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See-Through Captions in a Museum Guided Tour:

Exploring Museum Guided Tour for Deaf and Hard-of-Hearing People with Real-Time Captioning on Transparent Display

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Background & Introduction

How can we update the accessibility of museum guided tours for deaf and hard-of-hearing people?

Approaches to accessibility of audible information

Sign-language guided tours

Auditory information via mobile device

Image (Left): Namatame et al. 2020. The Science Communication Tour with a Sign Language Interpreter
Image (Right): Namatame et al. 2019. Can Exhibit-Explanations in Sign Language Contribute to the Accessibility of Aquariums?

Background Accessibility of Museum Guided Tour for DHH People

Sign-language guided tours

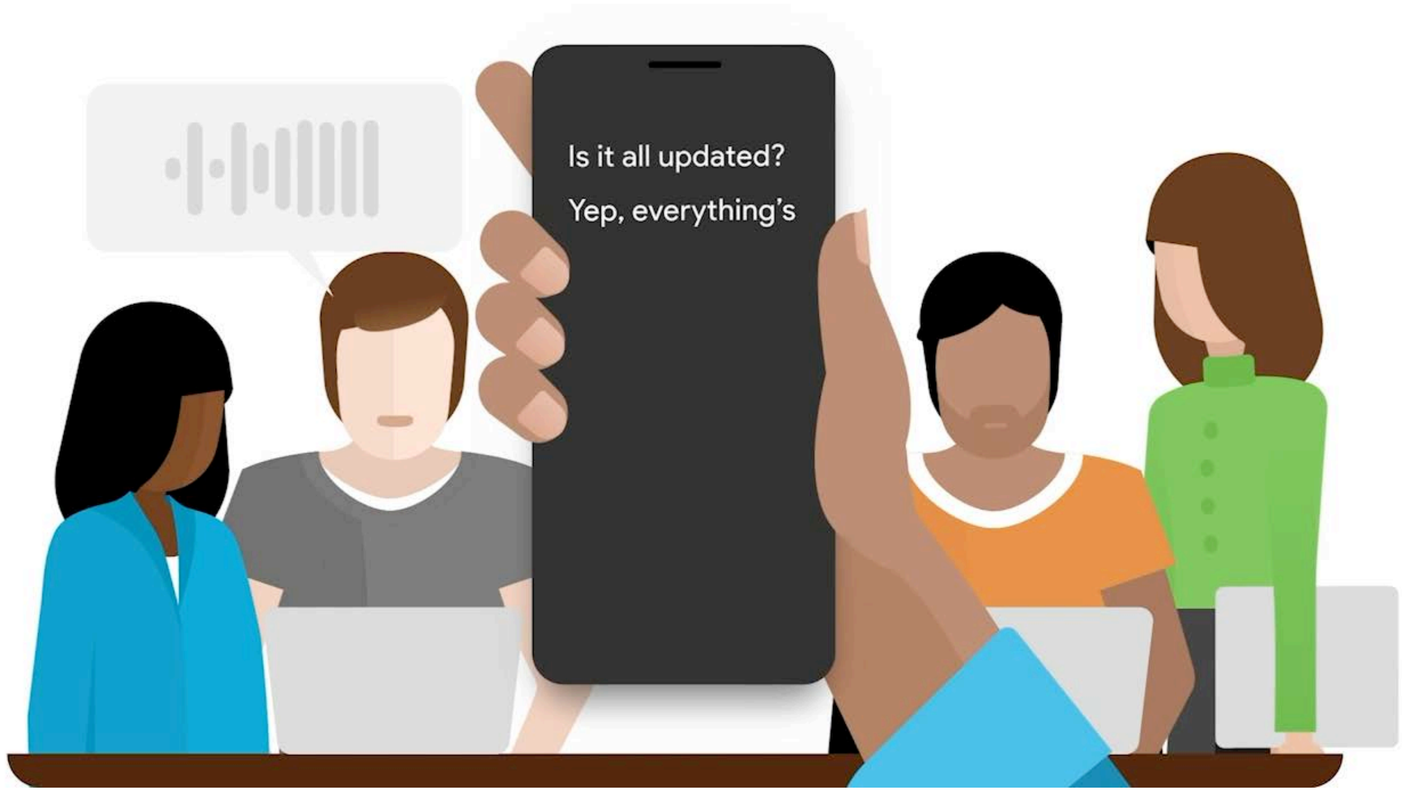
Difficult to recruit an interpreter

Auditory information via mobile device

One-way information
Cannot communicate with guide

Image (Left): Namatame et al. 2020. The Science Communication Tour with a Sign Language Interpreter
Image (Right): Namatame et al. 2019. Can Exhibit-Explanations in Sign Language Contribute to the Accessibility of Aquariums?

