The Expansibility of User Interfaces Using Peripheral Multisensory Stimulation

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Abstract. The present study has explored the expansibility of using everyday objects for game interface to provide additional multisensory stimuli. The perceived expansibility of game interfaces was investigated by measuring user various responses such as the degree of presence, immersion, and enjoyment. Offering actual sensations assumed in the virtual environment of game could enhance user experience by effectively accessing their emotions. Participants were provided with one of four output modes: basic condition, room light stimulation, chair vibration stimulation, & both light and vibration. Consequently, tactile stimulation has resulted in higher presence and immersion than visual did. The result also suggests that a gamer could experience the expanded interfaces with additional multisensory output, bringing more enjoyment. These tendencies are especially recognized for high immersive tendency group. These findings can be applied to various fields of game interface design.

Keywords: Multisensory, Multimodal, Computer Game, User Interface, Expanded Game Interface.

1 Introduction

A growing trend in game interface design is using multimodal input and output user interfaces. Previously, much of efforts to improve the game interface are centered on high fidelity graphics and sound, but the success of console game platforms has suggested other alternatives, for example an input device affording natural gesture and movement. It is presumed that a player feels more engaged and immersed in the game by evoking their various sensations beyond merely processing visual information.

Presence is defined as the subjective experience of being in one place or environment even when one is physically situated in another [1]. We empirically investigated the expansibility of perceived user interfaces by adopting presence that defines epistemological dimension regarding spatial perception. Immersion, often synonymous to presence, refers to the sensation of being surrounded by a completely other reality. According to previous game studies, immersion is measured by the absence of awareness of real environment along with complete immersion in virtual game environment [2, 3]. Therefore, there are always possibilities that additional stimuli from peripheral space exterior game interface might work as a hindrance to gamer immersion in the game. However, research applying multisensory stimulation

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to game interface has displayed that a social interaction activated by input devices supporting natural movement has enhanced immersion [4]. The result indicates that virtual and real environments are not an exclusive dimension, offering a gamer an expanded experience by a specific environmental connection.

There are two common methods to improve gamers' experience by displaying multi-sensory information in game interface. The first is to offer sensory stimuli similar to those simulated in the virtual environment (i.e. the scent of a flower given in the scene of full bloom flowers in 4D movie theatre) [5]. Displaying useful information such as remaining energy level, ammunition is second approach in which gamers benefit in processing information valuable to their mission more efficiently, increasing their motivation and immersion to the game [6]. These approaches could improve gamers' enjoyment and satisfaction by accessing their emotion along with multisensory experience.

Based on theoretical backgrounds, we have explored the possibility of using everyday objects for game interface to provide additional visual and tactile stimuli. The perceived expansibility of game interface was emphatically investigated by measuring user's subjective responses such as presence, immersion, and enjoyment. We also measured the task performance since the potential relationship between presence and task performance is arguable whether performance is benefited or deteriorated by the enhanced presence. Offering actual sensations assumed in the virtual environment of game could enhance users' experience by effectively accessing their emotions. We measured participants' immersive tendency with using Immersive Tendency Questionnaire [1], since individual differences also play a critical role in experiencing presence along with technological components of media.

2 Experiment

2.1 Methods

Participants. 12 Participants (male: 8; female: 4, average age = 24.4) took part in this experiment, after administrating Immersive Tendency Questionnaire to measure their immersive tendency in virtual environment or game.

Materials. A simple shooting game was developed and connected to Arduino board in order to synchronize events in game with external visual and tactile stimuli additionally displayed. In the event of blast of an enemy, tactile feedback was provided by vibrator installed on their seats for tactile stimuli and a flicker lasting a second by a light bulb for visual stimuli in the event of blast in the game.

Procedure. Participants played the game after instruction of game. Shooting down enemies and avoiding crush with them simultaneously was the key of the game. Performance was measured by game score which a gamer gain from bringing down enemies during playing time. After the session, the questionnaire regarding immersion, presence, and enjoyment was administered for their subjective evaluation.

