iFeel_IM!: オンラインコミュニケーションにおける感情増幅のための着用型触感提示システム

iFeel_IM!: Affective Haptic Garment for Emotion Enhancement during Online Communication

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Abstract: The paper focuses on a novel system iFeel_IM! that integrates 3D virtual world Second Life, intelligent component for automatic emotion recognition from text messages, and innovative affective haptic interfaces providing additional nonverbal communication channels through simulation of emotional feedback and social touch (physical co-presence). The motivation behind our work is to enrich social interaction and emotional involvement of online interpersonal communication. iFeel_IM! users can not only exchange messages but also emotionally and physically feel the presence of the communication partner (e.g., family member, friend, or beloved person).

Keywords: Affective haptics, affective user interface, wearable devices, virtual reality, communication in virtual world.

1. Introduction

Interpersonal communication in 3D virtual world (e.g., Second Life, OpenSim) through instant messenger and chat is very popular nowadays. Recently mobile communication companies launched Instant Messenger service on cellular phones (e.g. AIM on iPhone). 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.

Besides emotions conveyed through text, researchers developed an additional modality for communicating emotions in Instant Messenger (IM) through tactile interfaces with vibration patterns [Rovers04]. However, in the proposed methods users have to memorize the vibration or pin matrix patterns and cognitively interpret the communicated emotional state.

Driven by the motivation to enhance social interactivity and emotionally immersive experience of real-time messaging, we pioneered in the idea of reinforcing (intensifying) own feelings and reproducing (simulating) the emotions felt by the partner through specially designed system, iFeel_IM! (Fig. 1). 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 elicited by physical stimulation might imbue our communication with passion and increase the emotional intimacy. The interpersonal relationships and the ability to express empathy grow strongly when people become emotionally closer.

Figure 1: User communicating through iFeel_IM!

2. Architecture of the iFeel_IM! System

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, 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! is presented in Fig. 2.

In order to communicate through iFeel_IM! system, users have to wear innovative affective haptic devices (HaptiHeart, HaptiHug, HaptiButterfly, HaptiTickler, HaptiTemper, and HaptiShiver) developed by us. As a

