

DESIGN AND IMPLEMENTATION OF PLC BASED ITEM COUNTING SYSTEM

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Abstract

The item counting system is mainly used for packaging and manufacturing operation in the factory. The process is automatic and continuous operation. The control design of the item counting system is the type of the photoelectric sensor feedback control system. It is one of requirement machine of the product packaging factory. The main idea of the project is to design and fabricate a small and simple conveyor belt system, and automate the process for packaging small cubic pieces into small paper box. KincoK205-16DR PLC was used to control and automat the system by ladder logic diagram software. In addition, the results obtained show that the system able to decrease product time and increase product rate as compared with traditional manual system. Nowadays, this item counting system is widely used in many packaging factories.

Keyword: Kinco K2 series PLC, Photoelectric sensor, 12V DC Gear motor

1.INTRODUCTION

This machine is designed to count each item during manufacturing to ensure that each package has the correct amount. The machine can also be used in different types of items. Automatic item counting machine proposes the idea of fast and efficient counting of item without human. This machine is no spending so much time by human.

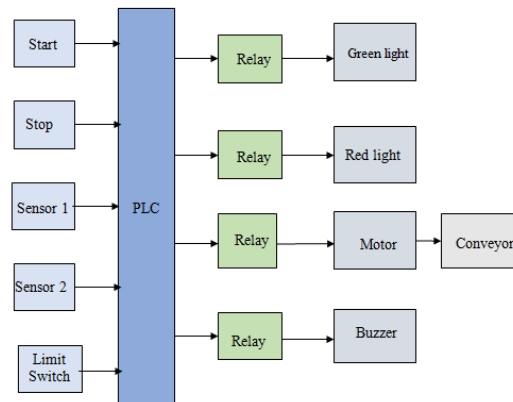


Figure 1. Block Diagram of the Item Counting System

In this system mainly consists of photoelectric sensors, Programmable Logic Controller (PLC) and 12V DC Gear Motor. Photoelectric sensors were used to provide the information to the controller. Electrical DC gear motors used as output actuators for the system to move the conveyor belts after get the orders from the control system. The sensors used to feed the control system by system information. Conveyor belt is used for transporting samples from location to another one, which would be packaged into a specific paper box later. The hardware system is controlled by Kinco-K2 series PLC device. Ladder Diagram is used for counting system by KincoBuilder software. The block diagram of the proposed system is shown in Fig. 1, which consists of five inputs (push buttons, two photoelectric sensors and limit switch) to provide the control by the system state. Also, the system consists of four outputs (12V DC gear motor, indicators and buzzer).

2.SENSOR SECTION AND PLACEMENT

In the prototype, the CDD11N photoelectric sensor is placed at the under of upper belt to sense and count the items before dropping them in the box. Fig. 2 shows the placement of photoelectric sensor.

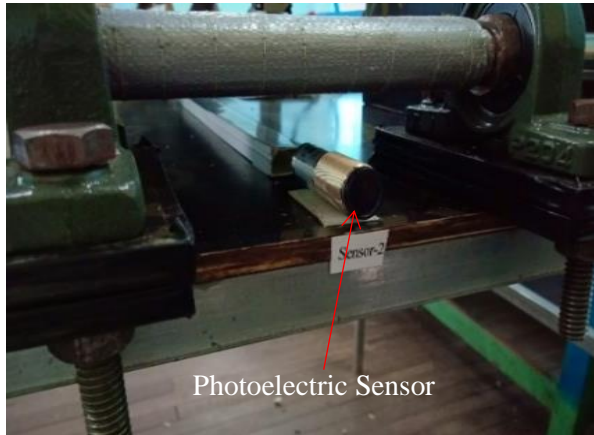


Figure 2. Placement of CDD11N Photoelectric Sensor

E3JKDS30M1 photoelectric sensor was installed beside the lower conveyor belt and in front of the particular upper belt to sense the coming boxes of the items for packaging. Fig. 3 shows the placement of photoelectric sensor.