2.2 Results

The participants' subjective rating data were analyzed by a series of repeated measured analyses of variance (ANOVAs) with four levels of game output interface

modes as an independent variable: basic, visual stimuli (light bulb), tactile stimuli (vibration of chair), and both tactile & visual stimuli(vibration plus light), with comparing low immersive tendency group with high immersive tendency group. The main effect of four output interface modes in the score of performance, immersion, presence, and enjoyment were not significant, but immersion [performance: $F(3,11)=1.11$, $p>.05$; immersion: $F(3,11)=3.48$, $p<.05$; presence: $F(3,11)=1.51$, $p>.05$; enjoyment: $F(3,11)=1.63$, $p>.05$]. However, on the inside of these results, the discrepancy between basic and tactile condition and the one between basic and simultaneous tactile and visual condition in immersion are the most significant [basic and tactile stimuli: $F(1,11)=7.61$, $p<.05$; basic and both visual & tactile stimuli: $F(1,11)=5.04$, $p<.05$]. Tactile stimuli have resulted in higher presence and immersion than visual stimuli did. The strong response toward tactile stimuli rather than basic condition was consistent with the result of the one in presence [tactile stimuli: $F(1,11)=7.74$, $p<.05$], supporting the existing research that immersion and presence are positively related. High immersive tendency group was likely to feel more immersed, presence, enjoyment to different levels of output interface modes, while

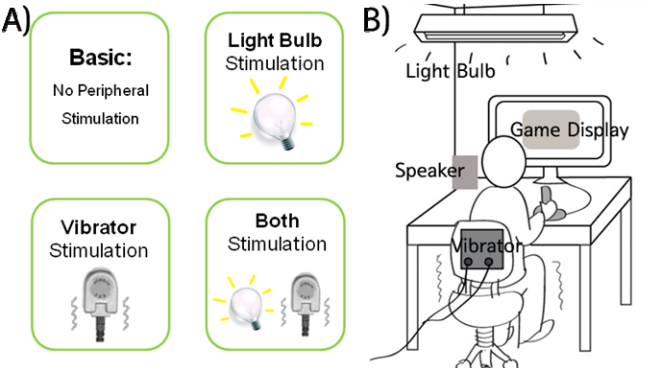

Fig. 1. A) Four levels of game output interfaces, B) An illustration of the experimental set-up used in this study

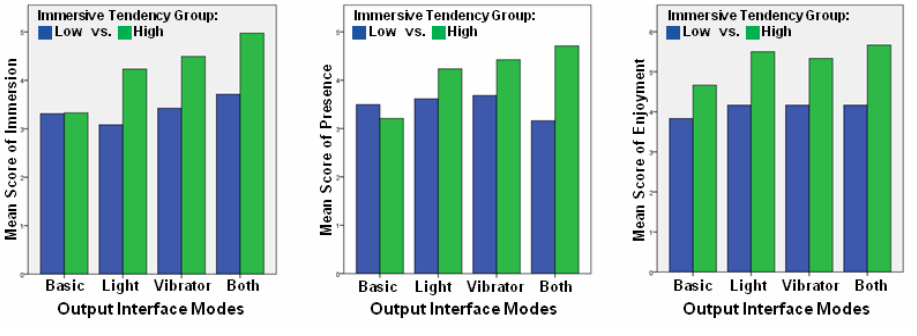

Fig. 2. The mean scores of participants' immersion, presence, and enjoyment responses as a function of four output interface modes and immersive tendency groups

low immersive tendency group showing less difference among different levels [immersion: $F(1,10)=9.39$, $p<.05$; presence: $F(1,10)=2.00$, $p=1.87$; enjoyment: $F(1,10)=5.00$, $p<.05$]. Especially, high immersive tendency group displayed the increase of enjoyment for visual condition and both visual & tactile stimuli condition than low immersive tendency group.

3 Discussion

The result suggests that a gamer could experience the expanded interface with additional multisensory output, bringing more enjoyment. These tendencies are specially recognized for the higher immersive tendency group. The finding can be applied to various game interface designs. Additional sensory cues, for example, can be used to assist players or even distract them to increase difficulty level. Future studies are expected in relation to different game interface designs and genres.

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