

Kanji Learning Support with Feedback based on Haptic and Pseudo-Haptic

Takanori Kono^{a*}, Yukihiro MATSUBARA^a & Masaru OKAMOTO^a

^a*Graduate School of Information Sciences, Hiroshima City University, Japan*

*lkono@lake.info.hiroshima-cu.ac.jp

Abstract: Learning systems with haptic or pseudo-haptic feedback has developed. However, a study have not been conducted about effect of haptic and Pseudo-haptic feedback in learning system. Therefore, in order to investigating effect of haptic and pseudo-haptic feedback in learning system, we developed Learning system with feedback based on haptic and Pseudo-haptic.

Keywords: Force feedback, Pseudo-Haptic feedback, learning support system for Kanji.

1. Introduction

Recently, various learning support systems using haptic devices were developed. Haptic devices can give users force feedback from manipulators, which is one of their uses. In learning support systems, force feedback is used for various purposes. Hidani et al. (2015) developed the virtual experiment environment for pulley learning using a portable haptic device (SPIDAR-tablet). SPIDAR-tablet is a haptic device for tablet type PC (Tamura, Murayama, Hirata, Sato, and Harada, 2011). Isshiki et al. (2009) used haptic interaction for English-accent learning. As another force-experience approach, Pseudo-Haptic is proposed (A. Lecuyer, 2009). Shiota et al. used Pseudo-Haptic for feedback to create a concept map and evaluated the effects of it (Shiota and Kashiwara, 2013). Yamasaki et al. showed the training effects of using Pseudo-Haptic in motion training (Yamasaki, Hanai, Arai and Seo, 2015).

Comparisons of effects of haptic feedback and the effects of Pseudo-Haptic feedback in learning support have not been conducted. In this paper, we developed a PC tablet-based learning support system using real force feedback and Pseudo-Haptic feedback. We also compare effects of haptic approach and Pseudo-Haptic feedback approach, as well as sound feedback in learning support systems. We then conducted an evaluation experiment with this novel system. In this study, a prototype system was developed for learning stroke order of Kanji (a kind of character set used in Japan).

2. Learning system for Kanji (Characters used in Japan)

2.1 Outline of the System

This system supports learning of stroke order of Kanji (characters used in Japan). The system uses three methods (Force, Pseudo-Haptic, and Sound) to give learners feedback about stroke order. In order to compare each feedback method, the system points out mistakes by a single feedback method. Learners enter stroke order by writing Kanji displayed on the tablet PC screen. The system instructs learners by selected feedback method if and when a learner makes a mistake. The system judges stroke order by start-point coordinates, endpoint coordinates, and by node coordinates.

Figure 1 shows the overview of the system. The system is constructed with a tablet PC and a SPIDAR-tablet. Force feedback of the system is done with the SPIDAR-tablet which is constructed with a black frame, motor, string, and ring as seen in Figure 1. Learners fit the ring (see Figure 1 center), which is connected with strings. The system performs force feedback by controlled tension of strings by the motor. SPIDAR-tablets are used when force feedback is selected as the feedback method.

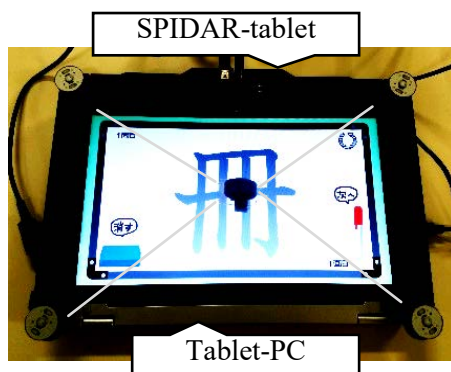


Figure 1. Overview of the system.

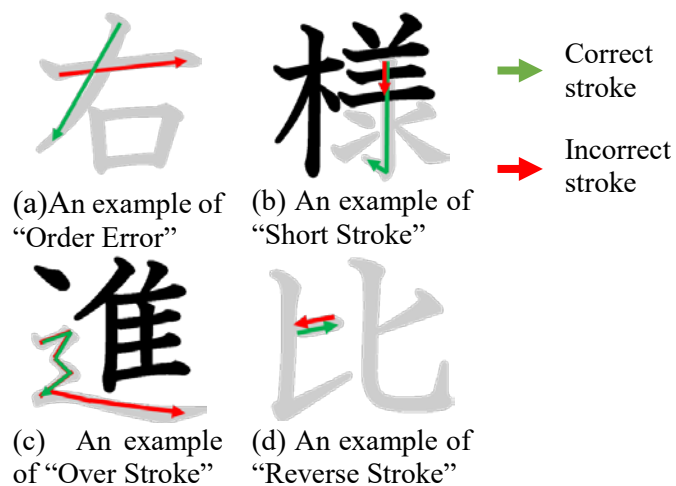


Figure 2. Examples of each type of error.

