Family Communication Over Distance Through Telepresence Robots

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Abstract
Video-based communication in home contexts is largely dominated by the usage of video chat systems such as Skype or FaceTime. However, in the near future, there is a strong possibility that families will begin to migrate to different types of video communication systems, including telepresence robots given their ability to be mobile in the home. We report on initial observations of how families experience and use telepresence robots through an introspective look at our own practices. This highlights the benefits and complexities around camera work, mobility, and accessibility. We use these lessons to pose future research directions for the study and design of telepresence robots in the home.

Author Keywords
Families; video-mediated communication; telepresence robots; awareness; privacy; autonomy.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous;

Introduction
Families often have a need and desire to stay connected over distance where they make use of a range of technologies, including email, instant messaging, and video chat [10]. Video chat is highly

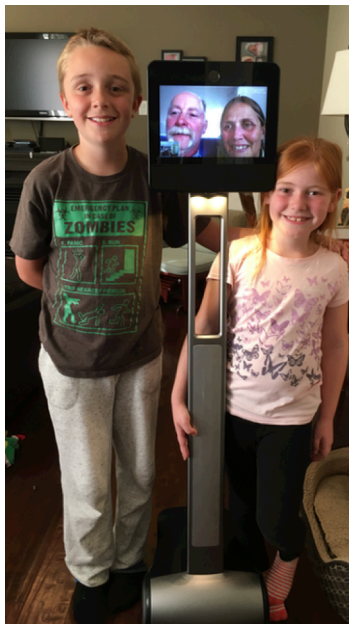

Figure 1: The Beam+ telepresence robot in the family's home, connecting with remote grandparents.

valued as it allows family members to see their loved ones, similar to how they might in person [1,4,8,12]. Research has explored the ways in which families make use of video chat systems with a focus on long distance couples [11], grandparents and grandchildren [1,2,8], and parents and children [8,15]. However, the focus has largely been on the usage of tablets and smartphones. Over the next few years, we are likely to see family members adopt and appropriate new forms of video-mediated communication systems as technology evolves.

One type of new technology that might show benefits for family communication is telepresence robots, given their mobility and the increased sense of physical presence that they provide. A large amount of research explores how telepresence robots support informal interactions and meetings at work [9,14], and even attendance at large-scale events like academic conferences [13]. However, what we do not see in the literature are explorations of how telepresence robots might be used in non-workplace settings like the home to support family communication over distance. This is despite the lowering cost of telepresence robots and designs specifically targeted at home contexts (e.g., Beam+).

Through introspections of our own use of telepresence robots in the home, we explore how robots shape the dynamics of family communication over distance, including how they benefit communication, and what challenges emerge. While these observations are tied directly to our own likely biased usage, they suggest important directions for future research to explore the usage of telepresence robots in the home more deeply.

Observational Setting

As part of our research on telepresence and telepresence robots, we used a Beam+ telepresence robot within the home of the first author for a period of six months. The goal was to create an initial understanding of how telepresence robots could be used to connect grandparents and grandchildren over distance in order to guide future studies and research. The first author's family consists of his wife and three children (ages 3, 7, 10) and they primarily used a telepresence robot to connect with remote grandparents who lived approximately 1000 km away. The robot was placed in the home of the parents and children and the remote grandparents connected into it.

The Beam+ is a telepresence robot designed for small offices and home environments (Figure 1). Users can remotely drive it using a tablet, smartphone, or computer where they see two video feeds of the remote environment. One video feed shows the floor in order to navigate and the other shows a video chat view of the remote environment from a height of approximately four feet.

As we used the telepresence robot, we were drawn to interesting phenomena that we describe in the following sections.

Camera Work

Research on video chat systems has very clearly articulated the challenges that users face around camera work [1,3,4,8]. That is, when using a video chat system like Skype or FaceTime, it is the remote party that controls what is seen over the video link. This is done by either holding or placing a device (e.g., tablet, smartphone, laptop) on a surface and turning it

so that its camera faces the object of desire. In family settings, this might involve holding a smartphone and aiming it at children so that remote grandparents can see what they are doing [2].

When using a telepresence robot, this type of interaction dynamic is very different and it is instead the remote party that controls the camera view. The benefit is that one is no longer responsible for holding a device and orienting it to create a 'good' view for the remote party. We found this especially valuable because it allowed the children in the family to interact with the remote grandparents without requiring parent scaffolding. That is, the parents no longer had to hold a smartphone or manage which child was allowed to hold the tablet/phone at a particular moment. The grandparents were now in charge of their own embodiment and what they saw. They could change their camera view by turning the robot or moving it to a different location.

