CAN WEARABLE TECHNOLOGY ENHANCE EMOTIONAL INTIMACY?
AN EXPERIMENTAL DESIGN RESEARCH

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ABSTRACT

Emotion is an intangible fact that is woven into interpersonal relationships in order to sustain social bonds with more understanding, trust and intimacy. Today, people are in an era of digitally mediated HHI (Human-to-Human Interaction), which is transforming the traditional way of communication and social dynamics. In order to increase the affective level of communication, research areas, such as affective haptics and wearable technology have emerged to find more affective interaction avenues and convey human emotions through technology in a more physical way. This paper presents a survey and a design practice that aim to explore how wearable technology can enhance emotional intimacy by introducing new ways for expressing emotions. The analysis of this study is addressed on the privacy issue of emotional expression through wearable technology and intimacy of emphatic communication through these agents.

Keywords: wearable technology, emotion, interaction, intimacy, design practice

INTRODUCTION

People are social beings that are always in communication with each other through their bodies. While human body works as a collector and a decoder to perceive others' emotions, it is also an object, of which signs are read by others. Body language refers to the non-verbal communication that can convey emotions and add meaning to the spoken language through posture, gestures and facial expressions. Many researches have been done in order to understand how emotions are expressed through nonverbal expressions (Frijda, 1987; Feldman & Rime, 1991; Ekman & Davidson, 1994, Russell & Fernandez-Dols, 1997). Emotional expression occurs mostly in the presence of others. For instance, infants produce their first emotional expressions, such as smiling, in a social interaction and this behaviour is coordinated with gazes at the face (Yale et al. 2003). Rimé et al. (1992) showed that emotional experiences are mostly shared with others shortly after they occur. The social sharing of emotions strongly depends on the intimacy level of the interpersonal relationships and circumstances. Due to the fact that emotion is a social phenomenon, its expression rests on display rules and social motives.

Today, people are in an era of digitally mediated HHI (Human-to-Human Interaction) that introduces various possibilities of engaging with people from anywhere in the world. However, due to the lack of emotional cues that are normally conveyed by human body it is difficult to express emotions through technological agents. In order to increase the affective bandwidth level that indicates how much affective information passes through the communication channel (Picard, 1997), new technologies, such as affective haptics and wearable technology have emerged by enhancing physical role of the human body in the interaction.

The research presented in this paper assumes that wearable technology can give new forms to social patterns through reinforcing the wearer's existence and sensorial experience. Emotional communication through wearable technology can strengthen social bonds and reconnect people in a way where the emotions are not hidden anymore, but shown as

tangible facts. Besides, this can be transferred apart from the human body to other bodies to enhance the quality of communication over a long distance. This paper consists of a survey on intimacy issue in emotional communication through wearable technology and a experimental research activity, based on a design practice, which aims at discovering new ways of sensing, interacting, and interpreting emotions by developing wearable prototypes.

INTIMACY AND PRIVACY OF EMOTIONAL EXPRESSION

Emotions are encoded and decoded from one person to another. This flow is called interpersonal relationship. Emotional expression can create relational activity that establishes a relationship between the subject and some object or environment (Frijda, 1987). According to Izard, Kagan & Zajonc (1984) one of the social functions of expressing emotions is fostering social interactions that can facilitate the development of interpersonal relationships. People generally feel the need of sharing their emotions with other people for social recognition, acceptance or support. Many scholars argue that it is better to express emotions, rather than to keep them inside. The findings of James, Gross and Levenson (1997) suggested that for negative emotions inhibiting emotional expressive behaviour does not provide relief from the subjective experience of that emotion.

There are various ways to express emotions, such as verbal and nonverbal tools, but the important thing is in which kind of relationships and environments people express their real emotions. There are some idioms for expressing emotions: such as letting ones feelings out, bottling them out. Bottling the emotions out is sometimes difficult or even not preferred in some certain situations and social norms. Hence, social context might affect the person's attitude towards expressing emotion. It defers to express an emotion from being alone to being in public. For example, crying could be relieving when someone is alone, but in public it could be embarrassing.

