Future of Human Security Based on Computational Intelligence Using Palm Vein Technology

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Abstract
This paper discusses the contact less palm vein authentication device that uses blood vessel patterns as a personal identifying factor. The vein information is hard to duplicate since veins are internal to the human Body. This paper presents a review on the palm vein authentication process and its relevance and competence as compared to the contemporary Biometric methods. This authentication technology offers a high level of Accuracy. The importance of biometrics in the current field of Security has been illustrated in this paper. We have also outlined opinions about the utility of biometric authentication systems, comparison between different techniques and their advantages and disadvantage. Its significance is studied in this paper with reference to the banks, E-Voting, point of sale outlets and card/document less security system. Fujitsu plans to further expand applications for this technology by downsizing the sensor and improving the certification speed.

Keywords: infrared rays, pattern, contact less, deoxidized hemoglobin, sensors.

1. Introduction

The prime responsibility of any technological development is to provide a unique and secure identity for citizens, customers or stake holders and it is a major challenge for public and private sector organizations. The
rise of identity theft in the internet age is well documented. Recent figures reported a 40% increase in the number of victims of impersonation during the last one year, when compared with the same period in 2009 . Organizations hold large volumes of personal data and thus entail flawless protection. The pattern of blood veins is unique to every individual human, and same is the case among similar twins also. Palms have a broad and complicated vascular pattern and thus contain plenty of differentiating features for personal identification. It will not vary during the person's lifetime. It is very secure method of authentication because this blood vein pattern lies underneath human skin. This makes it almost impossible for others to read or copy the vein patterns. An Image pattern of a human is captured (Figure 1) by radiating his/her hand with near-infrared rays. The reflection method illuminates the palm using an infrared ray and captures the light given off by the region after diffusion through the palm. The underlying technology of palm-vein biometrics works by extracting the characteristics of veins in the form of a bit image database [1][4]. As veins are internal in the body and encompass a wealth of differentiating features, attempts to forge or duplicate it is extremely difficult, thereby enabling a high level of protection. In addition, the sensor of the palm vein device can only recognize the pattern if the deoxidized hemoglobin is actively flowing within the
individual's veins. In recent years, palm-vein pattern recognition technology is not considered as dangerous as near infrared is a component of natural sunlight and it is also referred to as “vascular recognition. The scale of
a biometric system is driven by whether the purpose such as gait analysis, making them easier of years.

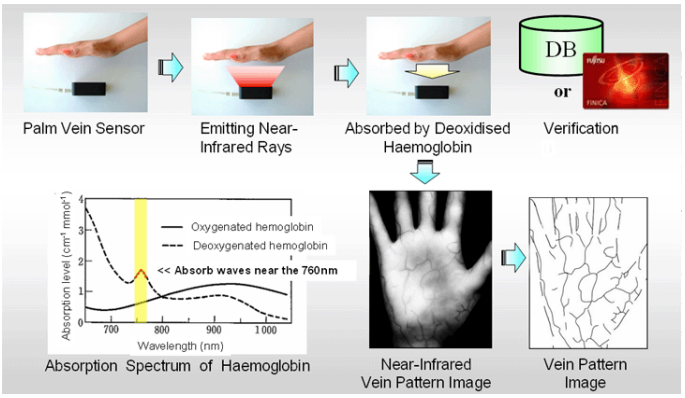

Figure 1 Flow of Palm Vein Technology Process [16].

Biometric template - a numeric representation of several characteristics measured from the captured image, including the proximity and complexity between intervened veins (figure 1). This template is then used to
compare against a user's palm scan each time they undergo authentication process. This technology is non-intrusive i.e. the user need not physically touch the sensor. The users must hold their hand above the sensor for a second. The method is also highly accurate. The International Biometrics Group (IBG), which evaluates all types of biometrics products through comparative testing, found that palm-vein technology was on par with iris scan biometrics in accuracy ratings. Palm-vein recognition technology is notably less costly than iris scanning technology. In fact, the only biometric solution less expensive than palm-vein authentication is fingerprint recognition but it has its own overheads on security feature. For health care organizations, effective palm-vein recognition solutions enable accurate identification of patients, enabling them to quickly retrieve their electronic medical records when they check into respective hospitals. This eliminates the potential human error of accessing the erroneous record, thus

