Haptic Technology for the Mobile Device: Future Research and Opportunity in Business

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Abstract

Haptics, the science and physiology of the sense of touch, has been investigated in the field of engineering and HCI to provide better computing environments for users. Previous haptic technology being focused was mainly on the PC environments; however, beginning with the i-Phone of Apple recent haptic technology has entered our daily lives. Despite its popularization, the business opportunities the technology will bring have not yet been investigated thoroughly. This research forecasts the application of haptic technology on mobile devices and the consequential business opportunity. Also, the direction of future research in the field of MIS will be proposed.

Keywords:

Haptic; Mobile Device; Human Computer Interaction

Introduction

The sense of cognition is engaged more fully when more of the five basic senses: touch, taste, hearing, sight and smell are all integrated [4]. Among them, the ones relevant to mobile devices are touch, hearing, and sight. The sense of touch is recognized as a tremendous but underused source of physical and emotional attachment for improved user experience of mobile devices[12].

People interact in the physical world mostly with the sense of touch and it is the only sense that can send and receive information simultaneously[18]. The science of touch is called haptics. Haptics, the term derived from a Greek word “hapesthai” meaning “able to lay hold of,” is “the science of simulating pressure, texture, temperature, vibration and other touch-related sensations [8, 19].” Haptic sensing is defined as the use of motor behaviors in combination with touch to identify objects [2].

Haptic technology is recently receiving the focus of many researchers and practitioners as a technology with potential to improve the usability

of mobile devices[15]. The mobile communications experience can gain immensely from the use of haptic technology as people intuitively and effortlessly communicate through the language touch, which we learn even before verbal language[12]. The technology is a solution for the dilemma of mobile device designers who should make products smaller while embedding more functions in it [16], and is even viewed as a technology which will replace all the confusing buttons on mobile phones except for the number pads [9]. Recent falling of its price could lead to widespread commercialization of the technology [8]. It plays essential role in human-computer interaction and has a quantifiable effect on efficiency and error rates and user satisfaction [13].

Haptic Feedback on Mobile Devices

Why haptic on mobile devices

With more buttons and higher display quality, mobile phones these days support added applications to ordinary communication function, including image creation and web surfing. However, the remaining or even decreasing size of the physical size limits the space for physical input controls and causes difficulties for designers to design a device which can support all the applications while too many buttons are not too cumbersome for consumers. One solution proposed to solve the difficulty is the offloading of information to the haptic modality [4, 15]. Haptic technology provides more responsive, high-precision control and advanced control functions, which improves the usability of mobile devices [16]. Moreover, mobile devices are sometimes used in situations when the user's visual and auditory attention required can not be provided (e.g., library, class room) and when the user is performing some other tasks which also requires the cognitive resource. Adding haptic feedback to mobile devices, which are often held by the users allows more channels of communication between the device and the user [15]. It was empirically tested by Tang et al.[21] that people can perceive and interpret haptic information while their visual sense if occupied. Several properties of haptic simulation make the technology ideal for communicating information such as private information, warnings or alerts, and intuitive confirmations [13].

Application on mobile devices

A white paper from Immersion Corporation illustrates the possible application of haptics in mobile devices to expand the mobile device interface, improve performance, reduce cognitive load, and increase user satisfaction. The application can be applied to user interface function and design (e.g., touchscreen presses, scrolling, haptic intensity control, etc.), haptic messages and alerts (e.g., differentiated status alerts, haptic emoticons, navigation and mapping, location-based services, etc.), and entertainment (e.g., games, etc.) [12]. Intelligent touch controls of Atrua Technologies, applying a type of haptic technology, is an input device for cell phones, PDAs, touch navigation system and practically all the mobile devices in the market. It also enables

advanced game control, flexible navigations, control of a handset, and secure access to data service [16].

New haptic technology for mobile devices

The collaborative technology of Immersion and Samsung named VibeTone applied to mobile phones will allow different vibrations for different callers that its users can identify the caller without looking at the screen[8]. A technology called piezoelectric actuators can control the amplitude and frequency of tactile waveforms, resulting in various vibrations such as small discrete pulses or a variety of prolonged signals[15]. Also during a phone call, personal touch which can be felt by the receiver can be sent and this can increase physical connection with the receiver [19]. Diversification of vibration tones can lead to its users uploading and downloading personally created vibrations at online community as they do the same with ringtones.

