Empa Talk: A Physiological Data Incorporated Human-Computer Interactions

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Abstract
We present a novel approach that allows the user to feel the other's emotional status while communicating with each other in a video chat. The video chat is composed of physiological sensors and multimodal displays. In our first prototype, we employed a Galvanic Skin Response (GSR) sensor and a Blood Volume Pulse (BVP) sensor as they were crucial indications to emotion. A vibrotactile motor and a RGB Led were also used in order to convey the other's emotion on one's wrist. Along with the hardware part, we implemented intuitive software for processing, transmitting, and displaying bio feedback data.

Author Keywords
Physiology; video chat; bio feedback; human senses

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction
The ability of emotion recognition has been evolved in human society since emotional understanding makes more effective communication possible among people.

In this regard, many researchers have studied computing systems that could recognize user's emotion and respond to it appropriately. To achieve this, in computer vision society, a few robust and efficient algorithms were proposed and verified to detect and recognize human's emotion. They defined and extracted useful visual cues in camera images such as facial expressions or body gestures, and analyzed them to understand human's emotion [2, 3, 4]. In the aspect of signal processing, emotion recognition based on speech and audio was also used for computers to understand human's emotional status [5]. Recently, compact and reliable physiological sensors allow us to employ them for detecting human emotion. In physiological sensing approach, human body's physiological signals are captured and analyzed to understand human's emotional/physiological condition. These signals include skin temperature / conductance, electromyogram (EMG), electrocardiogram (ECG), electroencephalogram (EEG), and so forth. In general, a few different types of signals are used to improve the recognition accuracy [6, 7, 8].

In this paper, we propose an Empa Talk that allows users to share their emotions while wearing the bracelet-type device, where one can see the other's emotional status and make a proper way to respond to it. In this sense, we expect the device is beneficial in the field of social communications as a tele-social tool.

Design and Implementation

Concept: The Empa Talk consists of two coupled bracelets. Each one recognizes its owner's emotion and displays another coupled user's emotion as shown in Figure 1.

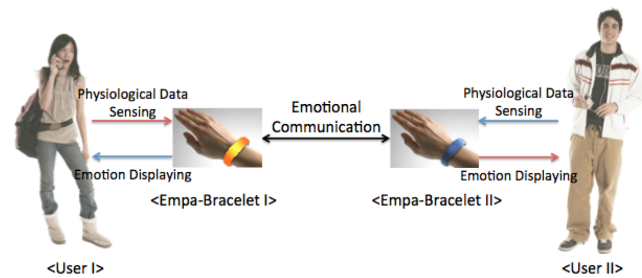

Figure 1. The concept of Empa Talk communication

System Overview: The Empa Talk is a supportive system for video chat, which is streaming one's physiological signals along with the video and audio. In addition, these signals are displayed not only on the computer screen but also on one's wrist with additional modalities. This additional channel, even if not emotion itself, can provide a way to glance at other's emotion. The general overview is shown in Figure 2.

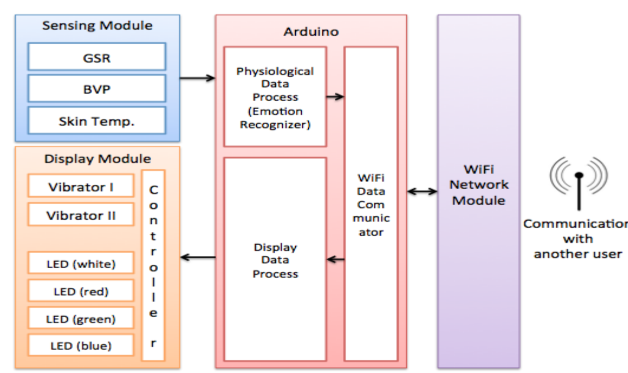

Figure 2. A System Block Diagram of Empa Talk

Prototype: A prototype was implemented and it is shown in Figure 3. In the prototype, Arduino Uno board was used to acquire, process and display user's sensation. For physiological data acquisition, a GSR sensor and a BVP sensor were used. Skin temperature sensor was considered but was not integrated due to its slow response time. The analog data from the GSR sensor were firstly filtered by built-in circuit, and later amplified by software. The employed BVP sensor had built-in circuit to amplify the raw signal. This amplified BVP signal was processed in Arduino board and sent to software with detected heart rates. In display part, one vibration motor was used to synthesize artificial heartbeat to convey sensation, and one multicolor (RGB) LED was also used to make a visual effect with colors based on the change of the GSR values.