Automatic Speech Recognition (ASR)



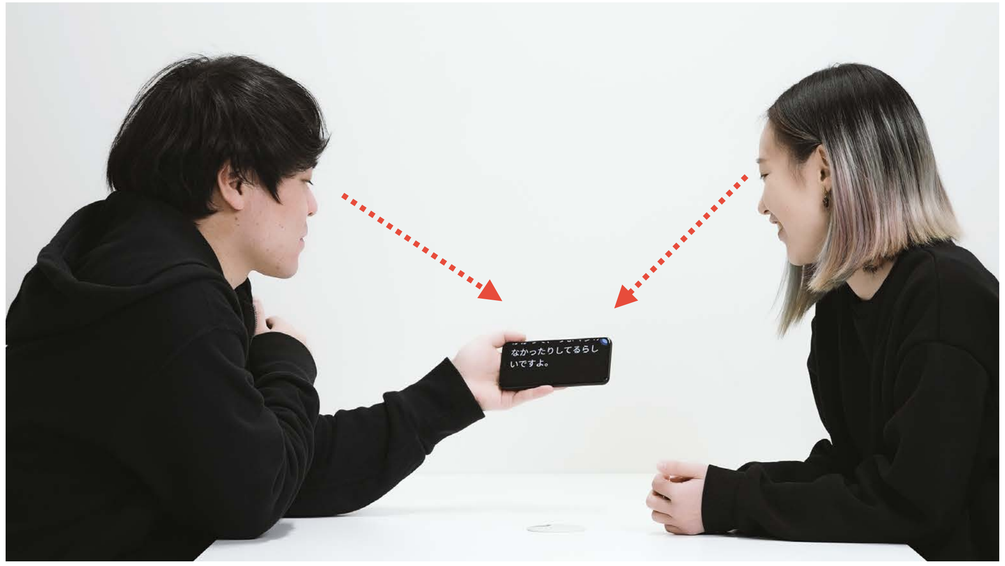
Video: https://www.android.com/accessibility/live-transcribe/

Approaches to utilize automatic speech recognition

ASR on mobile devices

ASR on augmented reality devices

Background Automatic Speech Recognition (ASR)



ASR on mobile devices

ASR on augmented reality devices

The facial expression and body language of the partner are overlooked

Speaker cannot confirm whether the speech has been correctly recognized.

Introduction Our Previous Work

Kenta Yamamoto, Ippei Suzuki, Akihisa Shitara, Yoichi Ochiai. ASSETS'21.
See-Through Captions: Real-Time Captioning on Transparent Display for Deaf and Hard-of-Hearing People.

Introduction Transparent Display

Implementation

Implementation Overview

Implementation Transparent Display

Implementation Transparent Display

Japan Display Inc.

Transparent Display

Resolution	320 × 360 pixels
Number of Colors	4,096 Colors
Transmittance	87%
Weight	Approx. 130 g
Brightness (Center)	270 cd/m²
Contrast Ratio	20:1

Shure; WH20XLR

Headset Microphone

Unidirectional cardioid directivity

Less surrounding noise

Image: https://www.shure.com/en-US/products/microphones/wh20

Implementation Backpack

Weight : approx. 3.3 kg

Audio Interface

Computer

Tablet PC

*Inserted into backpack

Battery

Display Drive Board

Mobile Wi-Fi Hotspot

Implementation Automatic Speech Recognition API

Javascript API

Web Speech API on Google Chrome

Image (Google Chrome Logo): https://www.google.com/chrome/

Implementation Overview

Case Study: Guided Tour in Museum

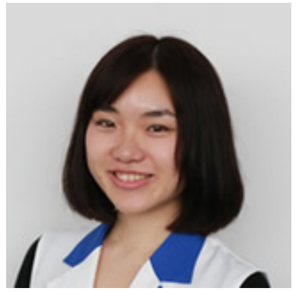
Case Study: Guided Tour in Museum

Miraikan

THE NATIONAL MUSEUM OF EMERGING SCIENCE AND INNOVATION

Science Communicators

Bunsuke Kawasaki

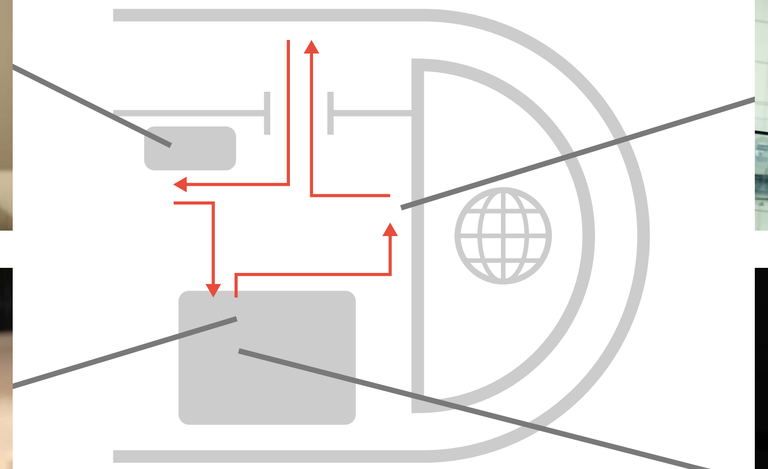


Sakiko Tanaka

Image (Right): https://www.miraikan.jst.go.jp/aboutus/
Image (Science Communicators): https://www.miraikan.jst.go.jp/en/aboutus/communicators/

