Generation and Display of Large Size Gothic Type KANJI Patterns for A Poster using Ming Type Dotted KANJI Patterns

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Abstract

Large size letters such as headlines in a computer-outputted poster of Japanese language are usually obtained by extension of regular size character pattern of 24×24 or 32×32 dot matrix to a larger size matrix using interpolation, etc. But the larger they are extended, the more they become rough and unnatural. In this paper, a new method for obtaining smooth and beatiful large size character patterns and printing them out for a poster using usual 24×24 dot matrix Ming type KANJI patterns is proposed.

1. Introduction

Recently Japanese language processing using a computer system becomes very useful and popular. As one of its application, many kinds of posters written in Japanese language can be directly printed out by a computer system. Their letters, KATAKANA, HIRAGANA, KANJI, are Ming type dotted pattern of 24×24 or 32×32 dot matrix. When they are used as regular size letters, they are beautiful enough. Posters, however, usually require not only regular size letters but also large size letters for headlines. For this purpose, each letter is extentioned into large size dot matrix using interpolation, etc. But these extended letters are usually very rough and unnatural pattern. In this paper, a method for obtaining good looking large size letters of Gothic type is proposed.

2. Outline of processing

The genaral flowchart of the proposed method is shown in Fig. 1. The input

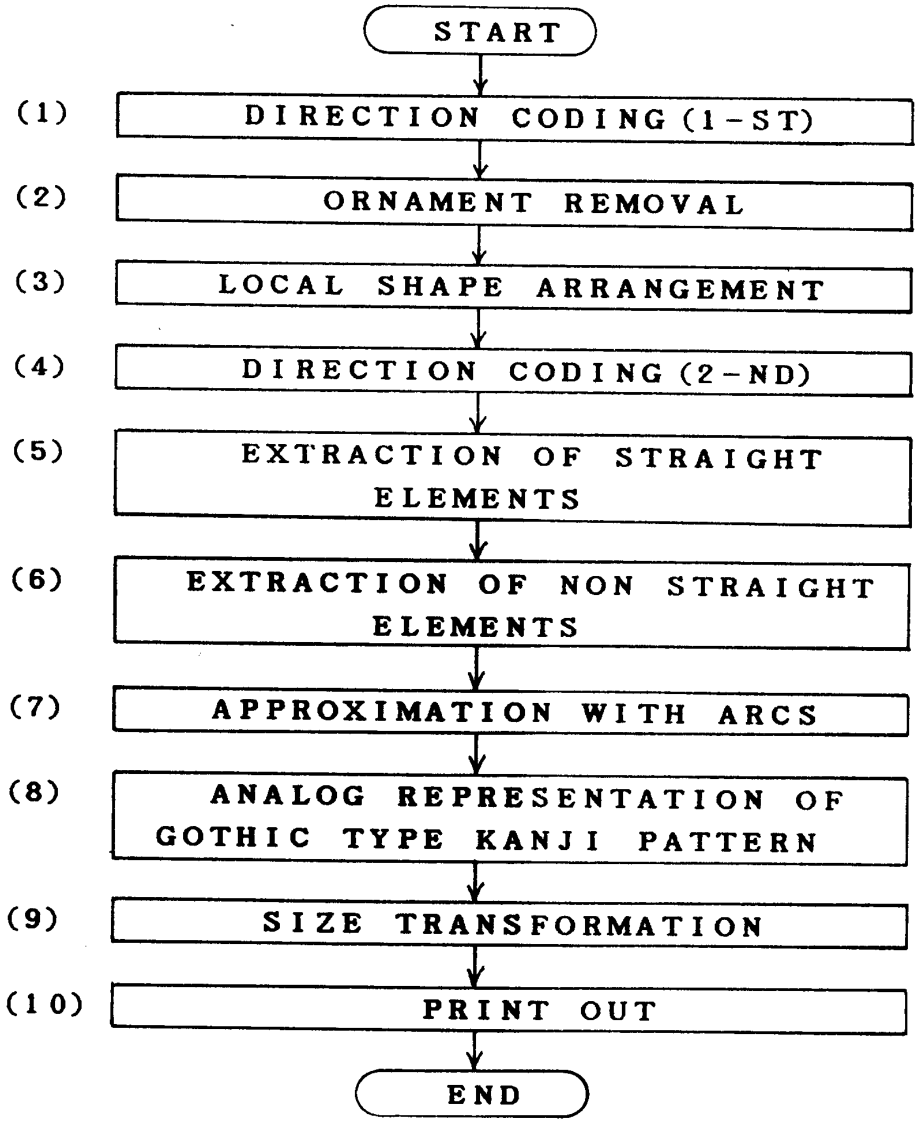

Fig. 1 The general flowchart of the proposed method.

