Understanding Everyday Mobile Robotic Telepresence

Exploring Interactions with Incidentally Co-present Persons

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ABSTRACT

Mobile Robotic Telepresence (MRP) can be used to interact and work remotely while potentially providing a greater sense of presence, and their mobility allows for a greater range of uses compared to traditional videoconferencing. Most uses of telepresence are in public places, such as schools, hospitals, museums, conferences and other workplaces. As such, MRPs are likely to be in the same space as incidentally co-present persons. In order for them to be more widely adopted and effectively used, it is important that those persons are comfortable around the MRP, and able to understand their capabilities and how interact with them. Social etiquette may be a problem, e.g., it may be important that people acknowledge the MRP's pilot as a person rather than treating it as a machine. People should also understand the mobility limitations of the MRP (e.g. opening doors) and be willing to help when needed. However, research on MRPs interaction with bystanders is lacking. Drawing from past work on bystanders, our position is that they should be included in the definition of users for MRPs and be given the appropriate amount of attention in research. We propose that this topic should be initially studied through ethnographic research complemented with semi-structured interviews, looking at bystanders' experiences with MRP systems in real world situations.

CCS CONCEPTS

• Human-centred computing • Human computer interaction (HCI) • Empirical studies in HCI

KEYWORDS

presence, public spaces, bystanders, ethnography, videoconferencing

1 Introduction

In the imaginary of technologists, telepresence robots—or Mobile Robotic Telepresence (MRP) systems—offer solutions to better support richer and more collaborative remote working, particularly for activities that require increased mobility. They can offer increased accessibility (e.g., for people with mobility difficulties). They can also be seen as a potential inevitability of significantly reduced travel in an era of climate change.

Broadly speaking, MRP systems consist of a video conferencing system mounted on a remotely controlled mobile robotic base. A *pilot user* controls the robot through a computer or smartphone interface, so that they can interact with the *local users*, who are located in the same place as the MRP. One of the main unique selling points of MRPs is that it is argued they provide a greater sense of presence than traditional video conferencing, due to the physical embodied presence of the robot and the affordance of certain of non-verbal communication cues [13].

In spite of their significance in all these regards, there have been few investigations into what *everyday life* might concretely look like for those both using and living alongside such systems. Critically, we need to know more about how MRPs will come to be embedded into everyday social interactions across a range of familiar contexts. This matters because, in many cases, MRPs are already being used in places that are public or quasi-public, such as schools, hospitals, museums, conferences and office spaces. For instance, MRPs have been used to teach students in remote areas [12], let doctors to check on patients after surgery [4] and allow people to visit museums, conferences and their office remotely [1, 3, 14, 21].

Given this, MRPs are highly likely to come in contact with incidentally co-present persons (InCoPs)[1]. What's distinct about MRPs is that from the perspective of a bystander they might look like a social robot or other electronic equipment. However, an MRP is more accurately conceived of as the robotic extension of a real person. It's been already noted in [10] that local users are at times confused about whether to treat an MRP as a person or as an object, for example with regards to touching and personal space. Because of such issues around social norms and etiquette, it is worth exploring how InCoPs make sense of MRPs and what factors shape any potential interactions that might arise. It is also worth noting that MRPs are limited in their movement and they might get stuck if they lose internet connection; in those cases, they rely on the help of local persons. For the successful adoption of MRPs more widely, it is important that everyone in a public space feels comfortable around them, understand what they are and are happy to interact with them and help them if needed. This paper discusses existing work related to MRP interactions with bystanders, highlighting that there is a lack of insights into how interactions are achieved and how social norms around them emerge, and arguing that there is a need for exploratory ethnographic work to better understand the nuances of those interactions.

[1]Although InCoPs is arguably a more precise term, we here follow the convention as in much of the literature and use the term *bystander* synonymously with InCoP.

In this paper we explore the existing literature on Mobile Robotic Telepresence (MRP) systems and outline a programme of work that will attempt to unpack the nature of everyday life with and around MRPs, in order to drive better understanding of their design.

