A TECHNIQUE FOR INTENSITY NORMALISATION OF FINGER VEIN IMAGE

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Abstract: Finger vein recognition technology is a new biometric technology, which has the characteristics of the living capture, stability, difficult to steal and imitation, etc. has a wide application space in the field of information security. However, the quality of the finger vein image capture and the accuracy of the finger vein extraction are directly related to the accuracy of the recognition. Finger vein recognition has been considered one of the most promising biometrics for personal authentication. However, the capacities and percentages of finger tissues (e.g.bone, muscle, ligament, water, fat, *etc.*) vary person by person. This usually causes poor quality of finger vein images, therefore degrading the performance of finger vein recognition systems (FVRSs). In this paper, the intrinsic factors of finger tissue causing poor quality of finger vein images are analyzed, and an intensity variation (IV) normalization method using guided filter based single scale retinex (GFSSR) is proposed for finger vein image enhancement.

***IndexTerms* - Finger vein, Image segmentation, Edge extraction, intensity variation, guided filter, single scale retinex.**

I. Introduction

The biometric identification technology system is transformed into a production technology, which is used to make relevant products and serve the real life. The biometrical technology is a kind of technology that uses human biological and activity characteristics to identify the identity authentication, and it is subdivided into physical and behavioral characteristics. Through a large number of experiments, it is proved that the biological characteristics are unique and not the same as those of any one. It is an automatic recognition, measurement and validation of the physiological characteristics or behavior. Because the biometric recognition has the characteristics of the human beings, there is no problem of forgotten or lost, difficult to be stolen, then, according to these characteristics, the researchers using the parts of the characteristics of the human body have developed various kinds of biometric recognition technology. It uses automatic technology to measure the characteristics of the physical or individual behavior, with the template data in the database to determine the identity, so as to complete the authentication. Biometric identification technology has the advantage: for the vast majority of people, will never disappear, will not be forgotten. According to the physiological characteristics of the human body, has fingerprint recognition, iris recognition, face recognition, palm print recognition, voice print recognition, vein recognition, brainwave recognition etc. Finger vein recognition is a new biometric technology.Based on the principle that the blood of the human body can absorb the light of the specific wavelength , the blood of the finger vein is captured. The characteristics of the finger vein recognition technology include the living capture, difficult to steal, not easy to imitate, rough and epidermal features are influenced by the external environment temperature is small, suitable for wide. It has broad application prospects in the military, social security, banking, public security, secret units,financial payment, smart city and common security market etc.

II. Finger vein authentication

2.1 Extracting finger veins:

The procedure for finger-vein extraction is shown in detailed as follows.

Step 1: Acquisition of an infrared image of the finger Fig.1 (a) shows an example of the captured image. The image is gray scale, 512 x 384 pixels in size, with 8 bits per pixel. The finger tip's direction is right, but it is out of the region of image.
Step 2: Preprocessing of the image Reduce the original image's size to 128 x 96 to make the processing faster.
Step 3:Remove the noise using the median filter.
Step 4: Extraction of edges of finger and finger-vein features.

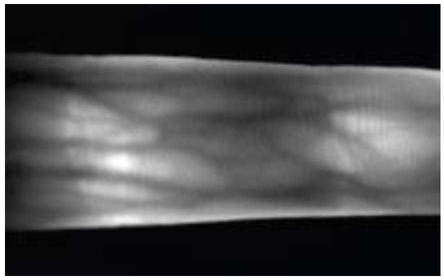
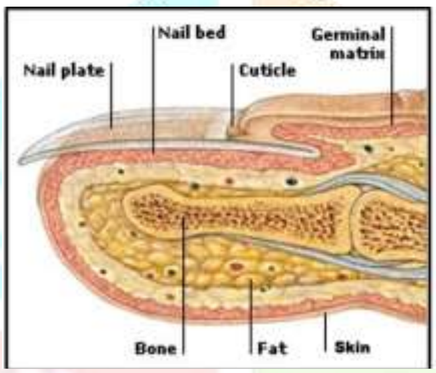


