A transporting apparatus configured to transport a recording medium to a target stop position includes a feeding mechanism; a transporting mechanism; a storing unit configured to store a stop deviation at the time of a previous transport drive; a transporting distance calculating unit configured to calculate a second transporting distance in which the stop deviation after the reset of the storing unit is reflected on a first transporting distance requested this time, and to calculate the second transporting distance in which the stop deviation in the storing unit is reflected on the first transporting distance requested this time; a setting unit configured to set a speed profile of a multistage transport when the multistage transport condition is satisfied, set a speed profile of a transport mode other than the multistage transport when the multistage transport condition is not satisfied.
FIG. 10

START

PAPER FEEDING?

NO

YES

ACCUMULATION COUNTER RESET

S_{\text{counter}} = 0

TRANSPORT DISTANCE CALCULATION

S_t = S_{\text{pt}} + S_{\text{counter}}

PAPER FEEDING?

NO

YES

S_{t} \geq S_{\text{min}}?

NO

YES

SET TWO-STEP DRIVE SPEED PROFILE

SET SIMPLE DRIVE SPEED PROFILE

DRIVE CONTROL PF MOTOR ACCORDING TO SPEED PROFILE

NO

PAPER DETECTED?

OFF \rightarrow ON

YES

CALCULATE SECOND TRANSPORT DISTANCE S_{t2}

S_{t2} \geq S_{\text{min}}?

NO

YES

RESET TWO-STEP DRIVE SPEED PROFILE

RESET SIMPLE DRIVE SPEED PROFILE

DRIVE CONTROL PF MOTOR ACCORDING TO SPEED PROFILE

NO

PF MOTOR STOPPED?

YES

ADD STOP ERROR AT AN ACTUALLY STOPPED POSITION WITH RESPECT TO TARGET STOP POSITION TO ACCUMULATION COUNTER

RETURN
FIG. 11

START

TRANSPORT DISTANCE CALCULATION
\[ S_t = S_{pf} + S_{counter} \]

PAPER FEEDING?
YES

\[ S_t \geq S_{t_{min}}? \]
NO

NO

SET TWO-STEP DRIVE SPEED PROFILE

YES

SET SIMPLE DRIVE SPEED PROFILE

DRIVE CONTROL PF MOTOR ACCORDING TO SPEED PROFILE

PAPER DETECTED?
OFF → ON

YES

RESET ACCUMULATION COUNTER
\[ S_{counter} = 0 \]

CALCULATE SECOND TRANSPORT DISTANCE \( S_{t2} \)
\[ S_{t2} = S_{t2} + S_{counter} \]

\[ S_{t2} \geq S_{t_{min}}? \]
NO

NO

PF MOTOR STOPPED?
YES

RETURN

ADD STOP ERROR AT AN ACTUALLY STOPPED POSITION WITH RESPECT TO TARGET STOP POSITION TO ACCUMULATION COUNTER
TRANSPORTING APPARATUS, RECORDING APPARATUS, AND TRANSPORTING METHOD

BACKGROUND

[0001] 1. Technical Field

[0002] The present invention relates to a transporting apparatus configured to feed a recording medium and transport in a recording process and reflect an accumulated error as an accumulation of stop deviation when the transport is stopped on a transporting distance in the transport of every time, a recording apparatus, and a transporting method.

[0003] 2. Related Art

[0004] In the related art, there is a printer provided with an automatic paper feed apparatus which feeds paper automatically (for example, JP-A-2004-90431). The automatic paper feed apparatus feeds papers stacked on a paper feed tray or in a paper feed cassette one by one to a starting position (initial position). A hopper system and a pickup roller system are known as the automatic paper feed apparatus.

[0005] The paper after having fed (to the printing starting position) is subjected to a recording action and a paper transporting action alternately during a printing job, so that the printing is proceeded. There is an apparatus in which the paper feed action and the paper transporting action are driven by a common power source. When transporting the paper, a transporting distance (transporting amount) which causes the paper to stop at a next printing position is required, and the velocity of a transporting motor (PF motor) is controlled according to a speed profile set on the basis of the transporting distance, so that the paper transporting action is performed.

[0006] However, the stop deviation with respect to the target stop position occurs due to the change of the frictional resistance of the transport drive system with time and the change of the motor load with time. When the stop deviation is accumulated every time the paper is transported, for example, the front edge of a printing position of one page is shifted in the transporting direction, so that there arise problems such that the amount of the page margin (bottom margin) is varied, or a slight margin is formed on the bottom side at the time of fromless printing.

[0007] For example, JP-A-2001-142537 discloses a printer motor control apparatus having a corrected amount-of-transport calculating unit configured to be activated on the basis of a PF motor activation command sent from a CPU and calculate a corrected amount of transport of the paper on the basis of a target position of activation “0” and the stop position of the previous operation, which is a counted value (pulse number) of a position counter immediately after reception of activation command, so that the corrected amount of transport is set.


[0009] Incidentally, while increase in paper feeding speed is required in view of improvement of printing throughput, there arise various inconveniences in association with the increase in speed. For example, in the automatic paper feed apparatus of the hopper system, if the power source is common for the feeding action and the hopper action, the hopper action becomes heavy in association with increase in feeding speed and hence the noise problem occurs. Also, a paper detection sensor configured to detect a leading end of the paper at a midpoint of the feeding process is provided to control the PF motor to be driven by a distance from the position where the paper is detected to the initial position (the driven amount of the motor), whereby the improvement of the accuracy of the initial position of the paper is achieved. In this case, the accuracy of position where the paper is detected is an important factor. However, if the paper is fed at a high speed, the accuracy of the position where the paper is detected might be lowered in comparison with the case of being fed at a low speed.

[0010] Therefore, in order to increase the feeding speed while avoiding the various inconveniences as described above, it is effective to perform a multistage transport (multistage transport) in which the feeding speed is switched stepwise in such a manner that the paper is fed at a low speed in a hopper-operated section or a sensor-detecting section, and then is fed over a remaining feeding distance at a high speed. However, when the same sequence is used commonly by the feeding action and the paper transporting action, if the stop deviation at the previous drive is reflected on the amount of transport at this time, and hence the amount of transport at this time is corrected to an amount shorter than a minimum amount of transport required for setting the multistage drive, there arises a problem that the multistage drive which should originally be set cannot be set, which might be a cause to impair the improvement of the printing throughput. In paper discharging other than feeding as well, employment of the multistage drive is effective if a low-speed section is needed and, in addition, there may be transporting apparatuses in which the multistage drive is effectively employed other than the printer.

SUMMARY

[0011] An advantage of some aspects of the invention is to provide a transporting apparatus, a recording apparatus, and a transporting method in which inconveniences such that the setting frequency of the multistage drive is lowered due to the fact that the stop deviation at the transporting drive at the previous time is reflected on the transporting distance at this time is avoided.

[0012] According to a first aspect of the invention, there is provided a transporting apparatus configured to transport a recording medium to a target stop position including: a mounting unit configured to mount the recording medium; a feeding mechanism for the recording medium; a transporting mechanism for the recording medium; a transport drive unit configured to drive the feeding mechanism and the transporting mechanism; a storing unit configured to store a stop deviation at the time of a previous transport drive with respect to the target stop position; a judging unit configured to judge whether feeding for feeding the recording medium mounted on the mounting bed by the feeding mechanism and the transporting mechanism or transporting for transporting the recording medium after having fed by the transporting mechanism; a resetting unit configured to reset the stop deviation in the storing unit at the time of the feeding and not to reset the stop deviation in the storing unit at the time of the transporting; a transporting distance calculating unit configured to calculate a second transporting distance in which the stop deviation after the reset in the storing unit is reflected on a first transporting distance requested this time at the time of the feeding, and to calculate the second transporting distance in which the stop deviation in the storing unit is reflected on the first transporting distance requested this time at the time of the transporting; a determining unit configured to determine whether or not the second transporting distance satisfies a
multistage transport condition on which a multistage transport including a plurality of constant speeds should be performed at the time of the feeding: a setting unit configured to set a speed profile of the multistage transport when the multistage transport condition is satisfied, set a speed profile of a transport mode other than the multistage transport when the multistage transport condition is not satisfied, and set a speed profile of a transport system according to the second transporting distance at the time of the transporting; and a control unit configured to control the drive of the transport drive unit on the basis of the set speed profile and cause the recording medium to be transported.

