EMBRACE: THE EMOTION SHARING BRACELET

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ABSTRACT

In this study we present *Embrace;* a wearable device that explores the potential of wearable technology harnessing the affordance of human form and deformable displays. We research new ways of communicating with loved ones in order to improve the experience of connectedness when they are apart. *Embrace* is a wearable device in the form of a bracelet that shares emotion between peers by providing both visual and haptic feedback. Other devices like smartphones and tablets have a rigid form and material. In contrast, the deformable display used in *Embrace* enables the user to wear the technology seamlessly on the body. The haptic feedback for sharing emotions is believed to provide a different experience since the physical sensation is more close to feeling heartbeats, hugs, and skin contact, compared to only visual information of today's mobile devices.

INTRODUCTION

According to research by Hiroshi et. al, current graphical user interface-based HCI-displays are restricting themselves to limited communication channels when it comes to human senses (Hiroshi et. al 1997). Hiroshi et. al writes: "GUIs fall short of embracing the richness of human senses and skills people have developed through a lifetime of interaction with the physical world" (Hiroshi et. al 1997 p.240). This indicates that there is much to explore in this area.

Figure 1: *Embrace* prototype with emotional cues.

In this paper we present *Embrace*, a wearable device that allows sharing emotions among peers through the transmission of haptic sensations besides visual feedback, see figure 1 above. We also explore potential use of bendable screen technology as opposed to regular (rigid) displays. In comparison, bendable screens are adaptable to the material and form of the human body which allows for custom fitted solutions when including such technology in wearable devices, i.e. wearable displays. We wanted to explore if using a bendable display in conjunction with emotion sharing could provide a more personal experience since the device becomes less of a foreign object, e.g. such as a rigid watch, and more part of the user's body.

A quick user study with a prototype showed great promise and suggests further research. The aim of this paper is to present our work which culminated in the concept of *Embrace,* where we used deformable display technology in conjunction with haptic cues to share emotions.

CONCEPT

Embrace is an emotion sharing bracelet that can be used to communicate feelings with people you care about. The device gives its users a richer communication experience, compared to texting, calls or video chats on mobile phones and laptops. It allows a sender to engage with the senses of a receiver – senses that are typically only possible to use when being physically close to another person. Calling on the receivers' visual (deformable display) and tactile senses (squeezing,

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vibration, warmth) we wanted the users to feel more connected to the other person.

Embrace allows you to send and receive a hug, share your heartbeat or a buzz. The cues that are perceivable are vibrations to represent heartbeat or a buzz, and a gentle warm squeeze to represent a hug. *Embrace* also gives visual feedback on a deformable screen by showing what cue was sent and by whom.

RELATED WORK

We wanted to explore if using a bendable display in conjunction with emotion sharing could provide a more personal experience, which is a significant difference from other related work. Of relevance to this paper is therefore both research in sharing emotion through technology as well as research of bendable displays and its applications.

EMOTION SHARING

Love, closeness, intimacy, social relationships in general are essential for humans to feel happy and satisfied according to several studies (e.g. Argyle 1987, Berscheid and Peplau 1983, Miesend and Schaafsma 2008, Myers 1999). This can become a problem for people who spend long periods of time apart from their loved ones. Hassenzahl et. al presented six strategies of mediating intimate relationships through technology which are: awareness, expressivity, physicalness, gift giving, joint action and memories (Hassenzahl et. al 2012). This toolbox of strategies guides the designer when addressing relatedness with devices, for instance it succeeds in giving hands-on advice applicable to *Embrace* prototype concerning the expressivity and physicalness.

Several studies have succeeded in communicating emotions through technology, artificially generating feelings of bodily intimacy through wearables or portable devices. Werner et. al developed *United-Pulse*, a device that allows couples to share their heartbeats between each other via a ring (Werner et. al 2008). Bales created CoupleVibe, a mobile application where users share their location by sending vibrotactile cues (Bales 2011), the findings shows that the information from your partner can enhance connectedness through tactile sensations which is similar to the haptic cues transmitted with *Embrace.*

When making a device meant to share emotions, it is important to consider the relationship of the users and how to best support their sharing. Kaye demonstrated with VIO prototype, how a single bit of communication between two people who share a context can leverage an enormous amount of social, cultural and emotional capital (Kaye 2006).

The Apple Watch, which has not yet been released, will have a similar feature to *Embrace* where the user can share his heartbeat to other users (Kastrenakes 2014). The watch records the user's heart rate and includes the option to send it to other apple watch users will be able to feel that heart rate on the arm with help of a vibrator.

BENDABLE DISPLAYS

Visual feedback is part of the concept and because the whole device has to be able to bend for wearability matters, studies of bendable screens have been a source of inspiration for possible interactions.