is a binary picture of white (*0*) and black (*1*) pixels and its matrix size is 24×24. At direction coding in step (1), every pixel value is changed from 1 to γ ($\gamma=1, 2, 3, 4$). Direction is quantized with 4 directons, horizontal, vertical, diagonal and counter-diagonal. Direction code is defined as shown in Fig. 2. The direction code γ is determined as follows. Along each direction, the distance from the edge (the bound of white region and black region) to the another edge through the pixel is measured. As the result, 4 distances are obtained. The direction of the longest distance is chosen for the pixel's direction code and the value of the pixel is replaced by the code. At step (2), ornaments called "uroko", etc. of Ming type KANJI patterns are removed by 7 kinds of 5×5 logical masks shown in Fig. 3 (a)~(g). In Fig. 3, sign $\triangle$ means "*don't care*" and $\times$ is greater than zero. If all 25 pixels

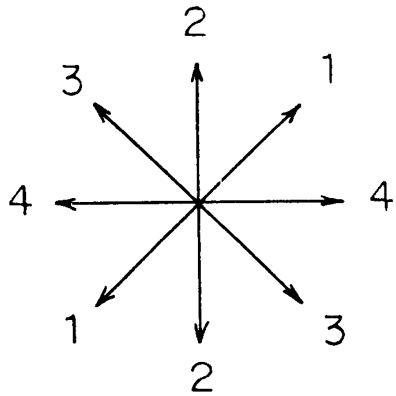

Fig. 2 Direction code.

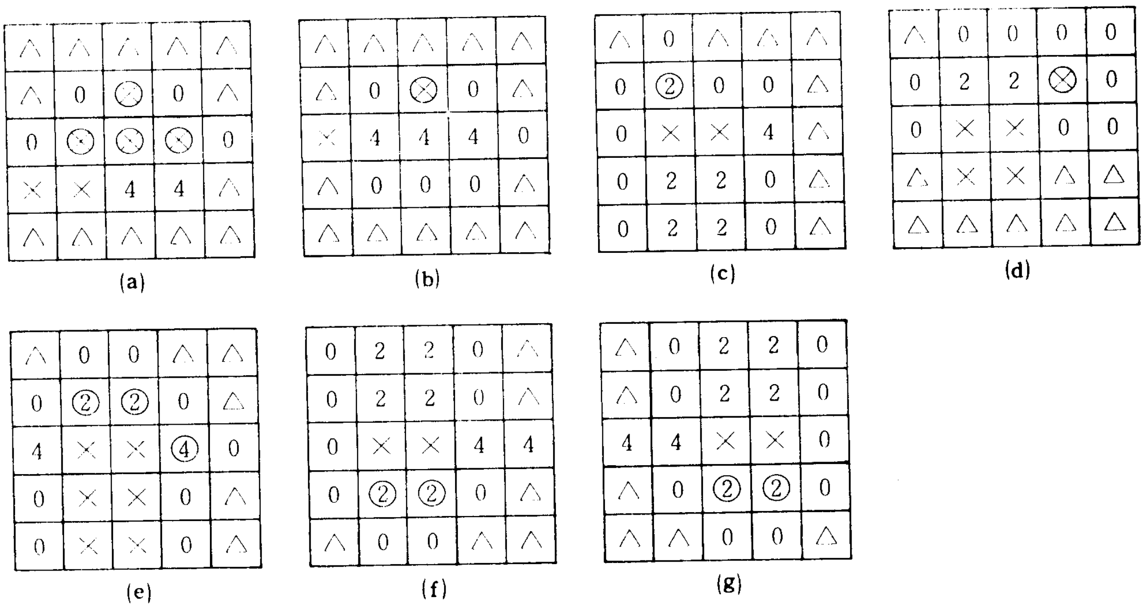

Fig. 3 Logical masks for ornament removal.

satisfy the mask's condition, the pixels surrounded with sign ○ are changed to zero.

Step (3) is some local shape arrangements, and in step (4), direction coding is executed again. In step (5), horizontal and vertical straight lines are extracted. In step (6), non straight elements are extracted. In step (7), non straight elements are approximated with arcs. In step (8), the analog representation of the Gothic type KANJI pattern is generated. In step (9), size transformation is executed. In step (10), Gothic type pattern is printed out.

