Exploring Bodies, Mediation and Points of View using a Robotic Avatar

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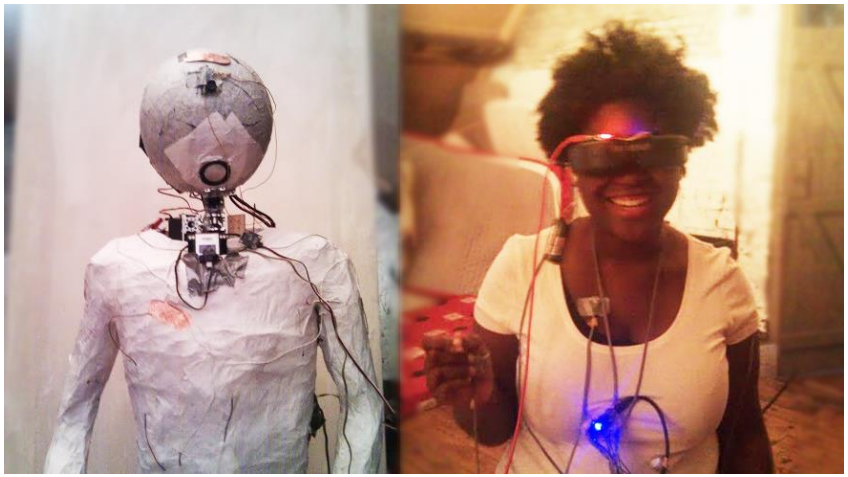

Figure 1 – Telerobot (left) controlled by remote user (right). The head movements of the robot are synchronized to those of the remote user and the remote user sees the world from the perspective of the robot.

The robot has eight touch sensors. When these sensors are touched the remote user feels vibrations at corresponding locations of their body.

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Abstract
Technology mediates the relationship we have with ourselves, others and the world around us. This paper describes an installation that explores minimum conditions for mediation, using a touch sensitive telerobot with an actuated head. People wishing to use the telerobot wear a head-mounted display and a head-tracking device. This enables them to see what the robot sees while the movements of the robot's head are synchronized to those of their own head. Vibration motors are attached to the user's body and vibrate when the robot is touched. This installation allows for playful exploration of mediation as well as adopting other perspectives through technology. When interacting with others through the robot, the installation enables reflection on the role of touch in communication and technology. Used by one's self, the installation allows us to perceive our bodies from a third person perspective.

Author Keywords
Telerobotics; Mediated Touch; Out of Body Experience

ACM Classification Keywords
H.5.1 Multimedia Information Systems;

Introduction
The point of view through which we experience the world is usually situated in our body. When using

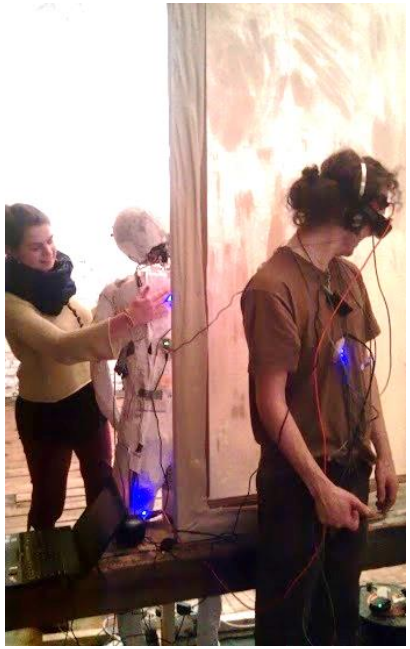

Figure 2 – A local user (left) touches the back of the robot. The remote user (right) feels a vibration at the corresponding location of his back. He sees the local user as if she were standing next to him.

virtual reality or remote viewing technologies we can modify this point of view, allowing us to situate our perspectives in places far away or within bodies other than our own. Telepresence systems, for example, relocate our point of view into another body.

When interacting with the telerobot installation, users are augmented with a series of vibration motors, a head mounted display, and a motion capture system (Figure 1, right). This technology allows them to connect with, and control, a robot (Figure 1, left). The user sees and hears through that robot and receives vibration cues when the robot is touched. Others can approach the robot and interact with the user through the robot (Figure 2). The user can also move into the visual field of the robot and interact with themselves from a third person perspective (Figures 4 & 5). This raises interesting questions regarding where the user is present, the user's identity, and how the user constructs their sense of self. This exploration challenges how we traditionally think of and perceive our bodies.

Related Explorations

While telepresence and remote manipulation are rather old concepts [8,13], technology has only recently matured to allow the concepts to become accessible to the general public. An early system exploring remote touch interactions was InTouch [5]. With the telerobotics becoming more commonplace, there is a growing interest in the role of touch in mediated settings, leading, for example, to explorations of the social effects of mediated touch [7] and remote hand-shaking [3] as well as various implementations to support remote touch interactions [12,14,19].

