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GSM Based Finger Vein Authentication Using Near-Infrared Imaging

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Abstract - This paper discuss about the Contactless finger vein authentication utilizing the vein patterns of the person for the testimony. It is a personal identification system that is based on near-infrared (wavelength between 700 and 1000 nanometers) finger vein pattern. Vascular network pattern are unique biometric future that are robust against temporal and environmental changes, thus they are resistant to criminal tampering. The vein patterns are different for each finger and for each person. The technology offers a high level of accuracy less than 0.01 % for False Rejection Rate (FRR),less than 0.0001% for False Acceptance Rate(FAR) and 0% for Failure to Enroll Rate(FTER). The one-to-one authentication time takes less than 1 sec, authentication speed approx 0.3 sec ARM9 9.96Mhz,5ms at inter Pentium GHz.The finger vein authentication has been revolutionizing banking.
Keywords— Finger Print, Authentication, Imaging, Pattern, Biometric

I. INTRODUCTION

A biometric system is essentially a pattern-recognition system that recognizes a person based on feature vector derived from specific physiological or behavioral characteristic that a person possesses. Physiological methods are related to shape of the human body. The characteristics focused upon in these methods include finger print, faces DNA, hand and palm geometries and irises. Behavioral methods are related to human behavior, including typing rhythm, gait and voice characteristics. The various biometric system include iris scan, face recognition, finger print. The finger prints can be cheated by dummy finger fitted with the copied finger print and some users feel psychological resistance to direct application of light rays into the eyes for iris pattern recognition. In addition to this,precise positioning of the eyes is required for accurate iris authentication. In order to overcome these aspects biometric finger vein authentication has been developed. Finger authentication is the new biometric technique using near-infrared rays to scan the vein patterns inside once finger for personal identity verification. Vein pattern are different for each finger. Vein pattern detection provides many important biometric features:

A. Uniqueness and permanence of the pattern,
B. Non-contact detection procedure,
C. Almost impossible to forge,
D. The biometric parameter is hidden from general view,
E. The vein pattern is instigate enough to allow sufficient criteria for positively detecting various subjects even identical.

II. FINGER VEIN PATTERN IMAGING

Vein pattern, invisible to naked eye, can be viewed through an image sensor sensitive to near-infrared light (wavelength between 700 and 1000 nanometers). Near-infrared light passes through the tissues of the human body and is blocked by pigments such as hemoglobin or melanin. When a user hand is held over a scanner, a near-infrared light maps the location of the veins. The red blood cell present in the vein absorb the rays and show upon the map as black lines, whereas remaining hand structure shows up as white. The system is able to detect veins but not arteries due to the specific absorption of infrared radiation in blood vessel. The deoxidized hemoglobin in the vein vessel absorbs light having a wavelength of about 0.00076 mm within the near–infrared area. When the infrared image is captured, only the blood vessel pattern containing the deoxidized hemoglobin is visible as a series of dark lines. Based on this feature, the vein authentication device translates the black line of the infrared ray image as the blood vessel pattern of the palm. In order to achieve visual penetration through the tissue, lighting should be performed under a very tight optical window namely 740 nm (inside the near-infrared part of the electromagnetic radiations spectrum). Because of the optical properties of the human tissue, a near-IRvein scanning device cannot penetrate very deep under the skin therefore the devices will recognize the superficial vein and rarely deep veins.

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Fig.1 .Infrared image



Fig.2.Extracted vein pattern

III. LIGHTING PATTERN IMAGES

There are two method used for capturing vein pattern images:"light reflections" and "light transmission".

A. *Light reflection*

In case of light reflection (Fig.3), the light source and image sensor are placed on the same side of the finger, and the image sensor captures the reflected light from the surface of the finger. The vein pattern image (Fig.4) is formed by minute differences in the intensity of the reflected light since the veins absorb the light; the image shows feeble light from the veins and bright light from the other part of the blood vessels.

