

Human-Computer Interaction

Project Introduction

Professor Bilge Mutlu

General Outline

We will carry out a semester-long research project where you will practice the research methods we learn to conduct *original research*.

- » Friday class time for team meetings, milestone kickoffs, and feedback sessions
- » Ideally teams of 3, fewer or more should be exceptions
- » 40 + 20% of your total grade, integrates team member evaluations
- » Incrementally write a full-length (~10-pages) paper potentially submittable to an HCI conference

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Designing Persuasive Robots: How Robots Might Persuade People Using Vocal and Nonverbal Cues

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ABSTRACT

Social robots have the potential to serve as personal, organizational, and social media agents. In this paper, we explore how the robot's abilities, and especially its vocal and nonverbal cues, can affect participants' perceptions of the robot and their responses to the robot's suggestions across four conditions: (1) no vocal or nonverbal cues; (2) vocal cues only; (3) nonverbal cues only; (4) vocal and nonverbal cues. The results showed that participants were more inclined to accept the robot's suggestion when it used nonverbal cues than they did when it did not use any cues. Participants also perceived the robot as more persuasive when it used nonverbal cues than when it did not use any cues. The results also indicated that the use of nonverbal cues and experiential results had been influential in the design of persuasive behaviors for persuasive robots.

Categories and Subject Descriptors

H.I.2.2 Models and Principles: User/Machine System | H.I.2.3 Design and Evaluation Methods: H.I.2.3.2 Evaluation and Presentation | User Interfaces—Collaborative computing, Computer-supported cooperative work, Evaluation/theory, User-centered design

General Terms

Design, Human Factors

Perception, Persuasion, nonverbal immediacy, nonverbal cues, game, gesture, presence, vocal tone

1. INTRODUCTION

In society, the concept of *cheating* is largely tied with violation, anger, and revenge. For example, Bilge Mutlu initiated a large-scale fraudulent investment operation, which resulted in the recovery of \$61.8 billion from thousands of investors (Frank, Eifert, Iaccetti, & Bray, 2009). A judge sentenced Madoff to 150 years in prison and hundreds of millions of dollars in restitution. Thus, society viewed Madoff's cheating as highly unethical and infamous. Similar rules about cheating are also applied to sporting events, children's games, schoolwork, and video games. For example, when humans are playing video games against other humans, cheating is not accepted if one player cheats in the game world; other players either resort to shooting themselves or disengaging entirely with the game (Kubas, Terpna, Cilia, & Buchmann, 2005).

When it comes to computer-controlled agents, cheating is not only the norm; the human competitor generally accepts it (Fairclough, Fagan, Mac Namee, & Cunningham, 2001). That is, in order to construct a realistic and evenly matched competitor, designers must create algorithms that allow the agents to "see" through walls and to locate the user's position in space. The human competitor is often willing to disengage with the game; rather, he or she is aware on some level that this subtle form of cheating is necessary in order for the game to possess an aspect of challenge (Fairclough et al., 2001). Interestingly, little empirical evidence has been collected and analyzed regarding a cheating agent controlled by the computer. This paper will study the effects of the ethicality of cheating in video games in order for designers to be able to create video games that are more enjoyable, interactive, and engaging. These theoretical models will help to explain possible effects of cheating in a game.

Robotics hold great promise for several tasks that may potentially affect and improve people's motivation and compliance [1]. For example, robots can assist patients with physical therapy [2], the success of these robots in motivating people with physical disabilities to move again is well-known [3]. The question is, "How can we design persuasive robots?" And how can we design persuasive behaviors?

Research in human communication has identified a number of key factors that influence the effectiveness of verbal and nonverbal communication [4]. These attributes play a key role in persuading others to accept a particular message or action. For example, facial body cues such as proximity, gaze, and smile are important for the effectiveness of persuasion [5]. The degree of perceived bodily and verbal immediacy—the degree of perceived bodily and verbal immediacy—can increase the persuasiveness of a message [6]. These attributes are also important for the effectiveness of nonverbal communication [7].

