Enhancing Mediated Interpersonal Communication through Affective Haptics

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Abstract. Driven by the motivation to enhance emotionally immersive experience of real-time messaging in 3D virtual world Second Life, we are proposing a conceptually novel approach to reinforcing (intensifying) own feelings and reproducing (simulating) the emotions felt by the partner through specially designed system, iFeel_IM!. In the paper we are describing the development of novel haptic devices (HaptiHeart, HaptiHug, HaptiTickler, HaptiCooler, and HaptiWarmer) integrated into iFeel_IM! system, which architecture is presented in detail.

Keywords: Affective haptics, affective user interface, wearable devices.

1 Introduction

In a real world, whenever one person interacts with another, both observe, perceive and interpret each other's emotional expressions communicated through a variety of signals. Valuable information is also transferred by non-verbal communication (e.g. social touch). Nowadays, communication in 3D virtual world through instant messenger and chat is very popular. However, during on-line communication people are concentrating on textual information and are only slightly affected emotionally. Conventional mediated systems usually (1) support only simple textual cues like emoticons; (2) lack visual emotional signals such as facial expressions and gestures; (3) support only manual control of expressiveness of graphical representations of users (avatars); and (4) completely ignore such important channel of social communication as sense of touch.

To deliver emotions through instant messenger, Shin et al. [1] developed a tactile interface. However, in the proposed methods users have to memorize the vibration or pin matrix patterns and cognitively interpret the communicated emotional state. Moreover, such device cannot evoke user's emotion in a direct way. To our knowledge,

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the only work concentrated on the physical emotion elicitation through physical means is described in [2].

Driven by the motivation to enhance social interactivity and emotionally immersive experience of real-time messaging, we are proposing a conceptually novel approach to reinforcing (intensifying) own feelings and reproducing (simulating) the emotions felt by the partner through specially designed system, iFeel_IM!. The philosophy behind the iFeel_IM! (**i**ntelligent system for **Feel**ing enhancement powered by affect sensitive **I**nstant **M**essenger) is "***I feel*** [therefore] ***I am!***". The emotion evoked by physical stimulation might imbue our communication with passion and increase the emotional intimacy, ability to be close, loving, and vulnerable. We argue that interpersonal relationship and the ability to express empathy grow strongly when people become emotionally closer through disclosing thoughts, feelings, and emotions for the sake of understanding.

In this work, we focus on implementation of novel devices for generation of physical stimulation aimed to convey (and influence on) the emotion experienced during online conversations.

2 iFeel_IM! Architecture

In the iFeel_IM! system, great importance is placed on the automatic sensing of emotions conveyed through textual messages in 3D virtual world Second Life, the visualization of the detected emotions by avatars in virtual environment, and enhancement of user's affective state and reproduction of feeling of social touch (e.g., hug) by means of haptic stimulation in a real world. The architecture of the iFeel_IM! system is presented in Fig. 1.

In order to communicate through iFeel_IM! system, users have to wear innovative haptic devices (HaptiHeart, HaptiHug, HaptiTickler, HaptiCooler, and HaptiWarmer) developed by us. As a media for communication, we employ Second Life allowing users to flexibly create their online identities (avatars) and to play various animations (e.g., facial expressions and gestures) of avatars by typing special abbreviations (e.g., '/laugh' for laughing) in a chat window.

To automate emotional behaviour of avatar and to avoid thus manual control by user, we developed EmoHeart object [3] (invisible in case of 'neutral' state) that listens to each message of avatar, sends it to the Affect Analysis Model [3] located on the server, gets the result (dominant emotion and intensity for each sentence), and visually reflects the sensed affective state through avatar facial expression and EmoHeart texture and size. The motivation behind using the heart-shaped object as an additional channel for visualization was to represent the communicated emotions in a vivid and intense way.