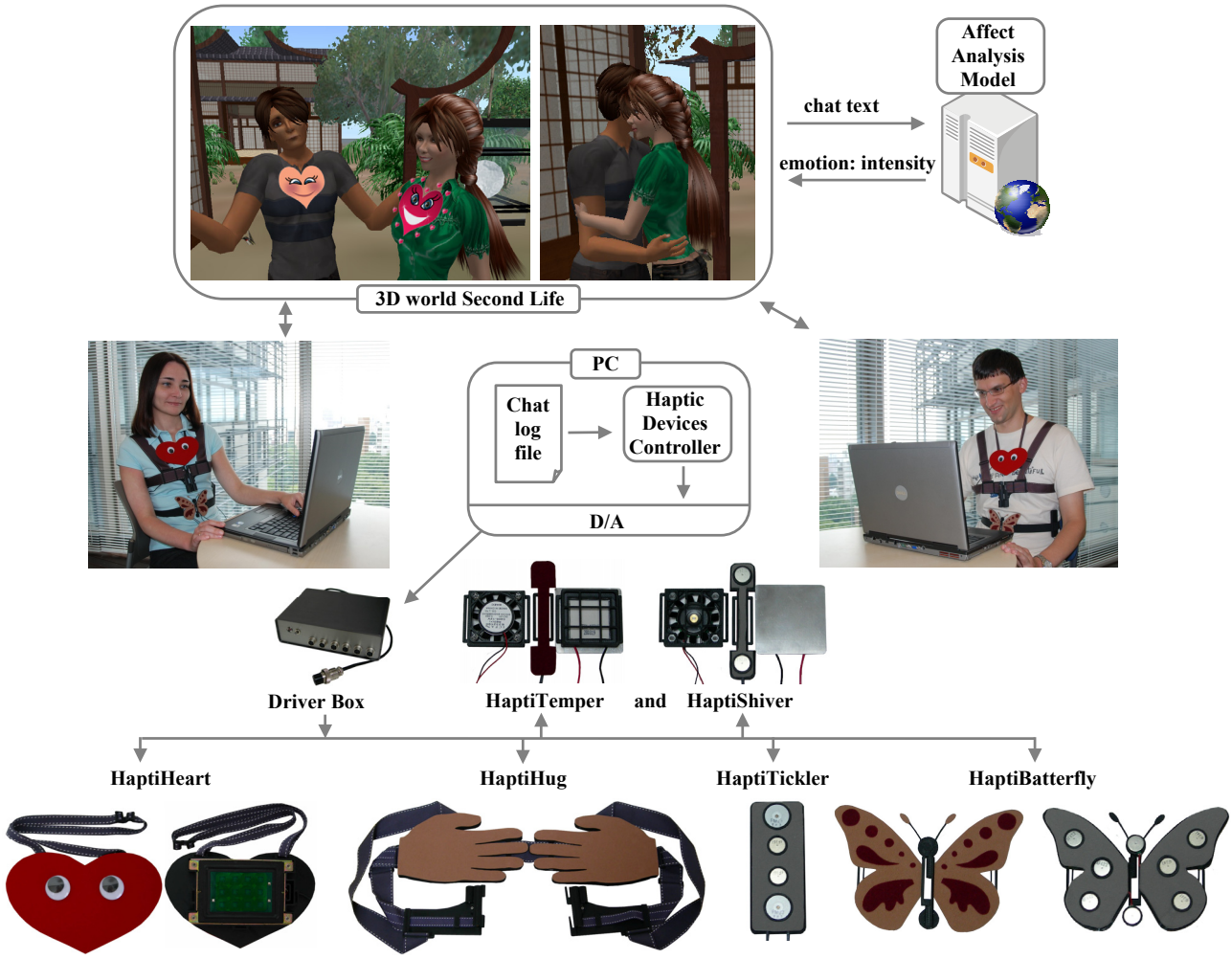

Figure 2: Architecture of iFeel_IM! system.

media for communication, we employ Second Life, which allows 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 in a chat window.

The control of the conversation is implemented through the Second Life object called EmoHeart attached to the avatar's chest. Once attached to the avatar, EmoHeart object (1) listens to each message of its owner, (2) sends it to the web-based interface of the Affect Analysis Model (AAM) [Neviarouskaya09] located on the server, (3) receives the result (dominant emotion and intensity), and visually reflects the sensed affective state through the animation of avatar's facial expression, EmoHeart texture (indicating the type of emotion), and size of the texture (indicating the strength of emotion, namely, 'low', 'middle', or 'high'). The motivation behind using the heart-shaped object as an additional channel for visualization was to represent the communicated emotions in a vivid and expressive way. The examples of avatar facial expressions and EmoHeart textures are shown in Fig. 3.

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

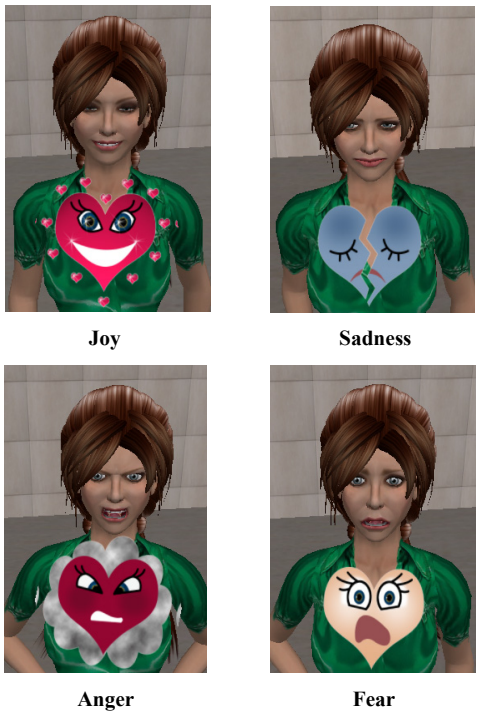

Figure 3: Avatar facial expressions and EmoHeart textures.

