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An Electronic ID System Using a Smart Phone

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Abstract: This paper proposes a personal identification method using a smart phone that displays a face image, character data and a two-dimensional including personal identification data. We have constructed the prototype personal identification system using a smart phone and a Web server to identify each student who attends a class. The effectiveness and the security of the proposed personal identification method are investigated from a wide viewpoint that is not limited to the prototype.

Keywords: smart phone, personal identification, two-dimensional symbol, security

1. Introduction

Personal identification is important in various information systems. We have already proposed the authentication method using a face image for a Web server. This paper proposes a personal identification method using a smart phone that displays a two-dimensional including identification data. Although plastic cards and smart cards are used as ID (identification) cards, the risk to lose these cards are large. In some countries including Japan, many people have color display smart phones with data communication functions. If a smart phone is used for personal identification, it is possible to dynamically display all of the identification data on the color display of the smart phone. Therefore, this is an electronic ID system.

Two-dimensional symbols are constructed by means of extending the functions of barcodes. Two-dimensional symbols have characteristics such as large recording capacity and high-level error correction capability using a Reed-Solomon code. There are various kinds of two-dimensional symbols. Two-dimensional symbols can be classified as a stack type and a matrix type. The stack type symbol such as PDF417 is constructed by stacking multiple low-height barcodes. The matrix type symbol such as QR Code is constructed to store a black or white pattern called as a smart that corresponds to a pixel of an image. By adding the two-dimensional symbol in the personal identification system using a smart phone and a Web server, the two-dimensional symbol including identification data can be quickly read by the CCD camera attached to a computer and decoded to the text data. The security of the personal identification data is strengthened. Because it is possible to apply encryption and digital signatures to the two-dimensional symbol.

The current student identification card in a college or a university is mainly used for the personal identification at the term examination, and at the time when each student receives a certificate from the office of the school. The problems of the current student identification card are that the face photograph size is not large enough to precisely distinguish each student, and it takes several hours or more to receive the reissued identification card when a student forgets to bring the identification card or loses it. We have constructed the prototype personal identification system using a smart phone and a Web server to identify each student who attends a class. The proposed method can be extended to the general personal identification method using a smart phone.

2. Fundamental Concept of the Proposed Personal Identification Method

The fundamental concept of the proposed personal identification method using a smart phone is summarized as follows.

(1) The personal identification data are stored in the database of a Web server (or a computer center).

(2) Each user receives the personal identification data from the Web server on each smart phone. The timing when the user receives the personal identification data depends on each application. It is possible for the user to request the personal identification data of the Web server. It is also possible that the Web server automatically sends the personal identification data at the appropriate time decided by the application.

(3) The smart phone displays the personal identification data such as character data (name, address, etc.), image data (face image, etc.). The checking person checks these displayed data.

(4) The two-dimensional symbol including the personal identification data is additionally displayed on the smart phone. The purpose is to read the displayed data by using a CCD camera with the two-dimensional symbol decoder, and automatically process the identification data at the terminal computer of the checking person.

(5) The two-dimensional symbol is secured by using encryption and authentication techniques [4]. Additionally, the two-dimensional symbol can include the timestamp to limit the valid time for the personal identification data.

3. Implementation of the Prototype

3.1 Overview of the Prototype System

To confirm the correctness of the proposed personal identification method using a smart phone, we have constructed the prototype personal identification system for a college based on the proposed method. The overview is shown in Fig. 1. At first, the administrator inputs the personal identification data for the Web server. The Web server creates a two-dimensional symbol including the personal identification data. The personal identification data including the two-dimensional symbol is transmitted to the student's smart phone at the pre-specified time. At the time of the beginning of a class, each student shows each smart phone displaying the two-dimensional symbol data to the CCD camera with a decoding function for the two-dimensional symbol. Therefore, the attendants are confirmed by using the personal identification data of the two-dimensional symbol.