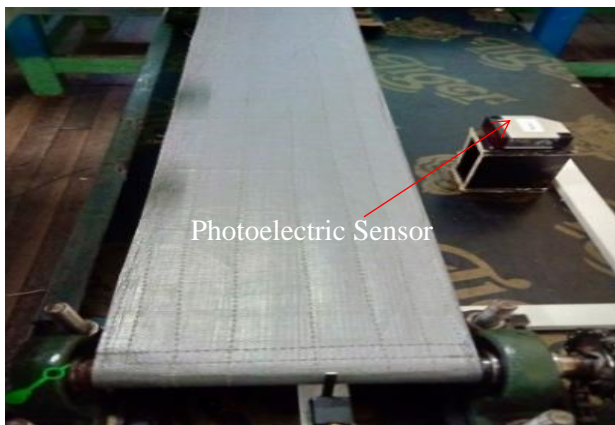


Figure 3. Placement of E3JKDS30M1 Photoelectric Sensor

2.1. Start and Stop of the System

To start the conveyor, the operator presses the start button. This provides power momentarily to a relay coil. As long as the relay is energized, the circuit is complete and power is provided to the conveyor. This button is

must for safe and reliable operation of conveyor. To stop the system manually the same switch is opened and the whole system then terminates, this action is done by using the stop instruction which is activated by opening the manual switch. The stop instruction causes a transition in the PLC from RUN mode to STOP mode there by terminating the whole process.

For the system to Stop automatically a counter is assigned to count the number of items existing through conveyor1, when this counter reaches a predetermined value, it activates the STOP output. The counter was set to activate STOP when three items were counted, the counter itself was incremented with each reading of the photoelectric sensor. In the program the counter is first reset by manual switch and incremented by photoelectric sensor. Fig. 4 shows to start and stop the system manually condition.

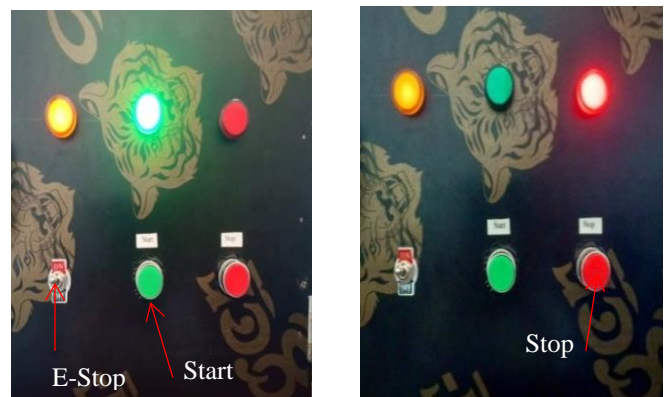


Figure 4. Start and Stop Button

Emergency stop (E-stop) button is an important safety component of many electrical circuits, especially those that control the hazardous equipment such as gas pumps, moving machinery, saws, mills, and cutting tools, conveyor belts and many other types of equipment. They are designed to allow an operator or bystander to stop the equipment in a hurry. Fig. 4 shows E-stop button.

2.2. Design of DC Gear Motor

DC gear motors provide very precise control. DC gear motor can be used for driving the conveyor belt. As shown below Fig. 5, two DC gear motor were installed on the project; one of them mounted with a pulley to

rotate the upper conveyor belt and the other one, mounted with a pulley to rotate the lower belt.

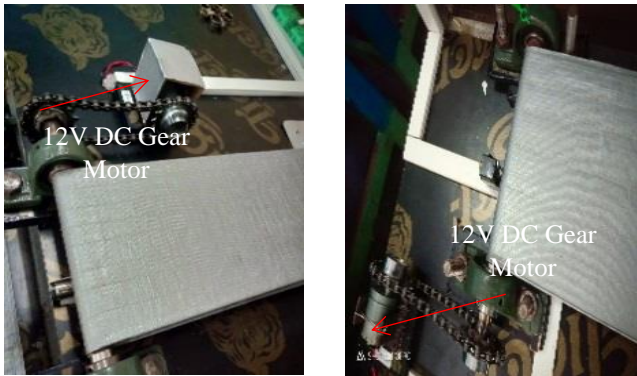


Figure 5. 12V DC Gear Motor

The two motors used to do next tasks:

- The lower motor starts first to bring empty boxes at desired position.
- The upper motor starts after the box reach desired position, to bring some stamped items for packaging into the box.

2.3. Design of Conveyor

The conveyor belt (88 x15cm) used here consists of two wheels on which the belt moves. Also, the lower conveyor belt (88 x 17cm) has been used. There is the continuous loop of the material over the rotating wheels. One of the wheels called the driver wheel is powered by the motor and other unpowered wheel is called idler. This leads to the movement of the conveyor belt that is used to carry the object over it. Fig. 6 shows two conveyor belts in this project.