Case Study: Guided Tour in Museum

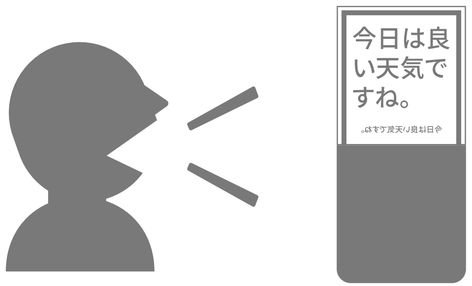
Tour theme: “The difference between humans and robots”



Case Study: Guided Tour in Museum

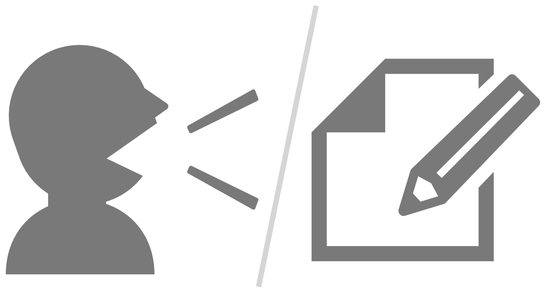
Communication Method

Tours were conducted in Japanese language



Guide Person ▶ DHH People

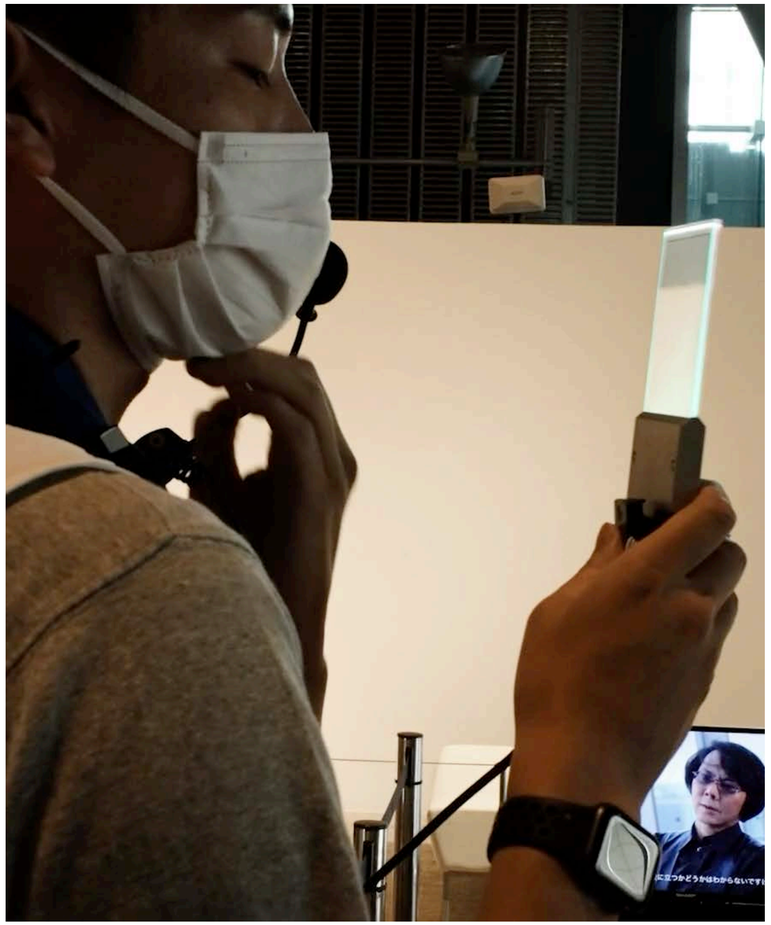
See-Through Captions



DHH People ▶ Guide Person

Speech or Writing

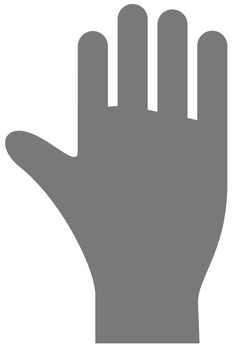
Communication Protocol



When ASR system stopped...