2.2 Method of Pointing out Errors

In this study, incorrect stroke orders are classified as “Order Error”, “Short Stroke”, “Over Stroke”, and “Reverse Stroke”. The system points out errors to the learner to help the learner distinguish the type of error; however, the system points out “Order Error” and “Reverse Stroke” by the same method. Therefore, the learner distinguishes 3 types of errors. Pointing out errors by sound is conducted by the same buzzer. However, the learner can distinguish types of errors by timing.

Here we describe each type of error. Figure 2 shows an example of each type of error. In Figure 2, the black painted stroke corresponds to the written stroke; red arrows are incorrect strokes; and, green arrows are correct strokes as well. “Order Error” is an error that learners wrote an incorrect stroke. “Short Stroke” is an error that the learner took a finger off at a point, which was before the correct end point. “Over Stroke” is an error that the learner wrote another stroke beyond the correct stroke. “Reverse Stroke” is an error that the learner wrote from the end point to the start point.

Here we describe concrete method of pointing out. If the learner commits an “Order Error” in the haptic mode, the system provides force feedback in the direction of the point that the learner began writing. In the Pseudo-Haptic mode, when the learner touches the screen, the system begins to provide Pseudo-Haptic. Next, we describe the method of pointing out “Short Stroke”. In the haptic mode, when the learner takes the finger off, the system provides force feedback in the direction of the point that the learner began writing. In the Pseudo-Haptic mode, when the learner takes the finger off, the system moves the pointer to point that the learner began writing. Next we describe the method of pointing out “Over Stroke”. In the haptic mode, when the learner writes away from the correct ending point, the system provides force feedback in the direction of the correct ending point. In the Pseudo-Haptic mode, when the learner writes away from the correct ending point, the system provides Pseudo-Haptic.

In the sound mode, the system points out each error by the same buzzer, however, the learner can distinguish the type of error by timing that is the system begins buzzer.

3. Experiment

3.1 Purpose and Method

This experiment was carried out with the system to investigate difference of learning effects that arise from each feedback method and the peculiarity of each feedback method in the learning system. Nine Japanese subjects (4 college students and 5 graduate students) participated in the experiment. The subjects were first tested on 24 questions about the stroke order of Kanji that is easy to mistake as pretest (paper test). After that, the subjects learned 8 Kanjis by each of the feedback methods. After learning, a post-test was conducted in the same way as the pretest was conducted, and we investigated the learning effect. Finally, a questionnaire was conducted.

3.2 Results and Consideration

Figure 3 shows the correct answer rate of pretest and post-test. Figure 3 indicates the amount of change from pretest results to post-test results, where each feedback method was nearly unchanged. Figure 4 shows the average touch count to users writing a correct stroke after a learner commits “Over Stroke”. We confirmed that touch count to users writing a correct stroke after a learner commits “Over Stroke” with sound feedback equates to more counts than with force feedback and Pseudo-Haptic feedback. We considered that learners find it difficult to distinguish the type of error by sound feedback, and that learners made the same mistake after the system pointed out error. The questionnaire also helped confirm a tendency that learners cannot distinguish the type of error by sound feedback. We confirmed personal difference in degree of felt of Pseudo-Haptic feedback is larger than force feedback, and users who hardly feel Pseudo-Haptic feedback find it difficult to distinguish the type of error. Some subjects who hardly feel Pseudo-Haptic feedback grasped it as a visual effect and thus could distinguish the type of error.

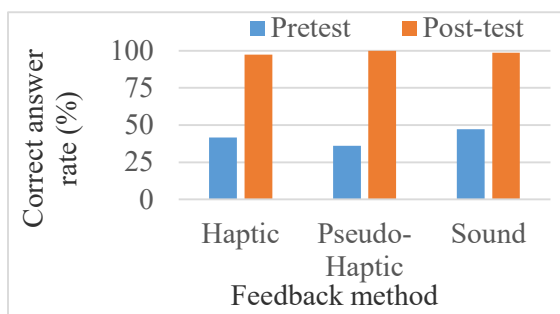


Figure 3. Correct answer rates of pretest and post-test.

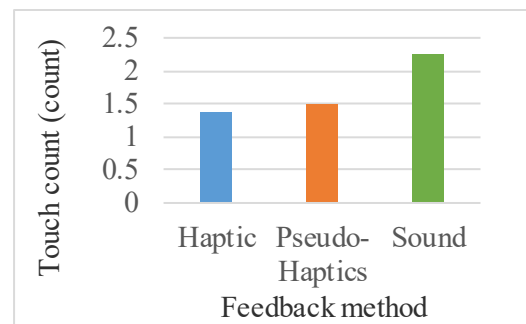


Figure 4. Average touch counts until users write a correct stroke after a learner commits “Over Stroke”.

4. Conclusion

In this study, we developed a learning system for Kanji that can provide force feedback, Pseudo-Haptic feedback, and sound feedback. The experiment confirmed that learners sometimes find it difficult to distinguish the type of error by sound feedback; additionally, we confirmed personal difference in degree of felt of Pseudo-Haptic feedback is larger than force feedback. We need to investigate a learning subject that can confirm the differences of learning results across each feedback method. Part of this research was made possible through the Grant-in-Aid for Scientific Research C (No.15K01084) from the MEXT Japan.

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