# 스마트폰용 동적 서명인증의 모바일 구현

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# Mobile Implementation of Enhanced Dynamic Signature Verification for the Smart-phone

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요 약

본 논문에서는 스마트폰에서 사용가능한 동적서명 인증기술의 사용자 인터페이스와 알고리즘을 제안하고, 제안된 시스템의 성능을 기술하였다. 개인 서명의 모양, 쓰는 속도, 기울기, 획 수와 획 순서 등의 정보를 활용함으로써 인증 여부를 결정하게 되며, 컴퓨터와 무선인터넷이 발달하고 관련 산업이 급성장함에 따라서 폭 넓은 산업 분야에 활용될 것으로 기대된다.

ABSTRACT

We propose a new enhanced graphical user interface and algorithm for dynamic signature verification using Smart-phone. Also, we describe the performance results of our dynamic signature verification system, which determine the authentication of signatures by comparing and analyzing various dynamic data such as shape of the signature, writing speed, slant of shape, and the order and number of strokes for personal signatures using an electronic pen, expecting the system to be understood and utilized widely in the industrial field.



키워드

Dynamic Signature Verification, Authentication, Smart-phone


## Ⅰ. Introduction

Authentication security becomes a more important problem with the increasing use of the computer network and wired/wireless Internet. The biometrics technology using physical and behavioral characteristics of a person is a hot issue nowadays. Many different types of human biometrics technologies such as fingerprint, face, iris, vein, DNA, brain wave, palm, voice, dynamic signature, etc. have been studied widely but remain unsuccessful because they do not meet social demands. Recently, however, many of these technologies have been actively revived and researchers have developed new products in various commercial fields.

The dynamic signature verification technology is intended to verify the identity of the signer by calculating his writing manner, speed, angle, and the number of strokes, order, the down/up movement of the pen when the signer inputs his signature with an electronic pen for his authentication. Expanded use of computer for business in


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접수일자 : 2007. 5. 14

most areas makes computer related crimes unavoidable. To reduce such crimes, we have researched handwriting signature security for the wireless Internet and Smart-phone market.

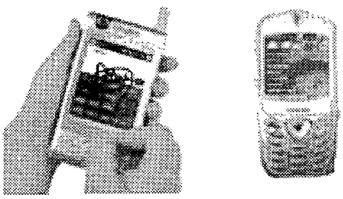

Fig. 1. Smart-phone

In this paper, we describe how this signature security system works when the signer signs his signature with the electronic pen of a Smart-phone in Fig. 1.

## Ⅱ. Dynamic Signature Verification Systems

To describe the system we can classify it into several processes. To compare a true signature with a forgery, the variation range of each signature has to be reduced and the feature points are extracted. To verify an authentic signature the feature information must be registered. To calculate the degree of similarity, a comparing process will be used. To verify a true signature, a decision process will be needed.

### 2.1. The preprocess

Signing varies with age, time and habit as well as psychological and physical condition. This preprocessing is in part to reduce the variation, which occurs while signing the signature. It consists of a noise reducing process, a re-sampling process and a normalizing process.

-The noise reducing process is to reduce or remove the noise produced from the surface slip on the input device or hand trembling while signing the signature.

-The re-sampling process is to speed up the time of the comparing process by reducing the number of coordinate points in case there are too many input coordinates.

-The normalizing process is to handle the variance of the size and slope of the signature.

### 2.2. Feature extraction process

We introduce useful feature points in our dynamic signature verification system. Finding out the best method to calculate the degree of similarity is very important. The previous approach for that is to select and arrange distinctive points [3,8]. For the best signature verification, it is important to reduce the range of variation of the true signature and to extend distinctiveness between the true and forgeries. Assigning the adequate weight for each feature is another important point.

The useful feature pointsare below:

- Velocity, acceleration, pressure information
- Shape of coordinates, direction and slope between two points
- Movement and number of pen down/up points
- Total time taken in signing
- Pen down/up time between strokes
- Number of strokes

Our system primarily uses directions and absolute distances between two points for the pen down/up strokes.

The feature vectors of pen down movement have values of 1 to 36 directions. And the feature vectors of pen up movement have values of 91 to 126 directions. But, distances have absolute length of value between two points. All distances are defined less than 128. So, these directions and distances can be stored in byte strings of small memory. And we use 'd=Max(x,y)+Min(x,y)/2' instead of 'd=SQRT(x2+y2)' to speed up processing time.

