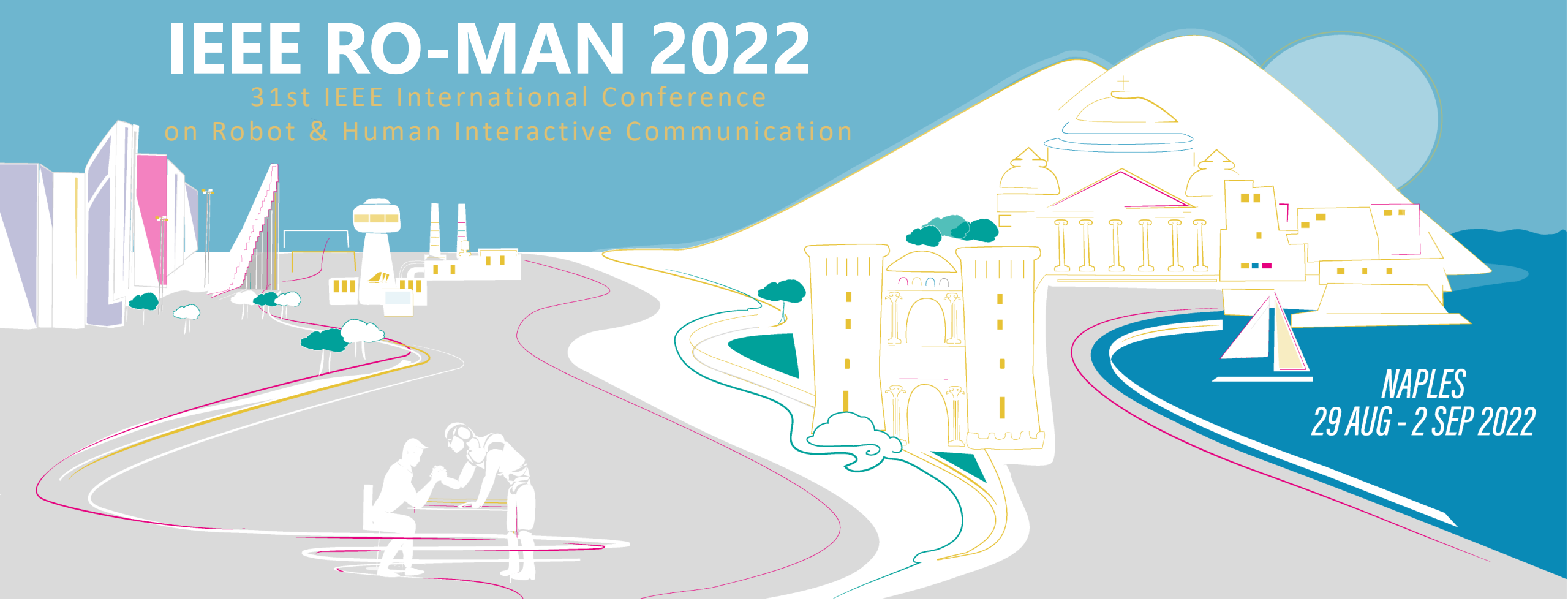
IEEE RO-MAN 2022

31st IEEE International Conference on Robot & Human Interactive Communication



How Users, Facility Managers, and Bystanders Perceive and Accept a Navigation Robot for Visually Impaired People in Public Buildings

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1. Waseda University 2. Miraikan - The National Museum of Emerging Science and Innovation 3. Carnegie Mellon University 4. IBM Research

Overview

AI-Suitcase: Navigation Robot for Blind People

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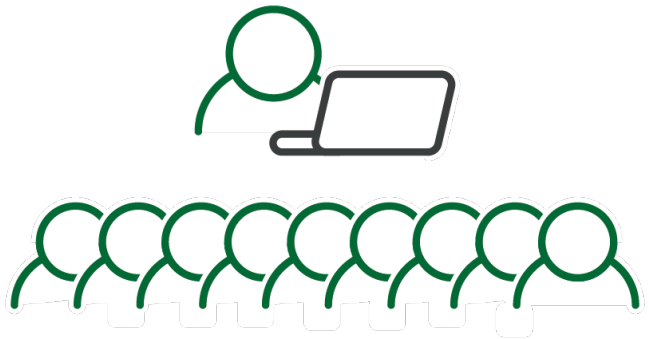
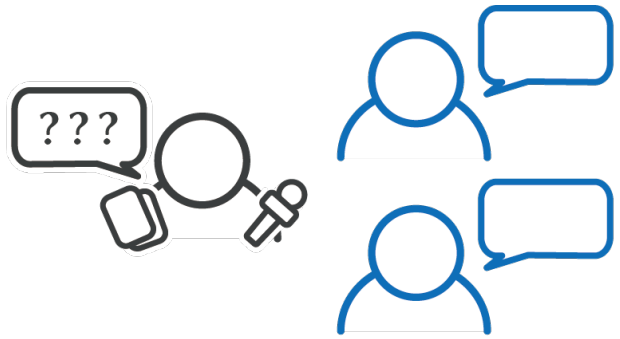
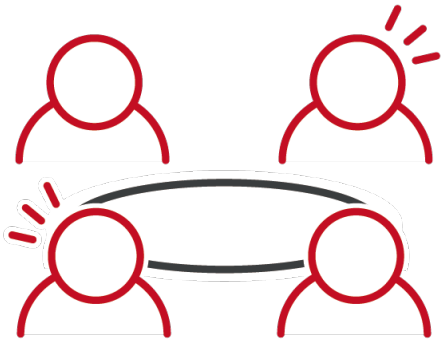
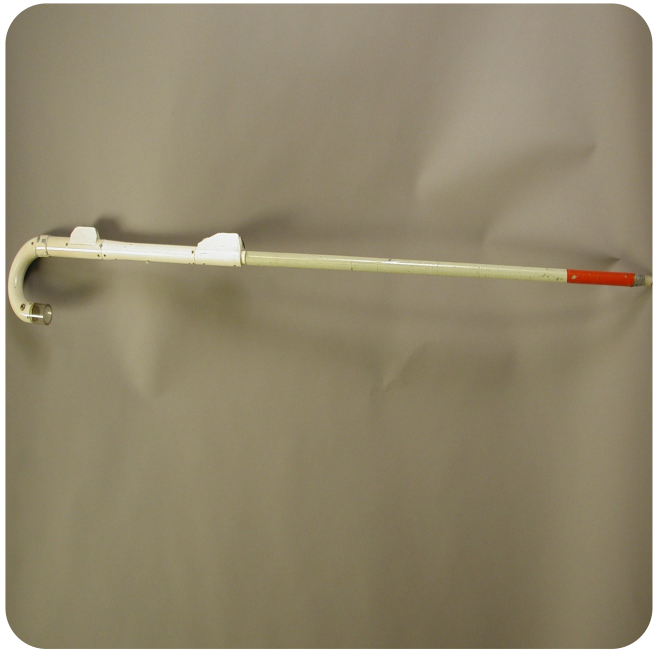
Overview

