Proceedings of EuroHaptics 2004, Munich Germany, June 5-7, 2004.

Design and evaluation of Hapticons for enriched Instant Messaging

Loy Rovers and Harm van Essen

Designed Intelligence Group, Department of Industrial Design
Eindhoven University of Technology, The Netherlands
{A.F.Rovers,H.A.v.Essen}@tue.nl

Abstract. Instant Messaging (IM) is a popular chatting platform on the internet and increasingly permeates teenage life. Even intimate and emotional content is discussed. As touch is a powerful signal for emotional content, haptic signals, and especially hapticons could contribute to overcome the inevitable loss of subtle non-verbal communication cues. This paper introduces hapticons (small force or vibration patterns that can be used to communicate emotions and feelings) to enrich instant messaging. The open source Hapticon Design Tool and the Haptic Instant Messenger that are introduced, provide a framework to combine communication of textual messages with haptic effects. Also the design process and evaluation methods for meaningful hapticon design are discussed.

1 Introduction

In our ongoing research on person-to-person communication by means of physical interaction over a computer network, we explore the opportunities of real-time haptic signals to enhance communication between two users. In this paper we explore the use of hapticons for Internet enabled person-to-person asynchronous communication technologies such as email and Instant Messaging (IM).

We chose instant messaging as communication tool as it is one of the most popular chatting platforms on the Internet that deals with person-to-person communication. Instant messaging increasingly permeates teenage life: it is no longer used merely to send messages, but has also become a major medium to stay in touch with friends and share intimate information [1][7].

IM primarily uses textual messages, often extended with audio-visual cues. In comparison to direct interaction in the real world, subtle non-verbal cues such as gestures, facial expressions or prosodic features of speech are lost. In order to strengthen meaning or expression, sounds and especially emoticons - both as character strings and graphical "smileys" - are frequently used.

Compared to vision and hearing, haptic information is the most direct and intimate manner of person-to-person interaction. Although IM is frequently used to pass intimate and emotional content, haptic effects are rarely used to support communication, while particularly touch is a powerful modality for this class of information.

The ContactIM application [6] developed by the MIT Palpable Machines Research Group is one of the rare examples of haptic-enabled instant messaging. In this application users can open virtual playing-fields beside the chat window and throw over virtual balls. Haptic effects are generated only when manipulating the balls, and are neither related to the message, nor do they create additional meaning for the message or generate a sense of emotion of intimacy.

In order to couple meaning and touch in IM, we introduce hapticons. Hapticons are defined as small programmed force patterns that can be used to communicate a basic notion in a similar manner as ordinary icons are used in graphical user interfaces. At the University of British Columbia, research has been conducted to the design and usability of hapticons [3][5], but it has not been explored yet to what extent hapticons can be used as an alternative to emoticons in the context of a chat-application.

The advantage of using hapticons as a medium for haptic signals in asynchronous communication is obvious. Hapticons can be used to support text messages and resolve some of the ambiguity that frequently arises during chatting. A special language consisting of haptic signals might arise over time.

We have developed a special instant messaging application that opens opportunities for haptic communication by allowing users to send messages enriched with haptic effects. The Haptic Instant Messenger, combined with the Hapticon Design Tool - an editor to design and create hapticons - provides the opportunity to explore and evaluate the function of haptics in asynchronous communication and study how users react to these new possibilities. All tools are open source and available on our website (www.haptics.nl/him).

A vision on the design and appropriate tools for creating hapticons is presented in section 2. Section 3 presents the Haptic Instant Messenger application, indicating how hapticons can be used in IM. Section 4 presents evaluation methods for different stages of hapticon design. Finally section 5 concludes the paper and indicates future work.

2 Hapticon Design

Hapticons may be defined as pre-programmed force patterns and force feedback devices may be used to display them [3]. However, also skin sensations like spatial pressure distributions and thermal properties are essential for perceiving the message or notion. In this paper we only explore the design of hapticons defined by specifying their amplitude and frequency content as a continuous function of time for small scale vibrotactile displays.