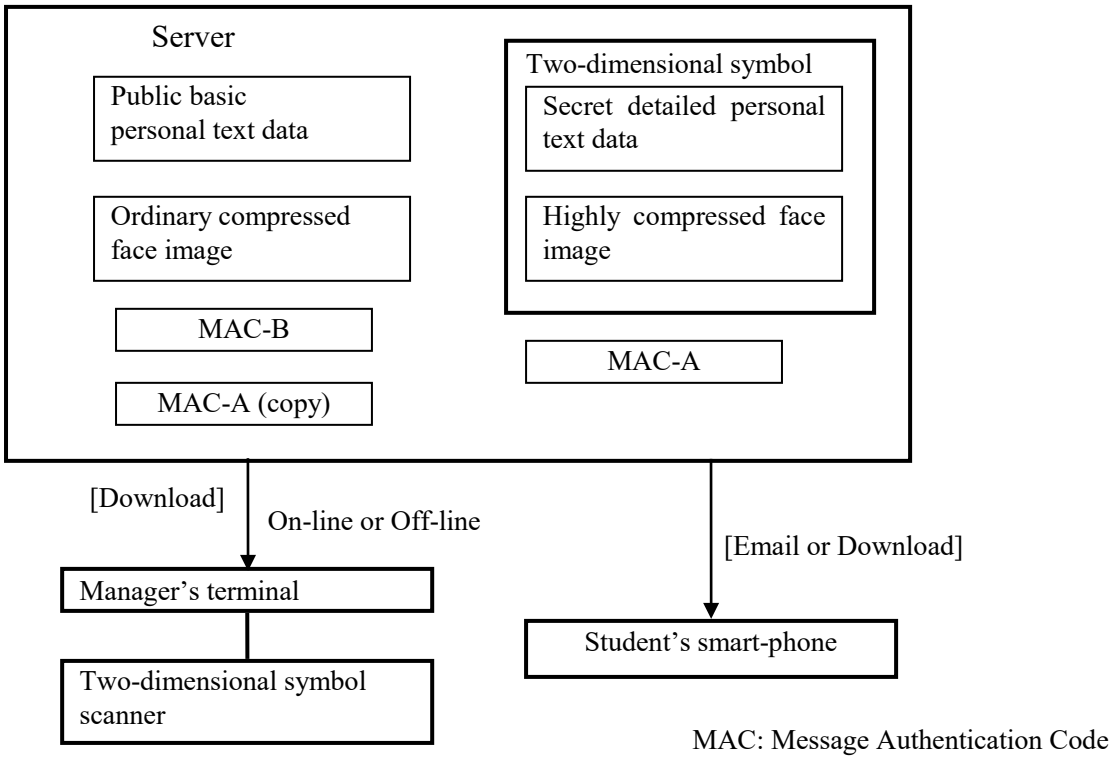

Figure 1. Overview of the prototype system.

Next, the student name and the student number are recorded in the roll database and can be displayed on the manager's notebook computer. The Web server is constructed by using Linux operating system, Web server software and Script language.

3.2 Smartphone of Students

An example of the displays of the electronic ID using a smart phone is shown in Fig. 2. The display of the smart phone can show the face image, the character data and the two-dimensional symbol. The two-dimensional symbol includes the identification data, and can include the digital signature generated by the Web server for the identification data. By using the two-dimensional symbol, the identification data can be quickly read by the CCD camera and the security of the identification data is strengthened. QR code is used for the two-dimensional symbol of the prototype system.

character data Face image Two-dimensional symbol

Figure 2. An example of the displays of the electronic ID using a smart phone.

3.3 Manager's Terminal Device

The manager's terminal device receives the decoded data of the two-dimensional symbol from the CCD camera with the two-dimensional symbol decoder that changes the content of the two-dimensional symbol to the text data, displays the identification data on the screen of the terminal, and displays the list of identified persons such as the student name and the student number.

4. Security Improvement for the Web Access by the manager's portable device

Since the transmission of a face image is performed directly, the size of transmission data is large and there is the danger of leakage of the face image from the communication line. In order to resolve these problems, the following schemes are investigated.

4.1 Message Authentication for the Image

Scheme-M:

Step M1: The face image for authentication is stored in the manager's portable device. At the time of logon, the manager's portable device creates the message authentication code MAC-1 of the transmitter side by using the face image and the transmission time. Next, the message authentication code MAC-1 is transmitted from the Manager's portable device to the Web server.

Step M2: The Web server receives the data from the terminal, and creates the message authentication code MAC-2 of the receiver side by using the registered face image in the Web server. Then, if the message authentication code MAC-1 of the transmission side is coincided with the message authentication code MAC-2 of the receiver side, and only if there is no inconsistency between the transmission time and the received time considering the communication line delay, the user's logon is

permitted. The outline of processing of Scheme-M using the message authentication codes of face images is shown in Fig. 3.

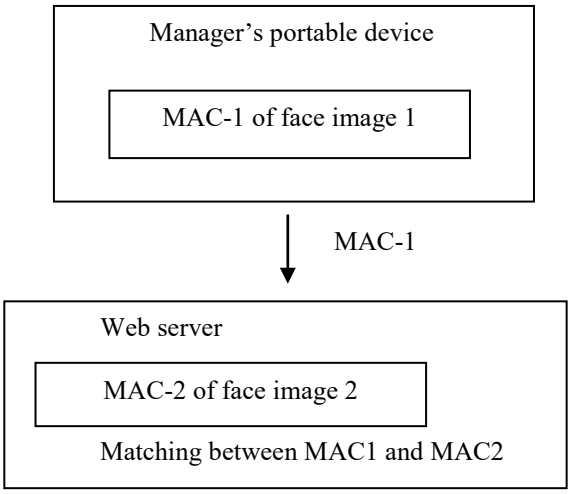

Figure 3. The outline of processing of Scheme-M using the message authentication codes (MAC) of face images.

The message authentication code is a technique to detect the forgery of a message. The message authentication code is a message digest of data that is created by using a common key cipher algorithm.

The procedures to create and verify the message authentication code (MAC) using the face image are described in more detail as follows.

