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Automatic Metal Separation and Packaging Using PLC

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ABSTRACT- In this work is to design, develop the programmable logic controller based Metal Separation and Packaging. This work will provide high accuracy and flexibility to the system and at the same time it will provide accurate amount of material in box by saving operational time. In this work, a prototype has been designed. The system sequence of operation is being designed by ladder diagram. Components used in this work are programmable logic controller (PLC), proximity sensor, DC Motors.it consist of three sections; the primary conveyor, the secondary conveyor and packing section. The mechanical part of the project consists of mechanical drawing, measuring, welding and fabricating process, while electrical part consists of electrical drawing; electrical wiring and programming.

Keywords: PLC, Proximity sensor, Conveyor, DC motor.

I. INTRODUCTION

The use of PLC is a major factor. A digital computer used for automation of typical industrial electro-mechanical processes such as control of Machinery on factory assembly lines, amusement rides or light fixtures. The PLC is the main controlling unit & dc motor controls the conveyor belt. To accomplish this system, Dc motor, load cell, Photo-sensors are used [1]. The purpose of this project is to segregate the metal and nonmetal waste for the industrial and domestic use. Due to the environmental aspect as well as increasing prices for raw materials, scrap separation is a global topic and also the business model of the future. The advantages of scrap separation system are to improve the results in energy savings, better environmental performance, minimize raw materials wastage and reduce manufacturing costs. Automation is the use of control system and information technologies to reduce the need for human work in the production of goods and services [2]. Packaging is a stage that is important because to make product safe and good in condition. PLC is a digital electronic device that uses a programmable memory to store instruction. It scans memory, input and output in determined manner. Packaging machines are machines that complete stages of the packaging process. Food packaging is packaging of food. Filling machines are also used for packaging, mainly for food/beverage but for other products as well. This paper will help to try to help and improve the packaging system to make the process run systematic and make the product good in condition [11]. 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 (2 × 1.4 × 1) cm3 of wood into small paper box (3 × 2 × 3) cm3. Inductive sensor and photoelectric sensor were used to provide the information to the controller. Electrical DC 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-32MT was used to control and automate the system by ladder logic diagram software [10]. High degree of flexibility is basic requirement of manufacturing. Industries face many other challenges like continuously increase in the production volume and reduction in the cost. Also industries need to operate safely. In older systems as there will be continuous increase in production also Increases, the maintenance cost. So the manufacturer face problem as higher cost, high downtime and unsafe operation. New technologies are required that will reduce

water usage, increase energy efficiency and minimize downtime in high-speed separation & packing process. Companies must automate in order to deliver what today's customer is demanding when he wants it and at the price he wants to pay. The various process of this system is controlled by PLC. PLC is heart of the system and the system is controlled according to the programmed PLC. The automatic metal separation system based on PLC control has advantages of smooth operation and high in its efficiency for the metal segregation. So In order to improve the production efficiency, it is quite necessary to apply PLC (Programmable Logical Controller) in automatic separation system. Ladder logic is used to control the process. Separation process is controlled by using various methods using motor, sensors, conveyor belt, PLC. The PLC concept increases reliability and reduces installation costs by localizing control functions near the process plant, with remote monitoring and supervision. The system is used in tools packing industry, waste disposal industry. This work is divided into three sections; the conveyor section (transfer section), sensing section and packing section. The whole sections are controlled by the Delta PLC. The mechanical part of the project consists of mechanical drawing, measuring, welding and fabricating process, while electrical part consists of electrical drawing; electrical wiring and programming. The software of the Delta PLC theory includes the electrical and mechanical actuators for the hardware will be showing a good result to fulfill the objectives.

A. PLC (Programmable Logic Controllers) system

Programmable controller is an industrial digital computer. They were first developed in the automobile industry to provide flexible, ruggedized and easily programmable controllers to replace hard-wired relays, timers and sequencers. When digital computers became available, being general-purpose programmable devices, they were soon applied to control sequential and combinatorial logic in industrial processes. However these early computers required specialist programmers and stringent operating environmental control for temperature, cleanliness, and power quality. To meet these challenges the PLC was developed with several key attributes. The functionality of the PLC has evolved over the years to include sequential relay control, motion control, process control, distributed control systems, and networking.

There are five basic components in a PLC system:

- The PLC processor or controller.
- I/O (Input /Output) modules.
- Chassis or backplane.
- Power supply.
- Programming software that runs in a PC.
- Network Interface.

