Exploring How Telepresence Robot Might Facilitate Communication between Remote Helpers and Older Adults When Learning to Use Physical Devices

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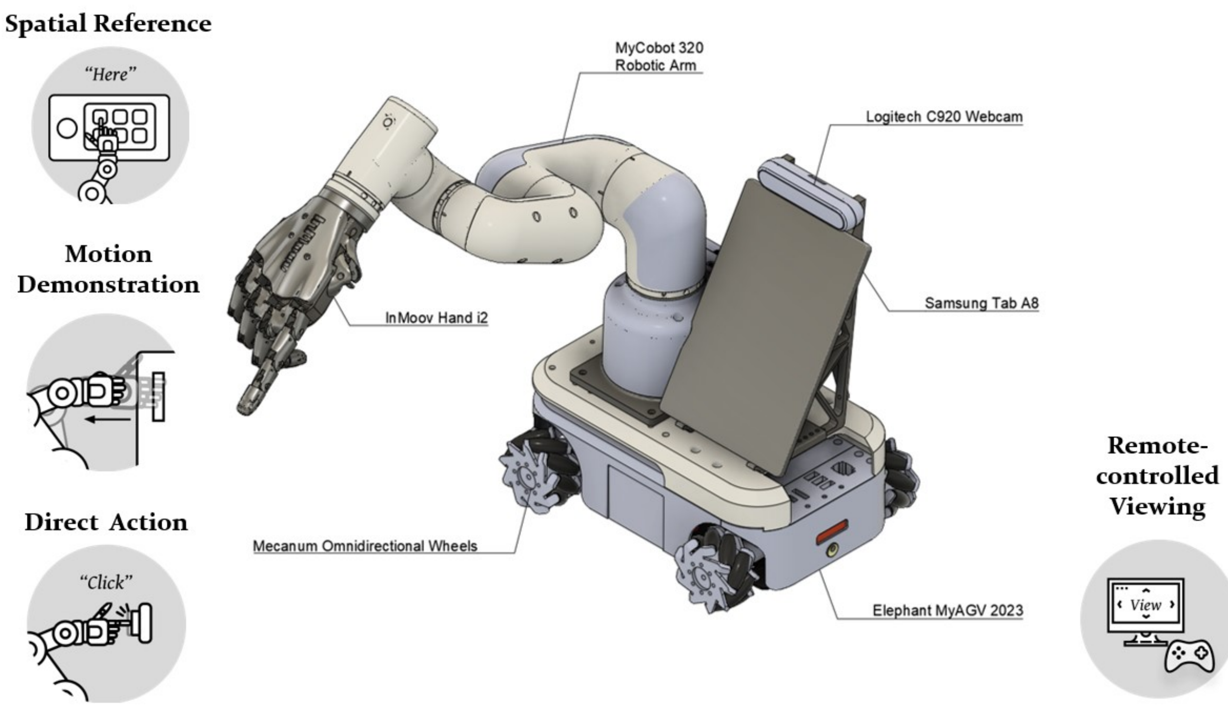

Figure 1: **The overview of the prototype, a telepresence robot augmented with hand gestures. The robot contains a chassis with Mecanum wheels capable of omnidirectional movement. A MyCobot320 robotic arm, a Samsung Tab A8 tablet, and a Logitech C920 camera are installed on top of the chassis. A robotic hand that resembles the shape and size of a real hand is attached at the end of the robotic arm. The system has four main functions: spatial reference, motion demonstration, direct action, and remote-controlled view.**

Abstract

Although remote assistance is a common resource older adults turn to when learning new digital technology, remote helpers face difficulty in assisting older adults in learning new physical devices as they are unable to perform trial-and-error operations or demonstrations remotely. Through a formative study with 8 older adults and 8 younger helpers, we identified key challenges in remote assistance, including poor camera placement, difficulty in communicating motion, and the limitations of remote trial-and-error methods. We designed a telepresence robotic system that augments remote assistance with gesture-based cues to address key limitations of video-call support, and to potentially facilitate in-the-moment learning during device use.

CCS Concepts

• **Human-centered computing → Empirical studies in HCI**; **Collaborative and social computing**; • **Computer systems organization → Robotics**.