Guide express ”wait”
in gestures of sign language

Communication Protocol



When participants wanted to talk

They raise their hand or notepad

When someone talked one’s idea

“Applause” in gestures of sing language

Procedure

1. Participants were asked about the preferred position of display and asked about preferred infection-prevention methods (face shield or face mask)
2. The guide described the theme of the tour and conducted some quiz games about Miraikan
3. Guided tour
4. Participants were asked to fill out the questionnaires and be interviewed

Display Position: Basic

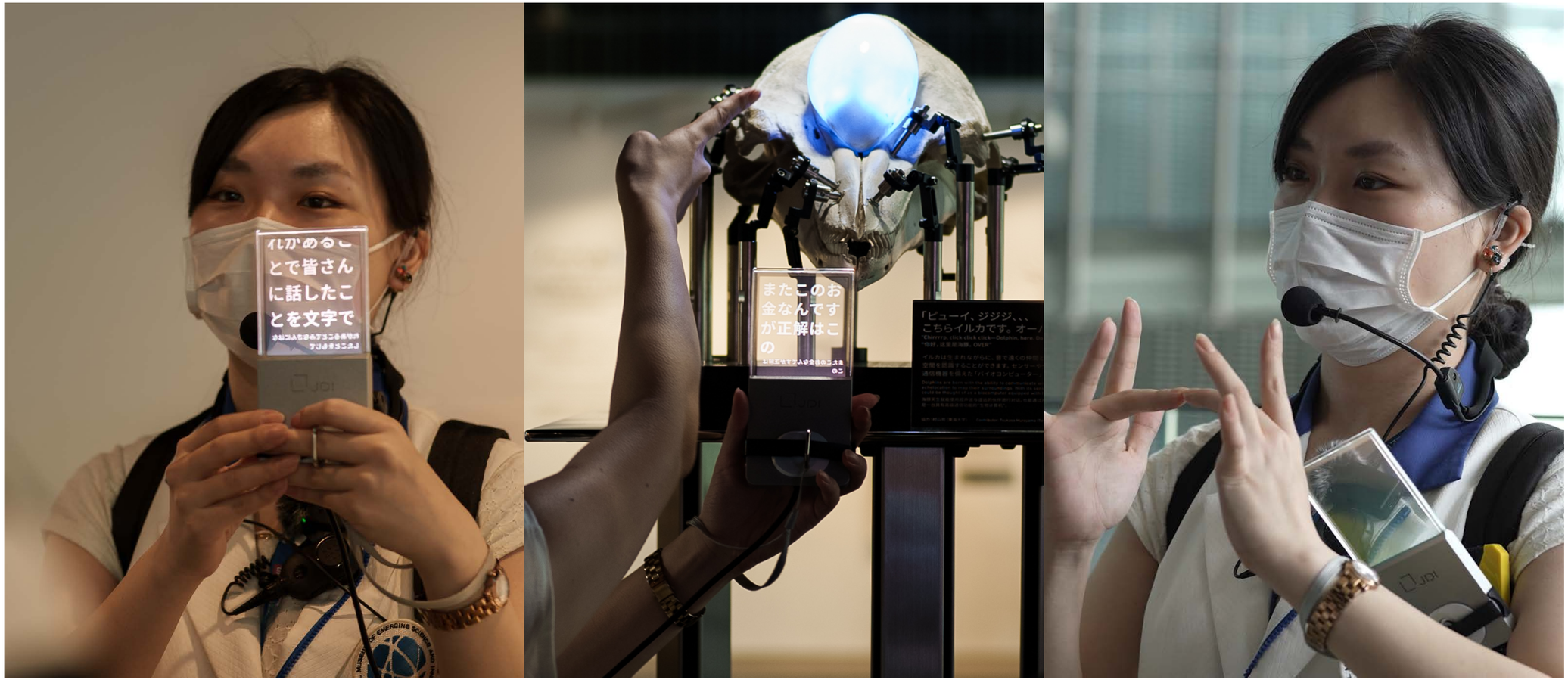
Case Study: Guided Tour in Museum

Display Position: Overlay

Display Position: Hands-Free

Case Study: Guided Tour in Museum

Display Positions



Case Study: Guided Tour in Museum

Participants

11 DHH Participants | 18-53 years old

4 Hearing Participants | 36-56 years old

+ 1 Hearing Participant without questionnaires

Tour Groups

9 Groups

Each tour group contained at least one DHH person; some groups contained a few hearing people.