Research with bendable displays in the areas of HCI and interaction design have centered on taking advantage of its flexibility to leverage new interactive interfaces. One such research is that of Lahey et al that explores bend gestures in a general sense to interact with and navigate through the system of a handheld computer (Lahey et al 2011). Other research has focused on a more specific context, for instance scrolling by bending corners or sides (Schwesig et al 2004) or through twisting the display (Kildal 2012). There has also been research of utilizing foldable displays to change the size of handheld devices in order to make it easier to carry and handier when texting a message or navigating through a GPS (Ramakers et al 2014).

DESIGN PROCESS

The design process applied was based on J.C Jones's design process model following three main phases: divergence, transformation and convergence (Jones 1970). In this stage the problem domain was not defined. To come up with problems we defined fictional characters as well as context of use. Later we filtered the problems not related to our intended users – defined as people between 20 - 30 years old with good understanding of technology. We later used the generated content to develop a prototype.

DESIGN STUDY

To outline the problem domain we defined what we call *extreme personas* – essentially a mix of extreme characters following Djajadiningrat et. al's model (Djajadiningrat et. al 2000) and personas similar to how Nielsen defined them (Nielsen 2007). People engaging frequently in extreme sports were determined as our (extreme) personas in order to get us thinking "outside the box". These were used as sources of inspiration through consideration of their age, personality and attitude towards life as well as activities they might encounter in their extreme living. Four ideation methods were used (brainstorming 6-3-5, reverse brainstorming, error analysis and scenarios) in order to identify problems they might have. The problems were judged against their applicability to our intended users in order to determine the problems' relevance. The most relevant problems we found stemmed from the personas not being able to use their mobile phones, them having difficulties navigating the terrain as well as difficulties communicating with friends, all the while engaging in their extreme activities.

In the next step (transformation phase) we wanted to come up with ideas for addressing those problems to which we sketched and produced quick-and-dirty paper prototypes. The evaluation of these ideas was judged based on the feasibility of implementing the idea as a high fidelity prototype using bendable display technology.

The concept of *Embrace* eventually emerged from combining three main ideas: gloves with display, a smart bracelet and a heartbeat sharing device, see figure 2. The gloves with display's purpose were to ease the user's navigation by using gesture controlled interactions with a GPS-enabled map representation. The smart bracelet was a practical solution to normal wearable devices being in the way (e.g. getting tangled in climbing ropes) by making the display more a part of the user's body. The heartbeat sharing device was intended as an alternative way of communication, where the extreme sports user could invite friends to participate in the user's experience in a more personal way, i.e. to feel his heartbeat. From this last concept came the whole notion of sharing emotions through technology, which became one of the two central points of research in this paper.

PROTOTYPE

After defining the concept and its context of use (sharing emotions through a wearable device), we started to tamper with the technology and building a prototype. We wanted to research how sharing emotions by sending haptic cues with the help of actuators could enhance communication between loved ones. We chose three feelings and translated them into tactile cues: a hug (squeeze or contraction around the user's wrist), a heartbeat (vibration at a heartbeat pace) and a buzz (random vibration), as well as visual feedback consisting of a picture of the sender and text describing the event.

A *Dynalloy Flexinol* contracting wire measuring 1.5 mm thick and 25 cm long was used to simulate the hugging sensation while a vibe motor was used to simulate heartbeats (and simple buzzes). The contracting wire needs to have current flowing through it to contract, which would also heat it up – above as much as 90° Celsius after 10 seconds. The time it was activated was therefore thoroughly tested and finally set to 5 seconds to achieve an optimal contraction as well as heat emission (still hot enough to simulate human warmth). A fabric case was also used to protect users' skin. We also experimented with the vibe motor in similar ways to achieve the impression of actual heartbeats. Moreover, the *Beaglebone* was programmed to handle all the logic pertaining the events – meaning it was in charge of sending the images and the text to the bendable screen as well as controlling the contracting wire and the vibe motor with digital signals accordingly.

Figure 2: The three main ideas merged to create *Embrace*

Four events were programmed to occur during this time and the time between the events was set to 14, 8, 14 and 10 minutes from the time that the *Embrace* was switched on. A buzz occurred directly when the *Embrace* was switched on to ensure the functionality and was thereby not a part of the study. The diary of the study participant presented in Table 1 shows how she experienced the events and what the true (programmed) events were. During the study, the participant expressed a wish of being able to send an emotion.

EVALUATION

The prototype was tested through a user study where one person got to wear the device and experience the sensations presented earlier. The following sections describe the evaluation.

