User's Affinity of Choice: Features of Mobile Device Graphical Password Scheme's Anti-Shoulder Surfing Mechanism

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Abstract

Presently, there are various types of graphical password schemes and anti-shoulder surfing mechanisms are available. Unfortunately, the features best suited for anti-shoulder surfing mechanism on mobile devices are still an uncertainty. Furthermore, it is futile to try embedding every single available feature into a single graphical password anti-shoulder surfing mechanism for mobile devices. In this paper, a survey of user affinity was conducted to investigate the features best suited for an anti-shoulder surfing mechanism for graphical password scheme on mobile devices. The survey results will identify the most preferred features by the users for the mobile device graphical password anti-shoulder surfing mechanism.

Keywords: *graphical password, anti-shoulder surfing mechanism, mobile device, user's affinity of choice survey*

1. Introduction

It is well known that graphical password is inherently vulnerable to the shoulder surfing attack as humans are better at memorizing pictures than texts [1] [2]. Shoulder surfing attacks are an attack whereby the shoulder surfers are stealing the victims' password by looking over or peeping over the victim's shoulders [3] [4]. Thus, usually, the anti-shoulder surfing mechanism is embedded in the graphical password scheme to prevent the shoulder surfing attack. However, at the present time, there are too many choices for graphical password scheme with anti-shoulder surfing mechanism. Furthermore, there are anti-shoulder surfing mechanisms that are specific for graphical password schemes on general devices, and those specific for usage on mobile devices. The general devices refer to devices such as the personal computer (PC), and the ATM machine and so forth. Meanwhile, the personal digital assistant (PDA), smart phone, or the ordinary cell phones are examples of mobile devices. This indirectly gave rise to curiosity of what are the features best suited for an anti-shoulder surfing mechanism for graphical password scheme on the mobile devices.

This paper is not interest in findings the features that best suited the anti-shoulder surfing mechanism of the general device graphical password scheme since there are already too many available at this day. Moreover, most of the existing mechanisms are already proven almost balance in terms of usability and security. Hence, in this paper, we are more interest in findings the features that are best suited the anti-shoulder surfing mechanism of the mobile device graphical password scheme through the user's affinity of choice survey. The significant of the result of the survey will deeply influencing the design and the construction of the mobile device graphical password anti-shoulder surfing mechanism in the future, while making it more easily being accepted by the users since these features are all chosen by the users themselves.

2. Related Works

Previously there were similar user's affinity of choice survey were conducted [5], however their survey was focused on picture attributes and not the features of graphical password scheme. These picture attributes are the picture's size, picture's presentation, picture's colour,

and the picture's category. Under the picture's size, there are three options are given to the respondents. The picture's which are in the big size, medium size, or the small size. In the meanwhile, in the picture's presentation, the respondents are given with these two options, the single picture or the multiple pictures. In terms of picture's color, another two options which are colored picture and the colorless picture are provided. Lastly, four main options (People, Nature, Animal, Entertainment, Miscellaneous) with 15 sub-options (face, whole body, land, sea, island, water animal, air animal, land animal, sport, movie, animator, car, food, signage, flag) are provided under picture's categories. Table 1 demonstrates the result of the user affinity of choice survey, showing the respondents chosen picture attributes.

Table 1: Respondents chosen picture's attributes for graphical password scheme

Picture	***Respondent Choice***
Size	Medium
Presentation	Single Picture
Color	Colored
Category	Animal (land)

3. Features of Existing Graphical Password Schemes' Anti-Shoulder Surfing Mechanism

In order to identify the features of the existing graphical password schemes, the anti-shoulder surfing mechanism of the general device graphical password schemes and mobile device graphical password schemes are study and analysis. The reviewed general device graphical password schemes' anti-shoulder surfing mechanism included S3PAS [6], Triangle Scheme [7], Intersection Scheme [7], YAGP [8], ColorLogin [9], RGGPW [10], Hasegawa algorithm [11], CTZ [12], Use Your Illusion [13], Association-based graphical password scheme, Stroke-based graphical password scheme [14], and PassGo [15]. The features that are used in the existing general device graphical password schemes' anti-shoulder surfing mechanism are as what are shown in Table 2.