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While existing work highlights the importance of persuasion in human-robot interaction and provides some guidelines for

persuasion in human-robot interaction, there is still much work to be done.

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Is cheating a human function? The roles of presence, state hostility, and enjoyment in an unfair video game^{1,2,3}

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ABSTRACT
Emerging wearable and mobile communication technologies, such as lightweight head-mounted displays (HMDs) and handheld devices, provide new opportunities for remote collaboration. Despite their potential for widespread use, their effectiveness in supporting remote collaboration is unknown, particularly in physical tasks involving motion. To better understand the impact of collaborative behaviors, perceptions, and performance, we conducted two experiments. In the first experiment, we tested computer-cheating, players perceived the opponent as being more hostile, causing more aggression and presence, but does not affect the level of enjoyment. In the second experiment, we tested the effect of the robot's presence on the computer-controlled significantly less state hostility compared to players that were less certain of the nature of their competitive behaviors. Our findings suggest that video games can integrate subtle levels of cheating into computer opponents without any negative responses from the players. The results indicate that more levels of cheating might also increase player engagement with video games.

Figure 1. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 2. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 3. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 4. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 5. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 6. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 7. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 8. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 9. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 10. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 11. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 12. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 13. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 14. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 15. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 16. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 17. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 18. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 19. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 20. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 21. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 22. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 23. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 24. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 25. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 26. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 27. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 28. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 29. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 30. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 31. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 32. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 33. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 34. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 35. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 36. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 37. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 38. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 39. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

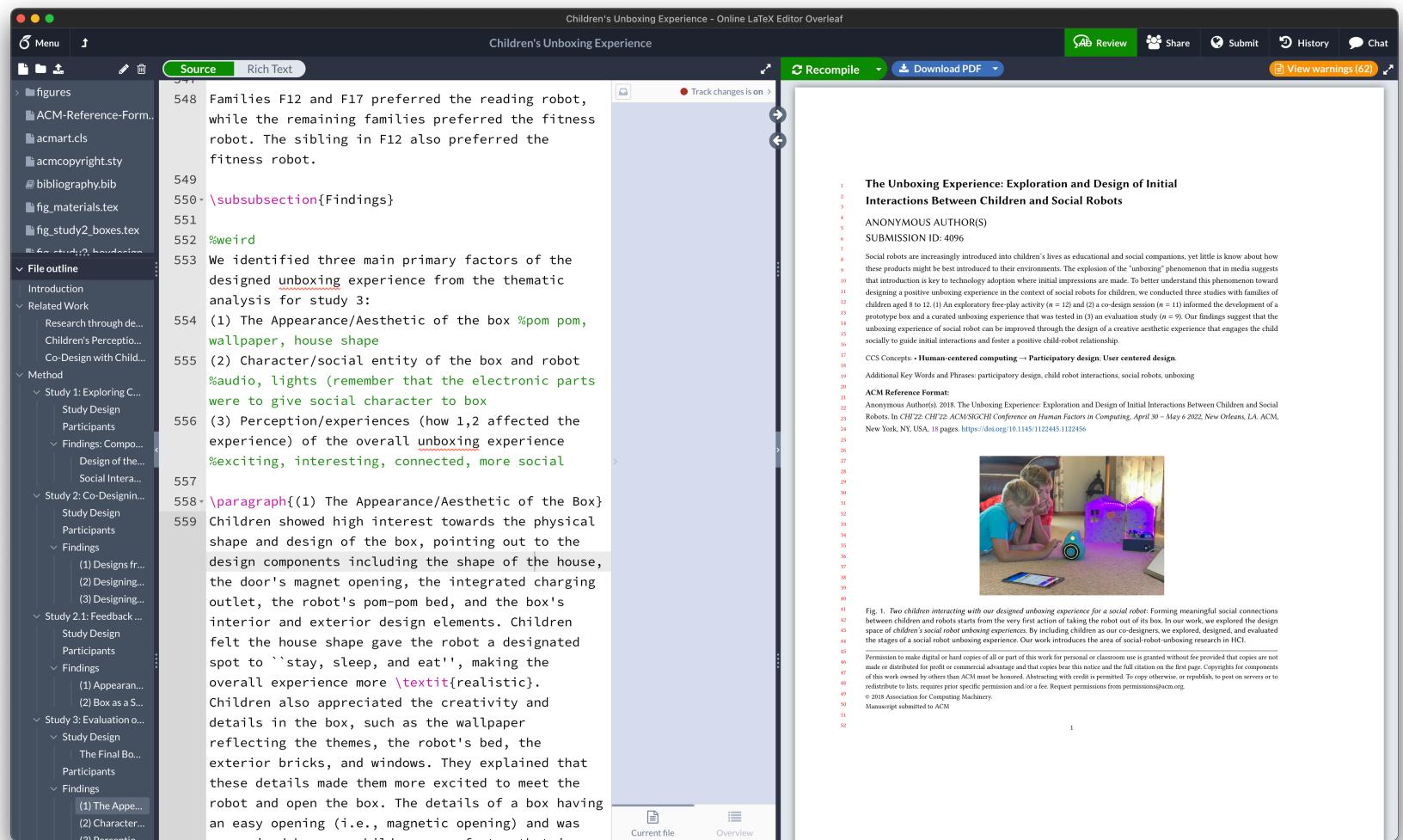
Figure 40. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 41. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user was seated at a desk and the robot was seated at a separate desk. The robot was connected to the user via a video link.