2. Research Challenges

This section reviews relevant work to draw out potential problems and challenges around bystanders to inform our research. We discuss the theoretical background for bystander interactions, a framework for understanding MRPs and empirical studies which have explored bystander interactions with MRPs or comparable technologies. Finally, we pull together the potential problems and challenges for our future research.

2.1 Theoretical background

Since little has been discussed regarding bystanders in telepresence, we draw from the HCI literature more generally as we begin to explore the topic. We take the stance that interactions are socially situated, as argued in [19], meaning that they take place among other people and should be observed and understood in the context within which they occur. We follow Goffman's conception of participation roles, as a nonexclusive list that dynamically changes during an interaction [18]. The list can include ratified or unratified participants as well as unaddressed persons and bystanders [18]. As highlighted by Reeves in [16], a bystander is an *unwitting spectator*, existing outside of the frame of the interaction but still implicated in what is taking place within it. In addition, as argued by Krummheuer in [9], a user can have different levels of background knowledge ranging from expert, novice, developer to tester or maintenance staff. As such, we can adopt a more liberal view of who should be considered as a "user" when observing an interaction in public, that takes into account InCoPs.

With regards to evaluating bystander interaction, Scholtz and Bahrami in [17] argue that we should not be looking at ability to complete a task, but rather, at ability to acquire an accurate mental model of the technology is and what it can do. Indeed, for a smooth interaction with MRPs, it is perhaps ideal that all users (including InCoPs) have a clear idea of what the MRP is can what it can do (therefore a good mental model of it). Most importantly perhaps, they should be able to tell that it is the extension of a real person, so that they treat it with appropriate respect. They should also be able to understand that it cannot go up the stairs or open doors and that it might lose Wi-Fi connection, so that they can help it if needed. In addition, they should understand that the pilot user isn't entirely responsible for certain disruptive behaviours, such as being accidently too loud, so as not to assign undue blame and give rise to unpleasant interactions. To evaluate bystander interaction, Scholtz and Bahrami propose looking at the predictability of behaviour (the match between the bystanders mental model of behaviour and actual behaviour), capability awareness (the match between mental model of functions and actual functions), interaction awareness (the match between mental model of possible interactions and actual interactions) and user satisfaction [17].

2.2 Framework

Rae et al. [14], devised a thorough framework for understanding telepresence, which provides a clear structure for approaching the topic and highlights the role of bystanders. Through an iterative process of literature review, interviews and testing, looking at a wide range of uses, they arrived at seven design dimensions: 1. Initiation, 2. Physical Environment, 3. Mobility , 4. Vision, 5. Social environment, 6. Communication, 7. Independence. We are particularly interested in the initiation and social environment dimensions.

The initiation dimension is concerned with factors relating to how interactions begin. This can be explored from the perspective of caller hegemony, drawing from literature on cell phones. With regards to MRP we see more spontaneous and informal interactions, more comparable to meeting a colleague in the hallway than answering the phone [8, 10]. This also raises questions about appropriate etiquette so as not to invade one's privacy.

The social environment dimension explores how interactions are achieved. The authors here identify six types of relevant stakeholders. These are; the remote (or pilot) and local *users*, who are the main actors of the interaction, the remote and local *party members*, who are peripherally involved in the interaction and the remote and local *bystanders*, who are not part of the interaction but are in the same space as the interaction. Most research on telepresence focuses on remote and local users and little attention has been paid so far to party members and bystanders and how they interact with the MRP. Also, to our knowledge research into how the users switch across these roles during an interaction is lacking. According to their definition, the term *bystanders* describes people who would also be characterized as InCoPs, as it refers to people who are in the same space as the robot but not part of the interaction. As such we consider the terms bystanders and InCoPs equivalent. In social psychology, the term bystander can also refer specifically to people watching an incident, but this is not the definition we are adopting in this paper [3].

