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Character Recognition by Flick Movements Presented on Fingers.

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Abstract. It is general to recognize informations of languages visually or audibly. But, the recognition of such informations by haptics can be a good way according to the surrounding environment. Moreover, people who lose visual and auditory senses need a character reading method without using such senses. Though the braille is given as an example for character recognition by haptics, learning braille requires a much time and the number of its users who can read braille enough is few. Then, this report proposes a device presenting flick movements onto the fingers for character recognition.

Keywords: Haptics, Character Recognition, User Interface

1 Introduction

Braille is given as an example for character reading by haptic clues. Braille is widely used for presenting symbolic information to visually handicapped people. On the other hand, it needs much learning in a long term, which perhaps results in a low percentage of current braille use[1]. As another example, a sort of tactile displays that presents stimulations representing the image patterns of letters to users' hands is proposed, although its use seems limited within a small number of users[2]. For the establishment of a more intuitive haptic-based symbolic display, we created a device that guides users' hand to trace alphabet trajectories of normal handwriting motion, by which they recognize alphabets they are forced to write[3][4]. These devices successfully let users tactually read alphabets accurately without long learning in advance. So, it can be said that this method is suitable for person with halfway loss of eyesight or even with normal sight. We expect improvements of the speed and accuracy of this method would enable users to detect sentences longer than a character. In this way, we aim to link haptics to new applications, other than conventional substitute sensing systems.

One intrinsic limitation of the above studies is that the displaying speed would not be faster than actual handwriting. In such a situation that requires fluent text reading, an essential improvement of the method is indispensable. As a new strategy, we noticed "flick input", which is widely used mainly among young Japanese users of smart phones. We briefly describe the Flick input. Users press a 3 x 4 dial matrix correlated with Japanese letters to the consonant with a finger, and flick to a direction out of several choices for designating the vowel. Flick input goes well with entering Japanese text since individual Japanese letters (Hiragana) denote a pair of a consonant and a vowel. Considering the following two merits in displaying text, we propose a device which presents flick movements on a finger: one is that it is much faster than normal handwriting, and the other is that the presenting position does not change in the flick movements. From the viewpoint of learning, using flick input in daily life might unintentionally reduce necessary learning for the device.

In this paper, we report about a fabricated device which presents flick movements along with the results of experiments using this device. The results indicate the device allowed users to tactually read some sentences and there existed learning effects over a period of hours.

2 Proposed Device

2.1 Outline

The fabricated device is shown in Fig. 1. The device consists of an acrylic jig imitating a smart phone and two-dimensional linear actuator（models EZS3D005-A and EZS6D005-A, Oriental Motor Co., Ltd) which moves relatively to the jig. Users are supposed to put a finger on an acrylic stage mounted on the tip of the actuators for perceiving flick movements. A vibrator (Forcereactor, Alps Electric Co., Ltd) is loaded on the stage, so that users can distinguish whether the displayed finger movements correspond to actual flick movements (indicating vowels), or transitions to a letter (indicating consonants) as described in the following. A switch is installed behind the jig, which allows users to control the character presentation.

Figure 1 shows an example of how to hold the device . It shows a user's hand, holding a whole jig with one-hand, putting the thumb on the stage and manipulating the switch with the middle finger, which is just like the way a user holds a smart phone.

The movements of the stage presenting single character of *Hiragana* are concretely as follows. As shown in Fig. 2, we suppose an imaginary character board on the display like actual flick inputs, and the character is presented as movements of a finger on the character dial. First, the initial position of the stage is at the position of "*na (な)*" located on the center of the character dial in the normal flick input. Second, the stage starts moving to the position of the corresponding consonant. The movement in this step is given as a combination of the lengthwise direction and the lateral direction (not on the diagonals) as shown in Fig. 2. This is because preliminary experiments showed that detection of the moving direction between diagonal movements and the other was a bit