However, the challenge that we quickly saw emerge was around privacy. The family was used to being in control of what the remote grandparents saw and, unbeknownst to them, they had somewhat shielded certain areas from the home so they were out of view. For example, this might include a messy kitchen counter or unkept piles of toys on the floor. The grandparents could now easily see these areas inadvertently. Moreover, the navigation camera that pointed down at the floor presented a view that the family was not used to the grandparents having.

Remote viewing with telepresence robots was also found to be asymmetrical, which is different than normal video chat (e.g., over Skype) where both parties control the remote party's view reciprocally. With a telepresence robot, the grandparents were in control of what they saw yet the parents and children were not. The grandparents still controlled the remote view of their location.

Overall, this suggests further research that explores how remote camera work affects aspects such as privacy and autonomy. It also brings forward opportunities for exploring both asymmetric and symmetric modes of interaction and viewing.

Mobility and Presence

Research on video chat has shown that people often use such systems in an effort to support conversations [1,4.8]. In these situations, people will orient themselves in front of their video chat display, trying to stay in continuous view, and have a conversation akin to being face-to-face with someone in person [4]. Alternatively, research has also shown that people sometimes use video chat systems in more of an 'always-on' way that allows people to share activities over longer periods of time [4,11,12]. Here a device is set down and aimed towards the activity. For example, a long distance couple might setup Skype so that it shows each partner cleaning in their respective homes [11]. The challenge in these situations is that it is difficult to move between locations in the home since it easily makes a person 'off camera' [11].

When using a telepresence robot, this problem is solved since remote users can simply drive the robot to different locations. However, during our usage, we found that the remote grandparents were hesitant to do so. First, they were used to being in a single fixed location (when using video chat) and often did not

deviate from this behavior because of its familiarity. This meant that activities often moved to where the telepresence robot was already situated, rather than the telepresence robot moving towards family members in other locations. For example, children might bring their toys over to the robot, rather than having the grandparent drive the robot to a child's playroom where the toys were normally kept.

Second, when the grandparents did move the telepresence robot, it meant that conversations and activities had to stop while the grandparents drove the robot to their location. Driving was a cognitively demanding task and it was difficult to do it while engaging in other activities. A similar problem has been found in workplace and academic conference settings [13,14]. The net effect during the family's usage was that it was sometimes difficult for conversations and activities to stay uninterrupted and continuous.

Third, we found that the telepresence robot created a much stronger sense of presence for the remote grandparents than with video chat systems like Skype. It very much felt like the grandparents were 'present' in the home and 'visiting' when they would connect into the telepresence robot. This was beneficial because it created stronger feelings of connection. Yet it also created tensions around when connections would occur and how long a video call would last. Sometimes the family felt as though they had to 'entertain' the remote grandparents while they were connected. They also found it difficult to know when a call should end, or delicately signal that this was the case. On the other hand, video chat calls were something that could be more fluidly started and stopped.

Overall, these observations suggest future research around the social norms that might develop and exist during telepresence robot calls in the home.

Accessibility

Research has explored how telepresence robot users face new accessibility challenges as a result of not being able to do things that they normally can in person. For example, they are unable to push elevator buttons in workplace or conference settings while using a telepresence robot and need people to help them [13,14]. They also have difficulties opening and closing doors. We noticed similar challenges in the home, but of a slightly different nature.

Telepresence robots require a relatively high Internet bandwidth to operate effectively (e.g., 10 Mbps download and upload). Home Internet *download* speeds typically match these requirements, yet *upload* speeds often do not. When Beam+ robots lose connectivity, the video appears frozen or the robot stops moving while the video continues to play. These problems occurred during the family's use of them and created confusion around what the remote grandparents were doing and whether they understood how to use the technology.

For example, if the grandparents were asked to come over to the kitchen table, but they did not, it wasn't clear if they simply didn't know how to, or if they had a poor Internet signal. We found that situations like this caused both the children and the parents to treat the remote grandparents differently, questioning their ability to use the technology when, in reality, the problems could have been out of their control. This created socially awkward situations and sometimes

meant that the local family members would move or reorient the telepresence robot for the grandparents. This occurred regardless of whether the remote grandparents actually needed the help or not.

While the technical constraints of the technology may lessen over time, there is also the likelihood that designs will continually demand more technical capabilities (e.g., even faster Internet connections). Overall, this suggests research directions around providing situational awareness of the remote location, such as what users' current connectivity level is, or other similar information that might help explain user behaviors.

Conclusion

Our initial observations show that families experience benefits from the use of telepresence robots, yet they also face new challenges that are somewhat different from those experienced when using video chat systems. It is certainly possible that the behaviors we have observed will go away with time as people become accustomed to telepresence robots and designs evolve to better accommodate the needs of family members. However, new and improved designs will likely continue to raise key research questions in the areas that we have identified. We also note that we only explored one side of the connection and did not comment on the experiences from the grandparents' perspective. Future research should explore both sides of the experience to understand user reactions.