The topics explored in our installation have been subject of past art installations. A notable demonstration of a kinetic communication system of mediated touch was White's remote arm-wrestling system [16]. It enabled users to arm wrestle each other at a distance, by interacting with robotic arms.

Various other installations were also inspirational: Mediated presence was explored in *Telematic Dreaming* [11]. This installation invited its audience to share a bed with a woman who was present only as a projection. Mediated touch and pain were explored in *CyberSM* [18], a sado-masochistic role-playing installation with electrically induced haptic feedback. *The Machine To Be Another* [2] allowed participants to see the world from the perspective of people with different genders, ages, and socio-political backgrounds. *Ping Body* [1] by Stelarc was a performance in which Stelark surrendered control over his body to the whims of people's internet surfing behavior, while maintaining agency over a robotic arm. The contraction and relaxation of Stelarks muscles were controlled by electrodes, based on ping-times from various websites, while the robotic arm was controlled through activation of muscles in his abdomen. Blurring the borders between humans and robots is also explored in research supervised by Rekimoto. such as JackIn or the Flying Head [9,10].

Full body illusions (when one believes their body not to be their body or when one takes ownership over another body) are studied in consciousness research [4]. Experiments have shown that with multisensory integration, participants are able to take ownership of foreign bodies [15] while at the same time disowning their actual body during the time of the illusion [6].

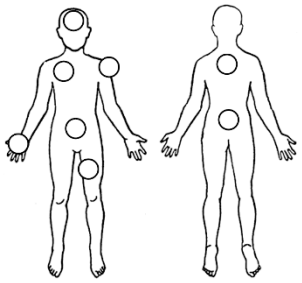

Figure 3 – Locations of capacitive touch sensors (circles) and vibration motors on front (left) and back (right) of remote participants and telerobot. Touch detection is done with native capacitive touch sensing on an Arduino, which also controls the motors.

Implementation

The installation consists of a simple robotic avatar that a local user can interact with and a wearable system that allows a remote user to experience and interact with people at the remote location. I refer to the person controlling the robot as the remote user and the person interacting with the robot as the local user.

The remote user experiences stereo sound via headphones and video via a head mounted display by Fat Shark. The remote user also has 8 vibration motors attached to their body, which are linked to 8 touch sensors on the robot (Figure 3). When the robot's sensors are touched, the corresponding motors vibrate. Finally, the head movements of the remote user are measured using an inertial measurement unit (IMU) and directly control the robot's head: when the remote user moves their head, the robot's head moves as well. The local user can hear the remote user through a speaker located where the robot's mouth might be, and sees the movements of the robot's head [19]. The robot was designed to explore minimum conditions for an embodied experience of remote presence, it is not intended as an exploration of haptic design as done by Tawil et al. [17].

Observations

The installation was set up for a week in the Mandril Cultural Center in Maastricht, the Netherlands (http://mandril-maastricht.org/). The Mandril hosts various events, including courses, workshops, political discussions, concerts and parties. Guests of the Mandril could interact with the robot and engage in informal experimentation and exploration of the technology [19]. People interacting with the installation provided us with rich qualitative feedback:

Observations of Local Users Interacting with the Robot

We[1] were interested if people would approach the robot with the same respect with which they approach others in a face to face setting. We observed a variety of very different behaviors: people who knew each other well, usually had a relaxed and almost joking attitude when interacting through the robot, their focus appeared to be more on exploring the technology, and less on the appropriateness of their behavior towards others. However, people who did not know each other were careful and respectful when touching, stating things such as "*I didn't touch her thigh, because I was not sure if she would be comfortable with me touching her there.*" Local users reported that they were especially careful with strangers, as they neither knew their comfort level, nor what the vibration actually felt like.

Observations of Remote Users Controlling the Robot

When designing the robot, there was an implicit assumption that a 'remote touch' would be an embodied experience for the remote user. This proved true to a certain extent, but not quite as expected: In response to "*how do you feel*" one user responded "*like a door*". The remote user explained that he felt like a door with a security camera. He was looking at the local user through the door's security camera and the local participant was pushing buttons on the door, ringing various doorbells, which he felt as vibrations. Similar observations were made by other users who

[1] 'We' means the many helpers I had (including Marian Schneider, Frauke Boesche, Undine Rubeze, Chris Kurt, Amber in't Veld and others) and Ike Kamphof (who I had regular meetings with in which we discussed the high-level aspects of my design) in addition to myself.

