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EDITORIAL

Does Touch Matter?: The Effects of Haptic Visualization on Human Performance, Behavior and Perception

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1. INTRODUCTION

As a dynamic interaction technology, haptic interfaces enable users to utilize the ability of touch to feel and interact with virtual objects in a simulated virtual environment as if they were real, physical objects. Haptic feedback has the potential to provide redundant feedback, which would greatly improve the saliency of signals, as well as provide a unique feedback as a new signal to reinforce or improve user understanding (Robles-de-la-Torre, 2006). Haptic technology has found many successful applications such as surgical simulation (e.g., Basdogan et al., 2004; Chebbi et al., 2005), medical training (e.g., Coles, Meglan, & John, 2011), virtual prototyping (Zhu & Lee, 2004), scientific visualization (e.g., Lawrence, Pao, Lee, & Novoselov, 2004), and assistive technology for users with visual impairments (e.g., Amemiya & Sugiyama, 2010) or motion-impaired users (e.g., Keates, Hwang, Langdon, Clarkson, & Robinson, 2002). Many studies have also shown that haptic feedback can improve user performance in various tasks (Dinse et al., 2005; Richard & Coiffet, 1995), enhance the sense of sharing and each user's perception on his or her partner's actions (Hubbold, 2002), and increase perceived togetherness (Basdogan, Ho, Srinivasan, & Slater, 2000; Sallnas, Rassmus-Gröhn, & Sjöström, 2000; Slater, Sadagic, Usoh, & Schroeder, 2000).

Despite a considerable amount of ongoing research and development, current efforts in haptic research and development still possess significant gaps. In particular, more systematic studies are required regarding the design, development, and evaluation of haptic interface technology as well as its effects on human performance, behavior, and perception. The primary goal of this special issue was to bridge these gaps in the knowledge and practice domains by presenting the state-of-the-art advancements in research and development related to haptic and tactile interface technology through contributions from researchers in different disciplines.

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2. SPECIAL ISSUE CONTRIBUTIONS

The increased demand in contributions from the human–computer interaction (HCI) community prompted the guest editors to compile this special issue, which intends to present a snapshot of current work in haptics research by including contributions from researchers from different disciplines, with a particular focus on work in HCI. Our call for papers resulted in a total number of 18 submissions from groups around the world, out of which only seven papers were included in this special issue after a rigorous three-stage peer review process. These papers are summarized briefly below.

The first article, by Bahn et al. ("Scenario-Based Observation Approach for Eliciting User Requirements for Haptic User Interfaces"), explores the modern-day process of requirements engineering, discusses the challenges in developing a haptic assistive system, and proposes a methodology of combining a controlled observation in a naturalistic setting with scenario-based design for an effective and efficient user requirements elicitation. A case study was also conducted to show validity and effectiveness of the proposed methodology, in which a haptically enhanced, collaborative learning-by-feeling science education system is designed and developed to assist visually impaired students.

The second article, by Martínez et al. ("VITAKI: A Vibrotactile Prototyping Toolkit for Virtual Reality and Video Games"), proposes a vibrotactile prototyping toolkit (VITAKI), which can facilitate the prototyping and testing procedures of new vibrotactile interaction techniques for virtual reality and video games. Martínez and his colleagues also performed a validation study on their prototyping toolkit following the approach proposed by Olsen (2007). The analysis of the seven claims identified by Olsen and the comparison with previous work shows that VITAKI not only allows the creation of new hardware prototypes but also provides a software toolkit to design and manage the haptic stimuli.

In the third article ("Haptics on a Touch Screen: Characterization of Perceptual Thresholds"), Chauvelin and his colleagues analyze the influence of the characteristics of vibration signals on perception thresholds, as well as the influence of gender on those thresholds using a touch panel equipped with piezoelectric actuators. The purpose of this work is to identify large tendencies regarding the participants' sensitivity in detecting haptic signals on a touch screen. Forty-six participants were asked to press on a touch panel and to inform the experimenter when perceiving a vibration. They observed a significant influence of waveform on perceptual sensations. In addition, statistical tests allowed identifying perceptual threshold ranges and associating them to behavior classes.

The fourth article, authored by Fakhoury and colleagues ("The Effect of Vision on Discrimination of Compliance Using a Tool"), investigates the effect of visual information in compliance discrimination when it is used in combination with a haptic interface. As the minimally invasive surgeries, such as laparoscopic surgery, are becoming more common, how to effectively convey haptic information that is crucial in examining the normality of the body is receiving more attention. This article, a fundamental study on this issue, investigated the performance of compliance perception by different sources of information: direct vision with haptic information, indirect vision on a computer screen with haptic information, only haptic information, and only indirect visual information. The results show the critical role of visual information in compliance discrimination when it is used in combination with haptic interface.

In the fifth article ("Use of Reference Frame and Movement Pattern in Haptically Enhanced 3D Virtual Environment"), Lee et al. discuss research outcomes regarding factors that affect the use of reference frame when visually impaired users verbally express a haptically constructed mental map, and how such preference corresponds to their haptic movement in the virtual environment. In the study, a haptic gravity cue was the most influential in determining a vertical axis of a frame. Totally blind users were more responsive to various frames than users with lower vision and were faster in determining a term to explain spatial relationship.

The sixth article ("The Impact of Combining Kinesthetic and Facial Expression Displays on Emotion Recognition by Users"), authored by Gaffary and his colleagues, investigates the potential of haptic channels to communicate emotions. They measured the improvement of the recognition rate of emotions using visuo-haptic feedback compared to facial and haptic expressions alone. Four experiments were conducted in which the recognition rates of emotions using facial, haptic, and visuo-haptic expressions were tested. The results reveal that participants are not equally aided by each modality for recognizing emotions efficiently. Beyond the recognition rate, multimodal expressions improved the sensation of presence and expressivity.

The last article, by Ammi and Katz ("Intermodal Audio-Haptic Metaphor: Improvement of Target Search in Abstract Environments") reports new types of audio-haptic coupling strategy to improve the search for targets in complex environments. The proposed approach enables the simultaneous use of both audio and haptic channels for the comparison of values at different spatial configurations. This feature employs the integration of a tempo parameter in both sensorial signals to create a connection between the two channels enabling an intuitive and efficient comparison. The results show an improvement in comparison accuracy and a reduction in the number of "back-and-forth" actions between relevant configurations. Based on these results, Ammi and his colleagues maintain that the intermodal metaphor can be used in subsequent works as a communication tool, addressing a collaborative search for targets to improve interpersonal awareness (e.g., partner's results).

3. CONCLUSIONS

The topics of the selected seven articles are additional evidence that the HCI community can make important contributions to the field of haptics research: development and successful application of theories, design and user requirement frameworks, and evaluation metrics that are inclusive, pluralistic, and generalizable to many other haptic system developments. Consequently, the multidisciplinary integration of HCI, universal design, and assistive technology appears to be critical to the success of a primary goal of haptics research and development.

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