iFeel_IM!: A Cyberspace System for Communication of Touch-Mediated Emotions

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Abstract. The paper focuses on a cyberspace communication system iFeel_IM!. Driven by the motivation to enhance social interactivity and emotionally immersive experience of real-time messaging, we proposed the idea of reinforcing (intensifying) own feelings and reproducing (simulating) the emotions felt by the partner through specially designed system 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). The paper will also describe a novel portable affective haptic system iTouch_IM!. The motivation behind the research is to provide the emotional immersive communication regardless the location. This system has a potential to bring a new level of immersion for mobile on-line communication.

Keywords: Affective haptics, affective computing, 3D world, emotional communication, haptic device, touch gestures.

1 Introduction

Touch communication is an essential part of our social life as it conveys our emotions and attitude toward people and helps with socialization. The physical touch is also very important to the health and development of infants and babies. It is considered that touch is the intensifier of emotion-related communication. It augments the emotional displays from other modalities [1].

Companies providing media for remote online communications place great importance on live communication and immersive technologies. Such internet services as Skype, Facebook, Twitter, Instagram let us keep in touch with friends in real time over multiple networks and devices. 3D virtual worlds (for example, Second Life and OpenSim) with embedded chat and IM bring rich communication experience.

Such systems encourage people to establish or strengthen interpersonal relationships, share ideas, gain new experiences, and feel genuine emotions during their VR adventures. However, conventional mediated systems usually:

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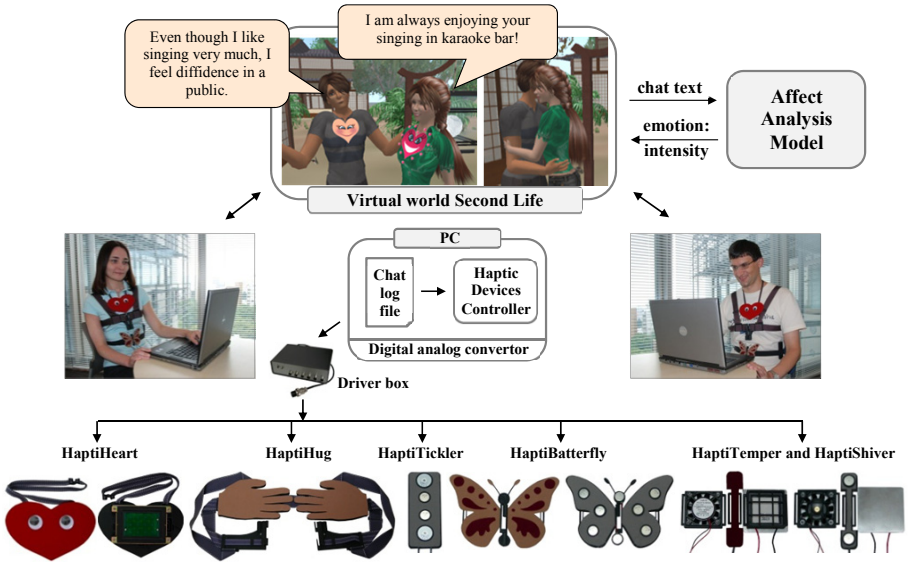

Fig. 1. Architecture of the real-time communication system iFeel_IM!

- support only simple textual cues such as emoticons,
- lack visual emotional signals such as facial expressions and gestures,
- support only manual control of the expressiveness avatars, and
- ignore such important social-communication channel as the sense of touch.

Tactile interfaces could let users enhance their emotional-communication abilities by adding a new dimension to mobile communications. When person stays in hospital for a long time, works abroad, or immigrates, they experience the emotional pressure because of not being able to share their experiences with family members, close friends, spouse as if they were conversing face-to-face. Several research groups have proposed to communicate messages with haptic effect (vibration pattern) to substitute the emoticons [2-4].