Author Biographies

Dr. Carman Neustaedter is an Associate Professor in the School of Interactive Arts and Technology at Simon Fraser University. Research projects heavily focus on technology designs for family communication and the design and use of video-based communication systems, including telepresence robots. Dr. Neustaedter was the Telepresence Co-Chair for Ubicomp/ISWC 2014, CSCW 2016, and CHI 2016. For each conference, he organized, facilitated, and studied remote attendance using BeamPros.

Lillian Yang is a PhD Student in the School of Interactive Arts and Technology at Simon Fraser University. Her research focus is on usability, as well as user experience surrounding technology. She holds a Master's degree in Neuroscience and a Bachelor's degree in Psychology.

References

1. Morgan G. Ames, Janet Go, Joseph 'Jofish' Kaye, and Mirjana Spasojevic. 2010. Making love in the network closet: the benefits and work of family videochat. In *Proceedings of the 2010 ACM conference on Computer supported cooperative work* (CSCW '10). ACM, New York, NY, USA, 145-154.
2. Azadeh Forghani and Carman Neustaedter. 2014. The routines and needs of grandparents and parents for grandparent-grandchild conversations over distance. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '14). ACM, New York, NY, USA, 4177-4186.
3. Brennan Jones, Anna Witcraft, Scott Bateman, Carman Neustaedter, and Anthony Tang. 2015. Mechanics of Camera Work in Mobile Video Collaboration. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems* (CHI '15). ACM, New York, NY, USA, 957-966.

4. Tejinder K. Judge and Carman Neustaedter. 2010. Sharing conversation and sharing life: video conferencing in the home. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '10). ACM, New York, NY, USA, 655-658.
5. Steven Johnson, Irene Rae, Bilge Mutlu, and Leila Takayama. 2015. Can You See Me Now?: How Field of View Affects Collaboration in Robotic Telepresence. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems* (CHI '15). ACM, New York, NY, USA, 2397-2406.
6. Norman P. Jouppi. 2002. First steps towards mutually-immersive mobile telepresence. In*Proceedings of the 2002 ACM conference on Computer supported cooperative work* (CSCW '02). ACM, New York, NY, USA, 354-363.
7. Atsunobu Kimura, Masayuki Ihara, Minoru Kobayashi, Yoshitsugu Manabe, and Kunihiro Chihara. 2007. Visual feedback: its effect on teleconferencing, *Proc of the Conference on Human Computer Interaction*, Springer-Verlag, LNCS 4553, 491-600.
8. David S. Kirk, Abigail Sellen, and Xiang Cao. 2010. Home video communication: mediating 'closeness'. In *Proceedings of the 2010 ACM conference on Computer supported cooperative work* (CSCW '10). ACM, New York, NY, USA, 135-144.
9. Min Kyung Lee and Leila Takayama. 2011. "Now, i have a body": uses and social norms for mobile remote presence in the workplace. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '11). ACM, New York, NY, USA, 33-42.
10. Carman Neustaedter, Kathryn Elliot, and Saul Greenberg. 2006. Interpersonal awareness in the domestic realm. In Proceedings of the 18th Australia conference on Computer-Human Interaction: Design: Activities, Artefacts and Environments (OZCHI '06), Jesper Kjeldskov and Jeni Paay (Eds.). ACM, New York, NY, USA, 15-22.
11. Carman Neustaedter and Saul Greenberg. 2012. Intimacy in long-distance relationships over video chat. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '12). ACM, New York, NY, USA, 753-762.
12. Carman Neustaedter, Carolyn Pang, Azadeh Forghani, Erick Oduor, Serena Hillman, Tejinder K. Judge, Michael Massimi, and Saul Greenberg. 2015. Sharing Domestic Life through Long-Term Video Connections. *ACM Trans. Comput.-Hum. Interact.* 22, 1, Article 3 (February 2015), 29 pages.
13. Carman Neustaedter, Gina Venolia, Jason Procyk, and Daniel Hawkins. 2016. To Beam or Not to Beam: A Study of Remote Telepresence Attendance at an Academic Conference. In Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing (CSCW '16). ACM, New York, NY, USA, 418-431.
14. Irene Rae, Bilge Mutlu, and Leila Takayama. 2014. Bodies in motion: mobility, presence, and task awareness in telepresence. In *Proceedings of the 32nd annual ACM conference on Human factors in computing systems* (CHI '14). ACM, New York, NY, USA, 2153-2162.
15. Svetlana Yarosh, Anthony Tang, Sanika Mokashi, and Gregory D. Abowd. 2013. "almost touching": parent-child remote communication using the sharetable system. In *Proceedings of the 2013 conference on Computer supported cooperative work* (CSCW '13). ACM, New York, NY, USA, 181-192.