In addition to communication with Affect Analysis Model, EmoHeart is responsible for sensing symbolic cues or keywords of 'hug' communicative function conveyed by text, and for visualization (triggering related animation) of 'hugging' in Second Life. The results from the Affect Analysis Model and EmoHeart are stored along with chat messages in a file on local computer of each user. Haptic Devices Controller analyses these data in a real time and generates control signals for Digital/Analog converter (D/A), which then feeds Driver Box for haptic devices with

control cues. Based on the transmitted signal, the corresponding haptic device (HaptiHeart, HaptiHug, HaptiTickler, HaptiCooler, or HaptiWarmer) worn by user is activated.

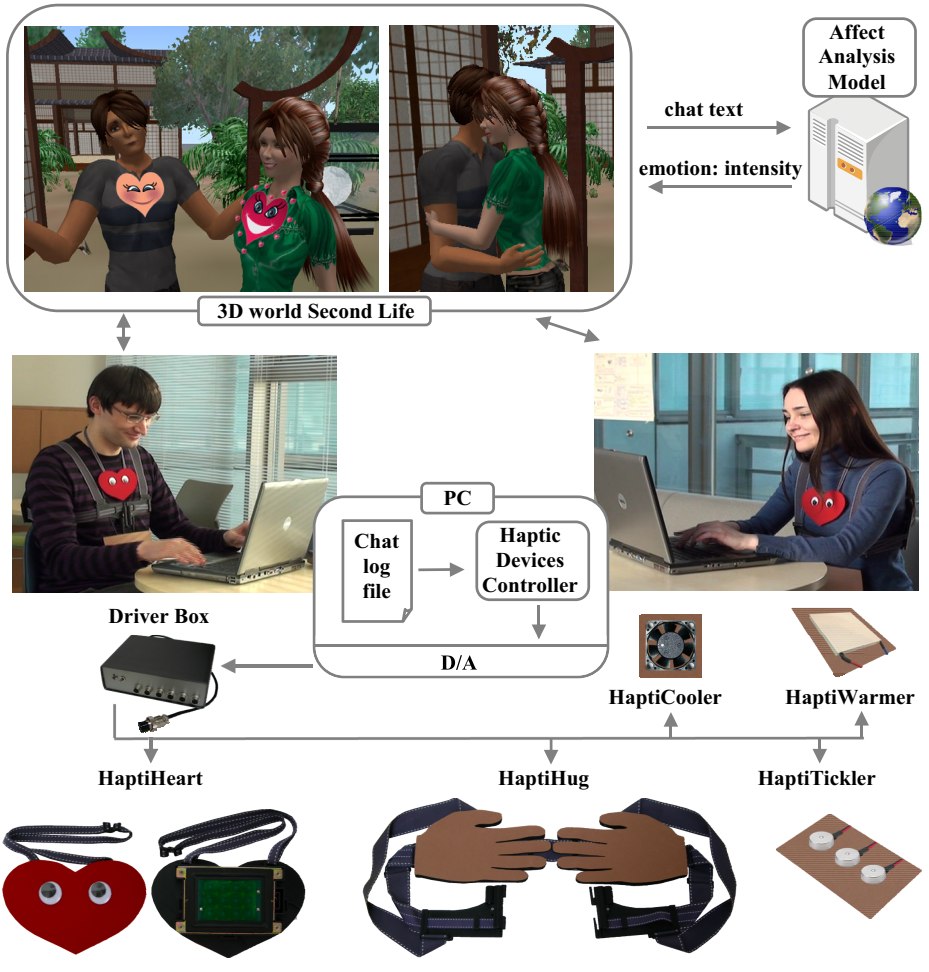

Fig. 1. Architecture of iFeel_IM! system

3 Affective Haptic Devices

In order to support the affective communication, we implemented several novel haptic gadgets embedded in iFeel_IM!. They make up three groups. First one is intended for emotion elicitation implicitly (HaptiHeart, HaptiCooler, HaptiWarmer), second type evokes affect in a direct way (HaptiTickler), and third one uses sense of social touch (HaptiHug) for mood influence. All these devices produce a sense of touch including

kinesthetic and coetaneous channels. Kinesthetic stimulations, produced by forces exerted on body, are sensed by mechanoreceptors in the tendons and muscles. This channel is highly involved in sensing stimulus produced by HaptiHug device. On the other hand, mechanoreceptors in the skin layers are responsible for cutaneous stimulation perception. Different types of tactile corpuscles allow us sensing thermal property of the object (HaptiCooler, HaptiWarmer), pressure (HaptiHeart, HaptiTickler), vibration frequency (HaptiTickler), and stimuli location (localization of stimulating device position enables association with particular physical contact).