Fig:1(a) Finger vein image

2.2 Intensity normalisation:

As shown in Figure 1 (b),1 (c) finger usually contains fat, bone, skin, and nail components. Veins are located in the subcutaneous layer deep in the skin with fat, connective tissue and other tissues. All the tissues and organs inside a finger can absorb near infrared (NIR) illumination with different absorptivity. As oxyhemoglobin and deoxyhemoglobin in blood vessels absorb more NIR radiation than the other substances, vein vessels are shown in darker color while the other tissues are presented with a brighter background in the captured vein image.



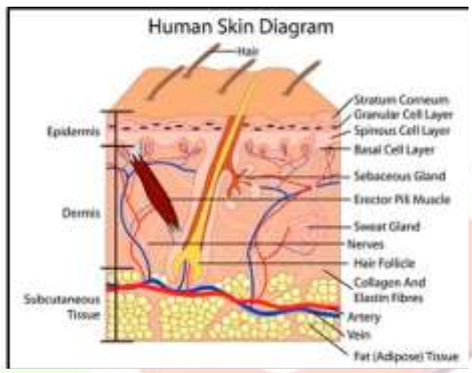


Fig: 1(b) Finger Fig:1(c) Skin

As mentioned above, while each individual has the same types of finger tissues, the capacities and percentages of each tissue vary from person to person. Thick fingers contain more fat, while thin fingers contain less fat. The captured images from a thin finger usually have higher image brightness than those from a thick finger. The acquired finger vein images from different individuals show different global and local contrast, especially between the venous and non-venous regions. Intensity variation in finger vein recognition is an internal factor that results in poor quality of the finger vein images and is inevitably generated in the process of imaging. No matter what kind of imaging model or device is used, intensity variation appears in the finger vein images, degrades the image contrast and thereby degrading the matching performance of an FVRS. Thus, a specialized method that focuses on alleviating the effect of intensity variation would be beneficial for enhancing the quality of finger vein images and the matching performance of the FVRS.

III. PROPOSED METHOD FOR VEIN EXTRCTION AND INTENSITY NORMALISATION.

The proposed system for identifying the edges of the finger,extracting the features of a finger vein and normalizing the intensities of finger vein images is explained below:

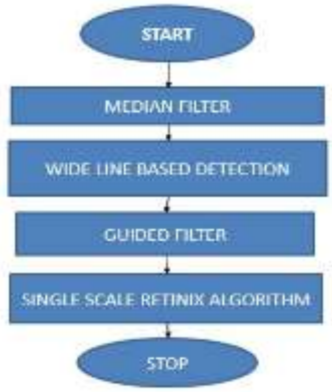


Fig 2 (a): Flow chart for proposed system

3.1 Median filter:

The median filter is normally used to reduce noise in an image, somewhat like the mean filter. However, it often does a better job than the mean filter of preserving useful detail in the image. Like the mean filter, the median filter considers each pixel in the image in turn and looks at its nearby neighbors to decide whether or not it is representative of its surroundings. Instead of simply replacing the pixel value with the *mean* of neighboring pixel values, it replaces it with the *median* of those values. The median is calculated by first sorting all the pixel values from the surrounding neighborhood into numerical order and then replacing the pixel being considered with the middle pixel value. (If the neighborhood under consideration contains an even number of pixels, the average of the two middle pixel values is used.) Figure 2 (b) illustrates an example calculation.

