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HAPTIC AND AUDIO-VISUAL STIMULI:
ENHANCING EXPERIENCES AND INTERACTION

Amsterdam, July 7, 2010

Anton Nijholt, Esko O. Dijk, Paul M.C. Lemmens, Steven Luitjens (eds.)

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Haptic and Audio-Visual Stimuli: Enhancing Experiences and Interaction
A. Nijholt, E.O. Dijk, P.M.C. Lemmens, S. Luitjens (eds.)
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Book orders:
Ms. C. Bijron
University of Twente
Faculty of Electrical Engineering, Mathematics and Computer Science
P.O. Box 217
NL 7500 AE Enschede
tel: +31 53 4893740
fax: +31 53 4893503
Email: bijron@cs.utwente.nl

Druk- en bindwerk: Ipskamp Drukkers, Enschede.

Preface

Abstract

The intention of the symposium on Haptic and Audio-visual stimuli at the EuroHaptics 2010 conference is to deepen the understanding of the effect of combined Haptic and Audio-visual stimuli. The knowledge gained will be used to enhance experiences and interactions in daily life. To this end, a number of key lectures have been organized and accompanying papers can be found in this proceedings. With the lectures and the interaction between the researchers at the symposium, we aim to initiate a community interested in multimodal stimulation involving haptic elements with an emphasis on experiences for entertainment, well-being and relaxation.

Background

Multimodal stimulation is capable of creating strong effects on users, because the effects of the various stimuli can enforce each other. It can be used to enhance entertainment experiences, as well as well-being and relaxation experiences. By default, multimodal stimulation often only considers visual with auditory stimulation, because these senses are most prominent in our environment. However, humans have at least three more senses that can be used to create multimodal sensations: touch, taste, and smell. The latter two are technologically difficult to implement but stimulation and feedback using the tactile sense is rapidly becoming more prevalent. An example application is to use haptic and tactile actuator elements to provide the player of a game with a more thrilling experience. In this case, tactile stimulation is provided that is linked to the visual and auditory information in the game and together, these stimuli create very strong experiences.

A deep understanding of the requirements to create a convincing multimodal experience is needed to create an experience that is more than just the sum of the elements. This understanding is needed on the level of individual sensory modalities but also on the interactions of information processing in each modality and covers aspects of the relative contribution of individual modalities, aspects of timing and synchronization, et cetera. This especially applies to the tactile modality that is relatively unexplored in the context of multimodal stimulation. Work on these topics is being carried out for separate modalities [1-3] and also for multimodal stimulation [4] and covers topics as diverse as intensity, spatial distribution, timing, tactile perception [1,5], tactile displays [6], et cetera. However, the effects multimodal stimulation including haptic elements on the user experiences and interactions has not yet been thoroughly studied in the context of entertainment, well-being, and relaxation applications.

About This Symposium

In this special symposium we address the specific effects of combined (multi-sensory) stimuli that aim to achieve total effects that are more than just the sum of their elements. Topics range from basic elements such as mutual timing in audio, video, and haptic stimuli, through actuator technologies, to how such "more than the sum of the elements" effects of multimodal stimuli are created in a user's perception and how to evaluate these experiences and perceptions.

Our guiding hypothesis is that an optimal user experience will be obtained by taking into account human perception, careful personalization, and intelligent optimization. The latter should be based on both general knowledge of human perception, and on (measured or inferred) knowledge of the individual user. Research on human perception will provide information on the basic capabilities and limitations of individual modalities but also on how combined information processing in multiple modalities operates. To this end we have planned a number of key lectures on the technologies employed, the psychological and physiological sensitivities of people and the algorithms used to optimize the effect of multimodal stimuli. We have been able to invite researchers working on the following topics:

- Haptic illusions
- Design
- Relaxation using haptic stimulation
- Mediated social touch
- Audiotactile interaction
- Personalized tactile feedback
- Tactile stimulation for entertainment

These presentations and the interaction between researchers could initiate a community of researchers who are interested in multimodal stimulation involving haptic elements with particular emphasis on experiences in entertainment, well-being,

and relaxation. In these proceedings of the symposium you can find the contributions of most of the key speakers. Short summaries of these contributions follow below.

