Automatic Packaging Line Control System Using PLC

Thin Thin, Yu Yu Mon Win

Abstract— This system uses of programmable logic controller in automation industry for packaging process. The main idea of the system is to design and fabricate a small and simple conveyor belt system, and automate the process for packaging apple samples into small plastic box (5 × 3.5) inches. IR sensors were used to detect the information to the controller. Gear motors used as output actuators for the system to move the conveyor belts after get the orders from the control system. Programmable logic controller Mitsubishi FX2n-10MT was used to control and automate the system by ladder logic diagram and Mnemonics codes. The experimental result of the prototype shows that the machine was done to package 3boxes in one minute. In addition, the counting samples will show on human machine interface or HMI.

Keywords— IR sensors, Conveyor, Gear Motors, PLC, Mitsubishi FX2n-10MT, HMI.

1 Introduction

THe industry information becomes the global trend in manufacturing, packaging process is one of the most used in industry; more and more are switching to automation. This system is about design and fabricate an automatic packaging machine system. Electrical DC motors control were used as actuator for the entire process to move the upper and lower conveyor belts, and sensors used to feed the control system by system information. Conveyor belt used for transporting samples from location to another one, which would be packaged into a specific paper box later. The control system for the hardware is to be control by the Mitsubishi FX2N programmable logic controller (PLC) device. Ladder logic diagram for programmable logic controller were used for control the actual prototype for the experimentation. The whole system executes to package apple samples into paper boxes. Finally, the prototype with system controller were successfully done to package.

2 Block DIAGRAM

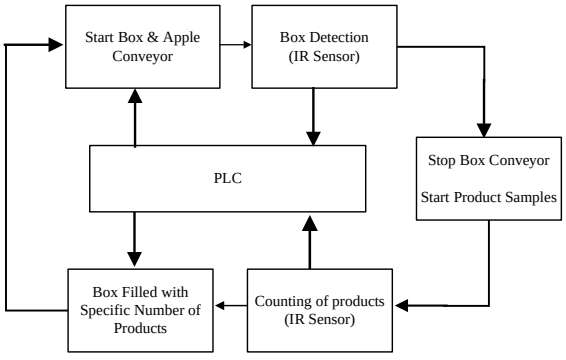

Fig. 1. System Block

3 Hardware components required

Components that are used in this system are belt conveyor, gear motor, IR sensor, power supply, OP320-A (HMI Display), Mitsubishi FX2n-10MT.

3.1. Belt Conveyor System

A belt conveyor consists of two or more pulleys, with a continuous loop of material – the conveyor belt that rotates about them. One or both of the pulleys are powered, moving the belt and the material on the belt forward. The powered pulley is called the drive pulley while the unpowered pulley is called the idler. Figure.2 shows belt conveyor system.

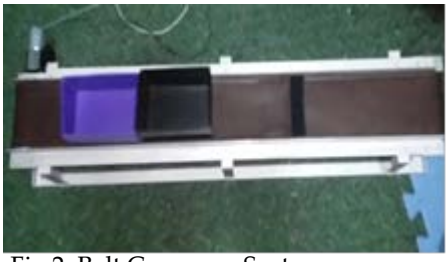

Fig.2. Belt Conveyor System

3.2. Gear Motor

A gear motor is a specific type of electrical motor that is designed to produce high torque while maintaining a low horsepower, or low speed, motor output. Gear motors can be found in many different applications, and are probably used in many devices in home.

Fig. 3. 12V, 20 rpm Gear Motor

3.3. IR sensor (Inf

IR sensor is t produces in order to detect some n infrared sensor can measure the hea tects the motion.

Fig. 4. Adjustable Infrared Sensor

3.4. Power Supply System

Two types of power supply circuit are used in this system. One is for using supply for programmable logic controller, the operating voltage is 24V. Second is for feeding conveyor driving motor, all sensing devices, it is normal operating voltage is 12V.

(a) (24V, 5A) (b) (12V, 5A)

Fig. 5. Power Supply

3.5. OP320-A

OP320-A is a display unit as shown in Figure 6. This display has the specialties as follows:

- 20 keys can be defined as function keys (12 of them can be defined as digital keys and for other use), and they can substitute some machine buttons on the control table
- Choose the communication format freely, RS232/RS422
- LCD display with backlight STN. It can display 24 characters × 4 lines, i.e. 12 Chinese characters × 4 lines.

