



A Telepresence Robot for the Social Integration of Older Adults: Exploring Human-Robot Gesture Interaction and Voice Commands

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Abstract. Background: The successful implementation of innovative communication technologies can contribute to the social integration and general well-being of older adults. As part of the CO-HUMANICS (Co-Presence of Humans and Interactive Companions for Seniors) project, a telepresence robot designed to help older adults to stay socially connected will be developed.

Aim: Following a human-centered approach, this study aims to explore older adults' preferences for the use of human-robot gestures and voice commands to enhance robot-mediated communication via a telepresence robot.

Methods: Two participatory design workshops were conducted in August 2024 with a total of $N = 13$ older adults (68–76 years old, $M_{age} = 72.46$, $SD_{age} = 2.73$, 54% women). Participants were active senior citizens without cognitive or mobility impairments, all of them living in Germany.

Results: Older adults discussed simple human-robot gestures and short voice commands that could enhance robot-mediated communication. Their application was considered especially useful during the following stages of human-robot interaction: (1) raising the attention of the robot, (2) moving closer to the robot, (3) initiating communication with a remotely located partner, (4) showing/pointing objects, (5) optimizing the location of the robot/direction of camera. Participants proposed gestures such as hand waving (wake-up signal for the robot) and pointing at objects with a finger and a raised arm and suggested simple voice commands such as “move forward”, “move backward”, and “stop”. Additionally, older adults showed a preference for using gestures and voice commands separately and simultaneously: “(I would say) ‘Robbie please show the pictures that are hanging on the wall’ and would accompany that with a gesture so that the robot knows where to look” (female participant, 72 years old).

Conclusions: The implementation of human-robot gestures and voice commands could have a positive impact on older adults' experience with robot-mediated communication. Recommendations for the future design of telepresence robots for older adults are made.

Keywords: robot-mediated communication · aging · participatory design

1 Introduction

Older adults will be 22% of the population by 2050 [1]. With age come several physical, psychological, and social conditions such as reduced mobility, cognitive decline, social role changes, new living arrangements, etc. [2, 3]. These age-related conditions can reduce older adults' interaction with their social networks which in turn can lead to loneliness and social isolation [4, 5]. The prevalence of social isolation in old age is currently considered a public health concern due to its relation to adverse outcomes affecting older adults' quality of life, general health and cognition, and mortality [6–9]. Several solutions that can support the social integration of older adults (i.e. the degree to which they are involved with their social environment at different levels, including community, individual network of social ties, and intimate relationships [10]) are being explored, including innovative communication technologies.

Among the most researched technologies in the context of old age are telepresence robots [11]. Telepresence robots allow interpersonal communication over distance. They consist of a remotely controllable mobile platform, with video conferencing equipment which allows remote users to move around a local environment (via PC, tablet, etc.) and have social interaction with local users (i.e. those sharing the physical space with the robot [12]). It has been shown that telepresence robots can increase social interaction, impact general well-being, and reduce loneliness and social isolation [12–15]. Previous research on the use of telepresence robots by older adults demonstrates that they can contribute to their social integration, especially in maintaining their social contacts [16–18].

However, technology acceptance among older people still remains a challenge [19, 20]. To improve the acceptance of telepresence robots among the aging population, a human-centered approach to technology development is being used. By including older adults in the creative and evaluation stages, researchers and developers ensure that their desires, preferences, and limitations are being considered [21, 22]. Among the preferences voiced by older adults is the desire to be more than passive users when interacting locally with a telepresence robot. Although telepresence robots are mostly controlled by the remote user, older people would like the ability to control some of the robot's functions [23]. The recognition of voice commands [24] and human-robot gestures [25] are two robotic capabilities that have been studied in the context of telepresence robots and could fulfill older adults' desire to be active local users.

In order to explore older adults' preferences and ideas on the use of human-robot gestures and voice commands during robot-mediated communication, the present study aims at answering the following research questions (RQ):

RQ1: How can human-robot gestures improve robot-mediated communication via a telepresence robot for the social integration of older adults?

RQ2: How can voice commands improve robot-mediated communication via a telepresence robot for the social integration of older adults?

2 Methods

Two design workshops were conducted in August 2024 with a total of $N = 13$ older adults (68–76 years old, $M_{\text{age}} = 72.46$, $SD_{\text{age}} = 2.73$, 54% women). Group 1 consisted of six older adults and group 2 of seven older adults. The sample size was based on similar

previous research [11, 22]. Participants were active senior citizens without cognitive or mobility impairments, all of them living in Germany.

The workshops were conducted in person by a team of three researchers, in a university setting, and the average duration was of 76 min.

The methodology for this study was based on research by Neuhaus et al. [26], which describes a co-design process with potential users for the development of new ideas for social robots. Neuhaus et al. [26] propose combining potential users' insights with the concept of "robotic superpowers" (strengths arising from the fact that robots are not humans but machines that are not limited by biological constraints).