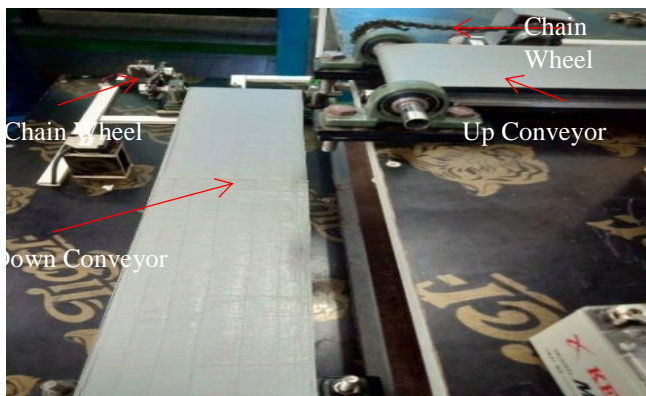


Figure 6. Two Conveyor Belts

2.4 Design of Limit Switch and Buzzer Section

A limit switch is used for controlling machinery as part of a control system, as a safety interlocks, or to count objects passing a point. A limit switch is an electromechanical device linked to a set of contact. A micro switch is used for this system. Micro switches are useful for detecting passage of a moving part or for implementing an electronic limit stop. The switch contains three contacts, which are known as C for Common, NC for Normally Closed and NO for Normally Open.

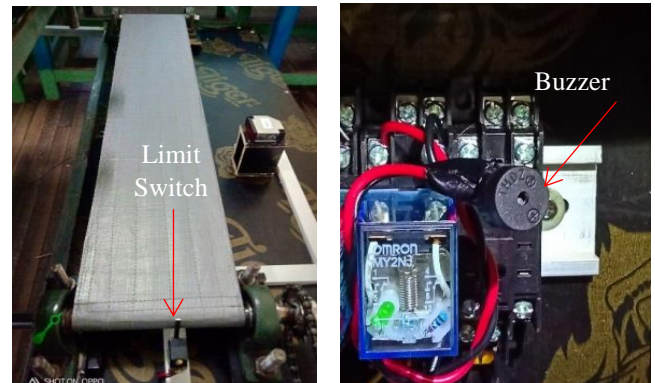


Figure 7. Design Section of Limit Switch and Buzzer

It is placed at the top of lower conveyor belt to detect the coming block boxes of the items for packing. When limit switch is detected moving box, the buzzer will cause the alarm to sound. Fig. 7 shows design section of limit switch and buzzer.

3. OPERATION OF THE ITEM COUNTING SYSTEM

Fig. 8 shows that the overall flowchart to complete the system from the beginning to the end. The item counting system is controlled by Kinco K205-16DR PLC and the control program is written by KincoBuilder software. When the start button is pressed on, the system starts running by moving the conveyor belt by DC gear motor which carrying and bring the empty box. Once an empty box reaches in front of the second photoelectric sensor, the sensor will activate and send signal back to the PLC to stop the conveyor belt moving.

And then, the first photoelectric sensor used to count the items, while packaging, when the box fill by three stamped samples, the sensor gives information back to the PLC to stop the upper conveyor belt and bring another empty box to package it. After the photoelectric sensor count three stamped items, the upper conveyor belt stop moving and the lower conveyor start moving to carry the filled box away with one second delay time. A delay time is set for each sensor sensing action. Then, when limit switch is touch the filled box on moving conveyor, it informs to the PLC and buzzer generates a sharp sound.