Three Studies into AI-Suitcase's Social Acceptance

1) Online Survey	2) Interview	3) Focus Group
		
300 Sighted People	15 Facility Managers	12 Blind People

Assistive Systems for Orientation and Mobility

LaserCane



Obstacle Detection

[Bionic Instruments ‘65]

NavCog

Smartphone-based Navigation

[Ahmetovic ‘16]

CaBot

Robotic Navigation

[Guerreiro ‘19]

Assistive Systems in Public Buildings

Blind User

By Standers

Facility Staff

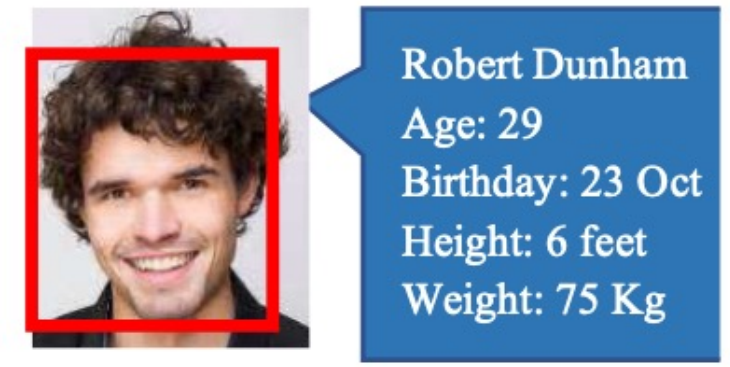
Assistive systems should obtain widespread acceptance by society

Social Acceptance of Assistive Systems

Wearable Camera

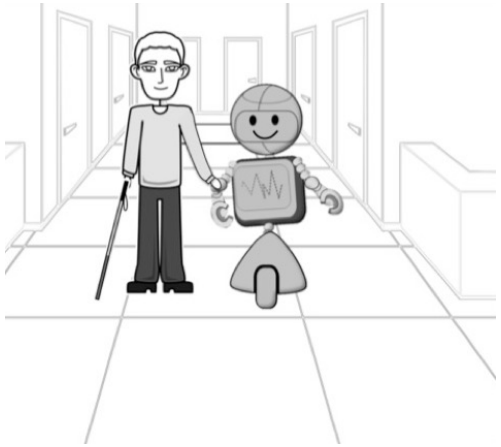
[Lee ‘20]

Computer Vision



[Ahmed ‘18]