According to the aspect of the invention, the storing unit stores the stop deviation at the time of the previous transporting with respect to the target stop position. The transporting distance calculating unit calculates the second transporting distance in which the stop deviation in the storing unit is reflected on the first transporting distance requested this time. The judging unit judges whether feeding for feeding the recording medium mounted on the mounting bed by the feeding mechanism and the transporting mechanism or transporting for transporting the recording medium after having fed by the transporting mechanism. At the time of the feeding, the stop deviation in the storing unit is reset by the resetting unit. The transporting distance calculating unit calculates the second transporting distance in which the stop deviation after the resetting in the storing unit is reflected on the first transporting distance requested this time. The determining unit determines whether or not the second transporting distance calculated by the transporting distance calculating unit satisfies the multistage transport condition on which the multistage transport including the plurality of constant speeds should be performed. When the multistage transport condition is satisfied, the speed profile of the multistage transport is set by the setting unit. When the multistage transport condition is not satisfied, the speed profile of the transport mode other than the multistage transport condition is set by the setting unit. The control unit controls the drive of the transport drive unit on the basis of the set speed profile and cause the recording medium to be fed. In contrast, at the time of the transporting after the feeding, the stop deviation in the storing unit is not reset. The transporting distance calculating unit calculates the second transporting distance in which the stop deviation in the storing unit is reflected on the first transporting distance requested this time. The setting unit sets the speed profile of the transporting system according to the second transporting distance. The control unit controls the drive of the transport drive unit on the basis of the set speed profile and cause the recording medium to be transported. For example, the frequency of occurrence of a state in which the multistage transport condition is not satisfied at the time of the feeding because the stop deviation which should be reflected at the time of the transporting other than the feeding may be lowered, and the frequency of occurrence of a state in which the feeding is performed in the multistage transport may be increased. By the increase of the feeding in the multistage transport, the throughput of the feeding may be enhanced.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

First Embodiment

Referring now to FIG. 1 to FIG. 10, a first embodiment in which the invention is applied to an inkjet printer will be described. FIG. 1 is a perspective view of an inkjet recording apparatus in a state in which an outer case is removed. As shown in FIG. 1, the inkjet recording apparatus as a printing apparatus (hereinafter, referred to as a printer 11) includes a substantially square-shaped body case 12 opening on an upper side thereof, and a carriage 14 is provided on a guide shaft 13 bridged in the body case 12 so as to be guided in a primary scanning direction (direction X in FIG. 1) so as to be capable of reciprocating. An endless timing belt 15 to which the carriage 14 is fixed on the back side thereof is wound around a pair of pulleys 16 and 17 disposed on an inner surface of a back plate of the body case 12, and the carriage 14 reciprocates in the primary scanning direction X by a carriage motor (hereinafter, referred to as "CR motor 18") whose drive shaft is connected to the one pulley 16 driven in the normal and reverse directions.

A printhead 19 configured to eject ink is arranged on a lower portion of the carriage 14, and a plate 20 configured to define the distance between the printhead 19 and a paper P as a recording medium is arranged downward position opposing the printhead 19 in the body case 12 in a state of extending in the direction X. Respective ink cartridges 21 and 22 for black and colors are demountably mounted on the carriage 14. The printhead 19 ejects (discharges) ink in respective colors supplied from the respective ink cartridges 21 and 22 from nozzle rows arranged on the color-to-color basis. The carriage 14 and the printhead constitute the recording unit.

Provided on the back side of the printer 11 are a paper feed tray 23 and an automatic paper feed apparatus (Auto Sheet Feeder) 24 configured to separate only a topmost paper from a number of the papers P stacked on the paper feed tray 23 and supply the same to the downstream side in a secondary scanning direction Y.

FIG. 2 is a waveform chart showing an encoder pulse signal.
FIG. 3A is a diagrammatic side view showing an automatic paper feed apparatus and a transporting mechanism.
FIG. 3B is a diagrammatic side view showing the automatic paper feed apparatus and the transporting mechanism.
FIG. 4 is a block diagram showing an electric configuration of the printer.
FIG. 5 is a graph for explaining a speed profile at the time of a two-stage drive of a PF motor.
FIG. 6 is a graph for explaining the speed profile of the PF motor at the time of an abnormal paper feeding.
FIG. 7 is a graph showing the speed profile of the two-stage drive.
FIG. 8 is a graph showing the speed profile of the two-stage drive.
FIG. 9 is a graph showing a speed profile of a simple drive.
FIG. 10 is a flowchart showing a transport controlling process.
FIG. 11 is a flowchart showing the transport controlling process according to a second embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described with reference to the accompanying drawings, wherein like numbers reference like elements.

FIG. 1 is a perspective view showing a configuration of a printer according to a first embodiment.
By the paper feed motor (hereinafter, referred to as “PF motor 25”) disposed on the lower right portion of the body case 12 in FIG. 1 being driven, a paper transporting roller 35 and a paper discharge roller 36 (see FIG. 3 for both) are driven to rotate, so that the paper P is transported in the secondary scanning direction Y. Then, by repeating a printing action in which ink is ejected from nozzles of the printhead 19 toward the paper P while reciprocating the carriage 14 in the primary scanning direction X and a paper transporting action in which the paper P is transported by a predetermined amount of transport in the secondary scanning direction Y substantially alternately (however, the timings of the respective actions may be overlapped), whereby characters or images are printed on the paper P. In this embodiment, the PF motor 25 is used also as a power source of the automatic paper feed apparatus 24.

The printer 11 is provided with a linear encoder 26 configured to output pulses of a number proportional to the distance of movement of the carriage 14 so as to extend along the guide shaft 13, and a speed control and a position control of the carriage 14 are performed on the basis of the position of movement, the speed of movement, and the direction of movement of the carriage 14 obtained by output pulses from the linear encoder 26. Disposed immediately below the carriage 14 positioned at a home position (at one end portion on the carriage movement path (the right end portion in FIG. 1)) in the printer 11 is a maintenance apparatus 28 for performing cleaning or the like for preventing or solving nozzle clogging or the like of the printhead 19. Also provided on the lower side of the platen 20 is a waste liquid tank 29 to which ink that the maintenance apparatus 28 sucks from the nozzles of the printhead 19 by cleaning is discarded.

FIG. 3 shows an automatic paper feed apparatus and a transporting apparatus. As shown in FIG. 3, a hopper 30 is supported on the upper surface side of the paper feed tray 23 arranged on the back surface portion of the main body in an inclined position so as to be tiltable within a range of a predetermined angle about a shaft 30a at an upper end portion. The hopper 30 is urged in the direction away from the paper feed tray 23 (upper left direction in FIG. 3) by a compression spring 31 interposed between itself and the paper feed tray 23.

A paper feed roller 32 is disposed obliquely upward of the hopper 30 near a lower end thereof so as to be rotatable about a rotational axis 32A thereof. The paper feed roller 32 has a substantially D-shape in side view, and an outer peripheral surface thereof includes an arcuate surface 32a extending at a constant distance from an axial center and a flat surface 32b extending at a distance shorter than that of the arcuate surface 32a.

Provided at a position near the upper end of a guide unit 23b formed on the upper surface of the downstream side (left side in FIG. 3) end of the paper feed tray 23 and opposing the paper feed roller 32 is a retard roller 33 which is able to be come into and out of contact with the paper feeding roller 32.

In this embodiment, the paper feeding roller 32, the hopper 30, and a paper return lever 34 are driven by the power of the PF motor 25 (see FIG. 1) in an interlocking manner.

