DH2670 Haptics, Tactile and Tangible Interaction
Royal Institute of Technology KTH

Using Touch to Communicate Emotions

Individual Literature Assignment

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1. Introduction

The use of touch as a means to communicate emotions is as new of a concept in the field of computer interaction, as it is ancient in human nature. Studies such as the one by Hertenstein et al. [2006] show that humans are capable of distinguishing between different emotions communicated by touch alone. Using touch for inter-personal communication is such a basic component of humanity, that we have evolved to have special nerve fibers which react to the touch from other humans, as demonstrated by Cascio et al. [2019]. Despite this, the modality of touch is rarely used to communicate emotions in human-computer interactions. As computers become a more and more integral part of society and everyday life, we risk losing this valuable tool of communicating emotions to the people around us. Instead, a user's emotional state is often conveyed using visual information. One example of this is the emoji. As indicated by a systematic review of two decades worth of emoji research by Bai et al. [2019], emojis are an important tool for conveying many different kinds of information in computer-mediated communication (CMC), one of them being emotions. With a language as ubiquitous at communicating emotions as touch, it is hard not to consider the possibility of providing haptics to communicate touch.

1.1 Research Question

In this paper, previous research on the topic of haptics and touch is investigated. Possibilities of future research in furtherance of the knowledge in the field and possible implementations of haptics for emotional communication are discussed. The research question is as follows:
How can the modality of touch be utilized to communicate or alter experienced emotions when interacting with a computer?

1.2 Delimitations

The main focus of this paper is the use of touch as either an input to or an output from a computer system in order to communicate, enhance or modify the emotional state of a user. The use of touch as an input for other types of information than emotions and emotional states will therefore not be covered. There are several ways to emulate touch, for example, vibrations and force-feedback. The differences in effect between the methods of implementing touch will not be investigated, instead, any technology which produces the experience of touch will be processed as a whole. In this paper, the difference between the emotional enrichment of interpersonal CMC versus communication between humans and computers will not be addressed. Research on both fields will be taken into consideration and regarded as relevant to the research question.

2. Background

To determine if touch can affect emotions, one needs to find a way to distinguish between different emotions. One way to classify emotions is the Valence-Arousal-Dominance model (sometimes referred to as the Pleasure-Arousal-Dominance model). This model was suggested in the 1974 book *An approach to environmental psychology* by Albert Mehrabian and James A. Russell. This model uses three measures to classify different emotions. Valence/Pleasure is the measure of how pleasurable something is perceived to be, Arousal measures how arousing or exciting something is, and Dominance measures how much or little control something is perceived to have.

In a study by Yohanan and MacLean [2011], the ability to communicate emotion through haptics was tested using an animal-like robot. Different states of emotion were portrayed by the robot through simulated breathing, purring, and stiffness of the ears. Three levels of arousal and valence were combined into 9 different emotions. The test subjects would hold the robot in their lap, and answer questions about which emotion they believed the robot was expressing. The results of the study showed that participants could, with high accuracy, distinguish between the different levels of arousal. However, the participants were not as accurate in interpreting the valence of the portrayed emotion.

Similar results were found by Obrist et al. [2015]. Using acoustics to give the sensation of touch on one hand, this study had one group of participants design haptic sensations based on images chosen from the International Affective Picture System (IAPS) representing different emotions. Another group reviewed the designed haptics in order to select the ones they perceived to be the best representations of the desired emotions, and a third group was shown the pictures and rated the different haptic designs on which seemed most appropriate. The participants of the third group rated the haptics designed for a specific level of arousal as more appropriate on the emotional images intended for the corresponding level of arousal, meaning there was a consensus between different participant groups on how arousal is communicated with haptics. Participants were not as apt at differentiating between different valence levels, but the researchers could identify some patterns in how valence was communicated. Positive valence was more often associated with a touch of the middle palm, the thumb, and the index finger, and tended to involve movement towards the person's body. Negative valence was more likely to involve the areas around the outer palm and pinkie finger, and movement was more done away from the person's body. Neutral valence involved touch on the upper palm.

Using the placement of touch to indicate emotions has been explored in another study, conducted by Huisman and Darriba Frederiks [2013]. In this study, a sleeve with both haptic input and output was placed on the participants' arms. The participants were instructed to

create the sensations they believed expressed 8 different emotions the best and to explain their thought process. Using the data from the haptic sleeve and the words the participants used to explain their created haptics, some trends could be identified. There were differences in the surface area touched, the gaps of time between touches, for how long they portrayed the emotion, and how much force they used. Researchers could, for example, link anger with longer interactions, using larger surface area, and harder touch. Participants would commonly describe the expression as hitting or squeezing.

Different emotional states being described using different types of touch have been corroborated in a study by Gaffary et al. [2013]. In this study, emotions that are close to each other in the Valence-Arousal-Dominance model were used in pairs in order to see if there is a pattern between how different people express themselves with touch. Participants were instructed to express the emotions on a haptic device simulating an arm. The data was analyzed with a clustering approach, and the results showed that all emotions were expressed with significant differences from its pair emotion. This indicates that there is a common way to express different emotions using haptics.

The difference in how touch is used during different emotional states was also the focus of a study by Gao et al. [2012]. Participants played a mobile game that used swiping motion as an input. The difference in how the participants swiped the screen during four different emotions (bored, excited, frustrated, and relaxed) was examined, and it was found that it was possible to determine the emotional state of the player from the way they swiped the screen while playing. Both two levels of valence and arousal could be distinguished with high accuracy, between 80-90%, and the specific emotional state could be predicted with a 77% accuracy.