These proceedings start with a (preliminary) position paper *("Audio-tactile Stimuli to Improve Health and Well-being"*) by Esko Dijk and his co-authors. The paper aims at defining a research area where auditory and tactile stimulation, possibly enhanced with visual information and stimuli, is combined and applied to improve people's health and well-being. It is argued that these combined stimuli can have effects on the human body and mind by, for example, reducing stress, improving alertness or promoting sleep. Presently there is a variety of low-cost and miniature tactile actuators on the market. They find application in mobile phones, but also in jackets that provide dynamic and spatial tactile patterns on the human body. Audio-tactile patterns can be designed for many applications, for example, for navigation, for entertainment or for health and well-being purposes. The paper briefly surveys research results on audio-tactile stimuli, available technology, and audio-tactile composition. Scientific challenges are identified that need to be explored in order to design personalized audio-tactile systems that adapt to their users either off-line or online. The aim of this position paper is to create a research community for answering these challenges.

Clearly, before being able to interpret the effect of audio-tactile stimuli it is necessary to know the effect of uni-modal stimuli. For example, how can tactile stimuli induce emotions? In *"Tactile Experiences"* Paul Lemmens and his co-authors take William James' viewpoint that every emotion has a distinct bodily reaction. They reversed this observation and studied whether providing bodily stimuli while watching appropriate video clips could induce or enhance an emotion. The design of an emotion jacket is described. The jacket provides tactile sensations on the torso with the help of sixty-four actuators (eccentric rotating-mass motors) embedded in stretchable fabric. Various tactile emotion patterns were designed for video clips that were chosen to elicit certain emotional responses. In a user study participants viewed the clips with and without the emotion patterns projected onto their bodies. Questionnaires were used and psychophysiological responses were recorded in order to obtain information about the emotional experience and immersion. The results convinced the authors that adding the tactile emotion patterns enhanced the emotional experience of the viewers.

Hendrik Richter's contribution (*"Multi-Haptics and Personalized Tactile Feedback on Interactive Surfaces"*) builds further on the recent trends of using haptic feedback for touch screen interaction. In this application area, the touch and visual senses come together. While current systems can mostly provide haptic feedback for only a single point of interaction (i.e. finger), he proposes a first extension to multi-touch surfaces. A second extension is also proposed to take away one important restriction of current solutions, namely that the haptic feedback is always given at the location of interaction on the screen. It is proposed to spatially disunite the body-part of interaction (finger, hand) and the resulting tactile feedback, potentially leading to completely new touch screen interaction paradigms using haptics. Firstly, feedback can be given at multiple body locations and/or using multiple actuation means (an approach called multi-haptics) and secondly the haptic feedback can be personalized to each user in collaborative scenarios where multiple users are interacting on the same touch surface. Three prototypes that have been used for initial explorations in this domain are described.

Valeria Occelli (*"Assessing Audiotactile Interactions: Spatiotemporal Factors and Role of Visual Experience"*) provides a well founded overview of her work on the interaction of hearing and touch; an interaction that happens often in daily life but that has received relatively little attention in scientific literature. She has studied monkeys, patients with brain damage, blind people, and a non-patient population and shows that the location at which crossmodal audio-tactile stimulations are presented strongly influences how much attention is given to the stimulus. Locations directly behind the head attract most attention. These stimuli in peri-personal space attract less attention and, with increasing distance from the body, the number of resources allocated to the stimuli also decreases. Moreover, Occelli shows that certain types of sound interact with the effects of spatial location: pure tones have different effects than white noise has.

Antal Haans and Wijnand IJsselsteijn (*"Combining mediated social touch with vision: From self-attribution to telepresence?"*) investigate the topic of mediated social touch, id est interpersonal touch over a distance by means of tactile display technology. They investigate combining mediated touch with vision, allowing people simultaneously to both feel and see how a remote partner is touching them. Adding another sensory modality (in this case vision) for the person receiving the touches, can potentially increase a user's sense of "being in the same environment" with the remote partner. The paper confirms this effect and also shows that adding vision can increase the perceived naturalness of the mediated touches. This serves as a good example of how perceived quality in one modality can be increased by adding congruent stimuli in another modality. The experimental findings illustrate that visual feedback, especially when the visual shows a resemblance to a human body being touched, can improve mediated social touch. As such, the results of this work could be seen as ingredients for future systems that improve people's well-being, by facilitating closer contact with loved ones even though they may be far away.

In the paper *"'Breathe with the Ocean': A System for Relaxation using Combined Audio and Haptic Stimuli"* by Esko Dijk and Alina Weffers, a breathing guidance system is introduced that uses audio, haptic, and visual stimuli and that was created for the purpose of relaxing a user. The authors provide evidence from the literature that audio stimuli (in particular music), haptic stimuli (in the forms of vibrations), and visual stimuli can induce relaxation. The breathing guidance system makes use of a Touch Blanket, an actuation device developed by Philips that can provide haptic patterns on body parts. The blanket contains 176 small vibration motors arranged in a 2D matrix. 'Haptic waves' synchronized with audio can move up and down the body in various cycles. These cycles can be fixed (e.g., taking a rate similar to a breathing pace that is associated with relaxation), they can follow the breathing behavior of the user or they can guide the user to an optimal breathing behavior taking into account respiration and heart rate. Results of a first evaluation of these approaches are shown.