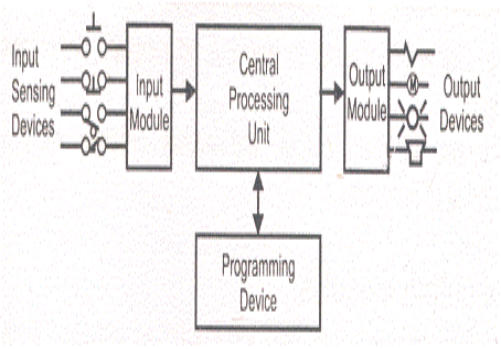

Fig.1 Block Diagram of PLC.

B. The PLC Processor

It stores the control program and data in its memory. It reads the status of connected input devices and executes the control program. Commands connected outputs to change state based on program execution For example: Turn a light on, start a fan, adjust a speed, or temperature and Comes in various physical forms.

C. I/O Modules

They physically connect to field devices. Input modules convert electrical signals coming in from input field devices such as pushbuttons, to electrical signals that the PLC can understand. Output modules take information coming from the PLC and convert it to electrical signals the output field devices can understand, such as a motor starter, or a hydraulic solenoid valve. I/O comes in various forms.

D. Power Supply

The function of the power supply is to provide the DC power required to operate the PLC system. It is supplied by single-phase 120 or 240V AC line power that powers the PLC system.

II. BLOCK DIAGRAM OF PLC AUTOMATIC METAL SEPARATION AND PACKING SYSTEM

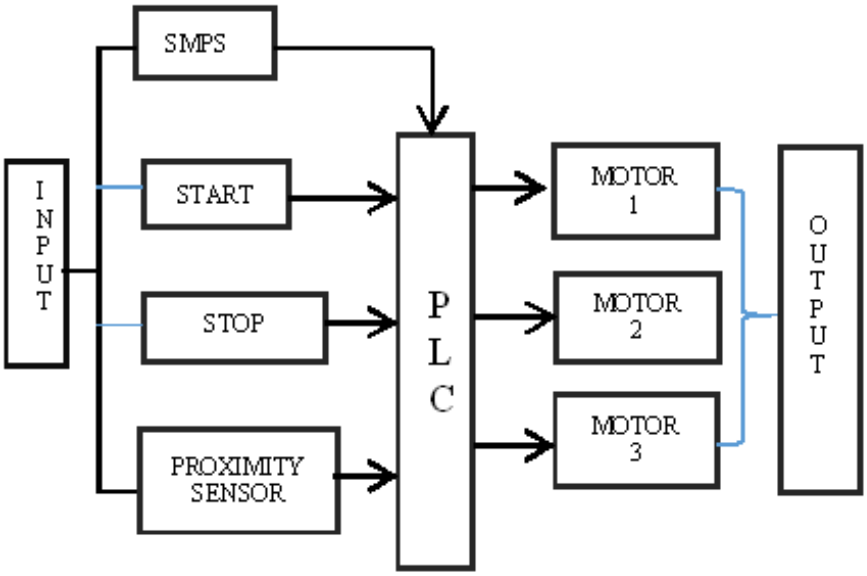

Fig.2 Block diagram of packing machine.

The block diagram shows the basic connections of the setup. Initially the input has been given by using the Switch Mode Power Supply [SMPS]. The SMPS has been used here in order to reduce the incoming 230v AC supply to 24v DC supply. Here we convert it to 24v DC supply because the components we used here specification of about 24v DC supply. The SMPS also act as filter purpose that is to reduce unwanted noises. The output from the SMPS is given to the PLC Inputs by using the terminal blocks. Here the diagram shows that the PLC consists of 4 Inputs, they are SMPS, start button, proximity sensor and stop button. The output of the PLC comprised of three motors, they are main motor 1, motor 2, and packaging motor 3.

A. Process flow diagram

Initially, when the push button is been pressed the conveyor start to move in a forward direction. In the conveyor we have placed any metal or non-metal product in it. After some distance the object which has been moving in the conveyor will be detected by the metal detector, that is whether the object is metal or not. If the object is metal, then the conveyor 2 will be moving in the reverse direction. Finally the metal object which moved in the reverse direction will be get into the packing zone by which the packing gets completed.