The interpretation of haptics in arousal and valence has also been investigated by Pradana et al. [2014]. In this study, the researchers tested if different haptics and light effects on a ring-shaped wearable could prime the subjects to interpret a text message as having a different emotional value. The results showed in this study too that touch was more efficient at changing the perceived arousal than the perceived valence of the text message, but the valence could also be affected.

This body of research indicates that touch is a modality apt for communicating emotions or enhancing and modify an emotional state.

3. Discussion

It is clear from the research in the field of touch that it is proficient for the communication of emotions. As has been demonstrated more than ever during the Covid-19 pandemic, CMC is here to stay, and its quality needs to be improved. New ways of adding emotional depth to CMC are therefore a very important subject. It could provide increased quality of communication with loved ones, in turn improving a person's quality of life and strengthening bonds. The addition of touch to, for example, a video call with a loved one can be very helpful if it adds an emotional depth to the interaction. The addition of touch could also provide increased inclusivity for the visually impaired, who could experience the added emotional layer that today might be provided by an emoji or image. It could also be used for those who experience emotional or cognitive impairment. One example of this being used today is the robot seal Paro, a robot used for the socialization of dementia patients. Paro uses touch both for input and output and has supposedly been very useful for reducing stress. The use of Paro raised concerns about whether it is ethical or not to use robots as companions for people who might not realize to a full extent that it is not a living thing. Opposers say that social interactions should be provided by humans and not robots. It is possible that similar technology which built Paro could be used for interacting with other humans, giving a solution to this problem. Relatives could use such a device to virtually visit their loved ones, even if they live far away, and the added modality of touch could give an emotional connection that would otherwise be lost.

Another finding that could have possible use in the real world is the study that showed that when people were asked to portray different emotions using touch on a hand, there was a pattern in which areas were touched for the different emotions. If it is possible to fine-tune this mapping even more, it is possible to imagine clothing that can simulate or enhance an emotion just by applying pressure on different areas. Maybe this could be used as a therapy method, in order to raise a person's mood or soothe mild anxiety. Reading this study, I started to think about the way nervous people tend to rub their hands together. Could there be a connection between the way people touch their hands to calm down, and how people show emotions using their hands? If so, are there other patterns of emotional touch that can be explained by the way humans interact with their own and others' bodies? Findings of this could have an effect on how we design wearables and their haptic feedback, but it could also affect how we use touch when interacting with other humans.

It is apparent from the research that humans find the level of arousal easier to identify in haptics than the level of valence. The reason for this does not seem to be all too clear, is it due to the way humans interpret touch or is it due to the limited simulations of touch used? Different studies have used different ways of providing haptic feedback, so it is unlikely that this is all down to a lack of proper hardware. This is, in my opinion, a possible field for

future research. Investigating whether this is true in both interpersonal communication or just in CMC could be a possible first step to explore this topic. It can also be noted that dominance is often omitted as a factor in these studies altogether. Most studies found on the subject that used the classification of emotions according to levels of arousal, valence, and/or dominance used the 2-space Affect Grid by Russell et al. [1989], which only includes arousal and valence. It would be of interest to explore ways to convey dominance through haptic CMC, and again compare it to real-life interactions between humans. Is it simply not as easy to communicate dominance through the modality of touch?

Since a lot of the studies on the subject had a group of participants design the emotional haptic output, it seems as if people tend to express different emotions in a specific way when using touch. This raises another question on the use of touch: how enriching is it to be able to use touch as an input? This is a part of the research question raised for this study, but since most research focuses on how experiencing haptic output from a computer affects the user emotionally, not many conclusions can be drawn about this. Even in the study where touch input on a smartphone screen was investigated, the emotional state of the participants was just a variable. Did it affect their playing experience to be able to show emotion? The participants had to define which emotion they felt at different times, does it affect the experience to be aware of your own emotional state? It would be interesting to see more studies on how a person is affected emotionally when interacting with a system using touch as an input, e.g. would reaching out and "touching" a character from a computer game make the player more emotionally attached to that character than if they were "touching" them by pressing a button? As shown in research by Vormbrock and Grossberg [1988], interacting with dogs by petting them lowers blood pressure, so using touch as an input can definitely have physiological effects, but what about emotional ones? If the addition of touch as input is shown to enhance emotional effects, one can imagine that this could be combined with the relatively advanced VR systems on the market today into a much more immersive experience, both physically and emotionally. Something like this could be useful for many areas of life, such as long-distance relationships, personal training, medical examinations, or collaborative online games. On the subject of games, using haptics to communicate emotions through or with a computer could affect the way haptic devices are designed. Today, most video game consoles that use haptics use the functions as either a way to control a character (e.g. tilt to turn a car) or to provide information about something which has happened in the game (e.g. vibrations when being shot). If instead the haptic devices were designed to input and output emotional touch, they would likely look different. Instead of shaking or tilting, a device might be used to pet or hit, and instead of vibrations, the output might be touch mimicking that of another human. Possibly these solutions would be wearable instead of hand-held devices, maybe similar to the sleeve-device from one of the aforementioned studies. A gaming device that affords emotional touch might help with introducing children to affectionate touch and could help with exploring concepts such as empathy.

There are of course ethical implications to this. Persuasive technology is a popular topic today, and the ethical implications are discussed frequently for good reason. The addition of an emotional layer to these morally dubious practices could definitely do more harm than

good. Devices that can affect the emotional impact on the user could be used to affect politics, by expressing positive or negative emotions together with a party or political person. Commercials could use an added layer of emotions to sell more products, by convincing the consumer that this product will give certain emotions if they buy it. Haptic input devices which record and save data could be used to track how individuals feel about certain topics, in order to sway public opinion or target advertisements. These are, of course, not new problems, a lot of this already happens using other modalities. However, the implications on ethics must be considered before launching a technology that could add even more persuasion or invite for more invasion of privacy.

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