

1                   Pattern Generation Method and  
                    Pattern Generation Apparatus

BACKGROUND OF THE INVENTION

5   Field of the Invention

The present invention relates to a pattern generation method and apparatus which can be applied to an output device capable of expressing gradation.

Related Background Art

10           When a gray scale font which can express gradation is assumed, it can be stored in a character generator in a bit map format, i.e., in a format that multi-value data is added to one dot.

            However, when font data is stored in the bit map  
15 format, the following problems are posed.

(1) A font cannot be enlarged or reduced to an arbitrary size.

(2) Since multi-value data is stored in the bit map format, a data size is increased, and a memory  
20 having a large capacity is required for storing fonts.

SUMMARY OF THE INVENTION

            According to the present invention, a font such as a vector font which can be arbitrarily enlarged or reduced can be expressed by gray scale levels by  
25 utilizing binary pattern data without increasing a memory capacity necessary for fonts.

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| <input type="checkbox"/> Description : paged ..... to paged .....                                   |    |
| <input checked="" type="checkbox"/> Claim(s) : paged .... <u>3</u> ... to paged .... <u>17</u> .... |    |
| <input type="checkbox"/> Drawing(s) : paged ..... to paged .....                                    |    |
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1           It is an object of the present invention to  
provide a pattern generation apparatus which converts a  
vector font into a binary bit map pattern, and  
generates, based on the binary bit map pattern, digital  
5 multi-value data in correspondence with a density based  
on a bit pattern distribution.

It is another object of the present invention to  
provide a pattern generation method and apparatus, for  
generating multi-value data on the basis of a vector  
10 font, converting the multi-value data into an analog  
image signal, and comparing the analog image signal  
with a triangular wave having a predetermined period to  
pulse-width modulate it, thereby outputting a gradation  
pattern.

15   BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram of a character generator  
according to an embodiment of the present invention;

20   Figs. 2A to 2C are views showing a procedure for  
generating a gray scale font according to the present  
invention;

Figs. 3 and 4 are flow charts showing control  
sequences of the present invention; and

Fig. 5 is a sectional view for explaining an  
arrangement of an output apparatus.

25   DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 best illustrates the characteristic feature  
of the present invention. In Fig. 1, an input device 1

1 receives an instruction to a character generator. A  
binary bit map font generator 2 generates a bit map  
font on the basis of vector data. A vector font data  
memory 3 stores vector font data of characters to be  
5 generated by the binary bit map font generator 2. A  
RAM 4 stores the bit map font data generated by the  
binary bit map font generator 2, and supplies the bit  
map data to a gray scale font generator 5. The gray  
scale font generator 5 generates a gray scale font on  
10 the basis of the bit map data generated by the binary  
bit map font generator 2. A bit map divider 6 divides  
the bit map data according to gray scale levels. A  
density detector 7 detects the densities of areas  
divided by the bit map divider 6. A data output device  
15 8 supplies the densities detected by the detector 7 to  
an output apparatus comprising the character generator  
shown in Fig. 1. In general, the character generator  
is assembled in a printer or a display device.

Figs. 2A to 2C show a procedure of operations of  
20 the character generator according to the present  
invention. Fig. 2A illustrates bit map font data  
generated by the binary bit map font generator 2, and a  
binary character of a bit map is generated based on a  
vector font. In this case, in order to obtain a  
25 necessary gray scale level, a character is generated  
with a resolution higher than an output resolution.  
When the size (resolution) of a character on a memory

1 is set to be  $m \times n$ , gradation of  $m \times n + 1$  levels can  
be obtained. That is,  $m$  and  $n$  are set to satisfy a  
relation (output resolution of the device)  $\leq m \times n + 1$ .  
In this embodiment, since 25%, 50%, and 75% gray levels  
5 are adopted, five gray levels are available together  
with 0% and 100% levels, and  $m = n = 2$  is set.  
Therefore, a character is generated at a x2 resolution  
in both vertical and horizontal directions. Fig. 2B  
shows a bit map divided by the bit map divider. Since  
10 a character has x2 resolutions in both the vertical and  
horizontal directions, the character is divided in  
units of 2 dots (vertical direction) x 2 dots  
(horizontal direction) areas. Fig. 2C shows detected  
densities based on the density-divided bit map. If  
15 there is one dot in a divided area, this area can be  
expressed by a 25% gray level; if there are two dots,  
it can be expressed by a 50% gray level; and if there  
are three dots, it can be expressed by a 75% gray  
level. As a matter of course, if there is no dot, the  
20 area is expressed by white, and if there are four dots,  
it is expressed by black. Densities detected in this  
manner can be directly output to an apparatus  
comprising this character generator (e.g., a print  
buffer) as outputs of the character generator, e.g.,  
25 digital multi-value (e.g., 4-bit) data. Thus, a memory  
capacity can be reduced as compared to a case wherein

1 digital multi-value data is adopted as a font, and a  
high-quality output can be obtained.

