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A Social Agent, or a Medium?: The Impact of Anthropomorphism of Telepresence Robot's Sound Interface on Perceived Copresence, Telepresence and Social Presence

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Abstract. Robot's sound feedback can have either speech or non-speech interface. Since a telepresence robot (FURo-i Home) is a robot intended to be used in remote communication where conveying the presence of the communicators is essential, this study investigated the effect of anthropomorphic sound interface on perceived copresence, telepresence and social presence of the communicator. We executed a 2 (modality of sound interface: speech and non-speech audio) between-participants experiment. Participants felt more copresence from the interaction through the robot which had speech interface than non-speech interface. The results suggested that the robot's identity from its anthropomorphic features as a social agent would complement the presence of the counterpart which could have been reduced or distorted during a robot mediated communication.

Keywords. Anthropomorphism, Copresence, Sound Interface, Telepresence, Social Presence, Social Agent, Medium

1 Introduction

Recently, despite presence of conventional tools for remote communication such as e-mail, text-message, telephone etc., several telepresence robots have been developed, most of which especially aim to enable remote communication. Developed by Willow Garage, Texai [1] is a remote presence system that enables people to telecommute to have an in-office presence, supporting audio and video transport of the operator. Similarly, MIT Personal Robotics Groups developed a telepresence robot, MeBot, [2] which gives a person a convenient way to work with the colleagues through video and phone conferencing. To suit the purpose of a medium, the robots above have little element that shows robots' own identities not to distort the presence of communicators. On the other hands, the Hug [3], created by DiSalvo et al., is a robotic product using

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anthropomorphic form with two arms that permits intimate communication across distance. Likewise, Elfoid P1 [4], developed by Ishiguro et al., is designed to represent the caller conveying the presence of individuals using robot's anthropomorphic appearance, texture and motion. They argued that the robot body having human-skin texture and anthropomorphic shape makes people feel the caller's presence better. In robotic tele-communication, as the robot is to convey presence of one to another or the other way around, it is necessary to investigate the effective ways to design telepresence robots. In the case of social interaction, the presence of voice as well as shape or facial expression of a robot could be a strong trigger for anthropomorphic perception. Thus, it is necessary to explore the effective way to design robot's sound interface to create anthropomorphism of a robot. Arons et al. [5] described that audio feedback could have either speech interface or non-speech interface and that people perceive each speech type differently. In this study, we investigated the impact of speech and non-speech sound interface of telepresence robots on people's perception of the communicators' presence in a remote communication.

2 Related Works

2.1 Telepresence robot

There are several telepresence robots developed and designed for the remote communication. As mentioned above, Texai[1] and MeBot[2] are robots designed to deliver people's presence as pure media having few anthropomorphic characteristics. As several mobile devices have been developed and widely used among consumers, some of telepresence robots recently made have mobile platform itself. PadBot [6], working directly on iPad, is another example of the pure medium having few humanlike feature. In contrast, some researchers have made an attempt to apply anthropomorphism on the interface of robots to enhance presence of communicators.
The Hug [3], created by DiSalvo et al., is a robotic product that permits intimate communication across distance and it uses anthropomorphic form with two arms that naturally increase physical interaction. Its sound interface, however, is non-anthropomorphic built on a metaphor of telephone calls and answering machine. Elfoid P1 [4], a telepresence robot having human-skin texture in anthropomorphic shape, is designed to convey the presence of individuals transmitting caller's face and head movements and voice. Even though several researchers have studied on how anthropomorphic forms affect interactions between a telepresence robot and the user, the effect of anthropomorphic sound interface of telepresence robots is limited.

2.2 Sound Interfaces

According to Stifelman [7], auditory feedback can have either speech or non-speech sound interface.

Speech sound interface is proved as being effective when conveying specified information and enhancing effectiveness of social communication [8]. Robot's anthropomorphic ability such as speech or gestures, can contribute to a person's increased perception of the robot's social capabilities and hence acceptance in social circle of the human [9]. Fink [10] has discovered that a verbal communication of the robot can be a way to express the robot's social awareness. According to the analyses above, we suggested a sociability hypothesis – people will feel more presence of the communicators when the telepresence robot has speech interface.

In contrast to the sociability hypothesis is the pure medium hypothesis – that non speech interface of the telepresence robot will be more effective when conveying the communicators' presence. Compared to speech interface, non-speech can provide terse, but informative, feedback to the user. According to Arons [5], the non-speech audio could be successful at unobtrusively providing feedback. In other words, it could be intrusive and interfering if the sound interface is presented in other manners. Ishiguro et al. [11]'s study shows that the more anthropomorphic personality the robots have, the more distortion and confusion there would be in the communication through the robot medium.

