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# A REAL TIME EMBEDDED SYSTEM OF VEIN USED FOR AUTHENTICATION IN TELLER MACHINE

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***Abstract***

**In this project, a real-time embedded finger-vein recognition system for authentication on teller machine being developed. This system is implemented on an embedded platform and equipped with a novel finger-vein recognition algorithm, so this system is an intelligent security system. Based on this a teller machine concept is developed. Wherein, the transaction is successful, If and only if the finger vein matched via GSM technology.**

***Index Terms*****--** **Finger –vein recognition, Teller Machine, GSM technology**

## I. INTRODUCTION

Automated teller machines (ATMs) are well known devices typically used by Individuals to carry out a variety of personal and business financial transactions and/or banking functions. ATMs have become very popular with the general public for their availability and general user friendliness. ATMs are now found in many locations having a regular or high volume of consumer traffic. For example, ATMs are typically found in restaurants, supermarkets, Convenience stores, malls, schools, gas stations, hotels, work locations, banking centers, airports, entertainment establishments, transportation facilities and a myriad of other locations. ATMs are typically available to consumers on a continuous basis such that consumers have the ability to carry out their ATM financial transactions and/or banking functions at any time of the day and on any day of the week .Private information is traditionally provided by using passwords or Personal Identification Numbers (PINs), which are easy to implement but is vulnerable to the risk of exposure and being forgotten. Biometrics, which uses human physiological or behavioral features for personal identification, has attracted more and more attention and is becoming one of the most popular and promising alternatives to the traditional password or PIN based authentication techniques [1]. Moreover, some multimedia content in consumer electronic appliances can be secured by biometrics [2].

There is a long list of available biometric patterns, and many such systems have been developed and implemented, including those for the face, iris, fingerprint, palm print, hand shape, voice, signature, and gait. Not with standing this great and increasing variety of biometrics patterns, no biometric has yet been developed that is perfectly reliable or secure. For example, finger prints and palm prints are usually frayed; voice, signatures, hand shapes and iris images are easily forged; face recognition can be made difficult by occlusions or face-lifts [3]; and biometrics, such as fingerprints and iris and face recognition can be are susceptible to spoofing attacks, that is, the biometric identifiers can be copied and used to create Artifacts that can deceive many currently available biometric devices. The great challenge to biometrics is thus to improve recognition performance in terms of both accuracy and efficiency and be maximally resistant to Deceptive practices. To this end, many researchers have sought to improve reliability and frustrate spoofers by developing biometrics that are highly individuating; yet at the same time, present a high complex, hopefully insuperable challenge to those who wish to defeat them [4].

Especially for consumer electronics applications, biometrics authentication systems need to be cost-efficient and easy to implement [5].

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The finger-vein is a promising biometric pattern for personal identification in terms of it security and convenience [6]. Compared with other biometric traits, the finger-vein has the following advantages [7]: (1) the vein is hidden inside the body and is mostly invisible to human eyes, so it is difficult to forge or steal. (2) The non-invasive and contactless capture of finger-veins ensures both convenience and hygiene for the user, and is thus more acceptable. (3) The finger-vein pattern can only be taken from a live body.

Therefore, it is natural and convincing proofs that the subject whose finger-vein is successfully captured is alive. We designed a special device for acquiring high quality finger-vein images and propose a DSP based embedded platform to implement the finger-vein recognition system in the present study to achieve better recognition performance and reduce computational cost.

## II. Overview Of The System

The proposed system consists of three hardware modules: image acquisition module, DSP mainboard, and human machine communication module. The image acquisition module is used to collect finger-vein images. The DSP mainboard including the DSP chip, memory (flash), and communication port is used to execute the finger-vein recognition algorithm and communicate with the peripheral device. The human machine communication module (LED or keyboard) is used to.Display recognition results and receive inputs from users.