Keywords

Older Adults, Robot, Remote Assistance, Learning

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1 INTRODUCTION

An increasing number of older adults are open to adopting new technology and using technology devices widely [2]. Learning new devices is crucial for them to stay connected with their social networks, access essential services, and enhance their perceived quality of life [10, 18]. However, challenges still exist in learning to use new devices due to non-inclusive designs, such as overly complicated user manuals [8] or complex digital displays [7]. As reported, more than 60% of older adults seek technical assistance from others [20]. However, in many regions, intergenerational co-residence rates are declining and family members are geographically dispersed, making *timely and actionable remote support* a practical necessity for technology use and daily activities [13, 21, 25].

For screen-based devices, remote helpers commonly rely on video calls or screen-sharing tools (e.g., Skype, TeamViewer) to provide step-by-step guidance [20]. However, these tools are only applicable to standard screen-based devices like laptops and smartphones and cannot be used for devices that rely on physical interactions, such as smart home appliances like coffee machines or vacuum-cleaning robots. For devices with no screen-sharing capabilities, older adults may turn to video chat apps on smartphones for assistance. However, maintaining a good camera position for the remote viewer while operating the device can be challenging [17]. Additionally, older adults may find it difficult to see demonstrations from the remote helper who has no direct access to the device, making the learning process more challenging.

Telepresence robots have shown potential in addressing the challenge of providing remote assistance across different devices. These robots act as local stand-ins for remote operators, enabling them to navigate local environments and gain various perspectives. Previous research has explored the use of telepresence robots in workplaces, schools, and home settings, highlighting their ability to enhance the sense of presence, which in turn leads to improved communication and task performance [3, 9, 15]. While prior studies in Human-Computer Interaction (HCI) have mainly focused on social interactions using telepresence robots, recent developments in robotics have led to the development of teleoperated humanoid robots [6] equipped with robotic arms capable of complex manipulation tasks and expressive motion. Leveraging this capability may be beneficial for the collaborative learning process between older adults and remote helpers. However, the potential of telepresence robots in providing remote assistance to older adults in physical device learning has not been extensively explored, and little is known about how to design a telepresence robot to facilitate collaborative learning and remote technology adoption among older adults.

Building on prior research, our study investigates how teleoperated robots can facilitate remote helpers in teaching older adults to use new technology devices. Specifically, we sought to answer the following research question (RQ):

RQ: How might a telepresence robot be designed to support older adults learning a new technology device that requires physical operations?

To answer the RQ, we conducted a formative study with older adults and young remote helpers to examine challenges with conventional video calls. We found difficulties in 1) maintaining good camera placement, 2) communicating position and motion, and 3) conducting trial-and-error for the remote helper. In response, we built a telepresence system combining a mobile telepresence robot (for helper-controlled viewpoint) and a stationary robotic arm with a hand end-effector (for spatial referencing and motion demonstration via predefined gestures). We aim to improve the learning outcomes and user experience for both the remote helper and the older adults in the future.

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2 RELATED WORK

2.1 Remote Support for Older Adults' Technology Learning

While in-person presence is highly effective for teaching device use, it is often constrained by the logistical demands of time and travel in an era of geographically dispersed families [13, 21, 25]. Pre-prepared instructional support (manuals, printed/recorded tutorials) can be provided offline [16], yet it is not always timely or adaptable to emergent glitches, and many older adults still prefer to seek assistance from their social networks [20].

Given these practical constraints, remote assistance offers a flexible alternative through various digital tools. For instance, screen-sharing/remote-desktop tools (e.g., TeamViewer/Skype) are effective for screen-based tasks but do not transfer to physical devices. However, they may raise privacy concerns by granting device control [11]. Smartphone video calls are flexible yet fragile: maintaining an informative camera view while operating the device is difficult, and remote helpers cannot easily demonstrate spatial actions, leading to frequent repair turns [17]. Prior work has also explored AR overlays and projected annotations to point, label, or draw on the scene—improving spatial referencing [14]—but AR still cannot *enact* a real 3D action in space, making it hard to convey nuanced manipulation [4, 5]. By contrast, telepresence robots offer embodied presence with helper-controlled viewpoints and non-verbal cues (e.g., indicative/demonstrative motion), which prior work shows can enhance communication and coordination across settings [1, 3, 9, 15]. This makes telepresence a promising way to deliver the convenience of "being there" without imposing the recurring time and travel costs of co-located help.

