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Design and Implementation of Automatic Sorting System by Height Sensing using PLC Automation Control

I. Sai Pranita[1], G. Devamani[2]

[1] Visakhapatnam, 531162, India
[2] Visakhapatnam, 531162, India

ABSTRACT :

With the development of processed food industry, there is increase in processed food where the food is been packed and supplied to the end consumers. The number of high-rise buildings is increasing, more and more high rise-buildings come into our life and the elevator has become an important part in our life. As same as elevator we had conveyor belt in the processed food industry as well. The conveyor belt has also been most important part in industry. The Automatic sorting system by height sensing and use of PLC automation control, so that the processed food belt can be easily identifies, if any processed food is out of the line or out of the preset height which help the food processing industry. The purpose of this paper is to introduce the relevant situation of the system for readers to understand. This paper mainly focuses on the sorting system on the conveyor belt in processing units, which helps in sorting and elimination of the faulty product on the line of processing.

Keywords: PLC; Height Sensing; Automatic Sorting System; Proximity Sensor; Conveyor Belt

1. Introduction

As the processing industry has many conveyor belts in line. Not only the processing units, the conveyor belts are much needed in the many other manufactures industry units, where the products are assembled on the line of belt were there are many products. These products are sometimes defective and faulty too. So, these products were needed to be sensed and acknowledged when they were on the line of production. In the process of manufacturing units, the products needed to be monitored very keenly to ensure that the is no single product which is faulty or defective product are there on the line. The author describes about the products which are defective and faulty on the line to be sensed first before the final production. To make that ensure, there is need room for the PLC automation control, which can used to sensing the faulty product and acknowledges with an indication.

1.1. PLC Control System

The design of the automation sorting system using PLC automation control was implementation using PLC. The PLC control system means Programmable Logic Controller which is an essentially a computer for industrial operations. PLC is a kind of digital operation equipment special y designed for these industrial applications like conveyor belt operations and automation operations kind of. This device has memory to control which uses the program code to store and responds to the inputs accordingly to that memory code in it. PLC is enables for all types of industrial applications and internal operation s procedures and instructions accordingly. This PLC was invented in 1960s and invented by the mighty United States to replaces the relay system. The PLC control system was rapidly development in relay system in industrial application and in science and technology field as well. The current PLC is no longer limited to previous logical control and has also played an important role in the industrial application of and in motion control as well.

Sometimes this PLC can also be used as the motor speed control and motor input over and under voltages control as well. This PLC can also in medical sciences as well. So, PLC control is everywhere.

1.2. Design of Automation Sorting System of Height Sensing Based on PLC

The sorting machine drives the conveyor belt to transport the objects whether in food industry, automobile industry as well. This conveyor belt was driven by the electric motor which was powered by the electrical supply. The electrical motor drives the conveyor belt, on which the processed food or any kind of objects were placed. The driving forces was powered by the electric motor and this motor shaft was used as the connecting rods and there is also another motor placed on the other side which also has the connecting shaft. These both connecting rods acts as the supporters and there is belt

around the connecting rods of the electrical driving system. This belt was made of the either rubber or plastics sometimes. The conveyor belt has some measurements by which the loads or the objects weight are depending upon accordingly. The electrical motor which is driving the conveyor belt also plays the crucial role of the driving the belt. The below table describes about the weight management can be done on the conveyor belt according to the electrical motor ratings. Where the belt ratings were according to the thickness and weight manageable on it, therefore the weight of load on the belt can be increased. The measurements are mentioned below table 1.

Table 1 – Comparison of Belt Weight and Thickness.

Rating (N/mm)	Thickness (mm)	Weight (Kg/m2)
EP 400/2	3,5	4,4
EP 630/2	4,5	5,4
EP 800/2	5,0	5,9
EP 400/3	3,0	3,4
EP 500/3	3,5	3,7
EP 630/3	4,0	4,3
EP 500/4	3,8	4,9
EP 630/4	4,1	5,2
EP 800/4	4,5	5,5
EP 800/5	5,0	6,3
EP 1000/5	5,5	7,1
EP 1250/5	7,0	8,9

The conveyor belt selection in design of the system plays very important and crucial role. As the electrical driving sources which are motors, these motors are placed in a such a way that this belt is accumulated on the shaft of the electrical motors. The drive of the automatic sorting machine has an electrical gear motor in order to reduce the speed and increase the electrical torque of electrical motor. This high electrical torque motor which can have the capability to drive heavy conveyor belt.

