Values-Guided Agile Robotics Research

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ABSTRACT

There is a renewed interest in exploring the use of agile robots for non-visual navigation guides as the robots become more affordable. Although studies do include Blind and Low Vision (BLV) participants, few include people with lived non-visual navigation experience as members of the research team from the inception of the project. Often researchers gather data from BLV guide dog handlers to find out their needs, preferences, and concerns at the end of the design process during user testing scenarios. Instead, this extended abstract offers two established frameworks, Co-Design and Value Sensitive Design, to incorporate accessibility expertise from the beginning of an assistive technology project. We provide an overview of both approaches and how they are applied in an early research project using an industrial quadruped robot as a navigation assistant in a human-robot team. We also share ways we have included community stakeholders who might encounter the research team in public spaces during research and testing sessions.

CCS CONCEPTS

• **Human-centered computing → Accessibility design and evaluation methods**.

KEYWORDS

Assistive Technologies, Co-Design, Value Sensitive Design

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1 INTRODUCTION

In recent years, industrial robotics companies have introduced various quadruped robots that mimic canine movement and tasks [3, 24, 27]. Most often these robots are used in industrial system monitoring, however, there is increasing interest in their potential as navigation assistants for blind and low vision (BLV) individuals. The robots are not intended to be replacements for traditional guide dogs; instead, they are seen as supplementary navigation aids when it is not possible or safe for a guide dog. This could include travel scenarios with long quarantines, living situations that do not permit a dog, allergies, waiting periods for a new dog, or any number of other dog-adverse circumstances in which a robot aid could be useful [18]. A dual approach is required to responsibly investigate quadruped robots as a potential assistive technology solution. First, there is the need to establish co-design partnerships with guide dog handlers to determine the actual need and basic navigation behaviors that are required for safe and efficient non-visual navigation. As this navigation takes place in public spaces, there are considerations of public perception and reactions to the human-robot pair that contribute heavily to conditions for successful navigation. We argue that there are existing frameworks for both the conceptual and practical aspects of this emerging technology integration process using a Co-Design approach [2] along with Friedman and Hendry's Value Sensitive Design (VSD) framework [8]. This collaborative approach provides a foundation for inclusive, respectful, responsible methods for developing embodied assistive navigation technologies. This poster describes how these approaches have been implemented in our research using an industrial robot [3]. We describe the VSD principles and processes we have applied as we have developed several iterations of a voice-based interface for the robot and a flexible handle that passes critical movement and spatial information to the handler during navigation.

2 CO-DESIGNERS AS RESEARCH PARTNERS

Including co-designers when considering a solution that is unique to their own experience is central to the success of any assistive technology research [5, 23, 28]. This requires finding co-designers at the beginning of the research and development process, not as engaged stakeholders or evaluation participants, but as longitudinal research partners [1]. Too often individuals with disabilities are brought in after the development process has been completed, in the user testing phase [15, 22]. In some cases, there may be significant flawed assumptions made by the research team or 'engineering traps' based on those assumptions [11, 19]. Individual sensory needs, environmental stimuli processing, and navigation challenges vary greatly for BLV handlers. As such, a research team must include the perspectives, experiences, and design input of as many handlers as possible throughout the development of the technologies [14].

3 VALUE SENSITIVE DESIGN

Value Sensitive Design gained recognition in the 1990s as an ethical approach to developing technology [9]. The approach requires centering the people directly and indirectly impacted by an emergent technology. This consideration happens through intense scrutiny of the potentially competing values, priorities, and conflicts of the multiple stakeholders. VSD sets itself apart from merely articulating an interest in stakeholder values by implementing an framework that employs theoretical and methodological techniques. The conceptual investigation examines the underlying values and tendencies of certain groups involved in the development and deployment of a technology [9]. The values become concise and relevant design premises related to the technology. Conceptual evaluations differentiate the needs among the communities that will be directly and indirectly impacted and how this may change when the technology interacts with people in different settings. Empirical investigations test the conceptual premises about which stakeholder groups must be recruited for the research team as co-designers, what level of stakeholder input is needed, and the values of each of those groups. The investigation may reveal false assumptions and value contradictions, ranging from within individual participants [7]. Technical investigations apply a critical lens in evaluating how well emergent technologies may function depending on the context. Technical investigations are guided by findings from the conceptual and empirical investigations. After a technology is deployed, researchers test if that technology has furthered or hindered the pursuit and sustainability of identified stakeholder values [10].