2.2 Telepresence Robots with Non-verbal Cues

The Human-robot Interaction (HRI) community has extensively explored the use of non-verbal cues to enhance telepresence robots in conversation and meeting scenarios. For instance, Adalgeirsson et al. [1] developed Metbot, which can reflect the motion of the teleoperator, to explore the impact of expressive body condition in remote communication. Similarly, Sirkin et al. [24] examined how consistency in physical and on-screen actions enhances understanding of motion in remote communication scenarios. Otsuka et al. proposed MMspace [19] to evaluate the effect of providing the robot with a sense of eye contact in symmetric group-to-group remote conversation.

Previous work has examined how non-verbal cues function in remote collaboration or assistance scenarios. Sakashita et al. [22] developed an embodied remote presence system aimed at facilitating design tasks that require interaction with physical artifacts. Gurevich et al. [9] presented TeleAdvisor. In addition to conventional telepresence capability, the TeleAdvisor contains a projector mounted on the end of a robotic arm to display additional information from the teleoperator on the onsite workspace to provide visual guidance and assistance to the local worker. Saraiji et al. [23] proposed Fusion, a wearable bimanual robot teleoperated by a remote user, allowing the remote user to "dive into" the local worker's body for collaborative tasks. VROOM [12] extended the conventional telepresence robot with a live-sized avatar overlay in Augmented Reality, allowing the local users to see the teleoperator's head pose and hand movements. Despite extensive research on telepresence robots with non-verbal cues, there remains a gap in understanding how these can be effectively integrated to enhance remote collaborative learning of physical devices for older adults. In this work, we investigate how integrating telepresence robots with non-verbal cues can improve older adults' collaborative experience in remotely learning to use physical devices.

3 Formative Study

To examine challenges in remote technology assistance, we ran a formative study with 8 pairs of older adults and college-aged remote helpers. Each older adult collaborated with a young helper on two devices: one task via remote video call and one face-to-face. After each session, we conducted semi-structured interviews with both participants to surface challenges and support needs. We observed three recurrent issues: (1) maintaining an informative camera view, (2) communicating position and motion, and (3) enabling trial-and-error remotely. These findings informed a set of design objectives and a prototype telepresence robot augmented with hand gestures to probe impacts on learning outcomes and user experience.

3.1 Participants

With ethics approval, we recruited 8 older adults (7 females, 1 male, M=58, SD=4.23) from a local Open University for older adults and 8 college students (4 females, 4 males, M=24, SD=3.34) from a local university. Participants are recruited with online advertising and word-of-mouth from local elderly communities and our home institution. All older adult participants self-reported low familiarity with the coffee machine (M=1.25/5, SD=0.65) and computer assembly (M=2.13/5, SD=0.87). The demographic information is shown in Table 1, with OF representing the older adults and YF representing the remote helpers. Each older adult participant is randomly assigned to a young participant for each task during the study.

We selected two devices for the formative study: a coffee machine (Philips 3200) and a desktop personal computer (Shown in Fig. 2). Participants completed two tasks—pulling an espresso on the coffee machine and connecting cables (display, chassis, keyboard, mouse) on the PC. Each pair performed both tasks under two conditions: (a) video call—older adult and helper in separate rooms using Tencent Meeting on tablets, with the older adult sharing the device view via the rear camera; and (b) face-to-face—both in the same room, communicating in person while operating the device.