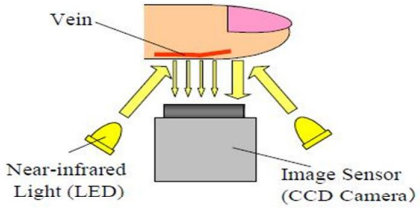


Fig.3 Light reflection method

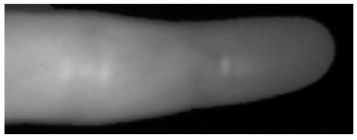


Fig.4 Imaging using light reflection

B. *Light transmission*

In case of light transmission (Fig.5), the finger is placed between the image sensor and the light source, and the near-infrared light passes through the finger where it is capture by the image sensor. It delivers a high-contrast (Fig.6) vein pattern image, because light is introduced from the opposite side of the finger,and there is no effect of reflection.

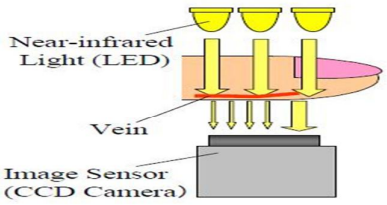


Fig.5. Light transmission method

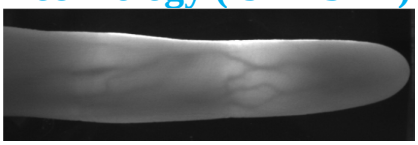
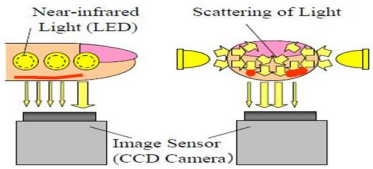


Fig.6.Imaging using light transmission

C. Side lighting

Both the above method delivers high accuracy of authentication, the finger has to be placed between the light source and the image sensor, causing the devices to be relatively large and sometimes causing discomfort to the user. As such, a new method called side lighting was developed which combines advantages from both of the conventional methods. In this new method, light source are placed on both the sides of the finger (Fig.7) near-infrared light shines through the sides of the finger and scatters inside the finger, then passing through the other side of the finger and detected by the image sensor to capture the vein pattern image. This method enables high contrast imaging as well as easy placement of the finger on an open, ceiling-less devices.



a) Side view b) Front view

Fig.7. Side lighting method

IV. AUTHENTICATION PROCESS

The system consists of an authentication unit and the near-infrared light source and the image sensor. The authentication unit includes a CPU core for all sort of signal processing, video I/O for capturing data from the image sensor, LED power controller, and I/O controller. The authentication outcome flows through the I/O controller. The system executes four tasks:

A. Capturing of finger vein pattern image,
B. Normalization of the image,
C. Feature pattern extraction from the image, and
D. Pattern matching followed by judgmentof outcome.

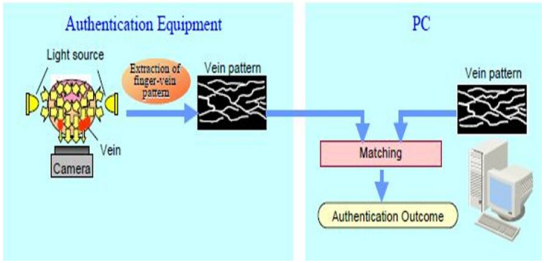


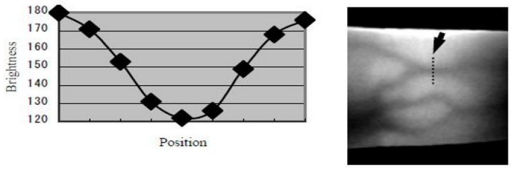
Fig .8.Authentication process

TASK 1: In the capturing of finger vein image pattern, the system takes an image of the finger vein pattern through the image sensor and transfers the image data to the memory of the CPU. At this point, the CPU adjusts the brightness of the light source through the LED power controller to eliminate error caused by individual variations or environmental fluctuation.

