

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*.

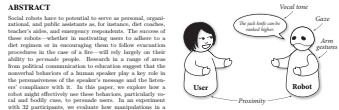
- » Friday class time for team meetings, milestone kickoffs, and feedback sessions
- » Ideally teams of 3, fewer or more should be exceptions
- » 40 + 20% of your total grade, integrates team member evaluations
- » Incrementally write a full-length (~10-pages) paper potentially submittable to an HCI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

2012

Chidambaram et al.

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, companion, and public interfaces for education, data collection, teacher's aides, and emergency responders. The success of these robots relies on convincing users to interact with a robot through an entertaining, fun, and social interaction. In this paper, we investigate the role of vocal and nonverbal cues in the use of a fun – but not largely on their ability to persuade people. Results from a series of studies from political communication, an education expert that the nonverbal behavior of a human speaker play a key role in the persuasion of the speaker's message and the listener, and compliance with the speaker. We explore how a social robot designed to persuade people, specifically, to vote, can use vocal and nonverbal cues to persuade users. In an experiment with 32 participants, we compare how nonverbal cues in a robot's use of nonverbal cues affected participants' group-level decision-making and their compliance with the robot's suggestions across four conditions: (1) no vocal or nonverbal cues, (2) vocal cues only, (3) nonverbal cues only, and (4) vocal and nonverbal cues. The results indicate that participants complied with the robot's suggestions significantly more when it used nonverbal cues than when it did not use vocal cues and that vocal cues were more effective in persuading participants in the design of persuasive behavior for persuasive nonverbal cues and experimental results have shown that nonverbal cues are more effective than vocal cues in persuading people. We discuss the implications of these findings for the design of persuasive behavior for social robots.

Keywords: Persuasion, compliance, nonverbal cues, nonverbal cues, gaze, posture, nonverbal cues, vocal cues.

1. INTRODUCTION
Robots hold great promise as social agents that may positively affect and improve people's motivation and engagement in such areas as education [2], health [3], and well-being [2]. The success of these robots relies on their ability to persuade people to interact with them. In this paper, we investigate the role of vocal and nonverbal cues in the persuasion of the speaker's message and the listener, and compliance with the speaker. We explore how a social robot designed to persuade people, specifically, to vote, can use vocal and nonverbal cues to persuade users. In an experiment with 32 participants, we compare how nonverbal cues in a robot's use of nonverbal cues affected participants' group-level decision-making and their compliance with the robot's suggestions across four conditions: (1) no vocal or nonverbal cues, (2) vocal cues only, (3) nonverbal cues only, and (4) vocal and nonverbal cues. The results indicate that participants complied with the robot's suggestions significantly more when it used nonverbal cues than when it did not use vocal cues and that vocal cues were more effective in persuading participants in the design of persuasive behavior for persuasive nonverbal cues and experimental results have shown that nonverbal cues are more effective than vocal cues in persuading people. We discuss the implications of these findings for the design of persuasive behavior for social robots.

Categories and Subject Descriptors: H.1.2 Models and Protocols; H.5.2 Information Interfaces and Presentation; I.2.7 Natural Language Processing; I.2.8 Human-Computer Interaction; I.2.9 Personalization; I.2.10 Data Abstraction, Retrieval, and Organization; I.2.11 Knowledge Representation

General Terms: Design, Human Factors

200 citations

2012

De Simone et al.

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

J.J. De Simone¹, Tessa Verbruggen, Li-Hsiang Kuo, Bilge Mutlu

Abstract
In sports and board games, when an opponent cheats, the other players typically greet it with disdain, anger, and disappointment. However, work has yet fully address the role of the computer cheating in video games. In this study, participants played either a cheating or a non-cheating version of a modified open source tower-defense game. Results indicate that when a computer opponent cheats, players perceive the opponent as being more human. Cheating also increases player aggression and presence, but does not affect enjoyment of the experience. Additionally, players that found cheating to be more enjoyable were more likely to cheat themselves. Our results show that, in the dynamic task, HMD use enabled helpers to offer more frequent directing commands and more proactive assistance, resulting in marginally faster task completion. In the static task, while tablets use helped convey subtle visual information, helpers and workers had conflicting perceptions of how the two technologies contributed to their success. Our findings offer strong design and research implications, underscoring the importance of a consistent view of the shared workspace and the differential support capabilities with different roles receive from technologies.

