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Sign Language Conversational User Interfaces Using Luminous Notification and Eye Gaze for the Deaf and Hard of Hearing

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Resume of the presenter

Takashi Kato

I am Deaf.
Course of Information Science,
Division of Industrial Technology,
Graduate School of Technology and Science,
Tsukuba University of Technology, Japan.
I am a member of Shiraishi lab.
The main interest is in human-computer interaction from the perspective of Deaf people.
Lab: https://www.shiraishi-lab.org/

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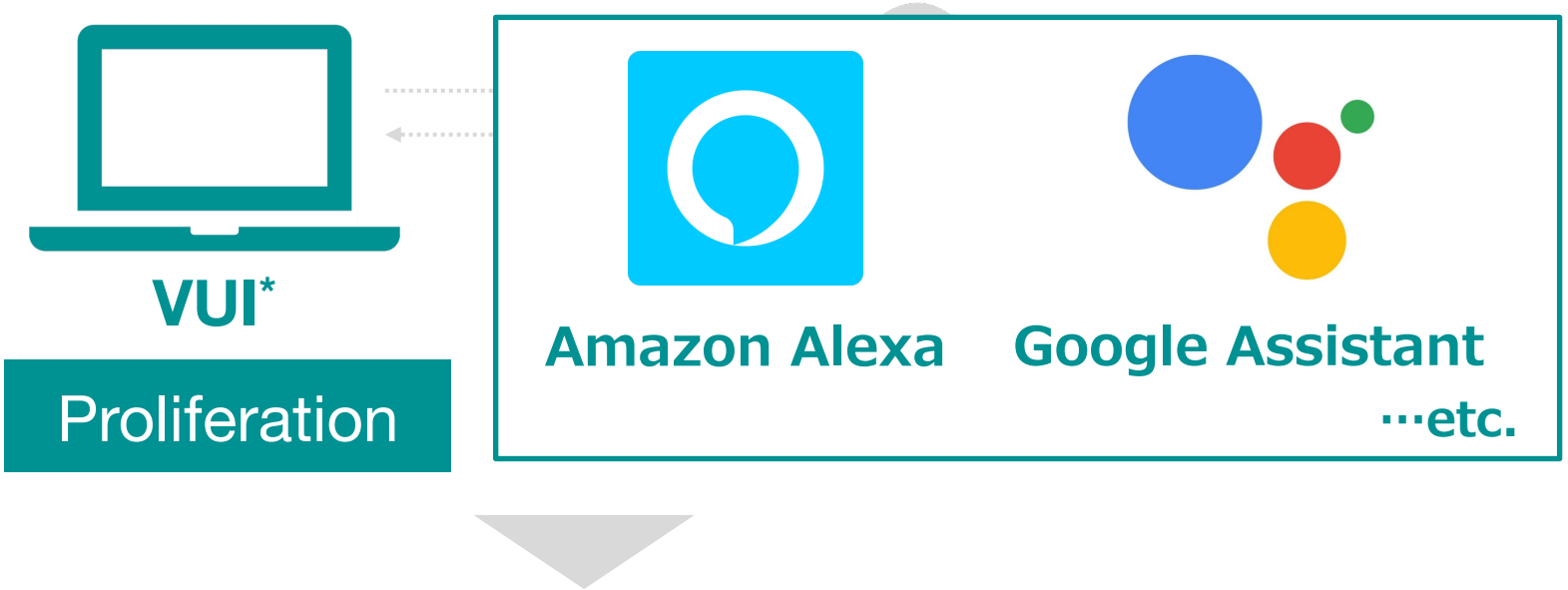
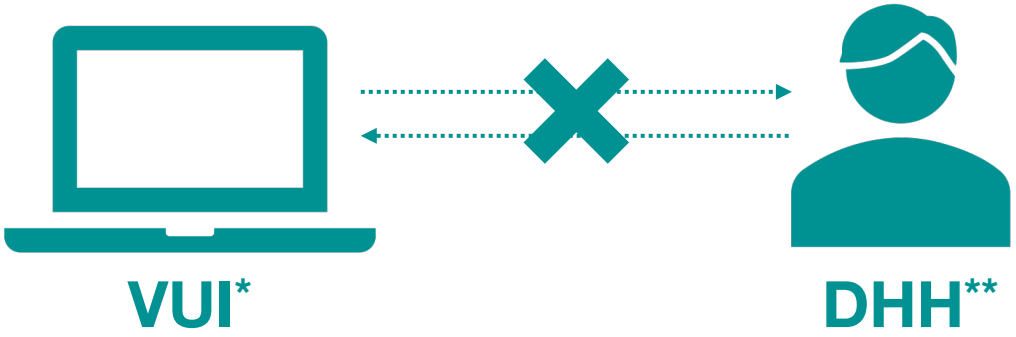
Background