Emotional expression can occur with or without control. Pervasive belief claims that hiding emotions is a sign of strength or maturity or even virtue (Kennedy-Moore, Watson, & Safran, 2001). For instance, in many cultures, a man crying cannot be acceptable. Fisher & Manstead (2000) argued that the males in individualistic cultures are likely to minimize emotional expressions, because expressing them might threaten their control. This issue is strongly related to power and influence over another person. There are socially engaging and disengaging emotions. Planalp (1999) stated that when people experience a strong emotion such as overwhelming, joy, or anger, they often feel an urge to let it out or communicate it to others, opposite may be the case with shame and regret. Chapmann (1983) reported that children, who watch cartoon alone, laugh less than those watching with others. People become more emotionally expressive when they know that others are observing them.

On the other hand, emotional expressiveness in an interpersonal relationship strongly depends on the level of intimacy or gender differences. Buck et al. (1992) found that the presence of a stranger in the environment can reduce the readability of emotional expressions, whereas the presence of a friend can increase. People express more intense emotions to the people they have an intimate relationship (Laurenceau, Barrett, & Pietromonaco, 1998), and women are more likely to show emotional intensity than men (Fischer & Manstead, 2000).

TECHNOLOGY MEDIATED EMOTIONAL COMMUNICATION

Connectivity has become an important characteristic of the 21st Century. The Internet has changed the structure of the social interaction, shifting from constructed rigid social groups to fuzzy groups. Hence, personal privacy and intimacy has gained flexibility and new dimensions. While the social structure is getting fuzzy with the new communication technologies, people may have the need to delink themselves in their close relationships, which are mostly built on intimacy and trust. In body-to-body interaction and relationships trust is mostly obtained through the exercise of the emotional intelligence (Vincent & Fortunati, 2009). Picard (1997) described affective bandwidth as how much affective information passes through the communication channel. According to her, email communicates the least affect than phone, than videoconference, and the most

affect is communicated in face-to-face communication. Computer-mediated communication sometimes can offer different methods to express emotions than the face-to-face communication. Pantic et al. (2007) said, “Through new applications of technology, computing can go beyond the traditional keyboard and mouse to include natural, human-like interactive functions, including understanding an emulating behavioural and social signalling”. Due to the fact that being connected but not physically, people have started to invent new ways of expressing their emotions, which is a missing part in virtual communication. For instance, people broadly use the ASCII-based codes known as emoticons in emails and chat to compensate for lack of contextual information in the form of facial expressions, gestures or tone of voice (O'Hagan & Ashworth, 2002). Emoticons have been invented to create ease in communication and have evolved as a way to temper and soften textual conversations without facial cues (Maeda, 2006).

On the other hand, it is assumed that reduced visibility of expression can also make communication easier to express emotions, especially when individuals find it difficult to express them in real life (Derks, Fischer, & Bos, 2007). People may prefer to have digital distance while expressing emotions, which are pushed back in real life. For instance, sharing emotions is one of the main goals of blogs in Internet (Nardi et al., 2004). Technology mediated communication can be a tool for people to express their emotions more easily than being in face-to-face conversations.

Innovations in haptic and affective technology have opened new avenues to express emotions by turning the interaction into a more physical state rather than digital. While computer-mediated communication is encouraging disembodiment, with these new technologies, such as affective haptics, it is possible to create an “embodied interaction” (Dourish, 2001) that can enable people not only to communicate with but also to feel each other. While the body as communication medium naturally exposes what goes on inside, it is possible to transmit this information onto physical displays and by means of this, to other bodies so as to regenerate social bonds, which are constantly transforming with the influence of the new communication technologies.

EMBODIMENT OF EMOTIONS THROUGH WEARABLE TECHNOLOGY

Garments have two different functions: on one hand, they interact with human body from a very close distance; on the other hand, they express many personal traits with their semiotic visual codes to the outside. With the innovations in material science and electronics, today it is possible to embed intelligence into garments to enable them to sense and respond to bodily and environmental data. Moreover, with the wireless technologies, garments can have connection with other bodies in long distance. Thanks to wearable technology, garments can become dynamic interfaces that can intimately stimulate sensory organs and turn the human body into a gate where the personal data, such as emotions, can transmit through.

