Mojirage: Average Handwritten Note*

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ABSTRACT

Because some people appreciate their own handwritten characters blended with the handwritten characters of others, we propose a method for generating good handwriting by the real-time blending of users' handwritten characters with their own past handwritten characters or others' handwritten characters. We also realize the prototype system and show its usefulness.

CCS CONCEPTS

• **Human-centered computing → Human computer interaction (HCI) → Interactive systems and tools**;

KEYWORDS

Handwriting, Note taking, Electronic Notebook

1 INTRODUCTION

Handwriting is better than keyboard input for writing complex shapes and formulas due to its flexibility. In addition, handwritten shapes differ, unlike computer fonts. However, it is more difficult to write letters, numbers, and symbols beautifully by hand than with computer fonts. Many Japanese people have difficulty writing letters beautifully by hand.

Researches by Nakamura et al. [1] and Niino et al. [2] on handwritings found that a user's handwritten characters and figures were evaluated to be more beautiful when they were averaged with those the user handwritten in the past than when they were not. The subjects in these studies also preferred the handwritten characters and figures averaged with all the users.

Zitnick [3] proposed a method to beautify handwriting by averaging the handwriting input in real time for electronic notebooks. In this method, the curvature of handwritten strokes is calculated in real time and averaged with the strokes written in the past, which produces more beautiful handwritten characters and figures of an individual user. This method works effectively for letters with longer curves such as English cursive letters, but it is difficult to apply the method to Chinese and Japanese handwritten

characters because they are more complex and consist of many strokes. In addition, this technique is not suitable for fusion with other people's handwriting, which usually have different curvatures, because the strokes of the user are identified on the assumption that the curvature is similar.

Therefore, we propose a method to beautify handwriting by blending a user's handwriting from electronic notebooks or electronic blackboards with their own handwriting in the past or another person's handwriting. In this paper, we examine the utility of a prototype system that implements the proposed method by performing a user study.

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This system is intended to create better handwriting. First, the handwriting input by a user is converted into a formula. Next, the handwriting input is blended with the past handwriting of the same user or past handwriting of another user (see Figure 1).
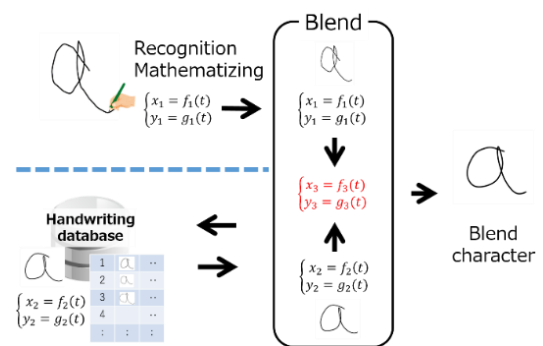

Figure 1: Overview of the proposed method

Then, the fusion rate can be changed. Furthermore, it is possible to produce a preferred handwriting by changing the proportions of the user's handwriting or those of the other person's handwriting.

First, the system recognizes the user's handwriting and makes the user's handwritten mathematical formulas using the method by Nakamura [1]. Next, the system adds a formula to the handwriting database. Then, the system gets the formula for the handwriting of the fusion target from the database. The blended handwritten character generates a formula. It is difficult to judge what kind of handwriting the user is trying to input until the user finishes entering the handwriting. Therefore, we will make beautiful handwritten characters by recognizing handwritten characters after

entering the handwriting without blending it and presenting the input of the handwritten characters. In addition, handwritten characters identify the characters and the number of strokes because we sometimes continue writing multiple strokes.

Figure 2 shows our prototype system. The system was implemented in a Web application (http://mojirage.com) with JavaScript, PHP, and MySQL. In addition, we used scalable vector graphics (SVG) to draw handwritten characters and used MyScript API for character recognition.
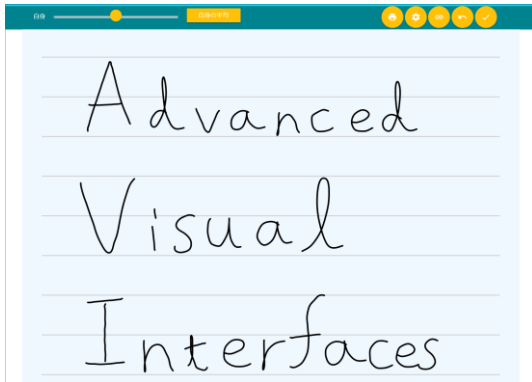

Figure 2: A screen capture of our system

3 USER TEST AND DISCUSSION

We conducted a user test to see the impressions of the subjects' handwriting which was blended with their handwriting from the past or other people's handwriting. Five university students (21–23 years of age; 4 males and 1 female) participated in the test. They were asked to write a specific text using our system. There were two different trials in the test. The first trial tested the subjects' handwriting blended with their past writing, and the second trial tested their handwriting blended with other people's handwriting. Each trial was conducted three times. We did not designate a blending partner.

Figure 3 shows handwritten characters that were written in the third trial by the user. The handwritten characters were blended with their handwriting from the past. We can confirm that the system beautified their writing with minor line blurring and gaps between the strokes. We got much positive feedback from the subjects. One of the subjects liked the blended handwritten characters because Chinese characters look well-balanced, and another said that some handwritten characters became just the right size after averaging. However, we also received negative feedback as well. The negative feedback includes an opinion that the subject did not really feel any difference, such as in the balance of handwriting, due to the homeostasis of handwriting.

Figure 4 shows handwritten characters that were written by the user and the same handwriting that were blended with other user's past handwriting. The balance changed considerably compared to the shape of the handwriting, which were blended with the user's own handwriting. We got many positive comments from the subjects. One of the subjects liked the handwriting blended with others and another said that they did not always write well, but they can write

satisfying handwriting. However, we also received negative feedback as well. The negative feedback includes opinions that they did not like the blend partner and that they want a lot more typefaces from different people. From the observations of the user study, we could confirm that handwriting characters generated by blending the handwriting of people who write neatly can be satisfactory to the users. However, blending beautiful writing with less beautiful writing is not favorable.
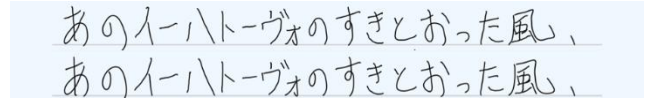

Figure 3: An example of blending a user's handwriting with the user's past handwritten characters.
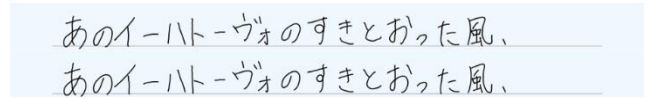

Figure 4: An example of blending a user's handwriting with other people's handwritten characters.

4 CONCLUSIONS

We proposed a method for presenting handwriting characters that are generated by blending a user's handwriting with their own handwriting in the past and with other people's writing. In addition, we implemented a prototype system and examined the usefulness of the system. We obtained many positive opinions for the entire proposed method and the system, however some problems were revealed. The followings are the problems;

- The blend target is dependent on the accuracy of character recognition.
- The handwritten characters are broken if the blend and stroke order is different from the user.
- The handwritten characters are broken if the blended handwriting is not written very well.

In the future, we will solve these problems. In addition, we will improve our method and system so that we can even use an electronic blackboard with a large screen or a mobile terminal with a small screen (e.g., a smartphone). We will also realize a new note-taking experience by accumulating handwritten characters from several people. One will be able to write beautiful handwritten characters on their tablet when they are in a hurry or in an unstable state. Finally, we will implement a mechanism that makes it easy for users to generate their own font.

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