VUI* : Voice User Interface
DHH** : Deaf and Hard of Hearing
CUI*** : Conversational User Interface

Background



Accessibility barriers

Purpose in our research

Propose **a CUI*** to improve the accessibility for DHH users**

VUI* : Voice User Interface
DHH** : Deaf and Hard of Hearing
CUI*** : Conversational User Interface

Background

The mutual input/output modalities

User \ Type	Conversation		Call	
	CUI → User	User → CUI	CUI → User	User → CUI
Hearing	Voice		Voice	
DHH				

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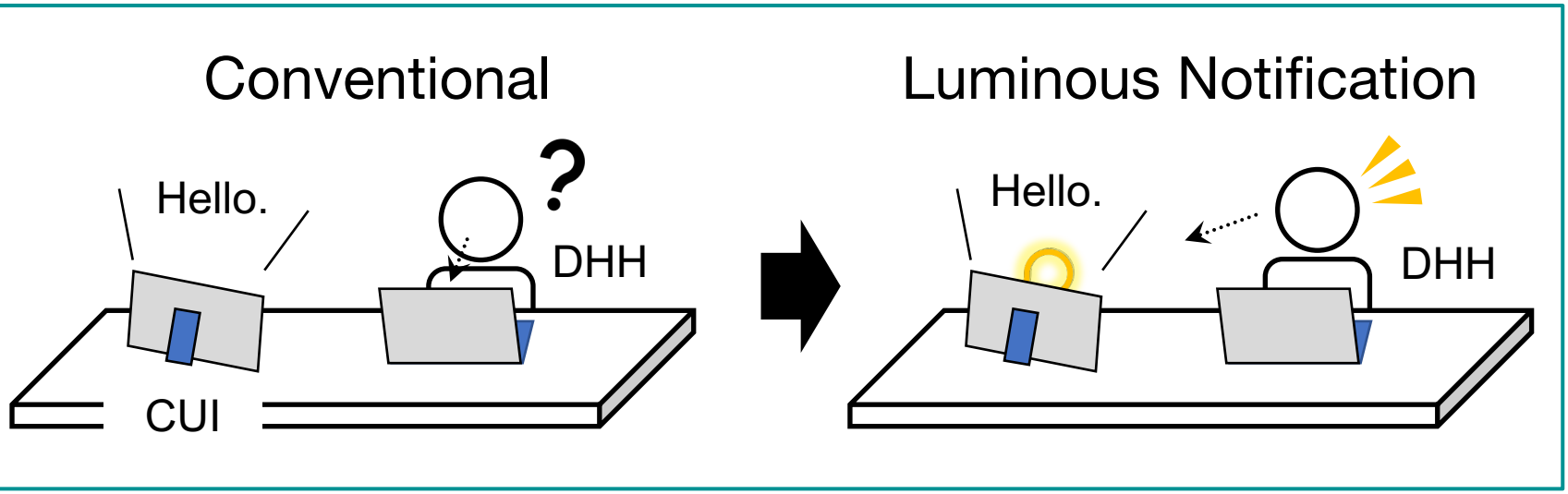
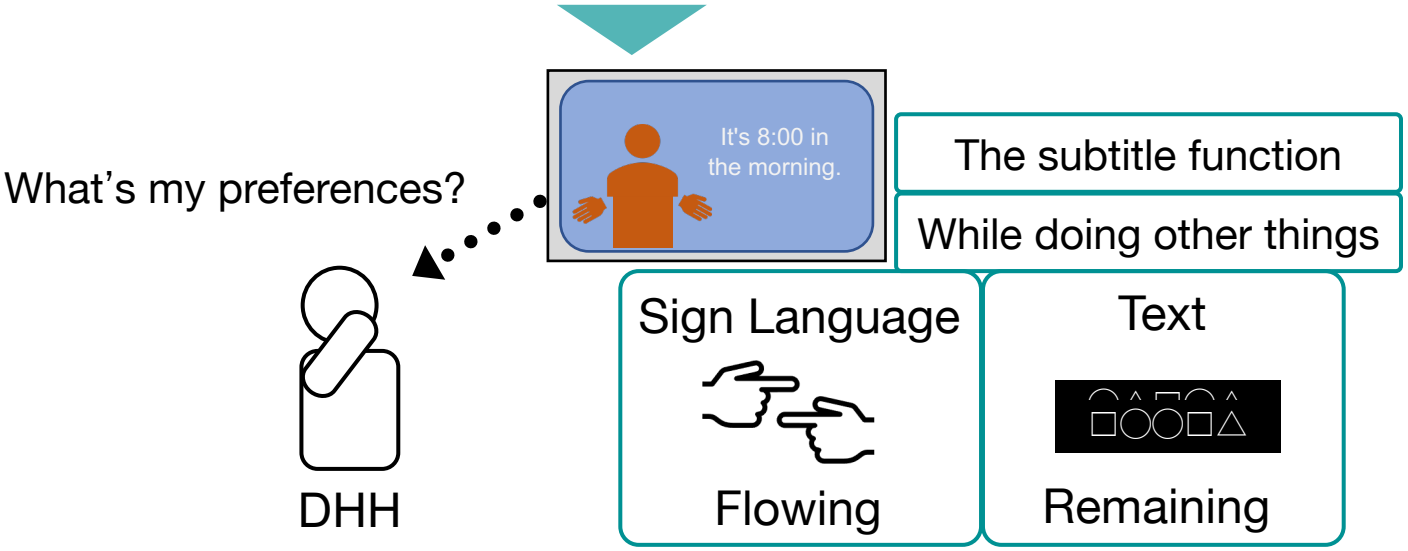


