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Game interface enhancement under smartphone platform focused on touchscreen interaction

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ABSTRACT

Virtual game controllers are essential for particular game genres where the game contents are transplanted from various platforms into a smart-phone platform. Virtual images are projected as a game interface at the smartphone's output screen. Therefore, a certain amount of space needs to be abandoned for the controller's interface projection. In addition, the functions of the game contents are fundamentally limited, thus eliciting the necessity of a limited number of buttons. In this study, diverse types of interaction that occur between the user and touch-screen were researched, and adequate interactions for smart-phone game contents were extracted and analyzed. In addition, the focus is placed on minimizing the number of controller buttons while including diverse functions at the contents level. Notably, the study pointed out that previous virtual game controllers are a mere metaphor of traditional methods, thus limited to *Tap* interaction. By analyzing fighting action game contents, the *Tap* interaction is enhanced by adding *Flick* and *Multi-touch* interaction to diversify and enhance previous interaction values. Finally, a prototype was developed by ameliorating past interfaces and referring to the intrinsic features of the aforementioned types of interaction, followed by user evaluation. A previous questionnaire method was adjusted to the particular research purpose, and quantitative evaluation was conducted while documenting and analyzing the user-log data of repetitive experiments.

The results show that *Flick* and *Multi-touch* interaction techniques are beneficial under a smartphone touchscreen environment beyond the traditional *Tap-only*. Furthermore, functions are maintained with a minimum number of buttons while the situation compatibility of user interaction is verified. This study also shows that adding diverse types of interaction to the simple *Tap-only* affords a distinctive user experience of long-term interest and fun to the players that were previously restricted to the accustomed *Tap-only*. The results authenticate the applicability of the intrinsic fun mechanism to the smartphone based touchscreen game interaction. The study has implications in enhancing the traditional *Tap-only* based virtual game controller, which is a mere metaphor of controllers loaded onto other platforms, through proposing a tailored interface design and evaluation method under a smartphone platform. Furthermore, this study contributes objective reference source for the engineers to design future game contents, interface and heuristics evaluation in the platform.

1. Introduction

A smartphone is a mobile phone that is technically and functionally developed from former feature phones (Kim, 2010; Nham, 2010). According to a review by Mac Rumors (2011), smartphone games occupy 34% of portable game industry and 8% of all of the platforms, excluding PC online games and PC games. The research shows that smartphone games are holding the place as a new platform in the game industry domain. Based on research conducted by Industry Games on the purchasing trend of game players (2010), players have recently been buying more smartphone game titles than portable games such as PSP and NDS (Kweon, Kim, & Choi, 2011). Unlike antecedent mobile phones, smartphones possess a high-level of specifications in regard to hardware and functions. That implies that the aforementioned growth of the mobile game market is heavily related to the vitalization of smartphone propagation. As a result of this tendency, various genres and contents of games formerly accessed through PC and video game consoles are currently shown on the new platform (Choi, 2011). In other words, the game titles once attractive in other platforms are transplanted to the smartphone platform. In

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spite of the relatively high technical level of the platform and diversity of games, however, casual games genres that used to be popular in the feature phone environment are still prevalent (Kim, 2013). That is because of the diversity of user types due to the simple control and mass appealing arrangement. Games with a sophisticated control method and composition are demanding to be served in the mobile game environment because of the restrictions that the device innately has.

