Field Trials of Autonomous Navigation Robot for Visually Impaired People

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

Current Mobility Aids

Guiding assistance

Guide dogs

White cane & tactile paving

Why a Suitcase?

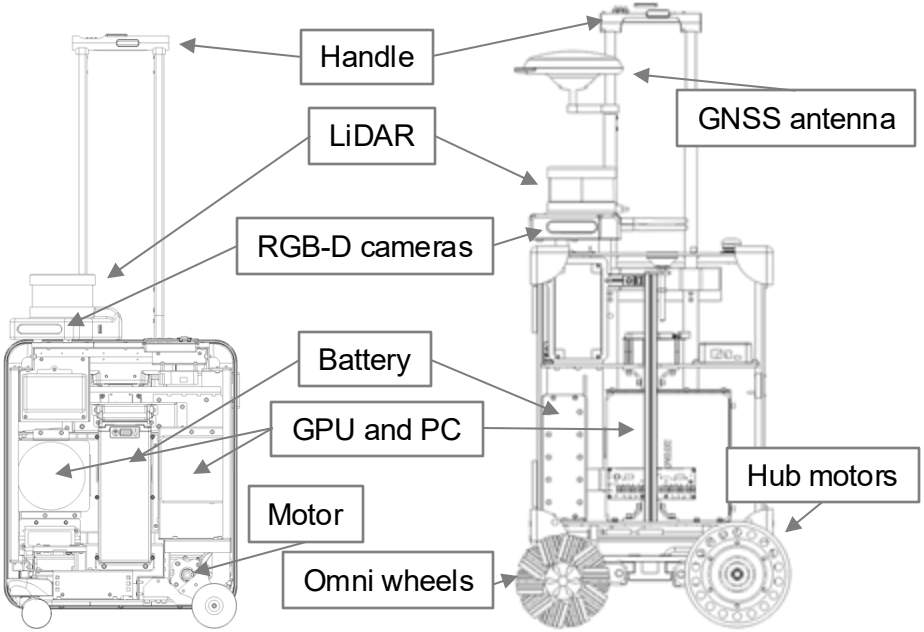
Detect obstacles and steps ahead

Not stand out in urban areas

Provided by the Next-Generation Mobility Assistance Technology Development Consortium.

AI Suitcase - Mechanism

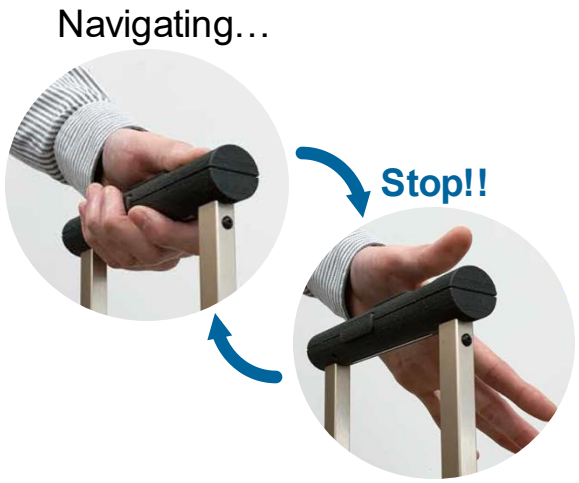
Indoor model (2022)



Outdoor model (2023)

User Interface

Automatic Stop



Stops when
the handle is **released**

Tactile Feedback

Vibrate to notify
turning direction

Smartphone app

Select **Destinations**
and get **real-time guidance**


1F
0.36 m/s
77
"You have arrived at the sweets shop."