TASK 2 : Normalizes the finger vein image to accommodate geometric changes in the positioning or angle of the finger used for authentication .The outline of the finger in the image is detected and the entire image is rotated so that the slope of the outline remains constant.

TASK 3: The distinctive feature patterns are extracted from the image. This process is essential for reliable authentication so as to control the variation of the image data caused by body metabolism or changes in imaging conditions. Uneven brightness

due to individual variations in finger size are lighting conditions often appear in the vein pattern image ,so this system is extract only the vein patterns from such an unstable image.Fig.9 shows the variations in brightness across a single vein in a vein pattern image , where veins clearly appear as dark lines. The shape of the variation forms a valley



a)Cross sectional profile b) Location of profile

Fig.9.Cross sectional profile of finger vein images

\TASK 4: Calculate the correlation between the extracted feature pattern and registered pattern in a database-the "matching" process. If the correlation value is higher than a pre-defined threshold value, a vein pattern is authenticated.

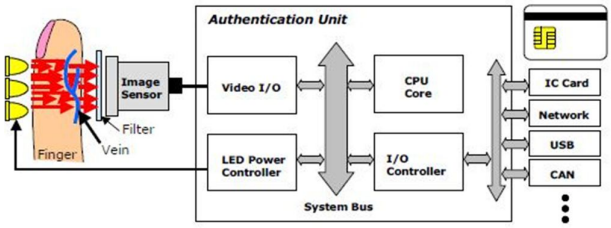


Fig.10. block diagram of finger vein authentication

V. FEATURES

Finger vein authentication technology has several important features that are set apart from other forms of biometrics as a highly secured and convenient means of personal authentication.

A. Resistant to criminal tampering: because veins are hidden inside the body, there is little risk of forgery or theft.

B. High accuracy: The authentication accuracy is less than 0.01% for the FRR(False Rejection Rate), less than 0.0001% for the FAR(False Acceptance Rate), and 0% for the FTE (Failure to Enroll).

C. Unique and constant: Finger vein patterns are different even among identical twins and remain constant through the adult years.

D. Contactless: The use of near-infrared light allows for non-invasive, contactless imaging that ensures both convenience and cleanliness for the user experience.

E. Ease of feature extraction: Finger vein patterns are relatively stable and clearly captured,enabling the uses of low-resolution cameras to take vein image for small-size, simple data image processing.

F. Fast authentication speed:One-to-one authentication takes less than one second. Moreover,the authentication devices can be compact due to the small size of finger.

VI. PRACTICAL APPLICATIONS AND COMPARISON

TABLE 1

Biometrics	Security	Accuracy	Cost	Authentication Speed	Size of Equipment
Finger vein	High	High	Low to Medium	High	Small to Medium
Palm vein	Medium to High	Medium	Medium	Medium	Small to Medium
Fingerprint	Medium	Medium	Low	Medium	Small
Face	Low	Low	Medium	Medium	Large
Iris	High	High	High	Medium	Large

TABLE 1 . Biometrics comparision * based on evaluation method for accuracy of vein authentication syatem of japan industrial standard trade report (JIS TR) X 0079.

The vein authentication access control device is compressed of palm vein pattern sensor,keypad under small display. This device controls access to rooms or buildings that are restricted for personal. The palm vein authentication system has been utilized for customer confirmation of transaction at bank windows or ATM's to solve the increasing problem of financial sectors in Japan. In the future, besides embedded application for portable IT devices such as cellular phones, finger vein authentication will take full advantage of its unique use of finger to expand into applications such as opening automobile doors, access control terminals, revolutionizing banking, secure payments. The encryption of data transmission and data memory , for strengthening resistance to data tampering , semiconductor technology will be of great importance in the future of finger vein authentication technology.

