

# Mobile Robotic Telepresence: A New Social Hierarchy?

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**Abstract**—In the past decade, Mobile Robotic Telepresence (MRP) systems have gained popularity as a tool to enable remote social interactions. However, there is limited work on the social norms that govern the novel human-MRP interactions introduced by these systems. For instance, is it possible that the users piloting MRPs from a remote location and individuals co-located with the MRPs have different expectations about how the other should behave? In this paper, we propose a study to determine if there is a difference in the social hierarchy expected by MRP pilots and co-located users, and to investigate what factors impact this expected social hierarchy.

## I. INTRODUCTION

MRP systems—devices typically characterized by a video conference system mounted on a mobile robotic base [1]—have been adopted and studied in an increasing number of application contexts this past decade (e.g., office, education, elderly care, long-distance relationship, and academic conference settings [2]–[6]). Most of the work investigating the use of MRPs have explored the new types of communication MRPs *enable*, rather than the social interaction norms MRPs *change*.

One of the few studies exploring the latter is Lee and Takayama [2]. In this paper, the authors conducted interviews, field work, and surveys of people in three companies where MRPs had been used for over two months. They found preliminary evidence that the use of MRPs changes what *remote pilots* (those who control the MRP) and *local users* (those who interact locally with the MRP) deem to be socially-acceptable behaviour. However, it is still unclear whether the remote pilot and local user always agree on what these new social norms should be. Our proposed work builds on [2] to conduct an empirical investigation on this topic.

As MRPs are more widely adopted, MRP designers and individuals looking to use MRPs in their organizations will need to address the potential social norm conflicts between pilots and local users. Do the social hierarchies pilots and local users expect the robot to follow differ during human-MRP interactions, and if so, what factors influence these hierarchies? We propose to empirically investigate these social norm expectations; the results of such a study may guide future MRP designs, future decisions to adopt MRPs, and future research.

## II. BACKGROUND

The need to study the social hierarchy introduced by novel technologies such as MRPs was first discussed by Paulos

and Canny [7]. A decade later, the aforementioned work by Lee and Takayama suggests that, during human-MRP interactions, MRPs may occupy a different part of the social hierarchy than both humans and non-teleoperated machines [2]. However, across the different Human-robot Interactions (HRI) in [2], a consistent pattern in the reported social norms was not found: Local users do not always treat MRPs with the same norms as they would a co-located human (e.g., some local users felt obliged to help the MRP move around the office), but they do not always treat the systems like any other communication device either (e.g., some local users considered it rude to shut off the MRP without asking the pilot first).

The above findings suggest that the expected social hierarchy between MRPs and local users may depend on the specific HRI setting and environment (*Context*). MRPs are currently being adopted in a plethora of settings, with the goal of making such settings more accessible [2]–[6]. Determining how the social norms that govern MRP use vary across different settings and environments may motivate future research on how MRPs can be designed to be Context-specific, and guide organizations in determining if MRPs are the right choice for their specific application.

In addition to the influence of *Context* on expected social norms, Lee and Takayama point out the following two factors that significantly influence a user’s perception of what is considered rude or polite treatment of an MRP: (i) whether the participant referred to the MRP as a “robot” or a “person”; and (ii) whether the participant was a remote pilot or a local user.

The first factor suggests that the norms local users anticipate in their interaction with an MRP depend on their perception of the MRP’s autonomy (*Perceived Autonomy*)—as an autonomous robot or an embodiment of the pilot. Booth et al.’s study on user overtrust in robots supports the idea that a user’s perception of a robot’s autonomy impacts social interactions: They report that whether or not participants communicated with a robot (Turtlebot) depended on the participants’ belief that the robot was autonomous vs. teleoperated [8]. Clarifying how the *Perceived Autonomy* of an MRP influences a local user’s anticipated norms may motivate more research on how MRPs can communicate a pilot’s presence (such as [9]), and guide designers to build MRPs with pilot presence in mind.