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, HaptiButterfly, HaptiTickler, HaptiTemper, and HaptiShiver) worn by user is activated.

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 group is intended for emotion elicitation implicitly (HaptiHeart, HaptiButterfly, HaptiTemper, and HaptiShiver), second type evokes affect in a direct way (HaptiTickler), and third one uses sense of social touch (HaptiHug) for influencing on the mood and providing some sense of physical co-presence. The affective haptic devices worn on a human body are presented in Fig. 4.

3.1. HaptiHug: Realistic Hugging Over Distance

On-line interactions rely on senses of vision and hearing, and there is a substantial need in mediated social touch [Haans06]. Among many forms of physical contact, hug is the most emotionally charged one. It conveys warmth, love, and affiliation.

When people are hugging, they generate pressure on the chest area and on the back of each other by the hands, 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 so that hugging partners can realistically feel social presence of each other. The couple of oppositely rotating motors are incorporated into the holder placed on the user chest area. The Soft Hands, which are aligned horizontally, contact back of the user. Once 'hug' command is received, couple of motors tense the belt, pressing thus Soft Hands and chest part of the HaptiHug in the direction of human body (Fig. 5).

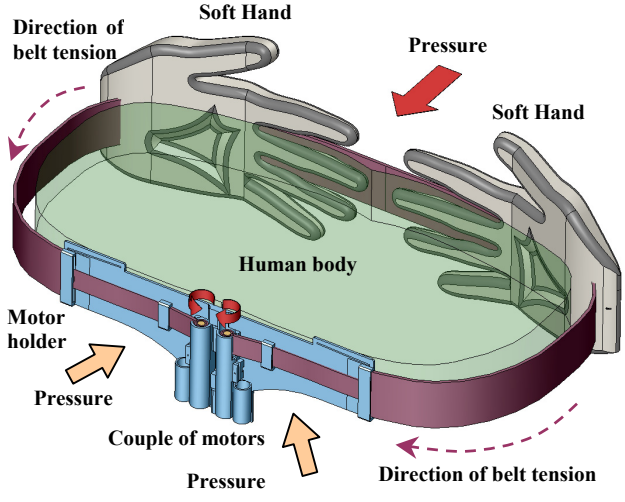

Figure 5: Structure of wearable HaptiHug device.

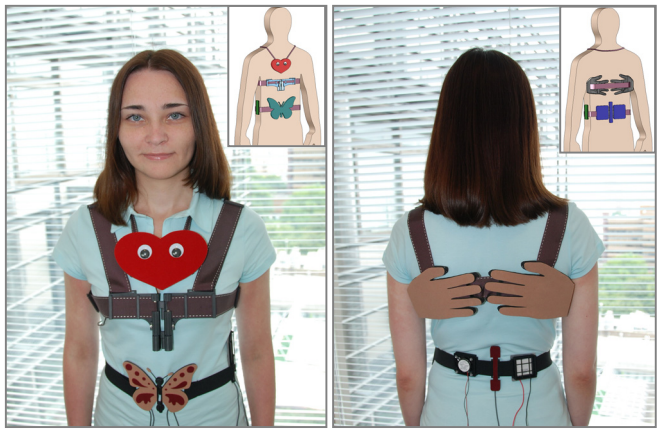

Figure 4: Affective haptic devices worn on a human body.

The duration and intensity of the hug are controlled by the software in accordance with the emoticon or a keyword, detected from text. For the presentation of a plain hug level (e.g., '(>^_^)>', '{}', '<h>'), a big hug level (e.g., '>:D<', '{{}}'), and a 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.

Figure 6: Hugging animation in Second Life.

The significance of our idea to realistically reproduce hugging is in integration of active-haptic device HaptiHug and pseudo-haptic touch simulated by hugging animation (Fig. 6). Thus, high immersion into the physical contact of partners while hugging is achieved.

3.2. HaptiHeart Enhancing Our Emotions

Each emotion is characterized by a specific pattern of physiological changes. We selected four distinct emotions having strong physical features [Wallbott88]: 'anger', 'fear', 'sadness', and 'joy'.

