EXTENDED ABSTRACT

Communicating as/through/with a robot: Human relations with telepresence robots

Dr Eleanor Sandry[1] and Dr Gwyneth Peaty

Curtin University, Western Australia

Introduction

This extended abstract summarises an initial literature review undertaken to frame future research into telepresence using two very different robot platforms. "Sim" is a mobile Teleport telepresence robot from Aubot (aubot.com/products/teleport). "Haru" is a desktop robotic platform developed by researchers at Honda Research Institute (HRI) Japan for human-robot communication research that can be teleoperated or can operate autonomously (Gomez, 2020). This abstract introduces some ideas about telepresence of different forms, theoretical perspectives, methodologies and methods as well as key questions for our research projects with these robots. The literature review is not exhaustive, just a starting point. Its aim is not to provide a complete review of the state of telepresence research, but rather to inform the design of our future projects.

Definitions of telepresence in relation to the Sim and Haru

Telepresence robots, or mobile remote presence (MRP) robots, are often described as machines that enable "embodied video conferencing" (Tsui et al, 2011, p.11). Many are "mobile (mostly wheeled) platforms equipped with microphones, cameras and a screen, which can be controlled remotely" (Keller et al, 2020, p. 448; with similar ideas in Moyle et al, 2019, p. e127; Barua et al, 2020; Cheng et al, 2019, p. 2096). The affordances of these machines allow "a person not just to be virtually present, interact and socially participate

[1] Presenter and corresponding author: e.sandry@curtin.edu.au

from a remote location, but also physically move in the robot's local environment, so allowing the remote user to take more control over her/his presence" (Niemela et al, 2019). The Teleport robot, Sim, one of the robots we will be using in our research, clearly falls within this category. It is effectively a tablet device on an extendable "neck", with a wheeled base unit. Users log in to control the machine remotely, and the robot allows them to listen and speak, see and be seen, as they move around a space.

Telepresence robots "can be used to attend a meeting without physically being present at the location". Their affordances enable "a 360° view of meeting proceedings": the robot allows the remote user to turn towards people as they speak and "exchange eye-gazes" (Barua et al, 2020). In this way, they allow people to "exercise a degree of agency in a remotely located place" enabling them to be "more actively involved in social episodes" (James et al, 2019, p. 2.3). Some researchers note that using a telepresence robot can increase the sense of "authenticity" and "social connection" when communicating with someone who is physically remote (Moyle et al, 2019, p. 1648). While others suggest that "social presence" can be "built to a significantly greater degree" than is possible with Skype, for example (James et al, 2019, p. 2.24).

In spite of their potential, some researchers point out that while "telepresence robots can convey certain types of nonverbal communication, such as voice inflection and facial expressions" through the video feed, "other aspects, such as gesture with the rest of the body, are typically lost" (Fitter et al, 2019). This has led to experiments using various nonverbal communication cues, including "LED light signaling and arm-based beat gestures" (Fitter et al, 2019). This type of nonverbal cue may be an important way to attract attention, while also assisting with turn-taking in conversation. It is worth noting that this perspective overlooks the potential for kinesic communication through the robot's overall movements, as a remote operator turns the robot to look at, or moves towards or away from, someone or something.

Not all telepresence robots are as mobile as those discussed above, some being designed instead as movable tabletop robots. When this type of telepresence robot incorporates a screen, as seen in Kubi (www.kubiconnect.com), the remote user is able to tilt and turn the screen and its camera, to look around and make eye contact with people around a table as they speak. In spite of these abilities, without being able to move freely around a space, these robots still raise some issues with a lack of nonverbal expression and body language cues. Maybe because of this difficulty, some tabletop telepresence robots operate without screens, but with other communicative affordances, for example, OriHime (http://ces15.orylab.com/). This class of telepresence robot, or avatar, provides a very different experience for both remote and local users. In particular, they afford remote users a level of anonymity, while also often giving them the ability to use nonverbal signals alongside speech (Vikkelso et al, 2020, p. 523). The Haru robot currently falls into this category, although future iterations of this robot might project video content that could include a remote user's video feed. Currently though, the focus for Haru is to enable users to share emotional responses through its expressive animated eyes, which tilt, roll and pop (by moving out of their frames) as well as its body lean, base rotation and LED mouth (Ackerman, 2018).

