Embedded Web Authentication System
Based on Fingerprint Characteristics

Runlin Zhao
Yuncheng University, 1155 Fudan West Road, Yuncheng, Shanxi, China
Tel.: 13350846017
E-mail: yczhaorunlin@163.com

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Abstract: Network security is an important part in the field of information security. With the rapid development of computer technology and Internet technology, the building of medical informatization is changing day by day. How to improve the security of health information systems has become the most important lessons which researchers and hospital managers focus on. As network communication usually begins with the identity authentication, the identity authentication security is critical to the security of the network system. Copyright © 2014 IFSA Publishing, S. L.

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1. Introduction

With the development of biological recognition technology, authentication is also gradually increasing based on all kinds of biometric. Now, the technologies such as biological characteristics identification of iris recognition, retina recognition, face recognition, voice recognition, fingerprint recognition are all in the stage of application or research. But the most mature and most stable characteristics are accepted by the user or the fingerprint recognition technology. Fingerprint used as a form of identification is used in forensic system, which is also threatened along with the development of the network information and network security in recent years. People began to accept by fingerprint features as a means of identification to strengthen the network security specification, which is also used to protect people's life and property safety [1-2].

Fingerprint is a bump on the skin texture in the end of the fingers, which contains large amounts of information. Fingerprint ridge is not straight, and there are always some breakpoints, bifurcation points. These points are fingerprint minutiae, if use for storage and identification of fingerprint image. On the one hand, fingerprint image takes up a lot of storage space, which cause the waste of resources, for the embedded system will greatly reduce the user storage. Fingerprint image, on the other hand, as a kind of personal privacy, are stored in a database can't be accepted by users. From the characteristic of fingerprint image to the fingerprint is a kind of single direction transformation, you can not convert to the fingerprint image from fingerprint characteristic data. So the fingerprint features not as plaintext storage and the fingerprint characteristics as the object is the most appropriate [3-4].

Different fingerprint will not produce the same fingerprint characteristics. Due to the uniqueness of fingerprints, these characteristics also have uniqueness, and the fingerprint characteristic as the basis of the identity authentication. In addition to some general characteristics of the fingerprint, the image feature points were also a means of
authentication. In short, the main two types of fingerprint characteristic are the overall characteristics and local characteristics.

1.1. General Characteristics

Overall characteristic is to point to the fingerprint classification, which mainly divides into the ring, bow and spiral, as shown in Fig. 1. Of course, these three rough classification authentications are not enough, and relatively large amount of calculation, so rarely used.

Fig. 1. The three classifications of fingerprint.

1.2. Local Characteristics

Local features refer to the node of the fingerprint minutiae, as shown in Fig. 2. The general characteristics of two different fingerprints are the same, but details can't be completely the same. Each feature point needs to use location, direction, classification of three properties. The position with the coordinates of feature points (x, y), direction refers to the feature points in the direction of the ridge line, and the classification is used to distinguish the feature points as the endpoint or bifurcation point.

Fig. 2. The node of the fingerprint minutiae.

Detail points to a different data structure combination, which can create a template fingerprint characteristic. However, at present there is no standard in a generic template. By comparing the fuzzy algorithm and two fingerprints similarity calculation, the two fingerprints matching results can be calculated.

Fingerprint identification algorithm means the fingerprint image collecting and the fingerprint template comparing to identify whether they come from the same finger. Firstly, fingerprint image is collected by fingerprint collection device, then the image preprocessing, image segmentation, image enhancement, binarization, thinning), will be useless information to eliminate noise and the useful information. Secondly, extracting fingerprint features, including the endpoints, fork points, the overall characteristics of the fingerprint, fingerprint characteristics to template matching. Fingerprint matching a 1: N and 1:1 in two ways. Than is, 1: N is under test and N fingerprint template fingerprint characteristic respectively, which one judgment for the fingerprint with the fingerprint matching. 1:1 is to fingerprint under test with a fingerprint template matching, to judge whether two characteristics from the same finger.