1. Introduction
In society, the concept of cheating is largely met with disdain, anger, and revenge. For example, Bernie Madoff enacted a largescale fraudulent investment operation, which resulted in the theft of \$64.8 billion from thousands of investors (Frank, Eroni, Lucchetti, & Bray, 2009). A judge sentenced Madoff to 150 years in prison and hundreds of billions of dollars in restitution. Thus, society viewed Madoff's cheating as highly unethical and inhuman. 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 human gamers, cheating is not accepted. If one player cheats in the game world, other players either resort to cheating themselves or disengage entirely with the game (Kabus, Terpsita, Cilia, & Hochmann, 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 or use other means to locate the human player's avatar. The human player does not 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 presents a study that begins to analyze the effects of the computer cheating in video games in order for designers to be able to create video games that are more enjoyable, immersive, and engaging. Two theoretical models will help to explain possible effects of cheating in a game.

¹ University of Wisconsin-Madison, Department of Computer Sciences provided financial support for this research.
² A preliminary version of this manuscript has been presented at the 2012 Association for Information Systems and Mass Communication Conference.
³ Authors thank Karyn Rakita for her valuable comments.

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12 citations

2015

Johnson et al.

Handheld or Handsfree? Remote Collaboration via Lightweight Head-Mounted Displays and Handheld Devices

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Figure 1. Participants remotely collaborated to pour water into a bottle in an HMD in a construction task in one of two task settings: a static task setting, requiring low levels of mobility, or a dynamic task setting, requiring high levels of mobility.

ABSTRACT
Emerging wearable and mobile communication technologies, such as lightweight head-mounted displays (HMDs) and handheld devices, promise support for everyday remote collaboration. Despite their potential for widespread use, their effectiveness as collaborative tools is unknown, particularly in physical tasks involving mobility. To better understand their impact on collaborative behaviors, perceptions, and performance, we conducted a two-by-two (technology type: HMD vs. tablet computer; task setting: static vs. dynamic) between-subjects study where participants ($n = 60$) remotely collaborated as "helper" and "worker" pairs in the construction of a physical object. Our results showed that, in the dynamic task, HMD use enabled helpers to offer more frequent directing commands and more proactive assistance, resulting in marginally faster task completion. In the static task, while tablets use helped convey subtle visual information, helpers and workers had conflicting perceptions of how the two technologies contributed to their success. Our findings offer strong design and research implications, underscoring the importance of a consistent view of the shared workspace and the differential support capabilities with different roles receive from technologies.

ACM Classification Keywords: H.5.3 Information Interfaces and Presentation; Group and Organization Interfaces; Collaborative Computing, Computer-supported cooperative work; Evaluation/Human-Computer Interaction

General Terms: Human Factors; Performance; Experimentation

Author Keywords: Computer-supported cooperative work; remote collaboration; videoconferencing; head-mounted displays (HMDs); wearable computing; handheld devices; tablet computers

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48 citations

2017

Rakita et al.

A Motion Retargeting Method for Effective Mimicry-based Teleoperation of Robot Arms

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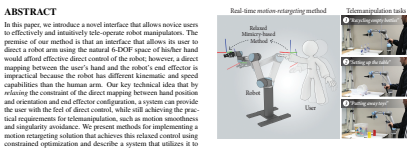


Figure 1. We propose a mimicry-based teleoperation method that uses relaxed constraints on the mapping between a user and a robot arm as an effective real-time control mechanism and evaluate it in three teleoperation tasks that follow a home care scenario.

