

DESCRIPTION

BILL PROCESSOR AND ITS CONTROLLING METHOD

TECHNICAL FIELD

The present invention relates to a bill processor and its controlling method, and more particularly to a bill processor and its controlling method used for bill accommodation processing in automatic vending machines and the like.

BACKGROUND ART

Generally, equipment such as an automatic vending machine for processing bill is provided therein with a bill processor which discriminates authentic or counterfeit of bill and accommodates authentic bills. The bill processor identifies inserted bill by denominations and discriminates as authentic or counterfeit, and when the inserted bill is judged as authentic, the bill processor accommodates that bill and informs the automatic vending machine and the like about the insertion of the authentic bill.

Fig. 4 is a side view showing a schematic structure of a bill processor.

As shown in Fig. 4, a bill processor 100 comprises a bill insertion slot 101, pulleys 102, a bill conveying passage 103, a discrimination sensor 104, a stack drum 105, a stacker chute 106, a stacker 107, a holding plate 108, and a coil spring 109.

When a bill is inserted into the bill processor 100

through the bill insertion slot 101, an insertion sensor (not shown) detects its insertion, and a conveying motor (not shown) is activated. When the conveying motor is driven, the pulleys 102 linked with it are driven to make a conveyor belt (not shown), which is disposed along the bill conveying passage, convey the inserted bill along the bill conveying passage 103. When the bill is conveyed through the bill conveying passage 103, the discrimination sensor 104 detects the features of the bill, and the bill is judged as authentic or counterfeit based on the detected result. When it is identified as counterfeit as a result of the identification for authentic or counterfeit, the conveying motor is rotated in the reverse direction, and the bill is returned from the bill insertion slot 101. When it is judged as authentic, the conveying motor continues to rotate in the forward direction, and the bill is stopped as being sandwiched by a slit 105a formed in the stack drum 105. The stack drum 105 will be described afterward.

Subsequently, the stack drum 105 rotates in a predetermined direction, and the stacker chute 106 also moves in a direction indicated by arrow A in Fig. 4 to accommodate the bill in the stacker 107. The holding plate 108 is provided in the stacker 107 with the coil spring 109 disposed between them to push the accommodated bill toward the stack drum 105 by the holding plate 108.

Operations of the stack drum 105 will be described with reference to Fig. 5.

Fig. 5 is a front view of the stack drum 105 viewed from

the side of the stacker 107.

As shown in Fig. 5, the stack drum 105 has stack drums 105-1 and 105-2 disposed in a pair. When the bill is transferred through the bill transferring passage 103 and stopped in a predetermined position indicated by a broken line, a stacker motor (not shown) is driven to rotate the stack drums 105-1 and 105-2 in directions indicated by arrows B and C respectively. The stacker chute 106 is moved toward you as the stack drums 105-1 and 105-2 are rotated, and the bill is accommodated into the stacker 107.

The stack drum 105-1 is provided with carrier switch 150, and the positions (positions against the rotation) of the stack drums 105-1 and 105-2 are detected according to a state of the carrier switch 150, so to control the stacker motor.

Now, the carrier switch 150 will be described.

Fig. 6(a) through Fig. 6(c) are top views of the carrier switch 150, and Fig. 6(d) through Fig. 6(f) are side views of the carrier switch 150 shown in Fig. 6(a) through Fig. 6(c).

The carrier switch 150 comprises rotation section 151 and detection section 152. The detection section 152 is switched between ON and OFF depending on the rotating position of the rotation section 151. For example, when the rotation section 151 is in the position as shown in Fig. 6(a) and Fig. 6(d), the detection section 152 is in the OFF position. The rotation section 151 rotates in a direction indicated by arrow D from the position shown in Fig. 6(a) to the position shown in Fig. 6(b) and Fig. 6(e) with the detection section 152 remained in the OFF position and further rotates in a

direction indicated by arrow E to switch ON the detection section 152 in the state as shown in Fig. 6(c) and Fig. 6(f). When the rotation section 151 further rotates in a direction indicated by arrow F with the detection section 152 remained in the ON position, it returns to the position shown in Fig. 6(a) and Fig. 6(d), and the detection section 152 is switched OFF. Fig. 6(g) shows the relationship between the positions of the rotation section 151 and the states of the detection section 152.