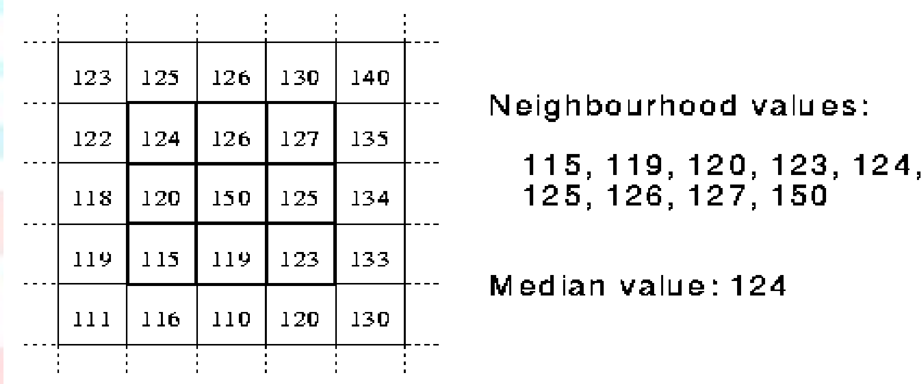


Fig:2(b) Calculating the median

3.2 Edge detection and feature extraction:

- The edges of a finger can be segmented from the image by using the thresholding techniques.
- The features can be extracted from a finger vein image.Here,we are using a special technique called as WIDE LINE BASED DETECTION.

3.3Procedure for feature extraction:

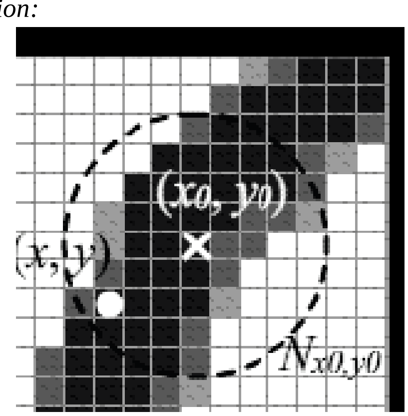


Fig 2 (c): The circular neighborhood region

The method of feature extraction is described in this section. Through observation and experiment, we consider that the vein feature can be presented by lines with different width. We use the wide line detector described in [5] to extract all the points on the vein lines in the image.

Here, *F* is the finger-vein image and *V* is the feature image. Both *F* and *V* are 8 bit 128 x 96 bitmaps. We define the values of pixels in *V* as parts of the background as 0 and the values of pixels as parts of the vein region as 255. For each point($xx0$, $yy0$) in *F*, consider its circular neighborhood region with the radius *r*:

$$N_{(x_0,y_0)} = \{(x,y) | \sqrt{(x-x_0)^2 + (y-y_0)^2} \le r\} \quad (1)$$

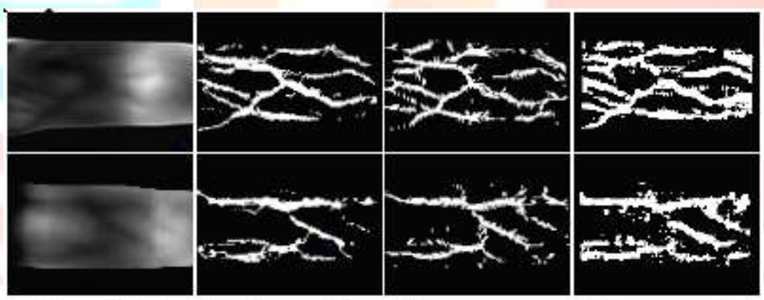
Fig.2 (c) shows the neighborhood region $N_{(x0,y0)}$ .Using the pixels in it, we can calculate the v（x0， y0）by (2)-(4):

$$V(x_0, y_0) = \begin{cases} 0 & m(x_0,y_0) > g \\ 255 & otherwise \end{cases} \quad (2)$$

$$m(x_0,y_0) = \sum_{(x,y)\in N_{(x0,y0)}} s(x,y,x_0,y_0,t) \quad (3)$$

$$s(x,y,x_0,y_0,t) = \begin{cases} 0 & F(x,y) - F(x_0,y_0) > t \\ 1 & otherwise \end{cases} \quad (4)$$

Here *t*, *g* and the radius *r* are parameters. We set *r* = *5*, *t*=1 and *g* = 41.Fig 2 (d) shows the extracted feature images of the proposed method and two other methods: line tracking and curvature . We can find that almost all points on the vein are extracted by proposed method while the other two methods lose a part of points, thus the proposed method can extract more information.