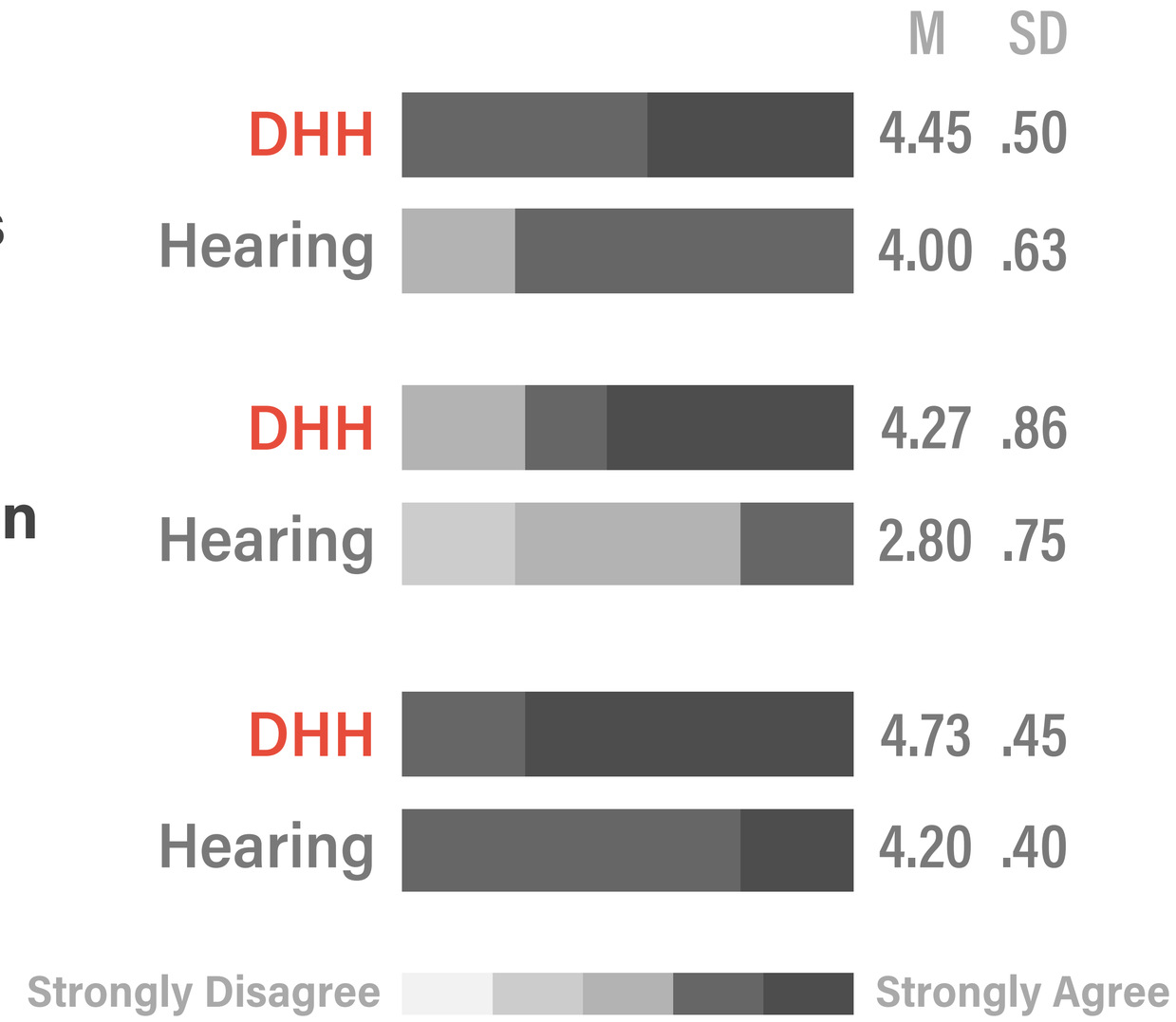
Results & Discussion

Results Quantitative Evaluation

Q1.
Readability of the ASR results

Q2.
Noticeability of misrecognition

Q3.
Whether they wanted to continue utilizing this system



ASR sometimes misrecognize the words

It was difficult to read when misrecognition occurred

Possible solution:

The speaker acquire utterances and speaking styles that were easy for the system to recognize correctly

Dictionary registration for technical terms / nouns

Results & Discussion Readability of Captions

The readability affected by background and reflection

Difficult to see in some settings especially when there is a strong light in the background

Possible solution:

The guide pays attention to that Easily text design changeable system

Results & Discussion How to Display Captions

Subtitle design is for a larger transparent display

The character flow was too fast

The screen was filled with rephrasing when misrecognition occurred

Possible solution:

Function to look back at the history
Little larger transparent display

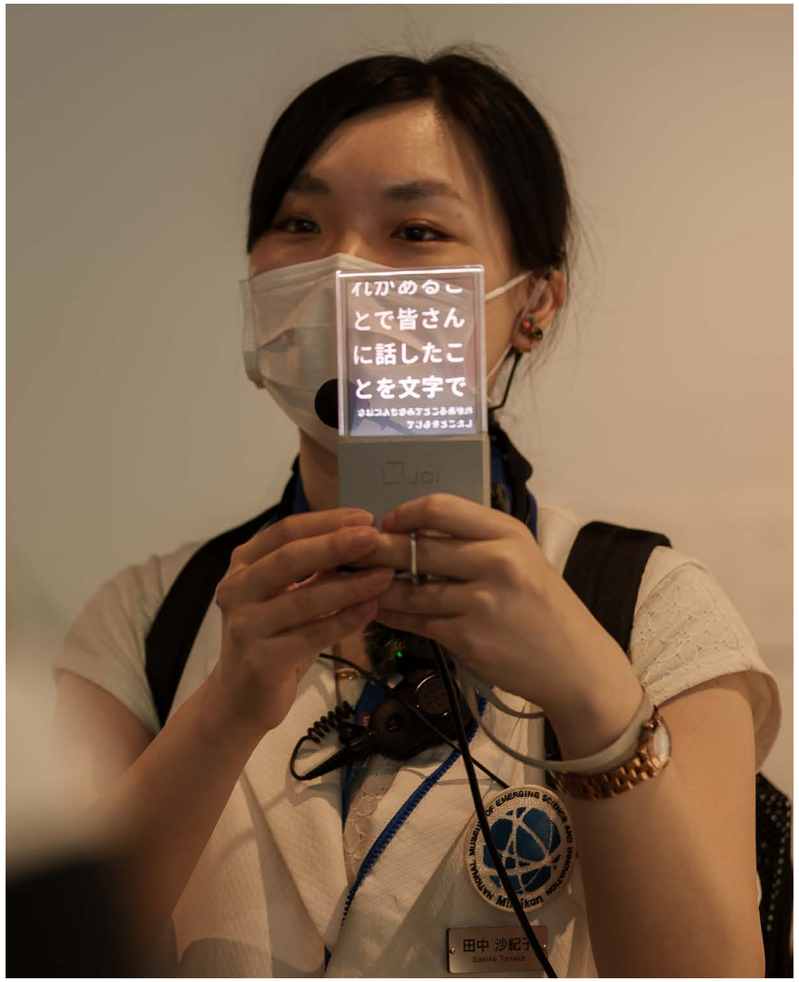
Results & Discussion Benefits of Transparency

Participants could see the subtitles while looking at the contents of the exhibition

It was easy to communicate in both directions by being able to see the guide’s face and make eye contact

Transparency made it possible to see the whole without obstructing the view, and that they did not feel any gap

Results & Discussion Display Position

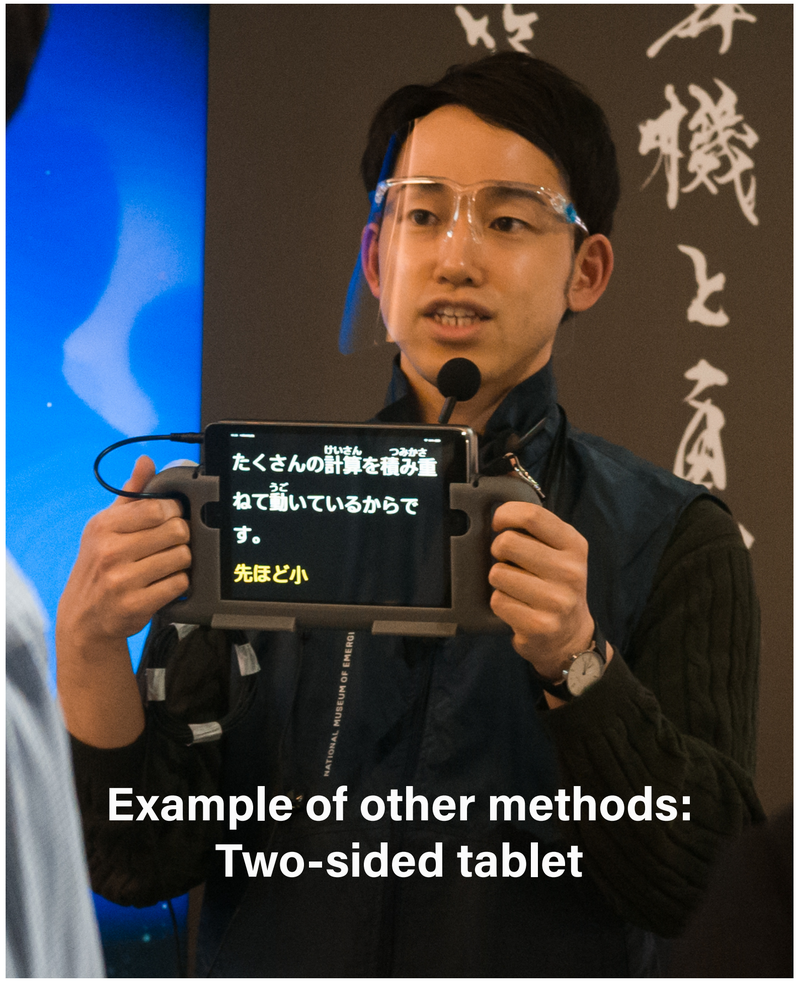


Handheld setup makes us easy to change the position

We asked participants which position is preferred

“If the display is held near the face, it is easier because there is only one place to watch.”

