A Graphical User Identifier Suggestion Function Scheme Using Sketching for Mobile Web-Services

Yusuke Matsuno, Hung-Hsuan HUANG, and Kyoji Kawagoe

***Abstract*—Despite a rapid progress in biological authentication technologies for user identification, the traditional text-based UserID-and-password scheme has still widely been used even for mobile web-services. In the mobile usage, a virtual keyboard is difficult to use for input texts, which causes much time to input a text. To decrease the difficulty, the authors previously proposed Graphical User IDEntifier Scheme(GUIDES). GUIDES can enable a user input his/her User-ID more efficiently and remember it more, compared with the text-based user-id scheme. It was shown from our previous experiment that GUIDES was able to enable a user input his/her User-ID more efficiently and remember it more, compared with the text-based user-id scheme. In this paper, we propose a new method to construct a graphical user-ID to improve our GUIDES. The new method, called Graphical user-ID suggestion scheme, can give a user a user id similar to the user-specified user-ID when the user specifies the same user-id that has already been registered.**

***Index Terms*—authentication, mobile web service, user-id, suggestion, graphical password;**

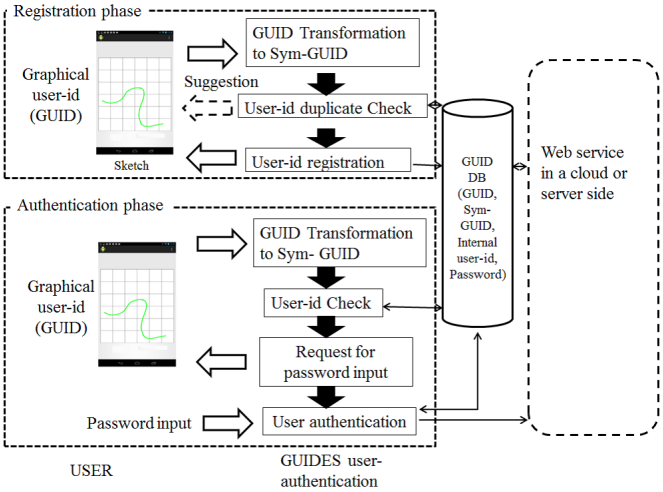

Fig. 1. GUIDES architecture

I. Introduction

MOBILE users have rapidly increased owing to the progress and popularization of mobile-related technologies on CPU, memory, touch-screen, and networking devices. The users can access to many web services at any time and from any place with mobile equipment in the same way of using PCs. A user of an internet shopping service can access to the user ' s shopping history which is only accessible to the user.

In order to realize such a customized web-service, the traditional user identifier method uses a pair of user-id and password. Although this user identifier scheme based on the user-id and password is simple and popular in PC environment, this scheme is not appropriate for a mobile user. This scheme has crucial problems, when a user manipulates a mobile device, such as 1) it is difficult for a mobile user to input his/her user-id and password via a virtual keyboard, and 2) a user frequently forgets his/her user-id and password which the user registered for a special web service. To prevent the above problems, a user stores the user-id and its password in a mobile device or writes down it on a memo. Some password management application services are available to manage a pair of user-id and password per a web service. However, the pair of the user-id and the password can be easily stolen and this may cause an illegal use of such user's data. In order to solve reducing user-id input time and reduction of memory burden, we previously proposed GUIDES (Graphical User IDEntifier using Sketching) [1]. GUIDES basically uses the signature scheme for developing the graphical user-id. GUIDES provides a user to register and to write a user's signature in a restricted format.

In this paper, we propose user-id suggestion function. When the user-id has already been registered, this scheme suggests a new user-id to the user. Suggested user-id resembles user-id that the user has already registered. We examined effectiveness of user-id suggestion function.

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II. Graphical User Identifier Scheme(GUIDES)[1]

In our previous paper[1], we proposed a Graphical User Identifier Scheme Using Sketching for Mobile Web-Services(GUIDES).

There are many schemes on text-based user-id. Any of the text-based user-id schemes has the following characteristics. 1) the more length it is, the more difficult to remember, 2) the id space is large enough to identify an individual user, 3) it is less necessary to hide a user-id than passwords, and 4) a keyboard is necessary to input a user-id.

From considering the above characteristics, a graphic-based user-id scheme has the following five requirements. First, the user-id space should be large enough to register a large number of users and to enable each user identified by a user-id. If 8 alphanumeric digits are used as a text-based user-id, the space size is approximately 10^{12}. Therefore, the graphical user-id should support such a user-id space size.

Second, neither a keyboard nor an additional special device is used for user-id input. It is tedious for a mobile user to log-in every time when accessing a web service using a virtual keyboard. The graphical user-id should be inputted only using the mobile touch-screen device.

