Evaluating Playability on Haptic User Interface for Mobile Gaming

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Abstract—There have been escalating research interests on areas relating to haptic modality in recent years, especially towards mobile devices. However, there seems to be limited studies in determining the relation between haptic user interfaces and its influence on the playability of mobile games. This paper aims to measure playability of mobile games by comparing two different types of haptic interfaces, namely hard and soft keypad, for mobile gaming. The results show that the participants (N=12) scored highest in using a soft keypad (mean = 591.92, SD = 322.57) as compared to playing games using a hard keypad (mean = 471, SD = 359.29). However, this paper highlights that the majority of users prefer using the hard keypad method in virtue of greater player experience with regards to game play.

Keywords- haptics; playability, user interface; evaluation; mobilegame, soft and hard key

I. INTRODUCTION

Mobile phones are fast becoming ubiquitous in determining the styles and trends of everyday communication for human kind in this modern world. With enhanced hardware and software in mobile phones, and increasing network enhancements, it is no doubt that mobile phones provide a viable platform for hosting personal games. Mobile games are one of the most proliferating industries with growing demands from the mobile users. As mobile phones evolve, more advanced functions and user interfaces are added to provide greater user experience. These additional features include touch screen, the ability to detect device orientation and motion via accelerometers, and also the ability to measure the strength and direction of the magnetic field by using magnetometers. PDAs, smart phones, Android phones, and pocket PCs with touch screens are fast gaining popularity among users the world over. Nowadays, with technology advancement, more mobile device manufacturers are adopting touch screen or haptic technology due to its decreasing price and mass manufacture. For instance, [1] highlighted that the emergence of touch screen is changing the landscape of gaming industry. The success of Nintendo DS, as one good example, had shown great ideas on the gaming possibilities. As a consequence, touch screen-based games are perfect examples of how haptic technology can advance the gaming industry and benefit from its popularity.

The aim of this paper is to evaluate playability on two different types of haptic user interfaces for mobile gaming. In this paper, Section 2 depicts the discussion on haptic modality on mobile user interfaces; whilst Section 3 discusses the challenges of playability for mobile gaming. Section 4 examines a user evaluation study for measuring playability by applying two different types of haptic user interfaces for mobile gaming; followed by a closing remark and recommendations for future work in Section 5.

II. HAPTIC MODALITY ON MOBILE PHONES

The use of haptic modality such as touch screen has recently received popularity among the mobile phone users as it is a relatively fresh interface from the usual hard keys. The characteristics of touch screen-based mobile phones are that they usually have fewer push buttons and the users interact with the interfaces by touch. With the development of touch screen-based phones, like Motorola A1200, HTC Diamond, Sony Ericson w960i, Samsung Ultra Smart F520, Apple iPhone, Android T-G1, Nokia XpressMusic 5800 and Blackberry Storm, new forms of user interaction technique have appeared through the use of fingers or a stylus pen. These types of mobile devices utilize gesture as the means for data input to allow much easier user interaction; for instance, flicking the fingers on the touch screen for browsing through the web pages, zooming options for photo viewing and many others features. In addition, majority of the touch screen devices have two kinds of gesture input that is, dragging (users touch tap on the screen surface while moving slowly across the screen) and pressing (users press harder on a device surface).

The successful launch of Apple iPhone in June 2007 has revealed greater opportunities for mobile device manufacturers to produce various mobile phones models using haptic modality and multi-touch display. This opportunity also came about as capacitive touch technology was made widely available for third-party development. Multi-touch with a gesture option as a possible input method for mobile user interface. For example, it features flicking, tapping, pinching and stretching. With only one physical button, most user interactions are performed via haptic interactions on the Apple iPhone. With reduced number of physical button in mobile devices, the frame of a mobile display can fit onto a larger display hence providing the opportunity for designers and engineers to enhance the visual feedback which in turn enhances the player experience during interaction and gameplay.
By adding touch screen that is coupled with a higher mobile screen display resolution and by augmenting its processing power, it will enhance the enjoy-ability for existing gamers, and also attract potential new gamers. For instance, hardcore gamers will be able to reach greater heights in terms of playability with an enhanced credible gaming platform. On the other hand, the ease-of-use of touch screen will also attract potential casual gamers to indulge in touch screen-based mobile games. Given this notion, touch-screen-based mobiles create new opportunities to tap into this lucrative gaming industry.