Figure 4 – This user sees herself from the perspective of the robot. Experiencing herself in the third person, she is confused on how to refer to herself. Some users avoid this issue by saying "The real me" or "the me who is wearing the glasses" instead of "I"

reported *"feeling like an object"* as well. This experience seemed to occur when users did not feel they had sufficient control over the interactions.

This issue was also addressed in concrete terms in regard to the robot's degrees of freedom. It was often criticized that, aside from the head, the remote user was unable to move the robot. A common comment was: *"If I could just raise my hand, it would already be so much cooler."* One surprising comment was by a remote user who stated that "I *found it very disturbing that I could not touch myself. Usually, when you have a conversation with someone else, you can touch yourself."* The inability to touch herself left the participant with a disembodied feeling.

Users stressed the importance of synchronization between vision and touch: because the robot could not bend over, or raise its hands, many of the touch areas were not visible to the remote user. This was seen as a design flaw, as the synchronization of touch and vision was considered important: *"Usually it does not feel like touch, but when I see your hand move and then I feel the vibration, it almost does".* The ability to see the hand approaching allowed the users to anticipate the touch and provided a sense of control.

Tinkering in Search for Embodied Experiences

Remote users were able to associate the vibrations with touch, but also stated that the vibrations did not feel like touch. This indicates that much of the interaction occurred at a symbolic, rather than an embodied, level.

In an attempt to find a better way to create an embodied experience, we connected a vibration motor, placed on the remote participant's chest, to a proximity sensor placed on the robot's chest. The vibration motor varied its vibrations depending on the distance between the local participant and the robot.

Asked what they felt during the mediated touch conditions, a remote participant might respond, *"it feels a bit as though my phone is vibrating in my pocket, just it's somewhere else",* while during the mediated proximity condition a participant might respond *"I feel her, [the local participant], walking past me."* When talking about experiences they had when using the touch sensors, participants often talked about the vibrations. When referring to the experiences they had using the proximity sensor, they were more likely to refer to the interaction. We therefore believe the proximity sensor condition provided a more embodied sensation requiring less interpretation than the touch sensor condition.

Finally, upon request of participants, we combined the touch and proximity systems. This was positively received: e.g. a participant stated that *"Before, the touches where sort of discontinuous and difficult to make sense of. Now [with the added proximity cues] the individual vibrations sort of become continuous. I feel [the local participant] coming closer and then I feel the touch and it all makes sense."*

We believe that because the proximity cues were easier to anticipate, they created a more embodied experience. The proximity cues are also a completely new sensation. To interpret the touch cues, the remote user needs to forget or ignore what touch actually feels like, and instead mentally create a new definition of the sensation. This process is not required when interpreting the proximity cues. We believe that this

Figure 5 – This user reaches out to touch herself. She initially believes her body to be to the right of herself. Once she sees herself executing the movement, she reaches towards the robot, to the left of her. It is a surprise to her when she finally locates the actual position of her body.

leads to a more symbolic experience of the touch cues and a relatively embodied experience of the proximity cues. These assumptions are in agreement with previously published questionnaire data [19].

Auto-Interaction

In the spirit of playful exploration, we asked participants to take on the role of the local and remote user: We asked the remote user to cross the room into the local user's area. The remote user would interact with the robot, taking over the local user's role, while maintaining their own role (Figure 4 & 5). This had two very odd consequences. For one, the participants were able to see the video-goggles and various cables attached to their body. The technology which was previously a 'medium of perception' additionally also became an 'object of perception'. Using Heidegger's vocabulary, the technology was simultaneously Ready-to-hand and Present-at-hand.

This effect is interesting from a phenomenological point of view, but not something the users would take note of. They were too absorbed trying to mentally grasp the sensation of being both observer and observed, both subject and object simultaneously. The complexity of this experience became apparent through the users' reactions. All users required a significant amount of time to adjust to and understand the situation, some participants had to close their eyes because the situation was too intense. Verbalizing this experience proved difficult as well. We commonly heard questions such as *"Where is the real me?"* or statements such as *"I am incredibly confused what I mean when I say I."* (Figure 4). This drift in perception and confusion as to one's own identity also becomes apparent when users try to interact with their own body: The location and orientation of their bodies does not match what they intuitively expect, leading to surprised reactions when participants touch their body or the robot (Figure 5).

Conclusion

This installation provides a playful and engaging opportunity to explore the role of the body in HCI. It enables users to experience their environment mediated through the body of a robotic avatar. It also lets users experience their body from a third person view, providing new perspectives on the conference theme of 'Our Body is Our Manual'. I hope to have the opportunity to present my installation, as I believe the experience it provides will stimulate discussion and ideas around the conference theme.

Video Link

https://www.youtube.com/watch?v=1Bx71aYF6CA

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