In the paper feeding process, the hopper 30 is tilted (moved upward and downward) so as to move among a waiting position shown in FIG. 3A, a feeding position shown in FIG. 3B (hopper-up position), and a retracted position displaced from the waiting position toward the paper feed tray 23 (hopper-down position) (not shown) in sequence while the paper feeding roller 32 is rotated by one turn. In a state in which the hopper 30 is in the feeding position being tilted in the urging direction of the compression spring 31, the papers P stacked on the hopper 30 are pressed against the paper feeding roller 32. Then, when the paper feeding roller 32 rotates, an abutment position with respect to the paper P is moved from a leading end to a trailing end of the arcuate surface 32a, so that an uppermost paper of the group of papers stacked on the hopper 30 is fed while being pinched between the paper feeding roller 32 and the retard roller 33. The paper return lever 34 has a function to secure a paper feed port for the paper P by being tilted in the retracted position shown in FIG. 3B when starting paper feeding, and move upward to an upright position shown in FIG. 3A when the feeding of the topmost paper is ended.

The paper transporting roller 35 positioned on the downstream side in terms of the paper feed direction of the automatic paper feed apparatus 24 includes a pair of transport drive roller 35a and transport driven roller 35b. The paper discharge roller 36 positioned on the downstream side in terms of the transporting direction of the platen 20 includes a pair of paper discharge drive roller 36a and paper discharge driven roller 36b. In this embodiment, the paper feeding roller 32, the transport drive roller 35a, and the paper discharge drive roller 36a are driven by the PF motor 25 (see FIG. 1) as an identical power source, and perform paper feeding (to the initial position), paper transporting, and paper discharging in cooperation with each other. However, the paper feeding roller 32 is disconnectable from a power transmitting path of the PF motor 25, and is connected only at the time of the paper feeding so as to be transmitted with the power.

Provided between the paper feeding roller 32 and the paper transporting roller 35 is a paper detection sensor 39 including a lever 37 extending by a length which reaches a paper transporting path at the lower end thereof and an optical sensor 38 configured to detect an upper end portion of the lever 37 as an object to be detected. The paper detection sensor 39 is configured in such a manner that the lever 37 is restored to its original position shown in FIG. 3A by an urging force of a spring and is in OFF position in a state in which a paper P1 which presses the lower end of the lever 37 is not present, and is turned ON when the paper P1 presses the lower end of the lever 37 in the course of being fed and rotates the same as shown in FIG. 3B.

When the carriage 14 is moved to an end position (paper feed position) on the opposite side of the home position on the moving path thereof, it presses a clutch lever (trigger lever), not shown, so that a clutch (not shown) provided on the power transmitting path of the PF motor 25 is connected. By the connection of the clutch, the power of the PF motor 25 is brought into a state of being transmittable to the paper feeding roller 32, the hopper 30, and the paper return lever 34. By the PF motor 25 driven in the normal direction in a state in which the clutch is connected, the paper feeding roller 32 starts rotating and, in association with it, the hopper 30 is moved in the urging direction of the compression spring 31 via a cam mechanism and is arranged at the paper feed position. Only the uppermost paper P1 in the group of papers stacked on the hopper 30 is separated from other papers and is fed as shown in FIG. 3B by a balance among a frictional resistance of the arcuate surface 32a of the rotating paper feeding roller 32, a rotational resistance of the retard roller 33, and a frictional resistance of the surface of the paper P. The paper P1 fed by the arcuate surface 32a of the paper
feeding roller 32 is fed to a position where the leading end portion is nipped by the paper transporting roller 35.  

[0040] When the paper feeding roller 32 has made one turn and been restored to a reset position, the hopper 30 is moved to the retracted position, and the clutch on the power transmitting path between the PF motor 25 and a paper feeding system mechanism is disconnected. The fed paper PF is transported continuously by the paper transporting roller 35 and is located to a print starting position. The position of nozzle on the uppermost stream in terms of the transporting direction of the printhead 19 corresponds to a reference position (the position indicated by an inverted solid triangle in FIG. 3B), and locating to the initial position is achieved by feeding the paper P to a position at which the print starting position on the paper matches the reference position. The initial position varies according to the print starting position on the paper.  

[0041] When the revolving speed of the PF motor 25 is increased to a high speed in a paper feeding process, the hopper 30 is reciprocated heavily, which causes noise. Therefore, the revolving speed of the PF motor 25 is set to a lower level in a section where the hopper 30 is operated. Since the paper detection sensor 39 is positioned at a substantially midpoint between the paper feeding roller 32 and the paper transporting roller 35 on the transport path (feeding path), the paper detection sensor 39 detects the paper P being fed in mid course of the section where the hopper is operated where the feeding speed is set to a relatively low level. Therefore, in this low-speed section, the transport of the paper P at a low speed contributes to improvement of paper detection accuracy by the paper detection sensor 39.  

[0042] FIG. 4 is a schematic configuration diagram showing an electric configuration of the printer 11. The printer 11 includes a controller 40, an interface (hereinafter, referred to as I/F 41), the CR motor 18, the PF motor 25, the linear encoder 26, the paper detection sensor 39, a rotary encoder 42, a PF motor drive circuit 43, a CR motor drive circuit 44, and a head drive circuit 45.  

[0043] The controller 40 receives print data from a host apparatus 80 (for example, a personal computer) via the I/F 41. The controller 40 includes a buffer 46, a main control unit 47, and a sequence control unit 48. The main control unit 47 includes a command interpretation unit 49 configured to interpret a command in the print data taken from the host apparatus 80 via the I/F 41. The main control unit 47 issues various requests such as a paper transport request or a print request to the sequence control unit 48 according to the instruction of the command that the command interpretation unit 49 has interpreted. The main control unit 47 sends raster data (bit map data) other than the command in the print data to the sequence control unit 48, and the sequence control unit 48 (specifically, a print control unit 53) performs a discharge drive control of the printhead 19 on the basis of the raster data.  

[0044] The sequence control unit 48 receives various requests such as a paper feed request, the paper transport request, a paper discharge request, or a CR activation request, the print request from the main control unit 47. The sequence control unit 48 includes a paper transport control unit 51 configured to control the drive of the PF motor 25 via the PF motor drive circuit 43, a CR control unit 52 configured to control the drive of the CR motor 18 via the CR motor drive circuit 44, and the print control unit 53 configured to control the drive of the printhead 19 via the head drive circuit 45.  

[0045] The paper transport control unit 51 is activated upon reception of requests relating to transport (the paper feed request, the paper transport request, and the paper discharge request) by the sequence control unit 48, and sets an activation schedule of the PF motor 25. In the activation schedule, an activation timing and a speed profile according to the transporting distance to a target stop position of the activated PF motor 25 are set. When the activation timing of the PF motor 25 arrives, the paper transport control unit 51 activates the PF motor via the PF motor drive circuit 43 according to the set speed profile to achieve the feeding, the transporting, and the discharging of the paper P.  

[0046] The CR control unit 52 sets an activation schedule of the CR motor 18. In the activation schedule, the activation timing of the CR motor 18 and the speed profile to the target stop position of the CR motor 18 are set. When the activation timing of the carriage 14 arrives, the CR control unit 52 controls the drive of the CR motor 18 via the CR motor drive circuit 44 according to the set speed profile to move the carriage 14 in the primary scanning direction X.  

[0047] The print control unit 53 reads the raster data for each line (one raster line) of the buffer 46 and obtains the print starting position and a print ending position on the basis of the read raster data. Then, the print control unit 53 sets the print schedule in a range from the obtained print starting position to the print ending position (printing area), and controls the drive of the printhead 19 according to the print schedule while the carriage 14 moves from the print starting position to the print ending position. The data at the print starting position and the print ending position are used by the CR control unit 52 for obtaining an activating position and a stop position of the carriage 14.  

[0048] As shown in FIG. 4, the linear encoder 26 includes a tape-type sign panel 26a with a number of slits at a regular pitch (for example, \( \frac{1}{180} \) inch = (2.54/180 cm)), and a sensor 26b having a light-emitting element and a light-receiving element provided on the carriage 14. When the carriage 14 moves, the light receiving element receives light emitted from the light-emitting element and passed through the slits, so that the sensor 26b outputs two pulse signals ES1 and ES2 of phase A and phase B shifted by 90° in phase.  