Figs. 3 and 4 are flow charts showing a sequence  
for generating a gray scale font according to the  
5 present invention. This processing is executed by a  
CPU for controlling the overall output apparatus (not  
shown) on the basis of a program. Fig. 3 shows a  
sequence from the beginning to the end of character  
generation. In step S101 in Fig. 3, the input device 1  
10 inputs a code of a character to be generated. In step  
S102, the input device 1 designates the size of a  
character to be generated. In step S103, a bit map  
font whose character size is enlarged twice in both the  
vertical and horizontal directions is generated by the  
15 binary bit map font generator 2 on the basis of vector  
font data stored in the vector font data memory 3, and  
is stored in the RAM 4. More specifically, original  
one dot is expressed by 2 x 2 dots, and a dot  
distribution in the 2 x 2 dot area is checked. The  
20 character size is enlarged twice in both the vertical  
and horizontal directions since the five gray levels,  
i.e., 0%, 25%, 50%, 75%, and 100% are available. If  
the number of gray levels is changed, an enlargement  
magnification is also changed. In step S104, a gray  
25 scale font is generated on the basis of the bit map  
generated in step S103. Fig. 4 shows in detail the  
processing in step S104.

1           Fig. 4 is a flow chart showing a sequence for  
generating gray scale font data, and this processing is  
executed by the gray scale font generator 5. In step  
S110 in Fig. 4, a vertical check position YC is set to  
5       be 0. In step S111, a horizontal check position XC is  
set to be 0. The bit map divider 6 executes step S112  
using the bit map font generated on the RAM 4. In step  
S112, the number of black dots included between a  
position (XC,YC) to a position (XC+1,YC+1) is counted.  
10       The number of black dots included between the position  
(XC,YC) to the position (XC+1,YC+1) can take a value  
falling within a range of 0 to 4. In step S113, the  
density detector 7 checks if the number of black dots  
is 0. If YES in step S113, step S114 is executed. In  
15       step S114, a gray level at the position (XC,YC) of the  
gray scale font is set to be 0%. In step S115, the  
density detector 7 checks if the number of black dots  
is 1. If YES in step S115, step S116 is executed. In  
step S116, the gray level at the position (XC,YC) is  
20       set to be 25%. In step S117, the density detector 7  
checks if the number of black dots is 2. If YES in  
step S117, step S118 is executed. In step S118, the  
gray level at the position (XC,YC) is set to be 50%.  
In step S119, the density detector 7 checks if the  
25       number of black dots is 3. If YES in step S119, step  
S120 is executed. In step S120, the gray level at the  
position (XC,YC) is set to be 75%. In step S121, the

1 density detector 7 checks if the number of black dots  
is 4. If YES in step S121, step S122 is executed. In  
step S122, the gray level at the position (XC,YC) is  
set to be 100%. The set value is output from the data  
5 output device 8. In step S123, "2" is added to XC. In  
this case, a value to be added is a horizontal  
enlargement magnification in step S103 in Fig. 3. In  
step S124, it is checked if XC exceeds the width of the  
bit map font. If YES in step S124, step S125 is  
10 performed. If NO in step S124, step S112 is executed.  
In step S125, "2" is added to YC. In this case, a  
value to be added is a vertical enlargement  
magnification in step S103 in Fig. 3. In step S126, it  
is checked if YC exceeds the length of the bit map  
15 font. If YES in step S126, gray scale font data  
generation processing is ended; otherwise, step S111 is  
executed.

An apparatus for generating a bit map font based  
on a vector font has already been used in "Laser Writer  
20 (registered trademark)" (available from Apple Computer  
Inc.) or in "EZPS (registered trademark)" (available  
from CANON INC.) An apparatus of this type selectively  
generates bit map data according to one vector font  
data based on data, e.g., a character code, and is  
25 known to those who are skilled in the art. In this  
embodiment, a bit map font is generated based on a  
vector font. Alternatively, a bit map font having a

1       predetermined size may be stored in the RAM 4 in step  
S103 in Fig. 3.