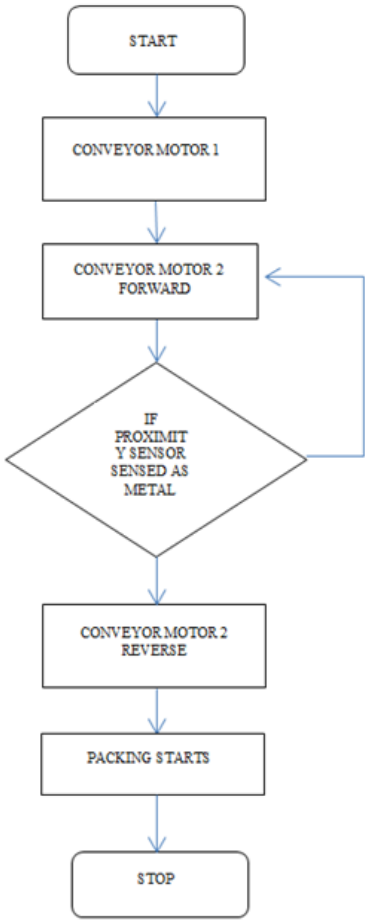

Fig.3 Basic operations of our work in Flow chart manner.

III. DESIGN AND SIMULATION

The basic process of design and simulation has an important role in order to get good results. Here we have attached with some of our basic design methods and the components used for the designing methods.
The simulation process has been done through the software process by which the Programmable Logic Controllers has been programmed in the ladder logic manner. In our design and simulation process we have included the overall mechanical setup which we have fabricated and also the packing system in which the incoming products will get segregated.

A. Experimental details

The basic components which we have used in our work are belt conveyors, Switch mode power supply (SMPS), relay cord, DC motors, Proximity sensor, MCB switch. The belt conveyor is usually made from the mica sheet.
The Switch Mode Power Supply has been used in order to get regulate the incoming signal or voltage.
In PLC, we mostly use 24V dc supply because it will not produce more noises and disturbances. The terminal blocks have been used in order to get more number of positive and negative terminals from the switch mode power supply. The switch mode power supply will have only one positive and one negative terminal.

Table 1: Components Used and Its Specification

COMPONENTS	SPECIFICATION	QTY
Belt conveyor	length of belt : 80 inch width : 5 inch material :resin	2
Relay Cord	-	1
Dc motors	12v ; 30rpm	3
Proximity sensor	-	2
Delta PLC	-	1
On-off button	-	1
Connectors	-	As Required
SMPS	24v & 12v	2
MCB switch	-	1

B. Process model and connections

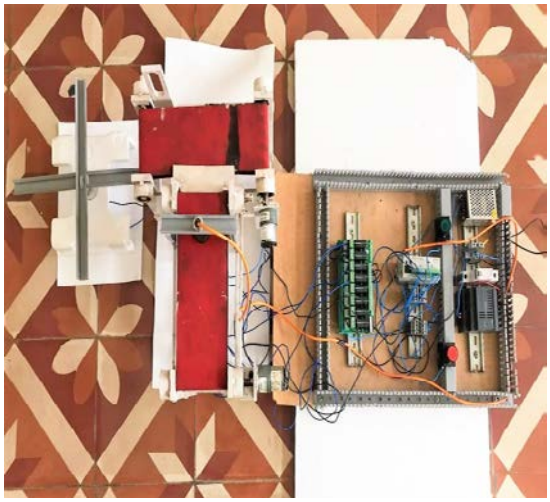

Fig.4 Design of the packing and separation process.

The fig.4 shows the overall setup of the metal separation process and packing. From the left, the relay board set up has been done where in that the relay wirings, SMPS, push buttons, MCB switch which has been used for safety purpose. In the relay board the PLC has been placed in between the Relay board and SMPS set up. After the relay set up has been worked, the conveyor set up has been placed in which the basic sensing process takes place. And at last the packing set up has been placed in a fan like structure in which the incoming metal product has get collected in the box which has been placed in the fan wings like structure.

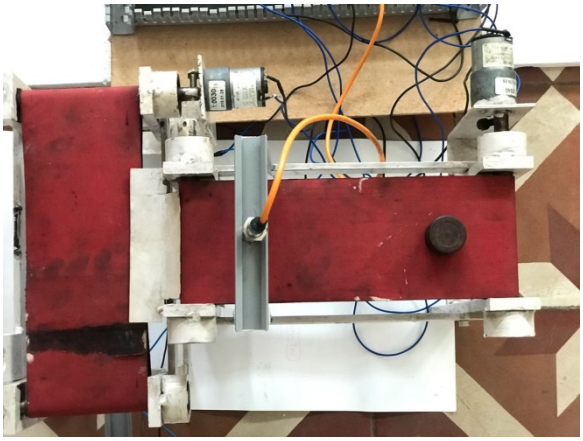

Fig.5 Separation mechanism prototype.