The research hypothesis is that *wearable technology can extend the human existence into a second layer, which is able to transmit emotions for a more emphatic interaction.* This can bring more understanding and trust, and therefore positive influences to the interpersonal relationships, which are obtained by technology. While the embodiment of emotions in real life occurs as expressions and visceral sensations on the human body, this practice aims at simulating this embodiment through wearable technology by creating various wearable devices that provide a tacit communication between two people.

In order to verify the hypothesis and to analyse the privacy issue of these kinds of design solutions, a user survey and a design practice with real wearable prototypes were done. This section presents the studies, the tests and their analysis in the light of theoretical background of the research.

SURVEY

This survey aims to analyse people`s reaction towards the idea of expressing emotions via wearable technology. 100 participants, 50 males and 50 females, selected from Europe, with average age 29, were asked to answer a questioner. This section of the paper presents the questions and the analysis of the results.

Question 1: Would you like to use wearable technology in your daily life?

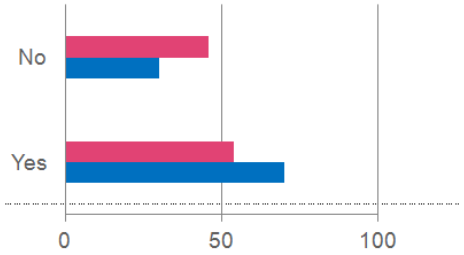

Figure 1. Question 1: Would you like to use wearable technology in your daily life? (pink: female, blue: male)

65% male and 52% female participants would use wearable technologies in their daily lives. This result shows that the male participants are more open to use wearable technology than females. Besides, the majority of both genders are positive about the use of this type of technology in their daily lives.

Question 2: If you used wearable technology, what for would you use it?

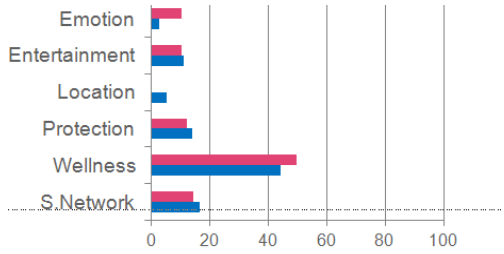

Figure 2. Question 2: If you used wearable technology, what for would you use it? (pink: female, blue: male)

50% female and 42% male participants chose the wellness option as an answer for the use of wearable technology. Social networking was chosen by 18% male and 16% female participants; protection was chosen by 16% male and 15% female participants; and 3% male and 15% female participants chose emotional communication as an use for wearable technology. These data show that wearing technology on the human body is mostly related and associated with health and wellness. Besides, social networking, which requires mobility and constant connection, is chosen as an important application area. Although some female participants chose emotional communication as an area of use for wearable technology, it is not preferred by male participants.

Question 3: Would you like to wear garments, which expose your emotions?

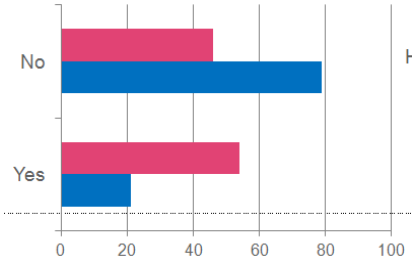

Figure 3. Question 3: Would you like to wear garments, which expose your emotions? (pink: female, blue: male)

This question is related to the expressive level of the wearable technology. 80% male participants said no, while 54% female participants are positive to wear garments that can express emotions. This results show that expressing emotions through wearable technology is mostly acceptable for women rather than men.

Question 4: Where would you use this garment?

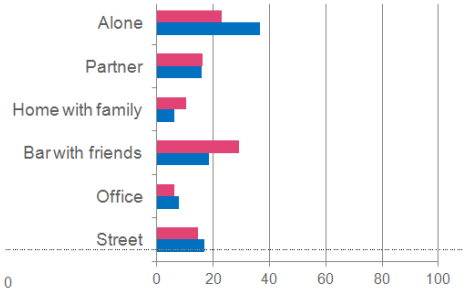

Figure 4. Question 4: Where would you use this garment? (pink: female, blue: male)

This question aims to understand the public usage of the wearable technology that exposes emotions. The majority (30 %) chose being “alone” option; and besides some participants chose ‘bar with friends’ (24 %),‘partner’ (18 %) and ‘on the street’ (18 %) options.