It is worth noting that the dimensions are interdependent and should not be viewed in isolation. For example, the quality of vision can influence whether the pilot notices bystanders, and the physical environment.

2.3 Empirical Studies

While many studies have observed the use of telepresence in public, few have addressed interactions with bystanders or InCops and the insights are limited.

In [6] pairs consisting of one local user and one remote user were asked to play a game of geocaching (treasure hunting) in a public park. When asked if they had any concerns about using an MRP in public the remote participants mostly reported that they did not really notice other people as they were simply following their partner and focusing on the task. However, some also noted feeling uncomfortable with the attention of local bystanders, or wishing they had the ability to whisper to their partner and have private conversations. Some also found themselves to be accidently staring at local bystanders due to the configuration of camera and position the MRP. While these findings address how the pilot felt towards bystanders, and highlight some problems in bystander interaction, the research did not ask bystanders about their experience.

The environment, in which the interaction occurs seems to also shape the users' behaviour, as suggested by Neustaeder et al., who compared observations of telepresence use across three different conferences in [11]. They found that there were more issues in bystander interaction at the larger conference (CHI) compared to the two smaller ones (Ubicomp/ISWC, CSCW). In all cases remote participants found it difficult to enter conversations with local attendees. They reported wanting to express their identity by personalising their robot, and wished for better sound feedback, spatial awareness and peripheral vision, so as to make interacting and social mingling easier. However, at the larger conference, local attendees exhibited rude behaviours towards the robots, such as pointing, laughing and stepping on the base of the MRPs to prevent them from moving. In other cases, local participants threatened the MRP when they thought that there was no one online at that time (in fact, the pilot user had just covered their camera). In the second case, the issue can be explained in part from a flawed mental model of the MRPs functionalities, as the local users did not understand that someone could be listening to them via the MRP even if their face is not visible on screen. However, the general rude behaviour cannot be explained as a mismatch in mental models, as the local users knew that the MRPs were in fact a real people and not social robots. Other potential causes might be difficulty in empathising through an MRP, novelty effects or out-group bias, amplified by the size of the conference. Certainly, more studies are needed to understand this phenomenon. The study also brings up the issue of people using the MRPs in ways that the local bystanders might not expect, and ways not made obvious by the MRPs appearance. For instance, some MRPs were used by two people simultaneously, and one MRP was used by a professor and his entire class of students who were watching behind him. Although a questionnaire was given to attendees, more in-depth interviews could have uncovered more about their experience of interacting with the MRPs.

While not explicitly about bystander interactions, Lee and Takayama have pointed out that MRPs disrupt certain social norms and new ones are seen to emerge [10]. From observing the use of MRPs in office spaces and conducting surveys on both local and remote users, they found that that pilots showed more autonomy in initiating interactions and that most of interactions were impromptu and informal. They also observed many cases were local users' approach towards the MRP varied in terms of whether they treated the MRP as a person or as an object. For instance, local users would switch between using the pilot's name or refer to the MRP as "robot" or "it". One example was the negotiations of personal space, where some users felt the need to make as much room for the MRP as they would for a person while others did not. They also pointed out, that a person in the place of the robot would make space themselves if they saw a college approaching or trying to squeeze by. Other examples included changing the MRPs volume without permission or touching and moving it when it blocked the view. They also found issues with leaving an interaction, where some pilots would log off at the end of a meeting, similar to using a phone, leaving the local users to put the robot away.

Still we could not say that all the interactions which seem to treat the MRP as more of an object are undesirable, nor can we expect to MRP interaction to perfectly mimic face-to-face interaction. Indeed, [10] reports that new norms were observed to emerge that blurred the distinction between person and object. For instance, pilots would actively ask local users to grab them and transport them when they were late to a meeting.

Given that these behaviours are related to the user's mental models of what and MRP is and how it should be used, we can see that mental models of MRPs seem to vary across people and situations.

