Biometric Products

Whitepaper

Palm Vein Pattern Authentication Technology

Fujitsu has developed a contactless palm vein pattern authentication technology that uses vascular patterns as personal identification data. Vein recognition technology is secure because the authentication data exists inside the body and is therefore very difficult to forge. It is also highly accurate — in testing using 140,000 palm profiles of 70,000 individuals, it had a false acceptance rate of less than 0.00008% and a false rejection rate of 0.01%*. Suruga Bank, The Bank of Tokyo-Mitsubishi, The Hiroshima Bank and The Bank of IKEDA started customer confirmation using palm vein pattern authentication in July 2004, October 2004, April 2005 and June 2005, respectively. Additionally, in response to the "Act for the Protection of Personal Information," which came into effect in April 2005, an increasing number of financial institutions, including The Nanto Bank, have adopted this technology. Fujitsu has also begun sales of PalmSecure™ products for door security, login authentication and other applications. Business growth will be achieved with these solutions by reducing the size of the palm vein sensor and shortening the authentication time. This paper describes this technology and its expected business expansion.

* *Internal research by Fujitsu resulted in a false acceptance rate of less than 0.00008% and a false rejection rate of only 0.01%. False acceptance rate is a rate at which someone other than the actual person is falsely recognized. False rejection rate is a rate at which the actual person is not recognized accurately.*

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Introduction

In the ubiquitous network society, where individuals can easily access their information anytime and anywhere, people are also faced with the risk that others can easily access the same information anytime and anywhere. Because of this risk, personal identification technology, which can distinguish between registered legitimate users and imposters, is now generating interest.

Currently, passwords, Personal Identification Numbers (4-digit PIN numbers) or identification cards are used for personal identification. However, cards can be stolen, and passwords and numbers can be guessed or forgotten. To solve these problems, biometric authentication technology, which identifies people by their unique biological information, is attracting attention. In biometric authentication, an account holder's body characteristics or behaviors (habits) are registered in a database and then compared with others who may try to access that account to see if the attempt is legitimate.

Fujitsu is researching and developing biometric authentication technology focusing on four methods: fingerprints, faces, voiceprints, and palm veins. Among these, because of its high accuracy, contactless palm vein authentication technology is being incorporated into various financial solution products for use in public places.

This paper introduces palm vein authentication technology and some examples of its application to financial solutions. It then describes PalmSecure, an authentication product that Fujitsu has developed for the general market, and the company's key milestones in an effort to standardize PalmSecure for biometric authentication.

Palm vein authentication technology

Palm vein authentication works by comparing the pattern of veins in the palm (which appear as blue lines) of a person being authenticated with a pattern stored in a database. Vascular patterns are unique to each individual, according to Fujitsu research — even identical twins have different patterns. And since the vascular patterns exist inside the body, they cannot be stolen by means of photography, voice recording or fingerprints, thereby making this method of biometric authentication more secure than others.

Principles of vascular pattern authentication

Hemoglobin in the blood is oxygenated in the lungs and carries oxygen to the tissues of the body through the arteries. After it releases its oxygen to the tissues, the deoxidized hemoglobin returns to the heart through the veins. These two types of hemoglobin have different rates of absorbency[1]. Deoxidized hemoglobin absorbs light at a wavelength of about 760 nm in the near-infrared region. When the palm is illuminated with near-infrared light, unlike the image seen by the human eye [Figure 1(a)], the deoxidized hemoglobin in the palm veins absorbs this light, thereby reducing the reflection rate and causing the veins to appear as a black pattern [Figure 1(b)]. In vein authentication based on this principle, the region used for authentication is photographed with near-infrared light, and the vein pattern is extracted by image processing [Figure 1(c)] and registered. The vein pattern of the person being authenticated is then verified against the pre-registered pattern.

(a) Visible ray image (b) Infrared ray image (c) Extracted vein pattern

Figure 1: Extracting a palm vein pattern.