The sensing element which is Proximity sensor has the ability to detect the objects which is near to it. The detection of automation sorting system mainly works on Proximity principle where it detects the presence of object which is near to it. This sensor changes the electrical parameter such as inductance or capacitance according to the type of the sensor used. There are few types of proximity sensor which are inductive and capacitive proximity sensors. So, due to the distance and the type of object to detect. This sensor entails that the dielectric constant of the object changes in capacitance when the object moves closer to sensor which depend mainly on the speed of the conveyor belt. This sensing element detects the object on the conveyor belt which exceeds the preset height of the objects on the conveyor belt.

1.3. Construction of Automatic Sorting System based on Height Sensing System

The conveyor belt was accumulated in between the electrical gear motors, where the objects would run on it. The PLC system executes the automation in which the relay would acts to the inputs given to the system. There are also the LED indicators to indicate the electrical motors are working or not. There is NC and NO switches which are used to give the input to the system. These switches will enable the signal to starts and stops the system. The proximity sensor mounted near the conveyor belt to detects the height of the objects on the conveyor belt.

2. Illustration of Automatic Sorting System

The Automation sorting system enables with the many types of sorting techniques. The sorting techniques depends on the cost and implementation procedures as well. The sorting can be implemented based on the weight of the objects, color of the objects, height of the objects. In this implementation the author concentrated on the height of objects sorting system. The height of the objects are detected with the help of the proximity sensor, the sensor sends the signals to the PLC control system, the PLC control system controls whole system eventually stops the conveyor belt. The proximity sensor was mounted near the conveyor belt, at a specified and preset height. This sensor once detects the object's height comes to contact with the proximity sensor, then this sensor would detect that the object is above the preset height. This is how the automatic sorting system would be illustrated. The automatic sorting system was implemented as shown below figure 1. The installation of the Conveyor belt system was shown in figure 2 where the electrical motors are accumulated with conveyor belt system and also housing of the conveyor belt system ensures that the products or objects not to fall behind the line of production.

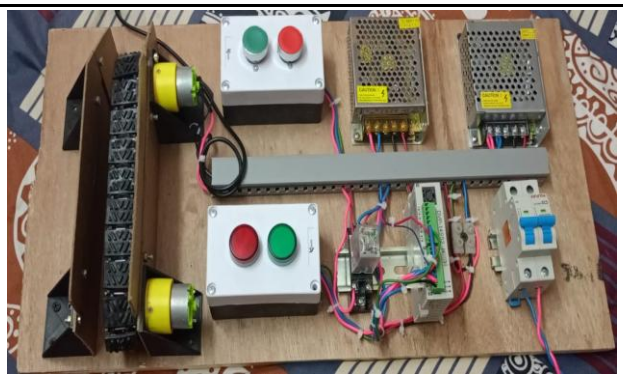

Fig. 1 - (a) Automation Sorting System

Fig. 2 - (b) Conveyor Belt System

3. Detection of Objects through Proximity sensor

The Proximity sensor is a vital sensor in industrial applications and medical and scientific applications as well. The proximity sensor detects the objects would rely on multiple types of detections like sounds, light, vision, color and also electromagnetic field. The sensor which used here in thesis is proximity sensor which basically relies on the capacitance parameter. The proximity sensor is a non-contact sensor, it differentiates the objects which are metallic or non-metallic. Basically, there are few types of proximity sensors which are inductive and capacitive sensor. The inductive proximity sensor detects only the metallic objects which is its limitation. While considering capacitive sensors are able to detect and identify metallic objects and as well as non-metallic objects as well. There is no limitation for the capacitive sensor that works irrespective of shape and form of the object. The material is detected by capacitive and two photo electric sensors placed at small and medium height then it is medium sized wood. The material is detected by capacitive and all three photo electric sensors then it is large sized wood. The material is detected by only one photo electric sensors placed at small height then it is small sized plastic.