Three Types of Field Trials

Indoor Pilot
at Commercial Complex

Daily Operation
at a Science Museum

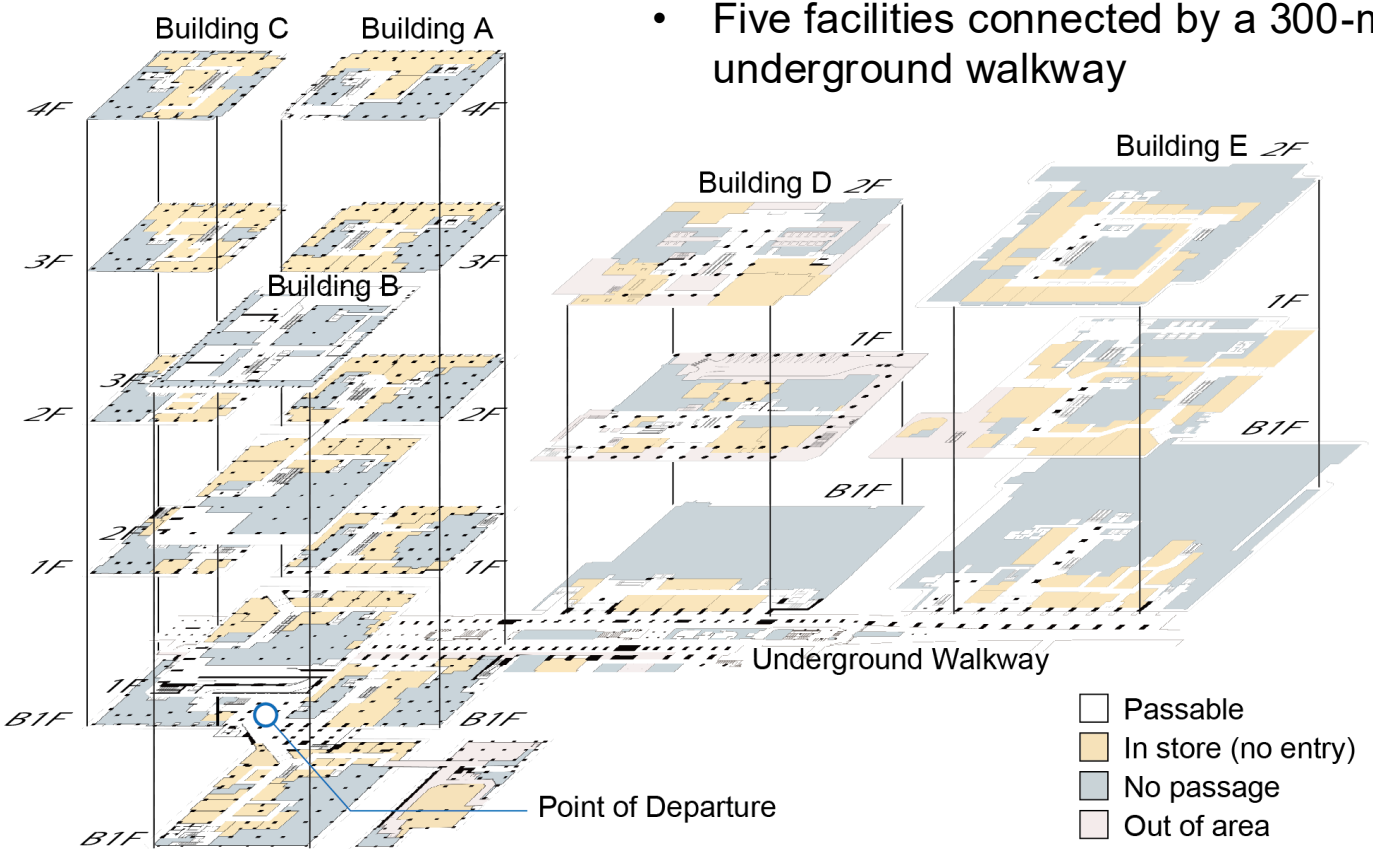
Outdoor Pilot
at Museum - Station

Indoor Pilot Study at Commercial Complex

- At a **large commercial complex** in Nihonbashi, Tokyo
- Participants: **38 visually impaired people**

Map and Route

- Five facilities connected by a 300-meter underground walkway



Results

Comments

- Many found **AI Suitcase easier to follow** than guide dogs because it required **no special training**.
- Users appreciated the **ease of navigation**, **safety**, and **reduced stress**.