Autonomous Robot

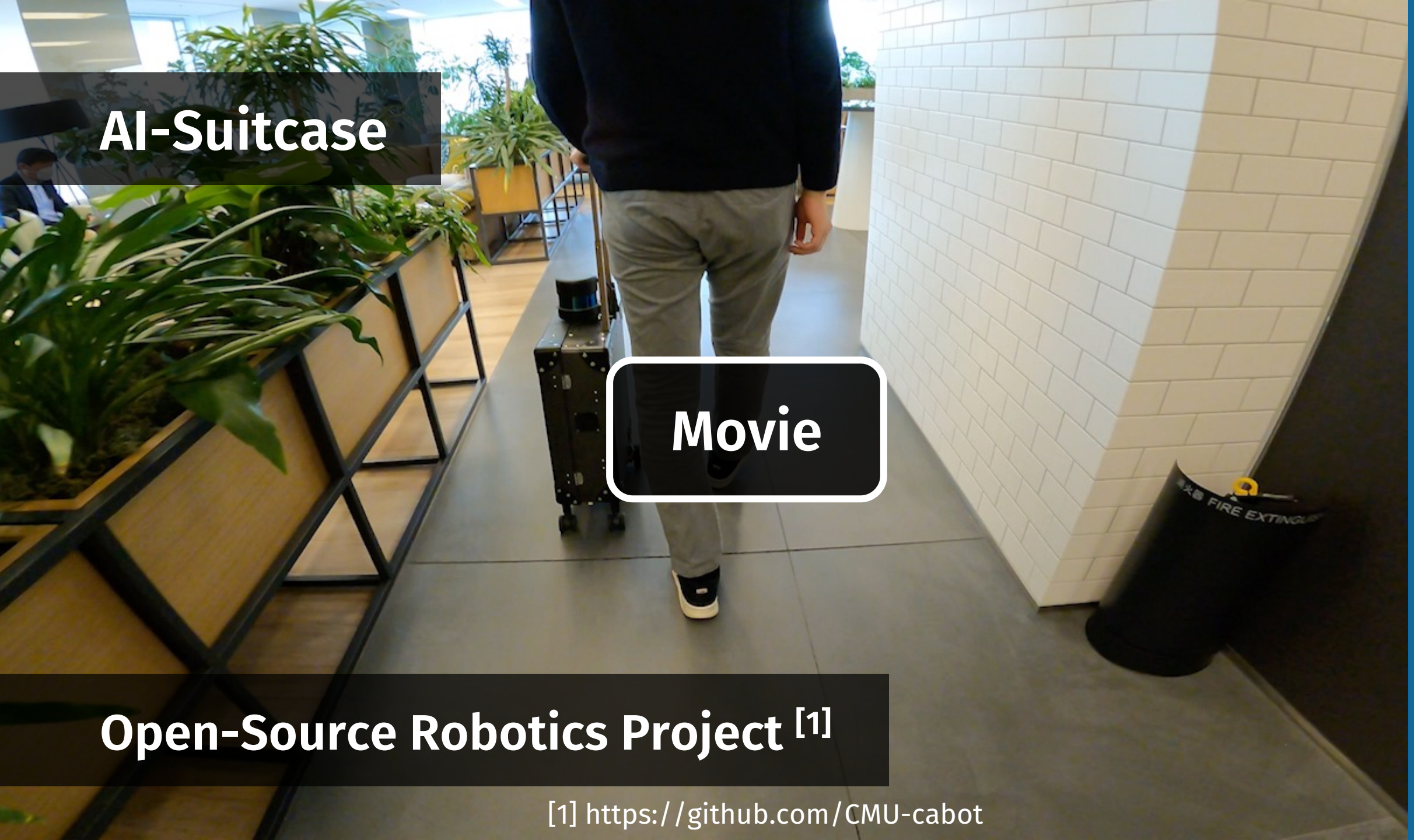


[Azenkot ‘16]

Blind User and Bystanders

Blind User only

Our studies’ targets are blind user, bystanders, and facility managers



AI-Suitcase

Movie

Open-Source Robotics Project [1]

[1] https://github.com/CMU-cabot

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Hardware

iPhone
Robot’s destinations control

RGBD-Camera
Pedestrian detection

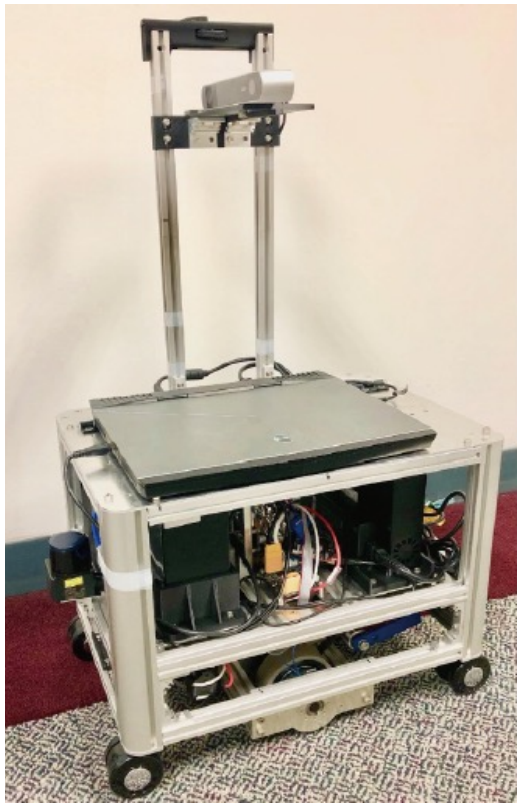
LiDAR
Localization & Obstacle Detection

CPU, Battery
Robot control

Motor
Autonomous driving

Design Principle

CaBot



[Guerreiro ‘19]

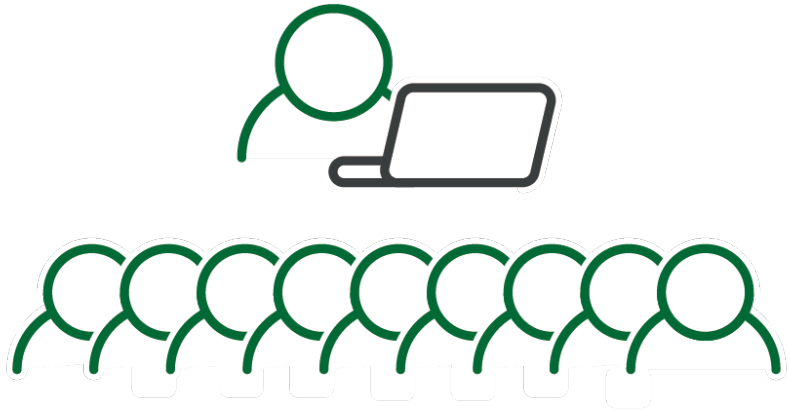
AI-Suitcase

Assemble the robot into a suitcase

The user and robot can

assimilate into the environment

Part 1, Online Survey of the Public



300 participants answered **their impressions of AI-Suitcase** after watching videos that presented the futures of AI-Suitcase.

Social Acceptance of Autonomous Robot

Security Robot

[Joseph '20]

Delivery Robot

[Pani '20]

