

Community-Situated Mixed-Methods Robotics Research for Children and Childhood Spaces

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Abstract—Robots are increasingly present in ethically fraught childhood spaces. In such contexts, HRI researchers should leverage mixed-methods approaches. This is especially true in domains where robots are teleoperated by adult experts—such as therapy. A mixed-methods approach can help researchers build a thorough qualitative understanding of adult experts’ needs, incorporate stakeholder perspectives through participatory design, and motivate experimental evaluations with this insight. Through such a user-centered, mixed-methods approach, robotics researchers can ultimately improve the experience of both adults and children in these spaces.

Index Terms—Child-Robot Interaction, Participatory Design, Teleoperation

I. MOTIVATION

In the future, robots will have a role in children’s lives across settings like education [1], [2], therapy [3], and medicine [4], [5]. Roboticians working in these spaces must create accessible, ethical technologies that are sensitive to the needs of both adults and children. This is challenging because robot users in these spaces are not often technology experts and because the customs and requirements of childhood environments are not always known to technologists. In this disjoint-expertise use-case, HRI research benefits from a mixed-methods approach grounded in rich, qualitative understanding of users’ needs and perspectives on technology. By prioritizing user-centeredness, researchers can better create and evaluate robotic technology for childhood spaces.

Early in my graduate career, I interviewed a Children’s Hospital Gaming Technology Specialist, who used technology like video games and VR to help children play, express themselves, and cope with pain [6]. For hospitalized children, expressing creativity and controlling their own choices is critical due to the inevitable loss of control over many aspects of life. This project made me curious about how technology can support children’s needs to have agency, to express themselves, and to make choices about their own lives.

Design solutions in this domain must originate from mutual understanding with adult experts, such as therapists, educators, and practitioners. It will be these users, not researchers or developers, who make choices and implement solutions for robots in childhood spaces—especially for teleoperated robots. Ultimately, these users will decide whether robots meet their needs and are worth using. In all childhood spaces, a deep

understanding and working relationship with both adult experts and children themselves facilitates exploration of the question: **How can robots and their interfaces better support child outcomes, maintain sensitivity to children’s agency, and address ethical concerns in this domain?**

II. BACKGROUND

Robots benefit children in a variety of ways. They support interactive educational activities in which children do not feel judged by peers or adults [1], [2], encourage play and creative thinking [7], [5], and bring excitement to medical or therapeutic settings [4], [3].

In some of these use cases, *teleoperated* robots are advantageous in situations where human expertise and adaptability are critical components of a child’s experience. For example, robots can positively impact children during therapy sessions; they are novel and exciting, and can help children stay engaged in therapy activities [8], [9], [10]. As we have shown in recent work [11], a substantial portion of current research in this space focuses on autonomous robots [12] or does not thoroughly consider how socially assistive robots should be controlled [9], [13], [14], [15]. However, it is important for technologists to recognize therapists’ training and expertise in this use case. Teleoperation facilitates child-robot interaction while enabling effective therapy delivery *by a therapist*. Similarly, the use of teleoperation in other settings, like education, also supports a human expert’s decision making ability.

Even when robots are teleoperated, researchers must still consider child-robot relationships. There are clear ethical risks to creating robots that interact with children—especially with respect to the relationships children may form with robots [16], [17], children’s understanding of robots that exaggerate their cognitive or social abilities [18], and children’s mental models of robot’s affective and moral status [19].

Child-robot interaction researchers have a duty to understand how both children make sense of robotic technologies, and to incorporate their ethical risk-awareness into design practices just as they would with any other stakeholders. To this end, participatory design practices offer methods for engaging with children as experts in their own lives [20], [21] and for building mutual reflexive practice with children around technology and tech ethics [22], [23], [24], [25].

Based on these insights, my research seeks to answer the following key questions: How can teleoperation interfaces and practices better support child-robot interaction in therapy and education? When and how should adults communicate a robot’s cognitive, social, or affective status to children?