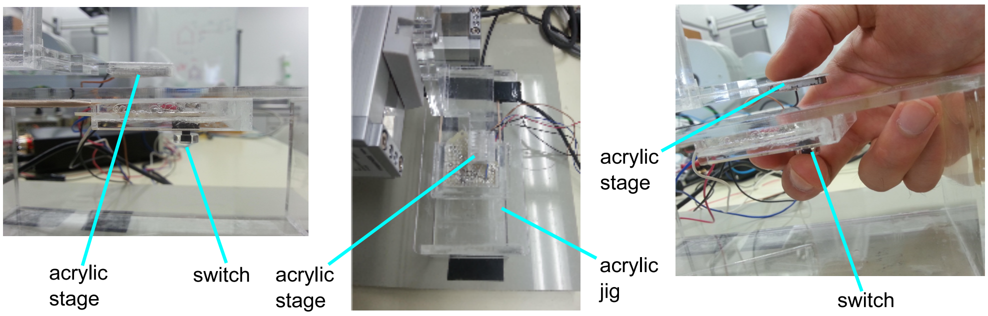

Fig. 1. Proposed Device : Side view (left figure), top view (middle figure) and an example of how the user holds the device (right figure).

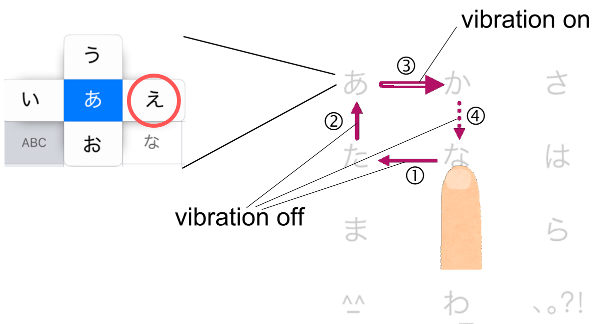

Fig. 2. Presenting Flick Movements: an example of presenting ”*e*”.

difficult. Third, the flick movement, which represents the information of vowels, is presented. For the distinction of this flick movement from previously described one, a vibration is added while moving. At the end of each letter the stage moves back to the initial position. As an example in Fig. 2, the sequence of movements that presents ”*e (え)*” is as follows. The stage moves to upper left which stands for the consonant of ”*a (あ)*” at first. Next, the stage moves to right which stands for the vowel of ”*e (え)*” . Then, the stage goes back to the position of ”*na (な)*”, the initial position, to prepare the next character. Thus, user re-experiences the flick movements through the moving stage.

In an actual operation, user can control the presenting of characters with a switch. When the switch is pushed to right, the system aborts presenting current character and starts presenting the next one. When the switch is pushed to left, the current character begins to be presented from the beginning again. In either case, user can feel some corresponding patterns of vibrations when the switch is pushed.

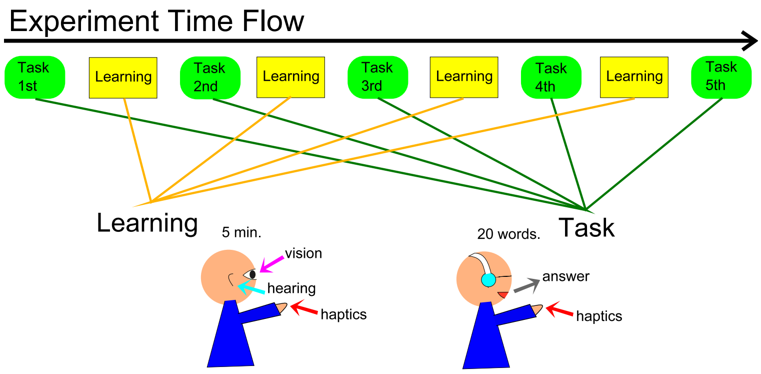

Fig. 3. Procedure of the Experiment.

2.2 Design

The proposed device consists of three part, a motion presenting part, a switch, and a processing system part.

The processing system includes PC and a microcontroller board (Arduino Mega 2560, product of Arduino). Two-dimensional linear actuator and switch is electronically controlled by the computer via a microcontroller board.

3 Experiment

With the proposed device, we did an experiment as below to give light on users' recognition and learning speed with the device.