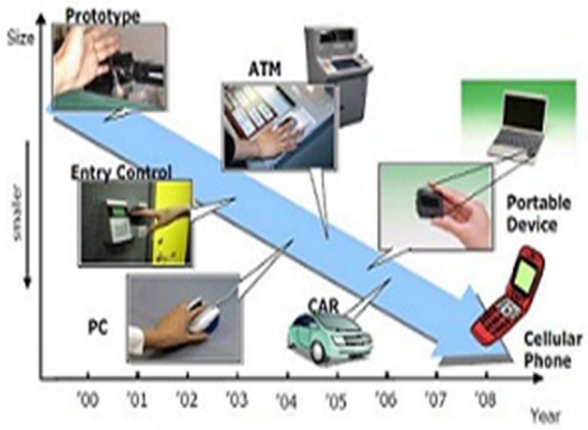


Fig.11 .Application of finger vein authentication and future developments

VII. PROPOSED SYSTEM

A. High alert global system for mobile communications short message service

The techniques GSM SMS is handled main role in this system of devices in which finger vein is captured and authenticated. This GSM SMS alerts to the user whose system is accessed by anyone with illegal. This is the technique which is very useful and also it has loud speaker for providing alert signal beep loudly. SMS alert is new techniques for providing high level security for the users and this will be sent to their mobile phones.

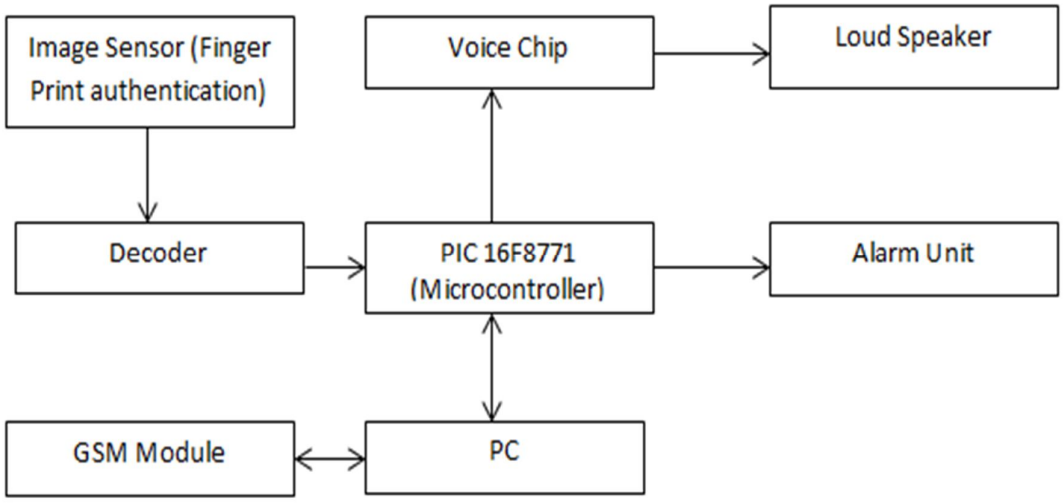


Fig.12.Block diagram of Proposed System

VIII. RESULT

As a result of the Fujitsu research using data from 140,000 palm (70,000 individuals), Fujitsu has confirmed that the FAR is 0.00008% and FFR is 0.01 % with the condition that the person must hold the palm over the sensor for three scan during registration ,and the only one final scan is permitted to confirm authentication. The palm vein authentication technology offers contactless authentication and provides a hygienic and non-invasive solution, thus promoting a high level of user acceptance. The opportunities to implement palm vein technology span a wide range of applications.

