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CONTROL METHOD AND SYSTEM FOR A PRINTER

The present invention relates to a method of controlling an address counter of a print head in a serial printer in which the print head effects printing while moving across a recording medium. The invention extends to control systems for such printers.

A print head in a typical serial printer is mounted on a carriage and adapted to move across a recording medium, such as paper. The arrangement is such that the print head is moved by an amount corresponding to one dot each time a carriage motor for driving the carriage is rotated by an amount corresponding to one pulse. The position at which a dot is formed by the print head is designated by the count in an address counter, and the address (count) in the address counter is updated in accordance with drive pulses (Figure 5(A)) for driving the carriage motor.

When a power supply for the printer is turned on or when a printer cover, which has been opened for the purpose of setting a recording medium or replacing ink ribbon, is closed, initialisation is carried out in order to obtain correspondence between the position of the print head and an address indicated by the address counter. In response to an initialise command, the

print head is returned to a home region from the present position. If the print head is within the home region when the initialise command is received, the head is first moved out of the home region and then returned thereto. The entry of the print head into the home region is sensed by a home sensor and generates a detection signal. From the position at which the output of the home sensor is inverted from OFF to ON or vice versa, the print head is further advanced into the home region through a distance corresponding to a predetermined number of pulses (nine pulses in the illustrated example) and is then stopped and the address counter is then cleared. Thereafter, when a print instruction is received the print head is moved rightward as viewed in Figure 5(A), and a printing operation is executed from a predetermined address position (the position corresponding to a count of 13 in the address counter in the illustrated example). The print head is reciprocated within the print region without being returned to the home region until a subsequent initialise command is received. When the print head is moved rightward, the count in the address counter is incremented, whereas, when the print head is moved leftward, the count in the address counter is decremented.

The above-described conventional control method suffers from the following problems. The address counter is cleared every time it receives an initialise command, and this involves the problem that the actual position of the print head before initialisation and the address indicated by the address counter after the initialisation may not be coincident with each other, resulting in an amount of positional error or offset corresponding to ± 1 dot. Such a difference between the actual position of the print head and the address indicated by the count in the address counter leads inevitably to undesirable shift or dislocation of a printed character or the like.

The way in which such dislocation in printing occurs is shown in Figures 5(B) and 5(C).

The dislocation of a printed character or the like is mainly caused when the timing at which the output of the home sensor is inverted during an initialising operation fails to coincide with the carriage drive pulse due to, for example, mechanical errors in production of the printing head moving mechanism. For instance, if the inversion timing is shifted from the position shown in Figure 5(A) to the position shown in Figure 5(B), the printing head is stopped after nine pulses in the home region at the position corresponding

to a count of 1 in the address counter. Despite this fact, the address counter is cleared, and therefore the print start position and the print region are undesirably shifted rightward by an amount corresponding to one dot. If the inversion timing is shifted from the position shown in Figure 5(A) to the position shown in Figure 5(C), the print head is stopped after nine pulses in the home region at the position corresponding to the count of -1 in the address counter. Again the address counter is cleared, so that the print start position and the print region are undesirably shifted leftward by an amount corresponding to one dot. Accordingly, a difference corresponding to two dots is produced between the results of printing obtained by operations carried out in the states shown in Figures 5(B) and 5(C), respectively, which constitutes a problem in terms of printing quality.

Accordingly, it is a primary object of the present invention to provide a method of controlling the address counter which enables the above-described problems of the prior art to be readily overcome, thereby improving the printing quality.

According to one aspect of the present invention there is provided a method of controlling an address counter of a print head in a serial printer, in which the position of the print head is indicated by the count in the address counter, comprising the steps of moving the print head to an initial stop position in a home region when a power supply for the printer is turned on, setting the count in the address counter to a predetermined initial value N with the print head in the initial stop position, moving the print head towards a stop position in the home region each time a subsequent initialise command is received, comparing the initial value N and the count K in the address counter when the print head reaches a stop position after a subsequent initialise command, and resetting the count in the address counter to the initial value N only when the difference between the count K and the initial value N exceeds a predetermined amount.

According to another aspect of the present invention, a method of controlling an address counter of a print head in a serial printer in which the print head effects printing while moving across a recording medium, and the position of the print head is

indicated by the address counter, comprises the steps of: setting the count in the address counter to a predetermined initial value N when a power supply for the printer is turned on; comparing the count K in the address counter and the initial value N each time an initialise command is received; and resetting the count in the address counter to the initial value N only when the difference between the count K and the initial value N exceeds a predetermined amount.