Background

The mutual input/output modalities

User \ Type	Conversation		Call	
	CUI → User	User → CUI	CUI → User	User → CUI
Hearing	Voice		Voice	
DHH			Luminous	



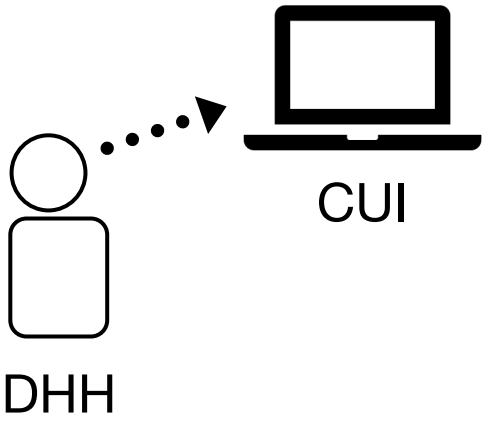
Background

The mutual input/output modalities

User \ Type	Conversation		Call	
	CUI → User	User → CUI	CUI → User	User → CUI
Hearing	Voice		Voice	
DHH	Sign Language/Text		Luminous	

Without wake word
（Exp.“Alexa”, “OK, Google”, ）

Use Eye Gaze



Background

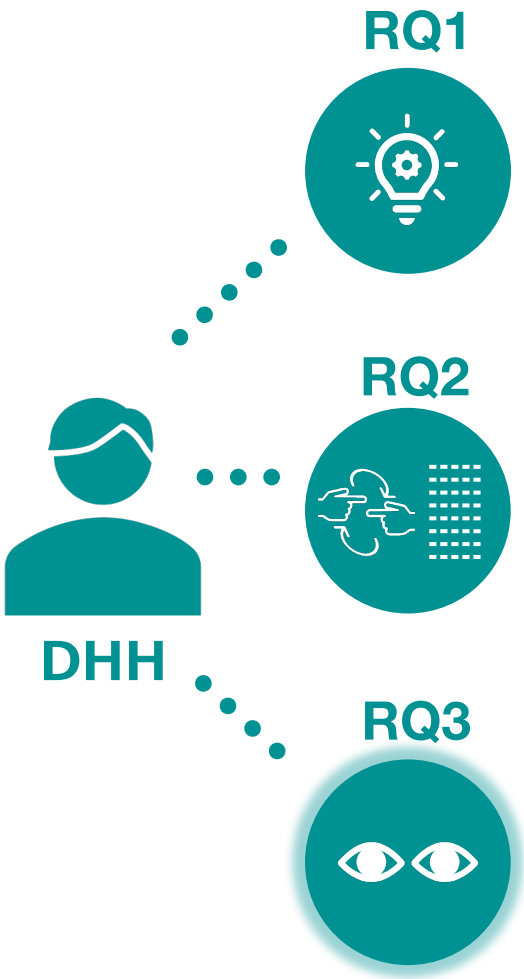
The mutual input/output modalities

User \ Type	Conversation		Call	
	CUI → User	User → CUI	CUI → User	User → CUI
Hearing	Voice		Voice	
DHH	Sign Language/Text		Luminous	Eye Gaze

Can these modalities improve the user experience of DHH users?