3. Rectangle preserved thinning

For obtaining precise skeleton of KANJI patterns, rectangular parts such as "L" shape part (rectangular corner), "T" shape part (rectangular branch), "+" shape part (rectangular crossing) must be surely preserved. But usual thinning methods such as Hilditch's method [1], Rosenfeld's method [2] and Deutsch's method [3] do not guarantee the preservation of rectangles. In this paper, rectangle preserved thinning [4] is used.

The details of the algorithm is written in the preceding paper [4], the main processing using a 3×3 logical mask shown in Fig. 4 is discribed as follows. The

n_3	n_2	n_1
n_4	n_0	n_8
n_5	n_6	n_7

Fig. 4 The operator for thinning.

process consists of 4 parts, the 1-st∼4-th thinning. Suppose that $n_0 \neq 0$ and α, β are logical expressions. Sign $\wedge$ means "and", $\vee$ means "or", and $:=$ means substitution.

(I) The 1-st thinning.

$\alpha = \{n_2 = n_3 = n_4 = 0 \ \wedge \ n_6 \cdot n_7 \cdot n_8 \neq 0\}$

$\beta = \{n_2 = n_3 = n_4 = n_7 = 0 \ \wedge \ (n_6 \neq 2 \ \vee \ u_8 \neq 2 \ \wedge \ n_8 \neq 4)\}$

if α = true $\vee$ β = true then $n_0 := 0$

(II) The 2-nd thinning.

$\alpha = \{n_1 = n_2 = n_8 = 0 \ \wedge \ n_4 \cdot n_5 \cdot n_6 \neq 0\}$

$\beta = \{n_1 = n_2 = n_8 = n_5 = 0 \ \wedge \ (n_6 \neq 2 \ \vee \ n_4 \neq 2 \ \wedge \ n_4 \neq 4)\}$

if α = true $\vee$ β = true then $n_0 := 0$

(III) The 3-rd thinning.

$\alpha = \{n_4 = n_5 = n_6 = 0 \ \wedge \ n_1 \cdot n_2 \cdot n_8 \neq 0\}$

$\beta = \{n_4 = n_5 = n_6 = n_1 = 0 \ \wedge \ (n_2 \neq 2 \ \vee \ n_8 \neq 2 \ \wedge \ n_8 \neq 4)\}$

if α = true $\vee$ β = true then $n_0 := 0$

(IV) The 4-th thinning.

$\alpha = \{n_6 = n_7 = n_8 = 0 \ \wedge \ n_2 \cdot n_3 \cdot n_4 \neq 0\}$

$\beta = \{n_6 = n_7 = n_8 = n_3 = 0 \ \wedge \ (n_2 \neq 2 \ \vee \ n_4 \neq 2 \ \wedge \ n_4 \neq 4)\}$

if α = true $\vee$ β = true then $n_0 := 0$

In this thinning method, connectivity is not uniquely defined, that is, 4-connected is used for vertical / horizontal lines and 8-connected is used for slanting lines.

4. Representation of Gothic type pattern by lines and arcs

The skeleton pattern is represented with straight elements $\boldsymbol{L}$ and non straight elements $\boldsymbol{F}$.

A non straight element is approximated with an arc as follows. When the endpoints of the non straight element are A(x_1, y_1), B(x_2, y_2) and the central point is C(x_3, y_3), the equation of the circle containing three points A, B, C is shown as follows.

$$\begin{vmatrix} x^2+y^2 & x & y & 1 \\ x_1^2+y_1^2 & x_1 & y_1 & 1 \\ x_2^2+y_2^2 & x_2 & y_2 & 1 \\ x_3^2+y_3^2 & x_3 & y_3 & 1 \end{vmatrix} = 0 \qquad (1)$$

Eq. (1) can be rearranged into the standard form of a circle as follows.

$$a(x^2+y^2)+2gx+2fy+c=0 \qquad (2)$$

where,

$$\left.\begin{aligned} a &= \sum_{i=1}^{3} (x_{i+1}\, y_i - x_i y_{i+1}) \\ g &= \sum_{i=1}^{3} p_i(y_{i+1} - y_{i+2}) \,/\, 2 \\ f &= \sum_{i=1}^{3} p_i(x_{i-1} - x_{i-2}) \,/\, 2 \\ c &= \sum_{i=1}^{3} p_i(x_{i+1}\, y_{i+2} - x_{i+2}\, y_{i+1}) \end{aligned}\right\} \qquad (3)$$

