white, but keeps the ridges as it is. The result of this technique makes the transitions from a ridge to a valley which makes the background *sharper*. This sharper transition gives the results of threshold and thinning by making very clear difference between ridge areas and non-ridge areas.

The requirement in the fingerprint identification is to detect ridges from the background. There for thresholding is used for the conversion of a gray level image into a binary image. In this paper we have presented some commonly used threshold algorithms and their relevant results.

II. Variance cum mean based segmentation

This is a spatial processing technique which is used for cleaning up the background i.e. making the grayish non-signal areas white, by keeping the original ridges. The result of this technique is that it makes the transitions from a ridge to a valley or the background *sharper*. This sharper transition improves the results of threshold and thinning as it helps to make a very clear distinction between ridge areas and non-ridge areas. This improves the contrast. It changes the value of a pixel depending upon, *Global Mean, Local Mean and Local Variance,* which is computed using a WxW mask in the neighborhood of the pixel

Principle:

Signal Area = High Local Variance + Low Local Mean.

Non-Signal Area = Low Local Variance + High Local Mean.

Algorithm:

1) *Calculate Global Mean of the entire image.*

$$X_{global} = (1/n) \sum_{i=1}^{i=n} x_i$$

2) *Consider a WxW mask around each pixel in the image.*

3) *Calculate the local mean ($\mathbf{X}_{local}$) and local variance ($\boldsymbol{\sigma}^2_{local}$) in this mask.*

$$X_{local} = (1/m) \sum_{i=1}^{i=m} x_i$$

$$\boldsymbol{\sigma}_{local} = \left(\sum_{i=1}^{i=m} (x_i - X_{local})^2 / (n-1) \right)^{1/2}$$

4) *If,*

$$X_{global} < X_{local}, \text{ and } \boldsymbol{\sigma}^2_{local} < \boldsymbol{k}.$$

*Then, make the center pixel with white. Else, write the pixel as it is. The value of '**k**' was determined empirically by testing over a portion of the database.*

The result of segmentation on an image from the database is shown below.

Original image Segmented image

Figure 1: Result of segmentation.

III. DESPECKLE

There are number of pores or holes in the ridges in segmented image. For the improvement in thinning algorithm performance it is the need to remove these holes. So noise reduction algorithm is implemented . In this approach, the gray level of each pixel is changed by the mean of the gray levels in the area of that pixel. This method is very useful in removing major spike like components while preserving the edge sharpness in the ridges.

Algorithm:

Consider the pixel gray level with 8 neighbors,

***X**[i] ; where i = 0 ~ 8*

*If, **X**[i] < M, then*

X[i] = X[i];

Else X[i] = 255;

Where M is the median value in 3x3 block.

THE RESULT OF THIS ALGORITHM ON A SEGMENTED IMAGE IS SHOWN BELOW.

SEGMENTED IMAGE DESPECKLED IMAGE.

FIGURE 2: RESULT OF DESPECKLE.

IV. THRESHOLDING

The requirement in the fingerprint identification is to detect ridges from the background. So a monochrome representation of the fingerprint is enough to serve the purpose. Thresholding involves changes a gray level image into a binary image. We are showing a few commonly used Threshold algorithms and relevant results.

4.1 CONSTANT THRESHOLDING

In this method, a fixed threshold is decided. If the pixel is darker than the one represented by the threshold it is made black, else white.

Algorithm:

If, $\mathbf{X}[i] > \mathbf{k}$ *then,* $\mathbf{X}[i] = 255$.

Else, $\mathbf{X}[i] = 0$.

Where, ***k*** *is a suitable constant determined empirically by testing the Histogram of fingerprint database.*

4.2 GLOBAL MEDIAN THRESHOLDING

In the Global Median approach, the median of the gray level intensity distribution of the complete image is found. This median is used as the threshold.

Algorithm:

If $\mathbf{X}[i] < M$, *then* $\mathbf{X}[i] = 0$;

Else $\mathbf{X}[i] = 255$

Where M is median value of the image gray level.

4.3 GLOBAL MEAN THRESHOLDING

This approach dictate that *Mean* of the gray level intensity distribution in an image be taken as the Threshold.

Algorithm:

$$X_{global} = (1/n) \sum_{i=1}^{i=n} x_i$$ *; Where n is Width(W) x Height(H).*

$\mathbf{X}[i] = 0$; *if* $\mathbf{X}[i] < X_{global}$

$= 255$; *otherwise.*

4.4 Local Median Thresholding

In the proposed method of image *Binarisation,* a block of size W x W is considered around each pixel and the *Median* of gray level intensity distribution inside this block is determined. This Median value is used as the Threshold.

Algorithm:

Consider the pixel gray level with 8 neighbors,

$\mathbf{X}[i]$; *where* $i = 0 \sim 8$

If, $\mathbf{X}[i] < M$, *then*

$X[i] = 0;$

Else $X[i] = 255;$

Where M is the median value in 3x3 block.

4.5 Local Mean Thresholding

In the ***L**ocal Mean Thresholding* Algorithm, a block of size W x W is considered around each pixel and the mean of the gray level intensity distribution inside this block are calculated. After calculation, mean value is used as the threshold for the binarization.