Results & Discussion Display Type and Size



Example of other methods:
Two-sided tablet

As a future work, it is necessary to compare See-Through Captions with other methods in detail

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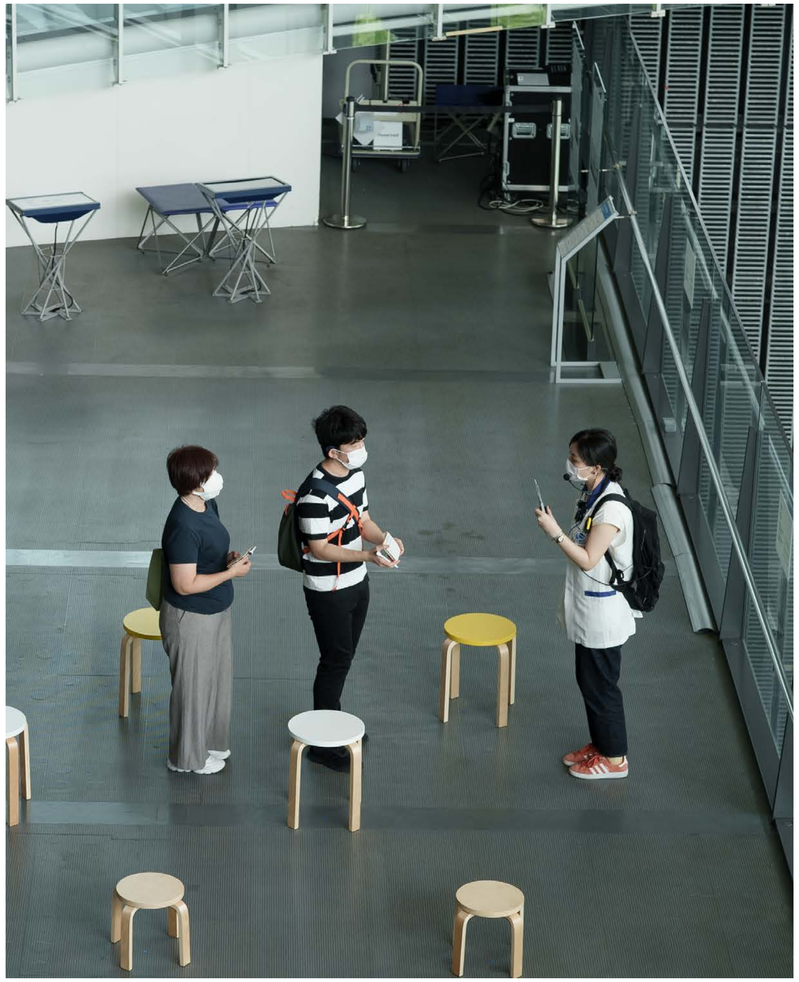
Participants mentioned:

AR glasses was tiring but See-Through Captions was easier

Display size was small

Results & Discussion

Challenges Specific to Guided Tours



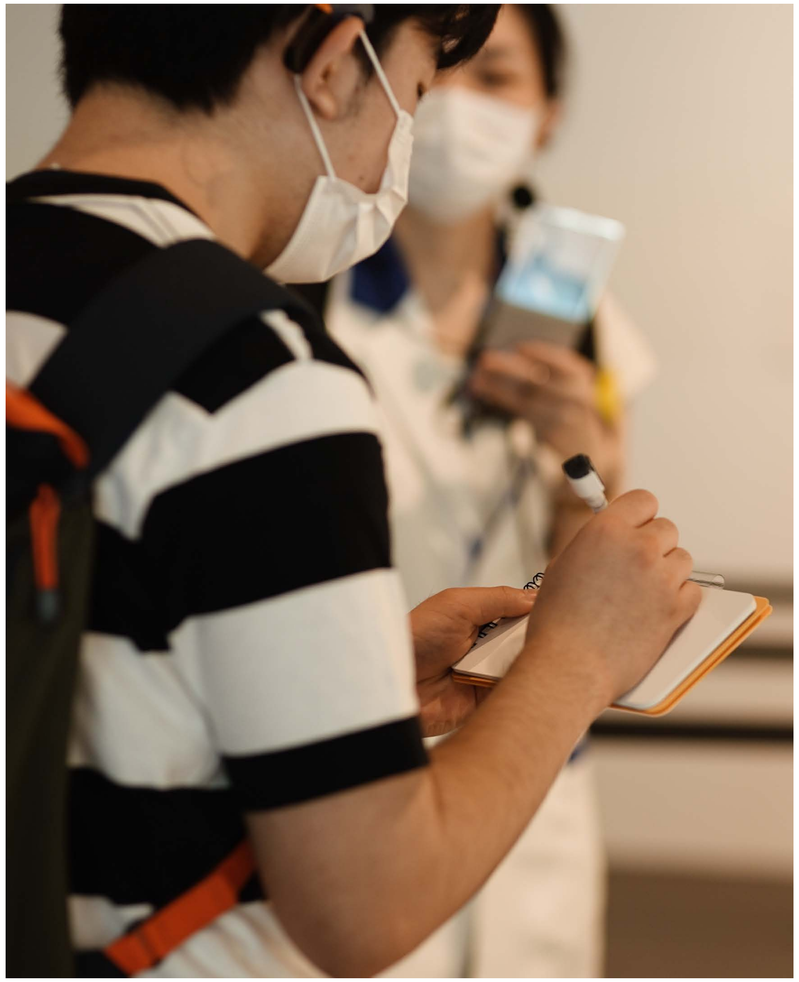
See-Through Captions was originally developed as a 1:1 communication

When multiple people participated, their voice is NOT displayed

Possible solution:

Participants also wear microphones
Participants also hold displays

Future Work How Can DHH People Communicate with Tour Guide?