3.2 Procedure

Participants first completed a demographics questionnaire. Both OF and YF received the device manual, then the older adult entered the task room and attempted the task independently for 5 minutes. If the task was not completed, the helper joined—via video call or face-to-face, depending on the condition. Each session ended at completion or after 15 minutes. Each pair completed two sessions, following the same procedure but with a different device and condition each time. After both sessions, we interviewed both participants (30 min) about perceived challenges and observed behaviors. Interview transcripts were analyzed using an inductive thematic analysis approach. Two researchers independently

ID	Sex	Age	Coffee Machine	Computer Assembly	ID	Sex	Age	Coffee Machine	Computer Assembly
OF1	Female	65	1	1	YF1	Female	24	3	4
OF2	Female	59	1	1	YF2	Female	22	1	4
OF3	Female	56	1	1	YF3	Female	22	1	3
OF4	Female	52	1	3	YF4	Female	32	4	5
OF5	Female	54	2	3	YF5	Male	26	1	3
OF6	Male	62	1	3	YF6	Male	23	4	4
OF7	Female	58	2	2	YF7	Male	23	1	1
OF8	Female	60	1	3	YF8	Male	23	3	3

Table 1: Participants' demographics in the formative study. It contains participants' sex, age, and level of familiarity with the coffee machine and the assembling computers (rated on a scale of 1 to 5, from never used to high proficiency).

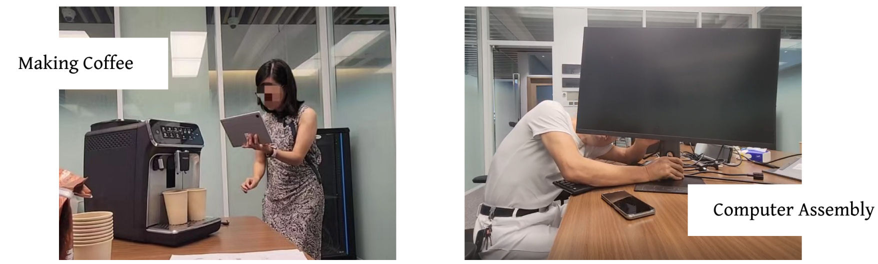

Figure 2: Formative study setup in the video call condition. The image on the left illustrates the coffee-making task, while the image on the right depicts the computer assembly task.

performed open coding, met regularly to compare and reconcile codes, and iteratively grouped them into broader themes through discussion and consensus.

3.3 Findings

After the experiment, most older adults were ultimately unable to complete the task within the allotted time and did not acquire knowledge from the process. Building on this, our interview results revealed three main challenges older adults and helpers might face during remote assistance: *1) maintaining ideal camera placement for the onsite user*, *2) communicating motion and position*, and *3) conducting trial-and-error for the remote helper*.

3.3.1 Maintaining Camera Position. Many remote helpers (5/8) reported that the undesirable handheld camera position was a major barrier to providing useful assistance. Views were often too narrow or shaky to see the device clearly (YF2, YF5, YF7). Visibility was worst while the older adult was operating: helpers could not see which button was being pressed (YF5, YF8). As OF8 put it, "I can only focus on one place—when I focus on the device I can't keep the camera on my hand." In some cases the tablet was set aside, leaving the helper with no view at all (YF3).

3.3.2 Communicating motions and location. Describing where to act and how to move produced notable anxiety. Identifying a specific button/port was hard for both sides (YF5; OF7, OF8), and OF8 said she was often unsure which control was meant but hesitated to ask repeatedly. Explaining the water tank removal on the coffee machine was especially difficult: "Verbal description is always too vague—it's hard to convey the pulling direction and required force," noted YF3; similar concerns arose for YF7 and YF8. Several participants (YF8, YF7, YF3, OF8) said direct demonstration—as in the face-to-face condition—would make the task much easier.

3.3.3 Remote Trial-and-error. Helpers differed in device familiarity. When they were unfamiliar or unexpected errors occurred, they tried trial-and-error—but only the older adult had hands on the device, forcing helpers to "teleoperate" through verbal guidance. This made trial-and-error slow and frustrating because precise locations and motions were hard to communicate. "I wanted to try it myself first and see how the water tank comes out," said YF8, after multiple failed attempts by the older adult. The inefficiency frustrated both parties: OF7 felt the helper "didn't know how to help," while YF7 said he couldn't help effectively because he could not try the actions himself.

4 PROTOTYPE

To address the challenges revealed in the formative study, we designed a teleoperated robotic system with the following design goals: 1) allowing remote users to adjust camera position and orientation, 2) supporting spatial referencing, and 3) supporting trial-and-error for the remote user. The system comprises a mobile telepresence robot and a stationary robotic arm, as shown in Fig. 1.