Here, we describe iFeel_IM!, a system that employs haptic devices and visual stimulation to convey and augment the emotions experienced during online conversations [5]. iFeel_IM! stands for Intelligent System for Feeling Enhancement Powered by Affect-Sensitive Instant Messenger.

2 Architecture of the System

Fig. 1 shows the structure of the affective haptic communication system. iFeel_IM! stresses:

- automatic sensing of emotions conveyed through text messages (artificial intelligence),
- visualization of the detected emotions through avatars in a virtual world,
- enhancement of the user's affective state, and
- reproduction of social touch through haptic stimulation in the real world.

We use Second Life as the communication platform. With Second Life, users can flexibly create their online identities (avatars) and play various animations (for example, facial expressions and gestures) of avatars by typing special abbreviations in a chat window.

We implement control of the conversation through EmoHeart, a Second Life object attached to an avatar's chest. EmoHeart communicates with the Affect Analysis Model (AAM), a system for textual affect sensing [6]. It also senses symbolic cues or keywords in the text that indicate a hug and generates a hugging visualization (that is, it triggers the related animation).

The haptic-device controller analyzes the data in real time and generates control signals for the digital/analog converter, which then feeds control cues for the haptic devices to the driver box. On the basis of the transmitted signal, iFeel_IM! activates the user's corresponding haptic device.

3 The Affect Analysis Model

The AAM senses nine emotions conveyed through text: anger, disgust, fear, guilt, interest, joy, sadness, shame, and surprise. The affect recognition algorithm, which takes into account the specific style and evolving language of online conversation, consists of five main stages: (1) symbolic-cue analysis; (2) syntactical-structure analysis; (3) word-level analysis; (4) phrase-level analysis; and (5) sentence-level analysis.

The AAM is based on the compositionality principle. According to this principle, we determine the emotional meaning of a sentence by composing the pieces that correspond to lexical units or other linguistic constituent types, governed by the rules of aggregation, propagation, domination, neutralization, and intensification, at various grammatical levels.

Empirical testing showed promising results regarding the AAM's ability to accurately classify affective information. Employing the Connexor Machinese Syntax parser (www.connexor.eu/technology/machinese/machinesesyntax), the AAM achieves 81.5 percent accuracy.

4 EmoHeart

The EmoHeart object listens to its owner's messages and sends each message to the AAM's Web-based interface. After receiving the results (the dominant emotion and intensity), it visually reflects the sensed affective state through:

- animation of the avatar's facial expression,
- EmoHeart's texture (its expression, shape, and color, which indicate the type of emotion), and
- EmoHeart's size (indicating the emotion's strength—low, medium, or high).

Fig. 2 shows avatar facial expressions and EmoHeart textures.

Fig. 2. Avatar facial expressions with the corresponding EmoHeart: (a) joy, (b) sadness, (c) anger, and (d) fear. EmoHeart's texture (its expression, shape, and color) indicates the type of emotion; its size indicates the emotion's strength

During the experiment, 89 Second Life users became owners of EmoHeart; 74 actually communicated using it. The AAM categorized 20 percent of the sentences as emotional and 80 percent as neutral. The most frequent emotion conveyed was joy (68.8 percent of all emotional sentences), followed by surprise (9.0 percent), sadness (8.8 percent), and interest (6.9 percent). We believe that this dominance of positivity is due to the nature and purpose of online communication media (to establish or strengthen interpersonal relationships).

5 Affective Haptic Devices

Physiological changes controlled by autonomous nervous system play the fundamental role in emotional experience [7]. According to the James-Lange theory, the conscious experience of emotion occurs after the cortex receives signals about physiological-state changes. That is, certain physiological changes precede feelings. The research suggests the existence of multiple, physiologically distinct positive emotions [8]. To support affective communication, iFeel_IM! incorporates three types of haptic devices:

- HaptiHeart, HaptiButterfly, HaptiTemper, HaptiShiver implicitly elicit emotion.
- HaptiTickler directly evokes emotion.
- HaptiHug uses social touch to influence mood and provide a sense of physical copresence.

