Adaptive UI from Human Behavior Pattern on Small Screen Interface: Focused on Double-Swipe Interface

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Abstract. Recently, various smart devices are released and user's task environment is changing from desktop-sized interface to mobile device. This research proves possibility of AUI optimized for touch screen device. This paper is aimed to lead enhanced AUI with improved performance and gesture error ratio. We made experiments about users' intuitive behavior pattern on restricted interface, especially focused on double-swipe. Main contribution of this research is approach to AUI by focusing on input method from small mobile device kinds of smart watch.

Keywords: Adaptive UI · Personalization · Gesture behavior pattern · Small screen interface · Double-Swipe interface

1 Introduction

Smart device has been dramatically developed for a few years in the direction of becoming smaller. Input gesture based on tiny screen display would be limited, therefore it causes collisions between similar touch gestures. These collisions trigger user's gesture error and reduce task performance. Adaptive UI, which adapts its layout to the context of user, can be one of solutions to compensate the problem.

The aim of this paper is to suggest improved AUI with better practice time and gesture error rate based on small screen device. We made experiments about users' intuitive behavior pattern on restricted interface, especially focused on double-swipe interface with readjusting swipe threshold, considering various factors of AUI, and thereby specified guideline for designing AUI.

In the existing literature, adaptive menu, which learn user's purpose in response to item selection, has been studied primarily. Nevertheless adaptivity of interface provides better performance, AUI based on item selection often brings negative usability by showing incessant visual changes. In comparison, we focused on AUI based on input gesture, which adjust internal threshold unrecognized by user. Also, we considered novel user factors, such as satisfaction of controllability and user context, and thereby practiced more detailed approach in small screen interface.

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2 Related Work

Adaptive User Interface (AUI) is defined as interface that provide immediate user assistant by learning user's actions [4]. First notion of adaptive UI was announced by Greenberg and Witten [1]. Adaptive UI applied with frequency of item usage showed better performance than static UI.

Sears and Shneiderman developed existing drop-down menu and suggested novel adaptive menu, split menu which is composed of adaptive part and functional part [3]. These adaptive menus brought positive effect on users' satisfaction and task performance. In comparison, Mitchell and Shneiderman suggested that static menu is rated better than adaptive menu altering the visual location of items both performance and satisfaction [2]. Gajos showed duplication-typed adaptive menu which don't include visual alteration had much choices from participants [5].

While importance of small screen device was emphasized, AUI was studied with focusing improvement at small screen interface. Findlater and Mcgrenere proceeded research with effect of screen size, and showed smaller sized interface can take better effect for task efficiency and satisfaction with adaptive UI [6]. Recently, researches are focused on the interactions of cause and effect with factors of adaptivity. Gajos found out accuracy and predictability of adaptive UI is related with user's satisfaction, though only accuracy influences actual performance [7].

3 Experiment I: Observing Human Behavior in Small Screen

3.1 Overview

The focus of the present paper is observing human behavior, therefore we designed UI that user can inputs double swipe gestures causing collision depending on swipe range on typical touch-based mobile phone. Two sets of experiment were considered by following factors; (1) satisfaction of recognition, (2) satisfaction of controllability. Also, user survey was followed in order to investigate human behavior.

In order to suggest gesture-based AUI, we have tried an experiment to observe general patterns of user's behavior under the condition of collision happening when two gestures are activated simultaneously. As illustrated in Fig. 1, the situation of using internal and external swipe simultaneously (double-swipe interface) was given to the participants.

Because preceding research data showed that changes coming from AUI actually decreases the usage by causing visual confusion, we then devised the experiment that detect an influence of participant's visual recognition of AUI and the actual gesture. First set included two designs; the first design of making participant aware of the AUI changes visually, and the second blueprint of making changes unnoticeable.

Also, we constructed the experiment about users' satisfaction of controllability. For clear judgment about gesture errors in terms of using UI, the experiment was progressed to see general patterns of user's reaction when unintended errors occur.

Fig. 1. Experiment I Circumstance

3.2 Methodology

Set 1: Satisfaction of Recognition. We set up four experiment environments classified with alteration method (Random/Learning) and visibility (Visible/Invisible). And accordingly, time for achieving the task was measured. In order to increase credibility, motivation was given to the participant who achieved outstanding time management, by offering additional compensation. User surveys were conducted to figure out overall satisfaction of users afterwards including measurement of users' cognitive width of threshold.

Set 2: Satisfaction of Controllability. The same method applied; motivating participants and recording time spent for accomplishing the task. Frequency of usage of particular gesture in the process was recorded as well, based on observation from prior experiment, which defined the error-response gesture. Survey was conducted after the experiment, asking participants whether their intentions and UI actually matched, and their satisfaction about the system.

3.3 Result

Set 1: Satisfaction of Recognition. 16 individuals participated (10 Males, 6 Females, age 20–29) and result is showed in Fig. 2. Some of remarkable points are that, (1) as compared with actual performance, users' satisfaction of recognition is much affected by interface, (2) invisible alteration was highly evaluated in learning condition, especially with satisfaction ($p < .1$). Various results of experiments are presented in figures.

Set 2: Satisfaction of Controllability. Samples are identical with set 1; 16 college students who are in 20 s (9 Males /7 Females). Each comparison between frequency of error-responding gestures and time efficiency, and satisfaction are analyzed on Fig. 3. Linear trend line (red) was fitted with scatterd data, each standard deviation of slope was 45.17 % (Left) and 17.76 % (Right).