The capacitive proximity sensor varies its own capacitance due to the nature of the object. The material is detected by capacitive, inductive and one of the photo electric sensors placed at small height then it is small sized metal. The capacitive proximity sensor has good range of detection which is approximately 3 – 60mm and these sensors are used in close range detection and also used for the non-ferrous materials and also can be used for metallic materials as well. These sensors target ed materials would be liquid, wood, granules and especially this sensor can detect objects through glass medium also. The material is detected by capacitive, inductive and two photo electric sensors placed at small and medium height then it is medium sized metal. The material is detected by capacitive, inductive and all three-photo electric sensor then it large sized metal. The material is detected by capacitive and one of the photo electric sensors placed at small height then it is small sized wood.

4. Conclusion and Future work

This paper proposes an efficient sorting system where the sorting system which is automatic and based on PLC was concentrated on the height sorting. The proposed methodology shows that the 100% accuracy in identification of material's height was successful, and this identification was also happened within less than 0.5 milliseconds time interval. The proximity sensor identifies the materials exceeds the preset height then it would stops the conveyor belt running on electrical motors. This work also proposed in terms of the automatic sorting system based on PLC automation would be more beneficiary to the processed units and also medical sciences as well. The Automatic sorting system by height sensing and use of PLC automation control, so that the processed food belt can be easily identifies, if any processed food is out of the line or out of the preset height which help the food processing industry. The purpose of this paper is to introduce the relevant situation of the system for readers to understand. The methodology also mainly focuses on the sorting system on the conveyor belt which ever are present in processing industries or textile industries also, which helps in sorting and elimination of the faulty product on the line of processing.

The Performance of this system can be enhanced by the implementation of the proposed system with help of detecting and sensing the objects on the line of conveyor belt, by inclusion of some more features. The features would enhance the proposed system, like detecting objects by means of color of object on the line of production, if the product or material is faulty color, then that particular product can be detected and removed from the line. The features would enhance the proposed system, like addressing the objects by means of shape of object on the line of production, if the product or material is foul in shape form, then that particular product can be detected and removed from the line. The features like detecting objects by means of weight of objects on the line of production, if the product or material is incorrect in weighing of the respective product, then that particular product can be addressed and removed from the line.

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Appendix A. Principles of ladder diagram for Delta PLC

The WPLsoft is a software which is used to develop the ladder diagrams. The ladder diagram is a graphical programming language used for programming PLCs (Programmable Logic Controllers). It is based on the principle of electrical ladder diagrams used in relay-based control systems. A ladder diagram consists of two vertical rails, which represent the power supply, and horizontal rungs, which represent the controlled logic. The structural switches are represented in tabular form figure (1) below.

Structure	Explanation
	Normally open, contact A
	Normally closed, contact B
	Normally open in series connection
	Normally closed in series connection
	Normally open in parallel connection
	Normally closed in parallel connection
	Rising-edge trigger switch
	Falling-edge trigger switch

Fig. 1 - (a) Structures of Ladder diagram

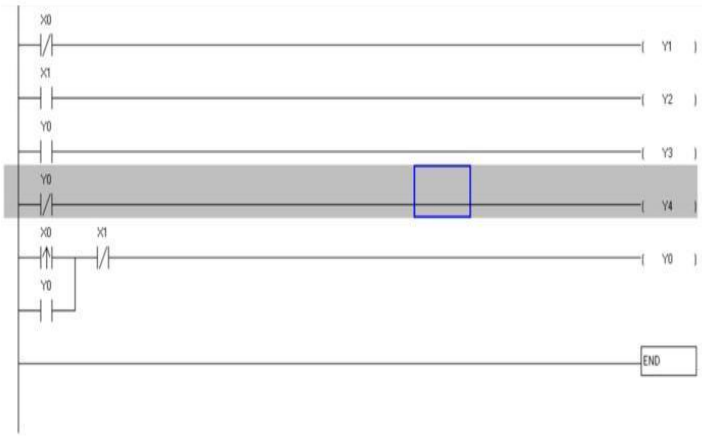

Fig. 2 - (b) Proposed System's Ladder diagram

The Proposed system has the ladder diagram logic which is stored in the PLC memory as shown above in figure(2). The first line consists of NC switch used to start the system with respective Y1 is output. The second line consists of NO switch used to Stop the system with respective Y2 is output. The third and fourth lines consists of outputs. Fifth and Sixth lines consists of rising edge trigger and NC switch which proximity sensor. When X0 is pressed the system would start and X1 is used to stop the system by means of proximity sensor.

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