3 Study Design

This experiment was performed to investigate the impact of the types of sound interface on perceived copresence, telepresence and social presence of the robot. We used a 2 (types of sound interface: speech vs. non-speech) within-participant experiment design.

3.1 Participants

Twenty-eight people (14 male, 14 female) aged from 21 to 45 participated in this study.

3.2 Material

The robot we used in the experiment was a home service robot FURo-i Home (Fig. 1). This robot enables tele-communication with a video call function. We developed two

types of sound interface: speech and non-speech. The robot with speech interface generated human-like voice while the robot with non-speech interface generated machinelike ringtone. The robots were controlled via Wizard-of-Oz technique.

Fig. 1. Robot Stimuli (FURo-i Home)

3.3 Procedure

A video-clip in which a man was having a video call using the telepresence robot was shown to the participants. In order to apply two modalities (speech and non-speech sound) of sound interface, we inserted a sound feedback into each robot when the phone was ringing, the call was on hold, and the call ended. The robot with the speech interface had a human voice saying "you have an incoming call," "the call is on hold," and "the call is ended." On the other hand, the robot with the non-speech interface had an inanimate beep sound. In each condition, the robot showed the status of the video call with a visual notification on the screen. After the participant experienced the condition, a questionnaire regarding the stimulus was administered and a post-interview was proceeded.

3.4 Measure

On the post-experimental survey, participants evaluated the experience on 34 different Likert-types items combined into 4 scales: self-reported copresence, perceived other's copresence, telepresence, and social presence, drawn from Nowak et al. [12]'s study. Since the experiment was done through video, the items in the questionnaire were modified measure the participants' evaluation of the service from the point of view of the man in the video.

4 Results

We investigated the effect of anthropomorphism of sound interface on self-reported copresence, perceived other's copresence, telepresence, and social presence. Statistical analyses were conducted for hypotheses using the paired *t*-test.

As predicted in sociability hypothesis, the participants felt more presence of the counterpart when communicating through the robot with speech interface than with non-speech interface. The analysis showed a significant effect of anthropomorphism of robot's sound interface on perceived self copresence with t=2.059, df=27 and p=.03 (one-tailed). Participants felt more self copresence when the robot had speech interface (M=3.37, SD=1.34) than when the robots had non-speech interface (M=3.99, SD=1.43). Perceived presence of others was also significantly higher with t=2.501, df=27, p=.01 (one tailed) when the robot had a speech interface (M=3.73, SD=1.52) than a non-speech interface (M=3.03, SD=1.20). There was no significant difference in telepresence and social presence. These results are described in Fig. 2.

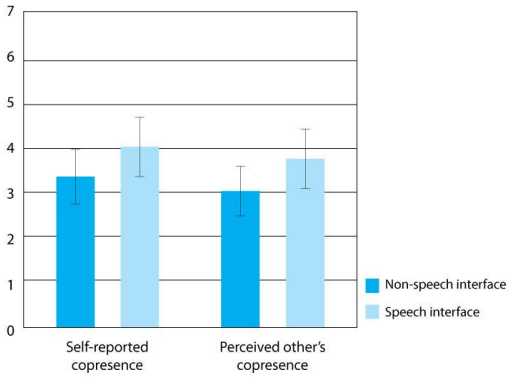

Fig. 2. Effect of sound interface types on copresence

5 Discussion

As predicted by sociability hypothesis, people engaged more in the telepresence communication through robot which had speech interface. This indicates that the amount of anthropomorphism of a robot's interface is an important factor to increase presence of the communicator and involvement to the interaction. As Groom et al. [13] discovered, a robot with anthropomorphic feature would be perceived as having more identity of robot itself. We suppose that the identity of the robot itself as a social agent facilitate the social interaction in a robot-mediated tele-communication. This suggest that robot developers or designers should consider applying anthropomorphism on the interface of telepresence robots.

6 Conclusion

In this study, we found that speech interface could be more effective than non-speech interface to feel the communicators' presence in a remote communication through a telepresence robot. Since the presence of communicators could be reduced or distorted through a robot medium, robot's identity as a social agent could facilitate social interaction. These results provide a basis for robot interaction designers that anthropomorphism could be used as an effective way to convey communicators' presence in robot mediated communication.

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