Technical Challenges

- Occasional **unnecessary stops in crowded areas** and difficulty **navigating stairs**.

Non-technical Challenge

- **Securing permissions** from multiple facility owners

Daily Operation at a Science Museum

Daily Operation at a Science Museum

- Started April 18th, 2024 (No defined end date).
- Three slots a day
  (10:30 – 11:45, 13:30 – 14:15, 15:30 – 16:15)
- Visually impaired people can make reservations, while other people can use if there is no reservation.
- To ensure safety, museum staff acted as observers, following the users at a distance to monitor the operation and assist if necessary.

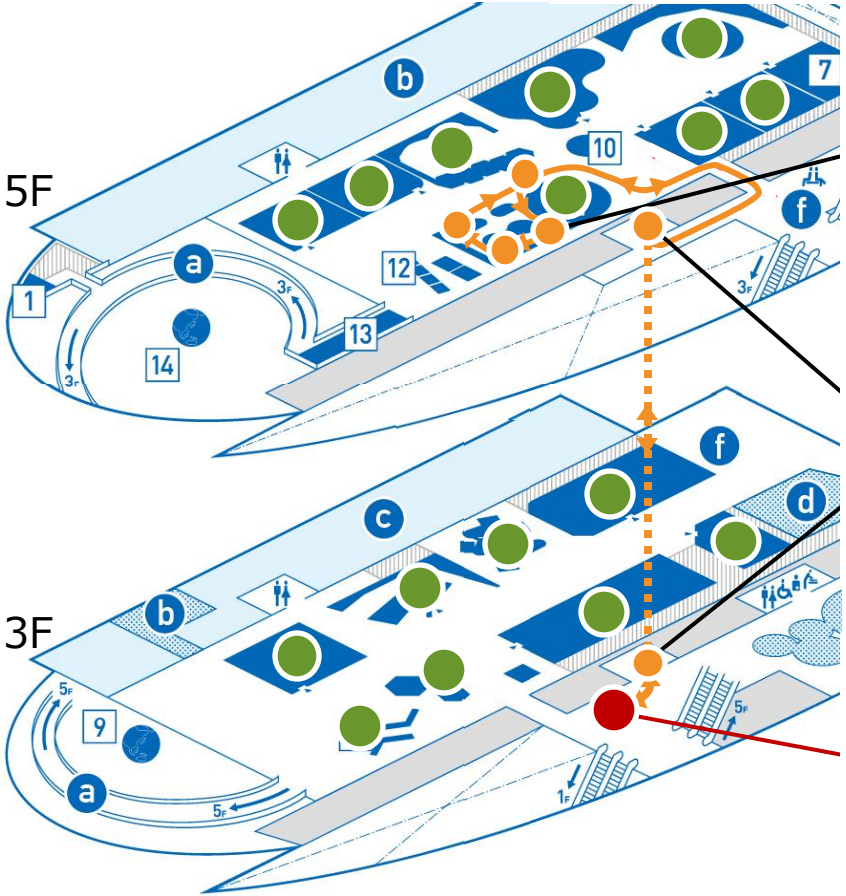
Reception & Instructions

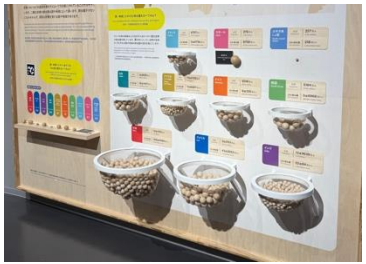
Museum Tour

Routes

- 11,000㎡ exhibition floors

- **(1) Predefined Tour**
  (Planetary Crisis Tour)
- **(2) Free Choice**




Touchable exhibits


Elevator

AI Suitcase station

Exhibition Explanation

“Starting from the left, let's begin with the fertilized egg. It's incredibly small, with a diameter of about 160 micrometers.”
“Moving to the right, the next model represents the fetus at 19 days. At this point, the emergence of red blood cells can be observed.”
…

Results

- 1,288 participants (as of September 2024)
  - ¼ were estimated to be visually impaired.