Question 5: Would you like to control your garment?

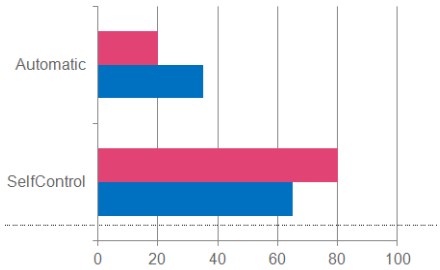

Figure 5. Question 5: Would you like to control your garment? (pink: female, blue: male)

This question aims at analysing the human behaviour towards emotional communication through wearable technology that is out of control of its wearer and conveys the real inner state without self-masking. The answers show that the majority (72%) of the participants chose to have self-controlled wearables instead of automatic ones. This result shows that people want to control what kind of affective information they express outside.

Question 6: To whom would you send your emotions?

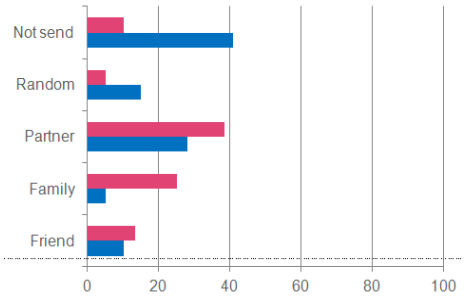

Figure 6. Question 6: To whom would you send your emotions? (pink: female, blue: male)

This question aims to understand what kind of relationships can have benefits from wearable technology that transmits emotions in a long distance communication scenario. 39% of females and 24% of males chose 'partner' as an option. 40% of male wouldn't send the data. 22% of females would like to send this emotional data to their families. These results show that females would like to send their emotions to the people with whom they have intimate relationships, such as love partners and family. On the other hand, males are not as open as females to the idea of sending emotion. The male participants who are interested to send their emotions mostly (27 %) chose their love partner to communicate with.

The results of the survey show that females are more open to emotional communication through wearable technology than males. On the other hand, males are more likely to place technology on their body in their daily lives. Wearables that dynamically communicate emotions are more accepted in a context where the user is alone or with friends and love partners. The public use is rarely acceptable. Females are more likely to send their emotions to a long distance partner than males. Besides, both genders prefer to control their garments with a self-activated system that gives them the freedom to decide which kind of emotion is sent or displayed.

DESIGN PRACTICE

According to the results obtained by the survey, a design practice was carried out in order to observe and analyse user experience in a real time setting. Basic technologies were embedded into the wearable prototypes to create a system that can translate the intentional hand movements into emotional messages and communicate them instantly to another person in long distance.

The design practice aimed at analysing how these kinds of products can enhance the emotional intimacy and what kind of interaction patterns can occur during the communication. These prototypes create an emphatic relationship between two people by using various sensorial channels (e.g. sight, touch and sound) in three different ways: *Sound Pad, Skin Deep and Hand Muffs.*

Sound Pad is a set of shoulder pads, which can transmit emotions in codes of sound between two people. The wearers can send two different emotions by touching the *Sound Pad* from chest or shoulder. By touching the chest it sends a higher pitch sound that is envisioned as positive emotion and by touching the shoulder it sends lower pitch that is envisioned as negative emotion. Piezo-electronics were embedded into the pads in order to generate two beeping sound in high and low pitch. The sound is produced in a low volume to provide an intimate communication that is only hearable by the wearer. *Sound Pad* creates an intimate communication through auditory stimulation of emotions.

Figure 7. Sound Pad in use

Skin Deep is a set of collar and bracelet that has vibration motors and LEDs simulating heartbeat sensation. When one person touches the wearable, other person receives a tactile and visual message that is envisioned as sender's heartbeats. While the collar provides the tactile sensation on the chest area where the heart locates, the bracelet provides it on the artery area that is commonly used to measure pulse. These wearables provide an intimate communication, which allows the wearers to touch and feel their inner rhythms.