USER STUDY

The user study took place in an everyday context with one study participant and was performed in order to find out what kind of emotions *Embrace* could evoke. The *Embrace* prototype was only used as the receiving device during the study. Even though there was only one prototype, the study participant was told that she had one out of two devices and that her sister had the other device. The participant was also informed about the emotions she would be able to receive but not how this would manifest itself. The batteries in the prototype would only last for one hour but in order to not affect the participant's experience she was told the test would last for the whole day. The study participant kept a diary during the experiment, in which she wrote down her experiences.

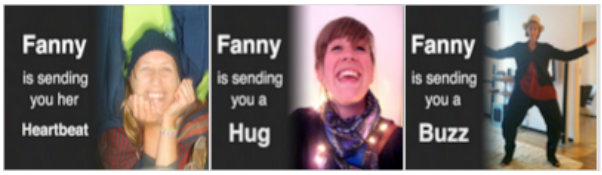

Figure 3: Different outputs from *Embrace*

During this time, the prototype was programmed to simulate 4 incoming signals by inducing a haptic sensation and showing images of the sender as well as an explanation of the event (see Figure 3). The time between the events was set to 14, 8, 14 and 10 minutes from the time that the *Embrace* was switched on. A buzz occurred directly to ensure the functionality and was thereby excluded in the study. The diary of the study participant presented in Table 1 shows how she experienced the events and what the true (programmed) events were. During the study, the participant expressed a wish of being able to send an emotion.

Table 1: Study diary

Programmed event: Heartbeat - vibrator buzzes to the rhythm of a heartbeat Feeling: I didn't feel anything, but the screen showed a message and a picture of Fanny, telling me that she was sending her heartbeats. Reaction: I felt surprised and happy, but a bit disappointed when I didn't feel any physiological change. **Programmed event:** Hug - contraction of the flexinol wire Feeling: What caught my eye was the image popping up on the screen, but this time I felt a very small squeezing sensation. The screen showed a message that told me that Fanny was sending me a hug, but it felt more like a very discrete tickle. Reaction: I again felt a bit disappointed, since I couldn't really feel the hug, and I start wondering if I'm doing something wrong. (I really appreciated seeing Fanny's picture while receiving the hug.) **Programmed event:** Heartbeat - vibrator buzzes to the rhythm of a heartbeat Feeling: I didn't feel anything, but the screen showed a message and a picture of Fanny, telling me that she was sending her heartbeats. Reaction: I felt happy, it felt good to be interrupted while working and seeing the face of somebody I like. **Programmed event:** Hug - contraction of the flexinol wire Feeling: I didn't feel anything, but the screen showed a message telling me that Fanny was sending me a hug. Reaction: It still feels nice when the screen lights up and tells me that I'm receiving something, but it feels sad, at the same time, when I don't feel anything.

During the test, one technical issue with the bracelet arose, as the buzzer did not work. The display and the contracting wire worked well and the study results brought new insights to the concept. These insights helped reinforcing that *emotion sharing* with wearables is an area for further studies.

The bendable screen turned out to have a positive influence on the participant. One of the comments written in the diary regarding the information on the display was "I felt happy, it felt good to be interrupted while working and seeing the face of somebody I like".

FINDINGS

By analyzing the information written in the diary, we found that the experience of receiving emotions through the bracelet was positive even though it interrupted normal workflow. This method could show how to give emotional support, provide motivation during work and generate a stronger feeling of connectedness.

The comment regarding the hug was that the study participant felt a squeeze and the visual information on the display helped her to understand the received emotion. The feedback regarding the prototype was important as it gave a direction of how to improve the current prototype and make a more purpose-fulfilling design. The diary also revealed that the participant felt disappointed when the display showed information about receiving a heartbeat, but she did not feel the buzzer due to technical issues. Having a lack of action from the bracelet reinforced the idea that people relate and interpret haptic sensations with feelings.

DISCUSSION

This paper presents the design and development of *Embrace,* a wearable device that explores the potential of wearable technology harnessing the affordance of human form and deformable displays and the ability to share emotions among peers.

Most computational devices like smartphones and tablets have a rigid form and material. In contrast, the deformable display used in *Embrace* enables the user to wear the technology seamlessly on the body. We believe that wearable displays allows for a more personal experiences as they can support both visual and haptic cues while being more integrated with, and accepted as part of, the human body. Where the human tissue ends and the technology begin is blurred.

Due to malfunction of the haptic feedback during the test, we could not find evidence strong enough to say with certainty that the haptic feedback provided an improved different experience of sharing emotions compared to communicating with text or pictures. We suggest to user test the idea further in order to validate this hypothesis.

