A User Identification System Using Signature Written with Mouse

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Today, computers are connected with other computers, and a world-wide network is established. Many people can access to information through that network. In this situation, a user identification system is very important for protecting information from illegal access.

Computer security is usually attained by the combination of many different security mechanisms. In most of situations, prevention of illegal access is one of the most fundamental mechanisms. It is very important to distinguish illegal users from legal users. Thus a user identification system is very important from security point of view.

There are identification systems using standard devices (keyboard or mouse) and systems using special devices. Generally, user identification schemes use

1. User's knowledge:
   Personal Identification Number (PIN), password.

2. User's possessions:
   seal, physical key, ID-card, IC-card, credit-card.

3. User's biometric:
   fingerprint, retina pattern, iris, voice print, handprint, face pattern.

4. User's action:
   signature, handwriting.

Methods 2 and 3 need exclusive devices, and these devices cost too much for the user identification in personal computers and workstations. Method 4 generally uses a tablet and a digitizer with pen, but they are not popular device yet.

Password is the simplest and the most popular user identification scheme, and does not need exclusive devices. However, we generally think that the degree of security is low, because the user identification using knowledge like password provides lower degree of security than using motion like handwriting or handwritten signature. It is very easy to imitate knowledge like password. If user identification using knowledge like password is cracked once, we can not distinguish illegal users from legal users. On the other hand, it is difficult to crack and imitate action like handwriting than knowledge. User identification scheme based on key stroke latencies can be regarded as an improved password scheme. That system which combines knowledge like password with action like key stroke latencies is more secure than password only.

A mouse is a standard device in today's computers, but a user identification scheme using a mouse is not popular at all. A user identification system using mouse was proposed by Hayashi[11]. But, the object of identification in the scheme is a simple figure, that it is usually very easy to forge a simple figure. Hence, to implement a more reliable identification system using mouse, in this thesis we propose a method to authenticate users using signature.

Handwritten signatures have long been used as proof of authorship of, or at least agreement with, the contents of a document. The reasons of using signature as authorship proof are:

1. The signature is authentic. The signature convinces firmly the document's recipient that the signer carefully signed the document.

2. The signature is unforgeable. The signature is proof that the signer, and no one else, carefully signed the document.

3. The signature is not reusable. The signature is part of document; a bad person cannot move the signature to a different document.

4. The signature is unalterable. After the document is signed, it cannot be altered.

5. The signature is unrepudiatable. The signature and the document are physical things. The signer cannot claim that he/she did not sign it, later.

Presently, signature verification is doing by human verificator who looks at signature with naked eyes, so the verification result is depend on his/her subjectivity. If the verification can be done by computer, the signature can be verified using a standart verification.

In an on-line writing signature process, there is many parameters can be observed. They are signature vertical width, horizontal width, area, length, number of points, points coordinates, number of culmination points, signature writing time, velocity, acceleracy, etc. But, not all of these parameters are usable in a user identification system. We conducted experiments to know which are good parameters. The results of the experiment,

the number of signature points, points coordinates, signature writing time, velocity, and acceleracy are good parameters. We used their parameters in our identification system.

The computation of user verification in our system does not use *arithmetic means* but *geometric average means*, because in *geometric average means* calculation, if one of parameter value is small, the totality of verification value become small too. In a signature forgery, it is difficult to satisfy with all of author's parameters.

In user identification, we can consider four situations: (i) a right user is identified as a right user, (ii) a right user is identified as a wrong user, (iii) a wrong user is identified as a right user, (iv) a wrong user is identified as a wrong user. These situations are called (i)*verify-success*, (ii)*verify-fail*, (iii)*miss-verify* and (iv) *reject-success*, respectively.

Naturally, it is important to keep verify-success-rate high and verify-fail-rate low. The verify-success-rate and miss-verify-rate are usually set to be over 80% and below 5%, in the handwriting identification schemes and the identification schemes based on key stroke latencies.

We implemented a user identification system using signature written by mouse on an X-window system of workstations. An experiment of the implementation system is conducted in our laboratory with 21 testee person. We request to testees to write his/her signature using mouse on X-window. When we have conducted an experiment, by verificating users on dynamic database the verify-success-rate is 93%, and miss-verify-rate is 0% on blind forgery. Our system's verify-success-rate is higher than usually set 80%, and it is higher than 87% in the past system, too.

As described above, we propose in this thesis a user identification scheme using a mouse. We have implemented our system and conducted experiments. In the proposed system, we considered signature's writing acceleracy parameter, computed verification value by *geometric average means*, and used dynamic database to increase the verify-succes-rate and to get down the miss-verify-rate. The implemented system achieves high enough verify-success-rate and low miss-verify-rate. Hence we can conclude that our system is better than the past system and useful for user identification.