$p_i = x_i^2 + y_i^2$

(subscript i is cyclic as 1, 2, 3, 1, 2, 3, …)

From Eq. (2), the center P(x_0, y_0) and the radius r of the circle can be obtained as follows.

$$\left.\begin{aligned} (x_0, y_0) &= (-g \,/\, a, \ -f \,/\, a) \\ r &= \sqrt{(g^2+f^2-ac) \,/\, a^2} \end{aligned}\right\} \qquad (4)$$

And from the endpoints A, B, the central angle range (θ_1, θ_2) can be obtained. These lines and arcs are thickened into the line width $2w$ as follows A straight element $\boldsymbol{L}$ becomes a rectangle $\boldsymbol{R}$ consisting of 4 vertexes $(x_1 \pm w, y_1)$, $(x_2 \pm w, y_2)$ or $(x_1, y_1 \pm w)$, $(x_2, y_2 \pm w)$. A non straight element $\boldsymbol{F}$ becomes a partial ring $\boldsymbol{D}$ consisting of 2 arcs with a circle center (x_0, y_0), central angle range (θ_1, θ_2), radiuses $r-w$, $r+w$. Let all rectangles extracted in the picture be $\mathbf{R}_1 \sim \mathbf{R}_m$, and all partial rings $\mathbf{D}_1 \sim \mathbf{D}_n$. Each rectangle and partial ring can be represented as follows,

$$\mathbf{R}_i = \{(x_a, y_a), (x_b, y_b)\} \quad (i=1\sim m) \tag{5}$$

$$\mathbf{D}_j = \{(x_0, y_0), \theta_1, \theta_2, r_1, r_2\} \quad (j=1\sim n) \tag{6}$$

where m is the number of rectangles and n is the number of partial rings in the picture. Two points in Eq. (5) are the both endpoints of the diagonal line of the rectangle.

Using Eq. (5) and Eq. (6), the Gothic type KANJI pattern $\boldsymbol{\Phi}$ can be expressed in the form,

$$\boldsymbol{\Phi} = (\bigcup_{i=1}^{m} \mathbf{R}_i) \cup (\bigcup_{j=1}^{n} \mathbf{D}_j) \tag{7}$$

The area where a character pattern exists is originally,

$$\left.\begin{array}{l} 0 \leqq x \leqq 23 \\ 0 \leqq y \leqq 23 \end{array}\right\} \tag{8}$$

But they can easily changed by multiplying desired magnifications. Though the picture area of the CRT display is,

$$\left.\begin{array}{l} 0 \leqq x \leqq 639 \\ 0 \leqq y \leqq 399 \end{array}\right\} \tag{9}$$

this area can be moved within the larger area so-called the world coordinates as follows.

$$\left.\begin{array}{l} -1.7\mathrm{E}+38 \leqq x \leqq 1.7\mathrm{E}+38 \\ -1.7\mathrm{E}+38 \leqq y \leqq 1.7\mathrm{E}+38 \end{array}\right\} \tag{10}$$

Using the world coordinates, the obtained character pattern can be printed at the optional place on printer-forms with optional size.

5. Output of Gothic type KANJI patterns

Using Eq. (5)~(10), a Gothic type KANJI pattern $\boldsymbol{\Phi}$ can be outputted. For this purpose, graphic commands of BASIC language are used. Required commands are LINE command for drawing a rectangle or a line, CIRCLE command for drawing an arc, and PAINT command for making black regions. Most personal computers have these commands. In this paper, NEC PC9801E/F personal computer was used. From Eq. (5), a black rectangle $\mathbf{R}_i$ can be made as follows.

LINE $(x_a, y_a)-(x_b, y_b)$, BF

From Eq. (6), a partial ring $\mathbf{D}_j$ can be made as follows:

CIRCLE (x_0, y_0), r_1, 7, $-\theta_1$, $-\theta_2$

CIRCLE (x_0, y_0), r_2, 7, $-\theta_1$, $-\theta_2$

PAINT (x_p, y_p), 7

CIRCLE (x_0, y_0), r_1, 0, $-\theta_1$, $-\theta_2$

CIRCLE (x_0, y_0), r_2, 0, $-\theta_1$, $-\theta_2$

where (x_p, y_p) is an inner point of the partial ring. At the 3-rd parameter of CIRCLE command, *7* means white circle and *0* means black circle on the CRT display (reverse on the printer). The minus sign before θ_1 and θ_2 indicates the option to attach radius lines to make a fan-shape. The PAINT command paints out the inside of a partial ring. Examples of output are shown in Fig. 5 (a)~(d).