Background

Research Question



Luminous Notification

Does the light-based response of the CUI improve the usability?

Display Sign Language/Text

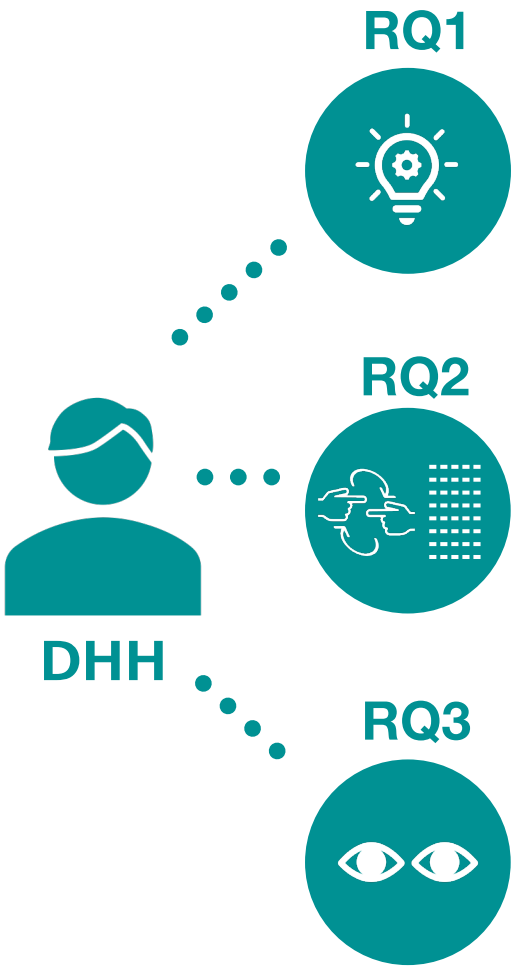
What is the best sign language/text display method for CUI?

Eye Gaze in wake up

Is eye gaze an effective method of waking up to CUI?

Background

Research Question



Luminous Notification

Does the light-based response of the CUI improve the usability?

This study guides future system designers.

display method for CUI?

Eye Gaze in wake up

Is eye gaze an effective method of waking up to CUI?

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Related Work -Accessibility studies of CUIs by DHH users-

As an alternative input method to speech,

Sign language is more suitable. [1]

The use of sign language is preferable [2]

to touch screens as an input method.

Two studies substitute sign language for speech in VUIs.

Assignment
No consider **the physicality of DHH users who mainly use visual information.**

[1] Rodolitz, Gambill, et al., Accessibility of voice-activated agents for people who are deaf or hard of hearing. CSUN '19, 144–156, 2019.

[2] Wojtanowski, Gilmore, et al., “Alexa, Can You See Me?” Making Individual Personal Assistants for the Home Accessible to Deaf Consumers. ASSETS '19, 16–31, 2019.

Related Work –Start of conversation by DHH person-

When starting a conversation, make **eye contact**. [3]

The preferred wake-up techniques [4]

1. The use of the ASL sign-name of the device
2. Waving in the direction of the device
3. Clapping

⋮

Assignment

The comparison does not include **eye gaze**.

[3] SignGenius, (June 30, 2021), ``Do's ¥& Don'ts - Getting Attention in the Deaf Community,'' https://www.signgenius.com/info-do's&don'ts.shtml

[4] Vaishnavi, Abraham, et al., Deaf Users' Preferences Among Wake-Up Approaches during Sign-Language Interaction with Personal Assistant Devices. CHI EA '21, 1–6, 2021.