As an introduction, participants were given a short explanation of the workshop's objectives and procedure. All participants read and signed consent forms which included details on anonymization and data protection. Subsequently, older adults were shown images of a telepresence robot, and their functions and capabilities were described. Additionally, they engaged in an initial "ice breaking" activity in which they got acquainted with each other (see Fig. 1).



Fig. 1. Participants engaging in "ice breaking" activity before the workshop (photo copyright: the authors).

The 3-step procedure proposed by Neuhaus et al. [26] was followed during the workshops. In the first step, participants were asked to describe their current practices when communicating with others. These practices included face-to-face communication as well as mediated communication (via smartphone, computer, etc.).

The second step consisted in exploring how human-robot gestures and voice commands could enhance older adults' experience during robot-mediated communication in different scenarios (starting communication with a remotely located family member, holding a conversation, showing objects around the house, etc.). During this step, bodystorming – a concept proposed by Burns et al. [27] in which one of the researchers "embodies" the robot – was used to help illustrate the scenarios for older adults (see Fig. 2).



Fig. 2. Body storming methodology, in which a researcher embodies the telepresence robot (on the far right of the photo), used during the workshops (photo copyright: the authors).

During the third step, the insights from participants' current practices (step 1) and the proposed robotic features (step 2) were combined and summarized.

Throughout the workshops, participants wrote down their ideas (see Fig. 3) and then took turns discussing them with the group and the researchers. The workshops were audio and video recorded, transcribed, and anonymized. Several rounds of thematic coding and qualitative analysis of the transcripts were done with the software MAXQDA.

The study was granted approval by the ethics committee of Technische Universität Ilmenau, Germany, on July 9, 2024.

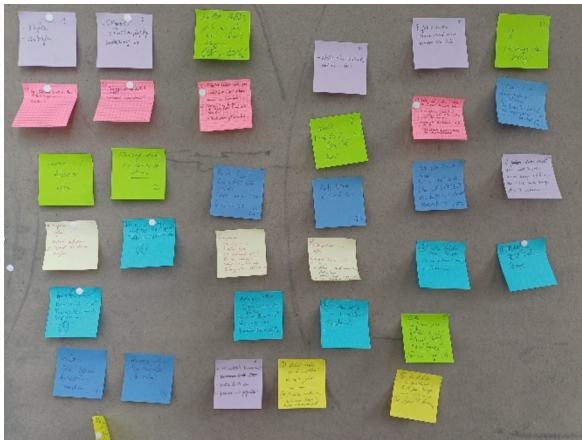


Fig. 3. Collection of ideas for human-robot gestures and voice commands contributed by workshop participants (photo copyright: the authors).

3 Results

Participants considered that using human-robot gestures (RQ1) and voice commands (RQ2) would improve robot-mediated communication via a telepresence robot.

Older adults described specific interaction stages in which their usage would be beneficial: (1) raising the attention of the telepresence robot, (2) moving closer to the telepresence robot, (3) initiating communication with a remotely located partner, (4) showing/pointing objects, (5) optimizing the location of the telepresence robot/direction of the camera.

To *raise the attention of the telepresence robot*, participants favored the use of voice commands over human-robot gestures. Given that the robot could be located far away from the user (even in a separate room), older adults wished they could “wake up” the robot verbally. Additionally, having the option of naming the robot and using its name when giving voice commands was desired: “*He should certainly have a name. Either he already has a predetermined one or you name him yourself. I would say: ‘Hello Robbie!’ to wake him up. Then he would be in standby mode*” (female participant, 71 years old).

When discussing how to *move closer to the telepresence robot* previous to starting robot-mediated communication, some older adults proposed going themselves to the robot’s location. However, most participants wished the robot would approach them while they guide it with voice commands: “*You address it with the name, [say] ‘please come to me’. It should also react to commands such as ‘stop’ or ‘continue’*” (female participant, 74 years old). Additionally, older adults expressed a desire for preset distances that could be recognized by the robot depending on the assigned task. For example, when the user gives a voice command to establish a connection with a remote partner: “*[The telepresence robot] should be at the right distance so that I can see the camera and they [the partner] can see me. I don’t want to give extra instructions about how close [the robot should be]*” (female participant, 71 years old).

Initiating communication with a remotely located partner was one of the most discussed communication stages. According to older adults, the telepresence robot should have access to all their contacts and be able to establish a connection with any of them via voice command. Additionally, they should have the option to select between different connection types (voice only, videoconference, etc.): “*You could give a keyword, i.e. either say ‘call’ [...] or you say, ‘video conference’*” (female participant, 72 years old). On the other hand, participants suggested that the remote partner should also have options before establishing communication: they should be able to accept the connection, reject the connection, indicate they will call back, indicate a time when they will be available to establish a connection, and indicate if they prefer voice only call or video call, among others.