2.1 Hardware setup

Many types of actuators can be used to generate a vibration (e.g. piezo elements, special purpose force feedback setups, etc), but we prefer to use simple vibration motors in an open-loop configuration. Vibrations are experienced as diffuse and

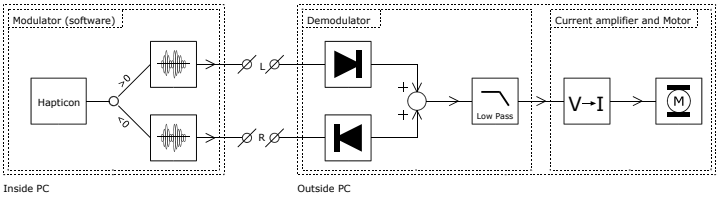

Fig. 1: Schematic overview of the hardware

delocalized, unlike vector force feedback, so a single vibrator for a region of skin may be adequate and effective single-channel devices are relatively easy to build. This type of actuator is already used in many consumer products like mobile phones, pagers and PDA's that might exploit hapticons in the future. The movements of the vibration motor are controlled by a standard sound card in combination with a simple external circuit (see schematic overview Fig. 1).

Because sound cards cannot to generate the low frequency signals that are often used in hapticons, the hapticon signal has to be modulated on an AM carrier wave inside the PC before it is send out of the soundcard. Positive parts of the hapticon are modulated over the left sound channel, while negative parts are modulated over the right audio channel. Outside the PC, a standard AM demodulator circuit demodulates the signals again. This signal is used as input for a current amplifier that provides current to the vibration motor that is linearly dependent on the amplitude of the hapticon signal.

2.2 Hapticon Design Tool

In order to explore hapticons, a design tool has been implemented in MATLAB^{TM} (Fig. 2). This tool creates the resulting motor current (bottom window) as function of time, split up in an amplitude (top) and a frequency component (center).

The amplitude of the current directly relates to the motor torque and thus rotation speed, while the frequency determines how often the direction of rotation changes. Although both parameters influence a vibration frequency, their effect is totally different: a change in direction is perceived often "unpleasant", while the vibration caused by the (rate of change of the) rotational speed is more "interesting". In order to provide the designer with opportunities to adjust all these parameters, a hapticon can be composed by superposing two sines. For example, by using one sine as a trend line (i.e. frequency zero) and a second sine for perturbation, the hapticon designer can create vibration patterns in which only the rotational speed of the motor and not its direction of movement varies in time, see Fig. 2.

2.3 Hapticon Design Process

With the Hapticon Design Tool, users can design new icons or modify icons from an existing library. A library with haptic implementations of the most popular

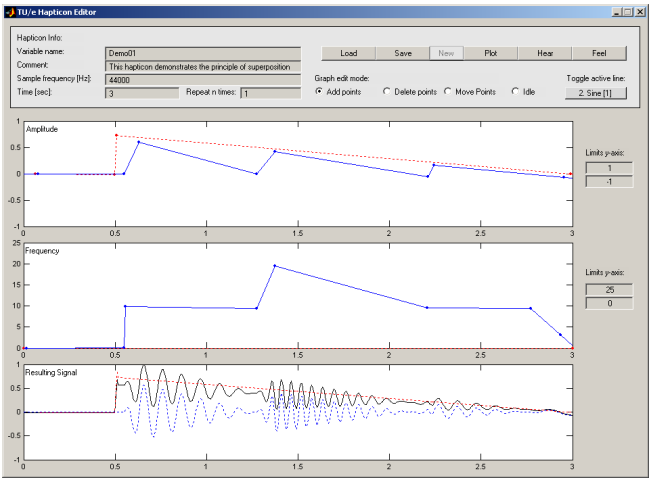

Fig. 2: Screenshot of the Hapticon Design Tool

emoticons is being developed. Because these hapticons will be evaluated in user-tests, such libraries provide a good starting point for novice hapticon designers.

When designing a new hapticon it is important to consider in what context the signal will be received and used by the user. Firstly, it makes a difference whether the signal will be played back as a continuous background vibration while reading a message, or is played only once. Secondly, the specifications of the vibration device and the position on the body are important for the experience of the hapticon. Finally, the designer has to decide whether the hapticon is intended to be an "icon" that is associated directly with phenomena in the real world (similar to the "Auditory Icons" by Gaver et al. [4] in the sound domain), or can be a more abstract "symbol" (compare to "Earcons" by Brewster et al. [2]). Because icons are based on metaphors, they seem to be suited for instant messaging: if designed properly, users directly understand the meaning of the hapticon even without having felt it before. This is even more the case when a hapticon is used to support a textual message. Moreover, the association with the metaphor in the real world can result in a more intimate experience. However, hapticons can be made more distinguishable by designing a symbolic set of signals [5].