The current system assumes that DHH people speak using voice

Some DHH people do not tend to speak by their voice

Possible solution:

Additional input interface?

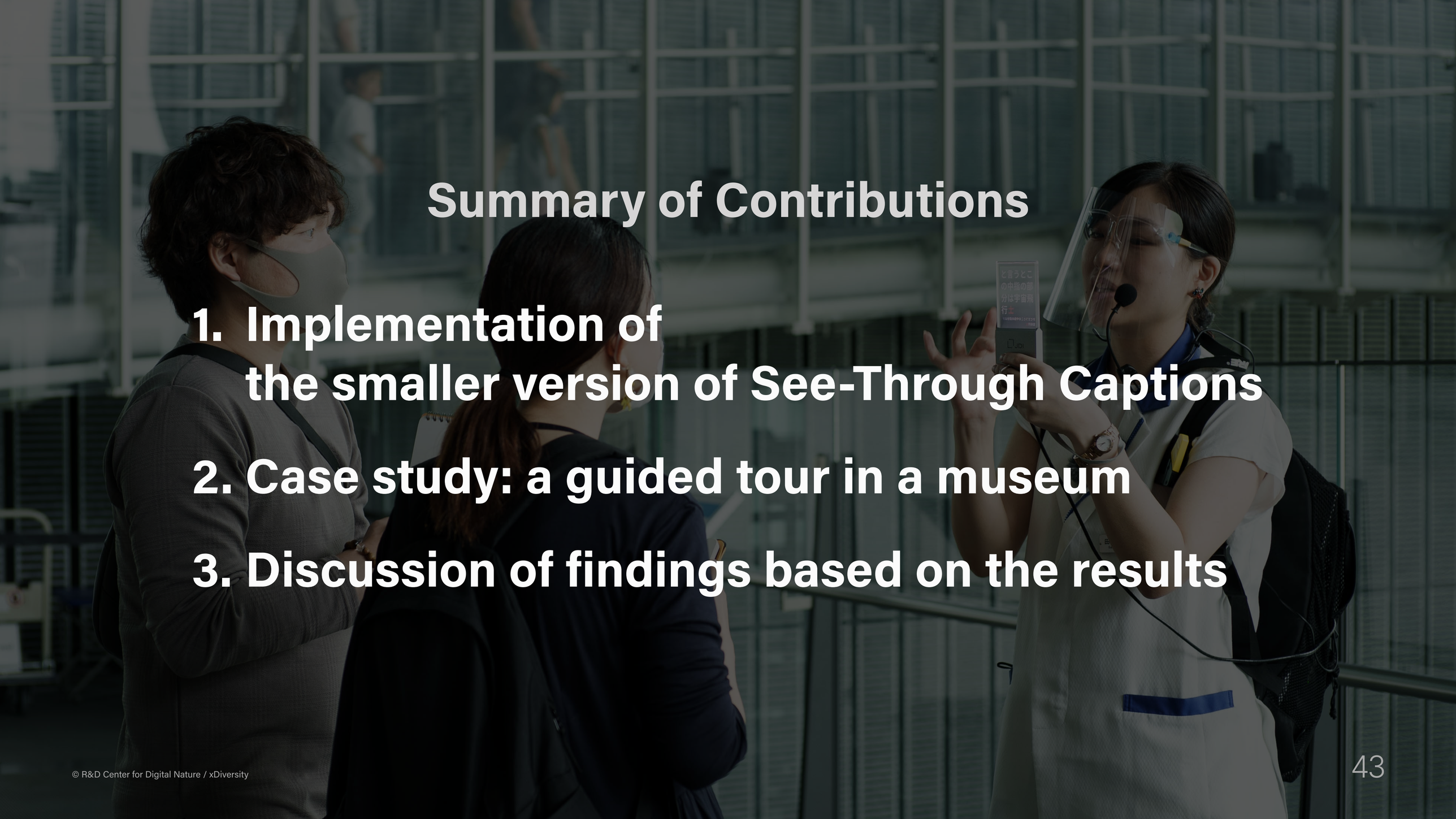
Future Work How Can We Communicate with DHH People Who Prefer Sign Language than Text?

The current system assumes that DHH people read texts

Some DHH people prefer to read sign language

Possible solution:

Text <-> Sign language Translator?



Summary of Contributions

1. Implementation of
   the smaller version of See-Through Captions
2. Case study: a guided tour in a museum
3. Discussion of findings based on the results

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