Table 2: Features of existing general device graphical password anti-shoulder surfing mechanism

	Picture type		***Color***			***Presentation***		***Input Behaviors***			
Graphical Password scheme's Name	Single Picture	Multiple Pictures	Colored Picture	Black & white Picture	Gray Scale Picture	With Grid	With No Grid	Touching \ clicking	Swipe left \ right	Swipe up \ down	Moving
S3PAS		√	√				√	√			
Triangle Scheme		√	√				√	√			
Intersection Scheme		√	√				√	√			
YAGP						√		√	√	√	√
ColorLogin		√	√			√		√			
RGGPW		√	√				√	√			
Hasegawa algorithm		√	√			√		√			
CTZ	√		√				√	√			
Use Your Illusion		√	√			√		√			
Association-based scheme	√	√	√		√	√		√			
Stroke-based graphical password scheme						√		√	√	√	√
PassGo			√			√		√			

As what is shown in Table 2, the features of existing general device graphical password anti-shoulder surfing mechanism are consisting of four categories. These four categories are picture's type, color, presentation, and input behavior. Currently, there are two types of picture's type that are used by the existing mechanism. These two types of picture's type are the single picture and the multiple pictures. At the same time, the colour type here represents if the picture is in colour, black and white, or grayscale. Then, it is follows by the general device graphical password anti-shoulder surfing mechanism presentation, where at this section these schemes are review from the aspect whether it is with the grid or without the grid. Finally, the input behaviors of the schemes, which indicate how data is input: through touching/ clicking, swiping (left/right or up/down) or moving. As can be seen in Table 2, there are only two recall-based general device graphical password anti-shoulder surfing mechanisms, namely YAGP and Stroke-based graphical password scheme that do not employ picture type and color. This is because no pictures are used in these two schemes. Furthermore, only

these two anti-shoulder surfing mechanisms have more than one type of input behaviors compared to the others.

In the meantime, the mobile device graphical password schemes which have the anti-shoulder surfing mechanism are also being revised. The reviewed schemes are the Interactive and Secure User Authentication Scheme [16] and User Authentication through Image Selection Scheme [17]. The features of these two schemes are as shown in Table 3.

Table 3: Features of mobile device graphical password anti-shoulder surfing mechanism

	Picture type		***Color***			***Presentation***		***Input Behaviors***			
Graphical Password scheme's Name	Single Picture	Multiple Pictures	Colored Picture	Colorless Picture	Gray Scale Picture	With Grid	With No Grid	Touching \ clicking	Swipe left \ right	Swipe up \ down	Moving
Interactive and secure user authenticati on scheme	√	√	√		√	√		√			
User Authenticat ion through image selection scheme		√	√			√		√			

Table 3 shows the features that are used in existing mobile device graphical password anti-shoulder surfing mechanisms. They are consisting of multiple pictures, and is presented with a grid. In term of input behavior, clicking/ touching are the only input behavior that is used in the existing mobile device graphical password anti-shoulder surfing mechanism. However, both the general device and mobile device graphical password anti-shoulder surfing mechanism are having the same categories of features, which are the picture's type, color, presentation, and input behaviors. Hence, in this user's affinity of choice survey, these features will be adopted.

4. Methodology

The user's affinity of choice survey was conducted to investigate the features that are best suited the mobile device graphical password anti-shoulder surfing mechanism. In Figure 1, the methodology of this survey is shown.