Further research should also be conducted to the use of bendable screens for input. It would be interesting to implement selection actions such as being able to send a hug by squeezing the screen or sending your heartbeat by placing the device close to your heart. The final device would also need to run a system that the user interacts with, which is relevant to the gestures that are possible for the bendable display. In addition to that, it would be interesting to study how the receiver would react when receiving a heartbeat on his or her arm for longer periods of time. Would the heartbeat of the receiver change? Would the pace increase or slow down? Can this bring advantages to other fields of study?

Current studies of mediating intimate relationships through technology shows how important it is for physically separated couples to express their emotions on a regular basis (Hassenzahl et. al, 2012). It would be interesting to find out how an emotion sharing device can affect long-distance relationships (which is not that unusual today). Moreover, devices like *Embrace* can bring a way of reconnecting people and incentive those to be physically closer to their friends and loved ones. More recently, Apple announced an emotion sharing feature for their upcoming watch product line. Even though this device is different from *Embrace* regarding its rigid form compared to the flexibility of the bendable display, the availability of this technology allows for research to develop future emotion sharing devices.

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REFERENCES

Argyle, M. (1987). *The Psychology of Happiness*. Methuen, London.

Bales, E., Li, K. A., & Griwsold, W. (2011). CoupleVIBE: mobile implicit communication to improve awareness for (long-distance) couples. In *Proceedings of the ACM 2011 conference on Computer supported cooperative work* (pp. 65-74). ACM.

Berscheid, E. and Peplau, L. A. (1983). *The emerging science of relationships*. In *Close Relationships*, H. H. Kelley, et al. Eds., W. H. Freeman, New York, NY, 1–19.

Djajadiningrat, J.P., Gaver, W. and Fres, .W. (2000) *Interaction relabelling and extreme characters: methods for exploring aesthetic interactions.* In Conference proceedings on Designing Interactive System (DIS) 2000, pp. 66-71. ACM Press.

Hassenzahl, Heidecker, Eckoldt, Diefenbach, Hillmann. (2012) *All You Need is Love: Current Strategies of Mediating Intimate Relationships through Technology.* ACM Trans. Comput.-Hum. Interact. 19, 4, Article 30 (December 2012), 19 pages.

Hiroshi I., Brygg U. (1997) *Tangible bits: towards seamless interfaces between people, bits and atoms*. Proceedings of the ACM SIGCHI Conference on Human factors in computing systems, p.234-241, Atlanta, Georgia, USA

Jones, John C. (1970). *Design Methods: seeds of human futures.* John Wiley and Sons, New York and Chichester

Kastrenakes, J. (2014). *Apple Watch uses four sensors to detect your pulse*. Available at http://www.theverge.com/2014/9/9/6126991/apple-watch-four-back-sensors-detect-activity. Visited 2015-03-09.

Kaye, J. (2006). *I just clicked to say I love you: Rich evaluations of minimal communication.* In Proceedings of the Conference on Human Factors in Computing Systems. ACM, New York, NY.

Kildal, J., Paasovaara, S., Aaltonen, V., (May 2012). Kinetic Device: Designing Interactions with a Deformable Mobile Interface. *CHI 2012 - It's the experience*. May 5–10, 2012, Austin, Texas, USA

Lahey, B., Girouard, A., Burleson, W., Vertegaal, R. (2011). PaperPhone: Understanding the Use of Bend Gestures. *CHI 2011 - Session: Flexible Grips & Gestures.* May 7–12, 2011, Vancouver, BC, Canada

Miesen, H. W. J. M. and Schaafsma, J. (2008). *Get a life: Relatedness needs, materialism, and subjective well-being*. In *Proceedings of the IAREP/SABE World Meeting*. Luiss, Rome.

Myers, D. G. (1999). *Close relationships and quality of life*. In *Well-Being: The Foundation of Hedonic Psychology*, D. Kahneman, E. Diener, and N. Schwarz Eds., Russell Sage Foundation, New York, NY, 374–391.

Nielsen, Lene (2007). *10 steps to personas*. Sniker & company, Copenhagen.

Ramakers, R., Schoning, J., Luyten, K. (2014). *Paddle: Highly Deformable Mobile Devices with Physical Controls*. *CHI 2014 - Session: Shape Changing Interfaces*. April 26 - May 01, 2014, Toronto, ON, Canada

Schwesig, C., Poupyrev, I., and Mori, E. (2004). Gummi: A Bendable Computer. *CHI 2004-Conference of Human Factors in computing Systems.* April 24 - 29, 2004, Vienna, Austria

Werner, J., Wettach, R., & Hornecker, E. (2008). United-pulse: feeling your partner's pulse. In *Proceedings of the 10th international conference on Human computer interaction with mobile devices and services* (pp. 535-538). ACM.