In the smartphone game environment, the action or fighting arcade genres use virtual controllers. They imitate video game controllers, which are unlike genres requiring simple control, and are rendered to be appeared in the touchscreen enabling the users to enjoy the games similarly. The virtual controllers used in action or fighting arcade genres commensurate to the purpose; they layout the direction control keys on the left space and motion control buttons on the right. Therefore, the controllers have their significance in that they enable unceasing enjoyment of the long-established action and fighting arcades game on the smartphone platform without any support of external devices (Kim, 2013). However, users experience more miss controls with games requiring compound controls and functions than with those necessitating simpler ones because the smartphone platform innately possesses limitations of the hardware in terms of size. Though smartphones have been released as full touch-screen forms, which are different from previous feature phones, limitations exist with the expansion of the sizes since they should function as portable phones. Currently released smartphones tend to own a screen size of 3.5–4.5 inches, even though some smartphones have a screen size that exceeds 5 inches. However, according to industry experts, the smartphone screen size cannot exceed over 5 inches at most due to the device's mobile features. The restrictions on the screen size ultimately act as critical constraints that hinder the vitalization of game genres that require delicate controls. Up to date, there has been a substantial increase of researches related to the subject of touch input following the use of the capacitive touchscreen system (Hobart, 2005; Parhi, Karlson, & Benderson, 2006; Park & Han, 2010). Based on the recent studies, the adequate key size for hand-touching performance was concluded to be at least 8–9 mm (Deininger, 1960; Park & Han, 2010). In particular, for the capacitive touchscreen, the favored distance among keys turned out to be about 3 mm, which is commensurate with the device's features (Hobart, 2005). Based on the research results, current virtual controllers have several limitations. Firstly, as mentioned above, there are restrictions on expanding the size of smartphones due to the features of portable devices. That is, only a limited number of buttons can be set on the screen (Kim, 2013). If the button size and distance among the buttons decrease, the users' error experience with controls increases. For instance, some virtual controllers have set more than four that is an above-average number of buttons, and have unavoidably decreased the button size and distance among buttons, resulting in a drop of user control satisfaction. However, the restrictions of the smartphone platform are not the only reason of control dissatisfaction of the users. Current virtual controllers do not sufficiently reflect the features of the platform because they merely imitate the controllers given by existing video and portable game devices. In particular, characters showing in the games played in the video and portable game devices carry out commands when players perform physical pressing action that transmits electric signals. Such behavior is only reflected the virtual controller and converted into a tapping action that leads to the behaviors of game characters. Thus, it is just emulating and sticking to the existing *Tap-only* technique that signals arising from pressing each of the buttons are taken. However, it is inappropriate just to follow the features of existing physical controllers because *Tap* with other interactions is enabled if various interaction methods are applied to a button area, and fewer buttons are required to assign various actions to the game characters. It is still a quite challenging assignment to transplant control mechanisms commensurate with the smartphone platform, the device that owns entirely different features, because existing game methods have depended on former physical controllers. Therefore, so far not much improvement has been made in game controllers.

The raised issues mentioned above are summarized as follows:

- Existing virtual controllers do not take full advantage of interactions shown in smartphone platforms, but they merely adopt the *Tap-only* method of tapping that copies from the former game controller method.
- Because of the features that touchscreens have, the sizes and the distance among buttons are required to exceed over a certain degree. The miss rate will increase if certain necessary conditions are not satisfied.
- As for the smartphone features, input and output mechanisms are processed on the same screen. Thus, only a limited number of input buttons can be set on the screen due to the restrictions of the sizes.

The goal of the paper is to overcome the restrictions of the smartphone platform and virtual controller on the size of the buttons and the arrangement. In particular, regarding diverse capacitive touchscreen-based smartphone games, interactions used to handle a smartphone are applied to the virtual controller of some game genres that require complicated controls to improve the aforesaid issues. Therefore, the research questions induced by the issues are as follows:

- Can *Tap* with other touchscreen interactions, adding more than one interaction to the existing game interface compared to the former *Tap-only* method (one-button-tap method), solve the limitations of the size of a smartphone display?
- Is there any difference in interface between the existing *Tap-only* method and *Tap* with other touchscreen interactions?
- What are the kinds of interactions within the smartphone environment that can be newly applicable to the former virtual controller?

To achieve the goal, case investigations were conducted on the virtual controllers used in the games from the former smartphone platform; (1) the general composition of the controllers and the limitations were defined, in particular, focusing on the game genres where the virtual controllers are applied, (2) analysis and classification were made through case investigations on the fun mechanism and required control & action methods. Based on the previous analysis and classification of the smartphone interactions, (3) a virtual controller was designed that is different from earlier works. (4) Through the experiment, both qualitative and quantitative data were collected by evaluating the usability, user satisfaction and adoption frequency rate of each interaction for particular tasks. (5) Finally, the significance of the proposed virtual controller method was validated by the obtained results.

The scope of the paper is as follows. In terms of the smartphone platform, the focus was placed on the device that services the capacitive touchscreen method. In terms of the smartphone system, the focus was placed on the mobile environment. Since the research scope encompassed all game applications currently served on the capacitive smartphone platform, genres that did not require a virtual controller were unavoidably added due to the diverse genre features that games have. The examples of environments include RPG, action arcade and adventure genres, where an active game progress and sophisticated control interface for a number of action commands exist. Moreover, the control interactions of a smartphone device are based on three methods as follows: (a)