[0049] The rotary encoder 42 includes a disk-shaped sign panel 42a fixed to an end portion of a shaft portion, which is connected to the PF motor 25 so as to be capable of transmitting the power, so as to rotate integrally therewith, and a sensor 42b configured to receive light passed through two types of slits formed on the sign panel 42a at a predetermined pitch in the circumferential direction and shifted by 90° cycle from each other respectively and output two pulse signals ES3 and ES4 shifted in phase by 90°.  

[0050] As shown in FIG. 2, the rotary encoder 42 (hereinafter, referred also simply as "encoder 42") outputs the pulse signal ES3 and the pulse signal ES4 delayed in phase by 90° therefrom when the PF motor 25 is rotated in the normal direction at the time of the transporting (normal drive).  

[0051] In this embodiment, the drive control of the PF motor 25 is performed with reference to the pulse signals ES3 and ES4. When the paper transport control unit 51 performs a PF speed control, as shown in FIG. 2, the both pulse signals ES3 and ES4 are used respectively, the distance between respective pulses edges are determined to be one step, whereby speed command values according to the respective steps are outputted. By counting the pulse edges of the pulse signals ES3 and ES4, the transported position y during the transport of the paper P (during paper feed, paper transport, and paper discharge) is grasped by the number of steps.
The linear encoder 26 also outputs the two-phase pulse signals ES1 and ES2 shifted in phase by 90°, and the CR control unit 52 determines the distance between the pulse signals ES1 and ES2 to be one step and outputs the speed command value according to the respective steps, whereby the speed of the CR motor 18 is controlled. Also, the direction of movement of the carriage 14 is grasped by comparing the phases of the pulse signals ES1 and ES2 (for example, inspecting the level of the pulse signal ES2 at the timing of rising of the pulse signal ES1 is Low or HI), and a carriage position x, whose home position is the original position, is grasped by the number of steps by counting the pulse edges of the pulse signals ES1 and ES2.

Subsequently, the paper transport control unit 51 will be described in detail.

As shown in FIG. 4, the paper transport control unit 51 includes a sequence unit 61, a drive unit 62, an accumulative counter 63 as a storing unit, a PF counter 64, and a remaining step counter 65.

The sequence unit 61 includes a first determining unit 66 and, upon acceptance of the transport request, determines whether the transport request is the paper feed request, the paper transport request, or the paper discharge request by the first determining unit 66, and issues a drive request to the drive unit 62 to instruct the determined transport. The sequence unit 61 also performs a resetting process which is a process to reset the accumulative counter 63 when the first determining unit 66 determines the transport request is the paper feed request. When the first determining unit 66 determines the transport request is other than the paper feed request (the paper transport request and the paper discharge request in this embodiment) the sequence unit 61 does not reset the accumulative counter 63.

As shown in FIG. 4, the drive unit 62 includes a calculating unit 71, a storing unit 72, a second determining unit 73 as a determining unit, a first speed setting unit 74, a second speed setting unit 75, and a drive control unit 76.

The drive unit 62 executes a sequence according to the request from the sequence unit 61 to perform the paper feed process, the paper transport process, and a paper discharge process. When the drive unit 62 accepts one of the paper feed request, the paper transport request, and the paper discharge request, it accepts a requested transporting distance Spf as a first transporting distance indicated by the number of steps of the PF motor 25 together.

The storing unit 72 stores speed tables TA1, TA2, and TB used for determining the speed profile of the PF motor 25 at the time of paper feed process. The storing unit 72 also stores the speed table for paper feeding and paper discharging.

Upon reception of the paper feed request, the second determining unit 73 determines whether to perform a two-stage drive (multistage drive) or to perform a simple drive (transport mode other than the multistage transport) according to the transporting distance. In this embodiment, the second determining unit 73 performs a first determination at a timing prior to the start of feeding, and performs a second determination at a timing when the paper detection sensor 39 detects the leading end of the paper P being fed. The first determination is performed on the basis of the transported distance from the paper feed start position to the target stop position (initial position), and the second determination is performed on the basis of a remaining transporting distance from a paper detection position K by the paper detection sensor 39 to the target stop position.

The first speed setting unit 74 sets the speed profile of the transfer mode (multistage drive or simple drive) determined on the basis of the result of the first determination prior to the start of paper feeding. More specifically, the first speed setting unit 74 sets the multistage speed profile using the speed tables TA1, TA2, and TB, and sets the speed profile of the simple transport (the transfer mode other than the multistage transfer) using the speed tables TA1 and TB.

The second speed setting unit 75 sets the speed profile of the transfer mode (multistage drive or simple drive) determined on the basis of the result of determination of the second determining unit 73 when the paper detection sensor 39 detects the paper. More specifically, the second speed setting unit 75 sets the multistage drive speed profile using the speed tables TA1, TA2, and TB, and sets the speed profile of the simple transport (the transfer mode other than the multistage transfer) using the speed tables TA1 and TB in the same manner as the first speed setting unit 74.

When the activation timing of the PF motor 25 arrives, the drive control unit 76 reads out a required speed table according to the previously set speed profile to grasp the speed command values corresponding to the respective steps y that the PF counter 64 counts with reference to the speed table, and outputs the speed command value to the PF motor drive circuit 43, so that the drive of the PF motor 25 is controlled.

Referring now to FIG. 5, the speed profile in the paper feed process will be described. FIG. 5 is a graph for explaining the speed profile at the time of the two-stage drive of the PF motor 25. In the graph in FIG. 5, the lateral axis indicates the step y of the PF motor 25, and the vertical axis indicates a PF speed Vpf (command position).

As shown in FIG. 5, the PF speed profile for the two-stage drive includes a first accelerating range A1, a first constant speed range C1, a second accelerating range A2, a second constant speed range C2, and a decelerating range B. In the first accelerating range A1, the first constant speed range C1, the second accelerating range A2, and the decelerating range B, transporting distances SA1, SC1, SA2, SB, which are indicated respectively by the number of steps, are fixed values, and the speed profile of the multistage drive are determined by adjusting the transporting distance SC2 (=SI - SA1 - SC1 - SA2 - SB) of the second constant speed range C2 according to a transporting distance St.

In this embodiment, the first constant speed V1 of the first constant speed range C1 corresponds to the first speed, and the second constant speed V2 of the second constant speed range C2 corresponds to the second speed. The first constant speed range C1 in this example is a low speed area set to the low constant speed V1 for restraining the noise when the hopper is operated and, as shown in FIG. 5, is set corresponding to the section where the hopper is operated, that is, from when the hopper 30 is moved up until it is moved down. Then, when the low first constant speed range C1 is ended, the speed is accelerated toward the second constant speed V2, and after having maintained the second constant speed V2 and driven at the constant speed, the speed is decelerated to stop at a target stop position y stop.

Here, in order to secure the section where the hopper is operated at a low speed, the period until the first transporting distance St1 is ended, it is driven at the first constant speed V1. Subsequently, in order to accelerate to the second constant
speed \( V_2 \), a remaining second transporting distance \( S_{t2} \) more than the minimum driving distance \( S_{rmn} \) indicated by the sum of the second acceleration distance \( S_{A2} \) and the decelerating distance \( S_B \) \( (S_{A2} + S_B) \) is required. Therefore, on the two-stage drive condition (multistage transport condition) that the second transporting distance \( S_{t2} \) is the minimum driving distance \( S_{rmn} \) \( (\equiv S_{A2} + S_B) \) or more, the second determining unit \( 73 \) determines whether or not the two-stage drive condition is satisfied or not satisfied.

In other words, at the first determination, the second determining unit \( 73 \) determines whether or not the two-stage drive condition (multistage transport condition) is satisfied by determining whether or not the transporting distance \( S_r \) is a minimum transporting distance \( S_{rmn} \) \( (\equiv S_{A1} + S_C + S_{rmn}) \) or more. At the second determination, the second determining unit \( 73 \) determines whether or not the two-stage drive condition (multistage transport condition) is satisfied by determining whether or not the second transporting distance \( S_{t2} \) is the minimum driving distance \( S_{rmn} \) or more.