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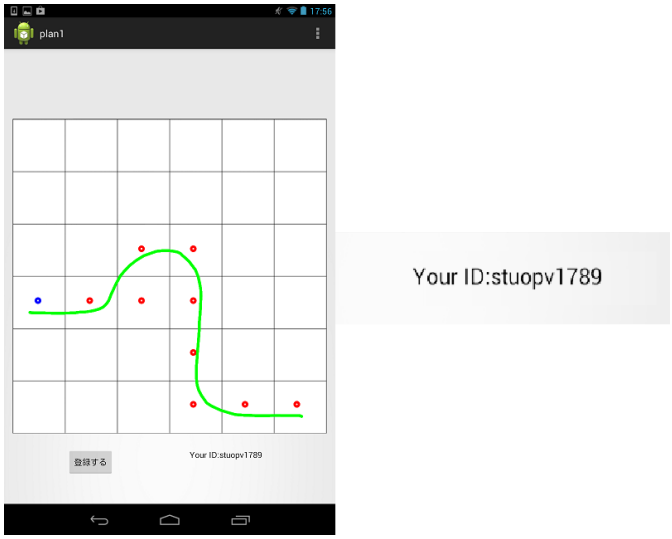

Fig. 2. GUID and Sym-GUID

Third, it should be reproducible and transferable. Even if a user forgets his/her user-id, it should be transferred and provided to the user.

Fourth, it should be easy to remember and to recall. As in the password, the user-id should be easy to remember and to recall without writing it on a memo for future reference.

Last, an acceptable user-id candidate should be suggested when the user fails to register due to an already-registered user-id. This requirement is necessary when a user intends to register his/her preferred user-id and the user-id has already been registered by others. In this situation, it is desirable for the user to receive a suggested user-id. The last one is an important point to differentiate our scheme from graphical password schemes such as DAS.

The basic idea of GUIDES (Graphical User IDEntifier using Sketching) is to use the hand-written signature which is the smart, natural, and practical way of user identification in a daily life. Figure 1 shows GUIDES architecture. GUIDES has a user registration function and user authentication function. The basic architecture of GUIDES is shown in Figure 1, in which a user registers their graphical user-ID, GUID, during the registration phase. The system transforms the GUID into its symbolic representation, Sym-GUID. The system then checks whether there is an existing Sym-GUID in the GUID database. If there is, the system suggests another GUID similar to the user-inputted GUID. If not, the GUID is stored in the database. During the authentication phase, after obtaining a GUID from the user, the GUID is also transformed into the Sym-GUID as in the registration phase. If the GUID exists in the GUID DB, the user is requested to input their password. Figure 2 shows GUID and Sym-GUID.

We conducted evaluation experiment to ascertain effectiveness of GUIDES. We compared a conventional text-based user-ID scheme (randomly generated 7 characters) and GUIDES. Also, we recruited ten participants to join the three experiments.

EX1: Success rate measurement
EX2: The time required for the GUID input is measured
EX3: Memorability check (the success rate measurement was conducted on the three days after EX1)

Result of evaluation is Table I. GUIDES obtained a high success rate than text-based user-ID scheme. Also, GUIDES required shorter input time than text-based user-ID scheme. Further, memorability of GUIDES was superior to the text-based user-ID.

TABLE I
RESULT OF EVALUATION

	GUIDES	Text-based user-id(%)
EX1	93.3%	96.7%
EX2	3.56 sec.	8.47 sec.
EX3	83.3%	66.7%

III. SUGGESTION FUNCTION

A. Suggestion Scheme

In this paper, we focus on user-id suggestion function. When the user-id has been already registered, recommending user-id similar to the user-id registered in the user. First, we will describe the overview of GUIDES up to the Suggestion Function.

Formally, GUIDES is described as follow. Assume that there is the GUID database $DB = d_i$, where d_i is a triplet of GUID, g_i, Sym-GUID s_i and user profile u_i for each user. s_i is obtained using a transformation function $F()$ for g_i that is $s_i = F(g_i)$. The inverse transformation $F^{-1}(s_i)$ is an approximation of g_i. Support that a user wants to register g_q, the s_q is obtained from $F(g_q)$. The s_q is whether there exists an s_k or not, such that $distance(s_q, s_k) \leq \epsilon_1$, for $s_k \in DB$. If not exists, then the triplet of (g_q, s_q, u_q) are added to DB. If s_k exists, g'_q is constructed and suggested to the user. This function's name is Suggestion Function. Suggestion Function suggests user-id which is resemble original to users. Using Suggest Function user-id is g'_q. $g'_q \approx g_q$. In the authentication phase, given the user input GUID g_q, $s_q = F(g_q)$ is obtained. Then, the s_k is checked as $distance(s_q, s_p) \leq \epsilon_1$ for $s_p \in DB$. If exists, then the obtained s_p is the user GUID, followed by password input.