4 CO-DESIGNED ROBOT NAVIGATION GUIDE

In this project, we have engaged in three forms of foundational VSD investigation data collection. First, during the conceptual investigation, we talked with our co-designer about joining the research team knowing the entire project would benefit from the experiences of someone who has spent the majority of her life handling and navigating with guide dogs. She agreed and began working with us both remotely and during several on-campus, multi day visits which helped to inform the early research and iterative development process. We tested the interface prototypes for the robot navigation guide, and she described and demonstrated how robots could potentially provide verbal spatial information and assistance in ways that guide dogs cannot. Her input has been invaluable and has grounded our work in VSD principles and co-design methods. We have also talked with several other guide dog handlers to gather their input and experiences and better understand the values and factors that might impact the use of this type of robot. This led to a set of premises that would guide our research objectives, the types of features that should be investigated or prioritized, and the necessary precautions to take during our design and testing processes. This included the robot tasks or actions to focus on and the types of commands and spatial language to provide direction without using a controller or the laptop. We also identified the safety features to build into the app and the handle, and ways in which the handle should move to mimic the types of spatial information passed between the guide and the human (e.g., direction, speed, orientation, and force) [6, 21]. All aspects of this research were reviewed and approved by the IRB, including the robot-team research and the social context impact of this team.

During our conceptual and empirical investigations, we also explored the values and perspectives of various stakeholders within our own campus community: students, faculty, staff, and administration. These groups were first invited to complete a short, baseline survey adapted from [16] to collect the attitudes and values towards this specific type of robot that shape our research occurring within a diverse campus community. The survey captured general attitudes of campus stakeholders on factors such as trust of robots[12], robot safety [25], and group empathy [20, 26]. The third form of conceptual and empirical investigative data collection was a series of focus groups hosted by an intermediate-level responsible computing course. Members of the campus community were recruited to participate in three focus groups. Questions focused on the use of this type of robot on campus for research, the factors that promoted feelings of trust and safety when around the robot, and what they thought about its potential as a non-visual navigation assistant. The inclusion of community stakeholder groups helped to investigate the implicit individual and community values the research team needed to understand to create a safe and effective research environment and the human-robot team would need for independent navigation through public spaces. We found that the level of trust of the robot in a public space for most groups was highly associated with the connections and interactions community members had with the faculty researcher and the lab. In other words, trust in the robot is based on a trust-based relationship with the human in charge of the robot as long as the robot does not deviate from expected behaviors [17]. This finding is similar to recent HRI studies in this area [4, 13]. Our team will continue with the iterative development and technical investigation of the robot interface designs (app and handle) and expand our formal VSD investigations to include focus groups and testing with a larger group of guide dog handlers and community stakeholders. We will be integrating a Large Language Model (LLM) approach in the voice-based interface to allow for computer vision scene descriptions, more onboard processing for object recognition and retrieval, and a lightweight handle design based on current running harnesses for guide dogs.

5 CONCLUSIONS

The central question of 'Can quadruped industrial robots serve as navigation assistants in public spaces to benefit non-visual navigators?' remains to be answered. However, we have addressed an equally important question: 'How can we as researchers better inform the design and development of this technology, keeping the values of inclusivity, respect, responsibility, and safety at the forefront of our research processes?'. Both of these are questions we hope to answer as we continue to move forward in our research. We also hope this work may contribute a practical example for researchers interested in integrating VSD and co-designer methods into all aspects of their emergent human-robot interaction research.

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