(a) Original. (b) Line tracking. (c) Curvature. (d) Proposed.

Fig 2(d):Results of pattern extracting using different methods.

3.4 Procedure for Intensity normalisation:

3.4.1 Guided Filter:

Guided filter is an effective smoothing filter and its edge-preserving smoothing ability can be controlled by parameters. Taking into account this property and vague edges in some finger vein images due to intensity variation, guided filter is adopted in the present paper for smoothing the input images. The key assumption of the guided filter is a local linear model between the guidance *S*, and the filter output *g*. The guidance image is guided for smoothing an input image. It is supposed that *g* is a linear transform of *S* in a window w_k, centered at pixel *k*.

$$g_i = a_k S_i + b_k \quad \forall i \in w_k \quad (5)$$

where (a_k,b_k) are some linear coefficients assumed to be constant in *wk*. This local linear model ensures that *g* has an edge only if *S* has an edge since $\Delta g = a\Delta S$ .To determine the linear coefficients, the cost function that minimizes the difference between the input image *L* and the output is as follows:

$$E(a_k, b_k) = \sum_{i \in w_k} ((a_k S_i + b_k - L_i)^2 - \varepsilon a_k^2) \tag{6}$$

$$a_k = \frac{\frac{1}{|w|} \sum_{i \in w_k} S_i L_i - \mu_k \bar{L}_k}{\sigma_k^2 + \varepsilon}$$

$$b_k = \bar{L}_k - a_k \mu_k \tag{7}$$

where ∑ is a regularization parameter preventing k a from being too large, μ,and ⌠ $^2{}_k$ are the mean and variance of S in k w , and L_k is the mean of L in k w . w is the number of pixels in k w . Hence, after computing (a_k ,b_k) for all patches k w in the image, the filter output can be computed by:

$$g_i = \frac{1}{|w|} \sum_{k: i \in w_k} (a_k S_i + b_k) = \bar{a}_i S_i + \bar{b}_i \tag{8}$$

where *ai* and *bi* are the mean values in a_k and b_k , respectively. Due to the linear model between the guidance and the filter output, the guided filter has a better edge-preserving smoothing property than other filters. The non-approximate manner in implementation results in good quality of the generated results. Furthermore, the linear running time of the algorithm depends only on the number of pixels in the image.

3.4.2 Single scale retinix algorithm:

Single scale retinex (SSR) is based on the assumption that an observed image L can be regarded as the multiplication of the illumination I and the reflectance images R. R can be considered as the textures without any illumination variations. Moreover, it is assumed that the reflectance changes sharply and that illumination changes smoothly. There are a lot of methods for decomposition of the intensity into these two components and the SSR algorithm is used as a technique to enhance images in various applications. The mathematic description for each pixel (x, y) in an image is defined as follow:

$$L(x, y) = I(x, y) \cdot R(x, y) \tag{9}$$

To eliminate the illumination from the captured image, a subtraction operator is applied in the logarithm domain.

$$\log R(x, y) = \log L(x, y) - \log I(x, y) \tag{10}$$

Since SSR is based on the idea that the illumination component tends to change smoothly, contrary to the reflectance, the illumination image I can be estimated by the convolution operation of the Gaussian filter on the captured image L . The operation for each pixel (x, y) is as shown below:

$$I(x, y) = L(x, y) \times F(x, y) \tag{11}$$

$$F(x, y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}} \tag{12}$$

Substituting Equation (11) into Equation (10), we have

$$\log R(x, y) = \log L(x, y) - \log(L(x, y) \cdot F(x, y)) \tag{13}$$

Consequently, log $R(x, y)$ is the retinex output, called single scale retinex (SSR), while it is also the illumination-normalized output. The block diagram for SSR is shown in Figure 2(e).