Fig. 6. OP320-A Display

3.6. FX2N 10MR

FX2N can support float point instruction. FX2N has many series. They are FX2N 10MR, 10MT, 40MR, 40MT etc. This system uses this model that FX2N 10MR 2AD EN10-T61-R-2N2AD 6 input and 4 relay output board two analog inputs (0-10V). Figure.7 shows FX2N 10MR.

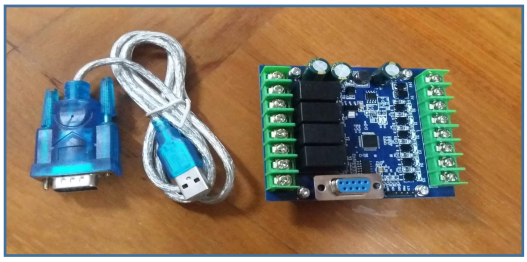

Fig. 7. FX2N 10MR

4 Implementation

To implement for this system, there are three general parts: PLC wiring, Ladder diagram and HMI Display.

4.1. Wiring of PLC

Step (1): The system starts running by moving the lower belt conveyor by Gear Motor (Y1) which carrying and empty boxes. When the empty box reaches the IR sensor (X2), the IR sensor (X2) will activate and send signal back to the OLC to stop the lower belt conveyor moving. In this time, the system starts running and also HMI screen shows ON signal to run conveyor. Although HMI describes ON for lower belt conveyor moving.

Step (2): The box reaches the desired location, the lower belt conveyor stops moving and the upper belt conveyor start moving. Upper belt conveyor starts to bring the apples one by one and drop them into the box. This operation running until five apple samples. The IR sensor (X3) used to count the apple samples. When the box fill by five samples, the upper conveyor belt stop moving and the lower conveyor start moving to carry the filled box away and bring another empty box to package it with an other five samples.

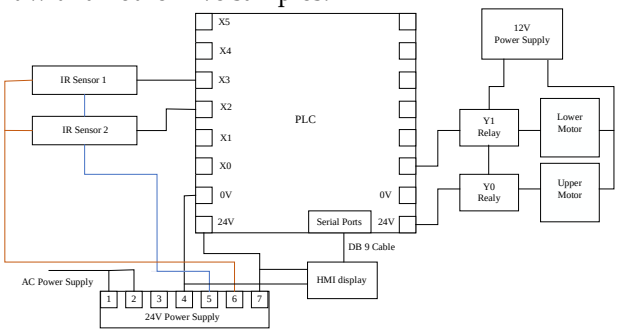

Fig. 8. Wiring of PLC

4.2. HMI Display Result

RUN is used to start the motors of two conveyors. RESET means to stop the two conveyors motors. Conveyor 1 is used for apple conveyor. Conveyor 2 is used for box conveyor. Setting can be changed specific numbers for counting. IR Sensor of apple conveyor can detect apple samples. And then HMI counts the apple samples.

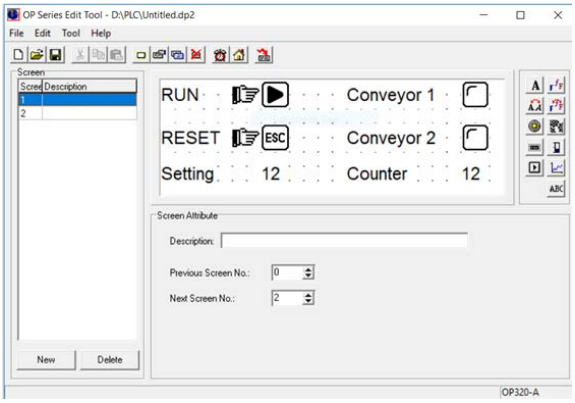

Fig. 9. HMI Display Result

4.3. Ladder Logic Diagrams of Packaging Line Control System

Programmable logic controller Mitsubishi FX2N-10MR was used to control and automate the system by ladder logic diagram software. X0 uses as main switch to start up and X1 uses as main switch to turn off the packaging system. Figure.10 shows ladder diagram detecting boxes and counting of apple samples on the conveyor belt by using the reference system (PLC). X3 is used to count the dropped apples during packaging process. Figure.11 shows ladder diagram of the counting system.