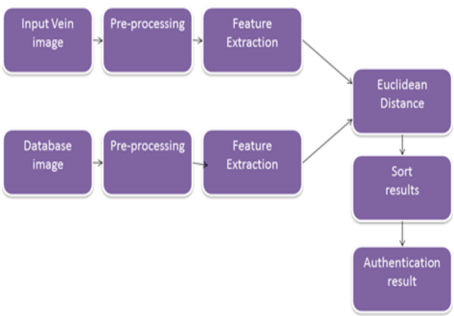


**Fig.1.the flow-chart of the proposed recognition algorithm**

The proposed finger-vein recognition algorithm contains two stages: the enrollment stage and the verification stage. Both stages start with finger-vein image pre-processing, which includes detection of the region of interest (ROI), image segmentation, alignment, and enhancement.

For the enrollment stage, after the pre-processing and the feature extraction step, the finger-vein template database is built. For the verification stage, the input finger-vein image is matched with the corresponding template after its features are extracted. Fig. 1 shows the flow chart of the proposed algorithm. Some different methods may have been proposed for finger-vein matching. Considering the computation complexity, efficiency, and practicability, however, we propose a novel method based on the fractal theory, which will be introduced in Section 4 in detail.

## III. Image Acquisition

To obtain high quality near-infrared (NIR) images, a special device was developed for acquiring the images of the finger vein without being affected by ambient temperature. Generally, finger-vein patterns can be imaged based on the principles of light reflection or light transmission [8].

We developed a finger-vein imaging device based on light transmission for more distinct imaging. Our device mainly includes the following modules: a Monochromatic camera of resolution 580 × 600 pixels, daylight cut-off filters (lights with the wavelength less than 800 nm are cut off), transparent acryl (thickness is 10 mm), and the NIR light source. The structure of this device is illustrated in Fig. 3. The transparent acryl serves as the platform for locating the finger and removing uneven illumination. The NIR light irradiates the backside of the finger. In [9], a light-emitting diode (LED) was used as the illumination source for NIR light. With the LED illumination source, however, the shadow of the finger-vein obviously appears in the captured images. To address this problem, an NIR laser diode (LD) was used in our system. Compared with LED, LD has stronger permeability and higher power. In our device, the wavelength of LD is 808 nm. Fig. 4 shows an example raw finger-vein image captured by using our device.

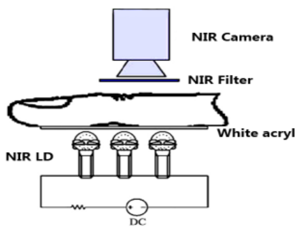


**Fig. 2. Illustration of the imaging device**

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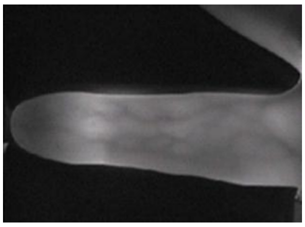

**Fig. 3.An example raw finger-vein image captured by our device.**

## IV. PROPOSED ALGORITHM

### *4.1. Image Segmentation and Alignment*

Because the position of fingers usually varies across different finger-vein images, it is necessary to normalize the images before feature extraction and matching.

The bone in the finger joint is articular cartilage. Unlike other bones, it can be easily penetrated by NIR light. When a finger is irradiated by the uniform NIR light, the image of the joint is brighter than that of other parts. Therefore, in the horizontal projection of a finger-vein image, the peaks of the projection curve correspond to the to the approximate position of the joints (see Fig.4). Since the second joint of the finger is thicker than the first joint, the peak value at the second joint is less prominent. Hence, the position of the first joint is used for determining the position of the finger.

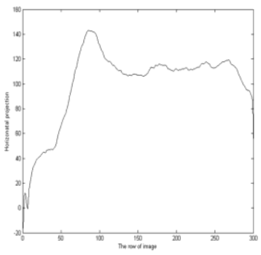

**Fig.4. Horizontal projection of raw image**

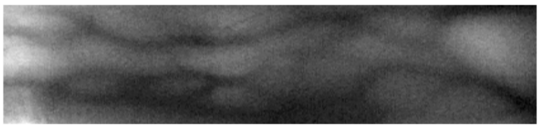

**Fig.5.The segmented ROI of the finger-vein image.**

The alignment module includes the following steps. First, the part between the two joints in the finger-vein image is segmented based on the peak values of the horizontal projection of the image.