Stefania Serafin et al., in *"Identification of virtual grounds using virtual reality haptic shoes and sound synthesis"*, report on an experiment using a combination of haptic and auditory stimuli to simulate the sensation of walking on different kinds of surfaces, for example beach sand, gravel, metal etc.. Haptic stimulation was provided by actuators mounted in the soles of shoes. Audio stimulation was generated by using physical models of walking combined with sounds recorded during walking on various kinds of surfaces. Both stimuli were coupled to the physical action of walking by sensors in the soles of the shoes. The aim of this interesting experiment was to find out about the enhancement of the sensation of walking by adding the haptic feedback to the auditory one. From the user tests it appeared that the main role in creating the sensation and recognizing the kind of surface was the auditory stimulation. Although in some cases haptic stimulation added significantly.

Finally, Saskia Bakker et al. (*"Design for the Periphery"*) work on the topic of designing for the periphery which revolves around design technology interactions in such a way that only peripheral attention is needed to process and carry out these interactions. As a foundation for their work, they discuss the notion of calm technology, and attention theory as developed in psychological literature. Calm technology is technology that works in the background, not demanding our attention, and that can be attended by peripheral attention. Bakker et al. propose that interaction design for calm technology should be guided by principles from psychological theories of attention such that the interaction with the technology can be done without requiring major attentional effort. Because humans effortlessly interact with tangible objects, the haptic modality seems a candidate with a lot of potential for interaction design in the periphery.

During the symposium some presentations were given that could not be included in these proceedings. George VanDoorn gave a talk entitled "Haptics Can Lend a Hand to a Bionic Eye." and Maud Marchal gave a talk on "Pseudo-Haptics". In addition to the oral presentations there were demonstrations of tactile vests by Sense-Company, Tilburg, in the Netherlands, and by the Hogeschool voor de Kunsten, Utrecht, in the Netherlands.

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Anton Nijholt, Esko O. Dijk, Paul M.C. Lemmens & Steven Luitjens Enschede/Eindhoven, July 2010

Committees

Program and Organizing Committee

Anton Nijholt	Human Media Interaction, University of Twente, The Netherlands
Esko O. Dijk	Philips Research Eindhoven, The Netherlands
Paul M.C. Lemmens	Philips Research Eindhoven, The Netherlands
Steven Luitjens	Philips Research Eindhoven, The Netherlands

Scientific Advisers

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Charlotte Bijron	Human Media Interaction, University of Twente, The Netherlands

Programme

09.30	Opening
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	Saskia Bakker, Elise van den Hoven, Berry Eggen
	Eindhoven University of Technology, The Netherlands
10.15	Pseudo-Haptics (preliminary title)
	Maud Marchal, Anatole Lécuyer
	INRIA, Rennes Cedex, France
10.45	Break
11.00	Combining Mediated Social Touch with Vision: From Self-attribution to Telepresence?
	Antal Haans, Wijnand A. IJsselsteijn
	Eindhoven University of Technology, The Netherlands
11.30	Haptics Can Lend a Hand to a Bionic Eye
	George VanDoorn, Barry Richardson
	Monash University, Churchill, Australia
12.00	Multi-Haptics and Personalized Tactile Feedback on Interactive Surfaces
	Hendrik Richter
	University of Munich, Germany
12.30	Lunch
13.45	Assessing Audiotactile Interactions: Spatiotemporal Factors and Role of Visual Experience
	Valeria Occelli
	University of Trento, Italy
14.15	Demonstrations and Talks by Sense-Company and HKU
	Ewoud Kuyper, Sense-Company, Tilburg, The Netherlands
	Gerard van Wolferen, Hogeschool voor de Kunsten, Utrecht
15.00	Break
15.30	Tactile Experiences
	Paul M.C. Lemmens, Dirk Brokken, Floris M.H. Crompvoets, Jack van den Eerenbeemd, Gert-Jan de Vries
	Philips Research, Eindhoven, The Netherlands
16.00	'Breathe with the Ocean': A System for Relaxation using Combined Audio and Haptic Stimuli
	Esko Dijk, Alina Weffers-Albu
	Philips Research, Eindhoven, The Netherlands
16.30	Identification of virtual grounds using virtual reality haptic shoes and sound synthesis
	Stefania Serafin, Luca Turchet, Rolf Nordahl, Smilen Dimitrov
	Medialogy, Aalborg University, Copenhagen, Denmark
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