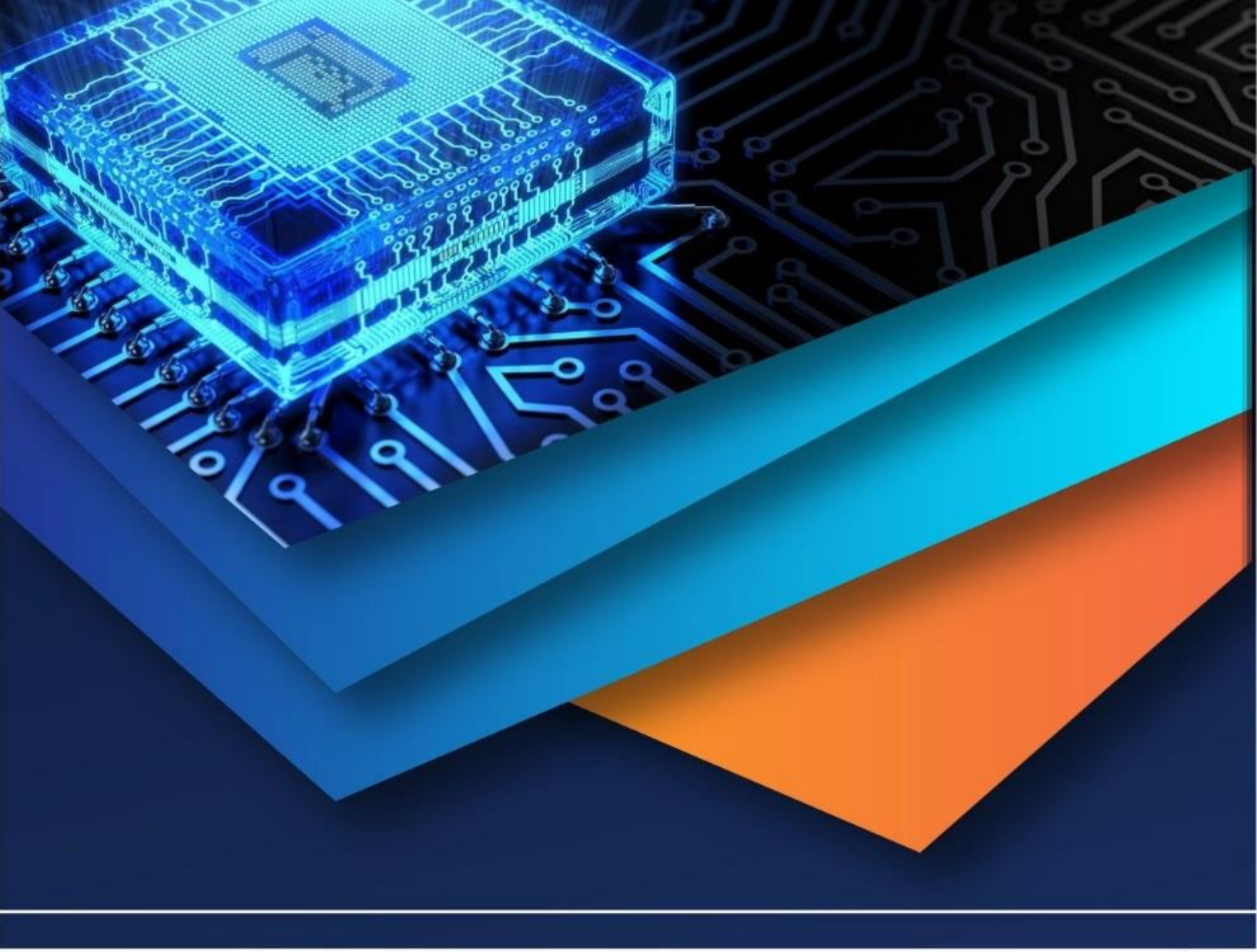
IX. CONCLUSIONS

In this paper, we presented finger vein based biometric security system that can be used for security based electronic devices. Security is a risk management strategy that identifies controls, eliminates or minimizes uncertain events that may adversely affect system resources and information assets.This method can extract the finger vein feature for recognition from the near-infrared images. Finger vein pattern is the next generation of biometrics and will open new opportunities for our identification systems by combining finger vein authentication with finger print analysis.

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