Advantages of using the palm

In addition to the palm, vein authentication can be done using the vascular pattern on the back of the hand or a finger. However, the palm vein pattern is the most complex and covers the widest area. Because the palm has no hair, it is easier to photograph its vascular pattern. The palm also has no significant variations in skin color compared with fingers or the back of the hand, where the color can darken in certain areas.

Advantages of reflection photography

There are two methods of photographing veins: reflection and transmission. Fujitsu employs the reflection method.

The reflection method illuminates the palm and photographs the light that is reflected back from the palm, while the transmission method photographs light that passes straight through the hand. Both types capture the near-infrared light given off by the region used for identification after diffusion through the hand.

An important difference between the reflection method and transmission method is how they respond to changes in the hand's light transmittance. When the body cools due to a lowered ambient temperature, the blood vessels (in particular the capillaries) contract, decreasing the flow of blood through the body. This increases the hand's light transmittance, so light passes through it more easily. If the transmittance is too high, the hand can become saturated with light and light can easily pass through the hand. In the transmission method, this results in a lighter, less-contrasted image in which it is difficult to see the vessels. However, a high light transmittance does not significantly affect the level or contrast of the reflected light. Therefore, with the reflection method, the vessels can easily be seen even when the hand/body is cool.

The system configurations of the two methods are also different. The reflection method illuminates the palm and takes photographs reflected back from the palm, so the illumination and photography components can be positioned in the same place. Conversely, because the transmission method photographs light that passes through the hand, the illumination and photography components must be placed in different locations. This makes it difficult for the system to be embedded into smaller devices such as notebook PCs or cellular phones. Fujitsu has conducted an in-depth study of the necessary optical components to reduce the size of the sensor, making it more suitable for embedded applications.

Completely contactless design minimizes hygiene concerns and psychological resistance

Fujitsu is a pioneer in designing a completely contactless palm vein authentication device. With this device, authentication simply involves holding a hand over the vein sensor.

The completely contactless feature of this device makes it suitable for use where high levels of hygiene are required, such as in public places or medical facilities. It also eliminates any hesitation people might have about coming into contact with something that other people have already touched.

High authentication accuracy

Using the data of 140,000 palms from 70,000 individuals, Fujitsu has confirmed that the system has a false acceptance rate of less than 0.00008% and a false rejection rate of 0.01%, provided the hand is held over the device three times during registration, with one retry for comparison during authentication.

In addition, the device's ability to perform personal authentication was verified using the following: 1) data from people ranging from 5 to 85 years old, including people in various occupations in accordance with the demographics released by the Statistics Center of the Statistics Bureau; 2) data about foreigners living in Japan in accordance with the world demographics released by the United Nations; 3) data taken in various situations in daily life, including after drinking alcohol, taking a bath, going outside, and waking up.

Product development for financial solutions

Financial damage caused by fraudulent withdrawals of money using identity spoofing with fake bankcards has been rapidly increasing in recent years, and this has emerged as a significant social problem[2]. As a result, there has been a rapid increase in the number of lawsuits filed by victims of identity theft against financial institutions for their failure to control information used for personal identification. The "Act for the Protection of Personal Information" came into effect in Japan on May 1, 2005, and in response, financial institutions have been focusing on biometric authentication together with IC (smart) cards as a way to reinforce the security of personal identification.

Vein authentication can provide two types of systems for financial solutions, depending on where the registered vein patterns are stored. In one method, the vein patterns are stored on the server of a client-server system. The advantage of this system is that it provides an integrated capability for managing vein patterns and comparison processing. In the other type, a user's vein pattern is stored on an IC card, which is beneficial because users can control access to their own vein pattern. Suruga Bank uses the server type for their financial solutions, and The Bank of Tokyo-Mitsubishi uses the IC card system.

