Development of Software for English Haiku with Writing-Brush Letters

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Abstract. *Haiku* (short Japanese poem) has become popular in America, where a *Haiku* Society is held annually. Generally speaking, the completed poem looks better when it is written with the touches of writing-brush letters. So, our study was focused to simulate this presentation with which even people of English-speaking countries can enjoy the poem written in brush touched letters.

Key Words: Haiku, brush character, handwriting

MSC 2000: 68U05

1. Introduction

In recent years, *Haiku* has been enjoying not only in Japan but also overseas, especially in America, and they are also written in English. It can well be imagined that English *Haiku* will convey appropriate atmosphere for the feeling expressed if they were written in writing-brush letters, as it is the case with Japanese *Haiku*. An example of an English sentence transcribed in writing-brush letters is shown in Fig. 1 [1].

However, it is uncommon for people in English-speaking countries to be familiar with writing-brush letters, and it would generally be very difficult for them to write actually letters with writing-brushes. Accordingly, we have made a prototype of a software that enables one to transcribe easily into writing-brush handwriting.

2. About English *Haiku*

The following are the primary conventions in writing an English *Haiku*.
  1. Writing within a total of 17 syllables
     A *Haiku* is written in 5-7-5 syllables, for a total of 17 syllables. A unit containing one vowel is called a *syllable*. An English *Haiku* is similarly written in 5-7-5 syllables, for a total of 17 syllables. In English, however, the number of vowels within different words
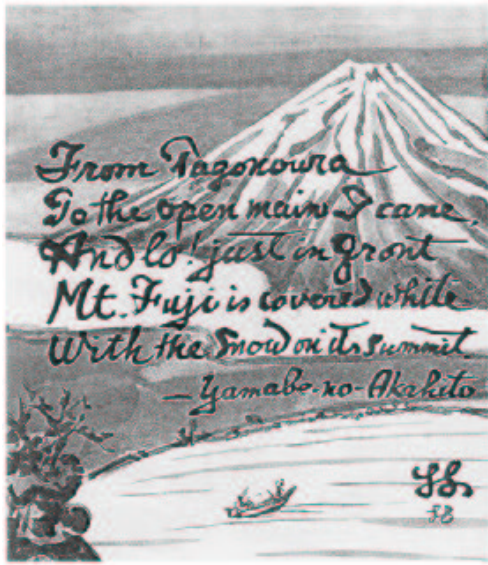
Figure 1: Example of an English sentence transcribed in writing-brush letters

Figure 2: Standard height of English letters (oblique letters)

is different. For example, 'spring' is a one-syllable word that contains one vowel 'i', and 'summer' is a two-syllable word that contains the two vowels 'u' and 'e'. Accordingly, a *Haiku* is created by counting the number of syllables within the words, instead of counting the number of words, so that the total of syllables is to be kept within 17.

2. The number of lines should be three
   A *Haiku* is a one-line poem, but it is usually written as a three-line poem in English, because it can be divided into three parts, 5-7-5.

3. About the letters

English letters actually written with a writing-brush and stored as images are used as the writing-brush letters to be displayed. The original writing-brush letters we used were creations of the calligrapher Mr. Mizuho TANAKA (pen name: Shimizu Kakehashi, a third-degree member of the Incorporated Association of the Japan Institute of Calligraphy). The height of the stored letter images was made to fit a standard format called 'oblique letters' [2, 3], as shown in Fig. 2, to display the letters in a good looking balance.

In this software a curved line is interpolated between the letters in order to display a character string as continuous handwriting. However, when there is a rising curve at the starting portion, or more particularly at the end portion of a letter, it is difficult to interpolate between the letters. Accordingly, the letter image was processed into three patterns, as shown in Fig. 3, to make the interpolation of the letters easier.