III. PRELIMINARY WORK

This year, our research team conducted an ethnographic study involving interviews with therapists and educators who have real-world experience with teleoperated robots. Our results revealed how robots and their interfaces are incorporated into operators’ routines. We identified several ways that robotic technology could be improved to better support teleoperators’ and children alike. In this way, framing teleoperators as the primary users of teleoperated robots ultimately supports children’s experience.

This research led to findings on the role of teleoperation in the broader scope of socially assistive robots [11]. In that work, we argue that a default focus on autonomous robots has led to blind spots in the research literature. Current guidelines for levels of robot autonomy suggest that many child robot interaction domains warrant the use of teleoperated robots. Teleoperation leaves power in the hands of human experts and allows them to adapt to unusual, complicated scenarios as they see fit.

Our ethnographic work also revealed a lack of consensus among robot teleoperators about whether to disclose a robot’s teleoperated status to children. Teleoperators use a variety of strategies to frame the relationship between themselves and the robot. Some clearly explain the robot’s controls. Others act as if the robot is fully autonomous. Some split the difference by relying on metaphors about other kinds of technology. This disparity of teleoperation practices raises questions of whether or when it is appropriate to deceive children about the capabilities of robotic technology. This question connects to several salient ethical concepts in child-robot interaction, including the effect of deception [18] and the possible externalities of children’s mental models for robots [19].

Though children are not the users of teleoperated robots in the sense that they are not robot operators, they are the primary patient of the ethical issues surrounding deception. I chose to collaboratively explore these concepts with children themselves through a pair of co-design workshops in which elementary-age children engaged with these concepts and expressed their perspectives through the co-design process [26]. Participatory design methods are well suited for building mutual reflexive practice with children for several reasons[22]. Conventional co-design activities, like drawing, making, and role-play, are accessible to children [21]. Additionally, the co-design community has a strong tradition of power-sharing—in which researchers treat children as equals and respect their voice and intellectual property [22], [24], [27].

These co-design workshops revealed that children are capable of understanding roboethics questions and speculating about design solutions with creativity and nuance. Furthermore, they revealed that participatory design methods are an

appropriate and compelling way to engage with children as technology stakeholders [26].

IV. CURRENT WORK

We are expanding our collaboration with therapists and educators to further explore our research questions about teleoperated robots. This work is done in association with a nonprofit—Peerbots—for whom I serve on the Board of Directors and get involved in community events with providers and families. With Peerbots, we conducted focus groups about robot teleoperation interface design which provided more detail about some of our high-level preliminary results. From our interviews, we knew that therapists need easy, accessible ways to connect to robotic technology that allows them to conduct remote sessions—a need that increased in the pandemic. Our focus groups revealed how this desirable feature is logistically and ethically complicated. It must be sensitive to each child’s information privacy, integrate with existing communication practices between providers and families, and intuitively guide therapists’ expectations of the robots capabilities. After analyzing the results of these focus groups, we will use our conclusions to plan further research investigating the design of teleoperated robots and their interfaces.

I am also experimentally investigating how robot dialog teleoperation interfaces can better support pace and quality of conversation. We learned in our preliminary qualitative research that therapists and educators who teleoperate robots sometimes struggle to adjust in the movement to unforeseen circumstances. Fast, intuitive interfaces support their need to adapt. Along with a team of undergraduate mentees, I am currently designing a human subjects study to evaluate interface features inspired by our qualitative work with respect to these conversation metrics.

V. CONCLUSIONS & FUTURE WORK

My research sits at the intersection of teleoperation interface design, child-robot interaction, and robot ethics. In this space, a mixed methods approach including ethnography, participatory design, and experimental evaluation supports the needs of both children and adults in ethically complex situations. In the future, I will expand my exploration of the ethical dilemmas surrounding child-robot relationships by connecting to broader ethical themes in HRI—such as transparency and explainability. I am curious about how the design of robots, robot teleoperation interfaces, and teleoperation practices can help stakeholders maintain accurate mental models of robots’ capabilities and build calibrated trust. My research can address this question by continuing to leverage a mixed-methods approach. I will investigate the role of transparency in teleoperation practices through our collaboration and participatory design efforts with operators who have real-world experience with children and by creating experiments which investigate the effects of transparent design.

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