Figure 9 (a). Results for Push Buttons and Pilot Light

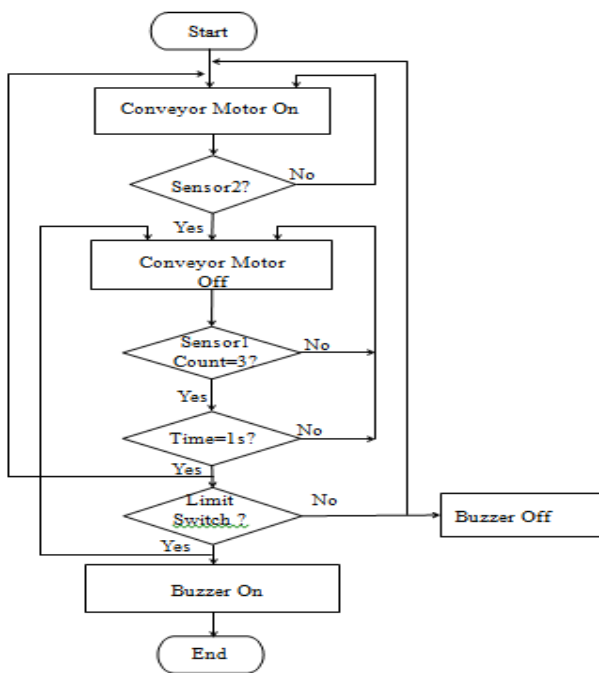


Figure 8. Flow Chart of the System

4. TEST AND RESULT FOR POWER SUPPLY AND PILOT LIGHT

When AC220V is supplied to the system, yellow light is on and the Kinco 24V power supply gets the power. And then, the start button (I 0.0) is pressed to start the system. Fig. 9 (a) shows result for power supply and pilot light. Green light (Q 0.0) and conveyor motor (Q0.2) are turned on simultaneously on. Simulation result for power supply and start conditions is shown in Fig. 9 (b).

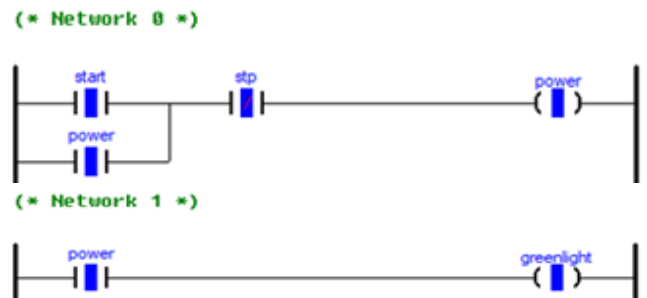


Figure 9 (b).Simulation Results for Start State

When stop button (I 0.1) is pressed, red light (Q 0.1) on and the 220V power supply to the system will be cut off. Fig. 10 shows the simulation results for stop state condition.

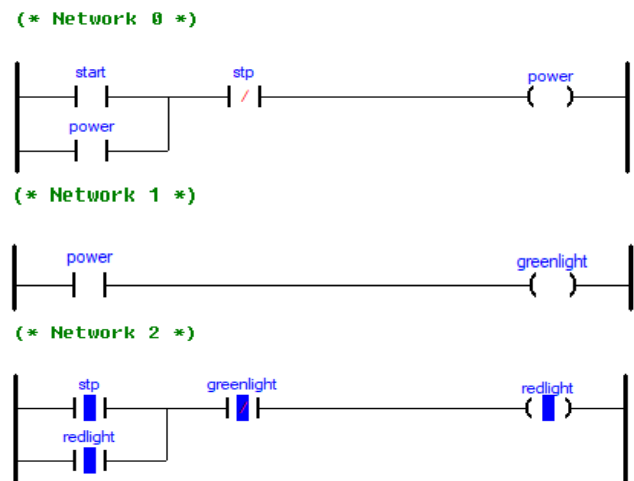


Figure 10.Simulation Results for Stop State

4.1. Test and Results for Second Sensor and Conveyor Motor

The running conveyor (Q 0.2) carries the items and when the items reach in front of the second sensor (I 0.3), the second sensor senses and then the conveyor stops. Fig. 11(a) and Fig. 11(b) show the simulation result and hardware result for second sensor sensing state.

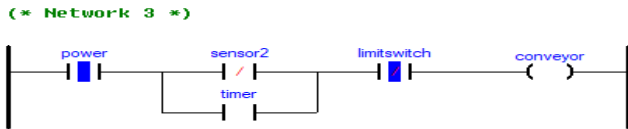


Figure 11 (a). Simulation Result for Second Sensor Sensing State



Figure 11 (b). Hardware Result for Second Sensor Sensing State

4.2. Test and Result for First Sensor Sensing State

And then, the first sensor (I 0.2) starts sensing the crossing items. But the conveyor (Q 0.2) is still stopped. The first sensor counts three items by sensing and informs to the PLC. Fig. 12 (a) and Fig. 12 (b) show the simulation result and hardware result for first sensor sensing until count three times condition.