2. The Fingerprint Image Preprocessing

Fingerprint image preprocessing is to collect simple processing fingerprint images again to extract the feature points, and remove the false feature points later, into the alignment process. In the process of fingerprint matching, effect of fingerprint image preprocessing is very important, feature extraction and matching was conducted on the basis of pretreatment, so the accuracy of the result of fingerprint image preprocessing of fingerprint recognition is crucial. General process of fingerprint preprocessing includes image normalization, image segmentation, image enhancement, binarization, thinning, among which the most complex image enhancement is also the most crucial step.

Low quality fingerprint image preprocessing, feature extraction and recognition are put forward higher requirements. The reason of low quality fingerprint image and performance are mainly are as follows. Finger skin is too dry to make the grain abruptly and forming the endpoint. Finger skin is too wet will make multiple grain together. Fingers are too dirty so that it is difficult to identify which collected image texture structure. Finger on the sensor's move will make the image blur. Fingerprints are some residual stains easily in the subsequent processing, which are mistakenly thought to be effective in the process of feature points. No matter how high is the accuracy of the fingerprint collection device, collected the fingerprint image can have a variety of problems, such as breakpoints, bubbles, and these defects can produce all kinds of the fingerprint feature extraction phase pseudo feature points. Too many false will affect the precision of matching feature points matching may even cause failure.

2.1. Image Normalization

Should first before the fingerprint image processing of image normalization, namely the mean and variance of fingerprint image is adjusted to a particular variance range, is convenient for subsequent processing. Normalization algorithm is through statistical image of each pixel gray value,
calculate the mean and variance of the image, the formula is as follows:

\[
M(I) = \frac{1}{WH} \sum_{i=0}^{W-1} \sum_{j=0}^{H-1} I(i, j),
\]

(1)

\[
Var = \frac{1}{WH} \sum_{i=0}^{W-1} \sum_{j=0}^{H-1} ((I(i, j) - M(I))^2),
\]

(2)

Specify the image after the normalized mean and variance of expectations, calculate the normalized image G formula such as:

\[
G(i, j) = \begin{cases}
  
  M_0 + \frac{Var_0((I(i, j) - M(I))^2)}{Var}, & I(i, j) > M(I), \\
  
  M_0 - \frac{Var_0((I(i, j) - M(I))^2)}{Var}, & I(i, j) \leq M(I).
\end{cases}
\]

(3)

Including M0, Var0 is mean and variance of expectations after normalization, the effect after normalization as shown in Fig. 3.

![Fig. 3. The effect after normalization.](image)

### 2.2. Image Segmentation

Images obtained by fingerprint collection device will consist of four types of area, clear fingerprint ridge, fuzzy fingerprint ridge, clear background region and background region with stain, as shown in Fig. 4. The purpose of the fingerprint image segmentation is to distinguish the prospect of the fingerprint image area and background area. Which get rid of the poor quality in prospect area and cannot recover fingerprint ridge area? Fingerprint image segmentation can reduce the workload of subsequent processing, improve the accuracy of feature point extraction, is a very important step.

![Fig. 4. The four types of area.](image)

Fingerprint image segmentation algorithm which can be roughly divided into two classes: based on block level segmentation and segmentation based on pixel level. The most used is based on image segmentation, namely the image is divided into several equal to the size of the block of each respectively determine the block belongs to prospect area or background area. Segmentation is based on pixel level, each pixel is a background or foreground, in order to segment fingerprint images.

At present the main fingerprint image segmentation algorithm is as follows: Ratha says fingerprint block along the direction of the vertical lines, pixel gray value changes quickly. Therefore, the fingerprint image prospect area of vertical ridge direction gray variance is bigger, the direction of the parallel lines gray-level variance is small. The background of fingerprint area along any direction gray variance values is quite small.

Prospect areas in the fingerprint image gray scale change are bigger, and gray background area is lesser. So usually the fingerprint segmentation algorithm based on variance. Of the original image is divided into W * W small pieces, and calculating grey value in each variance T, T1 if T is less than the threshold is considered background region, otherwise as prospect area, retained. W * W gray variance calculation formula of image block is shown in the following equation.

\[
V(k) = \frac{1}{W \times W} \sum_{i=0}^{W-1} \sum_{j=0}^{H-1} ((I(i, j) - M(k))^2),
\]

(4)

where V (k) is the k gray-level variance, I (I, j) is the pixel gray value (I, j), M (k) is the piece of k grayscale average. If V (k) < T, low k block image as the background, or for the future.

