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Design Research in HRI: Roboticists, Design Features, and Users as Co-Designers

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Abstract — Design research has explored design as it is embodied in many fields including engineering design and industrial design. Questions such as what it means to design, differences between design fields, expertise of designers, who should be included in design, and how to solve "wicked" design problems are all investigated in design research; seeking to understand design from multiple angles. Within human-robot interaction, design needs to be further integrated into research as robots become an increasing part of people's everyday lives. This paper argues for a triangulated approach, seeking to understand design in the context of the designers (or roboticists, in this case), the design features of the systems, and users as co-designers.

Keywords — co-design, participatory design, design research methodologies, social robot

1. INTRODUCTION

Design research refers to the development processes practitioners employ to ground, inform, and inspire the design of their product or user experience, and also the generation and evaluation of knowledge and tools that supports new design approaches [1]. Design is deeply integrated in human-robot interaction whether it is the design of a robot or the design of the user experience. It is also prevalent in our processes to create these systems. However, research investigating how different stakeholders (roboticists and users) engage in the design space of robots is less common. Through our perspective, we view design research in human-robot interaction as composed of three touchpoints: the roboticists as designers, the design features of the systems, and the users as co-designers. This position paper describes these touchpoints and their role in HRI design research, advocating for more emphasis on design research in HRI processes, education, and community engagement.

The research through design paradigm in HCI [2] (originally from [3]) has emerged as a way to engage with wicked problems [4], many aspects of which can be applied to HRI. Iterative processes of (1) field studies "in the wild" to gather information of social contexts, (2) design and implementation of solutions informed by field studies and other explorations, and (3) evaluation of these systems and their implications in the real world can integrate research by design approaches in HRI to solve societal problems [5]. At the same time, we must be mindful of our design space and stakeholders as we create these new technologies. We must consider three key design touchpoints that contribute to robot development: (1) the designers of the technology (the roboticists), (2) the design features embedded in the technologies, and (3) the users (preferably, as co-designers). Each of these touchpoints can influence how a technology is experienced and, potentially, the consequences of the technology. The designers dictate how the technology is developed, the tasks it will do, how it is created, and the values interwoven into it. The design features will influence how people engage with the technology, how they adapt their lives to it, and how it changes their experience in the world. The users (as co-designers) can inform how technologies should be made based on their needs, desires, and preferences and ensure technologies are responsibly designed to engage in social contexts. In the process of addressing societal problems in HRI, it should not be assumed that a robot is the solution [5] but maybe only a component or cog in the overall strategy. By triangulating the design touchpoints of human-robot development, i.e., roboticists, design features, and users, we can further understand how HRI can contribute to solving societal problems responsibly through prioritizing design in education, human-centered approaches, and interdisciplinary teams.

2. ROBOTICISTS AS DESIGNERS

Engineering is commonly associated with robot design and development [6] and design is an integral part of engineering [7]. Increasingly, HRI researchers have been calling for more interdisciplinary teams with members from robotics, engineering, and design as robots seek to go "into the wild" [8]. In order to support interdisciplinary teams in HRI and better train roboticists to collaborate within interdisciplinary teams, we need to understand how roboticists (our designers, in this case) create robots that will be entering our social contexts. While there has been a plethora of work focused on the users in HRI, there are very few works that focus on the roboticists [6]. Early works from Cheon & Su and Wallach & Allen have emphasized that "roboticists' values and perspectives are inseparable from the robots they construct" [9] and that the field needs to have a holistic perspective of robot design centered around designer and user values [10]. Roboticists' values are interwoven into the design process, whether consciously or unconsciously [10]. Additionally, Cheon & Su investigated how roboticists perceive users as naive or sensible users, potentially creating conflict between users and roboticists about robot design [6]. Investigating roboticists as designers can enable us to understand (1) how design is defined in HRI, (2) what design means to HRI, (3) the design processes of HRI and how it is experienced, and (4) how to support novice researchers in HRI and interdisciplinary teams. Our work focuses on conceptualizing how roboticists think about the implications of their work on society, delineating the values they incorporate into the work (similar in approach to [7]). We couple this with idea generation of future tools to investigate social robots or embodied artificial intelligence in social contexts through semi-structured interviews and scenarios. As a first step to understanding roboticists as designers within HRI, we interviewed researchers in HRI and HCI working with embodied AI and/or robots. Initial results demonstrate researchers exhibit a human-centered focus in their work with variances in values, motivations, and individual design processes based on expertise level and background (i.e. qualitative, quantitative). The spectrum of roboticists' values and motivations and how they impact the design process is what we should further study to better encapsulate design within HRI and, therefore, foster the development of robots and educational processes for novice roboticists.

