

COLOR VIDEO PRINTING

The present invention relates to colour video printing.

5 In general, it has been known that three elementary colours Cyan, Magenta and Yellow for making a print of a given document image in a color video printer may be obtained from a given color conversion process of the so-called three primary colours Red, Green and Blue of a light ray. The former three colours are mixed with each other to produce a desired color
10 image in the color video printer. That is, the latter three primary colours Red, Green and Blue are respectively, or compositively, converted to the former three elementary colours Yellow, Magenta and Cyan to obtain a desired number of color gradation, for example, 256 gradations for representing a given color image.

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In a conventional printing method, for a color video printer utilizing 256 gradations to print one document line from a line memory, a total of 256 thermal print head operations are required to complete printing of one line, which operations have no particular reference to the gradations and are
20 carried out either in heat or in non-heat state. In this case, the total 256 thermal print head operations should be always carried out irrespectively of gradation characteristic in the corresponding line, which inevitably may lead to an unnecessarily long printing time in a color video printer.

25 For example, when making a print for a given video image provided from a television screen to a color video printer, all of the three elementary colours Yellow, Magenta and Cyan may not be used in their respective maximum degree of thickness. Hence, there would be no need to have a

thermal print head of the color video printer always operate 256 times for every color representation.

5 It is therefore an object of preferred embodiments of the present invention to provide a high-speed printing method capable of considerably reducing printing time in a color video printer having at least one line memory.

10 According to an aspect of the present invention, there is provided a method of controlling printing in a color video printer comprising a heating element, said colour video printer having at least one line memory provided with a plurality of gradation data corresponding to a respective color component, said line memory receiving at least one line gradation data of one line of an image indicative of a given color image from a video memory, said
15 method comprising the steps of :

searching the largest value of said one line gradation data out of said line memory ;

20 designating said largest value as a maximum value of heating element gradation relative to said one line gradation data; and

terminating a cycle of printing operation for said one line gradation data when reaching said maximum value of the heating element gradation,
25 irrespective of the predetermined maximum possible number of gradations of said line.

Preferably, said searching step further comprises the steps of:

initializing an address designation variable indicative of a given address of said one line gradation data of said line memory;

storing a gradation data corresponding to said address designation
5 variable into a gradation data register;

comparing said gradation data with an initial or preceding gradation data stored in said gradation data register to obtain therefrom the largest value of one line gradation data; and

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repeating said storing and comparing of the gradation data at said number of total heating element gradation thereby to produce the maximum value of heating element gradation relative to said one line gradation data.

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Preferably, said repeating step comprises incrementing said address designation variable one by one until reaching the last address of a line of gradation data.

According to a further aspect of the present invention, there is provided
20 a method of controlling printing in a colour printer in which an image is composed of a plurality of lines, each having a predetermined maximum possible number of gradations, the method comprising the steps of determining for each line the highest number of gradations for that line, and terminating the printing operation for that line when said highest number of
25 gradations is reached.

The invention extends to a colour printer provided with means for carrying out, and adapted to carry out, a method according to any of the preceding aspects of the invention.

5 For a better understanding of the invention, and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying diagrammatic drawings, in which:

Figure 1 is a schematic block diagram of a part of a color video printer
10 in which an example of the present invention is applied;

Figure 2 is a flow chart of an example of a printing method according to the invention;

15 Figure 3 is a schematic diagram indicative of a preferred embodiment of a line memory used in an example of the invention; and

Figures 4a to 4e are waveform diagrams illustrating some operation stages of the printer of Figure 1.

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Referring to Figure 1, a part of a color video printer to which a high-speed printing method is applied is shown, which includes a microcomputer 20 controlling all the operations in the color video printer. Line memory 18 stores gradation data to be read or written under control of the microcomputer
25 20. Gradation counter 19 is also controlled by the microcomputer 20 to make a count of gradation number in the video printer. Three primary colours Red, Green and Blue provided by a video RAM (not shown) are converted by a converter 11 into three elementary color components Cyan, Magenta and

Yellow to be used later, which components are put into a memory 12 together with various control data to control a thermal print head in the printer. Comparator 14 compares the gradation data read out of the line memory 18 with the counted value of the gradation counter 19. Data switching circuit 13, 5 coupled to the memory 12 and the line memory 18, provides a part of the data retrieved from the memory 12 to the line memory 18 or passes data from the line memory 18 to the comparator 14. Data driver 15 switches a comparative output of the comparator 14 to either one of a first buffer 16 and a second buffer 17 in dependence upon an address provided from the line memory 18, 10 both of the first and second buffers being coupled, in synchronism with a clock (CLK), to a latch 21. Upon occurrence of a latch signal (LTH), the latch 21 receives gradation data from the first and second buffers 16, 17 and latches the received data before delivering the same data to a driver 22 for driving a heating element 23 of a thermal head assembly upon occurrence of 15 a strobe signal (STB).

Figure 3 is an exemplary diagram showing that a given number of gradation is being stored into a respective address location corresponding to each one line of the line memory 18, and Figures 4a to 4e are timing 20 diagrams showing some operative stages in the Figure 1 block diagram, wherein 4a represents a data waveform to be stored into the first buffer 16, 4b a data waveform to be stored into the second buffer 17, 4c a clock (CLK), 4d a latch signal (LTH) and 4e a strobe signal (STB), and wherein T1 represents a printing duration of one line in the printer.