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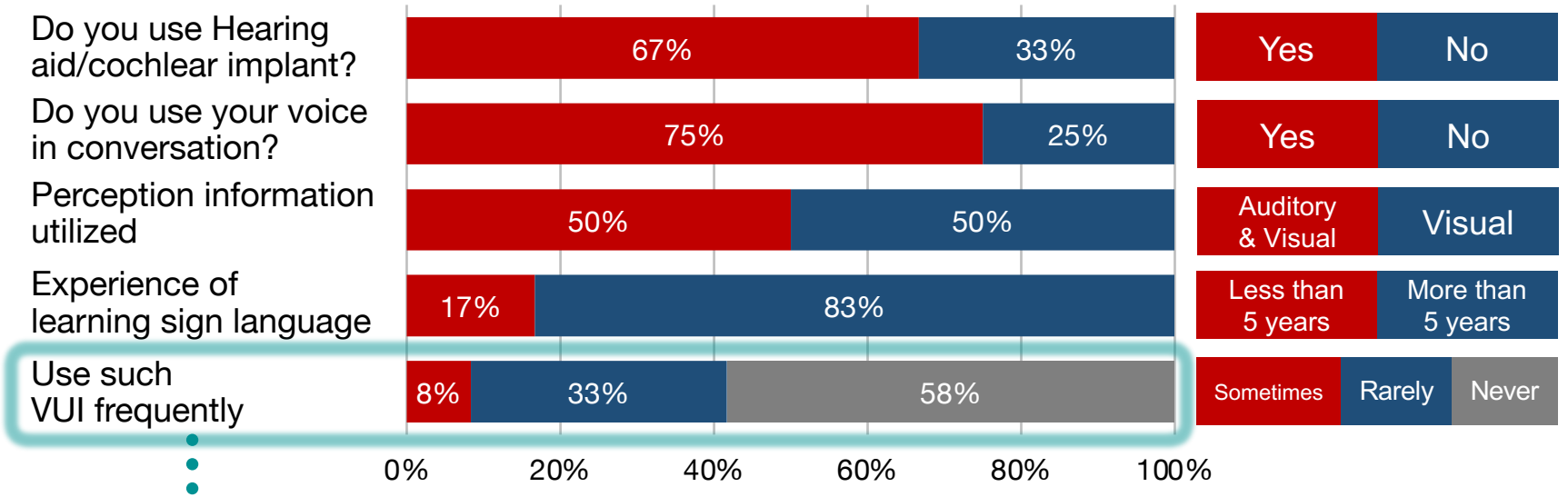
Methodology –Participants-

Participant

12 DHH students in their 20s



The characteristics of the participants

A similar trend research that
a minimal number of DHH users use personal-assistant devices [5]

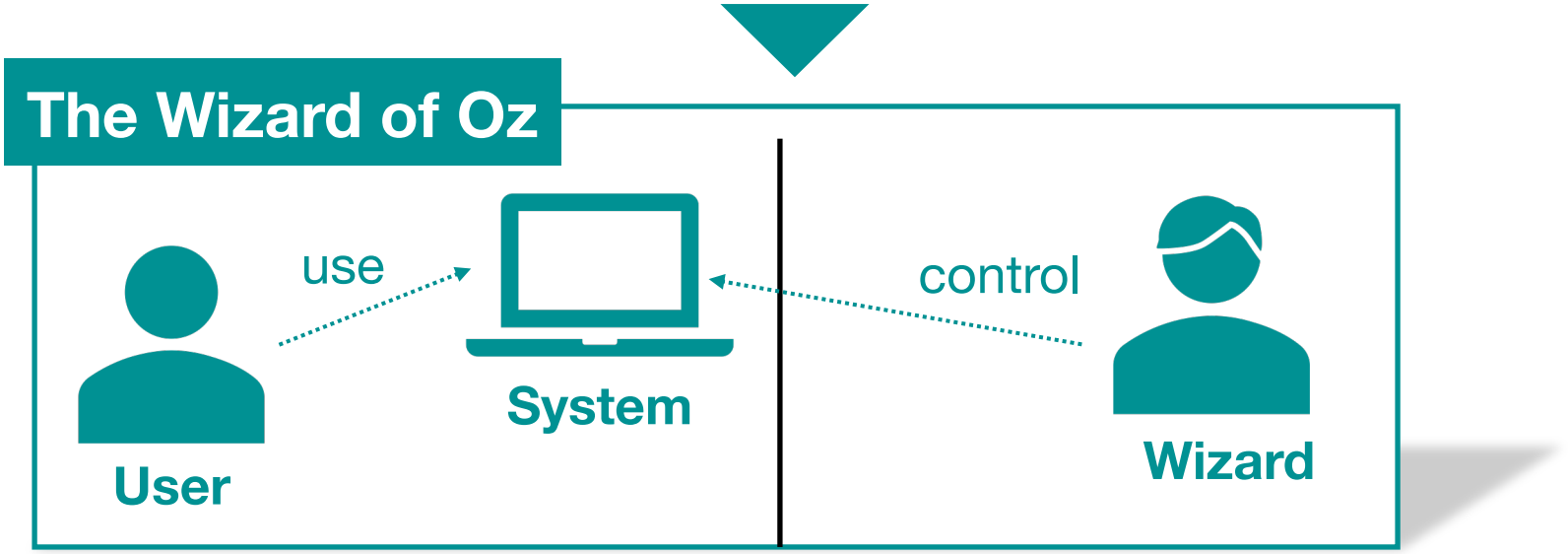
[5] Pradhan, Mehta, et al., "Accessibility Came by Accident": Use of Voice-Controlled Intelligent Personal Assistants by People with Disabilities. CHI '18, 1–13, 2018.