A user preference study [2] on mobile games also showed a 15-17% increase in user satisfaction for the overall game experience with advanced haptic interface as compared to simple on-off vibration or merely audio feedback. In addition, [3] presented a study of using pen gestures instead of buttons in a mobile first person shooter (FPS) game. The result showed that users have little preference in using buttons over gestures. The study indicated that touch screen-based devices provide much more freedom to the users in terms of control as compared to buttons-based mobile phones. In a nutshell, the players’ attention is enhanced while interacting with touch phone surface, thus increasing playability and the players’ experience.

III. CHALLENGES OF PLAYABILITY FOR MOBILE GAMING

Playability is depicted as ‘the instantiation of the general concept of usability ... determined by ... understanding and controlling game play’ [4]. The concept of playability is associated with fun, flow, fulfillment, player experience, satisfaction, engagement and pleasure. In a playability study on video game, [5] argued that playability is not limited to the degree of ‘fun’ or ‘entertainment’ experienced when playing a game. Instead, playability is defined as ‘a set of properties that describe the Player Experience using a specific game system whose main objective is to provide enjoyment and entertainment, by being credible and satisfying, when the player plays alone or in company’.

To characterize player experience, [5] relates player experience with 7 attributes that affect playability, which are satisfaction, learnability, effectiveness, immersion, motivation, emotion, and socialization. Each of the playability attribute is described in relation to their distinct characteristics and properties:

- **Satisfaction**: Gratification or pleasure derived from playing a game or from some aspects of it. (Properties: Fun, Disappointment, Attractiveness.)
- **Learnability**: Player’s capacity to understand and master the game’s system and mechanics (objectives, how to interact with a game). (Properties: Game Knowledge, Skill, Difficulty, Frustration, Speed, and Discovery.)
- **Effectiveness**: Time and resources necessary to offer players a fun and entertaining experience whilst they achieve the game’s various objectives and reach the final goal. (Properties: Completion, and Structuring.)
- **Immersion**: The capacity of the game contents to be believable, such that the player becomes directly involved in the virtual game world. (Properties: Conscious, Awareness, Absorption, Realism, Dexterity, and Socio-cultural Proximity.)
- **Motivation**: The set of game characteristics that prompt a player to realize specific actions and continue undertaking them until they are completed. (Properties: Encouragement, Curiosity, Self-improvement, and Diversity.)
- **Emotion**: The player’s involuntary impulse in response to the stimulus of the game the game that induces feelings or a chain reaction of automatic behaviors. (Properties: Reaction, Conduct, and Sensory Appeal.)
- **Socialization**: The set of game attributes, elements and resources that promote the social dimension of the game experience in a group scenario. (Properties: Social Perception, Group Awareness, Personal Implication, Sharing, Communication and Interaction.)

Nonetheless, current mobile phones lack usability as compared to handheld consoles, such as the Nintendo Wii or the Sony PSP [6]. With such a lucrative business and potential huge market for gaming industry, there are still a lot of rooms for development if mobile phones are going to cater for mobile gaming. [7] also argued that the current mobile devices did not appear as a feasible means for game play as they entail too much attentiveness on controlling the game with cramped buttons. Even though mobile phones are generally designed for communication purposes, the level of playability for mobile gamers is somewhat awkward, static and uninteresting.

With limited keypad space and miniaturized input and output modalities, this eventually gives rise to a rather limited game input control [8, 9, 10, 11]. Ultimately, this limits the gratifying user experience one would expect from gaming altogether. The consistent and prolonged use of the mobile phone hard keypad will undoubtedly cause repetitive strain injuries (RSI) on the wrists, fingers and other upper body parts. The issues of RSI, Blackberry Thumb and tenosynovitis are common health hazards faced by users who spend long durations on their mobile phones while playing games [12]. Undoubtedly, such symptoms will deteriorate the enjoyment, fun and affect the player’s experience.

IV. USER EVALUATION STUDY

We conducted an initial user evaluation study to measure the playability of haptic user interfaces for a mobile game. In this pilot study, we compared two different types of input methods for haptic modality on mobile phones. They are soft keypad (for a touch screen-based mobile phone) and hard keypad. Touch screen-based mobile device is primarily triggered by the soft keys for its functionality, which is a simulated button or keyboard that is displayed on a touch screen [13]. A soft key is also defined as a button flexibly programmable to invoke a number of functions rather than being associated with a singled fixed function or a fixed set of functions [14]. Hence, soft keys are usually located adjacent to
a screen or a readout that displays the function selected when
the key is pressed. On contrary, hard key refers to a hard-
coded key such as a number key pad or the Send/End key of a
mobile phone.