Each emotion is characterized by a specific pattern of physiological changes. We selected four distinct emotions having strong physical features: anger, fear, sadness, and joy. Table 1 lists the emotions that each haptic device induces.

Table 1. The iFeel_IM! affective haptic devices with the emotions they stimulate

	Stimulated Emotion			
Device	Joy	Sadness	Anger	Fear
HaptiHeart	—	Yes	Yes	Yes
HaptiButterfly	Yes	—	—	—
HaptiShiver	—	—	—	Yes
HaptiTemper	Yes	—	Yes	Yes
HaptiTickler	Yes	—	—	—
HaptiHug*	Yes	—	—	—

**HaptiHug also simulates social touch.*

HaptiHug. Online interactions rely heavily on vision and hearing, so a substantial need exists for mediated social touch. Of the forms of physical contact, hugging is particularly emotionally charged; it conveys warmth, love, and affiliation [9], [10].

We developed HaptiHug to create a wearable haptic display generating forces similar to those of a human hugging another human [11]. Our approach's significance is that it integrates both active haptics (HaptiHug) and pseudohaptics (the animation) [12]. Thus, it produces a highly immersive experience.

HaptiHeart. Of the bodily organs, the heart plays a particularly important role in our emotional experience. Research has proven that false heart rate feedback can change our emotional state [13]. We developed HaptiHeart to produce heartbeat patterns corresponding to the emotion to be conveyed or elicited. A low-frequency prerecorded sound generates pressure on the human chest through speaker vibration. We exploit the fact that our heart naturally synchronizes with the heart of the person we're hugging or holding.

HaptiButterfly. We developed HaptiButterfly to evoke joy. It reproduces "butterflies in your stomach" (the fluttery or tickling feeling felt by people experiencing love) through arrays of vibration motors attached to the user's abdomen. We conducted an experiment to see which patterns of vibration motor activation produce the most pleasurable and natural sensations on the abdomen.

HaptiShiver and HaptiTemper. To boost fear, we developed HaptiShiver and HaptiTemper. HaptiShiver sends "shivers up and down your spine" through a row of vibration motors. HaptiTemper sends "chills up and down your spine" through both cold airflow from a fan and the cold side of a Peltier element.

HaptiTickler. The reflex explanation of our inability to tickle ourselves suggests that tickling requires the element of unpredictability or uncontrollability [14]. Research also shows that the social and emotional factors of ticklishness can affect the tickle response greatly. We developed HaptiTickler to directly evoke joy by tickling the user's ribs. It includes four vibration motors reproducing stimuli similar to human finger movements.

6 User Study

We selected six participants and conducted a preliminary user study to evaluate the effectiveness of emotion elicitation and hug reproduction. The results revealed that the devices successfully generated the corresponding emotion (see Table 2, in which 100 percent stands for six positive replies).

Table 2. Results of a six-user study evaluating the effectiveness of emotion elicitation and hug reproduction

	Percentage of participants experiencing the emotion.			
Device	Joy	Sadness	Anger	Fear
HaptiHeart	—	83.3	66.7	100
HaptiButterfly	83.3	—	—	—
HaptiTickler	100	—	—	—
HaptiHug*	100	—	—	—

**100 percent of the HaptiHug users experienced social touch.*

7 iTouch_IM!

iTouch_IM! is a novel portable communication system with direct haptic avatar-mediated communication (Fig. 3). A user wearing the affective haptic devises and holding the tablet computer interacts with an avatar by finger gestures. The avatar represents the user's communicating partner.

A special gesture language Haptish is designed to trigger the avatar's emotions. The examples of basic touch gestures are given in Fig. 4. The user can hug the avatar by touching the avatar's body on the surface of display with two fingers and performing the pinching. The heartbeat is generated through rapid touch of surface with fingertips. The time between consequent touches defines the frequency of the heartbeat. The tickling of avatar is driven by quick brushing of the surface with fingertips continuously engaging in the process. To make avatar feel afraid, the user touches the surface by five fingertips continuously. The wearable affective robot developed by user evokes the emotion shown by avatar through haptic stimuli. The idea behind the Haptish was not only to provide communication language but also to deliver the capability of designing the own emotional expressions to the user.