Figure 42. Participants remotely collaborated in pairs using either a tablet or an HMD as a communication task. In one of our settings, a static task setting, the user and robot were seated side-by-side. In the dynamic task setting, the user

Project Milestones & Deliverables

- » Project Topic (Today)
- » Literature survey, RQs
- » Method
- » Data
- » Analysis, results
- » Final paper



Algorithm

Topic Selection & Team Formation

- » Given a set of keywords
 - » **Step 1:** Individual Discovery, Interest Development — 10 min
 - » **Step 2:** Construct Topics from Keywords — 10 min
 - » **Step 3:** Refine Ideas through Search & Discussion — 20 min

Technologies

- » LLMs, AI chatbots, VLMs, gen-AI
- » AR/VR
- » Agents, robots, digital assistants & companions
- » Wearable devices, smartwatches, on-body interaction, haptics
- » Smart homes, cities
- » Assistive technologies
- » Autonomous systems
- » Remote presence, telepresence robots
- » Physiological sensing (e.g., EEG, eye tracking)
- » Fabrication, 3D printing

Contexts & Populations

- » Older adults & assisted living
- » Workplace, meetings, collaboration
- » VIPs & the blind
- » Whellchair users
- » Learning or developmental disabilities
- » Parents, families, & the home
- » Learning & children
- » Vulnerable populations (chronic illnesses, low income/poverty, homelessness)
- » Health, disease management
- » Driving, transportation, navigation
- » Behavior change, wellbeing, mental health

Contribution Types

- » Artifact, system, design
- » Empirical study of people to inform design
- » Empirical study of people using a system
- » Survey, scoping/systematic reviews¹

¹Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach

Perspectives

- » Accessibility, usability
- » Building new capabilities
- » Discovering new techniques
- » Understanding user perceptions, experience, trust
- » Understanding adoption, failures, harm
- » Ethical & responsible design
- » Understanding new, emerging phenomena

Step 1

Individual Discovery, Interest Development — 10 min

- » Spend 10 minutes individually to digest keywords
- » Search for these keywords to see what kinds of papers they point to
 - » [CHI 2023 Program](#), [CHI 2022 Program](#)

Step 2

Construct Topics from Keywords — 10 min

- » Combine technologies, contexts, perspectives, contributions types that are of interest to you
- » Take cards and go to a booth, or go to a booth that sounds interesting to you
- » Spend 10 minutes chatting with others at the booth

Examples

- » **Context/population:** The blind, navigation
- » **Technology:** Robots
- » **Contribution Type:** Artifact
- » **Perspective:** Building new capabilities



PathFinder: Designing a Map-less Navigation System for Blind People in Unfamiliar Buildings

