Development of an App Combining Gaze-Based Text Input with Text-to-Speech Functionality and Gaze-Controlled Arm Operation for Object Manipulation

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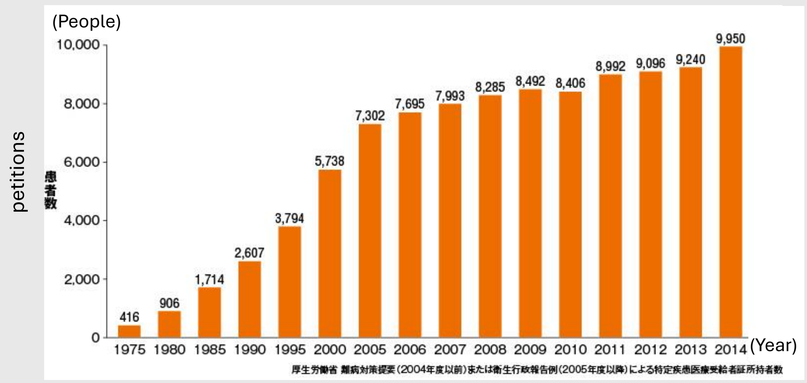
Our Purpose

The number of ALS patients in Japan is increasing, primarily due to aging. As Japan's aging society becomes more severe, the number of ALS patients is expected to rise. As the disease progresses, ALS patients find it increasingly difficult to speak and behavior. By providing patients with the option of turning their intentions into actions, we aim to expand their range of choices. Our goal is to increase the "can do" of our patients.



From: (Ministry of Health, Labour and Welfare)

Problem

- Our project began in response to a request from a local special needs school to create a communication tool using eye tracking.
- In both current analog and digital methods, it remains difficult for patients to perform physical actions, such as picking up a water bottle according to their own intentions.
- When conversing using existing eye-tracking input applications, it takes more time than speaking with words.

Our solution

- Development of easy-to-use communication
- Fast and easy to use

Framework

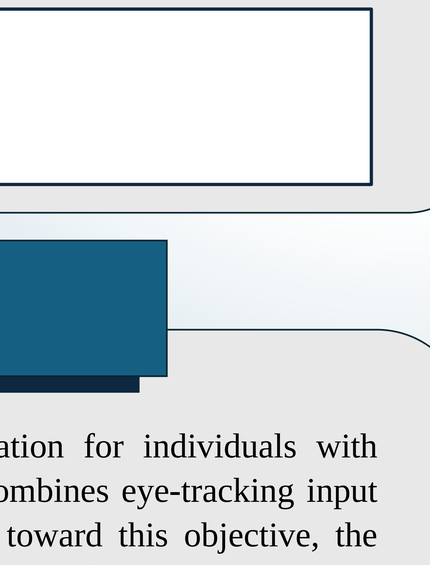
Our goal is to develop an integrated application for individuals with physical disabilities, such as ALS patients, that combines eye-tracking input with robotic arm functionality. As the first step toward this objective, the current project focuses on developing a keyboard that allows for easier input than existing alternatives.

In this project, we have prototyped an eye-tracking typing keyboard and made improvements based on feedback obtained from actual usage. Moving forward, we aim to add a function to control the robotic arm on the same screen as the typing keyboard, with the goal of creating a system that expands the range of actions patients can perform independently.

【Unity】
1.Development of an eye-tracking keyboard
2.Integration with synthesize speech
3.Creation of phrase

【Soft ware】
- Windows 11
- Mill Mouse
- Unity
- VOICEVOX

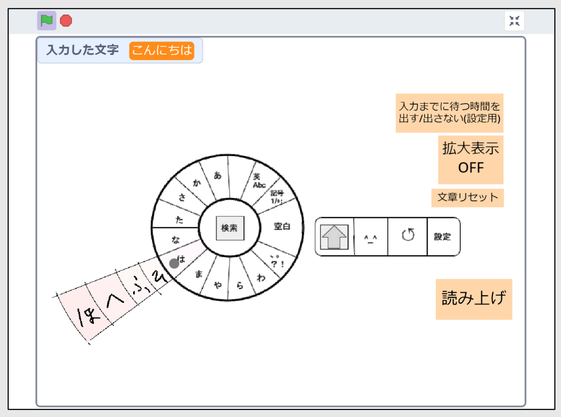
【Hardware】
- Tobii Eye Tracker 5
- Windows PC

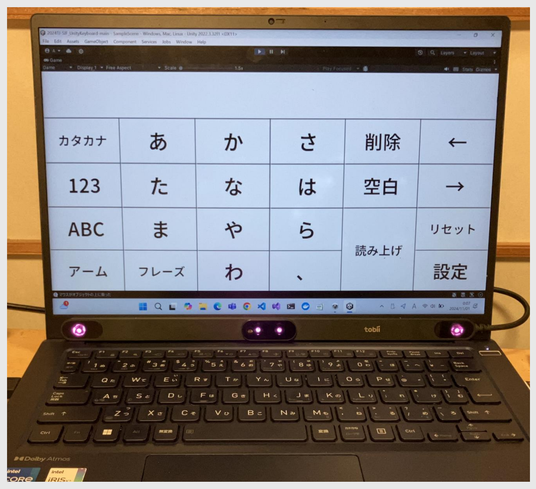


Finding

We created a prototype eye-tracking typing keyboard to gather feedback, receiving comments such as, "Small hit points make it hard to press", "Screen transitions could allow for larger hit areas," and "Typing is easier with automatic voice feedback."

Based on this feedback, we refined the keyboard further.





Prototype Keyboard

Input Method
From within a donut-shaped circle, you select the first letter of the row containing the desired character by using eye gaze. This action expands that row's characters. Next, by holding your gaze on the desired character for a few seconds, the character is confirmed and entered.

Advantages
For faster typing, more precise selections are required.

Disadvantages
The hit area is narrow, making selection difficult.

Improved Keyboard

Input Method
When you select the first key in the row containing the desired character with your gaze for a few seconds, the corresponding characters expand. By continuing to hold your gaze on the specific character for a few more seconds, that character is confirmed and entered.

Advantages
With a wider selection area, input is easier.

Disadvantages
Since two selections are needed to input a single character, it takes a bit more time.

Performance of the Keyboard (bad:1 - good:5)

the user	prototype keyboard		improved keyboard	
	ease of typing	less strain on the eyes	ease of typing	less strain on the eyes
1	1.2	1.0	3.8	3.0
2	1.0	1.0	3.5	3.0
3	1.5	1.0	4.0	4.0
4	1.0	1.0	3.0	3.5
average	1.2	1.0	3.6	3.4

User Satisfaction

the user	prototype keyboard		improved keyboard	
	typing speed (sec/char)	typing accuracy (%)	typing speed (sec/char)	typing accuracy (%)
1	79	32	6.2	100
2	122	8	6.1	100
3	67	38	6.1	100
4	30	73	6.0	100
average	75	38	6.1	100

Interpretation and Conclusion

In this project, we first prototyped a keyboard using Scratch, then created an improved version based on feedback received.

As a result, the average typing speed (seconds per character) increased by 92%, accuracy improved by 163%, ease of typing satisfaction rose by 200%, and satisfaction with reduced eye strain increased by 240%.

This shows that we were able to create a keyboard that better meets user needs. However, satisfaction levels did not reach 4.0, indicating for further improvement.