### 2.3. Image Enhancement

Fingerprint image enhancement processing is mainly to strengthen effective information in the image at the same time to weaken the noise elimination. Specific to the following effect: enhance the visibility of the fingerprint ridge line and line to line to remove adhesion between the ridges, cavitation; Be able to connect to a certain extent, broken ridges, make the fingerprint ridge line fairing, eliminate split ends.

Fingerprint image enhancement algorithm is generally divided into two types, that is, spatial domain and frequency domain. Enhancement in the spatial domain, such as average filtering, histogram method such as filtering, median filtering, but the effects of these methods are not ideal. Histogram reaction the statistical characteristic of the image grey distribution, histogram filtering is based on histogram transformation, based on the filter after the histogram of desired shape. Median filter is a kind of local smoothing technique, using a sliding window...
containing an odd number of points, with a window of each point in the grayscale average instead of window center pixel gray value.

The above method is aimed at a random noise in image, and the noise in the fingerprint image belongs to structural noise. Fingerprint image than other images are more rational and clear direction, there are two kinds of fingerprint image direction graph: pattern of point and block diagram. Point the direction is to use each pixel in the representative points in the direction of the grain line direction. Block direction is within the block on the direction of a pixel as a direction of the area. The local enough hours, fingerprint ridge line can be approximately regarded as the only direction, evenly spaced lines. Evenly spaced can reflect good cyclical or frequency. So on the local area, the direction and frequency of the ridge line has a more stable. The fingerprint enhancement algorithm is basic to fingerprint ridge orientation and frequency as a parameter, the main direction of Gabor filter and filter.

Gabor filter is a kind of good frequency characteristic and direction selection feature of band-pass filter, as long as the filter in the process of filtering, ensure that its direction and lines in the same direction, can obtain the airspace and frequency domain filtering joint optimal effect. Although this method in the pretreatment of overhead, but it overcomes the defect of traditional filtering method, has the very good effect on the fingerprint image enhancement. The difficulties of this method are that it is need to compute the frequency of the image, the relatively large amount of calculation. Each region of the fingerprint image can have a fixed frequency values, but calculated frequency will produce some deviation.

Direction filter, a representative of the basic idea is, along the ridge direction filtering, enhancing the visibility of the ridge line and line to smooth lines at the same time to eliminate adhesion have certain effect. O. Gorman and Mehtre first fingerprint image enhancement based on the direction filtering method is proposed, the main idea is: according to the fingerprint of the local frequency filter design, and then the fingerprint image with the convolution filter, the down side of this approach is too slow. Sherlock using time domain convolution is equivalent to the product of the frequency domain, the proposed the enhancement algorithm based on the direction of the frequency domain filtering, but the algorithm using only the grain line direction without using the ridge frequency. The partial fingerprint image gradient operator is used to estimate ridge direction, constructing eight direction filter template again, according to the grain line direction and image of the filter template for convolution.

The detailed principle of the Gabor filter is described below. The Gabor filter formula is

$$H(x, y, \phi, f) = \exp \left\{-\frac{1}{2} \left[\frac{x^2}{\Delta_x^2} + \frac{y^2}{\Delta_y^2}\right]\right\} \cos(2\pi f x_0), \quad (5)$$

One f the direction of the Gabor filter, f center frequency of the filter, s of x and y, respectively, said Gabor envelope in the standard deviation of x, y direction, usually set to a fixed value. So the filtering effect is the key to accurately determine the position of the Gaussian spectrum, which is located a fingerprint direction and frequency.

### 2.4. Image Binarization

Binarization is a very important step in image preprocessing, the so-called binarization is setting threshold, the image converted to only two grey value of image. On the one hand, can make the image binarization is no longer involve the grey value, only associated with the location of 01, reducing the workload of subsequent processing. On the other hand, will eliminate some of the image binarization adhesion, prepare for the subsequent feature extraction and matching.

The main problem is to determine the image segmentation threshold $T$. $T$ select determines the effect of binarization. At the current technology, $T$ can be divided into global threshold and partial threshold. Global threshold is set a fixed threshold values for the whole image $T_1$, local threshold value for image of each block set a threshold $T_2$ respectively. Global threshold value on the downside, for uneven grey value of image binarization after cause grain line break; Compared to the local threshold processing effect will be better.