4. Spline curves

In order to display the letters as handwriting, spline curves are used to interpolate between the letters. A spline curve is a smooth curved line that goes through all control points. We will explain this by using numerical formulas in this section.
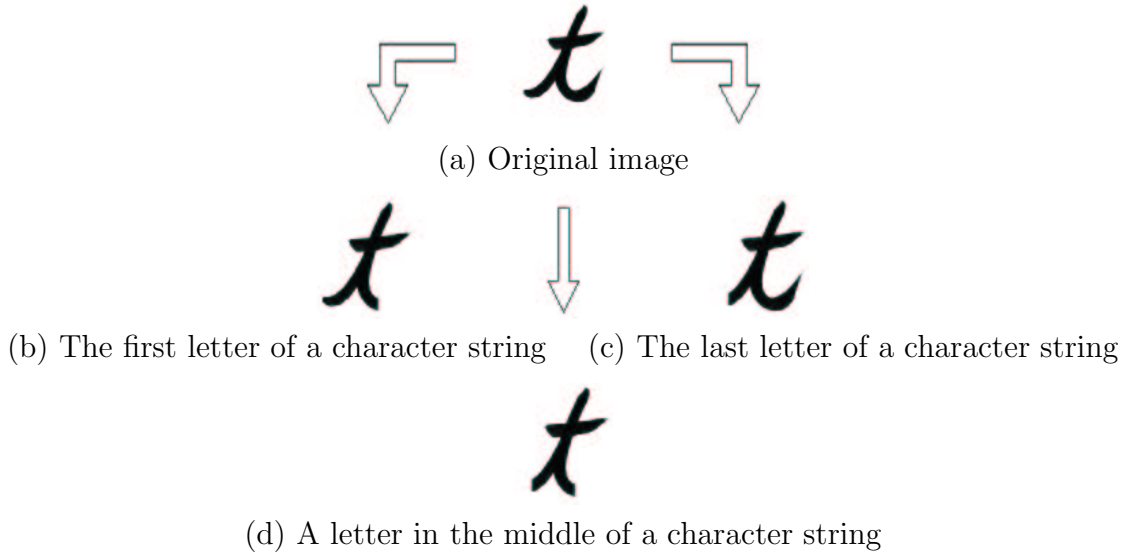
(a) Original image

(b) The first letter of a character string   (c) The last letter of a character string

(d) A letter in the middle of a character string
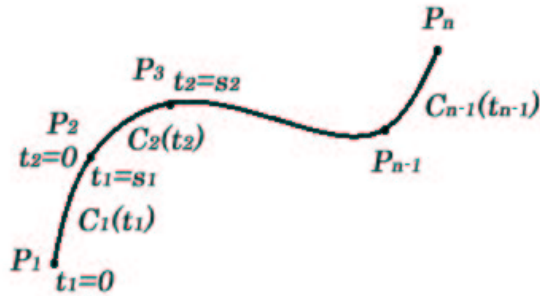
Figure 3: Processed letter images

Figure 4: Cubic spline curve

Given a point sequence $P_1, \ldots, P_n$ like in Fig. 4, we will explain a calculating method which gives $(n-1)$ cubic spline curves connecting these sequence. The curved line (curved line segment) that interpolates any two consecutive points of the sequence can be expressed by a cubic polynomial. For example, the first curved line segment C_i is as follows.

$$C_i(t_i) = W_{i3}t_i^3 + W_{i2}t_i^2 + W_{i1}t_i + W_{i0}, \qquad 0 \le t_i \le s_i. \tag{1}$$

Moreover, if this equation is differentiated with respect to t_i, we obtain

$$C_i'(t_i) = 3W_{i3}t_i^2 + 2W_{i2}t_i + W_{i1}. \tag{2}$$

If P_i' denotes the derivation at point P_i, then the following four coefficients can be expressed by P_i, P_i', etc., from the conditions $C_i(0) = P_i$, $C_i'(0) = P_i'$, $C_i(S_i) = P_{i+1}$, $C'(S_i) = P_{i+1}'$.

$$
\begin{aligned}
W_{i3} &= 2(P_i - P_{i+1})/s_i^3 + (P_i' + P_{i+1}')/s_i^2, \\
W_{i2} &= 3(P_{i+1} - P_i)/s_i^2 - (2P_i' + P_{i+1}')/s_i, \\
W_{i1} &= P_i', \\
W_{i0} &= P_i.
\end{aligned}
\tag{3}
$$

If at each connecting point a second-order contact is required, then the following simultaneous equations are necessary.