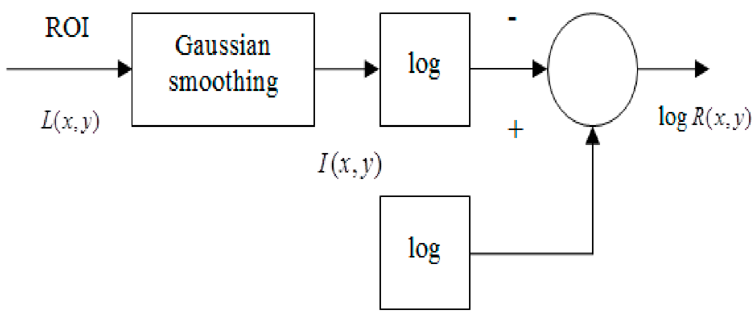


Fig 2(e):Block diagram of SSR algorithm

3.4.3 Proposed GFSSR algorithm:

Each tissue in a finger can absorb NIR illumination to different extents, causing undesired intensity variations in a finger vein image. The intensity variation normalization proposed in this paper is designed to eliminate this effect. Inspired by the assumption of SSR, it was assumed that a captured finger vein image L could be regarded as the multiplication of the intensity variation IV and the reflectance R. The mathematic description for each pixel (x, y) can be represented as follow:

$$L(x, y) = IV(x, y) \cdot R(x, y) \qquad (14)$$

As mentioned it is common that an intensity variation image IV can be estimated by the convolution operation of the smoothing filter on the captured image L. Here, we use a guided filter as a smoothing filter to obtain an intensity variation image of a finger vein image. A result of guided filter at a point (x, y) , is obtained by a weighted sum of an intensity value at (x, y) in a given guidance image, s, and an average of a patch centered at (x, y) in a given input image, $\lceil(x, y)$. a and b are used as its weights, which are determined by whether a patch centered at a point in the guidance image has relatively high variance, as defined in Equations (3) and (4). If a patch has relatively high variance, a becomes relatively large and contributes to $g(x, y)$ more than $\lceil(x, y)$. Otherwise, $\lceil(x, y)$ contributes to $g(x, y)$ more than $s(x, y)$. As shown in Figure 4, r is a radius of a patch and becomes larger. A region with relatively high variance also becomes larger and their variance values become smaller, so the contribution of $s(x, y)$ to $g(x, y)$ at a position (x, y) becomes smaller than in a case of using a smaller r . While its smoothing effect becomes stronger, its edge-preserving effect becomes weaker, but its tendency still remains. Therefore, the guided filter can work pursuing for a given purpose, when its parameter values and a guidance image are chosen properly. The proposed Guided filter based SSR (GFSSR) algorithm can be described as:

$$\log R(x, y) = \log L(x, y) \square \log(L(x, y) \cdot G(x, y)) \qquad (15)$$

where $IV(x, y)$ is estimated by the convolution operation of the guided filter, $G(x, y)$, on the captured image L ,

$$IV(x, y) = L(x, y) \cdot G(x, y) . \qquad (16)$$

The block diagram of GFSSR is depicted in Figure 2(f):

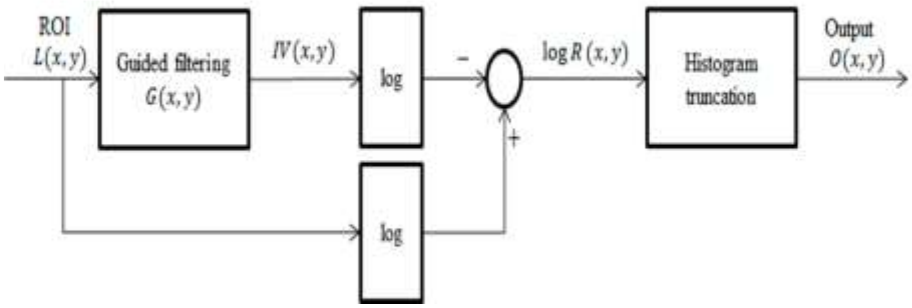


Fig 2(f):Block diagram of *GFSSR* algorithm.