AI-Suitcase

Robot only

Robot + User

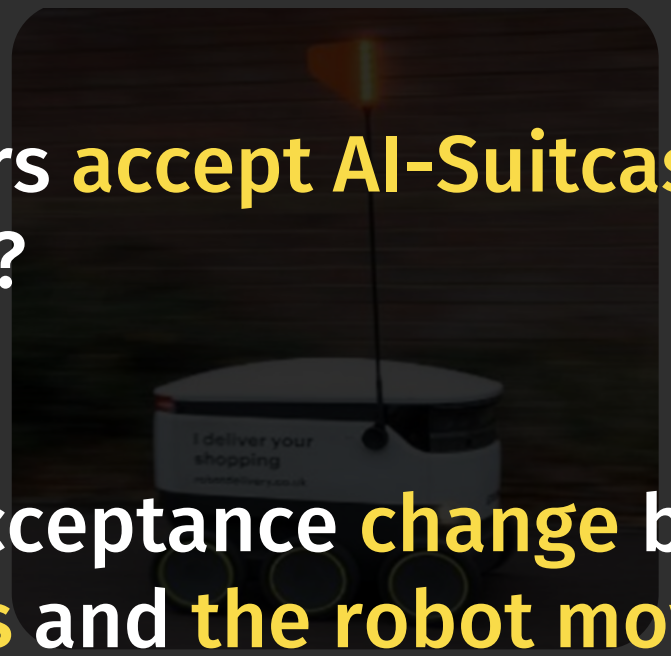
Social Acceptance of Autonomous Robot

Research Question

Security Robot

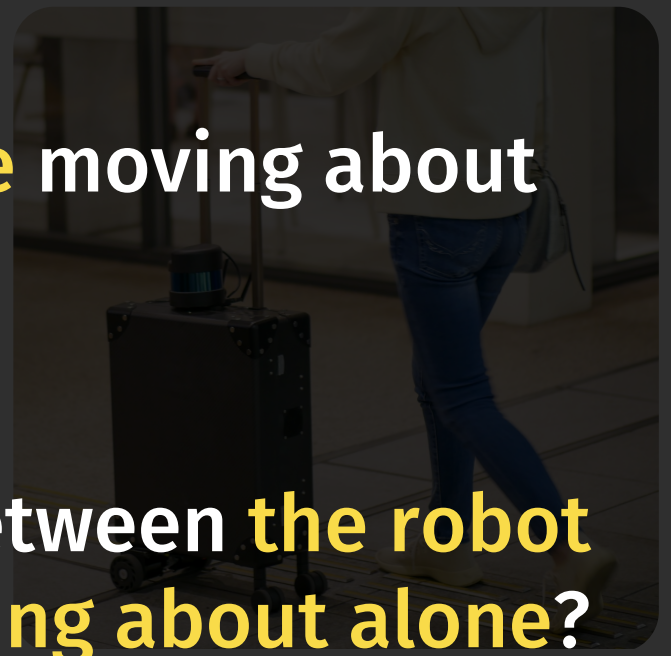
[Joseph '20]

Delivery Robot



[Pani '20]

Blind Navigation Robot



How will bystanders accept AI-Suitcase moving about in public buildings?

How does social acceptance change between the robot guiding blind users and the robot moving about alone?