Due to the ridge line and line width of the fingerprint image is roughly equal, the image of each small, should try to make the selection of threshold is greater than the threshold value of pixels within the image block points and less than the threshold value of the pixel points are equal. Specific algorithm is as follows:

- Will the size of the fingerprint image is divided into non-overlapping for $W \times W$ small pieces.
- The average grey value of each block $m$, $N_h = \text{number of pixel gray value is greater than } m$, $N_t = \text{grey value is less than the number of pixels in the } m$. If $N_t > m$ then $u$ is a very small value), the $m$ as the threshold value; Otherwise, if the $N_h > N_t$, $m + 1$ as the threshold value; If $N_h < N_t$, $m - 1$ for the threshold.

### 2.5. Image

After detailed image becomes a single pixel wide ridge, and refine the grain line is equivalent to the original axis. After binarization ridge is still have
width, fingerprint identification only interested in grain line direction. So the image thinning can reduce redundant information.

Of image thinning algorithms have many, commonly used algorithms are: Hitditch algorithm, E. S. Deutsch algorithm and OPTA algorithm. Refinement algorithm need to meet the following requirements:

- Convergence: iterative process must be able to converge;
- The continuity: can't interrupt continuous lines;
- Topology: ensure the integrity of their lines;
- Retention: keep the details of the fingerprint itself characteristics;
- The detailed sex: after refining grain line width to one pixel.

2.6. The Fingerprint Characteristics Comparison

Fingerprint matching to solve the problem is the feature information extracted from two image matching and determines whether two images from the same finger, this process is very difficult:

Fingerprint acquisition is a process of elastic deformation. Distribution of fingerprints is stereo, fingerprint acquisition is actually the three-dimensional image projection on a two-dimensional image. Due to the pressure Angle, strength, in a different direction, the fingerprint image. Even if the same person in the same finger to collect fingerprints will be different. So the different fingerprint image lies in the scale of change, will lead to the change of the position and Angle.

Low quality fingerprint image to occupy a high proportion of. Because the finger injury, special population of shallow fingerprints and will appear in the image of adhesion and wet finger fracture, when collecting image due to the rotation of the fingers, the scene of the crime collecting fingerprints fragments will influence the effect of fingerprint feature extraction, which will produce some pseudo characteristics, can also cause the real characteristics of omission.

Therefore, even from the same fingerprint image will be produced in the number of feature points, coordinate and Angle change. Should be allowed to exist a certain degree of error in the process of fingerprint matching. Need to tolerate error mainly includes the following several parts:

- Translation deformation, two images differ in position;
- Rotational deformation, there are two image Angle rotation;
- The omission of feature points is allowed;
- Allow the existence of the false feature points.

There are two major categories: the current fingerprint matching algorithm based on feature points matching and based on the feature point matching, which is based on feature points matching is widely used. Single fingerprint image details with 40-120 points, the feature point information is very rich, is also a relatively stable in the image. Based on the feature points matching is generally use fingerprint matching, texture structure for those with poor quality of fingerprint feature points or less is better.

Through the efforts of the researchers, is the ideal of the fingerprint matching algorithm has the following kinds: Isenor is pointed out that to use map matching on two image matching algorithm, such as Hrechak use F structure for fingerprint identification, the most commonly used is developed by the federal bureau of investigation to coordinate to do fingerprint minutiae matching, moreover Ranade relaxation algorithm, genetic algorithm Tian Jie, Ghose the point pattern matching algorithm based on asymmetric neural network, Stockman the method based on Hough transform is put forward by, and Luo for Jain algorithm is proposed to improve the algorithm, etc., have been used for fingerprint identification.

The point pattern matching is an important algorithm of fingerprint matching, it refers to contain feature points \{P1, P2, P3, P4... Pn\} and \{feature points Q1, Q2, Q3 and Q4... Qm\} if two fingerprint images from the same finger of judgement. Point pattern matching is the first thing to solve the two point sets, the geometry of the same problem again to point and point matching fingerprints is obtained by the method of fuzzy matching results.