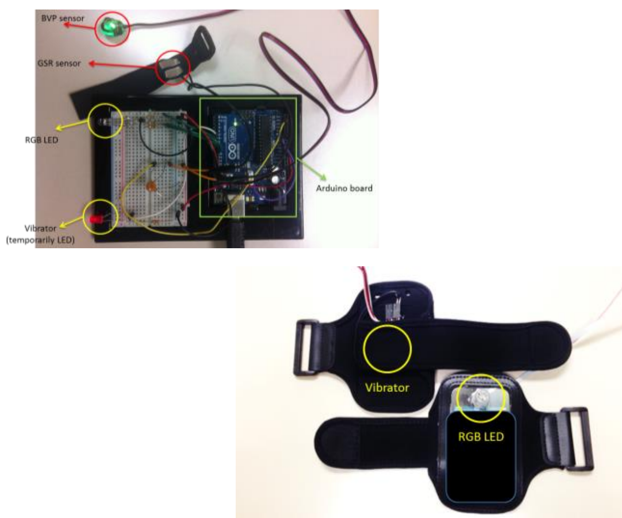

Figure 3. Empa Talk prototype device (up) and Armband with Vibrator and RGB LED (down)

In figure 3, we inserted the vibrator and the RGB LED into an armband. The GSR sensor could not be implemented on the armband because it required to be placed in specific body part; although a state-of-art GSR device works on wrist, our sensor worked well only on fingertip. With similar reason, the BVP sensor was not included in the armband; it should be placed on an earlobe.

A user interface was developed as shown in Figure 4. Users can see his or her own bio data or the coupled one's. To control the LED and vibrator manually, there were scale bars in the right side of user interface, which allowed us to adjust the level of RGB color and vibration. However, the detailed graphs were not good illustrations to show the change of user's emotional changes, so we pursued more simple and intuitive design for user interface.

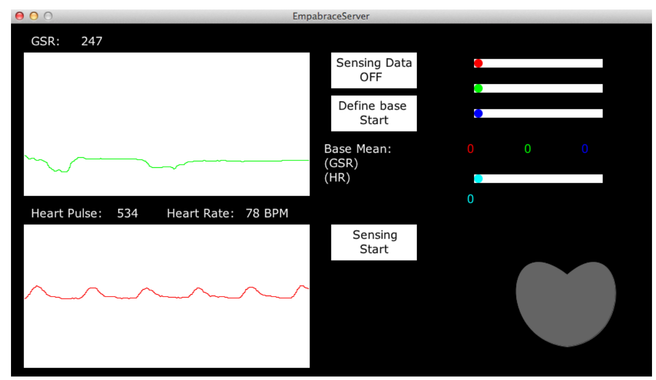

Figure 4. First version of Empa Talk

Evaluation

A pilot test was conducted with a purpose how the Empa Talk affects in communication. Five subjects participated in this experiment. All participants were 20s. The design was a within-subjects design; each participant experienced both systems in a row. The order of the systems was counterbalanced. Participants were paired to have video chat with/without physiological signals (i.e. Empa Talk), and one participant was paired with one of our team member. Since we focused on the communication at a distance, each participant of the pair was assigned into a physically separated room.

Procedure

When participants were arrived, they were asked to fill out pre-questionnaire, and each two of them were paired. Paired participants were told that their goal was to play the Truth or Lie game with each other. Each participant made three sentences per each condition (i.e. three for video chat only and three for Empa Talk), and there were no restriction on the number of lies. In paired group, both participants experienced both systems in same order. After finishing each condition, they were asked to fill out post-questionnaire.

Dependent Variables and Expectations

We brought some dependent variables from the human computer interaction and the virtual reality literatures to compare two conditions: Video chat vs. Empa Talk.

Table 1. Quantitative Dependent Variables

Measure	Variable
Number of correct answers	Performance
Time duration	Involvement

As in Table 1, we measured the number of correct answers as performance and time duration per each condition as involvement. Since GSR level is mainly used in lie detection, we expected that by seeing other's GSR signal, participants could make correct answers more easily and correctly. This implied that workload of guessing answers would decrease with Empa Talk as well. We also expected that involvement will increase with our new features. This expectation on involvement was not conflict with assumption on workload since there was no time limit on each task. We assumed participants would spend more time to see the changes in signals. We also used a post questionnaire per each condition to obtain participants' subjective experience of the systems. We employed 7 point Likert scale to measure each variable. The relationship between questions and variables is shown in Table 2. We expected higher enjoyment/sense of presence/engagement and lower workload on Empa Talk. We asked additional questions only for Empa Talk to assess its own attributes.