25 Referring back again to Figure 1, data of one print line retrieved in sequence out of the line memory 18 is compared in the comparator 14 with a series of gradation count numbers from the gradation counter 19, in either

one set of odd numbers, viz. 1,3,5,7 ... 255 or even numbers, viz. 2,4,6,8 ... 256, in order to produce therefrom a logic high or low signal in dependence upon the status of the data. A logic high signal is produced if the data is larger than the gradation counter number, while a logic low signal is produced if the data is less than the gradation counter number. The data driver 15 receives the logic high or low signal from the comparator 14 and drives the received data to either one of the first buffer 16 and the second buffer 17, which buffers are selected by an address of the retrieved data in the line memory 18, wherein the lower addresses 256 to 1 are for the second buffer and the higher addresses 512 to 257 are for the first buffer.

The data stored in the first and second buffers 16, 17, as shown in the waveforms of Figures 4a and 4b, is latched into the latch circuit 21 upon occurrence of a latch signal (LTH) having low logic level of Figure 4d, which latch signal is generated subsequent to occurrence of 256 clocks of Figure 4c. Thereafter, when a strobe signal (STB) goes low, as shown in Figure 4e, prior to latching the next line memory data, the driver 22 receives the latched data from the latch 21 thereby to enable driving of the thermal head assembly 23. A driving time of the thermal head assembly needed to perform a color printing for one line in the driver 22 is limited to a maximum gradation number of the corresponding line.

The microcomputer 20 carries out a detection of the maximum gradation number therefrom to control the driver 22. For example, assuming that a series of addresses (1 through 512) in one line of the line memory 18 have various gradation data such as those in Figure 3 and that the maximum gradation data may be '10' in the 511th address location, then the microcomputer 20 initializes an address variable (n) designating a given

address in the line memory, that is, $n=1$, and then sets gradation data ($=3$) of a first address location into a first variable value (k), in step 2a of Figure 2. Thereafter, in step 2b, the data in the first address location is stored into a register (J). The first variable value (k) is then checked in step 2c as to
5 whether it is equal to or smaller than the data of the first ($n=1$) address location. Here, because the data is 3, the first variable value (k) is also 3. If $n=1$, for example, then step 2d is carried out to maintain the first variable value (k) as it is. In a decision block of step 2e, the address variable (n) is checked as to whether it reaches a number of 512, wherein if it does not reach
10 the number of 512, the address variable (n) is incremented by 1 in step 2h followed again by the step 2b. That is, the steps 2b through 2e are repeated until the address variable (n) finally reaches the number of 512 in the step 2e. As a result of this looping operation through the steps 2b through 2e, the final first variable value (k) after 512 times of the comparing operation will be 10
15 in reference to the exemplary one line of the line memory of Figure 3. Therefore, the value 10 is designated as a maximum gradation data in step 2f, and the heating element 23 is driven only 10 times prior to execution of a next line printing.

20 Therefore, for example, assuming that a Yellow color element is to be printed at a half degree (50%-thick Yellow), rather than a full degree (100%-thick Yellow), it would be sufficient to drive the heating element only 128 times, rather than 256 times as in the conventional video printer. In this way, the total time necessary to accomplish one print line in the line memory
25 having a 50%-thick, 128-gradation of a given color component, for example, of Yellow, will be at the maximum 8.192 msec ($=64 \mu\text{sec} \times 128$), as compared to 16.384 msec ($=64 \mu\text{sec} \times 256$) for a 100%-thick, 256-gradation

color component. Thus, this would enable a decrease in printing time for one print line of up to a half of the time in the case of 256 gradation printing.

Moreover, since a usual color video printer employs three kinds of colours such as Yellow, Magenta and Cyan, a total time of about 24 msec (8msec x 3 = 24msec) would be able to be saved when using this example of the present invention. The time could be further decreased in the case where a less thick color is applied to the video printer - for example, for 30% thick Yellow color component in one print line from the line memory.

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As is understood from the aforementioned description of a preferred embodiment of the present invention, a maximum gradation data of one memory line in a line memory of a color video printer is determined, by which maximum data a heating element is driven for printing. Thus, the embodiment of the invention eliminates waste of printing time, thereby increasing the efficiency of the video printer.

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CLAIMS

1. A method of controlling printing in a color video printer comprising a heating element, said colour video printer having at least one line memory
5 provided with a plurality of gradation data corresponding to a respective color component, said line memory receiving at least one line gradation data of one line of an image indicative of a given color image from a video memory, said method comprising the steps of :
 - 10 searching the largest value of said one line gradation data out of said line memory ;

designating said largest value as a maximum value of heating element gradation relative to said one line gradation data; and
15 terminating a cycle of printing operation for said one line gradation data when reaching said maximum value of the heating element gradation, irrespective of the predetermined maximum possible number of gradations of said line.
- 20 2. A method as set forth in claim 1, wherein said searching step further comprises the steps of:
 - 25 initializing an address designation variable indicative of a given address of said one line gradation data of said line memory;

storing a gradation data corresponding to said address designation variable into a gradation data register;



comparing said gradation data with an initial or preceding gradation data stored in said gradation data register to obtain therefrom the largest value of one line gradation data; and

5 repeating said storing and comparing of the gradation data at said number of total heating element gradation thereby to produce the maximum value of heating element gradation relative to said one line gradation data.

3. A method as set forth in claim 2, wherein said repeating step comprises
10 incrementing said address designation variable one by one until reaching the last address of a line of gradation data.

4. A method of controlling printing in a colour printer in which an image is composed of a plurality of lines, each having a predetermined maximum
15 possible number of gradations, the method comprising the steps of determining for each line the highest number of gradations for that line, and terminating the printing operation for that line when said highest number of gradations is reached.

20 5. A method of controlling printing in a colour printer, the method being substantially as hereinbefore described with reference to the accompanying drawings.

6. A colour printer provided with means for carrying out, and adapted
25 to carry out, a method according to any of the preceding claims.

7. A colour printer substantially as hereinbefore described with reference to the accompanying drawings.