Robot only

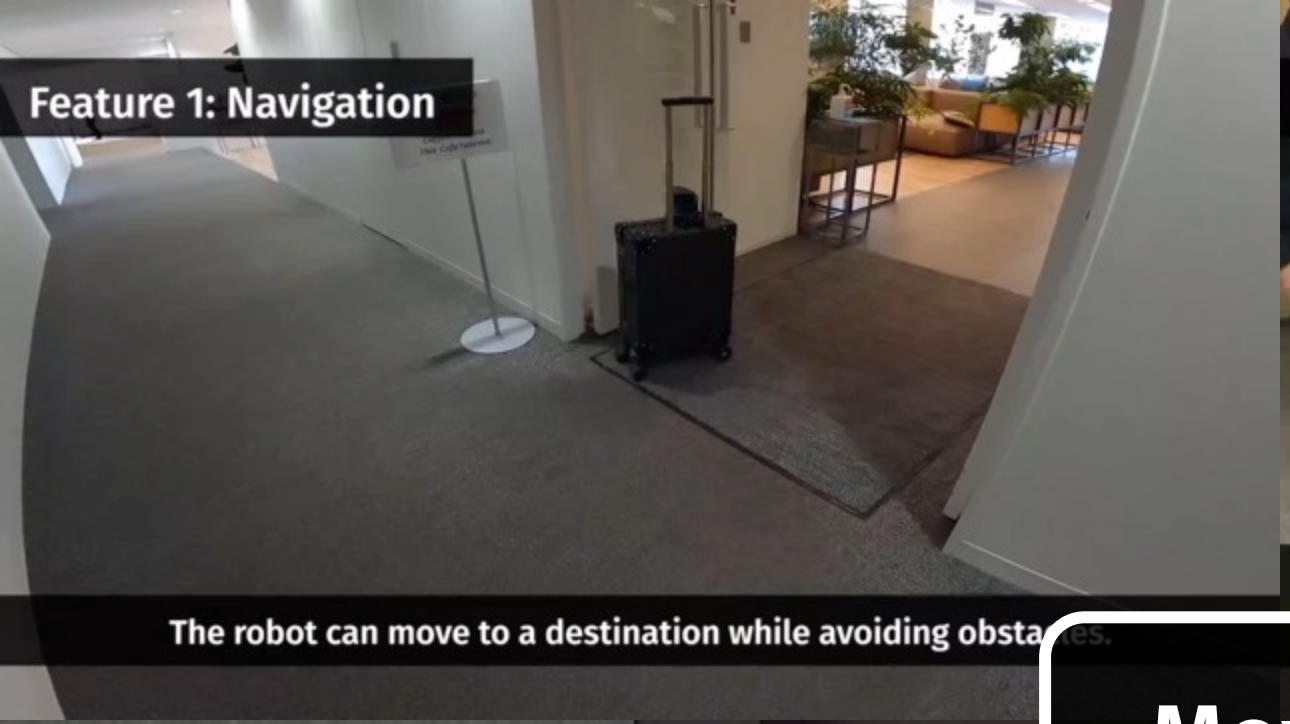
Robot + User

Video Stimuli

Watch two videos that present the future of AI-Suitcase

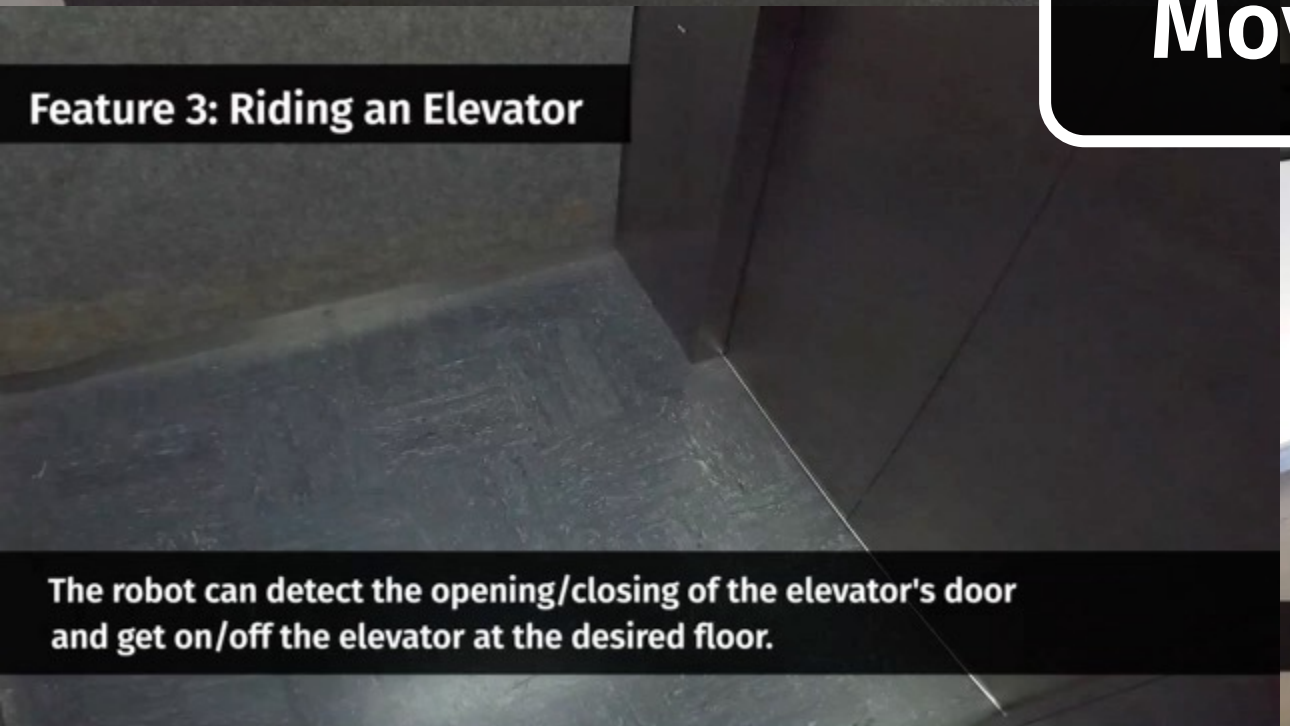
Robot only

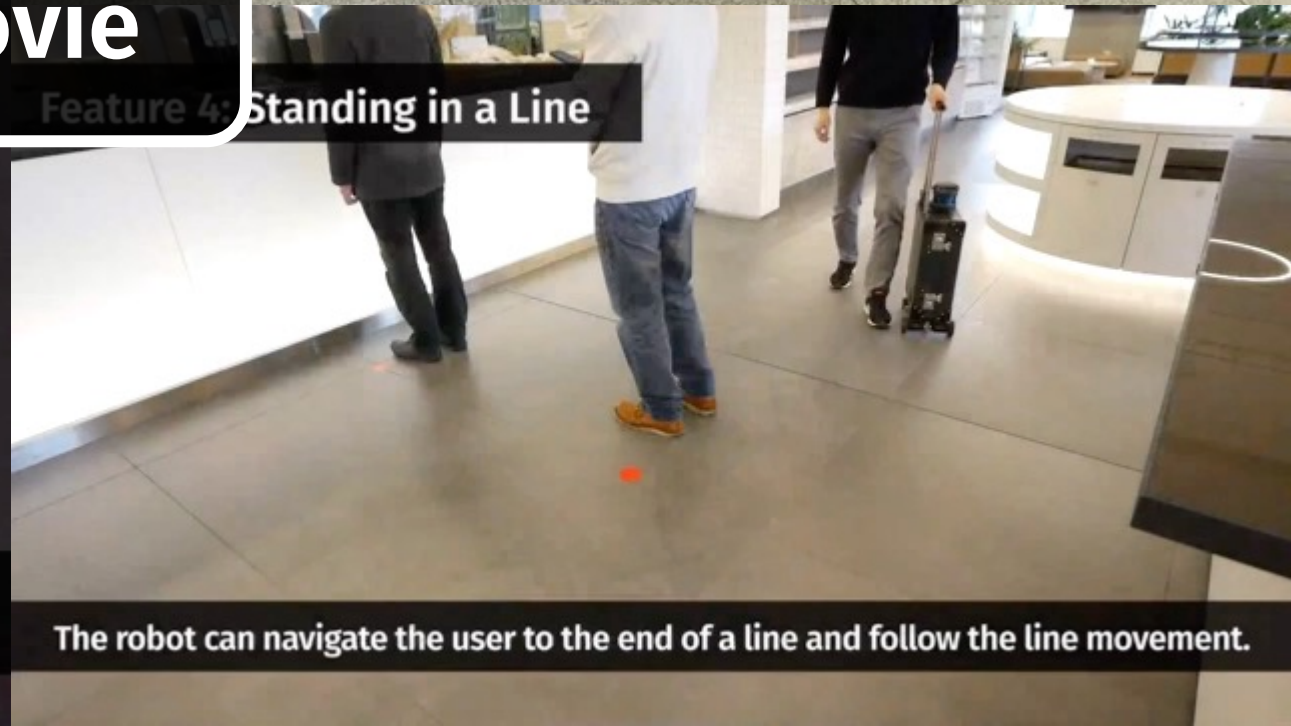
Robot + User


Feature 1: Navigation
The robot can move to a destination while avoiding obsta


Feature 2: Pedestrian Avoidance
The robot can avoid collisions with nearby pedestrians
if a pedestrian is going to cut across in front of the robot.

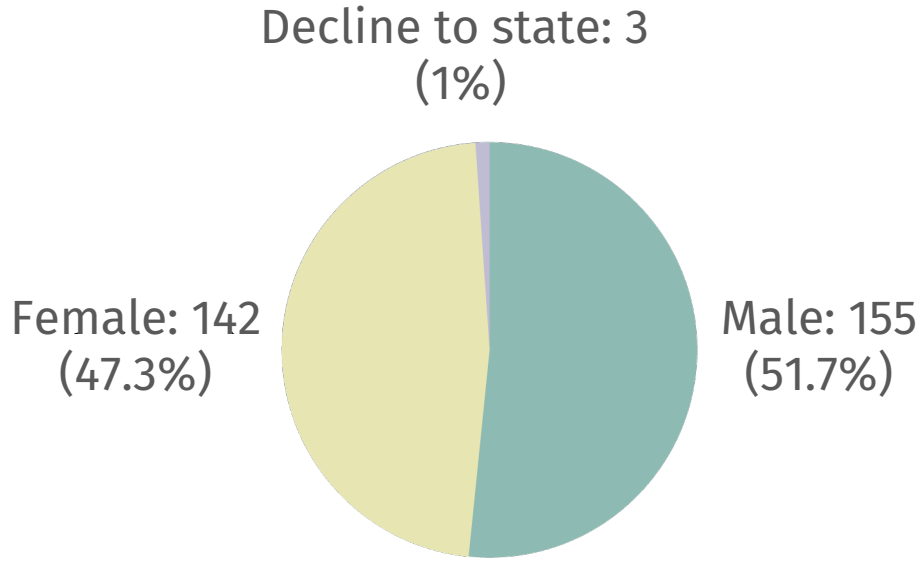
Movie


Feature 3: Riding an Elevator
The robot can detect the opening/closing of the elevator's door
and get on/off the elevator at the desired floor.