Second, a canny operator with locally adaptive threshold is used to get the single pixel edge of the finger. Third, the midpoints of finger edge are determined by edge tracing so that the midline can be obtained. Fourth, the image is rotated to adjust the midline of the finger horizontally. Finally, the ROI of the finger-vein image is segmented according to the midline (see Fig. 5).

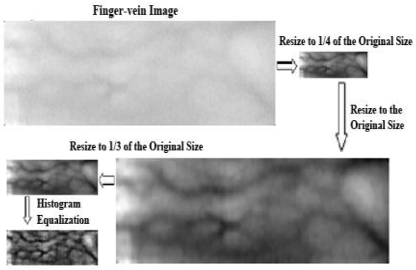


**Fig.6.The procedure of our method for image enhancement**

### *4.2. Image Enhancement*

The segmented finger-vein image is then enhanced to improve its contrast as shown in Fig. 7. The image is resized to 1/4 of the original size, and enlarged back to its original size. Next, the image is resized to 1/3 of the original size for recognition. Bicubic interpolation is used in this resizing procedure. Finally, histogram equalization is used for enhancing the gray level contrast of the image.

### *4.3. Feature Extraction*

The fractal model developed by Mandelbrot [10] provides an excellent method for representing the ruggedness of natural surfaces and it has serve data successful image analysis tool for image compression and classification. Since different fractal sets with obviously different textures may share the same fractal dimension [11], Fractal Dimension allows us to measure the degree of complexity by evaluating how fast our measurements increase or decrease as our scale becomes larger or smaller .We will discuss two types of fractal dimension: self-similarity dimension and box-counting dimension .Essentially, data behave with a power law relationship if they fit the following equation:

$y=c*x^d$ where c is a constant.

One way to determine if data fit a power law relationship is to plot the log(y) versus the log(x). If the plot is a straight line, then it is a power law relationship with slope d.

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### *4.4. Transformation Techniques*

Input vein image texture features are usually extracted using transform-based method such as Fourier Transform [5] and Discrete Cosine Transform [6].

While using Discrete Cosine Transform, some of the points are missed leading to an inaccurate inference. Also Fourier Transform involves floating-valued signals to integer-valued signals, thus less accuracy. Besides that, Wavelet Transform [7] is also used to extract the texture features of the vein image. In this work, a Sequential modified Haar Wavelet is proposed to find the Modified Haar Energy (MHE) feature.

$$MHE_{i,j,k}=\sum_{p=1}^{P}\sum_{q=1}^{Q}(C_{p,q})^2 \qquad \text{-----(1)}$$

Where i is the level of decomposition, j is Horizontal, Vertical or Diagonal details, k is the block number from 1 to 16, P x Q is the size of the block. The MHE energy feature for every detail coefficients are arranged as in (2).

MHEi.j=[MHEi,j,1,MHEi,j,2,…..,HEi,j,16] -----(2)

### *4.5. Matching*

The wavelet transform distance *HD* between two finger vein patterns and the energy feature distance *H*Λare defined as

$$HD \square \square \square D_{1\square}(i,j) \square D_{2\square}(i,j) \quad \text{-----(3)}$$

$$H \square \square \square \square \square_{1\square}(i,j) \square \square_{2\square}(i,j) \quad \text{-----(4)}$$

$$\square\square 2\ i,j$$

In our method, the dimension and energy features are combined for finger-vein recognition: if $HD<th1$ and $<th2$ (th1 and $th2$ are thresholds), then the two finger vein patterns are considered to be from the same finger; if $HD>th1$ or $H>th2$, they are considered to be from different fingers.

## V. EXPERIMENTAL RESULTS

### *5.1. Dataset*

To the best of our knowledge, is no public finger-vein image database has yet been introduced. Therefore, we constructed a finger-vein image database for evaluation, which contains finger-vein images from 100 subjects (55% male and 45%female) from a variety of ethnic/racial ancestries.

The ages of the subjects were between 21 years old and 58 years old. We collected we collected finger-vein images from the forefinger, middle finger, and ring finger of both hands of each subject. Ten images were captured for each finger at different times (summer and winter). Therefore, there were a total of 6,000finger-vein images in the database. Fig. 8 shows some example finger-vein images (after preprocessing) from different fingers.