helping in protecting patients from identifying fraudulent attempts. Until now, there has been no biometric technology that can achieve the highest levels of security and usability at a reasonable cost. Palmvein recognition hits that success spot of biometrics between security, cost, accuracy and ease of use that make it an optimal answer and IT enabled control solution for health care organizations and hospitals. Compared with a finger [4] or the back of a hand, a palm has a broader and more complicated vascular pattern and thus contains a wealth of differentiating features for personal identification. The palm is an ideal part of the body for this technology; it normally does not have hair which can be an obstacle for photographing the blood vessel pattern, and it is less susceptible to a change in skin color, unlike a finger or the back of a hand. However research appears to have conquered this challenge and an early demonstration device is built into a computer mouse by Fujitsu in a development of vein pattern identification by researcher Masaki Watanabe. This was used to control access to the computer system. More recently, Fujitsu demonstrated their Contact less Palm Vein Identification System at the annual CeBIT show in March 2005. At least five vendors have been pursuing this technology including Fujitsu, Hitachi, Bionics Co., Identica and Techsphere. Japan's Bank of Tokyo-Mitsubishi made this technology available to customers on 5000 ATM's from October 2004. The biometric template is stored on a multi-purpose smart card that also functions as a credit and debit card and issued to customers. Other Japanese banks are also now introducing this technology. EFTPOS terminals, incorporating palm vein technology are being developed for use in for use in retail stores. While the size of earlier devices limited their use and added to cost, recent developments have reduced the size to make mobile and portable devices feasible. These use 35mm sensors which makes the device small enough to use with laptops and other mobile devices and other office equipment such as copiers [8]. Several of Japan's major
banks have been using palm and finger vein recognition at cash points, rather than PIN, for almost 3 years now and are confirming extraordinarily high standards of accuracy.

2. Principles of Palm Vein Biometrics and Contact less Authentication

The contact less palm vein authentication technology consists of image sensing and software technology. The palm vein sensor (Fig.2) captures an infrared ray image of the user's palm. The lighting of the infrared ray is controlled depending on the illumination around the sensor, and the sensor is able to capture the palm image regardless of the position and movement of the palm. The software then matches the translated vein pattern with the registered pattern, while measuring the position and orientation of the palm by a pattern matching method. In addition, sufficient consideration was given to individuals who are reluctant to come into direct contact with publicly used devices [7] [14]. The deoxidized hemoglobin in the vein vessels absorbs light having a wavelength of about 7.6 x 10-4 mm within the near-infrared area. The device captures an image of vein patterns in wrist, palm, back of the hand, finger or face. This is similar to the technique used to capture retinal patterns. The backs of hands and palms have more complex vascular patterns than fingers and provide more distinct features for pattern matching and authentication. As with other biometric identification approaches, vein patterns are considered to be time invariant and sufficiently distinct to clearly identify an individual. The difficulty is that veins move and flex as blood is pumped around the human body [12]. Human Physiological and behavioral characteristic can be used as a biometric characteristic as long as it satisfies the following requirements:

- Universality: each person should have the characteristic.
- Distinctiveness: any two persons should be sufficiently different in terms of the characteristic.
- Permanence: the characteristic should be sufficiently invariant (with respect to the matching criterion) over a period of time.
- Collectability: the characteristic can be measured quantitatively.

How does Biometrics System Work?

Irrespective of type of biometric scheme is used; all have to go through the same process. The steps of the process are capture, process, and comparison.

- Capture – A biometric scheme is used to capture a behavioral or physiological feature.
- Process – The captured feature is then processed to extract the unique element(s) that corresponds to that certain person
- Comparison – The individual is then enrolled into a system as an authorized user. During this step of the process, the image captured is checked against existing unique elements. This verifies that the element is a newly authorized user. Once everything is done, the element can be used for future comparisons [5].

Certain questions need to be asked when choosing a Biometric System Implementation:

1. What is the level of security is needed?
2. Will the system be attended or unattended?
3. Does your requirement demand resistance to spoofing?
4. What reliability level is required?
5. Should this system be made available throughout the day?
6. Does the system require backups- if yes how many hours of Backup?
7. What is the acceptable time for enrollment?

8. Is privacy to be addressed for your system?
9. What about the storage of the signature?
10. Is the system integrated with Front end and Backend database system?
11. Is the system open for Maintenance activity and tuning around the clock?