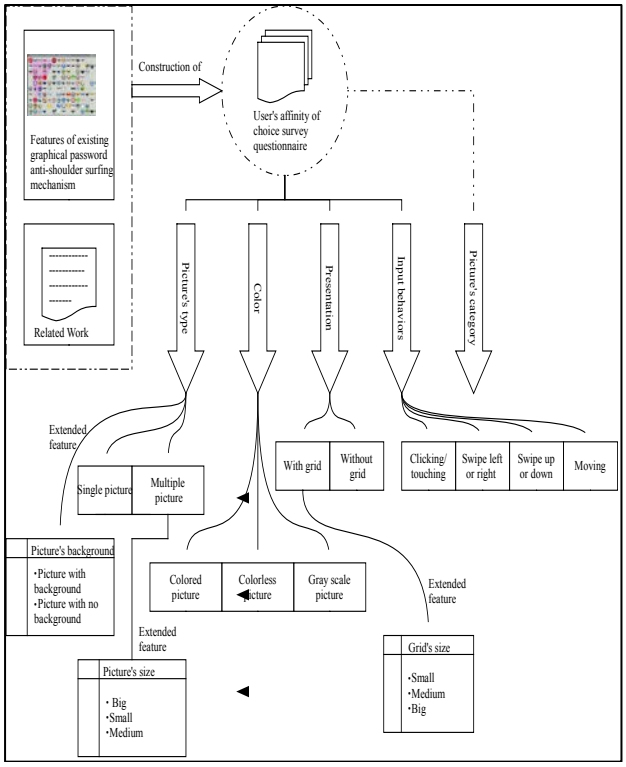

Fig. 1 Methodology of user's affinity of choice survey

As shown in Figure 1, the questionnaire of the user's affinity of choice is constructed based on the features of the reviewed existing graphical password anti-shoulder surfing mechanism, and the related work discussed at the previous section. Within the questionnaire, not only are the four previously discussed features, the picture type, color, presentation, input behaviors are adopted. The picture category is also included as one of the features tested.

The options that are available for each feature are same as what are discussed in the Table 2 and Table 3. For the example under the feature of the color, the options that are available are the colored picture, colorless picture and the gray scale picture; or under the feature of the input behaviors, the options available are the clicking/ touching, swipe left or right, swipe up or down, and moving. Only these two features, the picture's type and presentation are extended with options for the picture's size, picture's background, and grid's size. Meanwhile, with regards to the extra features, picture category, there are 16 options available. These 16 options are love, nature, season, cartoon, car/ vehicles, fantasy, school, animal, funny, partying, games/ entertainment, lifestyle, art/photography, fashion, sport, cartoon, and miscellaneous. For more detail, the questions and options employed in the questionnaire are summarized in Table 4.

Table 4: Questions and options available in user's affinity of choice survey

Features	*Questions*	*Options*
Picture's type	The mobile device graphical password anti-shoulder surfing mechanism with single picture and multiple picture, which one you prefer the most	1. Single picture 2. Multiple pictures
	If you choose to have the multiple pictures mobile device graphical password anti-shoulder surfing mechanism? Which size of picture is your choice?	1. Small 2. Medium 3. Big
	Between the picture that is with background and picture that is with no background. Which one is your choice?	1. Picture with background 2. Picture with no background
Color	Among these three options, which is your favorite picture's color for the mobile device graphical password anti-shoulder surfing mechanism?	1. Colored picture 2. Colorless picture 3. Gray scale picture
Presentation	In your opinion, is it suitable to have grid in the mobile device graphical password anti-shoulder surfing mechanism?	1. Yes. 2. No
	If you choose to have grid for the mobile device graphical password anti-shoulder surfing mechanism, from your point of view, which size is your choice?	1. Small 2. Medium 3. Big
Input behaviors	How you are normally interacting with your mobile device?	1. Clicking/ touching 2. Swipe left or right 3. Swipe up or down 4. Moving
Picture's category	Among the picture's category shown below, which one(s) are you favorite?	1. Love 2. Nature 3. Season 4. Car/ vehicles 5. Fantasy 6. School 7. Animal 8. Funny 9. School 10. Gaming/ entertainment 11. Lifestyle 12. Art/ photography 13. Fashion 14. Sports 15. Cartoon 16. miscellaneous

In order to known the features that are best suited the mobile device graphical password anti-shoulder surfing mechanism, the constructed questionnaire were distributed to 53 respondents. All of this survey's respondents are the students of the Universiti Teknologi Malaysia. During the survey, the 53 respondents were request to choose their desire picture's type, color, presentation, input behaviors, and picture's category for the mobile device graphical password anti-shoulder surfing mechanism.