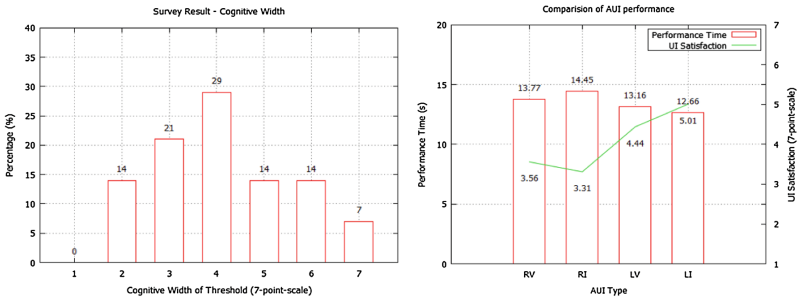

Fig. 2. Experiment I Result 1, (Left) Participants' cognitive width was examined with 7-point-scale; from Very Narrow-1 to Very Wide-7. /(Right) Comparison of four experiment group; RV(Random-Visible Threshold), RI(Random-Invisible), LV(Learning-Visible), LI (Learning-Invisible).

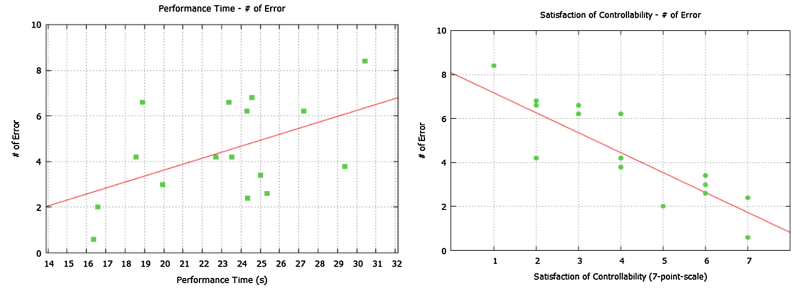

Fig. 3. Experiment I Result 2, (Left) Correlation between performance time and number of error gesture /(Right) Correlation between users' satisfaction (of controllability) and number of error gesture.

3.4 Discussion

According to the result of Set1, in the case of R (Random alteration)-group, participant showed higher efficiency when managing task when there was visual perception. In the case of L(Learning alteration)-group, there was not much differences in managing task related to visual perception, yet, their satisfaction increases when there is a visual guideline.

The more frequent usage of error-responding gesture lengthens the subtle amount of time needed for task management, which eventually result in decreasing efficiency. And as easily implied, survey also shows that the more actions participant has to take, the lower their satisfaction becomes. An interesting factor is that although the actual efficiency decreases only a little amount, participant felt greater dissatisfaction.

4 Experiment II: Applying to Tiny Screen

Tiny screen interface has been magnified as a wearable device. With limited screen size, adaptive UI still has an important role. Moreover, we attempted in-depth approach with the experiment, considering participants' using circumstance like listening music.

4.1 Methodology

We devised experimental environment like Fig. 4 (Left). Participants were lead to accomplish the task at gesture-recognizing screen (2-inch, typical watch size). Also they were instructed tasks in double-swipe interface with three kinds of main using context (Message/Music/Photo). We measured number of error for each condition, also including post-survey.

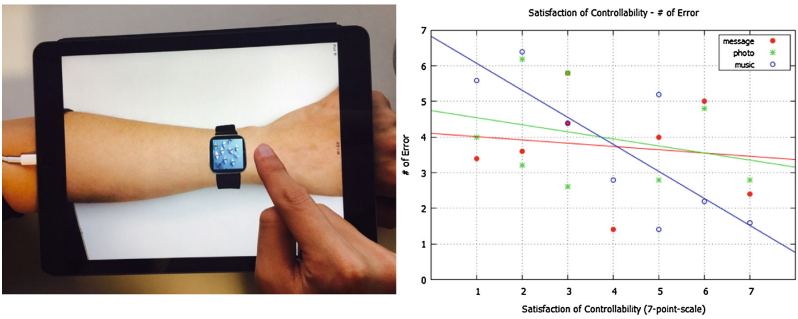

Fig. 4. (Left) Experiment II Circumstance; double-swipe interface within 2-inch screen was provided to participants /(Right) Experiment II Result; we measured correlation between satisfaction of controllability an number of error gesture within three kinds of using context (checking message, viewing photos, listening music).

4.2 Result

8 individuals (6 Males and Females, age 21–27) are participated the experiment including 5 sets of task for each condition. Result is in Fig. 4 (Right) that compared correlations between satisfaction and number of error within 3 kinds of using conditions. For each condition, linear solid lines were fitted with the data. Despite "photo" / "message" conditions are not seem to be statistically significant, within "music" condition, decreasing correlation was detected.

4.3 Discussion

One of the most notable points is that, satisfaction rapidly dropped with listening music sharper than viewing photos/messages. In order to figure out this, we found two major factors affecting context-based adaptive UI: (1) immersion in contents, (2) inherent

habit of existing context. In practice, participants feels more negative usability from wrong cut-off with listening music, which has more immersion, than checking messages. It suggests that variability of AUI within using circumstance which has much immersion should be handled deliberately.

5 Conclusion

As results of various experiments, we specified several propositions with AUI. (1) Users have considerably personalized touch gesture pattern. (2) Satisfaction of recognition and controllability is affected by interface keenly, and these factors are mainly used to evaluate interface. (3) Depending on user's context, input behaviors are differentiated due to immersion, inherent habit.

Through above processes, we suggest guideline for designing AUI with three keywords. AUI on tiny screen device should focus on (1) Learning, gratifying users' personalized input pattern, (2) Context, distinguishing application of adaptation between various contexts, (3) Customizing, providing autonomy of control for user under satisfying with recognition.

This paper presents perspective for research with improving performance of users' various input device. Moreover, it can be developed with generalized input from various interfaces such as motion interface.

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