The apparatus used for the user testing was a Nokia N82,
configured as a hard keypad device, and a Nokia Xpress
Music 5800 with its touch screen interface configured as a soft
keypad (Figure 1).

![Figure 1. A Nokia N82 used for hard keypad (left), and Nokia Xpress
Music 5800 for soft keypad or touch screen (right).]

A. A Mobile Game - ‘Capture’

A classic game called ‘Capture’ was selected due to
the adaptive screen resolution available for both soft keypad
(touch screen) and hard keypad on mobile phones. The
concept of the ‘Capture’ game is to encourage the players to
fill the block on the mobile screen by capturing the flies flying
around, whilst avoiding being ‘killed’. Each player is given 3
‘lives’ at the first level until s/he manages to fill the block.
Once the block is filled, the player is promoted to the next
level up. The higher the level, the more challenges the player
will encounter to capture the flies. Figure 2 and 3 shows how
the ‘Capture’ game was played on both mobile phones - hard
keypad on Nokia N82, and touch screen on Nokia Xpress
Music 5800.

![Figure 2. The ‘Capture’ game play on Nokia Xpress Music 5800, a mobile
phone with soft keypad (touch screen).]

B. Participants

During this user trial, 12 interface design undergraduate
students (7 male, 5 female) were selected to participate in this
study. Their age range is from 19-21 years old (mean=20,
SD=0.95). In general, all the 12 students own a mobile phone
with hard keypad, and they do not have any prior knowledge
on touch screen-based mobile phone. In addition, they have
been using mobile phones between 1 to 8 years (mean=4.55,
SD=2.70). All 12 participants except one have been playing
games on the mobile phones.

C. Procedure

We conducted the user trial in three sessions, namely pre-
test, testing and post-test. Firstly, the participants were
informed to fill in a pre-test questionnaire before they engaged
with the game play. The pre-test questionnaire is to determine
the demographic profile of the participants which includes age,
gender, mobile phone usage, and mobile game experience. To
find out their general opinions on game, the participants were
prompted further when and how they started engaging in their
previous game experience, and their overall ideas on
enjoyment and fun on the game play. After the first test
session, the participants were required to engage with the
‘Capture’ game on both mobile phones. Either soft key (touch
screen) or hard keypad mobile phone was selected randomly to
avoid selection bias. The 12 participants were requested to
familiarize with the game for 5-10 minutes before we started
recording the game play session. Figure 4 shows a female
participant interacting with the ‘Capture’ game on the mobile
phone.
D. Results and Discussions

The results in Table 1 shows that the average score of playing the 'Capture' game on soft keypad is higher (mean=591.92, SD=322.57) than the hard keypad (mean=471, SD=359.29). Eight out of twelve participants scored higher on soft keypad (touch screens) as opposed to hard keypad during the game play. In terms of the game score for soft keypad (touch screen), the highest score is 1099 (N3) and the lowest is 32 (N10). On the other hand, the highest game score for hard keypad is 1336 (N6) and the lowest score is 64 (N10). During the debriefing session, the participants were prompted their keypad preference as input method for game play, 10 out of the 12 participants responded they preferred hard keypad for playing games.

<table>
<thead>
<tr>
<th>No.</th>
<th>Gender</th>
<th>Highest Score using SK (N)</th>
<th>Highest Score using K (N)</th>
<th>Keypad Preferences as Input Method for Game Play</th>
<th>Error Detection SK or HK</th>
</tr>
</thead>
<tbody>
<tr>
<td>N1</td>
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<td>*340</td>
<td>SK</td>
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</tr>
<tr>
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<td>608</td>
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<td>541</td>
<td>SK</td>
<td>2 (HK)</td>
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<td>*1092</td>
<td>909</td>
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<tr>
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<tr>
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<td>*413</td>
<td>HK</td>
<td>2 (HK)</td>
</tr>
</tbody>
</table>

Note: * mean higher score
SK: Soft Keypad (Touch Screen)
HK: Hard Keypad

It is interesting to learn that those who scored higher on the soft keypad are in contrary with their preference choice on hard keypad (i.e. N2, N4, N5, N7, N9, N11 and N12). Perhaps all of the 12 participants, who are currently hard keypad mobile users, was the first time experiencing the mobile game play on a soft keypad (touch screen). They also commented they preferred hard keypad over soft keypad due to the tactility of the sensation on pressing the hard keypad as opposed to soft keypad. For instance, N11 expressed he liked hard keypad because it was easier to navigate on the controls and move around the keypad. He also expressed the sensation of a tactile reference was important.