Algorithm:

$$X_{local} = (1/n) \sum_{i=1}^{i=n} x_i \text{ ; where } n \text{ is } WxW(\ 3x3).$$

$$\mathbf{X}[i] = 0 \quad ; \text{if } \mathbf{X}[i] < X_{local}$$

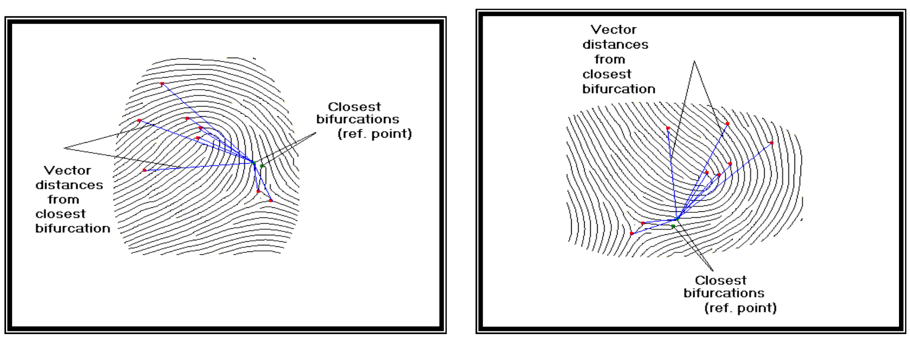
$$= 255 \quad ; \text{Otherwise.}$$

In this proposed method, we determined that the application of **Local Mean Thresholding Algorithm** worked best for the database under consideration. The effect of calculated threshold is as shown below.

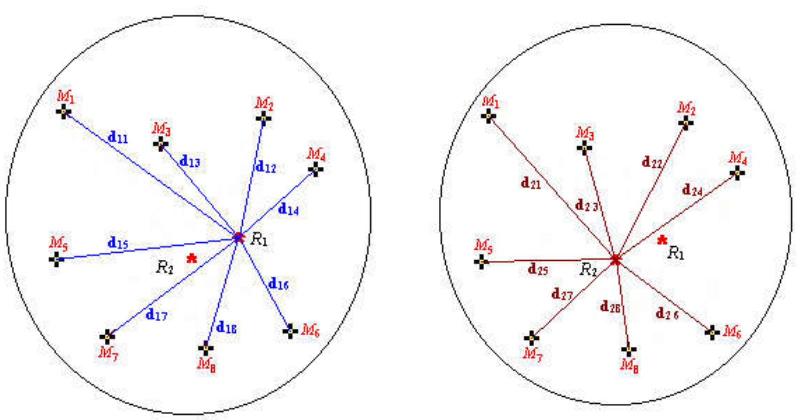
Despeckled image Threshold image

FIGURE 3 : RESULT OF THRESHOLDING

The symbolic concept of calculation of vector distances is given in figure 3 followed by the algorithm.



(a)



(b)

FIGURE 4 : THE SYMBOLIC CONCEPT

Distances from Reference bifurcation R1 to all other bifurcations:

{d11, d12, d13, ….., d18}

Distances from Reference bifurcation R2 to all other bifurcations:

{d21, d22, d23, ….., d28}

Algorithm:

1) *Store the X & Y co-ordinates.*

$$Cx[i] = X \text{ and } Cy[i] = Y \ ;$$

$$\text{if } \sum_{j=0}^{8} N_j > 2, \text{ for } f(X,Y) = 0 \ ; \text{ where } X = 0, 1 \ldots Width. \ Y = 0, 1 \ldots Height.$$

for i = 0 to (TNB-1), where TNB = Total Number of Bifurcations.

2) *Calculate the vector distances.*

$$VD[k] = \sqrt{(Cx[i] - Cx[j])^2 + (Cy[i] - Cy[j])^2}$$

for i = 0 to (TNB - 1) and j = 0 to (TNB-1).

3) *Mark reference points.*

$$\mathcal{M}1 = f(minX_1, minY_1)$$

$$\mathcal{M}2 = f(minX_2, minY_2)$$

where,

$$minX_1 = Cx[i],\ minY_1 = Cy[i] \text{ and}$$

$$minX_2 = Cx[j],\ minY_2 = Cy[j] \qquad ; \text{for } \min \lvert VD[k] \rvert$$

4) *From each reference point, calculate the vector distances.*

$$RVD_1[k] = \sqrt{(minX_1 - Cx[i])^2 + (minY_1 - Cy[i])^2} \text{ and}$$

$$RVD_2[k] = \sqrt{(minX_1 - Cx[i])^2 + (minY_1 - Cy[i])^2} \ ; \ \text{for } i = 0 \text{ to } (TNB - 1)$$

5) *Compare above vector distance values of input fingerprint with the claimed template and estimate percentage of matching.*

$$PM = \frac{MBi - |(Bt - Bi)|}{Bt} \times 100 \ \%$$

where, MBi = Number of bifurcation in input image satisfying the vector distance condition with specified tolerance and

Bt = Total number of bifurcation in the template.

Bi = Total number of bifurcation in the live image.

V. Conclusions

The The performance parameters of fingerprint based system are measured with percentage of genuine acceptance and false acceptance rates. Resolution and in turn quality of fingerprint image place an important role in deciding these matching scores

- Selection of Features and their extraction process preprocessing techniques like segmentation, thresholding and thinning

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