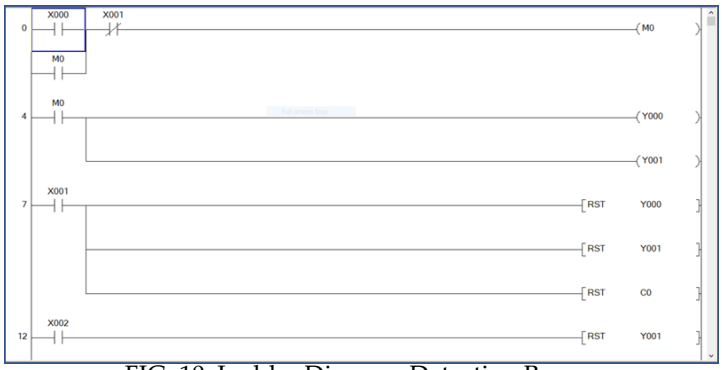

FIG. 10. Ladder Diagram Detecting Boxes

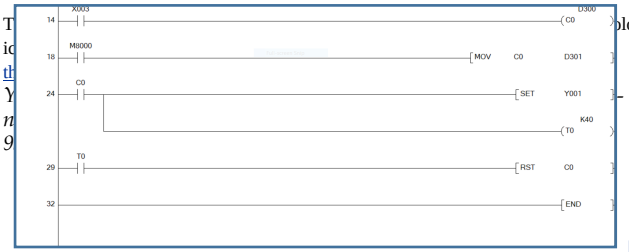

FIG. 11. Ladder Diagram of Counting System

Start (X0)/ Stop (X1): X0 uses as main switch to start up and X1 uses as main switch to turn off the packaging system.

- ❖ IR sensor (X2): This sensor has two main missions, the first one is to detect the empty boxes as arrival at the desired location, the second one is to stop the lower belt and activated the upper belt to drop the samples into the box.
- ❖ Lower Motor (Y1): It is responsible for the movement of the lower conveyor belt, to bring empty boxes in sequence to the desire location.
- ❖ IR sensor (X3): It used to count the dropped apples during packaging process.
- ❖ Upper Motor (Y0): It is responsible the movement of the upper conveyor belt, to bring the apple samples in sequence to packager them into the box.

5 TESTS AND RESULTS

5.1 Implementation Results of Packaging Line Control System

Figure.12 and 13 show the system running and detecting box for packaging system. Figure.14 shows the counting of sequential order of apple samples.

Fig.12. Running System

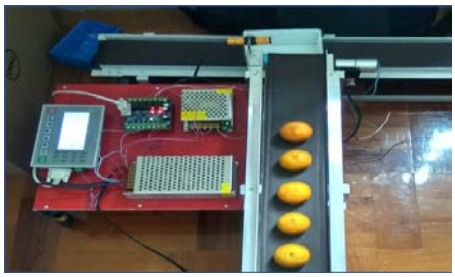

Fig.13. Detecting the Box

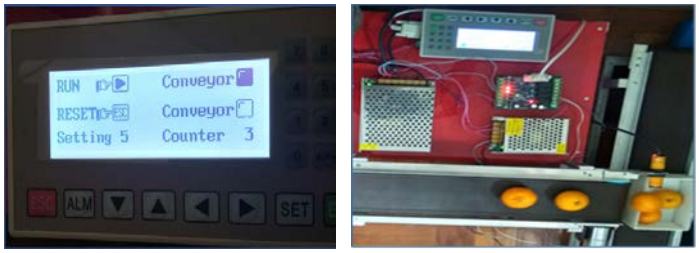

Fig.14. Counting System

5.2. System Product Rate

The experimental results for the manual operation show different products rate as shown in Table 5.1. below.

Table 5.1. System Product Rate

Product Time	Manual Packaging
One Minute	3boxes
One Hour	180boxes
One Day (8 working hours)	1440boxes
One Week (5 Working days)	7200boxes
One Month	288800boxes

6 Conclusion

An automated packaging machine prototype using PLC Mitsubishi FX2N has been successfully design, constructed and implement based on control system concepts. Mitsubishi ladder diagram applied for the programming and operation of the presented prototype, in which the operation is passed through two stages, carrying empty boxes to desired location, and packaging the samples into the boxes. The experimental prototype teste to improve the automation processes with the use of the PLC ladder diagram. The packaging prototype was done to package five apple samples per a box in very short time. From the experimental result, the automatic packaging machine was able to package 16 boxes per one hour.

- Improves product protection
- Improves works safety
- Improves housekeeping
- Improves space utilization
- Improve environmental impact

While packaging can do a lot to get customer attention, and may even add value to product, it also adds to the cost of production and the eventual retail price. According to know this, packaging can represent as much as 40 percent of the selling price of products in industries such as the cosmetic. New packaging can be expensive to develop, adding to the cost of products.

Acknowledgment

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