This situates Sim and Haru both as telepresence robots, albeit with very different movement affordances and capabilities to support communication. The overarching questions for our research relate to the experience that people have with these machines, both as remote communicators controlling the robot, and those communicating with the remote person through the machine. The continued review below therefore considers how existing research can provide a basis for various theorisations of people's responses to telepresence robots, to prepare for how we and our participants might experience telepresence as a relational and communicative process.

Telepresence and being a cyborg

In “My Life as a Robot”, Emily Dreyfuss describes her experience using a fully mobile telepresence robot, “an iPad on a stick on a Segway-like base”, for an extended period of time as a remote worker (2015). After some initial problems learning to operate the robot, Dreyfuss finds herself not only feeling like she was back in the office, but also integrally connected with the robot itself: “As soon as I call into EmBot, I am her, and she is me. My head is her iPad. When she fell, I felt disoriented in Boston. When a piece of her came off in the impact, I felt broken” (2015). From this description, it is clear that Dreyfuss feels so connected with the robot that her relationship with it might best be described as cyborg (Haraway, 2000[1985]), since the robot acts as an extension of her body, even at a distance. This idea is emphasised not only by her sense of powerlessness and horror “the first time someone touched [her] robotic body without asking” (2015), but also by the difficulty she faces when the original telepresence robot malfunctions and is replaced with a new one. Dreyfuss explains that “immediately upon activating it I knew it was not really EmBot. It rolls differently. Its speakers are quieter. It doesn’t connect to the Wi-Fi as well. It teeters differently on the carpet-edge. It’s not me. It’s just a robot. A robot I can’t trust” (2015). Her relationship with the new robot would seem to be considerably less seamless and cyborg.

A less fixed relation in a human-machine assemblage

The cyborg relation that Dreyfuss’ feels with the original Embot might only develop in situations where a telepresence robot is used by one person, becoming closely connected with that person’s self, body and presence in the remote location. It is possible that repeated and regular use a telepresence robot, even as one of a group of remote users sharing a robot, might still result in a sense of personalised embodiment during interactions. However, it seems likely that the knowledge a robot is not only facilitating your presence in the remote

location, but also that of other people, will affect the way the human-machine relation is perceived. Where telepresence robots are shared, instead of a cyborg relation carrying with it a particular pairing of human and machine, it might be better to consider humans and telepresence robots in a human-robot assemblage within which human and robot remain always separable and replaceable (Dant, 2004). From this perspective, the relation that develops is more fluid, as the participants in the relation, human and robot, change flexibly as required. This understanding might be even more appropriate when considering group use of a telepresence robot, such as when students attending a conference remotely shared the telepresence screen to talk to physical conference attendees, giving students the "experience of being 'many'" within the machine (Lueg, Castles & Wong, 2020), a situation where the multiple humans and one robot form a temporary and shifting assemblage.

Telepresence as a form of flexible human-robot team

Accounts about the use of telepresence robots, and our personal experience with the Teleport robot, Sim, indicate that a number of problems can arise to destabilize any sense of either a cyborg or assemblage type relation. These difficulties include lost Internet connections (both for the remote user and the telepresence robot itself), but also issues in navigating tight spaces, managing social cues and recognizing when a remote user needs help. While connection issues are to be expected (for any technology), some of these other difficulties might encourage the development of semi-autonomous telepresence robots with which human relations are likely to become more like teamworking experiences. Research in the benefits of semi-autonomous telepresence suggests the value of being able to pass control for following a person (Cheng et al, 2019) or allow the robot to detect who is speaking and look towards them automatically (Barua et al, 2020). Other research notes that supporting trust in these relations is key, with full automation having the potential to cause issues for remote

users (Khojasteh et al, 2019; Osawa et al, 2020). From this perspective, the relationship between human and telepresence robot becomes more clearly defined as a collaboration between two separate parts. This might still be theorised as a form of assemblage, but further research may suggest a greater division, as the agency of human and machine are more clearly interpreted by people as separate, even as they have the sense that they are working closely with the robot to engage with a space and people within that space.