The animation of hugging and tickling is played on the screen. The effect of affective haptic feedback (force, tickling sensation) is augmented by visual stimuli. The user can also evoke avatar's emotions by drawing a finger on the screen. The shape, speed, and duration of strokes trigger a particular emotion of the avatar.

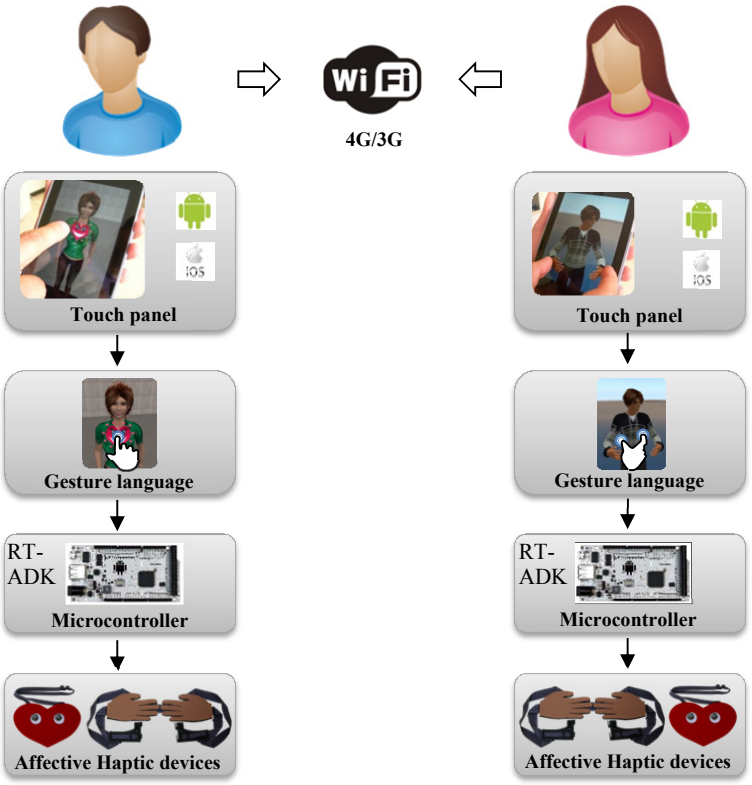

Fig. 3. iTouch_IM!: mobile affective haptic system for emotional communication

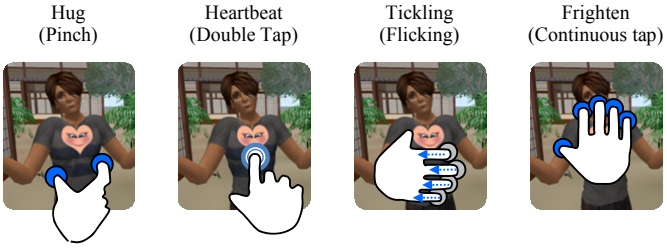

Fig. 4. Tactile gestures of communication language Haptish

8 Discussion and Conclusions

The combination of physical stimulation of emotions, remote touch, and visual stimuli increase immersion in the 3D environment and maintain the illusion of being there. We also presented a novel mobile affective haptic system iTouch_IM! that allows the emotional rich communication far and wide.

The examples of the possible applications of iFeel_IM! for future research include:

- treating depression and anxiety (problematic emotional states),
- supporting communication of person staying long time in hospital with severe disease,
- controlling and modulating moods on the basis of physiological signals,
- affective and collaborative games, and
- psychological testing.

We believe that iFeel_IM! and iTouch_IM! could greatly enhance communication in online virtual environments that facilitate social contact. They could also improve social life in terms of both interpersonal relationships and the character of community.

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