Advanced from previously existing haptic technology which recognized fingertip simply as an object moving across the sensor, new technology can observe the fine ridges, peaks and valleys of the finger and movements it makes, such as twisting and pressing, for sensitive and precise controls equivalent to human touch. This is enabled by the silicon sensor beneath the device surface which detects stronger electrical signals from the ridges and weaker signals from the valleys. Frame by frame finger data captured by haptic sensor is converted into a stream of digital data by reconstruction software for 'fingerprint authentification,' which matches the data to the previously stored fingerprint information for verification and 'control and navigation,' which provide control functions by analyzing the finger movement. The combination of different movements of the finger and unique print on each finger can trigger various different functions [9, 16]. The authentification with fingerprint makes it easier for the user of mobile devices to log on to applications and services which was difficult to type in passwords using the existing keypads [20].

Research on Haptic

The improved task performance of applying haptic feedback has been found by previous researches. 52% movement time improvements and 25% improvement time in drag-and-drop task using a force feedback mouse in GUI steering tasks were found by Dennerlein et al.[6], reduced errors and improved perceived easiness of workload using haptically augmented scrollbars were found by Oakley et al.[17], 5% faster performance of haptic feedback in quiet environments and 15% faster in noisy environments using haptic augmented touch screen buttons over audio augmented buttons were found by Fukumoto et al., and 20% improvement in response time using haptic augmented progress bars and 11% improvements in task completion time using haptic augmented scroll bars were found by Leung et al.[15]. Hwang et al.[11] found from an experiment conducted with motion-impaired, physically disabled people that the performance gain from the haptic feedback was the largest for those who are the most disabled. Dosher et al.[7] designed

an experiment in which subjects were presented with vibrotactile haptic effects varying in amplitude, wave shape, and duration to interact with a fingertip tactile display. Results show positive relationship between information flow volume and tactile effect amplitude and lower threshold of detection when feedback is rough rather than smooth. This provides empirical support for the ability of haptic technology that it can convey significantly more information than simple notifications.

The complementary effects of tactile feedback on sight and sound have been tested in multimodal feedback context. In their multimodal system which provided audio, tactile, and visual feedbacks to perform drag-and-drop task, Akamatsu et al.[1] found improved performance with bimodal and trimodal feedback compared to visual feedback alone. By comparing target acquisition performance of combination of audio, tactile, and pseudo-haptic feedback at Windows interface, Cockburn et al.[5] found gains by combining the modalities.

User satisfaction of haptic feedback, a subjective measure also has been tested empirically. In the experiment of Chang et al.[4], 42 subjects were asked to compare haptic and non-haptic phones by navigating the menu keys and playing ring tones. The result show that people perceive haptic phone to have better feel and better audio than non-haptic phone, and at the affinity test for the haptic vibration on show that most people perceive the haptic vibration agreeable. Brewster et al.[3] experimented with tactile feedback added smartphone type device in which subjects were asked to enter a series of poems in laboratory and on a moving train. As well as proving improvements in error rates, tactile feedback was preferred by the subjects and it also reduced their cognitive load.

Conclusion

This research viewed haptic feedback as a technology to enhance the functionality of mobile devices and reviewed existing researches relating to the technology. Despite the merits, new technology available and continuous technological development effort, current haptic mobile phones in market provide only primitive haptic feedback to its users. Practitioners should come up with ideas of how to apply more advanced haptic technologies such as vibetones and high sensitive fingerprint authentification to mobile devices and nicely timed business plan to introduce it to the market.

Although the domain haptic feedback focused in this study is limited to the haptic feedback on mobile devices, considerable research is done in the field of virtual reality (VR) using haptic feedback. When applied in VR, the technology brings visual illusions out of monitor screens that, people can interact in virtual environment and touch, feel, and manipulate virtual objects. The application area includes product design and virtual prototyping, factory layout simulation and process planning, training and education, and ergonomic analysis for product design [14, 18]. So far, it is widely applied in surgical-simulation devices with which are used to train doctors. Due to high price of haptic feedback devices in virtual reality areas however, the usage is still very

limited. Future researches on haptics could focus on lowering the price of haptic feedback device, leading to its further commercialization. Also, there exist several difficulties in developing a satisfying environment for realistic virtual interaction, such as network delay caused by network hardware, current congestion problem, and even the speed of light [10] and they are also obstacles that future researchers should overcome. Once the commercialization of VR haptic technology is achieved and applied to m-commerce and telecommunications, the world of 'haptic marketing' and 'haptic communication' could advent in the future. In haptic marketing, commercials in which consumers not only can visualize a product, but also can feel the product information such as texture in virtual reality, leading to consequential decreased uncertainty and increased purchase intention could be done. In haptic communication, callers on each side can interact physically with the virtual presentation of each other.

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