Very early experiences with Sim[2]

Our initial testing of Sim has now begun and, while there are resonances with some of the findings of previous research and documented experiences of using telepresence robots, it is also raising some additional ideas and questions. While my work with the Sim has mostly been to check the robot's setup and basic affordances, during which I have always been co-located with the robot (and thus able to check its progress by direct line of sight), Gwyneth Peaty has now had some time to experience the process of remote teleoperation.

As someone who regularly plays first person videogames, Gwyneth found the movement controls easy to use, but missed having a separate control for gaze direction. She was excited to begin to explore the office corridor as/through/with the robot as fast as possible. When thinking back on this, she remarked that she didn't really consider the effect this might have on people sharing space with the robot! It seems that Gwyneth, familiar with first person videogames, got quickly wrapped up in the telepresence experience adopting a cyborg perspective similar to Dreyfuss (2015). She even noted afterwards that if someone had touched, pushed or turned the robot without asking she would have felt uncomfortable. However, during our relatively short test, we had a lot of issues with connectivity and the

[2] This section was added in April 2021.

continual lost connections immediately broke this close relation and made it difficult to rebuild each time the connection was re-established.

Sim's affordances include being able to change the height of the tablet, something not possible with all mobile telepresence robots. Having discovered this, Gwyneth took delight in making "herself" as tall as possible. This offered her a way to experience the corridor and conversations with work colleagues from a new viewpoint. I had not realised how much impact this would have, but it was clearly an important aspect of Sim's capabilities much appreciated by Gwyneth. Alongside the choice over when and how to move, changing height enhanced Gwyneth's sense of control over her robot presence.

As we continued to work with Sim and talked after the tests, Gwyneth noted that the lack of a separate control for head movement (aside from turning the whole body) might make it difficult to talk in groups, seamlessly moving one's gaze to follow whoever was speaking. This missing capability for subtle movement was magnified by the noisiness of moving the robot as a whole. Gwyneth was oblivious to this as the remote operator, but on returning to debrief, watching me move the robot back to its charger, she was suddenly aware of how the noise made by even small movements might disrupt the social experience for people sharing space with the robot. This may be an issue for Sim in particular, since other research hasn't really remarked on noisy motors as a problem for telepresence overall.

Overall directions for our future research

In continuing research with Sim and soon, we hope, beginning research with Haru, there are a number of directions suggested by this literature review. Given Fitter et al's finding that "relationship closeness influenced the interaction experience more than any other considered predictor variable" (2020, p. 499) our research will first document and analyse our responses to both sides of the telepresence relation as close colleagues and friends. It will then compare

these findings with the responses of others using these robots at varying levels of familiarity with each other. At the extreme case, we will also research the experiences of people operating a telepresence robot to communicate with people they are meeting for the first time. Khojasteh et al note people may well find "initiating conversations with strangers" more difficult "than talking with friends or to people they know" through telepresence robots (2019, p. 244). Experiences with Sim, which does not support nonverbal cues other than through whole body movements and turns, will be compared and contrasted with those of operating the highly nonverbally expressive Haru.

Use of both Sim and Haru will also support research that considers the difficulties of controlling telepresence robots while also trying to communicate with people around you. Haru's expressive capabilities in particular are complex, but this robot has been designed with a teleoperation interface that allows the robot to monitor people's expressions and suggest potential expressive responses from which the remote operator chooses. The robot can even operate autonomously in this respect.

Sim and Haru are clearly very different types of robots, although both support remote operation and thus telepresence. Their differences do mean that research projects with each robot will need to be carefully tailored to exploring people's experiences as/through/with the specific features and capabilities available. Our focus is not to compare the effectiveness of these platforms for telepresence directly, but rather to consider the different perceptions and experiences of human-robot relations and communication that each support. We hope that a broad theoretical analysis developed from the research will be useful when considering other existing telepresence robots, as well as the design of future robots for this purpose.