In practice, a sensor emits these rays and captures an image based on the reflection from the palm. As the hemoglobin absorbs the rays, it creates a distortion in the reflection light so the sensor can capture an image that accurately records the unique vein patterns in a person's hand. The recorded image is then converted to a mathematically manipulative representation of bits which is highly complicated to get forged or compromised. Based on this feature, the vein authentication device translates the black lines of the infrared ray image as the blood vessel pattern of the palm (Figure 2), and then matches it with the previously registered blood vessel pattern of the individual [9].

2.1 Biometrics Parameters and Keywords Of Palm Vein Technology

- **Vein patterns:** Distinctive and unique to individuals, Difficult to forge
- **False acceptance rate:** A rate at which someone other than the actual person is recognized
- **False rejection rate:** A rate at which the actual person is not recognized accurately
- **Potential is limitless:** Easy to install on personal computer, Reliable , Accurate, Fast, Small
- **Equal Error Rate (EER):** Point where FAR=FRR
- **Failure to Enroll Rate (FTER):** Percentage of failures to enroll of the total number of enrollment attempts.

3. The Working Mechanism/ Implementation behind Palm Vein Biometric

An individual's palm vein image is converted by algorithms into data points, which is then compressed, encrypted, and stored by the software and registered long with the other details in his profile as a reference for future comparison (figure 2). Then, each time a person logs in attempting to gain access by a palm scan to a particular bank account or secured entryway, etc., the newly captured image is likewise processed and compared to the registered one or to the bank of stored files for verification, all in a period of seconds. Implementation of a contact less identification system enables applications in public places or in environments where hygiene standards are required, such as in medical applications. The vein pattern is then verified against a reregistered pattern to authenticate the individual. Numbers and positions of veins and their crossing points are all compared and, depending on verification, the person is either granted or denied access. As veins are internal in the body and have a wealth of differentiating features, attempts to forge an identity are extremely difficult, thereby enabling a high level of security [10]. In addition, the sensor of the palm vein device can only recognize the pattern if the deoxidized hemoglobin is traversing through the veins of the hand which makes the process more secured and safe.

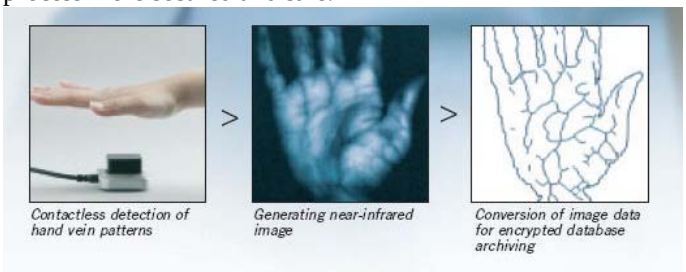

Figure 2. Palm Exposure to Sensor and Conversion/ Comparison against from Archival Database

3.1 Advantages and Disadvantages of Palm vein technology

Advantages	Disadvantages
It does not require user contact	----------
Matching performance is high	----------
Most suitable for authentication	----------
It is accurate , Potential is limitless	Require specialized devices, so can be expensive as of now.
Easy to use or handle	Requires highly active deoxidized hemoglobin.
Unlike fingerprints that change during childhood, the palm vein pattern is established in the womb and is constant throughout a person's life.	---------
It is neither be stolen nor reproduced.	----------

Table: 1 Advantage and Disadvantages of Palm Vein Technology

4. Practical Applications of Palm Vein Biometrics

The rapid growth in the use of e-commerce and online applications requires reliable user identification for effective and secure access control. Palm vein identification has emerged as a promising component of biometrics study. .Applications of palm vein biometrics are: Security systems, Log-in control or network access, Healthcare and medical record verification , electronic record management; Banking

and financial services like access to ATM , kiosks, vault etc. The medical problems like diabetes, hypertension, atherosclerosis, metabolic disorders and tumors are some diseases which affect the vascular systems and are need to be attended very often by the doctor and palm vein technology can come as a bonus facility for faster and accurate medical reading.. In this following section, we present a brief review on the applications and features of applications of palm vein technology useful in the above mentioned sectors.