ABSTRACT
In this paper, we introduce a novel interface that allows novice users to effectively and intuitively teleoperate robot manipulators. The premise of our method is that an interface that allows its user to direct a robot arm using the natural 8DOF space of his/her hand would afford effective direct control of the robot, however, a direct mapping between the user's hand and the robot's end effector is impractical because the robot has different kinematic and speed capabilities than the human arm. Our key technical idea is by relaxing the constraint of the direct mapping between hand position and orientation and effective collaboration, a system can provide the user with the feel of direct control, while still achieving the practical requirements for teleoperation, such as motion smoothness and compliance avoidance. We present methods for representing a motion retargeting solution that achieves this relaxed control using constrained optimization and describe a system that utilizes it to provide real-time control of a robot arm. We demonstrate the effectiveness of our approach in a user study that shows novice users can complete a range of tasks more efficiently and enjoyably using our relaxed-mimicry based interface compared to standard interfaces.

1. INTRODUCTION
Teleoperation systems, where a human user controls a robot arm from a distance, are valuable in scenarios where automation is impractical, where human judgment is essential, or where having the user engaged in the task is desirable [2]. However, controlling a robot arm from a distance introduces a number of challenges, including limitations in the capabilities of human operators and technical challenges in effectively translating human operator commands into robot actions. While shared control strategies are often used to improve performance by providing higher-level control through automation, such strategies have limited applicability, as they require prior knowledge of user goals, target object locations, and feasible robot trajectories [29, 18, 24, 6, 16, 8]. Therefore, many applications involving teleoperation must rely on direct control of robot arms. While successful real-world applications of direct control exist, such as tele-surgery, these interfaces are designed for expert users with substantial skill and training. Broadcasting applications and the potential success of teleoperation, such as family caregivers providing remote home care for an older parent, require interfaces that are intuitive and effective to novice users.

The goal is to provide a direct control interface that will support applications such as remote home-care or tele-surgery that require considerable human judgment and involvement without the opportunity for extensive training in system operation [19, 14]. We posit that enabling users to work in the "natural" space of their arms will allow the user to draw on their inherent kinesthetic sense and ability to improve performance by providing higher-level control through automation, such strategies have limited applicability, as they require prior knowledge of user goals, target object locations, and feasible robot trajectories [29, 18, 24, 6, 16, 8]. Therefore, many applications involving teleoperation must rely on direct control of robot arms. While successful real-world applications of direct control exist, such as tele-surgery, these interfaces are designed for expert users with substantial skill and training. Broadcasting applications and the potential success of teleoperation, such as family caregivers providing remote home care for an older parent, require interfaces that are intuitive and effective to novice users.

42 citations

2021

Kang et al.

ToonNote: Improving Communication in Computational Notebooks Using Interactive Data Comics

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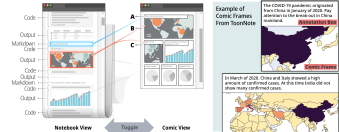