### 2.3. Comparison process

In this paper we use the revised dynamic programming method. The direction and distancebetween the two points are used as primary distinctive elements by assigning them the appropriate weight acquired from experiments. These two features indicate important information including speed and shape. Considering pen up movement, the number of strokes and relationships between the strokes are used to calculatethe degree of similarity. Indeed, two signatures cannot have exactly the same timing, besides these timing differences are not linear. Dynamic Time Warping (DTW) is an interesting tool; it is a method that realizes a point-to-point correspondence. It is insensitive to small differences in the timing. Calculation distances between signatures with DTW [6]to achieve a verification system more flexible, more efficient and more adaptive than the systems based on neural networks or Hidden Markov Models, as the training phase can be incremental. This aspect is very important when we envisage to elaborate an authentication method that takes into account the evolution of the signature along the years [4].

The cost function can be defined flexibly depending on the application, for example, cost(a[i], b[j]) = |a[i]-b[j]|*weight. This path can be determined using dynamic programming of our recursive equation:

$$G(i, j) = [\, cost(a[i], b[j]) + \min\{G(i-1, j)+w1, G(i-1, j-1)+w2, G(i, j-1)+w1\} \,] * \max(i,j)/\min(i,j)/(i+j).$$

W1 is a weight value adopted in case horizontal path or vertical path, and w2 is a weight value adopted in case diagonal path. This is the robustness that DTW provides to align sequences. Also we suggest that w1 and w2 are very important weight value for the measure of similarity with DTW.

### 2.4. Signature registration / verification process

The registration process is the stage to store signatures of the signer in the signature database. Fig. 2 shows the user interface registering a signature. The signer signs his signature and then clicks the 'Register' button. The signer then signs the same signature one more time and clicks the 'Test&Verify' button to see the degree of similarity. The signer can choose the security level according to his needs (secret: 1, important: 2 average: 5 low: 7) and tests as many times as he likes. If the signer is satisfied, he can press the 'Save' button to store his signature's feature informationand the value of the security level into a database.

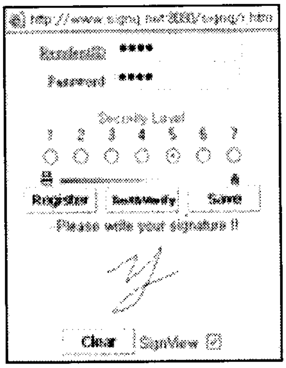


Fig. 2. Signature registration window

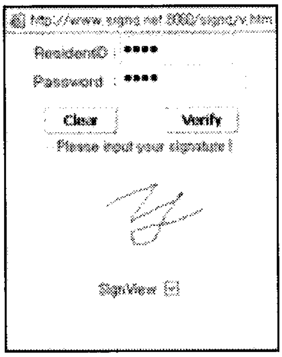


Fig. 3. Signature verification window

Fig. 3 shows the user interface indicating the verification results if the signer is the right person. In this process, if the signer is proved to be the right person,certain authority will be given. If the signer does not want his signature to appear on the screen, he can control with the 'SignView' button.

## Ⅲ. Performance Results

The characteristics of our system are as follows:

(1) Database for the signature is very small. It needs 20-250bytes of memory to register the feature information of a signer.

(2) Verification processing time is within 0.01 second.

(3) On the recommendation of the feedback system, the signer can choose from security levels of seven levels according to the ability of the signer.

(4) The size of our signature engineis 6KB for WinCE and JAVA so our system can be used in small, handy devices like smart-phones.

(5) Using dynamic information makes hacking nearly impossible.

(6) Accuracy rate (acceptance rate for true signers and rejection rate for forgeries) is very high.

(7) The signature security system using a smart-phoneis is economical and simple because you can install just signature verification software without purchasing any signature input devices.

(8) Like changing PIN numbers and passwords, the signer can change his signature if he wants. But the signer's training and efforts are needed for the higher security levels of the signature system.

## Ⅳ. Conclusions

The dynamic signature verification system tells true signaturesfrom forged ones. While the signer input his signature with an input device such as an electronic pen, our system analyzes and extracts feature information from the dynamic signature data and verifies whether the signature is a forgery or not by analyzing the dynamic information of the signer such as writing speed, writing order, elapsed time and pen up/down movement. In previous techniques, the signature appears on the monitor when the signer signs as verification. In our system, the signature to be verified does not appear on the monitor. Thus the possibility of stolen signatures is reduced. The system was designed to induce the signer himself to sign his signature consistently so that the system becomes more efficient and the degree of security is enhanced. As a result, imitation is nearly impossible.

The importance of security is being emphasized more and more at present. Our system is applicable to the security of computers, important documents, the access restriction of network servers, on-line shopping, credit cards, military secrets, national administrative security, internet banking, cyber trading, admittance to buildings, personal approval and so on.

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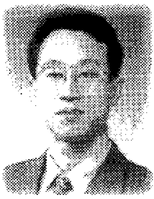
## 저자소개



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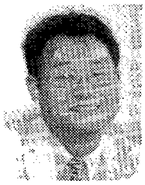

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