In terms of hand-device interaction, 6 out of 12 participants used one thumb to navigate the game (N1, N3, N6, N8, N10 and N11). On the other hand, another 6 used both thumbs during game play and interaction (N2, N4, N5, N7, N9 and N12). It is interesting to learn that those who scored higher using the soft keypad (touch screen) usually used both thumbs to navigate through the game controls. It is observed that those who scored higher with the hard keypad generally used one thumb to interact with the game.

During the debriefing session, the participants expressed their opinions about mobile games. Some mentioned that they play games on their mobile phones while waiting for a friend, before sleeping, or whenever they feel bored. They highlighted that reaching a higher score, breaking a new record and winning a game is the most fun. It provides them the highest feeling of achievement in their game play experience. In terms of the mobile usage, the most frequent activities reported are making calls, sending text messages (SMS), playing games and listening to music on the mobile phones. Figure 5 shows the participants’ preference towards the playability attributes in a word cloud fashion illustrating the frequency of responses from the participants. For instance, the relative frequency of ‘satisfaction’ is 11 counts whilst the second highest frequency shows 6 counts for ‘motivation’. This is followed by ‘immersion’ (2), ‘emotion’ (4) and ‘learnability’ (1). Effectiveness and socialization attributes were not selected by the respondents could be due to the context of the ‘Capture’ game. In such a user evaluation study, the respondent was conducted in an individual section, where ranking and higher score are not taken into consideration. The user testing was rather to evaluate which haptic user interface gives more enjoyment to the player. If the game play is a multi-player game, it will encourage the players to socialize with other players while attempting to achieve higher score, or compete with other player.

During the post-test session, it was found that the playability attribute most important to the participants is...
satisfaction, followed by motivation. Emotion and immersion were noted as being very closely rated while learnability was lowly considered by the participants during the study. The properties of satisfaction includes fun (achieving game objectives and getting high scores), disappointment (making less errors during game play, less cramped screen management, easy to learn) and attractiveness (aesthetics and content design).

![Diagram](motivation_emotion_satisfaction_immersion)

Figure 5. Degree of playability with its selected attributes considered by players during game play.

V. CONCLUSION

All haptic user interfaces and its input mechanisms have their intrinsic advantages and disadvantages. Soft keys may fare well in some aspects over hard keys, and vice versa. Based on the analysis of results, it is observed that a greater percentage of mobile game players tend to have a higher score via the touch screen interface, and barely made errors during game play. On the other hand, the results also highlight that the subjects are comfortable with using hard keypad on the mobile phone as indicated from their opinions during the interview. Nearly 84% of the subjects mentioned that they prefer using hard keys while the others prefer the touch screen. The non-physical attributes of the touch screen with its capacitive surface, its nature of use, and its supporting software development somehow provided additional flexibility in terms of the design of the overall interface, screen size, spatial considerations (screen management) and the displayed button sizes. On the other hand, hard keys seem to provide little flexibility in customizing the size of the keypad buttons as its manufacture and design are standardized, unless by changing mobile phone models.

With touch screens, a larger screen size can be achieved as there is no physical need to accommodate screen space for hard keypad buttons. The sizes of buttons will automatically be bigger, thus providing a perceived larger space to press and play around with. Nonetheless, players can opt to use a stylus to play on touch screens as some touch screen phones are provided with one. Since the percentage of players achieved higher scores by using the soft key (touch screen), this pilot study summarizes that the soft keys on touch screen provide better player experience during game play.

Although this pilot study only employed 12 participants, it provides us with ample insights on user preferences and perceptions towards touch modality for mobile gaming. As this is a pilot study, more participants will be involved in follow-up studies to further validate the findings. We also find that such test is better conducted using multi-method approaches to cross-validate the test result.

In future, we plan to examine the different variables such as the button layout, size, and shapes in determining the player experience. In addition to this, our future plan also intends to study the consequences and feasibility of allowing players to re-size the soft keypads through the game preferences in relation to the game genre. For example, customizing one soft button for a simple shooting game rather than having 5 navigational buttons activated on the device. Studies can be conducted to relate the size of gaming keys against game score, anthropometric data, economics of playability, screen management, and practicality. In terms of player experience, players highlighted that having high score or breaking records as being the most “fun” part for them during game play. There is also the possibility of studying the effects of cross-input mechanisms instead of purely keypads and its soft derivation. The combined use of a mobile device's microphone, camera, accelerometer, magnetometer, etc. provide further research opportunities in studying its effects towards the gaming experience as these functions are becoming ubiquitous with the production of current mobile technologies.

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