Methodology and methods

The literature review above provides support for the qualitative research direction we are planning in our research. In particular, it has highlighted to us, as humanities researchers, the frustration we feel with research that only follows quantitative methodologies (most often quantitative surveys without open-ended questions). Our research, while it may use surveys informed by previous work, in the main seeks qualitative information and experiential accounts. It is therefore encouraging to see that a number of research projects use semi-structured interviews in their work on telepresence (Ahumada-Newhart & Olsen, 2019; Khojasteh et al, 2019; Moyle et al, 2019; Tsui et al, 2011), while others draw on autoethnographic methods, such as thick description (James et al, 2019). Both interviews and detailed personal accounts will be collected as part of our research projects with Sim and Haru.

The goal for our research is to gain an in-depth sense of how people experience telepresence and telepresence robots from the perspective of the remote person and the people that encounter and may interact with that person and the robot. Its predominantly qualitative nature aims to provide a rich set of responses documenting people's feelings about their experiences with telepresence robots from both sides of the relation. Rather than expecting to decide upon one theoretical perspective from which to understand telepresence relations, this research remains open to adopting various theoretical frameworks, including those outlined above, to understand human interactions as/through/with such robots. This will allow for flexibility in considering the different affordances of the robots being studied and the different scenarios under which they are likely to be operated.

Potential research questions[3]

The following research questions have been identified to consider the perspective of remote users of a telepresence robot:

- How do people perceive themselves and a telepresence robot as they move through a remote space?
- How does communication seem to work as/through/with a robot?
- How does the experience of a communicative event as/through/with a telepresence robot compare with people's face-to-face communication experiences?

Alongside the questions relating to remote people, the next set of questions apply to the experience of the "audience", that is the people who share space with the telepresence robot and communicate with the remote person:

- How does a person seeing a telepresence robot understand its presence as both a robot and a person interacting in a shared space as/through/with the robot?
- How might the existing relationship between the people communicating using telepresence robots shape these responses?

If possible, our research will be developed so we can consider repeated and regular use of a telepresence robot, to get some sense of how the human relations as/through/with a telepresence robot change and develop over time:

- How do the responses, of both remote operators and those sharing space with a telepresence robot, change over time as familiarity with a robot increases?

Conclusion

This extended abstract can only report the very early work towards setting up for future research with the Sim and Haru. The literature review presented here has therefore focused

[3] This section was also added for the April 2021 revision in response to reviewer comments.

on supporting: how to position these machines as particular types of telepresence robot; an analysis to identify some initial ways to theorise people's relations with telepresence robots; the identification of some key directions for our research; the choice of methodologies and methods to be used; and development of an initial proposed set of research questions.

References

Ackerman, E. (2018). *Haru: An Experimental Social Robot From Honda Research - IEEE Spectrum*. IEEE Spectrum: Technology, Engineering, and Science News. https://spectrum.ieee.org/automaton/robotics/home-robots/haru-an-experimental-social-robot-from-honda-research

Ahumada-Newhart, V., & Olson, J. S. (2019). Going to School on a Robot: Robot and User Interface Design Features that Matter. *ACM Transactions on Computer-Human Interaction*, *26*(4), 1–28. https://doi.org/10.1145/3325210

Barua, H. B., Sarkar, C., Kumar, A. A., Pal, A., & P, B. (2020). I can attend a meeting too! Towards a human-like telepresence avatar robot to attend meeting on your behalf. *ArXiv:2006.15647 [Cs]*. http://arxiv.org/abs/2006.15647

Cheng, X., Jia, Y., Su, J., & Wu, Y. (2019). Person-following for Telepresence Robots Using Web Cameras. *2019 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, 2096–2101. https://doi.org/10.1109/IROS40897.2019.8967645

Dant, T. (2004). The Driver-car. *Theory, Culture & Society*, *21*(4–5), 61–79. https://doi.org/10.1177/0263276404046061