IV.RESULTS

The following are the results obtained :

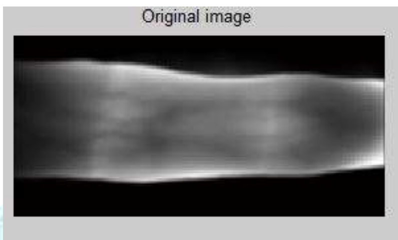


Fig 4(a):Input image

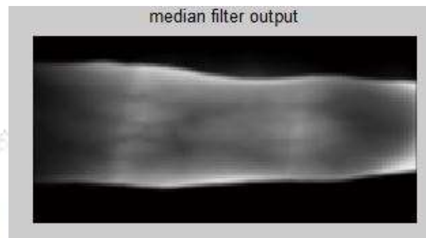


Fig 4(b): Output of the median filter

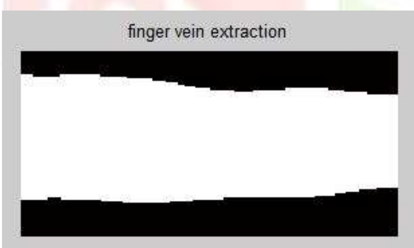


Fig 4(c): Output of the finger edge segmentation

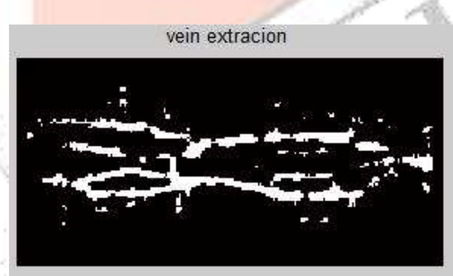
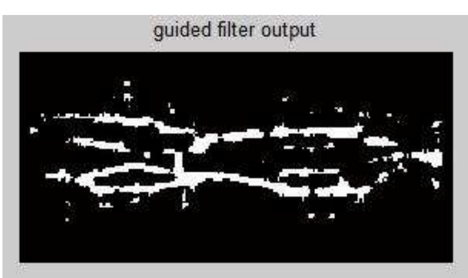


Fig 4(d):Output of wide line based feature extraction



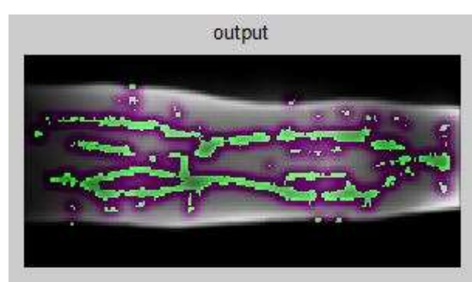


Fig 4(e):Output of guided filter

Fig 4(f):Output of the proposed method

V.CONCLUSION

In this paper, we have proposed a new method to improve the feature extracting capability of the finger vein by using wide line detector obtained It can obtain all the points on the lines of vein in the image and increase the information of the feature.And,moreover we have introduced a new method for normalizing the intensities that are obtained while capturing the finger vein images using infrared rays due to the variations in the internal factors of each individual.We described a personal identification method based on patterns of veins in a finger.To extract the patterns from an unclear original image.

VI.FUTURE SCOPE

In this paper,we have designed the algorithm for identifying the finger vein images.But usually our finger veins will shrink and get un-clear.This will happen during cold weather or in the condition we've stayed in the air conditioned room too long. Therefore, we'll still learn and investigate to create a device that can grab the vein image more clearly and/or algorithms or methods that can extract better vein pattern under this condition.

VII.ACKNOWLEDGEMENTS

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VIII.REFERENCES

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