Methodology –The Wizard of Oz-

39.6% recognition rate in a real-life continuous sign language [6]

Assignment

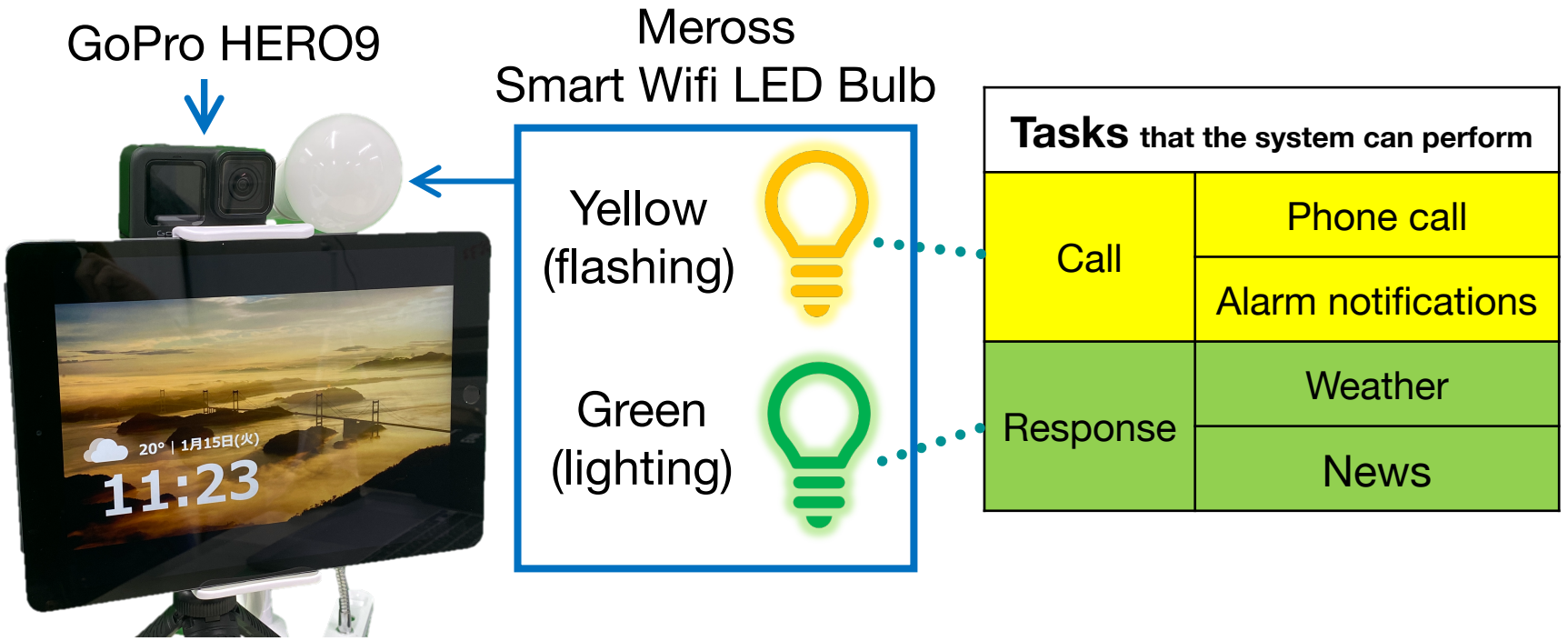
Impossible to conduct experiments to interact with
a user interface using sign language recognition technology



The wizard can complement the undeveloped parts of the system and make it work. [7]