Dreyfuss, E. (2015). My Life as a Robot. *Wired*. https://www.wired.com/2015/09/my-life-as-a-robot-double-robotics-telecommuting-longread/

Fitter, N. T., Joung, Y., Demeter, M., Hu, Z., & Mataric, M. J. (2019). Design and Evaluation of Expressive Turn-Taking Hardware for a Telepresence Robot. *2019 28th IEEE*

International Conference on Robot and Human Interactive Communication (RO-MAN), 1–8. https://doi.org/10.1109/RO-MAN46459.2019.8956413

Fitter, N. T., Rush, L., Cha, E., Groechel, T., Matarić, M. J., & Takayama, L. (2020). Closeness is Key over Long Distances: Effects of Interpersonal Closeness on Telepresence Experience. *Proceedings of the 2020 ACM/IEEE International Conference on Human-Robot Interaction*, 499–507. https://doi.org/10.1145/3319502.3374785

Gomez, R. (2000). Meet Haru, the Unassuming Big-Eyed Robot Helping Researchers Study Social Robotics. *IEEE Spectrum*.

Haraway, D. (2000[1985]). A Cyborg Manifesto: Science, technology and socialist-feminism in the late twentieth century. In D. Bell & B. M. Kennedy (Eds.), *The cybercultures reader* (pp. 291–324). Routledge.

James, M., Wise, D., & Langenhove, L. V. (2019). Virtual strategic positioning to create social presence: Reporting on the use of a telepresence robot. *Papers on Social Representations*, *28*(1), 2.1-2.30.

Keller, L., Pfeffel, K., Huffstadt, K., & Müller, N. H. (2020). Telepresence Robots and Their Impact on Human-Human Interaction. In P. Zaphiris & A. Ioannou (Eds.), *Learning and Collaboration Technologies. Human and Technology Ecosystems* (Vol. 12206, pp. 448–463). Springer International Publishing. https://doi.org/10.1007/978-3-030-50506-6_31

Khojasteh, N., Liu, C., & Fussell, S. R. (2019). Understanding Undergraduate Students' Experiences of Telepresence Robots on Campus. *Conference Companion Publication of the 2019 on Computer Supported Cooperative Work and Social Computing*, 241–246. https://doi.org/10.1145/3311957.3359450

Lueg, C., Castles, M., & Wong, M. C. (2020). We are here and we are many: Using a telepresence robot for shared exploration and learning (and fun). *Proceedings of the Association for Information Science and Technology*, *57*(1). https://doi.org/10.1002/pra2.381

Moyle, W., Jones, C., Dwan, T., Ownsworth, T., & Sung, B. (2019). Using telepresence for social connection: Views of older people with dementia, families, and health professionals from a mixed methods pilot study. *Aging & Mental Health*, *23*(12), 1643–1650. https://doi.org/10.1080/13607863.2018.1509297

Niemelä, M., van Aerschot, L., Tammela, A., Aaltonen, I., & Lammi, H. (2019). Towards Ethical Guidelines of Using Telepresence Robots in Residential Care. *International Journal of Social Robotics*. https://doi.org/10.1007/s12369-019-00529-8

Osawa, M., Okuoka, K., Takimoto, Y., & Imai, M. (2020). Is Automation Appropriate? Semi-autonomous Telepresence Architecture Focusing on Voluntary and Involuntary Movements. *International Journal of Social Robotics*, *12*(5), 1119–1134. https://doi.org/10.1007/s12369-020-00620-5

Tsui, K. M., Desai, M., Yanco, H. A., & Uhlik, C. (2011). Exploring use cases for telepresence robots. *Proceedings of the 6th International Conference on Human-Robot Interaction - HRI '11*, 11. https://doi.org/10.1145/1957656.1957664

Vikkelsø, S., Hoang, T.-H., Carrara, F., Hansen, K. D., & Dinesen, B. (2020). The telepresence avatar robot OriHime as a communication tool for adults with acquired brain injury: An ethnographic case study. *Intelligent Service Robotics*, *13*(4), 521–537. https://doi.org/10.1007/s11370-020-00335-6