	Q1: Overall Experience				
	Very Dissatisfied	Dis-satisfied	Neutral	Satisfied	Very Satisfied
BVIs (total)	0 (0%)	4 (4%)	11 (12%)	32 (36%)	42 (47%)
(age: ~20s)	0 (0%)	0 (0%)	2 (10%)	7 (33%)	12 (57%)
(age: 30~50s)	0 (0%)	1 (3%)	3 (9%)	11 (31%)	20 (57%)
(age: 60s~)	0 (0%)	3 (9%)	6 (18%)	14 (42%)	10 (30%)

83%

	Q2: Perception of Reliability and Safety in AI Suitcase Navigation				
	Very Unsafe and Anxious	Unsafe and Anxious	Neutral	Safe and Reliable	Very Safe and Reliable
BVIs (total)	0 (0%)	6 (7%)	19 (21%)	36 (40%)	28 (31%)
(age: ~20s)	0 (0%)	0 (0%)	2 (10%)	10 (48%)	9 (43%)
(age: 30~50s)	0 (0%)	4 (11%)	8 (23%)	15 (43%)	8 (23%)
(age: 60s~)	0 (0%)	2 (6%)	9 (27%)	11 (33%)	11 (33%)

71%


Outdoor Pilot

Outdoor Pilot

Overview

- Challenges
  - Uneven terrain, curb crossing, and long-distance travel
- Prototyped an outdoor model
  - Large wheels and GNSS localization

Method

- For safety, multiple staff members monitored the test area, including crosswalks, and were prepared to intervene if any issues arose.

Route

January 2023

- Outdoor only
- 400-meter-long path
- A zebra crossing at a two-lane road without a traffic signal

September 2023

- Indoor – Outdoor – Station
- Automatic door
- Elevator at the station

Starting point inside the Miraikan

Taking the elevator to the station

Arrival point inside the station

Exiting to the park through automatic doors

Following the tiled path in the park

Crossing at a zebra crossing

Results

System Usability Scale (SUS) score

- Average 83.2 (among 14 participants)

Scores for Feelings of Safety and Comfort (Five-point Likert Scale)

Positive Aspects

- Vibration Signal on the Handle – Average: 4.7 / 5
- Obstacle and Pedestrian Avoidance – Average: 4.5 / 5

Areas for Improvement

- Negotiating Curbs – Average: 3.5 / 5
- Crossing Zebra Crossings – Average: 3.4 / 5

Challenges to Social Implementation

- Cooperation with Facility Owners
- Crowded Situations
- Real-world Information
- Outdoor Navigation
- Infrastructural Support
- Legal and Social Acceptance

Field Trials of Autonomous Navigation Robot for Visually Impaired People

- We are refining its capabilities through continuous field trials and user feedback.
- Collaboration with public institutions and policymakers is essential for regulatory adjustments.
- Public awareness campaigns will help normalize the presence of autonomous navigation robots in everyday life.
- Looking ahead, AI Suitcase will be featured in a large-scale trial at Expo 2025 in Osaka-Kansai, showcasing its potential to a global audience."

User Feedback

- “I feel independent I’ve never experienced after I became blind”.
- "I want to bring this robot back to my home."
- "I want to give the robot a name like my guide dog."
- “I feel comfortable walking seamlessly and naturally in city areas without being recognized as a blind person.”
- “It might be a bit scared because passerby does not notice we are blind, and we may not expect necessary help from surrounding people."