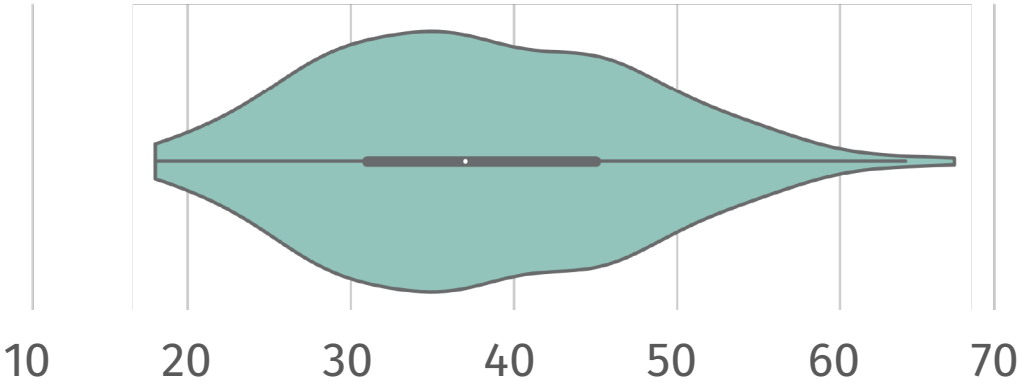

Standing in a Line
The robot can navigate the user to the end of a line and follow the line movement.

Participants

Gender



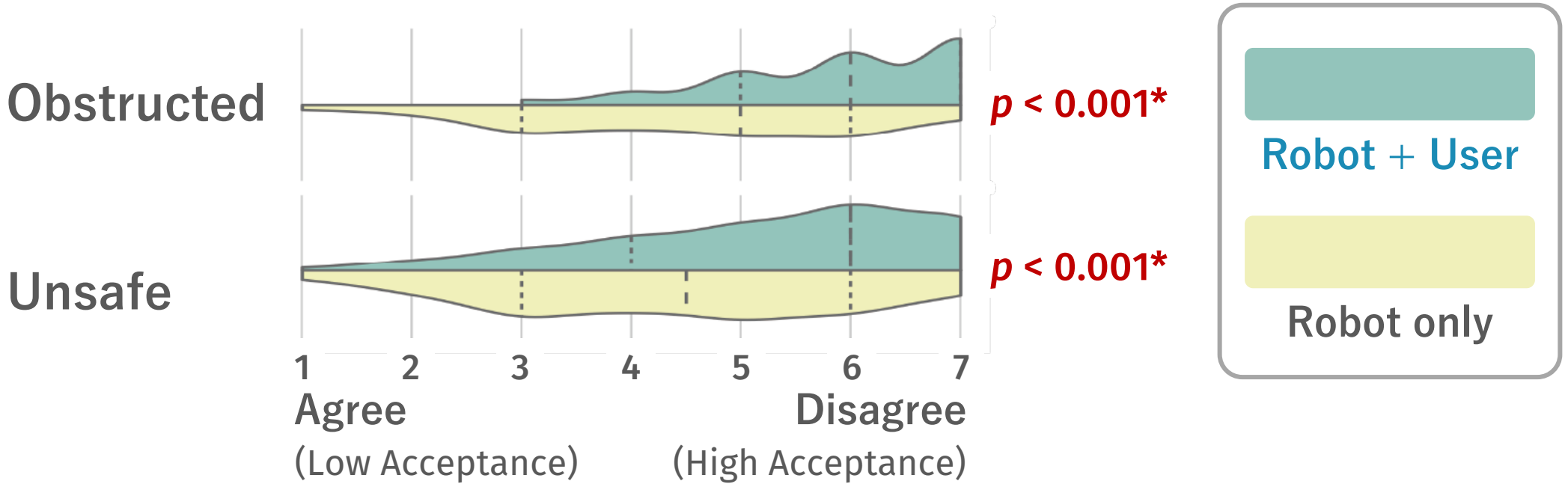
Age



18 ~ 67 (Mean = 37.94 and SD = 9.58)

Finding 1: Overall Acceptance

If the robot is moving about in public buildings, I would feel ...