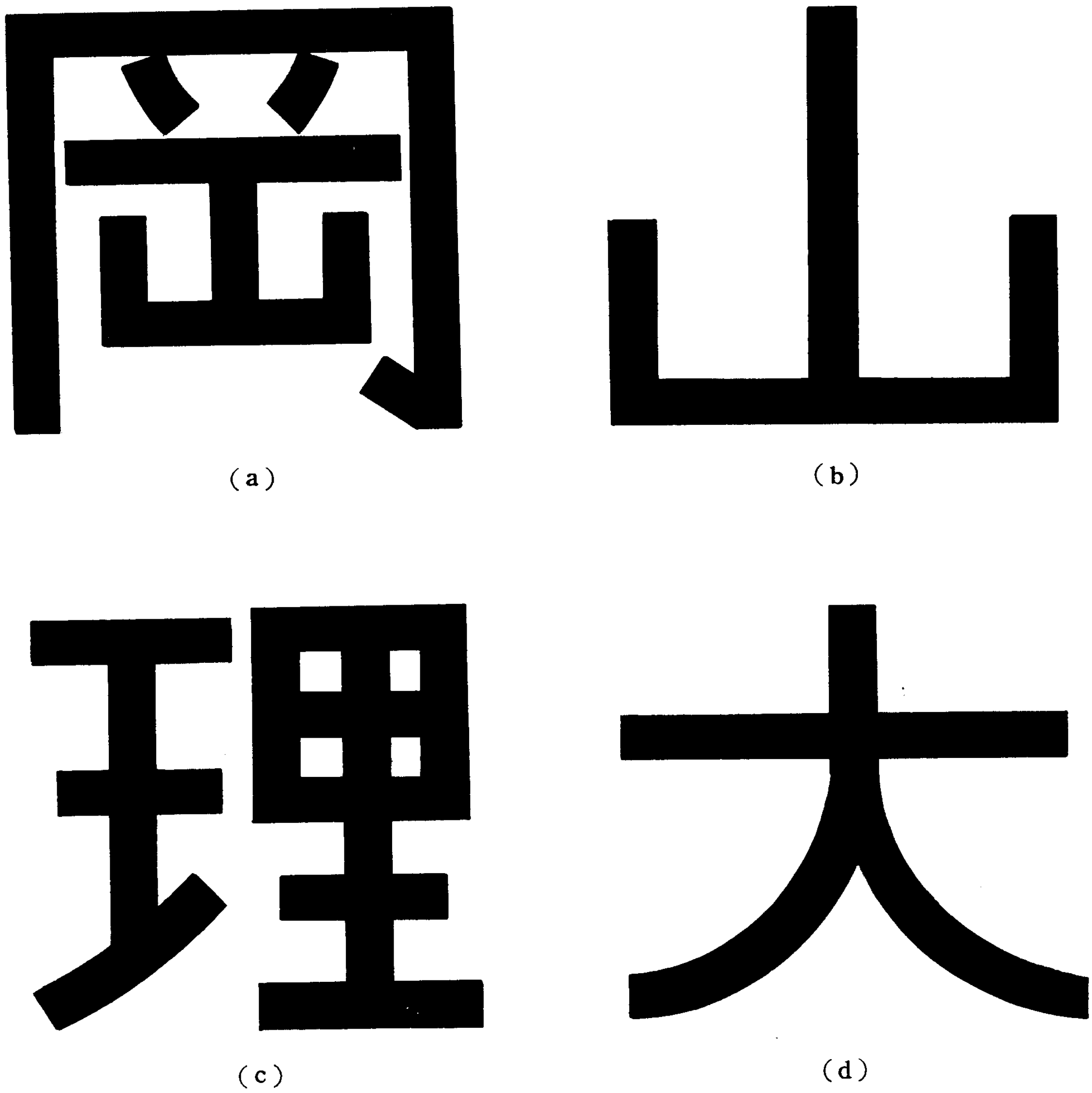

Fig. 5 Examples of output (character size is 13 cm × 13 cm).

6. Conclusion

Large size Gothic type KANJI patterns for Japanese language posters could be obtained by the proposed method. The merit of this method is not requring special data-base. It requires only usual 24×24 Ming type KANJI patterns which are nowadays very popular and most computer systems possess them. Needless to say, this method can be applied to 32×32 or another size dot matrix Ming type pattern too. Using this method, title posters for various kinds of events such as conferences, ceremonies can be easily and speedily drawn up.

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