Automatic Postal Parcel Turning Machine Experimental System Design

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Abstract. Automatic postal parcel turning machine experimental system has a design background that the parcel automatic sorting needs postal parcel automatic turning. It is the multidisciplinary integration of mechanical, electronic and computer technology. The article describes how the experimental system mechanism design, interface design and control system design are carried out.

Introduction

Automatic parcel turning machine is automated production equipment that is the integration of the optical, mechanical and electronic technologies. It is one of the logistics equipment that is often used in the postal industry. In this paper, taking the practical application of automatic postal parcel turning machine as the background, a set of automatic postal parcel turning machine experimental system is designed. In postal sorting processing center, delivered parcels are needed to meet the requirement that parcel stamp surface is up so that the postmark and automatic sorting by zip code can be carried out in the actual operation. Automatic postal parcel turning machine experimental system is composed of turning machine mechanism, interface circuit and control system hardware and software. Since the coating of the stamps can irradiate under the UV light, a rectangular parcel model with black and white surface can be used to simulate the postal parcel. The rectangular parcel model white surface which is reflective presents the stamp surface, and the rectangular parcel model black surfaces which are non-reflective present the non-stamp surfaces.

Automatic Postal Parcel Turning Machine Experimental System Mechanism Design

Automatic postal parcel turning machine mechanism is mainly composed of parcel feed chute, transferring mechanism, flipping mechanism, parcel sending out mechanism and detection device as shown in Fig.1.

Parcel Feed Chute. Taking the method that the parcel automatically slides to the conveyor belt, the inclined parcel feed chute is designed in the front of the conveyor belt. The parcel are placed on the inclined chute and automatic sent into the conveyor belt. Then the conveyor belt sends the parcel to the flipping station. The side of feed chute is installed with stroke switch K0. It is used to start the whole automatic postal parcel turning machine experimental system.
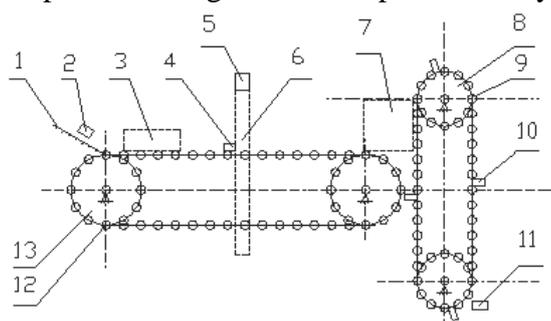

Fig.1 Automatic postal parcel turning machine experimental system mechanism
1.feed chute 2.start switch K0 3.send out mechanism 4.position detection phototransistor T1

5.surface detection phototransistor T2 6. gantry 7.parcel model 8.flip sprocket 9.flip chain 10.poke block 11.stroke switch K4 12.transmission sprocket 13.transmission chain

Transfer Mechanism. The transfer mechanism is mainly composed of the conveying belt, the drive motor M1 and the reduction gear device. By controlling drive motor M1 steering the conveyor forward and reverse transmission can be realized. The output shaft of the reduction gear device is installed with a pulse generating switch K3. At each time when the conveyor belt moves a distance of 1cm, a pulse is generated by the switch K3. Then the conveyor moving distance can be determined by the control system according to the number of pulses generated.

Flip Mechanism. The flip mechanism is a vertical sprocket chain drive mechanism installed with the parcel poke block. The sprocket drive motor M3 drives the sprocket through reduction gear device. Then the sprocket drives the poke block on the chain to make the parcel flip. The parcel can abut flip chain and the parcel will not be out of the poke block due to the continuous movement of the conveyor belt. Thus the parcel completes flipping a face. The flip station is installed with stroke switch K4. When the parcel flips a face, the stroke switch K4 produces a pulse.

Send out Mechanism. Send out mechanism is mainly composed of chute, push rod drive motor M2, reduction device, rack and pinion mechanism and push rod. When the drive motor M2 runs forward, rack and pinion mechanism drive the push rod to push the parcel outside and then a signal will be sent out by limit switch K1. When the push rod retracts to the original limit position, the limit switch K2 is pressed and a return signal is sent out.

Parcel Location and Surface Detection Device. Location and position detecting device are installed on a gantry. One side of the gantry is installed with horizontal light source L1, and the other side with a phototransistor T1. When the parcel blocks the light, the phototransistor sends out a signal that detection position is reached. A vertical light source L2 and a photodiode T2 are installed at the top of the gantry. The vertical light source emits light. When the parcel black surface is facing up, it is non-reflective, so the phototransistor T2 is not turned on. When the parcel white surface is facing up, it is reflective, so the phototransistor T2 is turned on.