From another ~~non-restrictive~~ aspect, the invention includes a control system for a printer having a print head which, to effect printing, is moved across a recording medium by a pulse motor whose drive pulses are counted in a counter, the system including means to operate the motor to move the print head to an initial stop position in a home region when a power supply for the printer is turned on, means to set the count in the counter to a predetermined initial value N with the print head in the initial stop position, means to issue a subsequent initialise command to operate the motor to move the print head towards a stop position in the home region, means to compare the initial value N and the count K in the counter when the print head reaches a stop position after a subsequent initialise command, and means for resetting the count in the counter to the

initial value N only when the difference between the count K and the initial value N exceeds a predetermined amount.

How the invention can be carried into effect is hereinafter more particularly described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a block diagram of a control circuit for carrying out the method according to the present invention;

Figure 2 is a flow chart showing the operation of the control circuit illustrated in Figure 1;

Figure 3 is a perspective view of a serial printer to which the control system and method according to the present invention is applied;

Figures 4(A), (B) and (C) show the relationship between the output of a home sensor and the address count according to the invention; and

Figures 5(A), (B) and (C) show the relationship between the output of a home sensor and the address count in the case of a conventional initialising method.

The mechanical arrangement of a serial printer to which the address counter control method according to the present invention is applied is similar to that of a known one. More specifically, as shown in Figure 3, a

print head 6 is mounted on a carriage 5 slidably supported by two guide rods 3 and 4 rigidly secured between two parallel side plates 1 and 2. The print head 6 faces a platen 7 rotatably supported by the side plates 1 and 2. Recording medium 8, such as paper, passes round the platen 7 and between the print head 6 and the platen 7. The paper 8 is fed upwardly for each line by the operation of a pair of tractors 9 and 10. On the left-hand side of the printer is a home region for the print head 6. In the home region, a home sensor 11 is rigidly secured to a base plate 12, the sensor 11 being defined by a combination of light-emitting and light-receiving elements (not shown). Depending from the lower surface of the carriage 5 is an integral shield 5a which, when the carriage 5 moves into the home region, enters the home sensor 11 to cut off the light-emitting elements from the light-receiving elements thereof and thus to cause the sensor 11 to change its output.

The carriage 5 can be driven across the paper 8 in the longitudinal direction of the platen 7 by a carriage motor 15 (Figure 1). The motor 15 is a pulse driven motor which steps the carriage 5 by a distance corresponding to one dot from the print head 6 for each pulse.

A printer control circuit (Figure 1) includes a main control section 13 in a central processing unit, a carriage motor driving circuit 14 connected to the carriage motor 15, a print head driving circuit 16, an address counter 17 and a comparator circuit 18.

When a power supply switch (not shown) of the printer is turned on, the count in the address counter 17 shown in Figure 1 is set to an initial value N (e.g. 1). Turning on of the power supply is treated as a kind of initialise command (step 21, Figure 2), and it is first determined (step 22, Figure 2) whether or not the print head 6 is within the home region on the basis of the output of the home sensor 11. If the print head 6 is within the home region, it is first moved out of the home region (step 23) and then returned thereto (step 24). If the print head 6 is out of the home region, it is returned thereto (step 24) from its previous position. The print head 6 continues to be fed with drive pulses until it is determined (step 25) that nine pulses have been fed after the home sensor 11 has turned OFF. As shown in Figure 4(A), the print head 6 is stopped within the home region after being moved through a distance corresponding to a predetermined number of pulses (nine pulses in the illustrated example) from its position when the output of the home sensor 11 is

inverted from OFF to ON. So far the operation is conventional. However, the address counter 17 is not then cleared but is set to the initial value N (in this example, 1). Thereafter, when printing data is delivered to the main control section 13 from a host computer, the print head 6 is moved rightward by pulses b which are counted by the address counter, and a printing operation is executed from a predetermined address position (the address position 14 in this example). The print head 6 is reciprocated within the print region to the right of address position 14 without being returned to the home region until a subsequent initialise command is received. The direction of movement of the print head 6 is designated by a direction switching signal a delivered from the main control section 13, and the print head 6 is moved stepwise through the carriage motor driving circuit 14 in response to drive pulses b. The count in the address counter 17 is updated in accordance with the drive pulses b and the signal a so that the count in the address counter 17 is incremented when the print head 6 is moved rightward and is decremented when the print head 6 is moved leftward.

An initialisation operation is also effected in response to an initialise command from the host computer

in a manner similar to the above.