We propose the following three types of Suggestion Functions in this paper.

- Addition-based suggestion (ADD-Suggerst)
- Detour-based suggestion (DETOUR-Suggest)
- Pattern-based suggestion (PATTERN Suggest)

B. Addition-based suggestion (ADD-Suggest)

First, we describe ADD-Suggest function. ADD-Suggest adds trajectory behind Sym-GUID. So, user-id which is using ADD-Suggest resembles original user-id. Added trajectory is four pattern that is top, down, left, right. First, ADD-Suggest checks whether added trajectory GUID exists in GUID DB or not. If added trajectory GUID exists in GUID, ADD-Suggest suggests another added trajectory GUID. Else, ADD-Suggest suggests added trajectory GUID to user. ADD-Suggest suggests resemble original user-id in order to be able to easily recall.

Formally, ADD-Suggest is described as follow. User-id registration is as described above. g'_q is using ADD-Suggest user-id. Length of $g'_q = g_q + 1$. So, $distance(s'_q, s_k) = 1$.

Figure 3 shows example of ADD-Suggest for $n_x = n_y = 6$. Length of $g_q = 8$. Result of using ADD-Suggest, length

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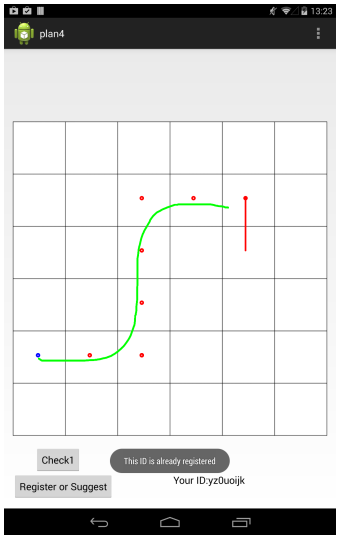

Fig. 3. ADD-Suggest

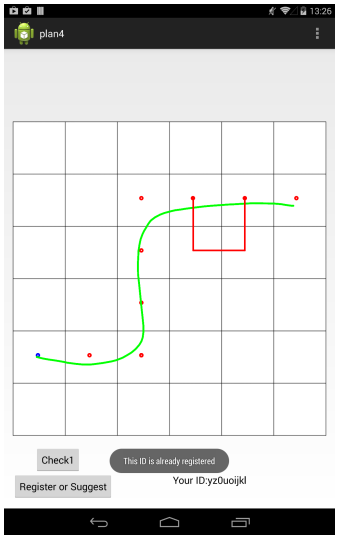

Fig. 4. DETOUR-Suggest

of $g'_q = 9$. Also, $s_q =$ "$yz0uoijk$", $s'_q =$ "$yz0uoijkq$". Suggested user-id is added trajectory by Add Suggestion function. Therefore, Sym-GUID increase one word. And then, user can register suggested user-id.

C. Detour-based suggestion (DETOUR-Suggest)

We describe DETOUR-Suggest function. When registered user-id has already registered, DETOUR-Suggest suggests new user-id to users. DETOUR-Suggest makes detour some of the registered GUID. Suggested user-id doesn't pass trajectory that tie two previous point from last and one previous point from last.

Suggested user-id and registered user-id difference is small. Therefore, GUID which is using DETOUR-Suggest is not burden of memory for users. Also, user does not feel uncomfortable.

Formally, DETOUR-Suggest is described as follow. User-id registration is as described above. Length of $g'_q = g_q + 2$. So, $distance(s'_q, s_k) = 2$.

Figure 4 shows example of DETOUR-Suggest. Length of $g_q = 9$. Result of using DETOUR-Suggest, length of $g'_q = 10$. Also, $s_q =$ "$yz0uoijkl$", $s'_q =$ "$yz0uoirsjkl$". Suggested user-id is transformed trajectory by DETOUR-Suggest. Therefore, Sym-GUID increase two words. And then, user can register suggested user-id.

D. Pattern-based suggestion (PATTERN-Suggest)

We describe PATTERN-Suggest function. When registered user-id has already registered, PATTERN-Suggest suggest new user-id to users. PATTERN-Suggest inserts certain pattern beginning of the original use-id. Inserted certain pattern is easy pattern. So, user needs only a simple work when you register a suggested user ID. Therefore, GUID which is using PATTERN-Suggest is not burden of memory for users.

User-id registration is as described above. Length of $g'_q = g_q + 4$. So, $distance(s'_q, s_k) = 4$.