The fig .5 shows that the initial setup of the main two conveyors. The conveyor 1 is the one in which the metallic object has been coming into the sensing area. Based on the sensing type whether it is metal or not, the conveyor 2 will move in its required direction. The metal sensor used here will detect the metals only when it is very nearer to it. For further improvements we can use high range metal sensors which can detect more accurate with a long range.
Here also we can use non-metal sensor by which we can separate the non–metallic products.

C. PLC program for metal detection and packing

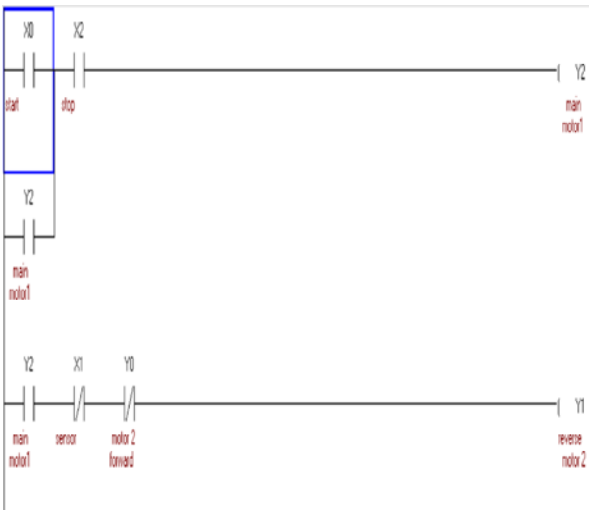

Fig.6 Basic Ladder diagram for conveyor

The fig.6 explains the basic operation of the conveyor 1 system. Here the x0, x1, x2, are the inputs of the PLC system and y0, y1, y2 are the outputs of the PLC system.

Fig.7 Ladder diagram for timer process.

Here the fig 7 shows the basic laddar diagram of the initial moving of the conveyor 1 as well as conveyor 2. The extra time delay has also been given in this in order to get a delay for the conveyor to move as per the sensing of the objects.

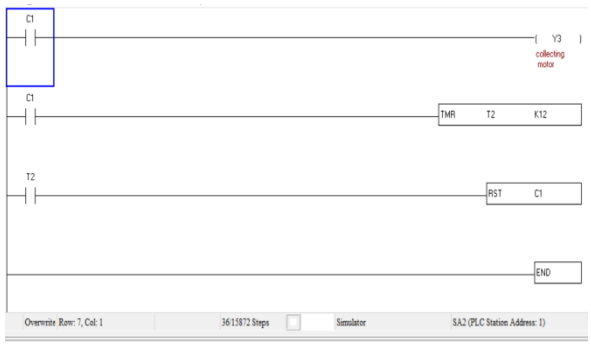

Fig.8 Ladder diagram for sensor process.

Fig.9 Sensing section.

The fig.8 and fig.9 shows that the Ladder, basic sensing process that is performed by the metallic sensor in the conveyor. When the metal or any other non-metallic product falls from hopper, then the product will travels on the main conveyor. Then the product will move towards the position of proximity sensor. A proximity sensor has been fixed in a perpendicular manner towards the main conveyor. If the product is detected

as a metal, then the secondary conveyor moves in reverse direction and the packing motor waits with the box for considerable counts then the motor starts moves for packing section, the next box moves for the cycle of rotation.

IV. RESULT AND DISCUSSION

Thus, from our projects we have got a clear idea about how to automate packing process using PLC automation. The metal separation has been widely used in the present industries in order to easy identification of a metallic and non-metallic product. Then out coming product will undergo into a packing section which is used for collecting metal or non-metallic products. The main application of our project is widely used in the garbage disposal process. The further improvement of our work can be done by increasing the efficiency of the conveyor system and by increasing the high range of sensitivity of the sensor.

V. CONCLUSION

From the above work we have made the fully automatic Metal separation and its packing process. The system meets the demand of high-speed production using the least mechanism requirements. The system also provides high accuracy and precision of incoming metals or any other non-metallic products. Although proposed system illustrates the separation of metallic and non-metallic products with the help of a PLC based conveyor system. It is true that the use of PLC is a costly affair particularly for small industries but it offers many advantages like it can be easily programmable and it is easy to handle.

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