Thus, the carrier switch 150 is used to stop the stack drums 105-1 and 105-2, which are rotated every time bill is accommodated, at an exact position (position after just one rotation). To accurately control the stop positions of the stack drums 105-1 and 105-2, detection of their positions is significant. It is ideal to stop the stack drums 105-1 and 105-2 simultaneously with switching of the carrier switch 150 (detection unit 152) from ON to OFF by using the carrier switch 150. In practice, however, the stack drums 105-1 and 105-2 and the stack motor (not shown) rotate in inertia after the stop command (after turning off the power supply of the stack motor).

Therefore, the control of the stack motor is made with the relationship between the stop positions of the stack drums 105-1, 105-2 and the position of the detection unit 150 which is switched from ON to OFF determined in view of the influence of inertia.

In practice, because of the variability due to characteristics different among individual products, it is

configured that a timer is activated when the detection unit 150 is switched from ON to OFF to turn off the power supply of the stack motor with the lapse of predetermined time, so that the time to be set on the timer can be adjusted.

Figs. 7(a) to 7(c) are diagrams showing the number of rotations of the stack motor, its feeding state, and the states of the carrier switch 150.

As shown in Fig. 7(a), the timer is activated when the carrier switch 150 is switched from ON to OFF. When predetermined time T is measured by the timer, the power supply of the stack motor is turned off, then the stack motor continuously rotates in inertia and stops in due time. In this case, the stack drums 105-1 and 105-2 rotate for distance (angle) L corresponding to an area of the shaped section in the figure within time TL between the switching of the carrier switch 150 from ON to OFF and the stop of the stack motor. And, time T is set so that the stop position after the aforesaid rotation is a desired position.

But, the stop position is not always constant because a load on the stack motor is variable depending on a temperature, the increase of the number of bill accommodated, changes in power supply voltage and the like. Generally, the load decreases in a high-temperature condition but increases in a low-temperature condition, and automatic vending machines and the like disposed outdoors tend to be influenced by such conditions. When the stop positions are largely variable due to the change in load, bill may jam in the processor?.

When the load is decreased, the stack motor rotates at a

relatively high number of rotations as shown in Fig. 7(b). Therefore, the stack motor takes longer time to stop when the power supply of the stack motor is turned off after the passage of predetermined time T from the moment the carrier switch 150 is switched from ON to OFF. Accordingly, time from the change in the state of the carrier switch 150 to the stop of the stack motor is $TL+TL_1$, and a moved distance within the aforesaid time is distance $L_1 (>L)$ corresponding to an area of the shaded section in the figure.

When the load is increased, the stack motor rotates at a relatively low number of rotations as shown in Fig. 7(c). Therefore, the stack motor takes shorter time to stop when the power supply of the stack motor is turned off after the passage of predetermined time T from the moment the carrier switch 150 is switched from ON to OFF. Accordingly, time from the change in the state of the carrier switch 150 to the stop of the stack motor becomes $TL+TL_2$, and a moved distance within the aforesaid time becomes distance $L_2 (<L)$ corresponding to an area of the shaded section shown in the figure.

As described above, the conventional bill processor cannot stop the stack drum at a predetermined position when the load on the stack motor is varied due to a change in temperature and the like and has a disadvantage that bill cannot be accepted if variations in stop position are enormous.

DISCLOSURE OF THE INVENTION

In view of the circumstances described above, it is an

object of the present invention to provide a bill processor and its controlling method which can stop a stack drum at a predetermined position in case of a change in load without using a sensor for measuring a temperature, detecting a detailed position of the stack drum or the like.