4.1 Mechanical Structure

The telepresence robot contains a screen and a camera to support conventional video conferencing capability. A Samsung A8 tablet

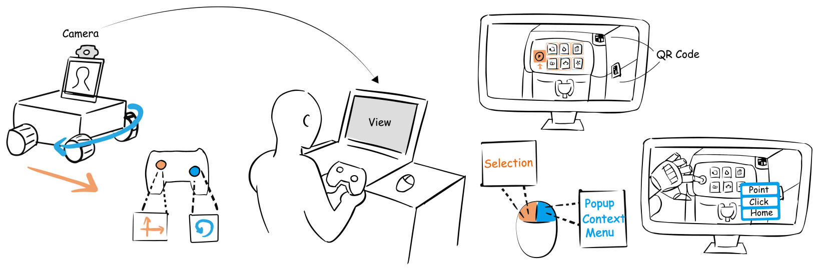

Figure 3: Interface for Controlling the Telepresence Robot and Robotic Arm. The controller's left and right joysticks are used to maneuver the telepresence robot, enabling translational and rotational movement, thus adjusting the remote helper's view for observing older adults' conditions. The mouse controls the robotic arm, where the left button selects an interactive area of the physical device on the screen, and the right button opens a context menu. This menu provides three key options: (1) Point (spatial reference) for identifying locations, (2) Motion Demonstration for actions like "click" based on the physical device, and (3) Home to reset the robotic arm to its initial position.

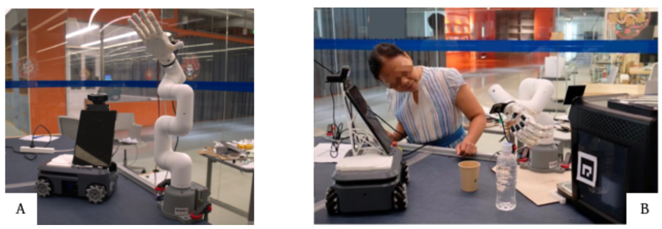

Figure 4: The prototype photos. To ensure participants' safety and better robot movement accuracy for a smooth experience, the robotic arm is fixed on the table. A: Photo of the prototype with the robotic arm fixed on the table. B: How participants use prototypes.

and a USB webcam are installed on the Elephant Robotics myAGV platform. Mecanum wheels on the robot allow for omnidirectional movement. The remote user can adjust their views by changing the robot's position and orientation using a gamepad. A 6-DoF robotic arm (Elephant Robotics MyCobot 320) is fixed on the table facing the device to be operated during the study. A robotic hand (modified InMoov Hand i2) that resembles the shape and size of a real hand is attached at the end of the robotic arm.

4.2 Robot Gesture

Because of collision-safety concerns, we disabled free-form gesture mirroring of the teleoperator's arm. Instead, the robot executes a predefined gesture set derived from formative-study challenges: (1) spatial referencing—pointing with the index finger to a teleoperator-specified location to disambiguate targets; (2) motion demonstration—showing how to act without contact (e.g., a grab-and-pull next to the coffee machine's water tank), which clarifies motion, supports learning, and covers movements the arm cannot safely execute on the device; and (3) direct action—pressing device buttons to enable teleoperator trial-and-error.

4.3 Teleoperation Interface

The teleoperator controls the telepresence robot and the robotic arm with a GUI interface on a PC. The interface is implemented with QT and OpenCV. The remote user can control the movement of the telepresence robot with two joysticks on a gamepad. They can command the robotic arm to carry out gestures by first selecting a component of the device to interact with by left-clicking on the streamed video feed. The areas that allow for interaction are localized by detecting the ArUco markers. Then, the remote user can right-click and select the gesture to be performed with the robotic arm. The telepresence robot and the robotic arm are connected to the teleoperator's PC over the WIFI network. The interface is shown in Figure 3, and the physical product and usage demonstration is shown in Figure 4.