3.1 HaptiHug: The Way of Realistic Hugging over Distance

When people are hugging, they generate pressure on the back of each other by the hands, and on the chest area simultaneously. The key feature of the developed HaptiHug is that it physically reproduces the hug pattern similar to that of human-human interaction. The hands for a HaptiHug are sketched from a real human and made from soft material. The important point is that the hands were designed in such a way that the user feels as if the friend's hands actually contact him. Couple of oppositely rotating motors are incorporated into the holder placed on the user chest area. Soft Hands, aligned horizontally, contact back of the user. Shoulder strips, supporting the motor holder and Soft Hands, allow aligning the vertical position of device. Once 'hug' command is received, couple of motors tense the belt, pressing thus Soft Hands and chest part of HaptiHug in the direction of human body (Fig. 2).

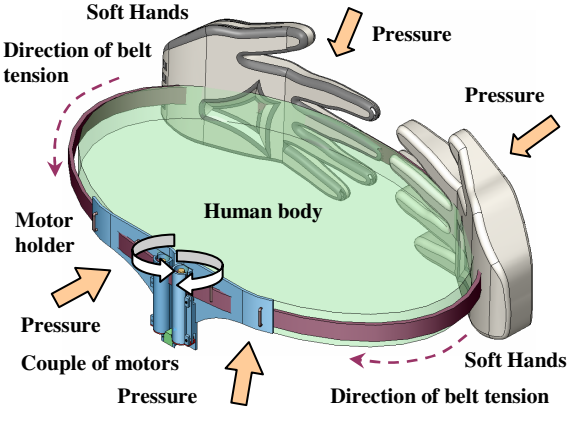

Fig. 2. Structure of wearable HaptiHug device

The duration and intensity of the hug is controlled by the software according to the detected emoticon or keyword. The Driver Box regulates the current magnitude in DC motor from 0 mA to 500 mA. For presentation of plain hug level (e.g., '(>^_^)>', '{}', '<h>'), big hug level (e.g., '>:D<', '{{}}'), and great big hug level (e.g., 'gbh', '{{{}}}'), the pressure of 200 N/m^2 with duration of 2 sec, the pressure of 300 N/m^2 with duration of 3 sec, and the pressure of 450 N/m^2 with duration of 4 sec, was applied on the user's back and chest, respectively.

The technical specification of the device is as follows. DC motors RE 10 1.5 W in combination with planetary gearhead GP 10 A (gear ratio of 64:1) generate stall torque of 192.6 mNm. The pressure produced on the human chest by tensed belt equals 450 N/m^2 at the most. Motor holder was manufactured on 3D printer Dimension DS 768 from ABS plastic material. Special slots were provided to make the pass for pressing belt.

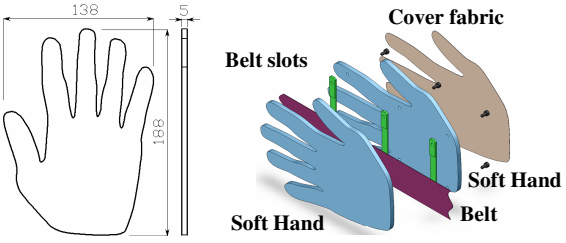

Fig. 3. Left: Soft Hand dimensions. Right: sandwiched structure of Soft Hands.