In July 2004, to ensure customer security, Suruga Bank[3] launched its "Bio-Security Deposit" — the world's first financial service to use PalmSecure. This service features high security for customers using vein authentication, does not require a bankcard or passbook, and prevents withdrawals from branches other than the registered branch and ATMs, thereby minimizing the risk of fraudulent withdrawals. To open a Bio-Security Deposit account, customers go to a bank and have their palm veins photographed at the counter. In order to guarantee secure data management, the palm vein data is stored only on the vein database server at the branch office where the account is opened.

In October 2004, The Bank of Tokyo-Mitsubishi[4] launched its "Super-IC Card Tokyo-Mitsubishi VISA." This card combines the functions of a bankcard, credit card, electronic money and palm vein authentication.

From a technical and user-friendly point of view, The Bank of Tokyo-Mitsubishi narrowed the biometric authentication methods suitable for financial transactions to palm veins, finger veins and fingerprints. The bank then mailed a questionnaire to 1,000 customers and surveyed an additional 1,000 customers who used devices in their branches. Finally, the bank decided to employ PalmSecure because the technology was supported by the largest number of people in the questionnaire.

The Super-IC Card contains the customer's palm vein data and vein authentication algorithms, and performs vein authentication by itself. This system is advantageous because the customer's information is not stored at the bank.

When a customer applies for a Super-IC card, the bank sends the card to the customer's home. To activate the palm vein authentication function, the customer brings the card and his or her passbook and seal to the bank counter, where the customer's vein information is registered on the card. After registration, the customer can make transactions at that branch's counter and any ATM (Figure 2) using palm vein authentication and a matching PIN number.

The Hiroshima Bank[5] started this type of service in April 2005, followed by The Bank of Ikeda[6] in June 2005. Other financial institutions, including The Nanto Bank, plan to start similar services during fiscal 2005.

Figure 2: ATM with PalmSecure sesor unit.

In 2006, Fujitsu reduced the PalmSecure sensor to 1/4 of its current size for its next generation product. By using a smaller sensor on existing ATMs (Figure 3), there will be room on the operating panel for a sensor for FeliCa mobiles, a 10-key pad that meets the DES (Data Encryption Standard), as well as an electronic calculator and other devices. The downsized sensor can also be mounted on ATMs in convenience stores (Figure 4).

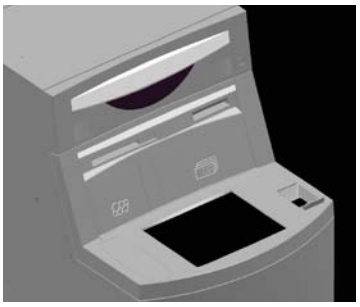

Figure 3: ATM with small palm vein pattern authentication sensor unit (CG design image).

Product development for general market

In addition to product development for financial solutions, Fujitsu has started to develop product applications for the general market.

Two products are in great demand in the general market. One is for a physical access control unit that uses PalmSecure to protect entrances and exits, and the other is a logical access control unit that uses PalmSecure to protect input and output of electronic data. This section describes the features of these applications.

Access control unit using PalmSecure

The PalmSecure access control unit can be used to control entry and exit for rooms and buildings (Figure 5). This unit integrates the operation and control sections. The operation section has a vein sensor over which the palm is held, and the control section performs authentication processing and issues commands to unlock the door. The system can be introduced in a simple configuration by connecting it to the controller of an electronic lock.

PalmSecure units are used to control access to places containing systems or machines that manage personal or other confidential information, such as machine rooms in companies and outsourcing centers where important customer data is kept.

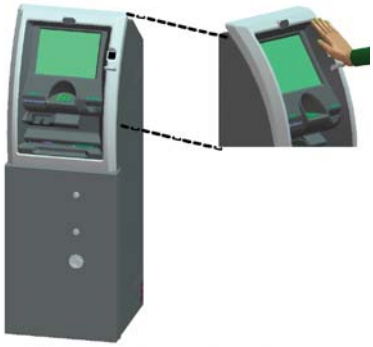

Figure 4: ATM for convenience stores with small palm vein pattern authentication sensor unit (CG design image).