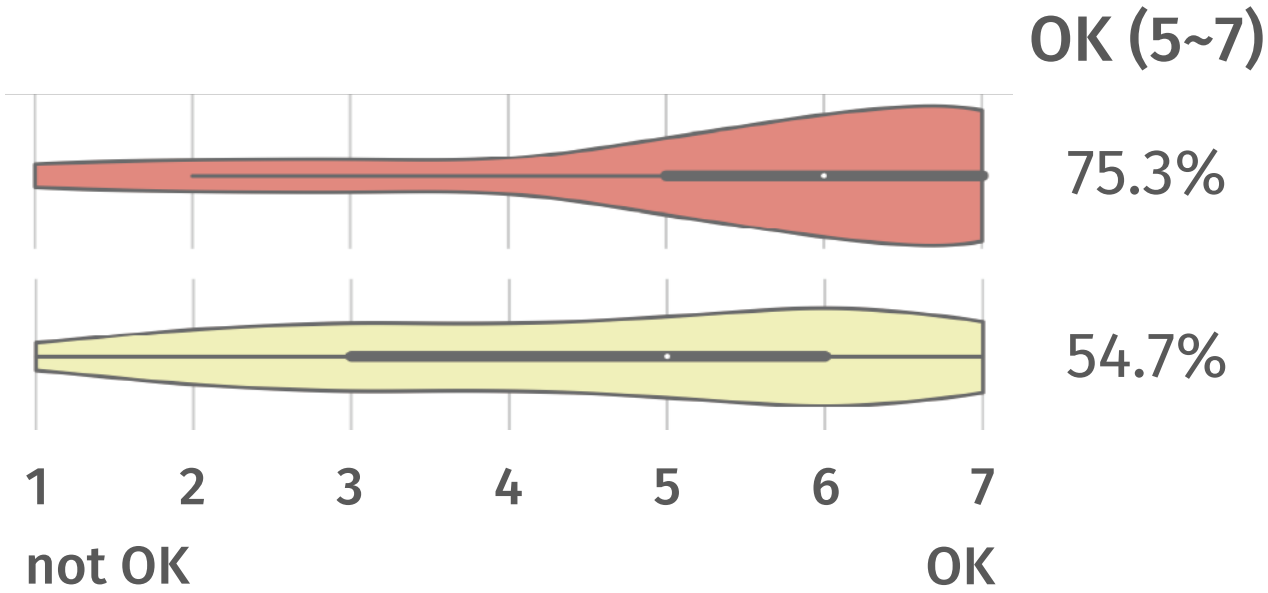


The robot guiding a user received significantly higher social acceptance than the robot moving about alone.

Finding 2: Camera Acceptance

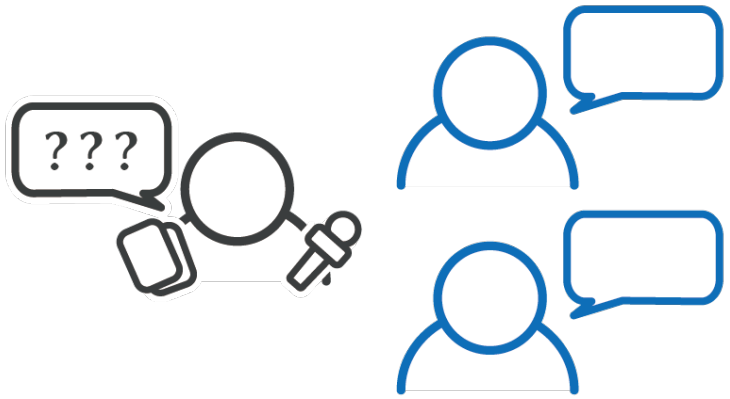
I am OK with the robot's camera capturing me if it is used for ...

(the captured data is used for one-time detection only and not saved)



The robot's camera will accepted if it is used for assisting blind people.

Part 2, Interview with **Facility Managers**



15 facility managers answered **the concerns** that may arise **when introducing AI-Suitcase to their facilities**

15 Facility Managers in 6 Organizations

Shopping Mall

- Tenant Manager

Rehabilitation Center

- O&M Trainer
- Technical Adviser

Polyclinic

- Manager

Real Estate Development

- CSR Promoter
- Customer Support

Science Museum

- Facility Manager
- Visitor Service
- Strategy Manager

Discount Store

- Corporate Officer
- Business Consultant
- Store Designer

Facility Manerger's Three Concerns

Privacy Concern

Handling Camera and Captured Data

Safety Concern

Ensuring Safety of Users and Visitors

Visibility Concern

Showing that users are blind people

Privacy Concern

*There is a concern that **customers may misunderstand the purpose of the robot's camera**, which could **cause some trouble**.*

[Shopping mall]

Safety Concern

This robot may be perceived as a suitcase for travel.

*I think that **public would not notice that the user is visually impaired** or **would not avoid them**.*

[Real Estate Development]

Visibility Concern

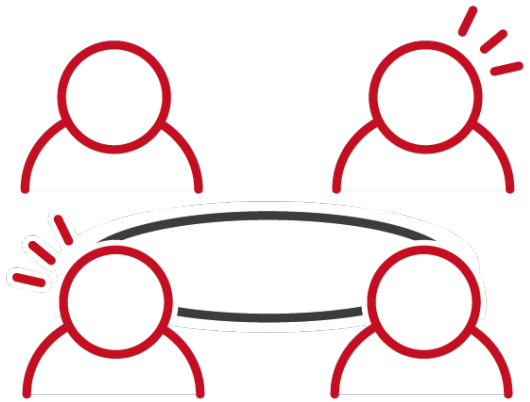
*If the robot **lets the surrounding visitors know that it is used for supporting blind users**, they will accept the robot's camera.*

[Shopping mall]

*If **the robot informs surrounding people** that **the user is visually impaired**, people could avoid them, **reducing the risk of collision**.*