The calculating unit \( 71 \) calculates the second transporting distance \( S_{t2} \) from a remaining transporting distance \( S_r \) grasped at the time the paper is detected from the counted value of the remaining step counter \( 65 \).

\[ S_{t2} = S_r - S_{t2} \]  

where \( S_{t2} \) is the second transporting distance and \( S_r \) is the remaining transporting distance. The calculating unit \( 71 \) calculates the second transporting distance \( S_{t2} \) from the counted value of the remaining step counter \( 65 \).

When the paper is detected, the remaining transporting distance \( S_r \) is grasped from the counted value of the remaining step counter \( 65 \).

At the time of the abnormal paper feeding in which the feeding action is started from a state in which the leading end of the paper \( P \) is fed a little due to the overlapped feeding when the previous paper is fed, the paper detection is achieved at a position indicated by an inverted hollow triangle in FIG. 6 at a relatively short transporting distance in comparison with the normal paper feeding in which the paper is detected at the position indicated by the inverted solid triangle in FIG. 6. At the time of the abnormal paper feeding, as shown in FIG. 6, the remaining transporting distance \( S_r \) seems to be longer in appearance by an extent corresponding to the extent of earliness of detection of the leading end of the paper than a transporting distance \( S_{r0} \) from the paper detection position \( K \) which originally should be to the target stop position \( y \). Therefore, in order to cause the paper to be positioned accurately at the target stop position \( y \), the value of the remaining transporting distance \( S_r \) of the remaining step counter \( 65 \) is required to be reset to the original remaining transporting distance \( S_{r0} \).

Since the first constant speed \( V_1 \) is needed to be maintained until the paper reaches a first position \( y \), \( S_k \) from the paper detection position \( K \) (inverted hollow triangle in FIG. 6) to the first position \( y \) is relatively longer by an extent corresponding to the distance of the early paper detection. Since the distance from the paper detection position \( K \) to the target stop position \( y \) is the remaining transporting distance \( S_{r0} \) \( (\equiv S_k + S_{t2}) \) which originally should be, the second transporting distance \( S_{t2} \) becomes relatively shorter by an extent of the increased amount of the distance \( S_k \). The shorted distance of the second transporting distance \( S_{t2} \) is calculated by subtracting the remaining transporting distance \( S_{r0} \) which originally should be from the remaining transporting distance \( S_r \) of the remaining step counter \( 65 \). Therefore, the calculating unit \( 71 \) calculates the second transporting distance \( S_{t2} \) by an expression \( S_{t2} = S_r - S_{t2} \). Here, a term \( S_{t2} \) is a second transporting distance at the time of the normal paper feeding. Therefore, at the time of the normal paper feeding, the remaining transporting distance \( S_r \) is equal to the transporting distance \( S_{r0} \) (\( S_r = S_{r0} \)), and hence the second transporting distance \( S_{t2} \) is equal to the second transporting distance \( S_{to2} \) \( (\equiv S_{t2} + S_{to2}) \).

However, at the time of the abnormal paper feeding, the second transporting distance \( S_{t2} \) is not equal to the second transporting distance \( S_{to2} \) \( (\equiv S_{t2} + S_{to2}) \), and hence \( S_{t2} \) is not satisfied at this time. If the remaining transporting distance \( S_r \) is larger than the transporting distance \( S_{r0} \) \( (S_r > S_{r0}) \) as the abnormal paper feeding shown in FIG. 6, there may be a case where the two-stage drive condition \( S_{t2} = S_{rmn} \) is not satisfied because the second transporting distance \( S_{t2} \) has become a value smaller than the value \( S_{to2} \) at the time of the normal paper feeding. The distance \( S_{r0} \) corresponds to a distance by which the paper is fed already a little in advance when the paper feeding is started due to the overlapped feeding or the like.

Therefore, even when the two-stage drive condition is satisfied at the first determination prior to the start of paper feeding, the second determining unit \( 73 \) performs the second determination when the paper is detected since there may be a case where the two-stage drive condition is not satisfied due to the abnormal paper feeding of this type. Then, when the two-stage drive condition \( S_{t2} = S_{rmn} \) is not satisfied at the second determination, the second speed setting unit \( 75 \) sets the speed profile (double-dot chain line in FIG. 6) of a simple drive and changes from the two-stage drive to the simple drive having the only first constant speed range \( C_1 \) as the constant speed area. In other words, as shown by the double-dot chain line in FIG. 6, the first constant speed \( V_1 \) is maintained even beyond the first position \( y \), and the deceleration is started from the deceleration starting position and is stopped at the target stop position \( y \).

The accumulative counter \( 63 \) stores a stop deviation \( S_{counter} \) (value corresponding to the number of steps) shown by the counted value of the remaining step counter \( 65 \) when the drive of the \( PF \) motor \( 25 \) is stopped. When the stop deviation is accumulated every time when the paper \( P \) is transported, the final low printing position on the paper is shifted in the secondary scanning direction \( Y \) from the estimated position, so that the amount of the bottom margin is varied, or a slight margin is formed on the bottom side irrespective of frameless printing. Therefore, in this embodiment, the calculating unit \( 71 \) is adapted to calculate the transporting distance \( S_t \) \( (\equiv S_{p} + S_{counter}) \) as the second transporting distance while reflecting (adding in this example) the stop deviation \( S_{counter} \) of the accumulative counter \( 63 \) on the requested transporting distance \( S_{p} \) as the first transporting distance. The calculation of the transporting distance by the calculating unit \( 71 \) is performed by the sequence common to paper feeding, paper transporting, and paper discharging.

Even though the stop deviation \( S_{counter} \) of the previous time is reflected when calculating the transporting distance \( S_t \) at the time of the paper feeding, if the remaining
transporting distance is reset when the paper is detected, it is possible to stop the paper at the target stop position. However, in this embodiment, when it is found that the feeding of the paper in the two-stage drive is not possible when the paper is detected even though the two-stage drive is set prior to the start of paper feeding, the resetting to change the speed profile of the simple drive is performed. In contrast, when the simple drive is set initially, granting that feeding in the two-stage drive is found to be possible when the paper is detected, the simple drive is continued.

[0076] For example, there may be a case where the two-stage drive condition is not satisfied because the transporting distance St obtained by reflecting the stop deviation Scounter on the requested transporting distance Spf is smaller than the requested transporting distance Spf (St<Spf) since the stop deviation Scounter is smaller than zero (Scounter<0). In this case, the PF motor 25 is continuously driven in the simple drive which is set initially although the requested transporting distance Spf which allows the satisfaction of the two-stage drive condition is constantly provided, and hence the time required for the paper feeding becomes relatively long, which may lower the print throughput.

[0077] Therefore, the sequence unit 61 is adapted to reset the accumulative counter 63 when the first determining unit 66 determines the transport request to be the paper feeding so that the speed profile of the two-stage drive is always set initially. Therefore, even though the calculating unit 71 reflects the stop deviation Scounter of the accumulative counter 63 on the requested transporting distance Spf, the stop deviation Scounter is always zero (Scounter=0), and hence the calculated transporting distance St is always equal to the requested transporting distance Spf. Therefore, the two-stage drive condition (St≥Stmin) is always satisfied at the first determination by the second determining unit 73, and hence the speed profile of the two-stage drive is always set.

[0078] The PF counter 64 counts the steps y for the respective speed ranges A1, A2, and B for controlling the speed of the PF motor 25 by counting the pulse edges of the pulse signals ES3 and ES4 from the rotary encoder 42. Then, the paper transport control unit 51 refers to the speed tables TA2 and TB to acquire the speed command values corresponding to the steps y, and sends the speed command value to the PF motor drive circuit 43 to control the speed of the PF motor 25. The cycle (the value in inverse proportion to the speed) may be employed as the speed command value.

[0079] The main control unit 47 and the sequence control unit 48 which constitute the controller 40 may be configured as a software for the CPU which executes a control program, may be configured as a hardware including an integrated circuit or the like such as ASIC (Application Specific IC) or may be configured as a cooperating combination of the software and the hardware.

[0080] FIGS. 7 to 9 are graphs showing examples of the speed profile at the time of the feeding. FIG. 7 shows a case where the second transporting distance St2 is equal to the minimum driving distance Srmin (St2=Srmin), FIG. 8 shows a case where the second transporting distance St2 is longer than the minimum driving distance Srmin (St2>Srmin) and FIG. 9 shows a case where the second transporting distance St2 is smaller than the minimum driving distance Srmin (St2<Srmin).