$$
\begin{bmatrix}
s_2 & 2(s_1+s_2) & s_1 & & \\
 & s_3 & 2(s_2+s_3) & s_2 & \\
 & & \cdots & & \\
 & & s_{n-1} & 2(s_{n-2}+s_{n-1}) & s_{n-2}
\end{bmatrix}
\begin{bmatrix}
P_1' \\ P_2' \\ \vdots \\ P_n'
\end{bmatrix}
$$
$$
=
\begin{bmatrix}
3\{(P_2-P_1)s_2^2+(P_3-P_2)s_1^2\}/(s_1s_2) \\
3\{(P_3-P_2)s_3^2+(P_4-P_3)s_2^2\}/(s_2s_3) \\
\cdots \\
3\{(P_{n-1}-P_{n-2})s_{n-1}^2+(P_n-P_{n-1})s_{n-2}^2\}/(s_{n-2}s_{n-1})
\end{bmatrix}. \tag{4}
$$

There are only $(n-2)$ equations against n unknowns, but this is because the condition is not determined at the endpoints P_1 and P_n. It is possible, for example, to specify tangent lines P_1' and P_n' at the endpoints (*fixing* condition), or to specify it so that P_1 and P_n are coincident thus constituting a ring (*cyclic* condition). When there are no particular conditions, then the following shall apply (*open* condition) [4]:

$$
\begin{aligned}
2P_1's_1 + P_2's_1 &= 3(P_2-P_1) \\
2P_n's_{n-1} + P_{n-1}'s_{n-1} &= 3(P_n-P_{n-1})
\end{aligned} \tag{5}
$$

In our software we adopted the open condition.

5. Control points

In order to interpolate between the letters with spline curves, control points have to be determined. Accordingly, the letters are interpolated by specifying two control points at the end portion of the previous letter (called 'endpoint' hereinafter) and two at the starting portion of the following letter (called 'starting-point' hereinafter), and one control point between the letters, for a total of 5 control points. An actual example of interpolation using a spline curve is shown in Fig. 5. The marked points indicate control points.
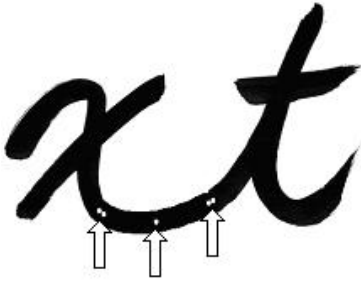

Figure 5: Example of interpolating letters

Figure 6: An example of expressing writing pressure

6. Expressing the writing-brush

Two of the features that appear when writing letters using a writing-brush is that the width of the line changes with the writing pressure, and that the brush lightly grazes the paper. The method to express these two features will be described in the following.
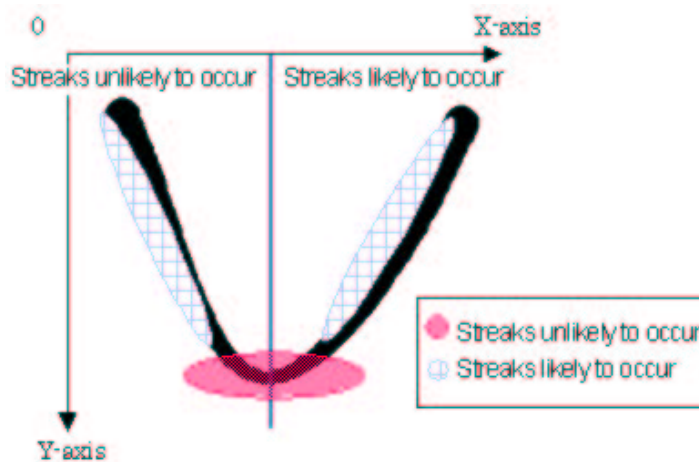
Figure 7: Drawing white lines

Figure 8: Streak incidence rate corresponding to the position of the curved line

6.1. Writing pressure

When writing with a writing-brush, the width of the line changes when the writing pressure is changed. In order to express this change in writing pressure, this software has been made so that the line width at the middle point of the interpolation line becomes the thinnest, as shown in Fig. 6.

6.2. Grazing brush streaks

Grazing brush strokes often result in continuous streak lines. Accordingly, the grazing brush streaks are expressed by drawing thin white lines upon the curved interpolation line, as shown in Fig. 7. Moreover, the same lines do not always appear even in the same brush stroke. Accordingly, we let vary the width of the white lines as well as their location and number, using a random function.