The second factor implies that the expected social hierarchy between an MRP and those interacting with it depends on who you ask: the pilot or the local user (*User Type*). Takayama argues that the difference in user experience between a remote pilot and a local user may be so great that

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we need separate theories to predict peoples' perceptions of the MRP's agency [10]. In another study of MRPs in office settings, Takayama and Go observe numerous instances of remote pilots and local users employing different metaphors to describe the same MRP, such as remote pilots using human metaphors (e.g., person with disabilities) and local users using nonhuman metaphors (e.g., Skype on wheels) [11]. They note that "mixing metaphors can be quite harmful to interpersonal interactions in the office" [11, p. 501]. Yang et al. similarly find in a study on the use of MRPs in a shopping trip between long-distance couples that remote pilots attributed higher levels of agency to the MRP than local users [5]. This influenced how the parties interacted socially, and whether the local users treated the MRPs as competent adults. The different ways in which pilots and local users order humans and MRPs on the social hierarchy is valuable information for organizations considering MRPs for their remote workers.

Building on the previous work, we propose to explore the relationship between expected social hierarchy of MRPs across the factors *Context*, *Perceived Autonomy*, and *User Type*. We hypothesize the following:

**H1.** The more the local user perceives the MRP to be an embodiment of the pilot, the higher the local user will rank the MRP on the social hierarchy.

**H2.** Remote pilots expect MRPs to be treated with a higher social hierarchy than those expected by local users.

**H3.** The expected social hierarchy between an MRP and those who interact with the robot varies across different settings.

### III. METHOD

#### A. Experiment Design

We propose a 2 (*User Type*: pilot vs. local user)  $\times$  4 (*Context*)  $\times$  2 (MRP display: human face vs. blank screen)  $\times$  2 (Scenario outcome: MRP given right-of-way vs. local user given right-of-way) between-within multi-factor experiment study to empirically investigate if a social hierarchy ordering appears across various human-MRP interactions. In this online experiment, we plan to design and implement video simulations of various HRI (*Contexts*) where a human and an MRP's needs conflict and the social priority ordering is ambiguous. One such *Context* involves a local user and an MRP running into each other while lining up at a store: Would the local user expect to be given right-of-way, or would they allow the MRP to line up first? What does the MRP pilot expect?

Participants will first be split into two groups according to *User Type* (pilots and local users). After answering a demographic questionnaire and reading an introductory excerpt about MRPs, participants will watch a random selection of simulated human-MRP interactions, recorded from the first-person perspective of their assigned *User Type*. Each simulation will be of a different *Context*, and will have

accompanying text that introduces the participant to the setting.

For each *User Type* of each *Context*, we will vary two factors: the MRP's display and the outcome of the scenario. We will vary the simulated MRP's display to either contain the face of a human pilot or a blank screen; this will manipulate the user's *Perceived Autonomy*. Secondly, we will vary whether the end of the simulated scenarios show the MRP or the local user receiving right-of-way.

#### B. Measures and Expected Results

To observe the social hierarchy pilots and local users expect across the independent variables, we will measure the acceptability of the HRI scenario outcomes and the perceived autonomy of the MRP. These measures will be collected in the form of an online questionnaire accompanying each recorded simulation, using acceptability and *Perceived Autonomy* scales that will be validated through a pilot study.

The difference in reported acceptability between the two scenario outcomes of each *Context* will indicate the relative social hierarchy ordering between MRPs and humans. We will conduct statistical analysis on this difference with respect to our experiment factors. We expect to find a significant relationship between the difference in acceptability scores and the *Perceived Autonomy* of the MRP (H1) and also between the difference in acceptability scores and the *User Type* of the participant (H2). We expect to find an effect of varying *Context* on the measures as well (H3).

### IV. CONCLUSIONS

Despite the growing popularity of MRPs in various social settings, there is limited work on the social norms that govern human-MRP interactions. Potential conflict between the expected social norms of MRP pilots and local users presents a challenge for both MRP designers and organizations looking to adopt MRPs. Our proposed study contributes to the design and deployment of MRPs through an empirical investigation of the social hierarchy pilots and local users expect and the factors that influence the expected hierarchy.

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