[0081] According to this embodiment, it is set to satisfy the two-stage drive condition in which the transporting distance St is equal to or larger than the minimum driving distance Stmin (St≥Stmin) even when the shortest requested transporting distance Spf is requested at the time of the feeding.

[0082] In the case of the paper feed request, the accumulative counter 63 is reset prior to the calculation of the transporting distance St. Then, after resetting, the transporting distance St is obtained by adding the stop deviation Scounter to the requested transporting distance Spf, and hence the transporting distance St is always equal to the requested transporting distance Spf and the relation St≥Stmin is always satisfied, whereby the speed profile of the two-stage drive is set.

[0083] Then, when the paper is detected, if the second transporting distance St2 obtained from the remaining transporting distance Sr of the remaining step counter 65 is equal to the minimum driving distance Srmin (St2=Srmin) the speed profile of the two-stage drive, in which the upwardly protruded speed waveform is assumed in a second speed range U2 as shown in FIG. 7, is reset. In contrast, when the second transporting distance St2 is larger than the minimum driving distance Srmin (St2>Srmin), the speed profile of the two-stage drive, in which a trapezoidal waveform including the second constant speed range C2 at the second constant speed V2 in the second speed range U2 as shown in FIG. 8, is reset.

[0084] On the other hand, at the time of the abnormal paper feeding in which the paper feeding is started from a state in which the paper P is fed a little due to the overlapped feeding, there may be a case where the second transporting distance St2 becomes smaller than the minimum driving distance Srmin depending on the requested transporting distance Spf and the fed amount thereof. When the relation St2<Srmin is satisfied, the speed profile of the simple drive as shown in FIG. 9 is reset.

[0085] Subsequently, the paper feed process performed by the paper transport control unit 51 will be described. The main control unit 47 issues the paper feed request to the paper transport control unit 51 when starting printing or feeding the next paper P after having ended the printing of the previous page. Upon reception of the transport request from the main control unit 47, the paper transport control unit 51 performs the transport controlling process shown in a flowchart in FIG. 10. The transport controlling process will be described below according to the flowchart shown in FIG. 10.

[0086] First of all, whether or not the accepted request is the paper feeding is determined (Step S10). If yes, the accumulative counter 63 is reset (stop deviation Scounter=0) (Step S20), and if no (that is, the request is paper transporting or paper discharging) (negative determination in S10), the procedure goes to Step S30. The processes in S20 and S30 are processes to be executed by the sequence unit 61. The processes from S40 onward are executed by the drive unit 62. The Step S20 corresponds to a reset step.

[0087] In the drive unit 62, the calculating unit 71 first calculates the transporting distance St (St=Spf+Scounter) (Step S30). At this time, since the stop deviation Scounter is zero (Scounter=0), the transporting distance St is always equal to the requested transporting distance Spf (St=Spf).

[0088] Subsequently, whether or not the relation St≥Stmin is satisfied is determined (Step S40). In other words, whether or not the two-stage drive condition as the multistage transfer condition is satisfied is determined. This time, which is the paper feeding (affirmative determination in Step S40), the relation St≥Stmin is always satisfied (affirmative determina-
tion in Step S50) and the two-stage drive condition is satisfied. Step S50 corresponds to the determination step.

[0089] When the two-stage drive condition is satisfied (St ≤ Smin), the speed profile of the two-stage drive is set (step S60), and when the two-stage drive condition is not satisfied (St > Smin), the speed profile of the simple drive is set (step S70). Then, the drive of the PF motor 25 is controlled according to the set speed profile (Step S80). Consequently, the PF motor 25 is driven at the low first constant speed V1 in the first constant speed range C1, and hence the PF motor 25 is driven at a low speed in the hopper-operated section, so that the hopper action is performed relatively quietly and hence the noise is not generated.

[0090] In the midsection of the first constant speed range C1, when the leading edge of the paper P being fed is detected by the paper detection sensor 39 (affirmative determination in Step S90), the second transporting distance S12 is calculated (Step S100). More specifically, the second transporting distance S12 is calculated using the remaining transporting distance Sr of the remaining step counter 65 by the expression S12 = S(−Sr−Sr).

[0091] Then, whether or not the relation S12 ≤ Smin is satisfied is determined (Step S110). In other words, whether or not the two-stage drive condition is satisfied when the paper is detected is determined again. When the relation S12 ≤ Smin is satisfied, the speed profile of the two-stage drive is reset (Step S120). In contrast, when the relation S12 > Smin is not satisfied, the speed profile of the simple drive is reset (Step S130). However, whether or not the simple drive is set initially is determined by a flag, not shown, and, if the simple drive is set initially (S70), the procedure goes to Step S140 irrespective of whether the relation S12 ≥ Smin is satisfied or not, and the speed profile of the simple drive is reset.

[0092] Then, the drive of the PF motor 25 is controlled according to the set speed profile (Step S150). Therefore, when the paper feeding is performed normally, the feeding is proceeded in the reset two-stage drive and, when the two-stage drive condition (S12 ≤ Smin) is not satisfied irrespective of the initial setting to the speed profile of the two-stage drive because of the abnormal paper feeding in which the paper feeding is started in a state in which the paper P is fed a little due to the overlapped feeding or the like, the feeding is proceeded in the simple drive.

[0093] Then, when the PF motor 25 is stopped after the deceleration in the decelerating range B, a counting process for adding the stop deviation Scounter at an actual stop position with respect to the target stop position y stop, which is indicated by the counted value of the remaining step counter 65 at that time, to the accumulative counter 63 is performed (Step S170). Before the addition of the stop deviation Scounter to the accumulative counter 63, the counted value counted up to that time is reset.

[0094] In contrast, when the paper transport request is accepted after having performed the paper feeding (locating to the initial position) and then transferred to the printing process, the accumulative counter 63 is not reset and a transporting distance St is calculated by the expression St = Spt−Scounter (S30). Then, the paper transporting profile is set according to the calculated transporting distance St the paper transport is performed by controlling the drive of the PF motor 25 according to the set paper transport speed profile (S150, S160). Then, the counting process for adding the stop deviation Scounter at the time of the paper transporting to the accumulative counter 63 is performed (S170). In this manner, the transporting distance is set while reflecting the stop deviation Scounter at every time when the paper transport is stopped during the printing operation to be cancelled at the next paper transporting. In this manner, inconvenience such that the stop deviations are accumulated and the final row printing position is shifted from the estimated position, so that the bottom margin is shifted from the set margin or a slight margin is formed on the bottom side even at the time of frameless printing is avoided.

[0095] When the paper is not set on the hopper 30 or when paper jam occurs during the paper feeding, it is detected as a defective paper feeding at a timing immediately after having passed through the first constant speed range C1 without paper detection. In this case, the drive is continued in the initially set speed profile until the PF motor 25 is stopped. Steps S80 and S150 correspond to the control steps. Furthermore, Steps S60 and S70, and S120 and S130 correspond to the setting steps, respectively. Steps S30 and S110 correspond to the transporting distance calculating steps, respectively. Step S170 corresponds to the storing step.

[0096] As described above, according to the first embodiment, the following effects are achieved.

[0097] Since the accumulative counter 63 is reset in the case of the paper feed request, even when the calculation of the transporting distance St equal to the requested transporting distance Spt is calculated without substantially reflecting the stop deviation Scounter. Therefore, it is always determined to be the two-stage drive in the determination whether or not the two-stage drive condition to be performed using the transporting distance prior to the start of the paper feeding is satisfied, so that setting of the speed profile of the two-stage drive from the beginning is achieved. Therefore, since the feeding in the two-stage drive is always achieved as long as the paper feeding is normally performed, reduction of the feeding time is effectively achieved, which contributes to the improvement of the printing throughput.