Fig. 8 indicates the incidence rate of streaks corresponding to the location of the curved line. Streaks by the writing-brush are apt to occur in the direction where the tip of the writing-brush is pointing (the circle of check in the drawing). Therefore, we have configured the program so that the probability of white lines being drawn in the minus direction of the X-axis is higher. Moreover, since streaks often occur when the amount of ink decreases, we have configured the program so that the probability of white lines being drawn in the latter half portion of the interpolation curved line is higher than that of the first half. Furthermore, the amount of streaks generated decreases as the line becomes thinner (the circle of mesh in the drawing). From this, we have configured the program so that the probability of white lines being drawn at the middle part of a curved line is low [5].

7. Modifying the curved interpolation line

Personality affects how the interpolation is done, when writing in writing-brush handwriting. In order to express this personality, we have configured the program so that users can freely change the curved interpolation line.

8. How to execute the software

Figure 9: The screen for executing the software
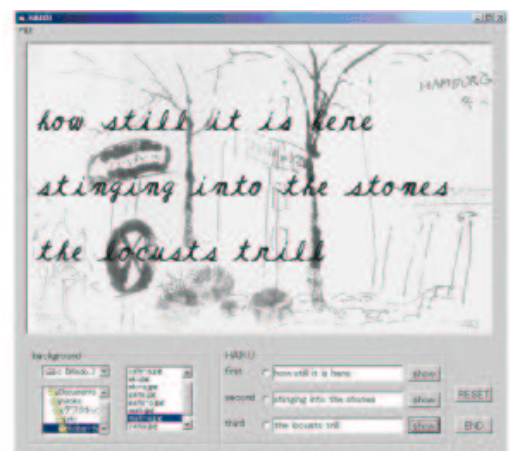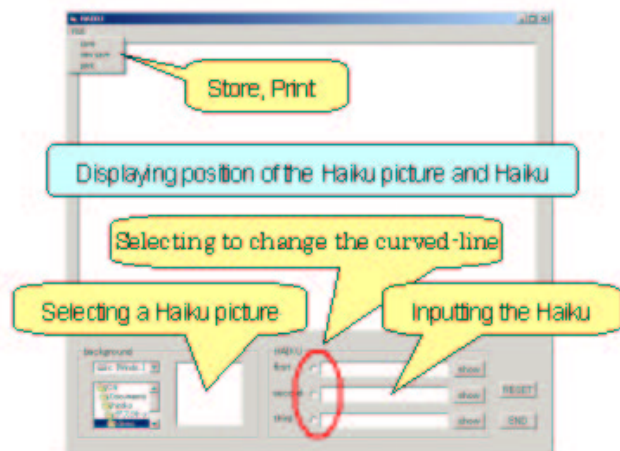
(Written by Basho Matsuo, translated by Donald Keene)

Figure 10: Result of the implementation

The screen for executing the software is shown in Fig. 9. A *Haiku* picture (background image) can be combined with a *Haiku*. To do so, the user selects from the menu the image that is desired to accompany the *Haiku*. The image changes as different image file names are selected. The user inputs the *Haiku* from the keyboard, and it is displayed as writing-brush handwriting when 'show' is clicked.

After the *Haiku* is displayed as writing-brush handwriting, the user can change the curved interpolation line between the letters freely. When changing, first the option button of the line to be changed is clicked. Then, the control point of the interpolation line to be changed between the letters is clicked, and then the new location is clicked where the user wants to draw the curved line. In this way, the curved line is redrawn in the desired shape.

Furthermore, it is possible to store the created piece of work as an image, or to print it.

9. The result, and considerations

The result of the implementation of this software is shown in Fig. 10, and an example of changing the interpolation curved line is shown in Fig. 11.

We were able to display the created *Haiku* as writing-brush handwriting. We were also able to reflect the user's sensitivity, and make a more tasteful piece of work by enabling the user to change the curved interpolation line.

As shown in Fig. 12, we were also able to express the streaks of the brush. Furthermore, it is conceivable that we can create streaks that are still closer to real streaks, by classifying the streaks into patterns according to the combination of the letters, and changing the probability and position of the drawing of the white lines of the streaks, for each of the patterns. It is also conceivable that the software can be made so that it will become possible to produce streaks according to the users preference, by providing plural patterns with differing numbers of streaks, etc.

(a) Before the change   (b) After the change

Figure 11: An example of changing the interpolating curved line

Figure 12: The result of making a blur

10. Conclusion

With this software we were able to express *Haiku* written in English in writing-brush handwriting, but the format is still provisional. In the future we will investigate the use of ornamental characters to increase expressivity and letter shapes peculiar to writing-brushes. We will also investigate ways to manifest individual personality, such as inputting handwriting of the user and imitating this in the software.