3. The Use of ActiveX

3.1. The Development of the ActiveX Technology

ActiveX technology developed the original OLE technology, it is a fusion of OCX technology and COM technology. ActiveX technology including automatic control, documentation, script language and Internet technology, a large number of need to implement the interface, it enables developers to directly use other language development program. ActiveX each feature can be traced back to the demand for small, reusable components. ActiveX component types including ActiveX server, ActiveX container, ActiveX controls, ActiveX automation server, ActiveX automation controller, COM components, etc. Among them, the ActiveX server can create ActiveX object for ActiveX container application, support embedded object and link object; ActiveX container can insert ActiveX object used in your application.

ActiveX control is a standard COM object, it is an interface elements at the same time, in the generated control should try to keep control of light. ActiveX controls can be used in a web page, ActiveX documents can be used in the Internet browser. When
a user calls the ActiveX controls, after the client automatically download controls without will transmit the command to the server, the client deployment code, so that we can greatly improve the running speed. Create ActiveX software has a lot of, such as VB, VC, Delphi. VC integrated development environment for the MFC class library, to solve problems encountered in the development of the majority. Using MFC development ActiveX specific process is described below.

Choose when creating the project "MFC ActiveX ControlWizard" option, establish ActiveX control is used to provide web calls, control called Test, create project automatically generated after CTestCtrl, CTestApp and CTestPropPage three classes. The following respectively introduce the three categories:

- CTestApp: COleControlModule derived from the type, while class COleControlModule derived from CWinApp. Through this class, we can get an OLE control object, this object contains controls for initialization and control for clearing member function, also includes the DllRegisterServer or DllUnregisterServer, they used to perform the registration and the registration of ActiveX controls.
- CTestCtrl: COleControl derived from the type, class COleControl is derived from the CWnd.
- CTestPropPage: COlePropPage derived from the type, class is Cole Prop Page derived from C Dialog.

It can be seen that the MFC application framework and general some similar, developers in C Test Ctrl most of the work. Compiler to generate Ocx files can use VC to provide ActiveX Test Container test after the control. Control class to a base class Cole Control on touch function overloading, the wizard to generate the default code is in control of the client area of the draw an ellipse.

### 3.2. ActiveX Control Register

When add ActiveX controls to the dialog box or web pages, you must first register controls, there are three ways of registered ActiveX controls:

- The use of VC in the registered to compile time control, this method can only apply to the local control. Then compile time on the project will complete the registration of ActiveX controls in the system.
- Under the environment of DOS manual registration. If there is no installation routine will be manually registered under DOS, open a DOS environment after switch to the directory Ocx files in the directory, run the regsvr32 command to complete registration of controls.
- The tool by VC6.0 ActiveX Contol Test registers ActiveX control Container. Open the toolbar in VC6.0 ActiveXContol Test Container, in the File drop-down list to open the Register Controls after selecting the corresponding control ID can complete control Register.

After completion of the registration, can be in the registry to see whether there is the ID of the ActiveX control, used to determine whether to register.

### 3.3. The Use of ActiveX

ActiveX controls in the operating system after registration, you can call in your web page. Suppose you have an ActiveX control called test, contains a Login method, call for the Login test control method in the HTML code is as follows:

```html
<OBJECT>
<script language = 'javascript'>
function Login()
{
 var result=Open1.Login(ar);
}
</script>
</OBJECT>
```

Every of them test control ID in the registry, you can in the engineering. Found in odl files or registry; Be the user to test the control of a name; Javascript function of Login function call is the Login method to test controls, including ar as input parameters, the result is the return value. So you can call the javascript function in the JSP page Login to complete the control's call.

If ActiveX control with JSP page relay array, or variable ar or variable result as an array, the array to use with the VARIANT type transformation. The VARIANT type is a data type in the COM technology, there is no shown statement for other types of variable data types, in addition to the fixed-length string data and user defined type, can include any type of data, during the program runs can dynamically change type. VARIANT has two fields in the data, the first domain VT describe the second domain data types. The following respectively introduce the VARIANT type and transformation of the array.