3. THE DESIGN FEATURES

Another critical aspect to understand these devices is how various design features of systems, such as movement or personality, impact and elicit behaviors in users. Through the "Computers as Social Actors" (CASA) paradigm, Clifford Nass and team demonstrated that humans socially interact with computers that exhibit anthropomorphic cues such as language, face, gender, personality, etc [11]. This also translates to robots and voice assistants [12], [13]. A key design feature that we investigate in our work is embodiment. Embodiment can elicit socio-emotional companionship creating rapport, emotional connection, and trust due to increased social presence [14]. Reciprocity, or the "give and take" in relationships [15], is also critical in socio-emotional relationships and, therefore, in computer mediated relationships. Socio-emotional relationships with technologies leveraging embodiment can be extremely important and valuable for workplace, education, and therapy situations in group and individual settings [16], [17]. Computer mediated collaboration, perhaps through telepresent robots, needs to be designed to smoothly work with people in teams [18]. Socio-emotional relationships within a classroom can establish a foundation for learning [19]. Within a therapy situation, rapport and reciprocity can support people's experience [15]. As technology is increasingly being developed for these situations, it is critical that we understand how design features, such as embodiment, personality, or gender, will impact users experiences and growth. We must also be mindful of the ethical design of these features, the autonomy given to these systems, and the autonomy preserved for the user. Further work is necessary around these design features to investigate the boundary between how socially-persuasive robots and assistants should be designed when leveraging design features such as embodiment to promote relationships.

4. THE USERS AS CO-DESIGNERS

Design approaches such as human-centered design, co-design, and participatory design are becoming increasingly part of HCI and HRI technology development. These processes are championed as ways to incorporate users into the design process and amplify voices that are not typically heard [20]. Participatory design, and similarly co-design, promotes a sense of place in the design process and feelings of empowerment for users [21], [22]. Within HCI, participatory design has been suggested as the "third space" of HCI [23]. However, participatory design practices have been less utilized in HRI [24]. Instead, laboratory studies are the common methodology choice. More and more robots are being developed to interact with people in the real world and, therefore, more in-context studies are necessary to understand how robots integrate into social settings, how people behave with these systems,

and how this will vary between various social contexts and cultures [8], [24]. As we move to conducting more studies "in the wild", it is critical that we involve users in the design process through approaches that empower users and create a space for them on design teams when developing new technologies that will have implications on society.

Within our work, we have primarily used participatory design and co-design approaches to ensure older adults have a voice in the design process of social robots. Through a community-based participatory design approach [25], we explored how older adults would design a social robot within an assisted living community context [26]. The study was structured around older adults living with a robot in their community space for three weeks with several opportunities to engage with researchers in participatory design activities, including art-therapy sessions and card sorting. The card sorting enabled older adults to map out the functions they would desire in their robot. Results demonstrated that older adults' preferences could be organized as high-openness, mid-openness, or low-openness, largely defined by privacy concerns around the technology. In addition to community based participatory design approaches, we have also co-designed with older adults in a year-long co-design process including a variety of design research methodologies, including art-based image making, rapid prototyping, storytelling, and design guideline generation sessions. Incorporating a variety of methodologies has enabled us to provide multiple ways for older adults to express themselves and co-design their ideal social robot. The methods range from more abstract image making to more interactive and embodied rapid prototyping by programming the robot. Initial results demonstrate the value of (1) incorporating methods that allow older adults to express emotion and personal experiences to generate design guidelines for social robots and (2) co-designing long-term with older adults as they create more informed and educated opinions around their technology desires and perspectives. Our work advocates for more sustained engagement with communities and users through co-design, participatory design, and human-centered design as robots increasingly become a part of everyday lives to promote responsible technologies that empower users. More emphasis on these design approaches will help support users as co-designers, the third touchpoint of HRI design.

5. CONCLUSION

HRI can be triangulated to three design touchpoints: roboticists as designers, design features of technologies, and users as co-designers. Each of these are critical areas for us to understand how design is defined, embedded, interwoven, and considered in order that we can better support existing and incoming roboticists, interdisciplinary work and teams, and users' continued engagement. With this in mind, HRI should seek to answer three questions:

- How is design defined by researchers in HRI? What methods are involved in a research by design approach, specifically for HRI?
- How can we democratize design in HRI for designers (roboticists) and co-designers (users)?
- How can we better support and train researchers in HRI to develop technologies through design research, mixed method, and interdisciplinary approaches? How can we support HRI researchers being mindful of the social context of these technologies?

Through this approach, we can better contribute to solving societal wicked problems through design-informed HRI.

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