Acknowledgements

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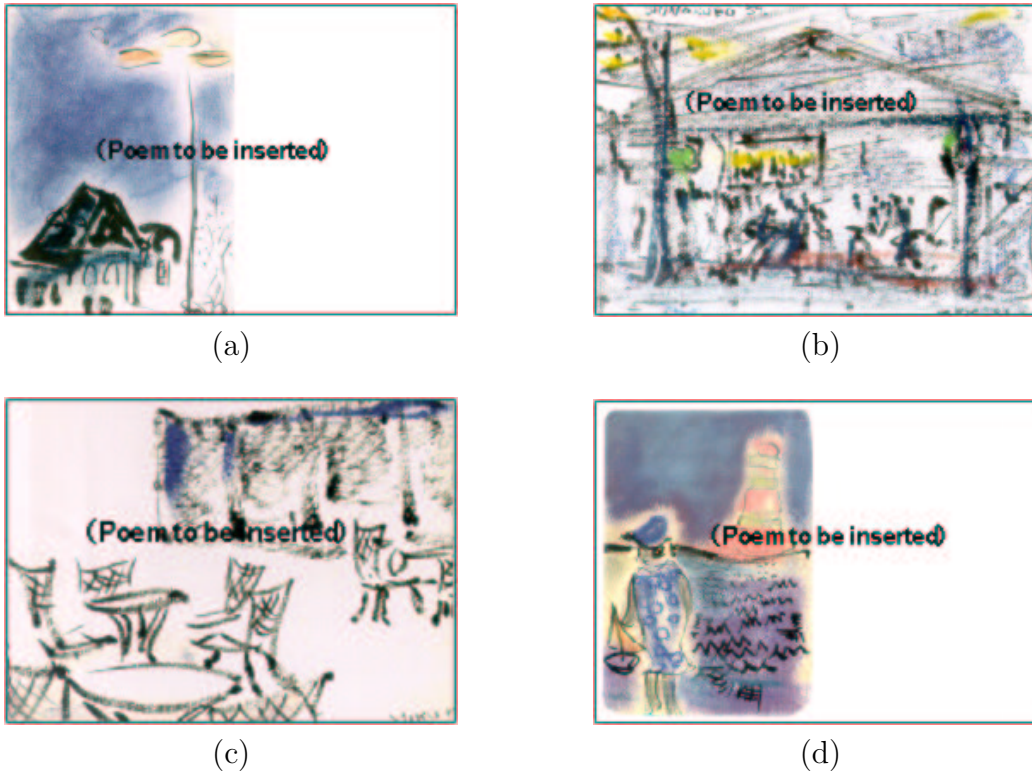
Appendix

(a)

(b)

(c)

(d)

Figure 13: Background sample images to be superimposed with poems

The images in Fig. 13 can be used as background images in this software. These were created in cooperation with Mr. Hiroshi KOBORI.
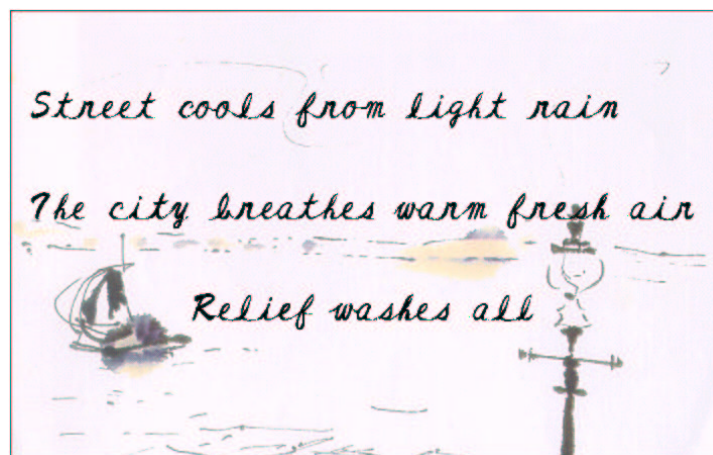

Figure 14: A sample of our results

Fig. 14 is the sample of our final example combined with English *Haiku* and background image. The English *Haiku* is the work of somebody who answered in the questionnaire.