Step 0 (Setup): The manager's portable device holds face image V1, encryption key K and the encryption program. The Web server holds face image V2, encryption key K and the encryption program using a common key cipher algorithm.

Step 1: The manager's portable device creates message authentication code MAC-1 by encrypting face image V using key K, and transmits MAC-1 to the Web server.
(Note: It is unnecessary to transmit face image V1. This is different from the usual usage of a message authentication code that transmits both the MAC and the original message.)

Step 2: The Web server receives MAC-1. Next, the Web server creates message authentication code MAC-2 by encrypting face image V2 using key K. If MAC-1 is equal to MAC-2, the Web server decides that face image V1 is equal to face image V2.

5. The Security of the Electronic ID System using a Smartphone

The attacks and counter measures with regard to the electronic ID system are shown as follows. These investigations are based on a wide viewpoint and are not limited to the prototype system

Attack-1: The unauthorized user who has a smart phone may access the fraudulent Web site created by him, without accessing the correct Web site, and he may display the fake identification data on the display of the smart phone.

Counter measures against attack-1: Attack-1 can be defended when the correct Web site attaches the digital signature in the electronic ID data such as a two-dimensional symbol.

Attack 2: The unauthorized user may display the two-dimensional symbol that is illegally obtained from the correct person on the smart phone.

Counter measures against attack-2: Since a face image is displayed on the smart phone, the check person can compare the face image to the live face. Additionally, since the two-dimensional symbol includes the timestamp to limit the valid time for the ID data, the two-dimensional symbol may become invalid when it is used illegally.

Attack-3: The intruder for the Web server may modify the personal identification data in the database of the Web server.

Counter measures against attack-3: It is very difficult to intrude the secure Web server, to modify the personal identification data, and to generate the two-dimensional symbol including the digital signature. The security measures of a Web server is beyond the scope of this paper (e.g., see [1]).

6. The Merits of the Personal Identification Method using A Smartphone

Table 1 shows the comparison of ID systems among the ordinary ID card system using a plastic card, the electronic ID system using a smart phone without the two-dimensional symbol, and the electronic ID system using a smart phone with the two-dimensional symbol. Comparison items are the risk for losing the ID card, precision of identification, the time for checking the identification data, and the security of the ID system.

Table 1: The comparison of ID systems.

systems / Items	The ordinary ID card system such as a plastic card	The electronic ID system using a smart phone without the two-dimensional symbol	The electronic ID system using a smart phone with the two-dimensional symbol
To reduce the risk for losing the ID card	C	B	B
The precision of identification	C	B	A
The time for checking the identification data	B	B	A
The security of the ID system	C	B	A
Notes: A(Excellent), B(Good), C(Unsatisfactory)			

The proposed personal identification method using a smart phone has the following merits for the electronic ID system using a smart phone. These merits are not limited to the prototype system.

- As the personal identification data can be down loaded from the Web server anytime, it is unnecessary for each person to worry about losing the identification card. Since a smart phone device is frequently used for a phone call and an email besides the electronic ID using a smart phone, the possibility to lose the smart phone is smaller than the possibility to lose a plastic ID card or a smart card.
- As the face image displayed on the smart phone is large enough in comparison with the photograph size of the ordinary plastic ID card, the precision increases when the check person compares the displayed face image to the live face.
- As the personal identification data can be directly read by using the CCD camera with the decoder of the two-dimensional symbol, the data can be automatically processed by the check person's terminal device such as a notebook computer. As the personal identification data can be down loaded from the Web server anytime, it is unnecessary for each person to worry about losing the identification card. Since a smart phone device is frequently used for a phone call and an email besides the electronic ID using a smart phone, the possibility to lose the smart phone is smaller than the possibility to lose a plastic ID card or a smart card.
- By adding the two-dimensional symbol for the electronic ID system using a smart phone, the forgery becomes more difficult and the time for checking the contents of the personal identification data is reduced.

7. Discussion

It is possible to use a specific image pattern instead of a two-dimensional symbol. However, it is difficult to devise a new image pattern, read it by a CCD camera, and quickly decode the specific image pattern to the text data. Therefore, two-dimensional symbols are better than a specific image pattern as for the electronic ID system.

The proposed personal identification method can be extended to the general-purpose electronic ID system using a smart phone, for example, the electronic ID system for a company or an organization, the electronic passport for international travelers, etc.

8. Conclusion

A personal identification method using a smart phone that displays a two-dimensional has been proposed. By using the proposed method, it is possible to construct an electronic ID (identification) system using a smart phone. By using a smart phone for personal identification, it is possible to display all of the identification information on the color display of the smart phone. A prototype personal identification system using a smart phone and a Web server has been constructed to identify each student who attends a class in a college. The display of the smart phone can present the face image, the personal character data and the two-dimensional symbol. The two-dimensional symbol includes parts of the personal data. By using the two-dimensional symbol, the personal identification data can be quickly read by the CCD camera and the security of the personal identification data is strengthened. The proposed system can be extended to the general-purpose ID system using a smart phone. The problem for further study is to construct the other applications using the idea of the proposed personal identification method.

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