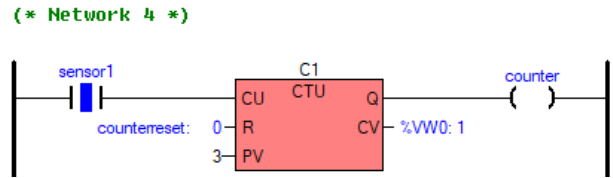
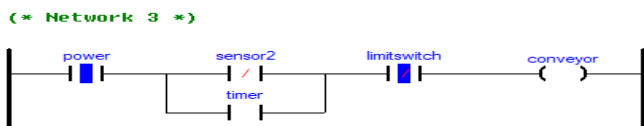


Figure 12 (a). Simulation Result for First Sensor Sensing until Count Three Times State



Figure 12 (b). Hardware Result for First Sensor Sensing State

After counting three items, there is needed to wait to complete time delay two seconds. And then, the conveyor runs again. Fig. 13 (a) and Fig. 13(b) show the simulation result after counting three times and waiting for one second delay time.

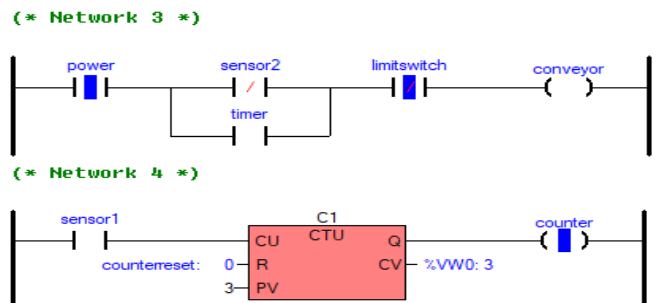


Figure 13 (a). Simulation Result after First Sensor Counting Three Times

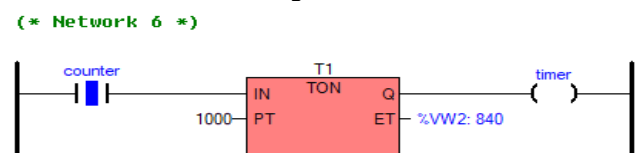


Figure 13 (b). Simulation Result for Timer Timing State

After one second delay time, the conveyor motor runs again. Fig. 14 show the simulation result after waiting time delay.

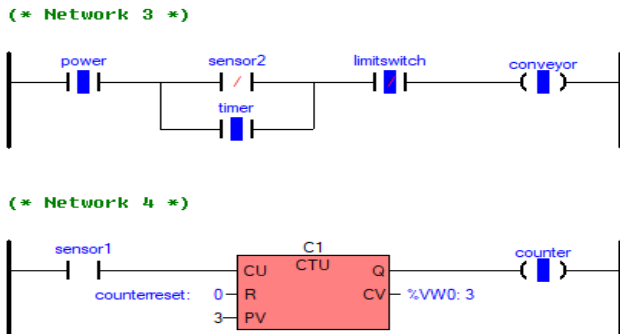


Figure 14 (a). Simulation Result after Time Delay

4.3. Test and Result for Limit Switch and Buzzer State

When the conveyor runs again, the filled box reaches at the end of conveyor and touches with limit switch. Then, the limit switch (I 0.4) informs to the PLC and the conveyor stops again. Also, the buzzer (Q 0.3) rings simultaneously. Fig. 15 (a) show the simulation result for limit switch and buzzer condition. Hardware result for limit switch touching state is shown in Fig. 15 (b).

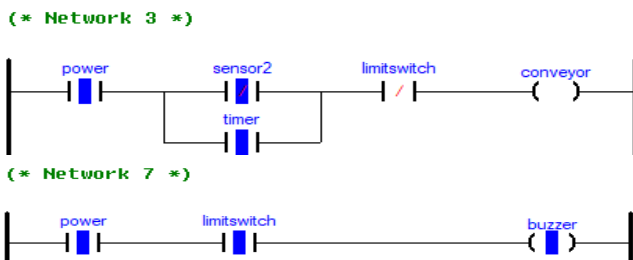


Figure 15 (a). Simulation Results



Figure 15 (b). Hardware Result for Limit Switch Touching State

5. DISCUSSIONS AND CONCLUSION

The item counting system can gain accurate result and able to use both for the small scale for industries and for complicated production line. Food packing process, tablets counting and bottle filling process etc: are some examples which are controlled by PLC. PLC program can arrange plan systematically. One of the most popular PLC program is Ladder diagram program. It is easy to write the program with electronic and electrical engineer sense. As the stamping and item counting system is controlled by Programmable Logic Controller, so, time and human energy can be saved and human energy can be reduced because of automation. And, this system has high effectiveness and accuracy.

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