5 Conclusion

In this paper, we explored the use of a telepresence robot system to enhance remote assistance for older adults learning to use physical devices. Through a formative study, we identified key challenges for remote helpers to assist older adults in learning physical devices, including maintaining the camera position, demonstrating motion and location, and conducting remote trial-and-error. To address these challenges, we designed a telepresence robotic system enhanced with a robotic arm that can perform gestures to improve communication.

This work presents our formative insights and prototype design as a first step. As future work, we plan to conduct a formal evaluation to assess the system's usability and its effects on learning outcomes and task performance in realistic device-learning scenarios. We also intend to examine how might a telepresence robot impact remote collaborative learning of a new technology device requiring physical operations for older adults.

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References

[1] Sigurdur Orn Adalgeirsson and Cynthia Breazeal. 2010. MeBot: A robotic platform for socially embodied telepresence. In *2010 5th ACM/IEEE International Conference on Human-Robot Interaction (HRI)*. IEEE, 15–22.

[2] Monica Anderson and Andrew Perrin. 2017. Tech Adoption Climbs Among Older Adults. https://www.pewresearch.org/internet/2017/05/17/tech-adoption-climbs-among-older-adults/ (Accessed on 10/4/2024).

[3] Jenay M. Beer and Leila Takayama. 2011. Mobile remote presence systems for older adults: acceptance, benefits, and concerns. In *Proceedings of the 6th international conference on Human-robot interaction*. ACM, Lausanne Switzerland, 19–26. https://doi.org/10.1145/1957656.1957665

[4] D. Bui, T. Barnett, H. Hoang, and W. Chinthammit. 2021. Tele-mentoring using augmented reality technology in healthcare: A systematic review. *Australasian Journal of Educational Technology* (2021), 81–101. https://doi.org/10.14742/AJET.6243

[5] D. Calandra, Alberto Cannavò, and F. Lamberti. 2021. Improving AR-powered remote assistance: a new approach aimed to foster operator's autonomy and optimize the use of skilled resources. *The International Journal of Advanced Manufacturing Technology* 114 (2021), 3147 – 3164. https://doi.org/10.1007/s00170-021-06871-4

[6] Kourosh Darvish, Luigi Penco, Joao Ramos, Rafael Cisneros, Jerry Pratt, Eiichi Yoshida, Serena Ivaldi, and Daniele Pucci. 2023. Teleoperation of Humanoid Robots: A Survey. arXiv:2301.04317 [cs.RO] https://arxiv.org/abs/2301.04317

[7] Rui P. Duarte, Valter N. N. Alves, and Mickael Mota. 2025. Designing Inclusive Smartwatch Interfaces: Guidelines for Enhancing Usability and Adoption Among Older Adults. *IEEE Access* 13 (2025), 64901–64929. https://doi.org/10.1109/ACCESS.2025.3559726

[8] Mingming Fan and Khai N. Truong. 2018. Guidelines for Creating Senior-Friendly Product Instructions. *ACM Transactions on Accessible Computing* 11, 2 (June 2018), 1–35. https://doi.org/10.1145/3209882

[9] Pavel Gurevich, Joel Lanir, Benjamin Cohen, and Ran Stone. 2012. TeleAdvisor: a versatile augmented reality tool for remote assistance. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM, Austin Texas USA, 619–622. https://doi.org/10.1145/2207676.2207763

[10] Rowena Hill, Lucy R Betts, and Sarah E Gardner. 2015. Older adults' experiences and perceptions of digital technology:(Dis) empowerment, wellbeing, and inclusion. *Computers in Human Behavior* 48 (2015), 415–423.