5. Results

At this section, the user's affinity of choice survey's result will be presented.

5.1 Picture's Type

This is the section where the respondents' choice for the picture's type is elaborated. In Table 5, the respondents' choice for the picture's type is shown.

Table 5: Respondents' choice for the picture's type

No.	*Questions*	*Options available*	*Results*
1.	The mobile device graphical password anti-shoulder surfing mechanism with single picture and multiple picture, which one you prefer the most	Single picture	42%
		Multiple picture	58%
2.	If you choose to have the multiple pictures mobile device graphical password anti-shoulder surfing mechanism? Which size of picture is your choice?	Small	26%
		Medium	36%
		Big	47%
3.	Between the picture that is with background and picture that is with no background. Which one is your choice?	Picture with background	74%
		Picture with no background	26%

As depicted in Table 5, the respondents chosen picture types for the mobile device graphical password anti-shoulder surfing mechanism are large multiple pictures, with background.

5.2 Color

For the feature of the color, the survey result is as what is shown in Table 6. The result clearly shows that an overwhelming number of respondents wanted the colored pictures for the mobile device graphical password anti-shoulder surfing mechanism.

Table 6: Respondents' choice for the color

No.	Question	Options available	Results
4.	Among these three options, which is your favorite picture's color for the mobile device graphical password anti-shoulder surfing mechanism?	Colored picture	87%
		Colorless picture	4%
		Gray scale picture	6%

The result had shown that the respondents wanted the picture of the mobile device graphical password anti-shoulder surfing mechanism's picture is in colors.

5.3 Presentation

The survey wanted to find out the preferred presentation for mobile device graphical password anti-shoulder surfing mechanisms. Consequently, respondents are requested to choose if they wanted a grid and if they do, what is the preferred size. Table 7 depicts the result.

Table 7: Respondents' choice for the presentation

No.	Questions	Options available	Results
5.	In your opinion, is it suitable to have grid in the mobile device graphical password anti-shoulder surfing mechanism?	yes	53%
		no	45%
6.	If you choose to have grid for the mobile device graphical password anti-shoulder surfing mechanism, from your point of view, which size is your choice?	Small	26%
		Medium	40%
		Big	34%

Based on results shown in Table 7, the mobile device graphical password anti-shoulder surfing mechanism with a grid is preferable, while the medium grid size is most chosen by the respondents.

5.4 Input Behavior

This section deals with the way the users normally interacting with their mobile devices. Inside this survey, we categorized the input behavior into four ways; clicking/ touching, swipe left or right, swipe up or down, and moving. In Table 8, the respondents' input behaviors are shown

Table 8: Respondents mobile device input behaviors

No.	Question	Options available	Results
7.	How you are normally interacting with your mobile device?	Clicking/ touching	51%
		Swipe right or left	23%
		Swipe up or down	11%
		moving	26%

As shown in Table 8, comparing these four input behaviors, the majority of the respondents interact with their own mobile devices by touching the display monitor that is touch screen supported, or clicking on the device button. Although the other input behaviors are also used by the respondents, however, it is not as frequent as clicking/ touching.

5.5 Picture's Categories

The final identified feature is the respondents' favorite picture category for the mobile device graphical password anti-shoulder surfing mechanism. Table 9 s hows the respondents' choice for the picture category.