Figure 8. Skin Deep in use

Hand Muffs are tactile soft wearables that can send and receive emotional hand gestures. These wearables were designed based on traditional hand muff that is used for warming hands in winter. This accessory is mostly used as a bag and hanged on the shoulder when it is not used as a warmer. In this concept, the idea is to combine this traditional accessory with technology in order to create emotional communication. Due to the fact that emotions are intimate phenomenon, this garment provides an intimacy by keeping the hands inside the muff. When the wearer activates the touch sensor placed inside the muff with rapid hand movements, the other person receives a playful light touch. On the other hand, when the wearer activates the touch sensor with a constant pressure, then this is transmitted as a firm affective touch to the other person's muff. The touch message is simulated by a mechanism activated with a small servomotor embedded inside the soft part of the muff.

Figure 9. Sound Pad in use

USER TEST AND FINDINGS

After the prototyping of three wearables, a user test was done to analyse user experience in three different emotional communication modalities. The test aimed to observe communication patterns during the interaction between two people through the wearable prototypes.

The test was done by 12 participants, divided into six groups. The groups were set in female-female, male-male and female-male combinations. Six participants were chosen among the students of Engineering School and six among the students of Design School. The test was done in a laboratory environment by placing the participants sitting back to back to simulate a far away situation. They were asked to communicate their emotions to the other person by actuating their wearables. The test was divided in three parts, in which the three prototypes were tested one by one. The results and observations were analysed according to three issues: interaction, pleasure and sensorial experience.

Interaction

Participants were left alone with the prototypes and they were asked to communicate with the other person who had the same prototype. Some participants had problems about how to activate the prototypes. According to Norman (2002), procedural knowledge can only be taught by demonstration and learned by practice; therefore, the results showed that in order to learn how to use these kinds of products, participants needed time to get used to. On the other

hand, it was observed that some participants created their own languages while communicating each other and they tended to mimic the message they received. For instance, when one person with *Sound Pad* sends a beeping sound that communicates positive emotions, the other person answers with the same positive message. Some of the participants (33 %) reported that when they received an emotional message, they felt the need to answer in the same way without any motive. Therefore, the results showed that when there is an instant messaging, this creates an expectation of an immediate reply and urge for answering.

The participants were asked, “In which kind of relationships they (you) would use these wearable prototypes”. The answers showed that participants mostly (83 %) preferred to use the prototypes in their intimate relationships, where they are more comfortable to express emotions and with people, whom they care about their emotional wellbeing. Most of the participants (66 %) stated that they would like to use them at home in a comfortable and intimate environment to concentrate and feel the intimacy of others. All female participants stated that they would use it with family or a love-partner. On the other hand, male participants mostly (66 %) stated that they would use it with close friends for fun.

Pleasure

In the user test, Jordan’s (2000) pleasure theory was used as the basis of quantitative analysis. Participants ranked their experiences from 0 to 10 (where 0 is very poor and 10 is excellent) according to four types of pleasure level: physio, psycho, socio and ideo.

Physio-Pleasure is related to the sensorial experience that the participant obtains from the experience. Psycho-Pleasure is related to participant’s psychological state during the experience. Socio-Pleasure is the pleasure that is gained by the enhancement of the interaction with others. Ideo-Pleasure is the pleasure that is obtained by the idea of how others think about the participant, while wearing the prototypes.

The rankings showed that the prototypes could give socio and physio-pleasure more than the other pleasure sorts (Fig. 10). Participants reported that the prototypes could increase their socio-pleasure, which is related to be engaged with others. Due to the fact that each prototype tends to induce basic sensorial experiences, most of the participants reported that having sensorial feedback was pleasurable. On the other hand, Ideo-Pleasure, which is related to self-reflection, was given less ranking by the students of Engineering School. They reported that wearing the prototypes in public was not pleasurable. Moreover, they would rather hide these wearables under their own clothes. Most of the participants from Engineering School (66 %) gave suggestions as having these objects in the form of normal clothes that were not recognizable as technological or weird. The students from Design School had different rankings for the Ideo-Pleasure level of the experiment. They found these objects as pleasurable to be worn in the public. Some of the participants from Design School (33 %) reported that these objects could be “cool and fancy” to wear around. The results showed that these kinds of products, which support an intimate communication of emotions, could enhance Physio and Socio-Pleasure of the user. Due to the fact that emotions are intimate, the communication may also be preferred to be done in an intimate way, which cannot be perceived by others.