Preliminary, Soft Hands were produced on 3D printer from ABS plastic material with thickness of 1 mm. However, plate flexibility was not enough to achieve touch sensation similar to human hand. Therefore, we decided to make hands from compliant rubber-sponge material. The contour profile of Soft Hand is sketched from the male human and has front-face area of 155.6 cm^2. Two identical pieces of Soft Hand of 5 mm thickness were sandwiched by narrow belt slots and connected by plastic screws. Such structure provides enough flexibility to tightly fit to the human back surface while being pressed by belt. Moreover, belt can loosely move inside the Soft Hands during tension. The dimensions and structure of Soft Hands are presented in Fig. 3.

HaptiHug device has lightweight tri-glide bucklers and side release fastener integrated into the motor holder to facilitate easy adjustment of the belt size to her/his body sizes and detaching it in a natural and rapid manner.

3.2 HaptiHeart, HaptiCooler, HaptiWarmer, HaptiTickler. Or How We Can Enhance and Influence on Our Emotions by Haptics

We selected four distinct emotions with strong and unique physiological patterns: ‘anger’, ‘fear’, ‘sadness’, and ‘joy’ [4].

There is no doubt that feelings are intuitively connected with the heart, and our lexicon confirms this. The research on interplay between heart rate and emotions revealed that different emotions are associated with distinctive patterns of heart rate variations. We developed heart imitator HaptiHeart to produce special heartbeat patterns according to emotion to be conveyed or elicited (sad is associated with slightly intense heartbeat, anger with quick and violent heartbeat, fear with intense heart rate).

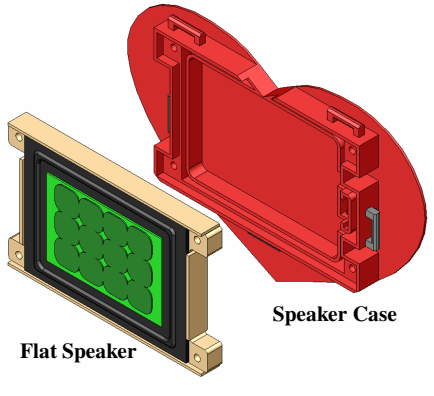

Fig. 4. HaptiHeart layout

We take advantage of the fact that our heart naturally synchronizes with the heart of a person we hold or hug. Thus, the heart rate of a user is influenced by haptic perception of the beat rate of the HaptiHeart.

The HaptiHeart consists of two modules: flat speaker FPS 0304 and speaker holder. The flat speaker sizes (66.5 x 107 x 8 mm) and rated input power of 10 W allowed us to design powerful and relatively compact HaptiHeart device producing realistic heartbeating sensation with high fidelity. The 3D model is presented in Fig. 4.

We recorded the heartbeat patterns for the cases of experiencing fear, anger, and sadness. The pre-recorded sound signal with low frequency generates the pressure on the human chest through vibration of the speaker surface.

HaptiTickler is responsible for joy emotion evocation. The idea behind this device is to reproduce effect of "*Butterflies in the stomach*" (fluttery or tickling feeling in the stomach felt by people experiencing love) by means of circular arrays of vibration motors attached to user abdomen area. HaptiWarmer is intended for the rise of skin temperature to evoke either aggression or pleasant feeling (hot or warm, respectively). In order to boost fear emotion physically, we designed HaptiCooler interface that sends "*Shivers down/up human body's spine*" by means of a row of vibration motors, and "*Chills down/up human body's spine*" through both cold airflow from DC fan and cold side of Peltier element.

4 Conclusion

In a nutshell, while developing the iFeel_IM! system, we attempted to bridge the gap between mediated and face-to-face communications by enabling and enriching the spectrum of senses such as vision and touch along with cognition and inner personal state.

In the paper we described the architecture of iFeel_IM and development of novel haptic devices, such as HaptiHeart, HaptiHug, HaptiTickler, HaptiCooler, and HaptiWarmer. All devices were designed with particular emphasis on ergonomic design. The user can comfortably wear them and easily detach from torso. We believe that iFeel_IM! will encourage users to get in "touch" with their emotions and to make social contact with other people in on-line communication.

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