Workflow. At beginning, the parcel slide along the feed chute to the conveyor and the start switch K0 is triggered, two lights sauces L1, L2 emit and motor M1 runs to transfer the postal parcel forward. When parcel is conveyed to the position that the light from the source L1 to the horizontal phototransistor T1 is blocked by the parcel, then a position signal is generated. The parcel continues to be fed forward to a place just under the detection device which is installed at the top of the gantry. Then phototransistor T2 starts to detect and detection will has two results: (1) The parcel white surface which presents the stamp surface is facing up. In this case the motor M1 will rotate reversely so that the parcel is transmitted back just to the exit of the sent out mechanism. Then motor M1 stops immediately and motor M2 runs to push the parcel outside, at same time the limit switch K1 is triggered. Then motor M2 rotates reversely and the push rod retracts to the original limit position, and a signal is sent out by limit switch K2. (2) The parcel black surface is facing up. In this case the motor M1 rotates so that the parcel is transmitted to the flip station. Motor M3 begins to rotate and the parcel is flipped by the poke block and conveyor. The parcel flip a face, the stroke switch K4 close once and produces a pulse. Then motor M3 stops and the motor M1 rotates reversely, and the parcel is fed backward to a place just under the detection device which is installed at the top of the gantry. Then phototransistor T2 starts to detect. If the parcel black surface is facing up, the parcel will be transmitted to the flip station and be flipped again until the parcel white surface is facing up. If the parcel white surface is facing up, the parcel will be transmitted back to the exit of the send out mechanism to push the parcel outside. After that, automatic postal parcel turning machine completes a work cycle and waits for next parcel enters the system.

Automatic Postal Parcel Turning Machine Control System Design.

In the system, there are seven input signals that are K0-K4 and T1-T2, and seven output signals that are M1+, M1-, M2+, M2-, M3, L1 and L2. A single-chip microcomputer STC12C5A60S2 is used for main control unit. Encoding is required for the operations to be complete and then control

word coding table is established. When parcel turning machine will act more than two actions at the same time, the corresponding action code can be added to obtain two or more corresponding actions. For the control signal input, the corresponding control words are also needed to be listed. The MPU reads the input status through the input port and make comparison with the coded word in the operation control table to determine the state of the limit switch and phototransistor. If there are two or more switches and phototransistors act at the same time, the input ports need to do shielding and then check the coding table.

Tab.1 control signal input and output port and control word

Symbol	significance	port	control word
K0	parcel enter the start	P13	08H
K1	push rod limit	P14	10H
K2	return limit	P15	20H
K3	pulse count	P16	40H
K4	number of turns	P17	80H
T1	parcel location detection	P10	01H
T2	parcel positive detection	P11	02H
M1+	conveyor drive motor	P01	02H
M1-	conveyor drive motor reversal	P02	04H
M2+	push rod drive motor	P03	08H
M2-	push rod drive motor reversal	P04	10H
M3	flip station drive motor	P00	01H
L1,L2	light sources	P32	04H

The control procedure is designed in accordance with the workflow previously described. A pulse count subroutine is designed for the cumulative number of K3 pulses, with the number of pulses different positioning of the conveyor can be calculated.

Automatic Postal Parcel Turning Machine Interface Design

Interface part is mainly composed of motor reversing control relays and power amplifier. It is important to avoid the error which a motor is asked runs both forward and reverse in programming at same time. This mistake will cause short circuit. So the motor reversible protection hardware interlock relay contacts are designed in the interface part. Since the port output current is very small and the relay can't be driven directly, power amplification is needed. The control system hardware is shown in Fig.2.
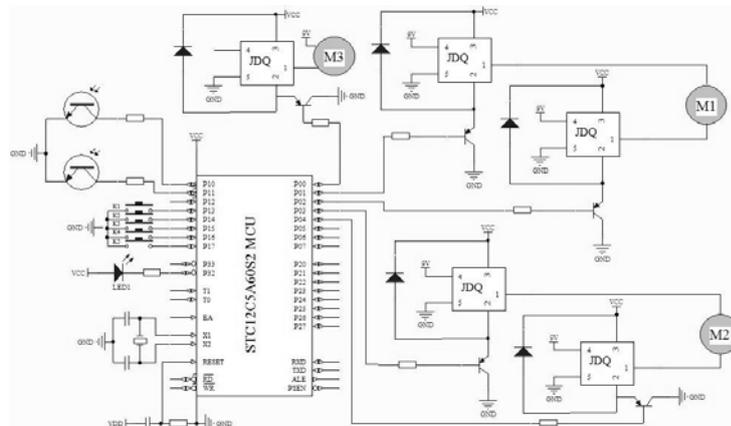

Fig.2 Automatic postal parcel turning machine experimental system control system hardware.

Conclusion

Through the understanding and use of the automatic postal parcel turning machine experimental

system, students can master the basic knowledge of mechatronics system, and good experimental content is increased to the mechatronics course. As automatic postal parcel turning machine experimental system is designed for the mechatronics experimental course, there is a distance from its actual use in the postal industry. Many practical factors should also be considered in different practical applications. The control system will be easier and the reliability will be improved when PLC is selected as the main control unit.

Acknowledgement

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