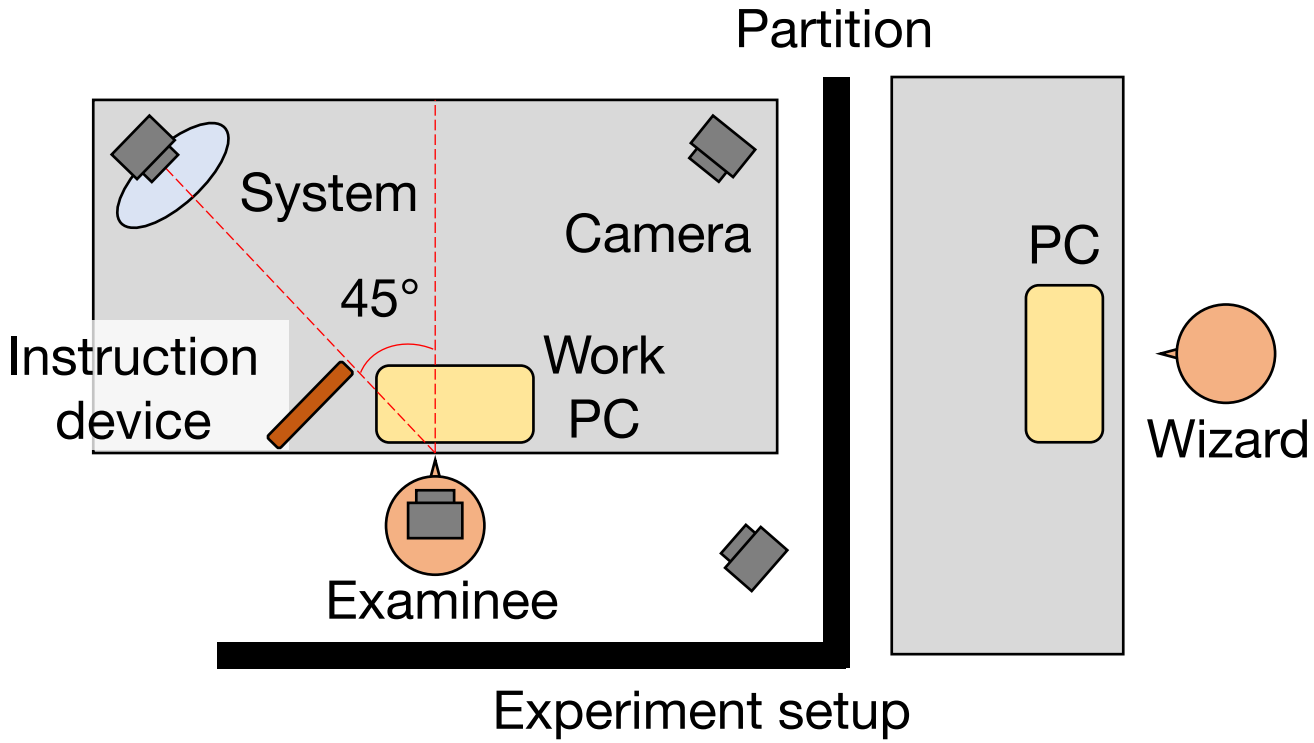
[6] Cui, Liu, et al., A Deep Neural Framework for Continuous Sign Language Recognition. IEEE '19, 1–12, 2019.
[7] Fraser, N.M., Gilbert, G.N. Simulating speech systems. Computer Speech and Language, 5:1:81–99,1991.

Methodology –Device Architecture-



- Remotely controllable
- Apple iPad simulated Alexa.
- The display was combined with the signer's video.

Methodology –Procedure-



- The participants interacted with the system while working on their PCs.
- Work PC that display numbers or English letters at random positions on the screen, the participant has to continuously work to entering with the keyboard.

Methodology –Analysis Method-

RQ1

Luminous Notification

- The system usability scale (SUS)
- The time between the notifications and when the participant noticed and reacted to them

RQ2

Display Sign Language/Text

- A questionnaire to determine the need using a five-point Likert scale

RQ3

Eye Gaze In wake up

- Percentage of eye gaze, time of eye gaze

[7] John. System usability scale (SUS): a quick-and-dirty method of system evaluation user information. DEC, 1986.

Contents

Results and Discussion

RQ1: Efficacy of Luminous Notification

Item	SUS Mean Score ± SD	Reaction Mean Time ± SD (s)	
		Notification	End of response
Luminous	80.67±7.62	0.91±0.35	1.37±0.50
Conventional	68.96±14.60	1.19±0.57	1.91±1.22
p	*	**	

SUS Score and Reaction Time

*<.05, **<.01

Wilcoxon signed-rank test result

- "Luminous" SUS Score was found to be significantly higher.
- The reaction time was significantly shorter for "Luminous" in Notification.
- The reaction time was no significant differences" in End of response.

Luminous notification improves the usability of DHH users.

Results and Discussion

RQ1: Efficacy of Luminous Notification

Assignment

- We incorporated a **luminous** notification as a means of responding.