Table 9: Respondents' choice for picture's category

No.	Question	Options available	Results
8.	Among the picture's category shown below, which one(s) are you favorite?	Love	38%
		Nature	55%
		Season	30%
		Car/ vehicles	19%
		Fantasy	23%
		School	9%
		Animal	30%
		Funny	32%
		Partying	6%
		Gaming/ entertainment	11%
		Lifestyle	38%
		Art/ photography	40%
		Fashion	23%
		Sports	21%
		Cartoon	36%
		miscellaneous	0%

Among the 16 opt ions, the respondents' most favorite picture category is nature. No one responded to the miscellaneous option, while a very small number chose the partying category.

6. Discussion

From the user's affinity of choice survey, we discovered that the features selected by the respondents generally corresponds to the currently used features by the existing mobile device graphical password anti-shoulder surfing mechanism, as elaborated in Table 3. For instance, the existing mobile device graphical password anti-shoulder surfing mechanism presentation utilizes a grid; which is also the popular choice among the respondents. This is similarly echoed for color, picture type and input behaviors features. Besides this, the survey was also shown that bigger the size of the picture, it is easier for the users to accept the particular mobile device graphical password anti-shoulder surfing mechanism. However, it might be because of the security and usability issue, the

respondents are not chosen the biggest grid size or the smallest grid size, but they choose to have the medium size for the grid's size. In Figure 2, the features chosen by the respondents for the mobile device graphical password anti-shoulder surfing mechanism is further summarized.

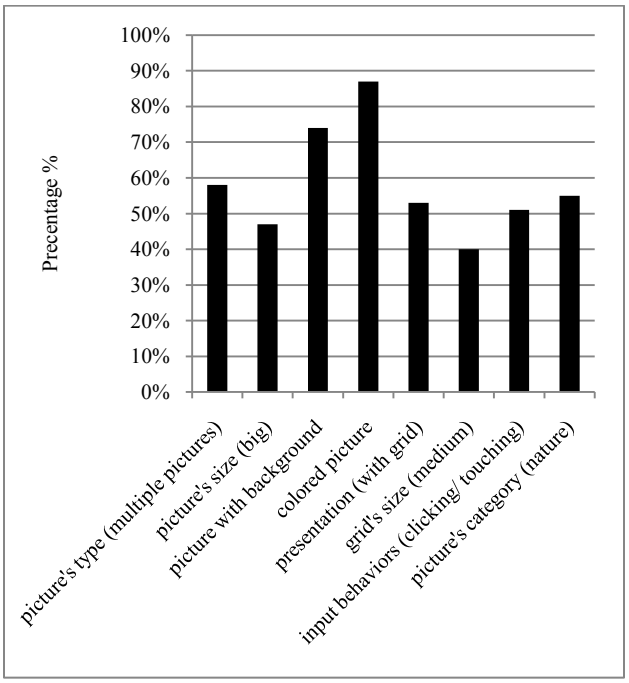

Fig. 2 Summary of the respondents' chosen features for mobile device graphical password anti-shoulder surfing mechanism

7. Conclusion and Future Work

The user's affinity of choice survey was conducted to investigate the features that best suited the mobile device graphical password anti-shoulder surfing mechanism. This is due to the ambiguity of the features that fits well for the mobile device graphical password anti-shoulder surfing mechanism. Furthermore, we are believed that it is not an impossible task to have all the features inside a mobile device graphical password anti-shoulder surfing mechanism. Hence, through this survey, the features that are not chosen by the respondents will be classifying as the unsuitable features for the mobile device graphical password anti-shoulder surfing mechanism and will be excluded from future proposed mobile device graphical password anti-shoulder surfing mechanism. In this survey, we divided the mobile device graphical password anti-shoulder surfing mechanism features into five main categories; which are picture type, color, presentation, input behaviors, and picture category. The survey result showed that the respondents wanted features for the mobile device graphical password anti-shoulder surfing mechanism that consist of multiple, large-sized pictures with background and in color. Respondents wants a medium-sized grid and preferred clicking/touching input behavior as well as nature picture category. In the future, all these features will be embedded into a g raphical password anti-shoulder surfing mechanism for mobile devices.

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