As shown in Fig. 3, each subject performed five sets of tasks with intermittent learning periods that lasted for five minutes between each task. In the tasks, the subject was presented twenty words or sentences by the device while listening to the white noise through headphones and to close eyes during the task. If the subject understands what words or sentences is presented, then he or she had to answer at once and move on to the next. The subject was allowed to repeat the same presenting until he or she recognizes it. In each task, we got the correct recognition rate of presented twenty words or sentences and the time required for twenty answers. We also checked the transition of answering time on each set of the task. In the learning time, the subject could get information about what was presented by the device not just by haptics but also by visual and auditory senses.

The kinds of characters used in the experiment includes 46 *Hiraganas* and a macron, and the number of characters of individual word or sentence is from two to nine. More than thousand words or sentences are used in each task, and the same words were never presented to the same subject.

4 Result and Discussion

The result of the experiment is shown in Fig. 4. Five subjects participated in the experiment, and those scores are shown in different colors in the graphs. All subjects are sighted, and everyone except Subject 2 always uses the flick input with their smart phones.

The upper graph indicates that almost all subjects could get to recognize presented words at about 80 percent of accuracy. Therefore, it can be said to let users recognize words or sentences through this device. Moreover, the results were improved from 1st trial to 2nd or 3rd trial in the both graphs, so short-term learning can be effective in this method.

The subject 1 in the graphs, who is one of the writer of this paper, showed almost perfect accuracy and the time much faster than other subjects. It is conceivable that the reason is he has been touching this device for a long time. So, this indicates a possibility that other subjects can perform much better scores if they have more time to learn about this device. And surprisingly, these results also show that how subjects get used to the flick input is not a big factor of how the person can recognize words in this method, since the subject 2 who doesn't use flick input in daily life showed the 3rd best scores in the experiment.

On the other hand, the results show great deviation between subjects, and I think the reason is the inflexibility of difficulties. The length and the speed of the flick movements affect the time for presenting one word and also the difficulty to detect it. These parameters were set for the subject 1, one of the writer, to achieve a good score, but it can be too hard for the beginners.

5 Prospect

With the proposed device, we showed that it is possible to recognize words or short sentences by haptics. Nevertheless, there was the variation of results attributable to individual differences, and one subject cannot improve the accuracy till the end in the experiment. So, it is conceivable, as a solution of these problems, to change difficulties according to the accuracy of the user or to learn from easier words and gradually switch them to more difficult ones.

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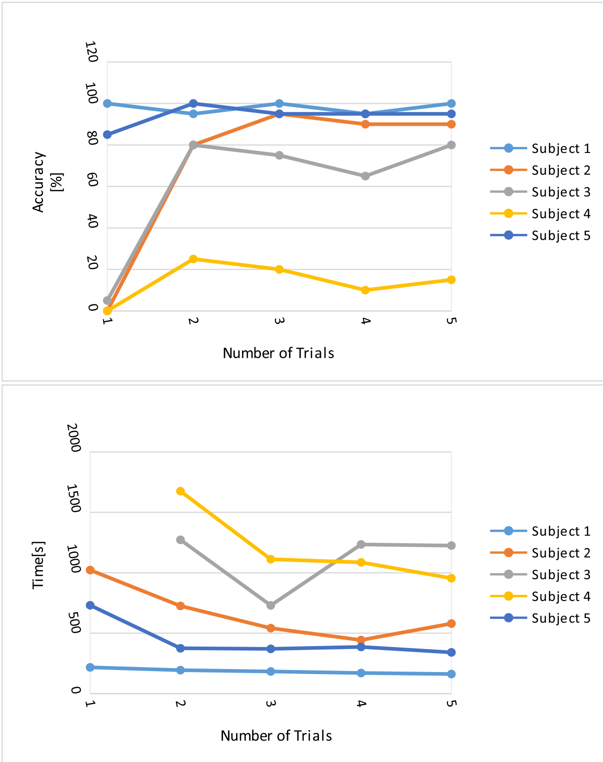

Fig. 4. Results of the Experiment: the accuracy transition (upper graph), and the time transition (lower graph). The horizontal axis in both graphs represents 1st to 5th trials of the tasks, and the vertical axis represents the accuracy of the trial in the upper graph, and the time required for the trial in the lower graph. In the lower graph, there are two missing points in the 1st trials, but this means that subject 3 & 4 couldn't finish the task without any learnings at the 1st trial.

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