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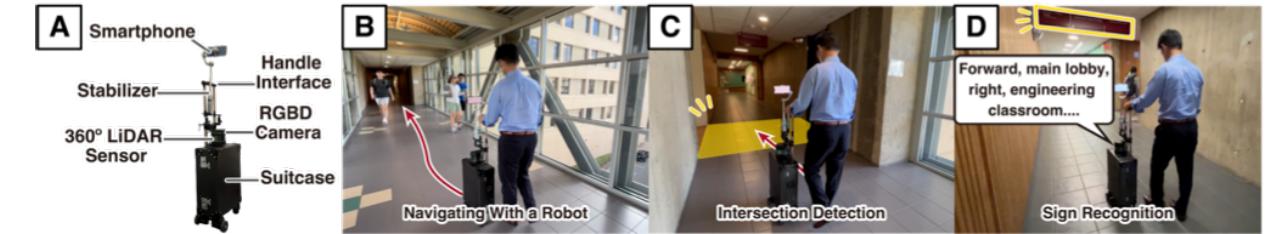


Figure 1: We present PathFinder, a map-less navigation system that can navigate blind people in unfamiliar buildings by detecting intersections and recognizing signs.

ABSTRACT

Indoor navigation systems with prebuilt maps have shown great potential in navigating blind people even in unfamiliar buildings. However, blind people cannot always benefit from them in every building, as prebuilt maps are expensive to build. This paper explores a map-less navigation system for blind people to reach destinations in unfamiliar buildings, which is implemented on a robot. We first conducted a participatory design with five blind people, which revealed that intersections and signs are the most relevant information in unfamiliar buildings. Then, we prototyped PathFinder, a navigation system that allows blind people to determine their way by detecting and conveying information about intersections and

signs. Through a participatory study, we improved the interface of PathFinder, such as the feedback for conveying the detection results. Finally, a study with seven blind participants validated that PathFinder could assist users in navigating unfamiliar buildings with increased confidence compared to their regular aid.

CCS CONCEPTS

- Human-centered computing → Accessibility systems and tools;
- Social and professional topics → People with disabilities.

KEYWORDS

visual impairment, orientation and mobility, intersection detection, sign recognition

ACM Reference Format:

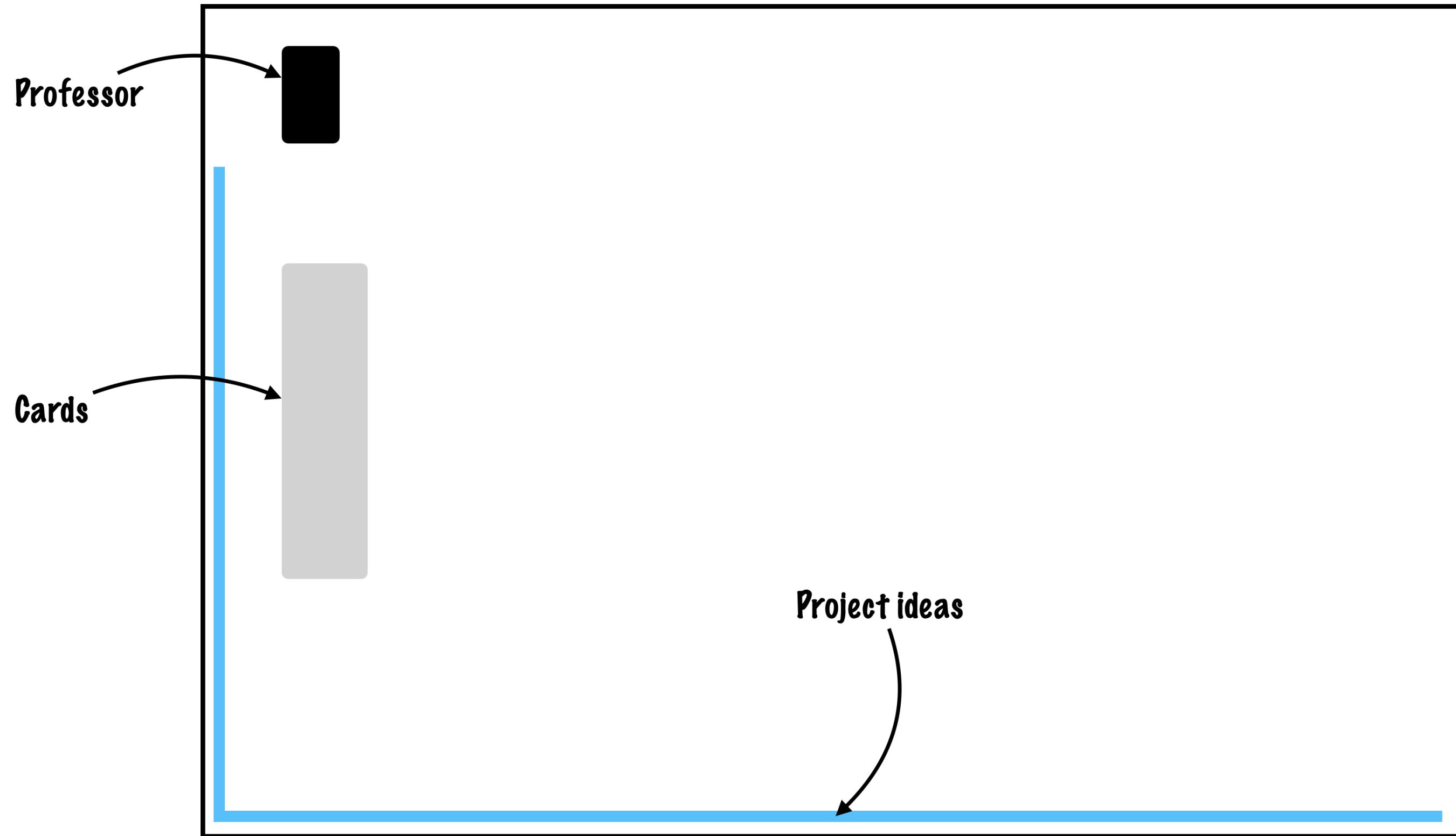
Masaki Kuribayashi, Tatsuya Ishihara, Daisuke Sato, Jayakorn Vongkulbhaisal, Karnik Ram, Seita Kayukawa, Hironobu Takagi, Shigeo Morishima, and Chieko Asakawa. 2023. PathFinder: Designing a Map-less Navigation System for Blind People in Unfamiliar Buildings. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems (CHI '23)*, April 23–28, 2023, Hamburg, Germany. ACM, New York, NY, USA, 16 pages. <https://doi.org/10.1145/3544548.3580687>

Tips

- » Understand the limitations of this process
- » Most combinations will be non-sensical, but some will be interesting
- » Find topics that are of clear value to study, beneficial to society, to science, etc.
 - » Problems worth studying must be: *not studied/understudied, significant/impactful, pervasive/frequent, persistent*
- » Choose perspectives that you are inclined to take
- » Important to find teammates you click with

Q&A

- » Q: Can I bring my own research into this?
 - » A: Yes. The technology, context/population, and/or perspective can come from your research. ideally, you will convince two of your classmates to work with you.



Step 3

Refine Ideas through Search & Discussion — 20 min

- » As a team, spend 10 minutes looking through papers you can find on your constructed topic
- » Spend another 10 minutes to discuss ideas toward refining your topic
- » Capture your team and topic in [this spreadsheet](#)

Q&A

- » Q: Will we have access to technology, platforms, funds/resources?
 - » A: Yes, within reasonable limits. You can borrow equipment from my lab. For participant samples, most teams will use classmates, friends, roommates. In general, we will try to be resourceful (e.g., reserve a room at the union/library to run studies).
- » Q: Can we change any part of our topic?
 - » A: Yes, you are committing to a starting place. You will shift and adapt different facets of your project topic along the way.

Next Steps

- » Congratulations! You have a project topic and a team 
- » Next project milestone is **literature review, research question**
 - » Due in two weeks
 - » Become familiar with ~30 papers on the topic you chose
 - » Build conceptual maps, identify gaps and opportunities
 - » Develop and refine a research question
 - » Write and submit a "related work" section