Table 2. Subject Self-Report Variables

Question	Variable
Do you think the experience was enjoyable?	Enjoyment
Did you feel that as if the partner was close to you?	Sense of presence
Did you feel you were engaged in the tasks?	Engagement
How easy was it to come up with your own answers to the partner's statements?	Workload

Results

All participants spent more time when they were using Empa Talk. We assumed that spending more time implied higher involvement in the communication and expected that Empa Talk could induce more involvement from users.

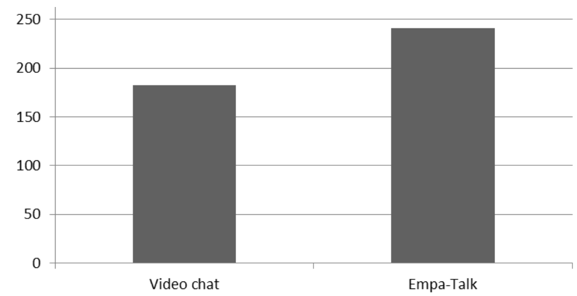

Figure 5. Time duration in seconds

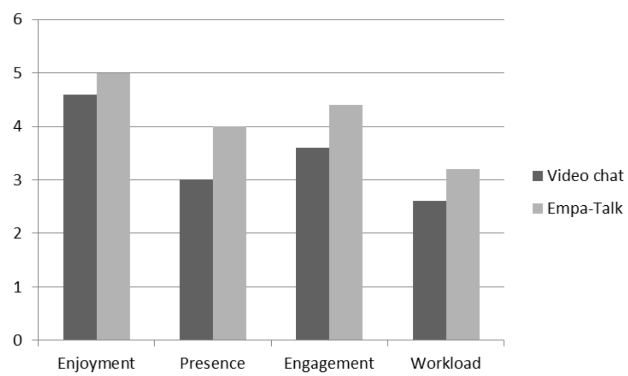

Figure 6. Results of Post-questionnaire

As seen in Figure 6, results of Enjoyment/Presence/Engagement were higher with Empa Talk as we expected; however, result of workload conflicted with our expectation. This result of workload might be caused by the conflict between facial expression and the physiological signals.

EMPA TALK QUESTIONNAIRE

For a question if they felt partner's heartbeat while video chatting, all participant answered they felt partner's heartbeat. Since we assumed that feeling the partner's heartbeat could reduce social distance between them, this result corresponds to the result of presence. As seen in Figure 6, participants generally thought the signals were helpful. In addition, we also asked them if sending physiological signals was uncomfortable. Over all perception on exposing physiological signals was close to neutral; however, female participants felt it more uncomfortable.

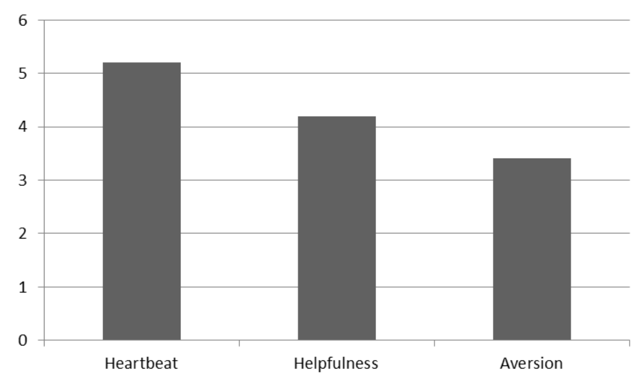

Figure 7. Results of Empa Talk related questions

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Conclusion

In this paper we present a novel approach that integrates physiological data into an HCI system design and shows a design example called, Empa Talk as proof of a concept. Although the Empa Talk uses only two types of physiological data, the results of the pilot test shows that integrating physiological data could improve the quality of human-computer interactions. In addition, users enjoyed and engaged their communication further by perceiving the other user's emotional status and presence. A further research is planned to evaluate the effectiveness of the prototype with more number of subjects.

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