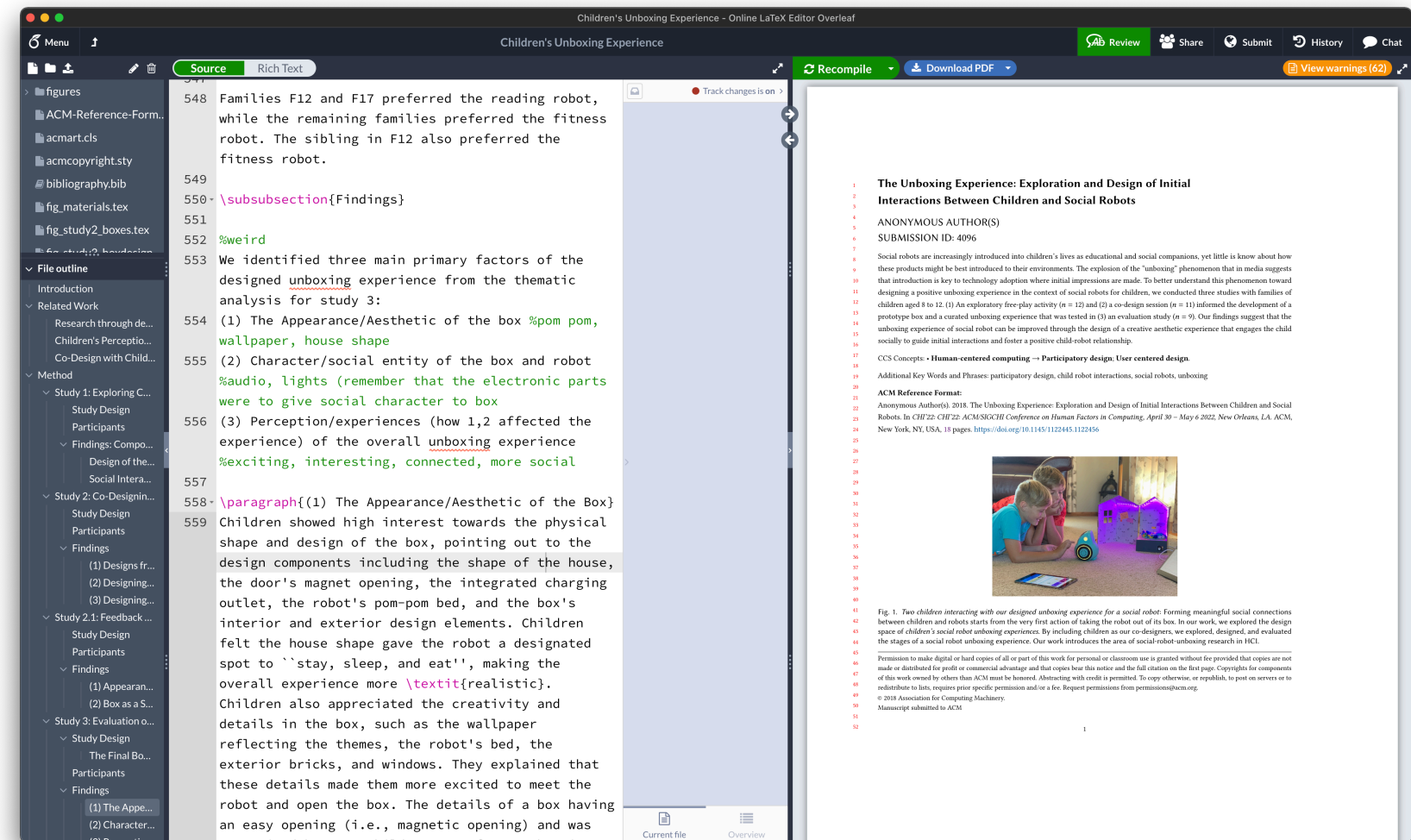
Figure 1. ToonNote is a novel technique for representing computational notebooks in the form of narrative data comics. ToonNote uses the traditional computational notebook format using a combination of multi-view data comics, which afford detailed analysis, but makes it difficult to easily comprehend the high-level story behind the data. Therefore, ToonNote provides a high-level, coherent narrative of the dataset in Comic View. The author can choose different narratives (A) and supports (B) which can be embedded in single or multiple (C) comic frames. When viewing the data in the Comic View, readers can focus on data storytelling, and not be hindered by code, unnecessary outputs, or worksheets – and can switch back to the Notebook View when needed.