[0098] For example, if the paper feeding is started from a position where the paper P is fed a little due to the overlapped feeding or the like, the paper P is detected slightly earlier by the paper detection sensor 39, so that there is a case the relation S12 ≥ Smin is not satisfied because the second transporting distance S12 is shortened by a distance corresponding to the extent of earliness of detection. In this case, even when the two-stage drive is set at the beginning, the setting is changed to the speed profile of the simple drive. Therefore, at the time of the abnormal paper feeding, the paper P may be located at the target stop position accurately. In contrast, even when the position of the paper detection is delayed from the estimated position due to the occurrence of the delay of the start of the paper feeding of this type, the paper P may be located accurately at the target stop position by performing an adjustment to elongate the second constant speed distance SC2 in the second constant speed range C2 and resetting the speed profile of the two-stage drive in this case as well.

[0099] Even with the configuration in which the transporting distance is calculated using the same sequence for the paper feeding and the paper transporting (including the paper discharging), addition of the stop deviation Scounter, which is to be reflected at the time of the paper transporting, to the requested transporting distance Spt is avoided by resetting the accumulative counter 63 before calculating the transporting distance at the time of the paper feed request. As described
above, even when the calculating sequence for the transporting distance is common for the paper feeding, the paper transporting, and the paper discharging, reduction of the paper feed time is efficiently achieved by calculating the adequate transporting distance at the time of the paper feed request.

Second Embodiment

[0100] Referring now to FIG. 11, a second embodiment will be described. In this embodiment, an example in which the accumulative counter is reset when the paper is detected. The electrical configuration of the printer 11 is the same as the first embodiment, and only the contents of the process shown in the flowchart are different, the detailed description will be given according to the flowchart in FIG. 11.

[0101] As shown in FIG. 11, it is characterized in that the timing of resetting the accumulative counter 63 in the case of the paper feeding is when the paper is detected.

[0102] The processes in Steps S210 to S270 are the same as the process in Steps S30 to S90 in FIG. 10. However, since the accumulative counter 63 is not reset, the stop deviation Scounter is reflected on the transporting distance St calculated in Step S210 (Sr=Sp+Scounter). Therefore, there may be a case in which the two-stage drive condition is not satisfied at the first determination. In such a case, the speed profile of the simple drive is set (S250), and the feeding is proceeded in the simple drive (S260). However, in most cases, the two-stage drive condition is satisfied, and the speed profile of the two-stage drive is set, so that feeding is proceeded in the two-stage drive (S260).

[0103] When the paper is detected in Step S270, the accumulative counter 63 is reset in the next step S280. Then, the second transporting distance S12 as the second transporting distance is calculated in Step S290. In other words, S12 = St2 + Scounter is calculated. Here, the St2 on the right side corresponds to S12−Sto2−(Sr−Sr0) described in the first embodiment, and corresponds to the first transporting distance in the second embodiment. In Step S290, an expression S12 = Sto2−(Sr−Sr0)+Scounter is calculated. However, since the stop deviation Scounter is zero (Scounter=0) by having been reset, the expression S12 = Sto2−(Sr−Sr0) is satisfied. At the time of the normal paper feeding, remaining transporting distance Sr is equal to the transporting distance Sr0 (Sr=Sr0), and hence the second transporting distance S12 is equal to second transporting distance Sto2 (S12 = Sto2). In this embodiment, the value of Sto2 is set to a value which always satisfies the relation Sto2≥Sr min.

[0104] Then, in Step S300 whether or not the second transporting distance S12 is equal to or larger than the minimum driving distance Smin (S12=Smin) is determined. If the multistage transport S12=Smin is satisfied, the speed profile of the two-stage drive condition is set (Step S310) and, if the relation S12=Smin is not satisfied, the speed profile of the simple drive is set (Step S320). In the this embodiment, the relation of S12=Smin is satisfied at the time of the normal paper feeding, and the speed profile of the two-stage drive is set. Therefore, even though the condition is not satisfied because whether or not the two-stage drive condition (S1=Smnin) is satisfied is determined on the basis of the transporting distance St on which the stop deviation Scounter is reflected at the first determination and hence the simple drive is set, if the paper feeding is normally performed, the two-stage drive condition (S12=Smin) is satisfied at the second determination when the paper is detected, and hence the setting is changed to the two-stage drive.

[0105] Therefore, even though the simple drive is set which should originally be set to the two-stage drive at the first determination because the stop deviation Scounter is reflected, the accumulative counter 63 is reset prior to the calculation of the second transporting distance S12 at the second determination when the paper is detected, so that the speed profile of the two-stage drive is reset at a timing before being switched to the second speed. Therefore, the feeding action is performed in the two-stage drive, and hence the reduction of the feeding time is effectively achieved, which contributes to the improvement of the printing throughput. Step S280 corresponds to the reset step, and Step S290 corresponds to the transporting distance calculating step. Step S300 corresponds to the determination step, and Steps S310 and S320 correspond to the setting steps. Step S340 corresponds to the control step and Step S360 corresponds to the storage step.

[0106] The embodiments are not limited to those described thus far, and may be modified to the following modes.

First Modification

[0107] Although the determination of whether or not the multistage drive condition is satisfied and the setting of the speed profile (the latter is resetting) are performed twice before starting the feeding and when the paper is detected, a configuration in which only one of those is performed is also applicable. For example, in FIG. 10, the processes in Step S10 to S90 are performed, and only the adjustment of the deceleration starting position is performed so as to be able to stop at the target stop position y stop instead of the processes in S100 to S130. Also, in FIG. 11, a process to set the speed profile of the simple drive is performed instead of the processes in Steps S220 to S250. In this case, since the speed profile may be selected between the multistage drive and the two-stage drive according to the remaining transporting distance (remaining amount of feeding) on the basis of the result of determination whether or not the multistage drive condition is satisfied after having detected the paper and, in addition, the frequency of selection of the multistage drive is increased by the resetting of the accumulative counter 63, the throughput of the feeding is improved in the same manner. In addition, calculation of the transporting distance, and the determination of whether or not the multistage drive condition is satisfied may be performed at other timings in a period from before starting the feeding until the end of the feeding and in this case, the accumulative counter 63 may be reset before the calculation of the transporting distance. For example, it may simply be a timing at which determination of the speed profile is achieved before reaching the first position y acc which is a turning point of the selection between the multistage drive and the simple drive.

Second Modification

[0108] In the respective embodiments shown above, the two-stage drive is always selected if it is the requested transporting distance (requested amount of feeding). However, a configuration in which one of the two-stage drive and the simple drive is selected even in the case of the requested transporting distance according to its value is also employable.

Third Modification

[0109] In the respective embodiments described above, the second constant speed (second speed) in the second constant
speed range in the speed profile of the two-stage drive is a constant value. However, a configuration in which the second speed is selected from a plurality of speeds according to the transporting distance S1 is also applicable. For example, when three second speeds in the relation of V21 < V22 < V23 are prepared, whether the second transporting distance S2 of the second speed range U2 of this time is equal to or larger than the minimum drive distance which allows setting of V21, is equal to or larger than the minimum drive distance which allows setting of V22, or is equal to or larger than the minimum drive distance which allows setting of V23 is determined in sequence, and the highest second speed is employed from among those which satisfy the condition. As a matter of course, the number of the second speeds is not limited to three, and must only be a plural number. If the second speed as high as possible may be selected from among the plurality of second speeds according to the transporting distance, the reduction of the feeding time is resulted, so that the further improvement of the printing throughput is achieved.

Fourth Modification

[0110] The storing unit configured to the stop deviations which should be reflected on the requested transporting distance (requested amount of feeding) is not limited to the counter as the accumulative counter 63. For example, it may be a register or a memory which stores the stop deviations.

Fifth Modification

[0111] The object of employing the multistage drive is not limited to the reduction of the noise of the hopper action. For example, the multistage drive in which the paper feeding speed is low in the paper detecting area may be employed for improving the accuracy of position where the paper is detected by the paper detection sensor in a configuration in which the automatic paper feed apparatus does not employ the hopper system, for example, in the printer in which the automatic paper feed apparatus of, for example, a pickup roller system is mounted. In this case, since the paper is fed at a low speed in the paper detecting area, the paper detection at a high positional accuracy is achieved by the paper detection sensor and, in addition, the time required for the paper feeding until the initial position may be reduced by accelerating from the position after the paper detecting area. Then, even when the time required for the paper feeding is reduced and the paper is located to the initial position at an early stage, the timing of CR activation may be hasten to a timing before the second constant speed area (final constant speed area) correspondingly.