To achieve the aforesaid object, the invention of claim 1 is a bill processor which rotates a stack drum by a stack motor to accommodate bill by rotations of the stack drum, characterized by:

position detection means which detects a rotation position of the stack drum;

time measuring means which measures a time required for the stack drum to rotate to a predetermined position on the basis of the rotation position detected by the position detection means; and

power feeding time determination means which determines a time from the rotation of the stack drum to the predetermined position until termination of power feeding to the stack motor on the basis of the time measured by the time measuring means.

The invention of claim 2 is the bill processor according to claim 1, wherein the position detection means is a carrier switch, and the time measuring means measures a time from the change of the carrier switch from OFF to ON until the change of the carrier switch to OFF again.

The invention of claim 3 is a method of controlling a bill processor which rotates a stack drum by a stack motor to accommodate bill by rotations of the stack drum, characterized by:

detecting load characteristics of the stack motor from a driving state of the stack motor, and determining a time to terminate power feeding to the stack motor based on the detected load characteristics.

The invention of claim 4 is the method of controlling a bill processor according to claim 3, wherein the detection of the load characteristics is carried out by detecting a rotation position of the stack drum and measuring a time required for the stack drum to rotate to a predetermined position.

The invention of claim 5 is the method of controlling a bill processor according to claim 4, wherein the detection of the rotation position is performed by a carrier switch, and the detection of the load characteristics is carried out by measuring the time from the change of the carrier switch from OFF to ON until the change of carrier switch to OFF again.

The invention of claim 6 is the method of controlling a bill processor according to claim 5, wherein the power feeding to the stack motor is stopped after a lapse of the feeding time determined by the feeding time determination means from a time point when the state of the carrier switch is changed from ON to OFF.

BRIEF DESCRIPTION OF THE DRAWINGS.

Fig. 1 is a block diagram showing the structure of a stack motor control unit which is a part of the structure of a bill processor;

Figs. 2(a) to 2(c) are diagrams showing the number of

rotations of a stack motor, its feeding state, and the state of a carrier switch;

Fig. 3 is a flow chart showing a flow of operations of respective parts ranging from the drive to the stop of the stack motor;

Fig. 4 is a side view showing a schematic structure of the bill processor;

Fig. 5 is a front view of stack drum 105 viewed from the side of stacker 107;

Figs. 6(a) to 6(g) are diagrams showing the structure and operation of carrier switch 150; and

Figs. 7(a) to 7(c) are diagrams showing the number of rotations of a stack motor, its feeding state, and the state of the carrier switch 150 (conventional).

BEST MODE FOR CARRYING OUT THE INVENTION

A bill processor and its controlling method to which the present invention pertains will be described in detail with reference to the accompanying drawings.

The bill processor according to the invention has basically the same structure as a conventional bill processor except that a control unit for a stack motor which drives a stack drum is different. Therefore, descriptions about the structure other than the control unit will be omitted.

Fig. 1 is a block diagram showing the structure of a stack motor control unit which is a part of the structure of the bill processor.

It is seen in Fig. 1 that the stack motor control unit

comprises carrier SW (switch) sensor 1, timer 2, timer value calculating unit 3, time measuring unit 4, and motor controller 5. The carrier SW sensor 1 detects a state of a carrier switch disposed within a stack drum (not shown), and the time measuring unit 4 measures time during which the carrier switch to be detected by the carrier SW sensor 1 is in the ON position. The timer value calculating unit 3 calculates time to be measured by the timer 2 on the basis of the time, during which the carrier switch is ON, measured by the time measuring unit 4, and the timer 2 measures the time calculated by the timer value calculating unit 3. The motor controller 5 drives the stack motor and stops the feeding to the stack motor when the timer 2 has measured predetermined time.

A number of rotations of the stack motor is variable depending on a state of load (magnitude), so that time, during which the stack motor drives to rotate the stack drum and the state of the carrier switch is changed (rotation angle is constant regardless of the load), is also variable.

Accordingly, the time measuring unit 4 measures the time during which the carrier switch changes its state from ON to OFF, and the timer value calculating unit 3 changes time set on the timer 2 according to the measured result. Thus, the stop position of the stack drum can be kept constant.

