Values-Guided Agile Robotics Research

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Motivation

There is a renewed interest among researchers in exploring the use of agile robots for non-visual navigation guides as the robots have become more affordable to buy than to build. The robots are not intended to be replacements for guide dogs; instead, they are seen as potential supplementary navigation aids when it is not possible or safe to bring a guide dog.

Figure 1: Guide Dog
Figure 2: Size Comparison of Quadruped Robots from smallest to largest [2, 6, 7]

Few of these studies meaningfully include people with lived non-visual navigation experience as members of the research team from the inception of the project. Too often individuals with disabilities are introduced to an assistive technology solution after the development process has been completed in the user testing phase, not at the beginning, where their informed input and design considerations might radically change the course of the research [1,2] In some cases, there are significant flawed assumptions or 'engineering traps' inherent in the design based on those assumptions[3,4] .

Design Values and Principles

We argue two approaches are required when developing an industrial robot for assistive navigation

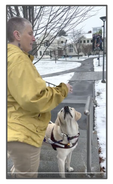
Co-design: Method of designing technology with individuals who bring their own lived experience to the design, development, and testing cycles [2]. Closely tied to disability rights philosophy of "nothing without us".

Value Sensitive Design (VSD): Framework examines underlying values and tendencies of groups involved in the development and deployment of a technology.

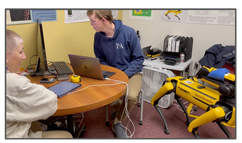
- Uses conceptual, technical, and empirical investigations into values of direct and indirect stakeholders [5].

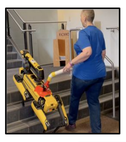
Co-Design Sessions

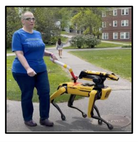
Co-designer: 30 years of experience in navigating with guide dogs;
Team began with conversations, moved to in-person observations of human-dog team, then exploring and identifying critical positioning and movements with robot (Figures 3-7).
After voice app and handle prototypes completed, began iterative testing in lab, in indoor multi-level public space, and outdoor real-world environments (Figures 8-15). Changes driven by co-designer input.



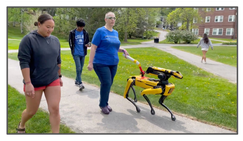
Figures 3-6 (Top Row-Left to Right) Initial visit and discussions with co-designer; observations of human-dog interactions, commands, spatial information exchanges; demonstrations of accurate positioning of handler and robot for handle design.

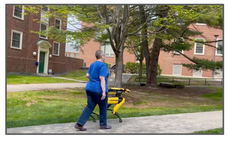






Figures 7-10 (Middle Row-Left to Right) Pilot prototype tests with co-designer; observations of human-robot team indoor navigation; indoor small stairs navigation; outdoor autowalk navigation.





Figures 11-13 (Bottom Row-Left to Right) Outdoor navigation sessions with co-designer.

VSD Investigation Methods

Conceptual Investigations

Examines the underlying values and priorities of the affected populations, which are distilled into concise design premises related to the technology .Evaluates the needs of stakeholders who may be impacted by the robot in different campus settings.

Administered campus community stakeholders adapted survey related to general attitudes towards agile robots.

Empirical Investigations

Tests conceptual premises about which stakeholder groups must be recruited for the research team as co-designers, level of stakeholder input needed, and values of each of those groups.

Conducted four focus groups of campus stakeholders with different roles (students, staff, faculty, administrators) to identify potential conflicts within and between groups.

Technical Investigations

Assess if technology has aligned with pursuit and sustainability of stakeholder values. Produces insights into the *technology*, rather than impacted *populations*.

User interface and navigation testing with campus community stakeholders and co-designer. Collected likert and Open Response feedback.

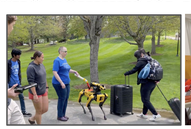
Preliminary Findings

Co-Design Findings: Identified minimum required guide commands and navigation skills. Voice-based interface should be flexible and responsive to variations in commands. Helped to target correct positioning and features of next version of handle. Shared the many challenges handlers-dog teams face in public settings and strategies for navigating trust issues that may transfer to human-robots teams.

Campus Stakeholder Findings: Community members attributed trust to person(s) handling robot more than the robot. Attitudes of trust of robot associated with trust perceptions of dogs. Concerns were related to the privacy of community members based on robot using camera for navigation and the robot being tested in public spaces where people may feel uncomfortable.
Community members reported that a benefit of this VSD work was that the campus community was talking about how robots should be used responsibly in public spaces. Process models how to promote community trust in responsible robotics research practices and create clear campus policies based on shared values and community priorities.

Future Work

We will expand co-design work with guide dog handler group, formalize campus community policies based on VSD findings, and administer revised survey to campus community.



We are developing the voice app (v. 2.0) for 2-way human-robot team communication, piloting new handle based on a running harness for guide dogs, and adding accessible navigation app.

1) Holly J Moist. 2013. *Technology and Disability: A Help or a Hindrance?* Masters thesis, McMaster University, Hamilton, Ontario.
2) Kat Holmes. 2020. *Mismatch: How inclusion shapes design.* MIT Press.
3) Jennifer Mankoff, Gillian R Hayes, and Devva Kasnitz. 2010. Disability studies as a source of critical inquiry for the field of assistive technology. In *Proceedings of the 12th international ACM SIGACCESS conference on Computers and accessibility.3–10.*
4) Nicholas A. Giudice. 2018. Navigating without vision: Principles of blind spatial cognition. *Handbook of behavioral and cognitive geography*, 260.Edward Elgar Publishing, 260–288.
5) Batya Friedman, Peter H. Kahn, Alan Borning, and Alina Huldtgren. 2013. Value Sensitive Design and Information Systems. *Early engagement and new technologies: Opening up the laboratory,* 55–95.