ABSTRACT
Computational notebooks help data analysts analyze and visualise data, and share analysis procedures and outputs. However, notebooks typically combine code (e.g., Python scripts), tables, and complex (e.g., tables, graphs). The combination of different content types is hard to handle the comprehension of notebooks, making it difficult for authors to understand their readers' comprehension of the data. To simplify this problem, we introduce ToonNote, a hybrid-like interface that enables the construction of narrative data "comic stories" that facilitate quick and simplified view of a paper notebook, highlighting the most important results supporting the analysis and the objectives of the dataset. This paper presents the results of a literature study that motivated the system, its implementation, and an evaluation with 18 users, demonstrating the effectiveness of the produced comics. We discuss how our findings

1 citations

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

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

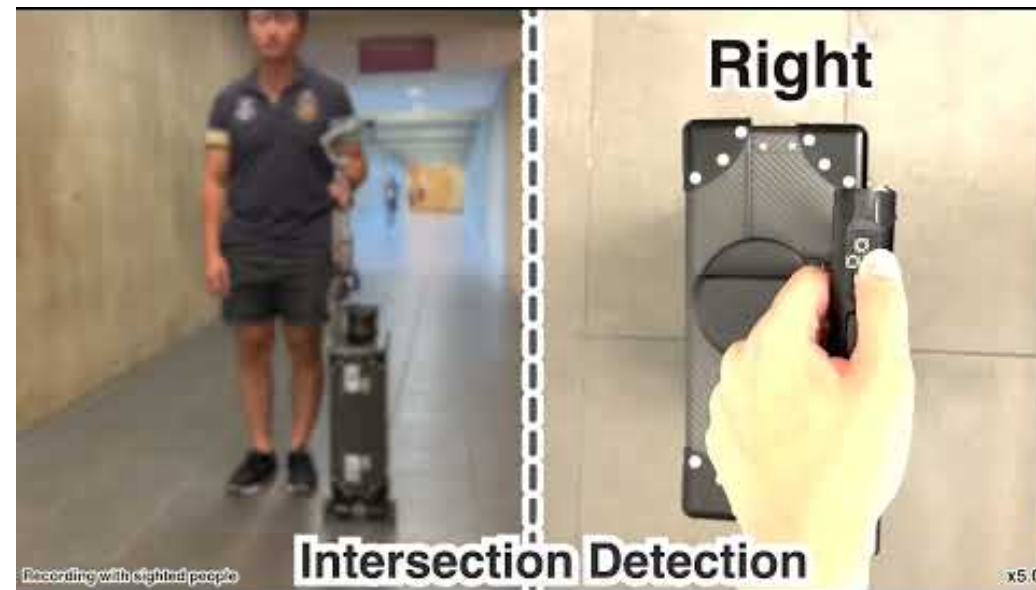
Step 2

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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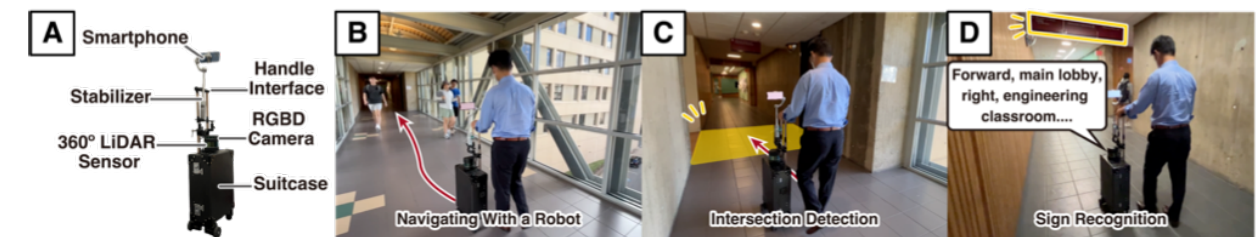


Figure 1: We present PathFinder, a map-less navigation system that can navigate blind people in unfamiliar buildings by detecting intersections and recognizing signs.