Figs. 2(a) to 2(c) are diagrams showing a number of rotations of the stack motor, its feeding state, and a state of the carrier switch.

Fig. 2(a) shows that when the motor controller 5 starts

feeding to the stack motor, the stack motor rotates, and the stack drum rotates accordingly. Then, the output of the carrier switch is changed from OFF to ON. When the carrier switch is changed from OFF to ON, the carrier SW sensor 1 detects the change, and the time measuring unit 4 starts measuring time. When the stack drum rotates to a predetermined position, the output of the carrier switch changes from ON to OFF, and the carrier SW sensor 1 detects its change. Thus, the time measuring unit 4 terminates measuring of ON time T_c of the carrier switch, and the timer value calculating unit 3 calculates according to the time T_c a count time to be set on the timer 2. The count time calculated by the timer value calculating unit 3 is variable depending on the time T_c measured by the time measuring unit 4. But, Fig. 2(a) shows the example with a standard load. Therefore, time T corresponding to the standard load is calculated. Thus, the timer 2 starts measuring the time T . After the time T is measured, the motor controller 5 stops feeding to the stack motor, and the stack motor rotates in inertia only and then stops in due course. In this case, a distance (angle) that the stack drum rotates in time T_L between the change of the output of the carrier switch from ON to OFF and the stop of the stack motor becomes L corresponding to an area of the shaded section in the figure.

Fig. 2(b) shows that the stack motor has a small load. It is also seen that when the motor controller 5 starts feeding to the stack motor, the stack motor rotates, and the stack drum rotates accordingly. Then, the output of the

carrier switch changes from OFF to ON. When the carrier switch is changed from OFF to ON, the carrier SW sensor 1 detects the change, and the time measuring unit 4 starts measuring time. The stack drum rotates to a predetermined position, and the output of the carrier switch is changed from ON to OFF, then the carrier SW sensor 1 detects the change. Thus, the time measuring unit 4 terminates measuring ON time T_{c1} of the carrier switch, and the timer value calculating unit 3 calculates count time to be set on the timer 2. At this time, time T_{c1} measured by the time measuring unit 4 is shorter than the time T_c in the case of the standard load, and the count time calculated by the timer value calculating unit 3 becomes time $T-t_1$ which is shorter than the time T , calculated in the case of the standard load, by t_1 . Therefore, the timer 2 measures the time $T-t_1$. When the timer 2 measures up to the time $T-t_1$, the motor controller 5 stops feeding to the stack motor, which then continuously rotates in inertia only and stops in due course. Time between the change of the output of carrier switch from ON to OFF and the stop of the stack motor becomes TL_1 . And, a distance (angle) that the stack drum rotates becomes L corresponding to an area of the shaded section in the figure. Therefore, the stop position of the stack drum is the same as in the case of the standard load.

Fig. 2(c) shows that the stack motor has a heavy load. When the motor controller 5 starts feeding to the stack motor, the stack motor rotates, and the stack drum rotates accordingly. And the output of the carrier switch is changed

from OFF to ON. When the carrier switch is changed from OFF to ON, the carrier SW sensor 1 detects the change, and the time measuring unit 4 starts measuring time. When the stack drum rotates to a predetermined position, the output of the carrier switch is changed from ON to OFF, and the carrier SW sensor 1 detects the change. Thus, the time measuring unit 4 terminates measuring ON time T_{c2} of the carrier switch, and the timer value calculating unit 3 calculates count time to be set on the timer 2. At this time, the time T_{c2} measured by the time measuring unit 4 is longer than the time T_c in the case of the standard load, so that the count time calculated by the timer value calculating unit 3 become time $T+t_2$, which is longer than the time T calculated in the case of the standard load, by t_2 . Therefore, the timer 2 measures the time $T+t_2$, and when the timer 2 measures the time $T+t_2$, the motor controller 4 stops feeding to the stack motor. Then, the stack motor continuously rotates in inertia only and then stops in due course. Time between the moment the output of the carrier switch changes from ON to OFF and the stop of the stack motor becomes TL_2 , and a distance (angle) that the stack drum rotates becomes L corresponding to an area of the shaded section in the figure. Therefore, the stop position of the stack drum becomes the same as in the case of the standard load.