          As described above, a gray scale font having an  
arbitrary size can be easily generated by a simple  
5       system.

          A printer as an example of the data output device  
8 shown in Fig. 1 will be briefly described below with  
reference to Fig. 5. A PWM (pulse-width modulation)  
circuit 778 converts a multi-value digital image signal  
10       (signal illustrated in Fig. 2C) from a printer I/F (not  
shown) into an analog image signal, and compares this  
analog image signal with a triangular wave having a  
predetermined period, thus forming a PWM signal. Note  
that the printer I/F includes a print buffer. The PWM  
15       signal is applied to a laser output device 711 to  
ON/OFF-modulate a laser, thereby forming a gradation  
image. The laser output device or scanner 711 includes  
a laser output unit for converting an image signal from  
the PWM circuit 778 into a light signal, a polygonal  
20       (e.g., octahedral) mirror 712, a motor (not shown) for  
rotating this mirror 712, and an f/θ lens (focusing  
lens) 713, and the like. The printer also includes a  
reflection mirror 714 for changing the optical path of  
a laser beam, and a photosensitive drum 715. A laser  
25       beam emerging from the laser output unit is reflected  
by the polygonal mirror 712, and linearly scans  
(raster-scans) the surface of the photosensitive drum

1       715 via the lens 713 and the mirror 714, thereby  
forming a latent image corresponding to an original  
image.

5       The printer also includes a primary charger 717,  
an entire surface exposure lamp 718, a cleaner unit 723  
for recovering residual toner which is not transferred,  
and a pre-transfer charger 724. These members are  
arranged around the photosensitive drum 715.

10       A developing unit 726 develops an electrostatic  
latent image formed on the surface of the  
photosensitive drum 715. The developing unit 726 is  
constituted by developing sleeves 731Y, 731M, 731C, and  
731Bk which selectively contact the photosensitive drum  
715 to develop the latent image, toner hoppers 730Y,  
15       730M, 730C, and 730Bk for storing replenishing toners,  
and screws 732 for transferring the toners. These  
members are arranged around a rotational shaft P of the  
developing unit. For example, when a yellow toner  
image is to be formed, yellow toner development is  
20       performed at the illustrated position. When a magenta  
toner image is to be formed, the developing unit 726 is  
rotated about the shaft P shown in Fig. 5, so that the  
developing sleeve 731M in the magenta developing device  
is placed at a position where it can contact the  
25       photosensitive drum 715. The same applies to cyan and  
black development operations.

1           The printer further includes a transfer drum 716  
for transferring a toner image formed on the  
photosensitive drum 715 onto a paper sheet, an actuator  
plate 719 for detecting a moving position of the  
5   transfer drum 716, a position sensor 720 which comes  
closer to the actuator plate 719 to detect that the  
transfer drum 716 is moved to a home position, a  
transfer drum cleaner 725, a sheet press roller 727, a  
discharger 728, and a transfer charger 729. These  
10 members 719, 720, 725, 727, and 729 are arranged around  
the transfer roller 716.

          The printer also includes paper feed cassettes 735  
and 736 for storing paper sheets, paper feed rollers  
737 and 738 for feeding paper sheets from the cassettes  
15 735 and 736, and timing rollers 739, 740, and 741. A  
paper sheet fed and conveyed via these rollers is  
guided by a paper guide 749, is wound around the  
transfer drum 716 while its leading end is carried by a  
gripper (to be described later), and is then subjected  
20 to an image formation process.

          A drum motor 550 synchronously rotates the  
photosensitive drum 715 and the transfer drum 716. A  
separation pawl 750 separates a paper sheet from the  
transfer drum 716 after the image formation process. A  
25 conveyor belt 742 conveys the separated paper sheet.  
An image fixing unit 743 fixes an image formed on the  
paper sheet conveyed by the conveyor belt 742. The

1 image fixing unit 743 comprises a pair of  
thermocompression rollers 744 and 745. As a printer  
for outputting a gradation image, an ink-jet printer  
for performing recording using an ink may be employed,  
5 and an ink dot size or the number of ink droplets may  
be controlled to output a gradation image.

As described above, according to the present  
invention, there can be provided a pattern generation  
apparatus comprising storage means for storing binary  
10 bit map data, judgment means for dividing an area of  
the bit map data stored in the storage means, and  
judging a density in a predetermined area, and  
generation means for generating corresponding digital  
multi-value data in accordance with the density judged  
15 by the judgment means.

