K-022

An Implementation of Letter Portion Practice Function in Calligraphy Learning Assistant System Using Projection Mapping

Samsul Huda‡ Nobuo Funabiki‡ Minoru Kuribayashi‡

1. Introduction

Nowadays, *calligraphy* has become popular around the world. It has been addressed that people can obtain logical thoughts and fresh ideas while practicing it [1][2].

To assist self-studies of *calligraphy*, we have proposed the *Calligraphy Learning Assistant System (CLAS)* using projection mapping [3]. Figure 1 illustrates the overview of the system. It adopts *Raspberry Pi 3* as the computer to process the high-definition video for projection mapping, and *openFrameworks* and *OfxPiMapper* [4][5] as the open source projection mapping software running on *Raspberry Pi 3*.

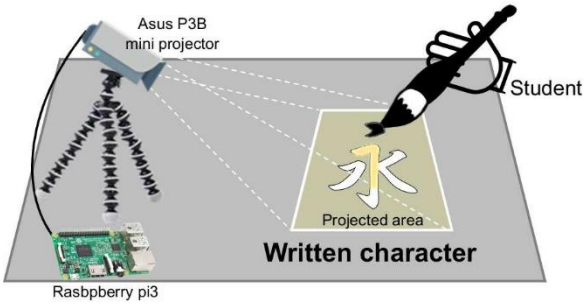

Fig. 1 System overview

In CLAS, a learner can learn calligraphy by imitating the letter writing video of a teacher that is projected on the paper. CLAS is utilized through: 1) recording a video of writing letters by a teacher, 2) converting the video to *projection mapping*, and 3) practicing calligraphy by imitating the letter writing projected on the paper.

In this paper, we implement a *letter portion practice function* in CLAS, to allow a learner to repeat practicing hard portions of a letter, which is useful for improving the whole letter writing. A learner can practice a selected portion with the video repeating the portion writing by a teacher.

For evaluations, we implemented this function, and applied it to 12 novice students from Indonesia, Myanmar, China, and Kenya in our group. The results confirm the effectiveness of this function, where any student has improved the skill in short time.

2. 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, "永" consists of five portions shown in Figure 2. "永" has been often used in calligraphy learning, because it has the eight basic brush strokes called *Eiji-happo* [6]. 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 proposed function, we prepare a video of writing several times each letter portion only by a teacher. A learner can repeat practicing the portion by imitating the video.

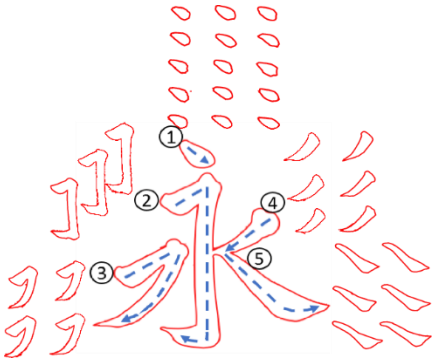

Fig. 2 Five letter portions of "永"

Then, we implement the user interface in Figure 3 using *LibreOffice*, to allow a learner to select one portion or whole letter writing that he/she wants to practice. By clicking the bottom, the corresponding video is automatically run and projected on the paper. In the implementation, the *macro function* and the *shell script* are used.

Fig. 3 User interface for letter portion practice function

Figure 4 shows the letter portion practice by a student using the proposed function. A student can repeat practicing the difficult portion for him/her by following the writing of a teacher that is directly projected on the paper.

† Graduate School of Natural Science and Technology, Okayama University.

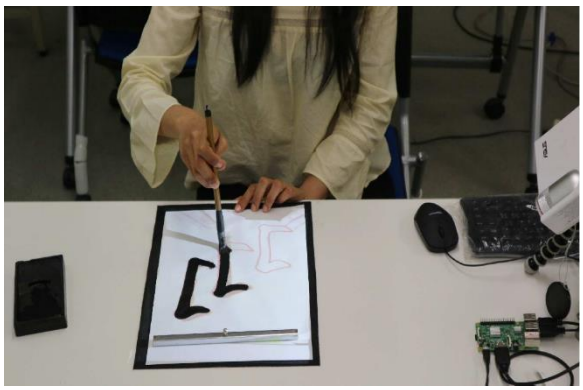

Fig. 4　Letter portion practice using proposal

3. Evaluation

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

First, we asked them to write the whole letter of "永" using CLAS as the pre-learning outcome. Then, we asked them to freely select the two difficult portions among the five ones of "永", and to practice them using the proposed function up to three times for each portion. After that, we asked them again to write the whole letter using CLAS. After writing we calculated the different pixel rate value of each written letter by a student from the letter by a teacher to evaluate the similarity. We also asked the teacher to grade their written letters with five points subjectively, in terms of the shape and the writing rhythm.

Table 1 shows the minimum, maximum, and average of the different pixel rate, and grading results of the letters by the students before and after applying the proposed function. It indicates that after the application, the average different pixel rate is reduced by 4.8% and the average grade is increased by 31.6%. Actually, most of the student obtained the highest point after the application.

Table 1　Experiment results

	Learning times	Different pixel rate (%)		Teacher grading	
		Before	After	Before	After
Min.	1	18.09	16.72	2	3
Max.	3	20.67	19.10	4	5
Ave.	2.58	19.28	18.34	3.08	4.5

Table 2 shows the *paired T-test* results. It suggests *t-value>t-table* and *p-value<0.05*, which means that there are significant differences between before and after application in the different pixel rate and grading results. Therefore, the effectiveness of the letter portion practice function is confirmed even for the short time use.

Table 2　Paired T-test result with α=0.05

T-test	Different pixel rate	Teacher grading
t-value	3.634374427	-7.340392083
t-table	2.20098516	2.20098516
p-value	0.003926501	0.000014659
result	yes	yes

Table 3 shows that the difficult portions for the students are 2, 3, and 5. The portions 2 and 3 consist of multiple basic brush strokes. Thus, they need the continuous writing of different brush strokes, which can be difficult for novice students. The portion 5 needs the slow brush work in *Migibarai*, which can be also difficult for them.

Table 3　Two difficult portions for students.

Portion ID	# of students
2 & 3	4
2 & 5	4
3 & 5	4

Figure 5 shows example calligraphy results by students before and after applying the proposed function. The result after application is clearly better than the one before application.

Fig. 5　Example calligraphy results by students

4. Conclusion

This paper presented the letter portion practice function in the *Calligraphy Learning Assistant System*. The results confirmed the effectiveness of the function, where any student has improved the calligraphy skill in short time.

Acknowledgment

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References

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