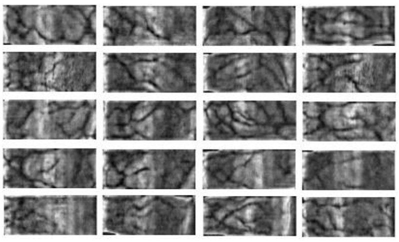

**Fig. 7. Finger-vein images from different fingers after preprocessing**

### *5.2. Performance Evaluation*

There are two types of errors in matching results in biometric verification. The first is false rejection, which claims a genuine pair as impostor, and the second is false acceptance, which claims an impostor pair as genuine. These two types of errors are in a trade-off relationship. In biometrics, the performance of a system is evaluated by the EER (equal error rate). The EER is the error rate when the FRR (false rejection rate) equals the FAR (false acceptance rate) and is, therefore, suitable for measuring the overall performance of biometric systems because the FRR and FAR are treated equally.

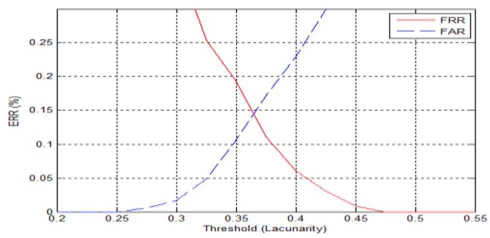


**Fig. 8. The FAR and FRR curves of the methods based on (a) wavelet transformation (b) energy feature respectively.**

Select the image folder by using folder path in current directory.Then ,Compare input vein image with Database images by using euclidean distance formula.

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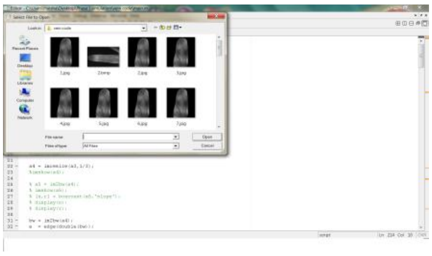

**Fig .9. Selecting image folders**

Getting Energy feature extraction by using modified sequential haar wavelet transform.Calculate eucildean distance between vein.If the images are matched,it will display has autherised person in eidtor command window via GSM.

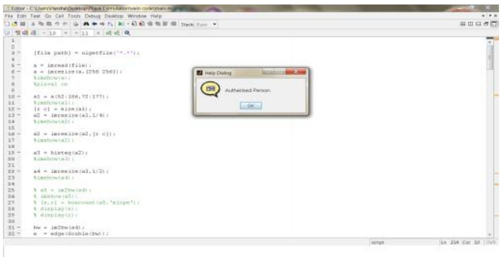

**Fig .10. Authorized people**

### *5.3. Comparison with Previous Methods*

Miura et al. [19] used a database that contained 678 different infrared images of fingers. These images were obtained from persons working in their laboratory aged 20 to 40, approximately 70% of whom were male. Song's [20] finger-vein image dataset contained 1,125 images collected using an infrared imaging device they built. Nine images were taken for each of 125 fingers. Compared with these databases, ours is larger and the data-collection interval is longer. Thus, our database is more challenging. Moreover, our system is implemented on a general DSP chip. Table 1 show that the average times required for feature extraction and matching in our system are 343 ms and 13 ms, respectively. For the whole system, plus the time for image capturing, the time required for the authentication of a user is less than 0.8 s. Although the feature extraction in our system is a little bit more complicated than that in Song's method, our system achieves an EER of 0.07%, indicating that our method significantly outperforms previous methods.

## VI. CONCLUSION

The present study proposed an end-to-end finger-vein recognition system based on the wavelet transformation and energy feature implemented on a DSP platform. The proposed system includes a device for capturing finger-vein images, a method for ROI segmentation, and a novel method combining wavelet transformation and energy feature features for recognition. The images from 600 fingers in the dataset were taken over long time interval (i.e., from summer to winter) by a prototype device we built. The experimental results showed that the EER of our method was 0.07%, significantly lower than those of other existing methods. Our system is suitable for application in mobile devices because of its relatively low computational complexity and low power consumption.

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