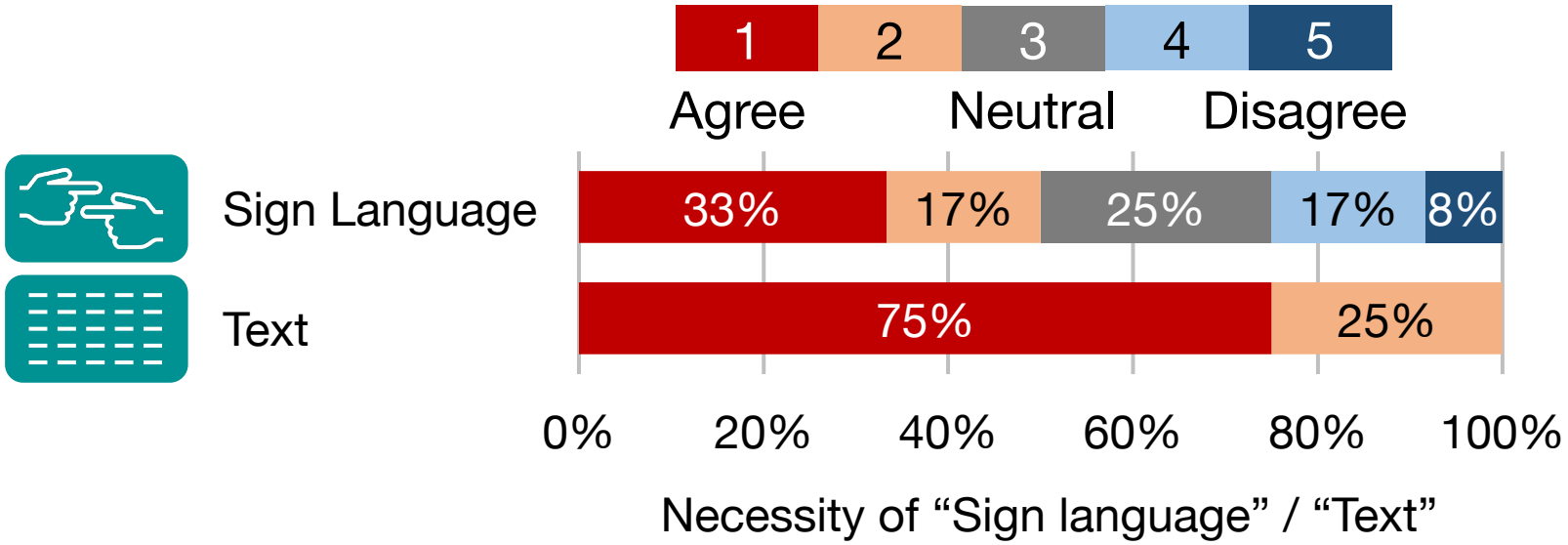
  Need to conduct a verification that includes a **vibration** notification

- We placed the system at the **front** of the participants in this experiment.

  Need to find a way to make them aware of the notifications from the **rear**

Results and Discussion

RQ2: How to Suitably Display Sign Language/Text



Participants who have not signed for a long time tend not to believe that sign language is necessary.

All of the participants need regardless of the user attributes.

Results and Discussion

RQ2: How to Suitably Display Sign Language/Text

VUIs has the advantage of being **eyes-free**. [8]

▶ **DHH users** The advantage of eyes-free interaction is lost.

Solution

Need **text information** that they can recognize, even if they look away for a moment

→ Need **to stop the sign language when the user looks away and start again when the user looks back**

[8] Chathy Pearl . Designing Voice User Interfaces: Principles of Conversational Experiences. O'Reilly Media. 2017.

Results and Discussion

RQ3: Efficacy of Eye Gaze

Percentage of Eye Gaze, Time of Eye Gaze

Task	Percentage (%)	Mean±SD (s)	min (s)	Max (s)
Alarm	100	0.76±0.61	0.20	3.18
Weather	100	0.43±0.23	0.10	1.08
News	86.4	0.59±0.44	0.20	2.08
Total	93.4 (1)	0.59±0.47	0.10	3.18 (2)

1. Percentage users gazed at the system before commanding is high.
2. A time limit when Alexa waits for a response from the user is 8.0 s. [9]

Eye gazing is a compelling wake-up method.

[9] Developer documentationamazon alexa, (June 7, 2021), ``Alexa Design Guide. Be Avaiable,'' https://developer.amazon.com/en-GB/docs/alexa/alexa-design/available.html