As described above, according to the present  
invention, there can be provided a pattern generation  
method comprising the steps of generating corresponding  
binary bit map data based on desired one of vector font  
20 data, dividing an area of the binary bit map data on a  
memory, judging a density in a predetermined area, and  
generating digital multi-value data in correspondence  
with the judged density.

As described above, when a pattern division means  
25 and a density detection means are added to a character  
generator for generating a binary character pattern, a

gray scale font having an arbitrary size or gray level can be generated.

5       It will be understood that the invention differs substantially from using a binary representation of the gray scale for each pixel of the image, because according to the encoding method used the number of bits set is monotonically related (i.e. directly proportional) to the image density at a pixel whereas  
10       a binary code is not monotonically related to the value it represents. It is believed that the monotonisity of the relationship enables the font to be scaled to expand or reduce its size whilst retaining the gray level information.



1     WHAT IS CLAIMED IS:

1.   A pattern generation apparatus comprising:  
storage means for storing binary bit map data;  
judgment means for dividing an area of the bit map  
5 data stored in said storage means, and judging a  
density in a predetermined area; and

generation means for generating corresponding  
digital multi-value data in accordance with the density  
judged by said judgment means.

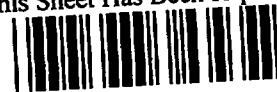
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2.   An apparatus according to claim 1, further  
comprising conversion means, having vector fonts, for  
converting desired data of the vector font into the  
binary bit map data.

15

3.   An apparatus according to claim 1, further  
comprising printer means for receiving said multi-value  
data, converting said multi-value data into an analog  
image signal, and comparing the analog image signal  
20 with a triangular wave having a predetermined period to  
form a pulse-width modulated signal.

4.   An apparatus according to claim 1, further  
comprising printing means for controlling ink injection  
25 in accordance with said multi-value digital data to  
express gradation.



1           5. A pattern generation method comprising the  
steps of:  
          generating corresponding binary bit map data based  
on desired one of vector font data;  
5           dividing an area of the binary bit map data on a  
memory;  
          judging a density in a predetermined area; and  
          generating digital multi-value data in  
correspondence with the judged density.

10           6. A method according to claim 5, wherein the  
step of judging the density comprises the step of  
judging a distribution state of a pattern in the  
predetermined area.

15           7. A method according to claim 5, further  
comprising printer means for receiving said multi-value  
data, converting said multi-value data into an analog  
image signal, and comparing the analog image signal  
20          with a triangular wave having a predetermined period to  
form a pulse-width modulated signal.

          8. A pattern generation method comprising the  
steps of:  
25          generating multi-value digital data on the basis  
of vector data; and



1            converting the multi-value digital data into an  
analog image signal, and comparing the analog image  
signal with a triangular wave having a predetermined  
period to pulse-width modulate the analog image signal,  
5            thereby outputting a gradation pattern.

9. A method according to claim 8, wherein the  
multi-value digital data is obtained by generating a  
binary bit map pattern based on the vector data, and  
10          judging a density based on a distribution of the binary  
bit map pattern.

10. A pattern generation apparatus comprising:  
generation means for generating multi-value  
15          digital data on the basis of vector data;  
means for converting the multi-value digital data  
into an analog image signal, and comparing the analog  
image signal with a triangular wave having a  
predetermined period to obtain a pulse-width modulated  
20          signal; and

laser output means for outputting a gradation  
image based on the pulse-width modulated signal  
obtained by said converting means.

25          11. An apparatus according to claim 10, wherein  
said generation means converts the vector data into the  
binary bit map data, and judges a density based on a

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distribution of a bit pattern so as to generate the multi-value digital data.

5 12. An image processing apparatus including a store means in which the arrangement of stored data is such that successive bits relate to continuous spacial lines of the image, characterised in that a plurality of bits are allocated to represent a single image point and in that the number of said plurality of bits  
10 which are set relates monotonically to the density of the image at that point.

13. Apparatus according to claim 12 in which N bits are allocated to each image point, and each image  
15 point can exhibit N+1 possible density levels, each density level corresponding uniquely to a given number of said bits being set.

14. A method of generating a digitally stored image  
20 representation comprising the steps of setting, for each image point, the value of a binary location within a memory in which an array of such locations are mapped onto corresponding image points, characterised in that it comprises also the steps of  
25 determining the density of the image at the point, and

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setting a predetermined number of bits proportional to the density within the memory.

5 15. A bit map image processing apparatus comprising means for expanding a bit map image so that a plurality of bits correspond to a given pixel.