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 Vongkulbhisal, 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>

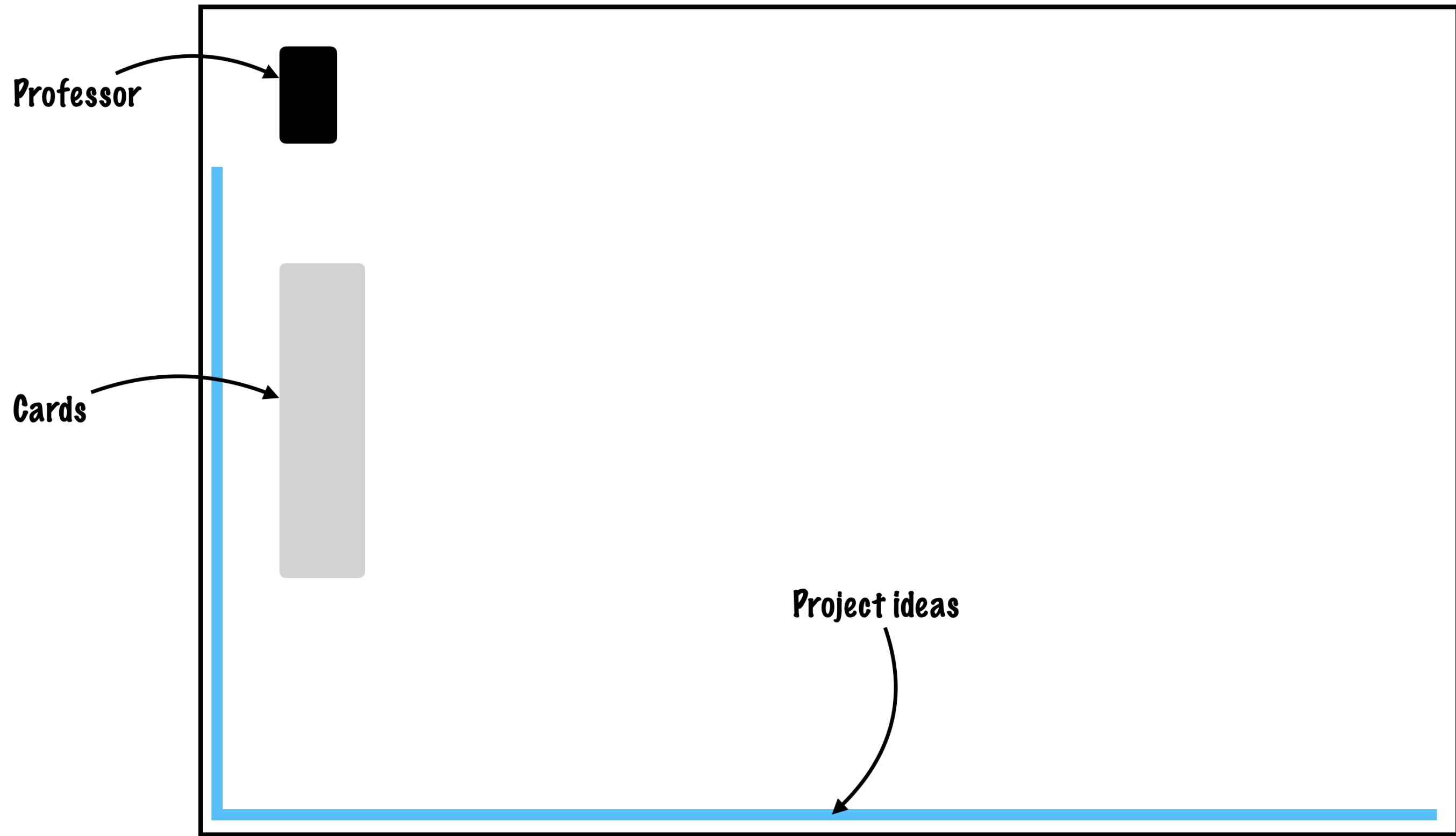
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<https://doi.org/10.1145/3544548.3580687>

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