IV. Evaluation Experiment

In this section, we describe evaluation experiments and their results to show effectiveness of our suggestion functions. GUIDES and Suggestion Function were implemented on Android 4.3 devices using JAVA. First, we checked registration success rate, meaning how much the GUID is successfully registered. Second, the time for inputting GUID is measured. These tasks were conducted by each of subjects three times. Suggestion scheme is compared with the case without Suggestion scheme. In these experiments, we use only ADD-Suggest.

Five participants were recruited to join in these experiments. Each participant first registered his/her GUID. These length values were chosen to create the same user-id space. Each participant input his/her GUID three times in the user authentication phase. The average input time is then calculated by aggregating all the input time for authentications.

We conducted two experiments. These are experiments of measuring registration success rate and input time.

A. Experiment of registration success

When users registered their user-ids, the user-ids may have already been registered. In this situation, such a user feels uncomfortable to consider another new user-id which resembles the original user-id. Therefore, we proposed Suggestion Function to provide the user a new user-id. And, we conducted experiments on registration success to show the effectiveness of Suggestion Function. First, the GUIDs for two hundred thousand users were automatically generated by our GUID automatic generation program and stored in the test user DB. Then, we calculated a registration success rate when our Suggestion Scheme are used to generate another user-ID. We compare its registration success rate after generating a new user-id with GUIDES without our suggestion scheme.

The result of experiment is shown in Table Ⅱ.

Table Ⅱ shows that GUID registration success rate using our Suggestion Scheme and GUIDE without our Suggestion Scheme. Average registration success rate of With Suggestion Scheme is 86.8%, while that of Without Suggestion Scheme is 73.6%. Registration success rate of With Suggestion Scheme is higher 13.2% than registration success rate of Without Suggestion Scheme. Because our Suggestion scheme can be used many times, the registration success rate of With

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TABLE II
RESULT OF REGISTRATION SUCCESS RATE

	With Suggestion Scheme	Without Suggestion Scheme
participant	registration success rate(%)	registration success rate(%)
A	67%	100%
B	100%	67%
C	100%	67%
D	100%	67%
E	67%	67%
Average	86.8%	73.6%

Suggestion Scheme will increase if several user-id generation is conducted. From the first experiment, using Suggestion Function is useful for users to register his/her own user-id.

B. Experiment of input time

We measured both input times of With Suggestion Scheme and Without Suggestion Scheme. We compared the time of With Suggestion Scheme and the time of Without Suggestion Scheme.

The result of this experiment is shown in Table Ⅲ.

TABLE III
RESULT OF EXPERIMENT OF INPUT TIME

	With Suggestion Scheme	Without Suggestion Scheme
participant	input time(sec.)	input time(sec.)
A	4.88 sec.	3.62 sec.
B	3.76 sec.	3.73 sec.
C	8.23 sec.	5.12 sec.
D	5.20 sec.	4.18 sec.
E	4.46 sec.	5.97 sec.
Average	5.30 sec.	4.52 sec.

Table Ⅲ shows that GUID input time of With Suggestion Scheme is slightly longer than that of Without Suggestion Scheme. The input time shown in Table Ⅲ is the average of the time of three times experiments for each subject.

As shown in Table Ⅲ, the average input time of Suggestion Function was 5.30 sec. while the average input time of GUIDES was 4.52 sec. The difference of these times is 0.78 sec, which is small. Therefore, there seems to be no difference in the Suggestion Function and GUIDES.

V. RELATED WORK

Although our method proposed here is not a graphical password scheme, many graphical password schemes has been studied for the last decade[2]. Graphical password is classified as drawing-based and selection-based schemes. The typical examples in the first category are Draw-a-secret (DAS)[3], TMD[4], TMO, and Pass-Go[6], while the second category includes Passpoint[7]. Many graphical passwords are mainly proposed to prevent a user from dictionary attacks and shoulder-surfing attacks. None of the graphical passwords can be used as replacement of user-id. Despite developments of the graphical passwords as well as those of the user authentication frameworks, no user-id schemes as a replacement of text-based user-id have yet been proposed, especially appropriate for mobile users.

VI. CONCLUSION

In this paper, we proposed user-id registration processing scheme, called Suggestion Function, in order for a mobile user to input the user-id without a virtual keyboard. We were sure effectiveness of Suggestion Function. We compared the user-id input time and success rate of Suggestion Function and GUIDES. Moreover, there was little difference of Suggestion Function and GUIDES on the input-time. As a result, it is shown that our Suggestion Function is effective in providing a user-id candidate to users.

In the future, we will evaluate memorability of Suggestion Function, by conducting the success rate measurement in three days after the user has registered a user-id. In addition, we will compare the success rate of Suggestion Function with that of GUIDES, to confirm effectiveness of Suggestion Function.

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