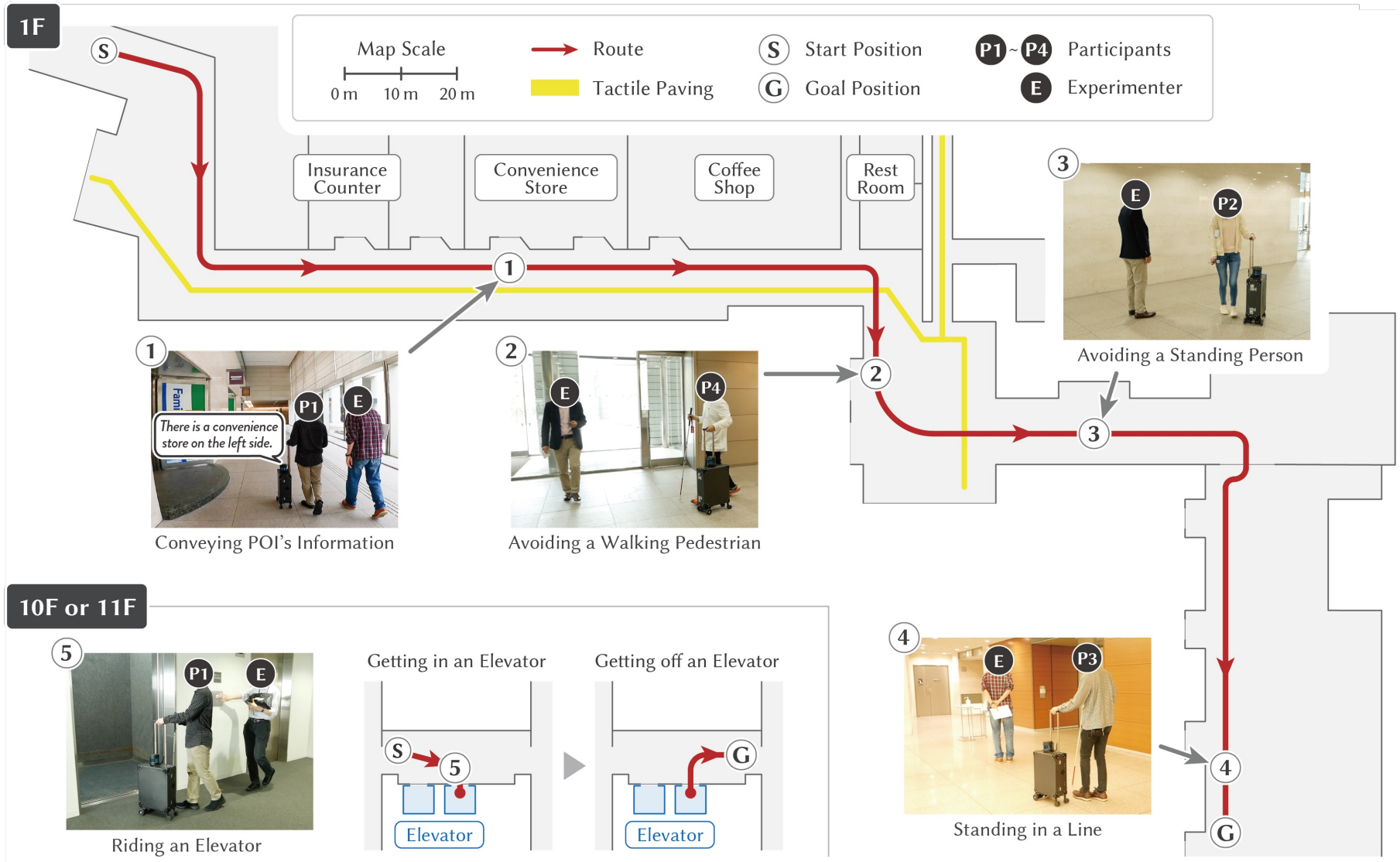
[Real Estate Development]

Part 3, Focus Groups with **Blind Users**



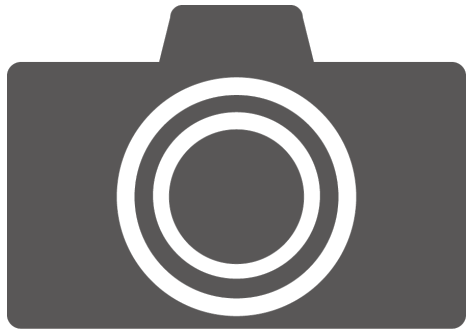
12 blind participants experienced the robot navigation and then **discussed the three concerns (privacy, safety, and visibility concern)**.

Trial Session of AI-Suitcase



Facility Manerger's Three Concerns

Privacy Concern



Handling Camera and Captured Data

Safety Concern

Ensuring Safety of Users and Visitors

Visibility Concern

Showing that users are blind people

Visibility Concern

Q: Do you OK with notifying surrounding people that you are blind people?

Not OK (5) / OK (7)

*I **do not want to emphasize that I am visually impaired**. It is great that the design of the robot is based on a suitcase and is **natural and modest**.* [P1]

*It is good that this suitcase-shaped robot **may not make me look like a visually impaired person**, unlike when walking with a guide dog, which may **make it obvious**.* [P6]

Visibility Concern

Q: Do you OK with notifying surrounding people that you are blind people?

Not OK (5) / OK (7)

*When I get into an accident such as a collision with someone, if **they are aware that I am visually impaired**, it can **reduce the possibility of me being in trouble**.*

[P11]

*If surrounding people will be **concerned about privacy** and so on, I think it might be **better to clarify the usage of the camera on the suitcase**.*

[P6]

Discossion: Divergent Opinion on Visibility Concern

High Visibility

More safety in crowded environment

*It should be **clear to others that a user is visually impaired** so that **decrease privacy and safety concerns**.*

[Facility Manager]

Low Visibility

Satisfy the **blind users' needs**

*The robot's design concept was good because it were **so natural and intelligent** that the **user would not seem visually impaired**.*

[Blind User]

Future Work

Studies in the wild to seek a **balance between visibility and assimilation**.

High Visibility Style

Low Visibility Style

Metrics

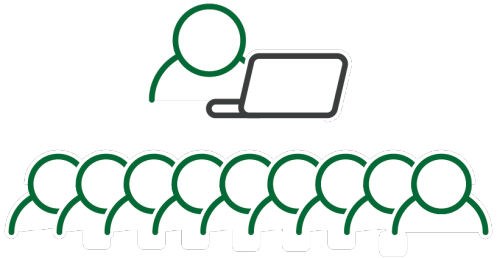
Number of collisions, System's acceptance with other visitors, User preference, ...

How Users, Facility Managers, and Bystanders Perceive and Accept a Navigation Robot for Visually Impaired People in Public Buildings

We investigated **acceptance and concerns** regarding autonomous navigation robots for visually impaired people **in public buildings** by conducting **three studies**.

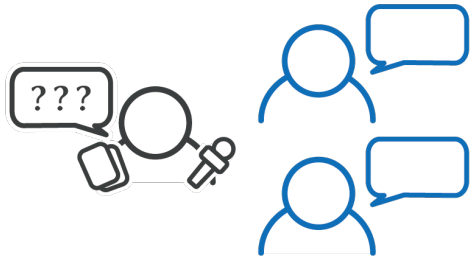
We analyzed the **privacy, safety, and visibility concerns** of our navigation robot and discussed the **convergent and divergent opinions** among each stakeholder.

1) Online Survey



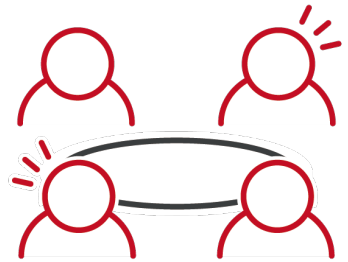
300 Sighted People

2) Interview



15 Facility Managers

3) Focus Group



12 Blind People

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