4.1 Palm Vein for Financial Security Solutions

A rapidly increasing problem among financial sectors in Japan is the illegal withdrawal of bank funds using stolen or skimmed fake bankcards. To address this, palm vein authentication has been utilized for customer confirmation of transactions at bank windows or ATMs. The smart card from the customer's bank account contains the customer's palm vein pattern and the matching software of the palm vein patterns. A palm vein authentication device at the ATM (Figure 3) scans the customer's palm vein pattern and transfers it into the smart card. The customer's palm vein pattern is then matched with the registered vein pattern in the smart card. Since the registered customer's palm vein pattern is not released from the smart card, the security of the customer's vein pattern is preserved. In 2004, the Suruga Bank and the Bank of Tokyo-Mitsubishi in Japan deployed a secured account service utilizing the contactless palm vein authentication system. Several other banks in Japan have followed suit in 2005[13][17]. Fujitsu plans to develop another type of ATM (Figure 3) for use at convenience stores in Japan, embedding the palm vein authentication sensor in the ATM.

Figure 3. ATM with palm vein access control unit pattern authentication sensor unit

4.2 Access Control in House Hold and Business Houses

The palm vein pattern sensor is also used for access control units. The "palm vein authentication access control device" is comprised of the palm vein pattern sensor, a keypad and a small display. This device controls access to rooms or buildings that are for restricted personnel. The device consists of two parts: the palm vein sensor, plus the control unit that executes the authentication processing and sends the unlock instruction [15]. A simple configuration system can be achieved by connecting this device to the electric lock control board or electric locks provided by the manufacturer.

4.3 E-Voting

The physical traits of an individual confirm or verify their identity. This gives rise to ensure citizens e-Voting to br fool proof with no flaws, thus can be employed widely for unique security benefits for identification and security. They can reduce and in some cases eliminate the need for individuals to carry documentation or other physical security measures they might lose or to remember passwords to prove their identification. A more secure future: enabling security through biometrics. Palm vein technology can be a good alternative to world in federal and general election system to figure out undisputed mandate to a winning party. This can introduce much accuracy and reliability dealing millions of voters within hours unlike classical manual methods of franchise votes.

4.4 Nations Border Security Control

Any Border officers have traditional methods by comparing an individual's passport photo to the person. in front of them. Many supporting documents such as entry visas carry no identification other than names, passport numbers, date of birth and addresses etc. Introduction of Biometrics can bring about revolutionary changes in eliminating intrusion into nation's entry. The palm vein technology along with face recognition and fingerprint biometrics can ease identifying

fraudulent and terrorist groups from creeping into other countries.

4.5 Retail Industry

Big retail outlets are making use of biometrics to cater to huge flock of customers and timely delivery of its products and services. This can regulate children age on the purchase of restricted product such as pharmaceuticals, digital products such as alcohol and tobacco etc. If Biometrics is employed in industries along with the ERP systems it can directly address and minimize the commercial and public sector security check burden for dispensing services its products. This can reduce the role of huge server records retrieval and verification at source.

5. Recent technological Developments using Palm Vein Biometric Authentication Sensors

Fujitsu Limited and Fujitsu Frontech Limited [17], Japan has announced that they have developed a PC Login Kit for use with the Palm Secure palm vein biometric authentication device and begun sales of a mouse model
and a standard model for corporate users. Palm Secure PC Login Kit comes standard with login authentication software, enabling client-side authentication and eliminating the need to use an authentication server, which had been required up until now [11]. In addition, other improvements have been incorporated, such as faster authentication speeds without a palm guide and greater tolerance for the distance and angle of the hand when it passes over the device. With the new PalmSecure PC Login Kit, logins to PCs or applications that are in use until now required IDs and passwords can now be done using the highly secure palm vein biometric authentication method. In recent years, as part of efforts to comply with Japan's Personal Information Protection Law and enhanced internal corporate compliance policies, it has become increasingly important to authenticate the identity of people using particular PCs in order to prevent data leaks from PCs that occur because of unauthorized access or identity fraud. Since 2004, Fujitsu and Fujitsu [17] Frontech commercialized the Palm Secure palm vein biometric authentication device, which offers superior security and is easy to use. Since then, the companies have provided the technology to financial institutions and wide array of other industries and organizations for use in various applications, including login to PCs, physical admission into secured areas, management for work time clocks, and library book lending systems. The two companies developed Palm Secure PC Login Kit to make it more simple and economical for customers to deploy Fujitsu's sophisticated palm vein authentication technology. Installing login authentication software as standard-equipped software, sophisticated authentication can be handled by the PC itself, with no need for an authentication server. Palm secure is now widely used in various fields: ATM, 92% of all Japanese ATMs i.e. 18,000 + ATM machines for Bank of Tokyo – Mitsubishi. The mouse model, which is the world's first PC mouse equipped with a palm vein biometric authentication sensor, can easily replace an existing PC mouse, offering convenience and space-saving advantages. The companies have also added a compact and portable standard model to their line of PC login kits for house hold security , user identification and passport verification systems. Both the mouse and standard models are available in black, white and gray to coordinate with different offices and computers. Fujitsu Frontech is in charge of development and manufacturing of the PalmSecure PC Login Kit, with both Fujitsu and Fujitsu Frontech handling sales. Over the next three years, Fujitsu aims to sell 200,000 PalmSecure sensors of all types globally [12][17].