Sixth Modification

[0112] A configuration in which a paper feeding motor specific for feeding the paper for driving the paper feeding roller is provided in addition to the PF motor 25, and the hopper is driven by the paper feeding motor may also be employed.

Seventh Embodiment

[0113] The mounting bed is not limited to the hopper, and may be a cassette for storing papers. When the mounting bed is the cassette, the paper transporting roller, a feed roller, and a pickup roller constitute the feeding mechanism. In this case, the transport drive unit may be only the PF motor, or both of the PF motor and the paper feeding motor.

Eighth Embodiment

[0114] In the embodiments described above, the two-stage drive (two-stage transport) provided with the two constant speed areas is employed. However, there may be the three or more constant speed areas in the speed profile of the multistage drive. For example, three-stage drive or four-stage drive may also be employed.

Ninth Embodiment

[0115] The invention is not limited to the multistage drive in which the first speed is lower than the second speed, and may be the multistage drive in which the first speed is higher than the second speed.

Tenth Embodiment

[0116] In the embodiments described above, the recording apparatus is embodied in the ink jet recording apparatus. However, the invention is not limited thereto, and the invention may be embodied in a liquid ejection apparatus of a serial type for ejecting fluid other than ink (including liquid, liquid-type substance including particles of functional material dispersed or mixed in liquid, fluid-type substance such as gel, and solid substance which can be discharged by flowing as the fluid). For example, it may be liquid-type discharging apparatus which discharges liquid-type containing materials such as electrode material or colorant (pixel material) in the form of dispersion or dissolution used for manufacturing liquid crystal displays, EL (electroluminescence) displays, and surface emission-type displays, liquid discharging apparatus which discharges biological organic substance used for manufacturing biochips, liquid discharging apparatuses which are used as accurate pipettes and discharge liquid as a test sample. Further, more, it may be a liquid discharging apparatus for discharging lubricant for pinpoint lubrication for precise machines such as watches or cameras, a liquid discharging apparatus for discharging transparent resin liquid such as a UV-cured resin on a substrate for forming micro-spherical lens (optical lens) used for optical communication elements or the like, a liquid discharging apparatus for discharging etching liquid such as acid or alkali for etching the substrate or the like, and a liquid-state substance discharging apparatus for discharging the fluid-state substance such as gel (for example, physical gel). The invention may be applied to any one of the liquid discharging apparatuses of a serial type.

What is claimed is:

1. A transporting apparatus configured to transport a recording medium to a target stop position comprising:
   a mounting unit configured to mount the recording medium;
   a feeding mechanism for the recording medium;
   a transporting mechanism for the recording medium;
   a transport drive unit configured to drive the feeding mechanism and the transporting mechanism;
   a storing unit configured to store a stop deviation at the time of a previous transport drive with respect to the target stop position;
   a judging unit configured to judge whether a feeding operation for the recording medium on the mounting base by the feeding mechanism and the transporting mechanism,
or a transporting operation for the recording medium after the feeding operation by the transporting mechanism;

a resetting unit configured to reset the stop deviation in the storing unit;

a transporting distance calculating unit configured to calculate a second transporting distance in which the stop deviation after the reset of the storing unit is reflected on a first transporting distance requested this time at the time of the feeding, and to calculate the second transporting distance in which the stop deviation in the storing unit is reflected on the first transporting distance requested this time at the time of the transporting;

a determining unit configured to determine whether or not the second transporting distance satisfies a multistage transport condition on which a multistage transport including a plurality of constant speeds should be performed;

a setting unit configured to set a speed profile of the multistage transport when the multistage transport condition is satisfied, set a speed profile of a transport mode other than the multistage transport when the multistage transport condition is not satisfied, and set a speed profile of a transport system according to the second transporting distance;

and

a control unit configured to control the drive of the transporting drive unit on the basis of the set speed profile and cause the recording medium to be transported.

2. The transporting apparatus according to claim 1, wherein the speed profile of the multistage transport includes a first speed and a second speed in sequence from the position where the feeding is started to a stop at an initial position, and includes:

a first speed range including a first accelerating range for accelerating from the position where the feeding is started to the first speed and a first constant speed range for maintaining the speed at the first speed;

a second accelerating range for accelerating from the first speed to the second speed;

a second speed range including a second constant speed range for maintaining the speed at the second speed, and a decelerating range for decelerating from the second speed to the target stop position;

the determining unit performs a determination on the multistage transport condition such that the transporting distance in the second speed range which is variable according to the second transporting distance is a minimum drive distance or more; and

the setting unit adjusts the transporting distance in the second constant speed according to the second transporting distance to set the speed profile of the multistage transport when the multistage transport condition is satisfied according to the determination of the determining unit.

3. The transporting apparatus according to claim 2, wherein the first constant speed range is set according to an operation range of the feeding mechanism.

4. The transporting apparatus according to claim 1, further comprising a media detecting unit configured to detect the recording medium in the course of the feeding,

wherein the respective processes by the resetting unit, the transporting distance calculating unit, the determining unit, and the setting unit are performed when the recording medium is detected by the medium detecting unit.

5. The transporting apparatus according to claim 1 further comprising a medium detecting unit configured to detect the recording medium in the course of the feeding,

wherein at the time of the feeding, respective processes by the transporting distance calculating unit, the determining unit, and the setting unit are performed twice before starting the feeding and at the time of medium detection in which the medium detecting unit detects the recording medium in the course of the feeding;

the resetting unit resets the storing unit either one of before starting the feeding and at the time of medium detection, when the multistage transport condition is satisfied before starting the feeding and the setting unit sets the speed profile of the multistage transport, even if the multistage transport condition is not satisfied at the time of medium detection in the course of the feeding at the speed profile of the multistage transport, the setting unit changes the speed profile for the remaining feeding into the speed profile of the transport mode other than the multistage transport.

6. The transporting apparatus according to claim 5, wherein the resetting unit resets the storing unit before starting the feeding, and

when the multistage transport condition is not satisfied before starting the feeding and the setting unit sets a speed profile of the transport mode other than the multistage transport, even if the multistage transport condition is satisfied at the time of medium detection in the course of the feeding at the speed profile, the setting unit does not change the setting into the speed profile of the multistage transport.

7. The transporting apparatus according to claim 5, wherein the resetting unit resets the storing unit at the time of medium detection and even when the multistage transport condition is not satisfied before starting the feeding and the setting unit sets the speed profile of the transport mode other than the multistage transport, if the multistage transport condition is satisfied at the time of medium detection in the course of the feeding at the speed profile, the setting unit changes the speed profile for the remaining feeding into the speed profile of the multistage transport.

8. A recording apparatus including a recording unit configured to produce a record on a transported recording medium and the transporting apparatus according to claim 1.

9. A transporting method for transporting a recording medium to a target stop position comprising:

storing a stop deviation at the time of a previous transporting with respect to a target stop position;

judging whether feeding for feeding the recording medium mounted on a mounting bed by a feeding mechanism and a transporting mechanism or transporting for transporting the recording medium after having fed by the transporting mechanism;

resetting the stop deviation in the storing unit at the time of the feeding and not resetting in the storing unit at the time of the transporting;

calculating a second transporting distance in which the stop deviation after the reset in the storing unit is reflected on a first transporting distance requested this time at the time of the feeding, and calculating the second transporting distance in which the stop deviation in the storing unit is reflected on the first transporting distance requested this time at the time of the transporting;
determining whether or not the second transporting distance satisfies a multistage transport condition on which a multistage transport including a plurality of constant speeds should be performed at the time of the feeding; setting a speed profile of the multistage transport when the multistage transport condition is satisfied, setting a speed profile of a transport mode other than the multistage transport when the multistage transport condition is not satisfied, and setting a speed profile of a transport system according to the second transporting distance at the time of the transporting; and controlling the drive of the transport drive unit on the basis of the set speed profile and causing the recording medium to be transported.