When it comes to *showing/pointing objects* during robot-mediated communication, older adults proposed the combined use of voice commands and human-robot gestures. Participants said they would like to wave to the robot to indicate it should move closer to them and to extend their arm and show the robot their open palm as a “stop” sign. They also suggested pointing with their extended arm and finger at an object so that the robot could direct the camera to focus on said object. According to participants, this would be useful to show specific objects or locations to the remote partner: “*[I would say] ‘Robbie*

please show the pictures that are hanging on the wall' and would accompany that with a gesture so that the robot knows where to look" (female participant, 72 years old).

When discussing voice commands to show or point objects, older adults expected the telepresence robot to be able to recognize specific items. In this way, users would only need to give short commands referencing said items: *"I would say '[robot], please show me what's on the chair'. I would show it the direction of the chair and [it] should actually know what a chair is"* (female participant, 71 years old).

To *optimize the location of the telepresence robot or the direction of the camera* participants again suggested a combination of human-robot gestures and voice commands. Older adults agreed that the most useful instructions for the robot would be short commands such as "move forward", "move backward", "stop", etc. Simple instructions for directing the camera were also proposed: "move up", "move down", "move left", "move right", "zoom in", "zoom out". Additionally, older adults expressed their desire to control other functions with easy gestures or voice commands: *"[I would say] during the conversation, 'would you turn the volume up a bit?'"* (male participant, 76 years old).

In general, participants mentioned that it should be possible to use human-robot gestures accompanied with voice commands when needed: *"I agree that verbal and gesture control [of the robot] makes it easier"* (female participant, 69 years old).

4 Discussion

Participants considered that using human-robot gestures and voice commands would improve their experience with robot-mediated communication. Simple gestures and short voice commands were considered intuitive by older adults and adequate functions to facilitate robot control. These results are in line with previous research in which human-robot gesture recognition has proven to enhance older adults' interaction with a robot [28] and voice command recognition has been one of the top suggestions across stakeholders (older adults, family caregivers, and clinicians) when discussing robots for older adults [29].

To raise the attention of the telepresence robot previous to connecting with a remote partner, older adults expressed their desire to use voice commands. According to participants, a simple "call out" to the robot would be effective even when it is located far away from them. After the robot has been activated, older adults considered voice commands could also help them achieve the optimal distance between them and the robot in preparation for engaging in robot-mediated communication. A short instruction such as "come here" should set up the robot at an optimal location for receiving further instructions. When initiating communication with a remotely located partner, older adults considered using voice commands would simplify establishing a connection. According to participants, with commands such as "call [name]" or "start a videocall with [name]" the telepresence robot should be able to sort through the user's contact list and start the appropriate connection. These results support previous research indicating that older adults show a preference to give robots simple, imperative statements as voice commands [30]. For showing and pointing objects to the remote user as well as to optimize the location of the robot or direction of the camera, older adults would like to give simple verbal instructions and complement them with hand or arm gestures for clarification. Additionally, the ability to switch between gestures and voice commands easily was also

desired. As it has been concluded by Tsui et al. [30] the flexibility of adapting the control options depending on situational contexts (for example, human-robot gestures would be preferred in noisy environments and voice commands would be optimal when the user has movement constraints) improves robot-mediated communication for older adults.

Finally, according to participants, using human-robot gestures and voice commands during robot-mediated communication would make it easier for them to control the robot, enhancing their experience. Moreover, giving older adults access to more control options could help alleviate the negative feeling that they are passive users of a telepresence robot [31].

4.1 Limitations

The present study is not without limitations. The sample for the co-design workshops was small and therefore results cannot be generalized to bigger populations or other cultural settings, as the workshop took place in Germany. Participants in this study were familiar with technology and interested in the topic which could have influenced the results. Furthermore, older adults participating in the study had no mental or physical limitations and they were all active and living independently. Including older adults with cognitive or physical impairments could have yielded additional results (such as alternative ways to control the robot) and different human-robot gestures and voice commands.

4.2 Outlook and Recommendations for Future Design

Future studies should focus on the development of specific human-robot gestures and voice commands in collaboration with older adults. It is recommended to include participants with physical and mental limitations in said studies to ensure that their needs and preferences are being considered. After the implementation of gesture and voice recognition functions in telepresence robots, it is advised to conduct evaluation studies including older adults in real-life conditions. Bigger samples for these evaluation studies should be strived for.

Several recommendations for future robot design can be made based on the opinions voiced by participants in the present study. Human-robot gesture and voice command recognition would be well received by older adults. Furthermore, switching between both functions ought to be easy and intuitive for users. The implemented human-robot gestures should be based on participants' currently preferred gestures during communication, to draw on familiarity and to facilitate their use. Additionally, the option of personalizing gestures based on the user's preferences and physical capabilities would be greatly valued by older adults. On the other hand, voice commands consisting of single words or short sentences that are present in participants' everyday vocabulary could facilitate their use. As with gestures, specific voice commands ought to be designed based on older adults' current communication practices and be customizable to each user.

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