In ActiveX control BYTE array is returned to the JSP page, need to put into a BYTE array VARIANT type variable. Because of the BYTE array can only pass values to safearray, so using Safe Array Create function assigned to create a one dimensional array safearray type variable psa. By Safe Array Put Element function will each element of an array of psa variable value passed to the VARIANT type variable setdt. The implementation code is as follows:

```c
SAFEARRAY FAR*psa;
SAFEARRAYBOUND rgsabound[1];
rgsabound[0].cElements=length;
rgsabound[0].iLbound=0;
psa=SafeArrayCreate(VT_VARUABT,1,rgsabound);
unsigned char;
long index;
VARIANT setdt;
for(index=0;index<length;index++)
{
```
3.4. The Realization of the Function of the ActiveX Control

The ActiveX JAVA and components are integrated, and OLE technology gives the ActiveX through the function of the network. In embedded Web identity authentication system based on fingerprint characteristics, in order to realize the registration and Login function, the two methods is added in the ActiveX Login and Register. Register method when the user Register, Login at the Login method call.

Login authentication process: the user login page. The JSPS to submit user ID to the server, if the ID has been registered, remind "the user name already exists, please register", or in the database to find the corresponding template fingerprint Data, and invoke the ActiveX login () method. The Login method through the fingerprint characteristic fingerprint acquisition instrument, Data and feature template matching, and to compare the results returned to the user.

The JSP page in the database query the corresponding template fingerprint Data (Data for character array), and as the input values to the Login function. The Login function receives the fingerprint template Data (types for the VARIANT), in the control of the VARIANT type to use variable into an array. At the same time the Login function through the USB interface connected to the embedded module pbufs fingerprint feature extracting. Characteristics in the embedded module template Data pbufs comparing with fingerprint characteristics, and to compare the results returned to the JSP page. Above all the Login function to the VARIANT type after receiving array, the VARIANT type of fingerprint template is converted to an array for C programs.

Registration process: after user input user name ID, if the ID has been in existence, prompt the user Register, or call the ActiveX Register () function returns the fingerprint template. Within the Register function to initialize the fingerprint module to extract fingerprint data Chara, Chara variable to a character array type, character array Chara should be converted to the VARIANT type is returned to the JSP page again. The client receiving the VARIANT variables, will feature template and user ID stored in the database to complete the registration.

In the process of user registration and certification require a PC with the fingerprint module of communication and working process including PC connection fingerprint module and transmitted to the PC, the fingerprint feature extracting fingerprint module respectively introduce the two below process. PC connected to the fingerprint module: fingerprint module connected to the PC through the general USB interface. Host the first password and address of fingerprint acquisition instrument using strHexToInt function parses, used to determine equipment password and address is correct, correct device will get equipment information including the handle, the types of equipment, serial number, the number of FG_USB device, the interface type and other information; According to these information open the device and verify password. So the fingerprint module and PC connection is successful. Next, all PC must be through the device information to the embedded module operation.

Fingerprint feature extraction module to PC: open the equipment after the first gets the current device handle effectively; then uses the device handle initialization and device address fingerprint collection device and get the fingerprint image generation fingerprint characteristics, repeat the above for image process, will generate twice the characteristics of the merger to generate template Data. Register function pass after feature template Data conversion for the VARIANT type to the JSP page.

This JSP page through javascript function call ActiveX Register and Login function, can realize the fingerprint feature extracting, feature matching. Detailed process about the client calls ActiveX are introduced in detail in Chapter 5.

4. Conclusions

In this paper, the innovation points are as follows. First, in fingerprint features instead of the traditional Web authentication way, overcomes the traditional Web identity authentication method is easy to crack, the shortcomings of easy to forget, make sure the safety of network identity authentication.

Second, research the fingerprint image segmentation algorithm, and to improve the algorithm. The fingerprint segmentation algorithm based on grain line search and verifies, in addition to the valid not restore the fingerprint image area, reducing the workload of the follow-up of the fingerprint image processing. Two were extracted from fingerprint features into the template, to ensure the stability of the fingerprint template.

This paper analyzes the disadvantages of existing network identity authentication and the statistical data shows that the loss caused by network information to the user, put forward the way of identity authentication based on biological
characteristics of the network. Research existing state of the development of various biometric methods and compares their advantages and disadvantages, relative to other biological fingerprint authentication has the stability, uniqueness, easy to user acceptance, fast algorithms and the advantage of high accuracy.

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