Operations of the respective units to drive and stop the stack motor will be described with reference to Fig. 3.

Fig. 3 is a flow chart showing a flow of operations of the respective units from the drive to the stop of the stack

motor.

Bill inserted through a bill insertion slot is transferred to a predetermined position, and its processing is started (step 51), and the motor controller 5 starts feeding to the stack motor (step 52). When the feeding to the stack motor is started, the stack motor is driven to rotate the stack drum, and the carrier switch is switched from OFF to ON. The carrier SW sensor 1 detects a state of the carrier switch (step 53), and when the carrier switch is switched from OFF to ON (YES in step 53), the time measuring unit 4 starts measuring (step 54). Subsequently, the carrier SW sensor 1 waits until the carrier switch is switched from ON to OFF (NO in step 55). And, when the carrier switch is switched from ON to OFF (YES in step 55), the time measuring unit 4 terminates measuring (step 56).

Then, the timer value calculating unit 3 calculates count time to be set on the timer 2 on the basis of the measured result of the time measuring unit 4 (step 57) and sets the calculated time on the timer 2 (step 58). Subsequently, when the timer 2 measures up to the set time (NO in step 59), the motor controller 5 is advised the time up (YES in step 59). After receiving the time up notice, the motor controller 5 stops feeding to the stack motor (step 60), and the bill reception processing is terminated (step 61).

The timer value to be set on the timer 2 is calculated as occasion demands but may be kept as a plurality of values in a table and selected from the table according to the time measured by the time measuring unit 4.

In the embodiment described above, the position of the stack drum was detected by the carrier switch. Besides, when the position of the stack drum is accurately detected in another structure having an encoder or the like, the position to stop the stack drum can be controlled by the same method as in the above embodiment because the stack motor continuously rotates in inertia after the termination of feeding.

INDUSTRIAL APPLICABILITY

The present invention is a bill processor and its controlling method which measures a time required for the stack drum to rotate to a predetermined position and calculates a time for stopping the stack motor according to the measured time. According to this structure, the stack drum can be stopped at the predetermined position even when a load fluctuates due to an environmental change such as a temperature or the like or increase in the number of accommodated bill.

CLAIMS:

1. A bill processor which rotates a stack drum by a stack motor to accommodate bill by rotations of the stack drum, characterized by:

position detection means which detects a rotation position of the stack drum;

time measuring means which measures a time required for the stack drum to rotate to a predetermined position on the basis of the rotation position detected by the position detection means; and

power feeding time determination means which determines a time from the rotation of the stack drum to the predetermined position until termination of power feeding to the stack motor on the basis of the time measured by the time measuring means.

2. The bill processor according to claim 1, wherein the position detection means is a carrier switch, and the time measuring means measures a time from the change of the carrier switch from OFF to ON until the change of the carrier switch to OFF again.

3. A method of controlling a bill processor which rotates a stack drum by a stack motor to accommodate bill by rotations of the stack drum, characterized by:

detecting load characteristics of the stack motor from a driving state of the stack motor, and determining a time to terminate power feeding to the stack motor based on the detected load characteristics.



4. The method of controlling a bill processor according to claim 3, wherein the detection of the load characteristics is carried out by detecting a rotation position of the stack drum and measuring a time required for the stack drum to rotate to a predetermined position.

5. The method of controlling a bill processor according to claim 4, wherein the detection of the rotation position is performed by a carrier switch, and the detection of the load characteristics is carried out by measuring the time from the change of the carrier switch from OFF to ON until the change of carrier switch to OFF again.

6. The method of controlling a bill processor according to claim 5, wherein the power feeding to the stack motor is stopped after a lapse of the feeding time determined by the feeding time determination means from a time point when the state of the carrier switch is changed from ON to OFF.