3 Haptic IM Framework

The newly designed hapticons can be tested in the real context by implementing these in the open source Haptic IM framework [7]. The Haptic Instant Messenger (HIM) - that was specially created for the purpose of the project - provides all features of an ordinary server/client-based messenger such as listing who is online and sending text messages. In addition, the HIM system provides a set

of predefined hapticons and custom input and output devices to generate haptic effects, which can be triggered by using their corresponding textual representation in the text message (just like emoticons) or using a special input device. The framework allows users - developers as well as individual users - to design and experiment with their own signals and appliances and add them to the client application. For instance it is possible to make the system operational with commercial force feedback joysticks, as well as with custom made IO devices like vibration motors embedded in everyday objects like a pencil.

For the proposed asynchronous communication, a more difficult problem to resolve is the question *when* the haptic effects should be played back exactly, for it is not known in advance when a user is looking at the particular message (multitasking environment) or otherwise at particular words in the text that are associated with the hapticon. Solutions to this problem comprise of playing only one background vibration that represents the "mean value" of the emoticons in the (short) message, introducing a visual pointer to indicate the text you are reading or treating the hapticon as an "attachment" that is played when a user clicks on or otherwise activates the corresponding emoticon in the message.

4 Evaluation

The use of hapticons for instant messaging is evaluated in three steps: the usefulness of the hapticon design tool to create new hapticons, the associations that users (e.g. chatting teenagers) have between hapticons and emoticons, and finally the users response to the implementation of hapticons in the HIM messenger.

Users, who have no prior experience with icon and sound design, are asked to design hapticons for three popular emoticons, i.e. happy, anger, sad. Experiments indicate that most users find it difficult to just design a new hapticon, which generates the feeling they intended. As it is hard to predict the perceived output of a hapticon, all participants used an iterative design approach (i.e. design, play back, redesign). The sample hapticons from the library were used intensively as a source for inspiration.

For the association test, we designed six hapticons. Four of these were especially designed for a certain chatting mood, i.e. anger, enthusiasm, wink and sadness. Anger, for example, is expressed by a short burst and enthusiasm by a jumpy vibration. In a test among teenagers these hapticons are associated with their intended meaning. Pairs of messages - each belonging to only one of the four chatting categories - are shown in a random order while a hapticon is played, see Fig. 3. Participants are asked to rate the match between the hapticon and the message on a seven point scale. The results provide valuable directions for hapticon improvement, as it is shown which hapticons are least ambiguous. More tests are required to derive guidelines for good hapticon design.

Most audio-visual extensions that that have been added to IM in the past to show emotions, in particular emoticons, have been received enthusiastically by their users. User tests among teenage chatting groups will be set up to value the use of hapticons in the real world.

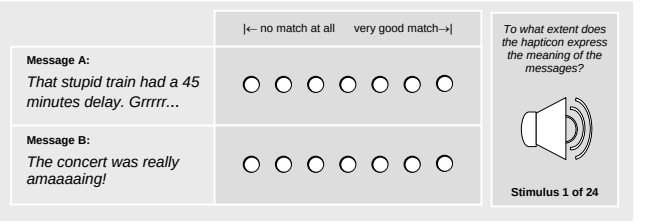

Fig. 3: Screenshot of hapticon association experiment

5 Conclusion

Instant Messaging (IM) is a very popular chatting platform for teenagers, that is also used to share intimate and emotional content. We investigate whether hapticons can contribute to overcome inevitable losses in subtle non-verbal communication cues. These pre-programmed force and vibration patterns can strengthen meaning and expression, and draw attention in multitasking user-environments.

The Hapticon Design Tool presented in this paper provides designers with a tool to create hapticons for simple vibration motors, that are already used in many consumer devices like mobile phones, pagers and PDA's. We started evaluating the associations between hapticons and emotions. This should result in a standard library of verified hapticons.

Hapticons are utilized in the Haptic Instant Messaging (HIM) application that combines traditional textual messages with haptic effects and hapticons. As HIM is an open framework, users can add their own hapticons and haptic IO devices. We are still evaluating this tool among target user-groups.

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