A Calligraphy Learning Assistant System with Letter Portion Practice Function Using Projection Mapping

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Abstract—For decades, Calligraphy has been a popular artistic activity in Japan, China, and some countries. To assist its self-learning, we have proposed the Calligraphy Learning Assistant System (CLAS) using projection mapping, where a learner can practice it by following the letter writing video of a teacher projected on the paper. In this paper, we newly implement a letter portion practice function in CLAS, such that learners may practice their weak portions with the video showing the writing by a teacher. It is expected that to repeat practicing weak portions is useful in improving the whole letter writing. Through applications to 12 novice students from Indonesia, Myanmar, China, and Kenya, we confirm the effectiveness of this function, where each student has significantly improved the calligraphy skill.

I. INTRODUCTION

For decades, calligraphy has been the prevailing artistic activity in Japan, China, and some countries, which produces the supreme art form [1]. Through practicing calligraphy, people can enhance their concentration, imagination, and even logical thinking [2][3].

To promote self-learning of calligraphy, we have proposed the Calligraphy Learning Assistant System (CLAS) using projection mapping [4]. CLAS adopts a small computer, Raspberry Pi 3, with open source software, openFrameworks and OfxPiMapper [5][6], to process the high-definition video for projection mapping with a portable projector and a set of calligraphy tools. Figure 1 shows the overview of CLAS.

In CLAS, learners generally learn calligraphy by imitating the letter writing video of a teacher that is directly projected on the paper. The CLAS utilization procedure is as follows: 1) recording a video of writing letters by a teacher, 2) converting the video into projection mapping, and 3) practicing calligraphy by imitating the video projected on the paper.

In this paper, we newly implement a letter portion practice function in CLAS. In this function, a learner can practice their weak portions of a letter writing with the video that shows the repeated writing by a teacher. It is expected that to repeat practicing weak portions is useful in improving the whole letter writing.

For evaluations, we applied the proposal to 12 novice students from Indonesia, Myanmar, China, and Kenya in our group. The results confirm the effectiveness of this function, where each student has improved the skill remarkably well.

II. LETTER PORTION PRACTICE FUNCTION

In this section, we present the letter portion practice function.

A Japanese letter including a kanji usually consists of several portions or strokes. For example, consists of five portions shown in Figure 2. On the whole, has been often used in calligraphy learning, because it has the eight basic brush strokes called Eiji-happo [7]. They include Ten (dot), Yokoga (horizontal stroke), Tatega (vertical stroke), Hane (upflick from a horizontal or vertical stroke), Migihane (rightward upflick), Hidaribarai (leftward downstroke), Hidarihane (leftward downflick), and Migibarai (rightward downstroke). In the letter portion practice function, we prepare a video of writing each letter portion several times by a teacher, as in Figure 2. A learner can repeat practicing the portion by imitating the video.

Besides, we prepare the user interface using LibreOffice so that a learner can select one portion or whole letter writing without difficulty. By clicking a button in the interface, the corresponding video will be automatically projected on the paper, using the macro function and the shell script. Figure 3 provides the letter portion practice by a student.
III. EVALUATION

In this section, we evaluate the letter portion practice function in CLAS through applications to 12 novice students who have used CLAS before.

First, we asked the students to write the whole letter of using CLAS as the pre-learning outcome. Then, we asked them to freely select two weak portions among the five of , and to practice them using the function up to three times for each portion. After that, we asked them again to write the whole letter using CLAS. Finally, we compared the difference rate (DR) of each written letter by a student. DR is given by dividing the number of the pixels whose binary values are different between the teacher’s calligraphy scanned image and the student’s one with the total number of pixels. As well, we asked the teacher to grade the written letters with the highest of five points subjectively.

Table I illustrates the minimum, maximum, and average of DR and grading results of the letters by the students before and after applying the function. It indicates that after the application, the average DR is reduced by 4.8%, and the average grade is increased by 31.6%. That is to say, most of the students obtained the highest grade after adopting the application.

Table II
PAIRED T-test RESULT WITH α=0.05.

<table>
<thead>
<tr>
<th>T-test</th>
<th>DR (%)</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>t-value</td>
<td>3.63</td>
<td>2.20</td>
</tr>
<tr>
<td>p-value</td>
<td>0.0039</td>
<td>0.000015</td>
</tr>
</tbody>
</table>

Table II reveals the paired T-test results, which suggests t-value > t-table and p-value < 0.05, representing that significant differences exist between before and after adopting application in DR and grading results. Therefore, the effectiveness of the letter portion practice function is confirmed even for the short time use.

Figure 4 shows example calligraphy results from two students before and after applying the letter portion practice function. The results after application appear to be evidently superior to the ones before application.

IV. CONCLUSION

This paper presented the letter portion practice function in the Calligraphy Learning Assistant System. The results have proven the effectiveness of the function, where each student has significantly improved the calligraphy skill in short time.

REFERENCES