[11] Xiaofu Jin, Xiaozhu Hu, Xiaoying Wei, and Mingming Fan. 2022. Synapse: Interactive Guidance by Demonstration with Trial-and-Error Support for Older Adults to Use Smartphone Apps. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 6, 3 (Sept. 2022), 1–24. https://doi.org/10.1145/3550321

[12] Brennan Jones, Yaying Zhang, Priscilla N. Y. Wong, and Sean Rintel. 2020. VROOM: Virtual Robot Overlay for Online Meetings. In *Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems*. ACM, Honolulu HI USA, 1–10. https://doi.org/10.1145/3334480.3382820

[13] M. Kalmijn. 2021. Long-term trends in intergenerational proximity: Evidence from a grandchild design. *Population, Space and Place* 27 (2021). https://doi.org/10.1002/psp.2473

[14] Jin Uk Kwon, Eun Sun Lee, and S. Ahn. 2016. Projector-camera based remote assistance system for the elderly: Design issues and implementation. *2016 IEEE/SICE International Symposium on System Integration (SII)* (2016), 230–235. https://doi.org/10.1109/SII.2016.7844003

[15] Jaewook Lee, Devesh P. Sarda, Eujean Lee, Amy Lee, Jun Wang, Adrian Rodriguez, and Jon E. Froehlich. 2023. Towards Real-time Computer Vision and Augmented Reality to Support Low Vision Sports: A Demonstration of ARTennis. In *Adjunct Proceedings of the 36th Annual ACM Symposium on User Interface Software and Technology (UIST '23 Adjunct)*. Association for Computing Machinery, New York, NY, USA, 1–3. https://doi.org/10.1145/3586182.3615815

[16] Rock Leung, Charlotte Tang, Shathel Haddad, Joanna Mcgrenere, Peter Graf, and Vilia Ingriany. 2012. How Older Adults Learn to Use Mobile Devices: Survey and Field Investigations. *ACM Transactions on Accessible Computing* 4, 3 (Dec. 2012), 1–33. https://doi.org/10.1145/2399193.2399195

[17] Jiannan Li, Maurício Sousa, Chu Li, Jessie Liu, Yan Chen, Ravin Balakrishnan, and Tovi Grossman. 2022. ASTEROIDS: Exploring Swarms of Mini-Telepresence Robots for Physical Skill Demonstration. In *CHI Conference on Human Factors in Computing Systems*. ACM, New Orleans LA USA, 1–14. https://doi.org/10.1145/3491102.3501927

[18] Charles A McMellon and Leon G Schiffman. 2002. Cybersenior empowerment: How some older individuals are taking control of their lives. *Journal of Applied Gerontology* 21, 2 (2002), 157–175.

[19] Kazuhiro Otsuka. 2016. MMSpace: Kinetically-augmented telepresence for small group-to-group conversations. In *2016 IEEE virtual reality (VR)*. IEEE, 19–28.

[20] Carolyn Pang, Zhiqin Collin Wang, Joanna McGrenere, Rock Leung, Jiamin Dai, and Karyn Moffatt. 2021. Technology Adoption and Learning Preferences for Older Adults:: Evolving Perceptions, Ongoing Challenges, and Emerging Design Opportunities. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*. ACM, Yokohama Japan, 1–13. https://doi.org/10.1145/3411764.3445702

[21] S. Ruggles. 2007. The Decline of Intergenerational Coresidence in the United States, 1850 to 2000. *American Sociological Review* 72 (2007), 964 – 989. https://doi.org/10.1177/000312240707200606

[22] Mose Sakashita, E Andy Ricci, Jatin Arora, and François Guimbretière. 2022. Remotecode: Robotic embodiment for enhancing peripheral awareness in remote collaboration tasks. *Proceedings of the ACM on Human-Computer Interaction* 6, CSCW1 (2022), 1–22.

[23] Mhd Yamen Saraiji, Tomoya Sasaki, Reo Matsumura, Kouta Minamizawa, and Masahiko Inami. 2018. Fusion: full body surrogacy for collaborative communication. In *ACM SIGGRAPH 2018 Emerging Technologies*. ACM, Vancouver British Columbia Canada, 1–2. https://doi.org/10.1145/3214907.3214912

[24] David Sirkin and Wendy Ju. 2012. Consistency in physical and on-screen action improves perceptions of telepresence robots. In *Proceedings of the seventh annual ACM/IEEE international conference on Human-Robot Interaction*. 57–64.

[25] Wen Wei, X. Gong, J. Li, Kun Tian, and Kai Xing. 2023. A study on community older people's willingness to use smart home—an extended technology acceptance model with intergenerational relationships. *Frontiers in Public Health* 11 (2023). https://doi.org/10.3389/fpubh.2023.1139667