Another important insight form [10] is that when the MRP produced disruptive behaviour, such as being too loud or blocking the view, local users tend to perceive the pilot user more negatively. This has also been found in [22]. However, it is often the lack of sufficient noise and space awareness that causes those issues rather than the pilots being themselves rude [10, 11].

Finally, the topic of privacy has also been brought up with regards to bystander interactions. For instance, [2] found that bystanders were concerned about being recorded by lifelogging cameras. This can also be applied to MRPs as they also have a camera, which might make bystanders think that are being recorded. In another study on public interactive displays, the authors suggest that the potential for embarrassment of being publicly seen to use something incorrectly might also be a deterrent of use [20]. These are two facets of privacy that are worth considering in bystander interaction in telepresence as well as openly exploring other potential privacy-related issues.

2.4 Summary of Findings

To structure our exploration of MRP interactions in public going forward, we have grouped the research problems and challenges identified from the review of the literature above into the following categories: mental models, social norms, technical features and privacy in public (see Table 1).

Mental Models	MRP mental model acquisition [17]
	Perceiving MRPs as people and as objects [10]
	Understanding MRPs affordances [17]
	Understanding MRPs limitations [10, 17]
	Understanding when and MRPs behaviour is caused by its limitations [10, 7]
Social Norms	Emergence of social norms in MRP interactions [10]
	Negotiating when to treat an MRP as a person and when as an object [10]
	How are interactions initiated? [14, 15]
	How is the end of an interaction achieved? [10, 15]
	What causes rude behaviour towards MRPs? [14]
	How does the physical environment affect social norms? [14, 15]
Technical Features	How do limitations around sound and space feedback shape interactions? [10, 14]
	How does peripheral vision impact bystander interactions? [14, 15]
	How does the physical configuration of the MRP shape interactions? [6, 15]
Privacy in Public	Bystanders concern about being recorded [2, 20]
	Pilot users need for privacy [6]
	How does the MRPs salience affect interactions? [6, 14]

Table 1: Summary of issues observed in MRP interactions with bystanders

3. Proposed Research

Very little has been explored so far in terms of how bystanders or InCoPs understand and interact with mobile remote telepresence robots. A first step towards that would be to include those persons within the definition of users, as proposed by Goffman, and actively seek to understand interactions from their perspective as well [18].

As we the literature suggests, a lot is still unclear about how users make sense of MRPs, and how they negotiate the appropriate etiquette. It seems, in fact, that mental models and desired behaviours with regards to the person or object nature of the MRP change dynamically and depend on the circumstances. For example, a pilot user might find being grabbed and moved by local users rude during a conference but might welcome it when they are rushing to a meeting. For that reason, we seek to understand MRP interactions as situational accomplishments.

We propose to conduct a baseline ethnographic research, complemented by semi-structured interviews. Given the early stage of research on this topic, the study would be approached without any pre-determined theories, and the aim would be to understand how interactions are achieved. We believe it is best to conduct observations in real world settings, so as to capture naturally occurring interactions. Furthermore, it is worth observing the prolonged use of telepresence, in order to understand the processes with which all users familiarize themselves with the technology and so as to observe interaction after novelty effects have been eliminated. We plan to conduct our study using the MRP Double 3, by Double robotics. We will begin with an autoethnographic phase in which we familiarise ourselves with the experience of interacting via the MRP with bystanders in public locations, such as the university building and campus grounds. Next we will recruit other participants to do the same. We will be collecting video data both from the perspective of the pilot user as well as from a third person perspective, which will be studied with interaction analysis. In addition, semi-structured interviews with remote users as well as local users will be carried out to support the observational data and give us more in-depth understanding of people's feeling about how they treated or were treated by their interaction partners.

The contribution of this line of research, beyond adding to our understanding of bystander interactions, would also be to provide design recommendations as well as suggestions for a more effective use of MRPs.

ACKNOWLEDGMENTS

This research is supported by a CASE studentship funded by the Engineering and Physical Sciences Research Council [voucher 18000109] and Microsoft Research Cambridge.

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