Due to increasing concerns about security, some condominiums and homes have started using this system to enhance security and safety in daily life.

For both of these applications, the combination of the following features provides the optimum system: a hygienic and contactless unit ideal for use in public places, user-friendly operation that requires the user to simply hold a palm over the sensor, and an authentication mechanism that makes impersonation difficult.

Figure 5: Palm vein access control unit.

Login unit using PalmSecure

The palm vein authentication login unit controls access to electronically stored information (Figure 6). As with the units for financial solutions, there are two types: a server type and an IC card type.

Because the PalmSecure login unit can also be used for authentication using conventional IDs and passwords, existing operating systems and applications can continue to be used. It is also possible to build the unit into an existing application to enhance operability.

In the early stage of introduction, the units were limited to businesses handling personal information that came under the “Act for the Protection of Personal Information” enforced in April 2005. However, use of the units is now expanding to leading-edge businesses that handle confidential information.

Figure 6: PalmSecure login unit.

Other product applications

Because of the importance of personal identification, we can expect to see the development of new products for various applications, such as:

- Management in healthcare
  - Access control to medication dispensing
  - Identification of doctors and nurses when accessing protected health records
  - Patient identification management
- Operator authentication
  - Settlement by credit card
  - Obtaining various certificates using the Basic Resident Register Card

- Owner authentication
  - Retrieval of checked luggage
  - Driver authentication
- Attendance authentication
  - Checking attendance in schools
  - Clocking in and out of the workplace.

Standardization

International standardization of biometric authentication technology is now in progress, centered on ISO/ITC JTC1/SC37. Items targeted for standardization include application interfaces, personal data formats, methods for evaluating authentication accuracy, and guidelines for applying this technology to various solutions. Japan has its own national committee for this technology and has established the Biometrics Security Consortium (BSC). Both of these organizations aim to standardize the implementation of biometric authentication technology in Japan.

Fujitsu is an active member of all the subcommittees, working groups and task forces of these standardization activities and also provides chairpersons and arrangers. Particularly for palm vein authentication, Fujitsu is drawing up a vein data compatibility plan and submitting an international proposal in cooperation with other companies in Japan and Korea.

To conform to standards, Fujitsu is preparing to deal with application interfaces and personal data formats such as the Biometrics Application Interface (BioAPI), which supports compatibility between biometric authentication programs, and the Common Biometric Exchange File Format (CBEFF), which is a personal data format that supports data compatibility between systems. When measuring authentication accuracy, Fujitsu conforms to the “Evaluation Method for Accuracy of Vein Authentication Systems (TR X0079),” which is an international standardization plan proposed by the Information Technology Research and Standardization Center (INSTAC), an organization within the Japanese Standards Association.

Conclusion

This paper introduces palm vein authentication. This technology is highly secure because it uses information contained within the body and is also highly accurate because the pattern of veins in the palm is complex and unique to each individual. Moreover, its contactless feature gives it a hygienic advantage over other biometric authentication technologies. This paper also describes some examples of financial solutions and product applications for the general market that have been developed based on this technology. Many of our customers have favorably evaluated this technology and have experienced no psychological resistance to using it. This has encouraged us to start development of new products for various applications, beginning with financial solutions and followed by access control units and login units.

Fujitsu will continue to work on reducing the size of components and programs in order to expand the application range of our authentication solutions. We will also develop products for North America, Europe, Asia and other overseas markets and continue to promote international standardization for this technology.

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About Fujitsu Computer Products of America, Inc.

Fujitsu Computer Products of America, Inc. is a subsidiary of Fujitsu Limited, a leading provider of customer-focused IT and communications solutions for the global marketplace. FCPA provides innovative solutions for the U.S. marketplace. Current product and service offerings include: high performance hard disk drives, Magneto-Optical drives, scanners and scanner maintenance service, palm vein recognition technology, 10Gb Ethernet switches and degaussers.

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