Design of Japanese Character Input Screen for Smartwatch

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***Abstract*—The demand for smartwatches has been growing in recent years, and opportunities to perform operations on smartwatches are increasing. However, the screen size of smartwatches is small, and complex input such as character input is often erroneous. Another problem is the high screen occupancy of software keyboards. Therefore, there is a need for a better input screen design for smartwatches. Since Japanese input has more characters than alphabetical input, it is necessary to provide many options. Therefore, we have proposed a new Japanese character input screen design for smartwatches. The user interface design should allow many selections to be made on a small screen with touch input. The proposed design has keys arranged in a circular pattern at the edge of the screen, allowing for a large key display while minimizing screen occupancy. The input operation is by touch and slide, and the slide allows multiple selections to be made from a single key. This design has resulted in superior input speed and accuracy, as well as screen occupancy, compared to the previous design. We investigate and evaluate user interface designs that allow users to input characters more comfortably.**

Keywords-smartwatch; character input; interface;

I. INTRODUCTION

In recent years, with the development of technology, various types of smart devices have become popular. According to the "Telecommunication Usage Trend Survey" by the Ministry of Internal Affairs and Communications, the ownership rate of mobile terminals will be as high as 97.3% by 2021 [1]. Among these, wristwatch-type smartwatches are attracting attention. According to a survey by MM Research Institute, the domestic sales volume in fiscal year 2020 is expected to increase by 19.9% compared to the previous year, indicating that the smartwatch market is expanding [2]. Therefore, the demand for smartwatches is expected to grow further in the future, and more user-friendly functions are required.

Recently, touch input and voice input are the most common input interfaces for smartwatches. Touch input is an intuitive input method because users can input data by touching the input target displayed on the screen. On the other hand, there are some problems with touch input. For devices with a small screen area, such as smartwatches, the size of the input target is so small that the input is misinterpreted as if a neighboring button is pressed during touch input. This is called the Fat Finger problem [3]. In addition, the conventional software keyboard on smartwatches has a very large screen occupancy ratio, and the area where the user can see the input characters is small. In addition, since the input target is not physically separated from the screen, it is necessary to check the input target while gazing at the screen while inputting. In the voice input method, the input is made by speaking the input to a microphone. Since this input method does not require the user to touch the screen of the device for input, it avoids the problems mentioned for touch input, such as pressing the wrong button. However, voice input is difficult to use in public places, such as libraries and hospitals where voices are not allowed, and in noisy places, such as crowded places and under elevated railway tracks, thus limiting the environment in which it can be used. It is also reported that many people are not comfortable with the actual voice input [4]. To solve these problems, various input interfaces have been studied.

Currently, touch input is the most common input method for smartphones. Therefore, touch input, which is familiar to many users, is also used in smartwatches. For Japanese input, Romaji input and Kana input are commonly used. In Romaji input, you enter Japanese sounds using the English alphabet, which are automatically converted to Hiragana. In Kana input, hiragana is entered directly using the Japanese keyboard layout. In previous research, touch input for smartwatches with small screens has been studied extensively. Various input methods have been proposed, such as character input by a combination of stroke gestures and taps [5], character input by slide-in [6], and a circular kana input interface [7]. However, none of these methods can solve the Fat Finger problem or the screen occupancy problem.

Therefore, we proposed a new screen design for touch input and conducted a character input experiment [8]. The proposed screen design consists of 12 keys on a circle at the edge of the screen, with consonants and vowels arranged in a clockwise direction. Character input is performed by touch and slide, and the screen vibrates when the selected character changes during input. The experimental results showed that the average character input speed per minute was 41.5 character par minute, and the error rate was 2.1%. These results are superior to those of conventional touch input methods for smartwatches and demonstrate the usefulness of the proposed method. It is considered that the clockwise arrangement of keys enables intuitive input, and the placement of keys at the edge of the screen maximizes key display size resulting in higher accuracy.

In this study, we will investigate screen designs with better usability. Character input experiments will be conducted to investigate how screen design affects the accuracy and speed of character input.