6. Result of experiments

As a result of the Fujitsu research using data from 140,000 palms (70,000 individuals), Fujitsu has confirmed that the FAR is 0.00008% and the FRR is 0.01%, with the following condition: a person must hold the palm over the sensor for three scans during registration, and then only one final scan is permitted to confirm authentication. In addition, the following data has been used to confirm the accuracy of this technology: data from 5-year to 85-year old people of various backgrounds based on statistics from the Ministry of Internal Affairs and Communications of Japan's population distribution; data from foreigners in Japan based on the world population Distribution announced by the U.N.; data of the daily changes of Fujitsu employees tracked over several years; and Data of various human activities such as drinking, bathing, going outside, and waking up. Figure 4 showcases the acceptance and rejection FRR (False Acceptance Rate) and FAR (False Rejection Rate) criteria's mapped with the error rate permissible. Its is very much evident from the table Table 2 how secure and efficient is Palm vein technology over other technologies.

TECHNOLOGY	FALSE ACCEPTANCE RATE	FALSE REJECTION RATE
Palm Secure	.00008%	.01%
Fingerprint	1-2%	3%
Iris	.0001% - .94%	.99% - .2%
Voice	2%	10%

Table:2. Comparison of various Biometric Technologies w.r.t FRR and FAR.

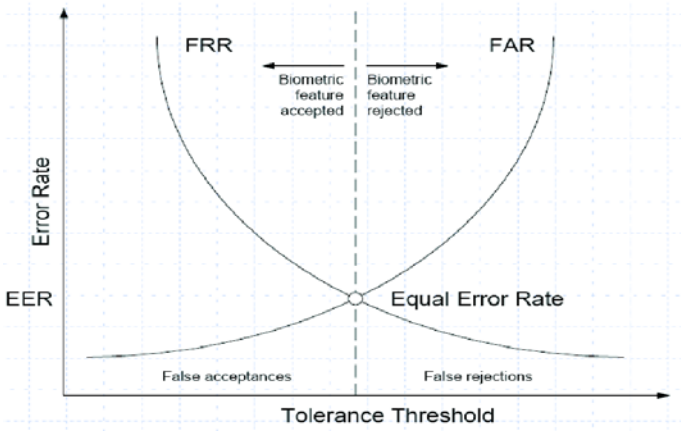

Figure 4. Performance Evaluation

Conclusion

Applications of palm vein biometrics are: a. Security systems: physical admission into secured areas; b.Log-in control: network or PC access; c. Healthcare: ID verification for medical equipment, electronic record management; d. banking and financial services: access to ATM, kiosks, vault. We have already started the work which can be useful for any one of the above mentioned sectors. Biometrics is used for identification purposes and are usually classified as physiological or behavioral. Sometimes a certain biometric can be classified as both. As we continue to progress into the future, more and more biometric schemes will become available. Also, more of the existing biometric schemes will advance further for a higher level of security. Identification and verification classify biometrics even further. The identification process matches 1 to N and the verification process is 1 to 1. As the need for security increases, so will the need for biometrics. It will definitely be interesting to see what the future holds for palm vein biometrics. Palm Vein Technology has presented a new face to the world of security system. It has low FAR and FRR and it has emerged as more hygienic as compared to other systems. In future it can be combined with multimodal biometric system to make the system more attack proof. Thus, we can look forward for an extra ordinary biometric based security systems which would include even passwords along with watermarking authentication algorithms.

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