If, during initialisation and return of the print head 6 to the home region, the time at which the output of the home sensor 11 is inverted fails to coincide with the carriage drive pulse, due, for example, to mechanical errors, the inversion of the output of the home sensor 11 may be undesirably shifted from the position shown in Figure 4(A) to the position shown in Figure 4(B). Thereafter nine additional carriage drive pulses move the print head 6 until it is stopped at the position where the count in the address counter 17 is 2. At this time a determination is made by the comparator circuit 18 (step 26, Figure 2) whether or not the deviation of the count K in the address counter 17 from the initial value N is 2 or more. When, as in the present case where K = 2 and is less than N + 2 which is 1 + 2 or 3, and is more than N - 2 which is 1 - 2 or -1, the deviation is not equal to nor greater than 2 (being 1 or less) the count K in the address counter 17 is left as it is, and a subsequent printing operation is executed. Printing at this time starts from a position corresponding to a count of 14 in the address counter 17, so that the print start position is the same as that in the previous printing operation. Accordingly, no positional difference is produced between the printing

operations carried out before and after the initialisation.

If the time at which the output of the home sensor 11 is inverted during an initialising operation is shifted from the position shown in Figure 4(A) to the position shown in Figure 4(C), the print head 6 does not stop until it reaches the position where the count in the address counter 17 is 0. The determination of step 26 reveals that the count K in the address counter equals 0 and is less than N + 2 which is 3 and is more than N - 2 which is 1 - 2 or -1. Accordingly, the deviation of K from N is not equal to nor greater than 2 and the count K is left as it is. Thereafter the print start position is the same as that in a previous printing operation.

When the count K of the address counter 17 deviates from the initial value N by 2 or more, the address counter 17 is reset to the initial value N in step 27 (Figure 2) and then printing resumed. Although deviation of the count K of the address counter 17 from the initial value N does not normally equal or exceed 2, such a deviation may occur when the print head 6 is moved by hand in order to set the recording medium or to replace ink ribbon or when a mechanical error is generated. Accordingly, the count in the address

counter 17 is reset to the initial value N only when an abnormal situation occurs.

As has been described in detail, the address counter controlling method according to the present invention completely eliminates the fear of the print start position and the print region after an initialising operation being displaced from those before the initialising operation, so long as printing is continued without turning off the power supply for the printer after it has been turned on. Accordingly, the printing quality is greatly improved. This advantageous effect is particularly noticable when printing is effected in graphic mode.

It will be understood that the deviation selected as acceptable without count resetting, in the example 1, may be a small integer chosen to conform with the anticipated deviations of home sensor output inversion. It will also be understood that the initial value N may be selected to be a sufficiently large integer to prevent the count K in the address counter going below 0 during leftward movement of the print head.



CLAIMS

1. A method of controlling an address counter of a print head in a serial printer, in which the position of the print head is indicated by the count in the address counter, comprising the steps of moving the print head to an initial stop position in a home region when a power supply for the printer is turned on, setting the count in the address counter to a predetermined initial value N with the print head in the initial stop position, moving the print head towards a stop position in the home region each time a subsequent initialise command is received, comparing the initial value N and the count K in the address counter when the print head reaches a stop position after a subsequent initialise command, and resetting the count in the address counter to the initial value N only when the difference between the count K and the initial value N exceeds a predetermined amount.

2. A method of controlling an address counter of a print head in a serial printer in which the print head effects printing while moving across a recording medium, and the position of the print head is indicated by the address counter, the method comprising the steps of: setting the count in the address counter to a

predetermined initial value N when a power supply for the printer is turned on; comparing the count K in the address counter and the initial value N each time an initialise command is received; and resetting the count in the address counter to the initial value N only when the difference between the count K and the initial value N exceeds a predetermined amount.

3. A method as claimed in claim 1 or 2, in which the predetermined amount is a small integer.

4. A method as claimed in claim 3, in which the small integer is 1.

5. A method of controlling an address counter of a print head in a serial printer, substantially as hereinbefore particularly described with reference to Figures 1 to 4 of the accompanying drawings.

6. A control system for a printer having a print head which, to effect printing, is moved across a recording medium by a pulse motor whose drive pulses are counted in a counter, the system including means to operate the motor to move the print head to an initial stop position in a home region when a power supply for the printer is turned on, means to set the count in the counter to a predetermined initial value N with the print head in the initial stop position, means to issue a subsequent initialise command to operate the motor to move the

print head towards a stop position in the home region, means to compare the initial value N and the count K in the counter when the print head reaches a stop position after a subsequent initialise command, and means for resetting the count in the counter to the initial value N only when the difference between the count K and the initial value N exceeds a predetermined amount.

7. A system according to claim 6, including a home sensor for detecting the entry of the print head into the home region and for initiating stopping of the print head at a stop position.

8. A control system for a printer, substantially as hereinbefore particularly described, with reference to Figures 1 to 4 of the accompanying drawings.