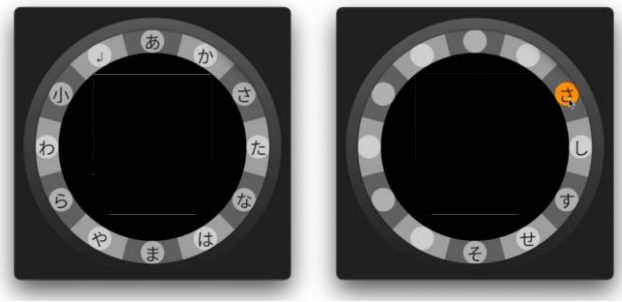
The rest of the paper is structured as follows. In Section II, we present our proposed method. Section III present the experiments and we conclude our work in Section IV.

II. PROPOSED METHOD

In this study, we propose a screen design and input behavior as a character input method for smartwatches.

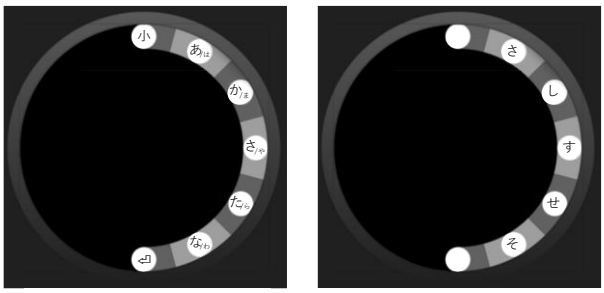
A. Screen Design

A character input screen design for a circular smartwatch was created based on a previous study [8]. In addition, a half-circle shape design was created in consideration of the fact that the keys are hidden by the fingers while inputting. These screen designs are shown in Figures 1 and 2. Since the screen size of a smartwatch is very small, we used the edge of the screen as the input area to make the input area as large as possible. In the design of Figure 1, twelve keys are arranged in a circular pattern at the edge of the screen, and 144 choices can be made by setting the screen state to two levels. In the design shown in Figure 2, the seven keys are arranged in a half-circle shape at the edge of the screen, and the number of choices is sufficient for character input by changing the state of the screen. These proposed designs have only two adjacent keys, reducing the possibility of pressing the wrong key compared to conventional keyboard designs.



(a) Initial screen design (b) Design after screen transition

Figure 1. Proposal input screen design.



(a) Initial screen design (b) Design after screen transition

Figure 2. Proposal input screen design.

B. Input Action

Input operations are performed by touching or sliding within the colored input area of the proposed screen design. In this proposed method, touch means touching the screen with a finger, and slide means sliding a finger on the screen. When inputting with the design shown in Figure.1, after selecting a character by touch in Figure 1 (a), the display change second state such as Figure 1 (b). To select a character, slide your finger to the position of the character you wish to enter, and release your finger. These operations allow the characters to be entered. The input operation for the half-ring design (Figure 2) is the same as in Figure 1, where characters can be entered by touch and slide. In addition, two characters are contained in one key, so that selection is made with or without a flick toward the center of the screen.

III. EXPERIMENTAL METHOD

The device used for the experiment is a Google Pixel Watch 2 (diameter: 41mm, resolution: 320ppi) running Wear OS by Google. The experimental application is developed using Flutter. The application record touch logs and input characters in addition to the input functionality of the proposed method. The experiment is conducted in a seated position with the experimental terminal attached to the non-dominant arm, and the subjects input with their dominant hand. The subjects practice typing after the explanation of the input method to them before the experiment. The subjects input the Japanese words displayed on the experimental terminal 30 times. This task is performed with each of the proposed designs.

IV. CONCLUSION

In this study, we aimed to explore the design of input screens to make character input on smartwatches more comfortable. Specifically, we proposed two input screen designs: one with keys arranged in a circular layout and the other with keys arranged in a half-circular layout, and conducted character input experiments. The results indicated that the circular design had a higher input accuracy, while the half-circular design had a faster input speed. Additionally, when considering the overall input efficiency, which combines both accuracy and speed, the half-circular design was found to be superior. Furthermore, it was confirmed that the proposed designs showed better input efficiency compared to conventional methods.

The significance of this study lies in improving the comfort of character input on smartwatches, thereby providing users with a more user-friendly input screen.

For future research, it is necessary to consider screen designs not only for Japanese input but also for other languages. This will enable comfortable character input for global users of smartwatches.

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