Of the bodily organs, the heart plays a particularly important role in our emotional experience. The ability of false heart rate feedback to change our emotional state was reported in [Decaria74]. We developed heart imitator HaptiHeart to produce special heartbeat patterns according to emotion to be conveyed or elicited (sadness is associated with slightly intense heartbeat, anger with quick and violent heartbeat, fear with intense heart rate). False heart beat

feedback can be directly interpreted as a real heart beat, so it can change the emotional perception.

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. It is able to produce realistic heartbeating sensation with high fidelity. The 3D model is presented in Fig. 7.

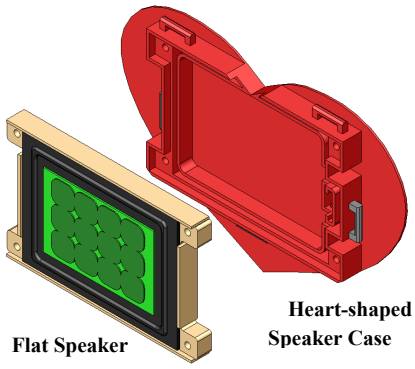

Figure 7: HaptiHeart layout.

The pre-recorded sound signal with low frequency generates the pressure on the human chest through vibration of the speaker surface.

3.3. Butterflies in the Stomach and Shivers on the Body's Spine

HaptiButterfly is responsible for the evocation of joy emotion (Fig. 8). 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 the arrays of vibration motors attached to the abdomen area of a person.

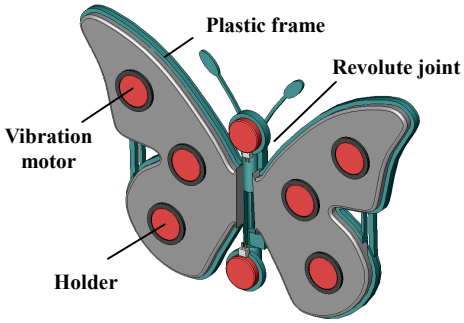

Figure 8: Structure of HaptiButterfly.

We conducted the experiment aimed at investigation of the patterns of vibration motor activation that produce most pleasurable and natural sensations on the abdomen area.

In order to boost fear emotion physically, we designed HaptiShiver interface that sends "*Shivers down/up human body's spine*" by means of a row of vibration motors (HaptiShiver), and "*Chills down/up human body's spine*" through both cold airflow from DC fan and cold side of Peltier element (HaptiTemper). HaptiTemper is also intended for simulation of warmth on the human skin to evoke either pleasant feeling or aggression.

We developed HaptiTickler with the purpose to evoke positive affect (joy emotion) in a direct way by tickling the ribs of the user. The uniqueness of our approach is in (1) combination of the unpredictability and uncontrollability of the tickling sensation through random activation of vibration motors, (2) high involvement of the social and emotional factors in the process of tickling (positively charged on-line conversation potentiates the tickle response).

3.4. Emotional Haptic Design

Aesthetically pleasing objects appear to the user to be more effective by virtue of their sensual appeal [Norman04]. Our core idea is to make user to feel affinity for the device by means of (1) appealing shapes evoking the desire to touch and haptically explore them, (2) usage of material pleasurable to touch, and (3) the pleasure anticipated through wearing. The designed devices are pleasurable to look at and to touch and have personalized features (e.g. the Soft Hands in HaptiHug). The heart-shaped HaptiHeart was designed with primary objective to emotionally connect the user with the device, as heart is mainly associated with love and emotional experience. The HaptiButterfly, its shape, and activated vibration motors induce the association with a real butterfly lightly touching the human.

4. Conclusions

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 the iFeel_IM! and the development of novel haptic devices, such as HaptiHeart, HaptiHug, HaptiTickler, HaptiButterfly, HaptiShiver, and HaptiTemper. User of iFeel_IM! can perceive the intensive emotions during online communication, use desirable type of stimuli, comfortably wear and easily detach devices from torso.

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