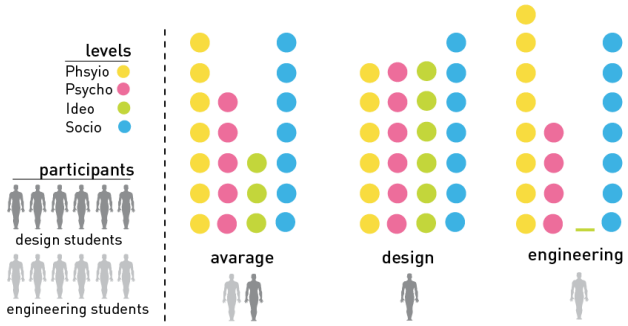

Figure 10. Results based on pleasure theory

Sensorial Experience

Each prototype can induce different emotions on the users. Most of the participants (66%) found the higher pitch beeping sound of *Sound Pads* funny and joyful; while the lower pitch as annoying and associated with negative emotions. The firm pressure sensation obtained by *Hand Muffs* was mostly (75%) associated with relaxation, warmness and affection. Besides, 58% of the participants found the light touch as playful, like tickling. On the other hand, the heartbeat sensation in *Skin Deep* was mostly (66%) perceived

as excitement and aroused emotion. Most of the participants (66 %) reported that they felt more intimately connected to the person with *Skin Deep* and found *Hand Muffs* the most effective in communicating emotions (83 %).
Participants gave rankings for each sensorial experience: tactile, auditory and visual, with a scale from 0 to 10, where 0 is very poor and 10 is excellent. Touch was found the most effective one with 7 points, and sound had 6.3 points. Vision had the lowest ranking with 3.7 points. The ranking and the comments of the participants showed that tactile based wearables would be more effective to communicate emotions in long distance.

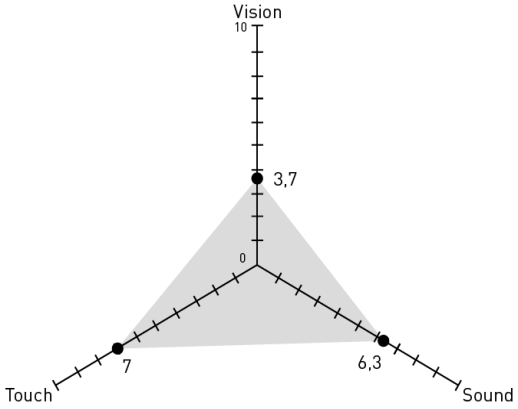

Figure 11. Sensorial ranking

CONCLUSIONS

Lurie (2000) said that people “put on clothing for some of the same reasons as they speak.” Clothes have a silent language that communicates personal values and cues. With wearable technology this mute surface can turn into a dynamic interface that can transmit emotions. This ability of having an *intelligent skin* on top of the natural skin can give people possibilities to extend their sensorial experiences and express their inner states beyond the physical limits. This research found out that people might not feel comfortable when their inner state was shown on a dynamic display in a public place, but they would appreciate this technology when they were alone or with people whom they had an intimate relationship. Automatically activated garments might not be desirable due to the fact that they could convey messages that the wearer doesn’t want to intend. Rather, people want to control garments and prefer garments that express the emotions that they want to express. This points out that although technology can introduce new ways of expressing emotions, people would like to be the controller of it.

Social networks are the digital platforms, where people have virtual personas and connect others in virtual ways. In these digital platforms, people can be more frank to express their inner states, than in the real life. This research tries to push the limits of technology by putting the screens of computers away and adding intelligence to the screens of the human body, which are garments. The results of this study showed that people may not be ready to expose their inner state in public with wearable technologies that are dynamically interfere their daily life interactions. The results also showed that people are willing to express their emotions, which are mostly positive, such as tenderness, love, joy and excitement to the people with whom they have intimate relationship. The survey and design practice that are presented in this paper showed that emotional communication through wearable technology can enhance emotional communication within the certain social circumstances.

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