AUTOMATIC SORTING SYSTEM USING PLC

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Abstract. The speed at which industries now work, and the concurrent rise of production has fueled the need for automation. Focusing on manufacturing industries, product packaging and sorting are of high priority and to be automated. Thus low Cost Automation(LCA) system for product sorting based on required dimensions is designed. This system uses Mitsubishi Goc PLC, an integrated PLC and HMI with uploaded Ladder Logic Programming using CODESYS to control multiple machine operation for product sorting. Multiple machine operation of product includes Conveyor, start sensor, Measuring section, Human Interrupt Analyzer. The system is also facilitated with Emergency and Reset stop buttons, Buzzer and a indicator to facilitate trouble shooting

I. INTRODUCTION

It is well known that Manufacturing industries plays a predominant role in the development of a countries economy. Thus countries with higher manufacturing ratio are developed whereas with lower manufacturing ratio are under developed. Therefore development of manufacturing industry is highly important and it depends on research and innovation in the manufacturing process. Basically manufacturing industries manufacture similar models of products with minimal alteration in their height, color, weight, shape and thus sorting becomes the area of interest. Earlier, it was workable to employ human labor for sorting the products. But in the world of technology with fast running industries the production ratio has increased ultimately. This forced industries to automatize sorting process. For a blooming industry, it is necessary to establish a LCA system.

For a successful automation industry, timeless innovation, Identifying effective way for productivity enhancement, cost reduction in operation being user friendly are to be enforced. All the above ways are made true using PLC for LCA system. Our project ultimately focuses on developing a automatic sorting system for height , width and material detection. These sorting are controlled by proximity and diffused beam photoelectric sensor for sensing and DC motor interfaced to PLC through program and wire. Motor is used to drive the conveyor belt which takes the products in front of sensors for detection. The system consists of a start sensor, which is used to start the conveyor if and only if the product is placed before it. Thus it saves the energy for shutting OFF. Next, a mounted casing holds two sensors to estimate object height, width and its material type, this entire casing is named as measuring station . It also contains security systems like Emergency Stop, Human Interrupt analyzer, Defect Product Indicators.

II. EXISTING SYSTEM

For present-day schemes, specific technology is used according to business budget and scope. This includes robotics systems, systems based on microcontrollers, sensors and pneumatics, etc.

A. Robotics based systems

The robotic arm is operated by servo motor in which revolutional degree is governed by the pulse rail of the timer that appears at the control inputs. Depending on the robotic arm framework various degrees of rotation are allocated to execute the operations for the servomotor. The robot arm is made with the help of aluminum brackets. To this end four styles of brackets are arranged. Because of the cost of the manufacturing process the robotic arms are too expensive and complex. Two types of brackets are used to carry the servo motors and two types for the robotic arm extensions and interconnections. The IR sensor identifies the box and sends the data to a microcontroller which controls the movement of the arm by box height. The servo motor movement is regulated in such a way that each box is lowered in a predetermined location to the respective boxes. The time taken for one single motion by the robotic arm is set at around 0.5 seconds. In case of picking up and dropping a product, eight steps of robotic arm motion are required. That includes default arm movement, picking, moving and dropping the product box to the basket and returning to the default position. The arm takes seven steps to pick and drop the product box counts, and one step was needed from that position to default position. It takes about a second for the microcontroller to establish box height. The robotic arm uses 4 motors. One for controlling the base's rotational motion, one for controlling the elbow angle, one for controlling the wrist movement and the final one for controlling the gripper, which is to hold and drop the ball. When power is applied, the starting position of the robotic arm and the robot is ready for operation. The gripper is opened and closed by a lever mechanism. Thus a solo motor is sufficient to control the gripper. For dropping a product box, the projections approach each other to pick and hold the box, and move apart. Using a single servo motor, two positions are designed to fingers. One in the closest position, and the other in the open. For the wrist and elbow motor which is to move up and down, two motions are allowed.

B. Microcontroller Based system

Microcontroller-based systems have some artificial efficiency as the microcontroller can be programmed as required by the system. The microcontroller is preached to sum total the carton which passes from the conveyor and also to measure the carton box weight. As this system has its drawback on weight measurement by microcontroller with the demands of weight measure in advance There are lots of such systems available that use online check weight to calculate object weight. The main drawback of using microcontroller is that it will also continue to increase its hardware requirements as it does not contain built-in timer, counter. In PLC-based object sorting automation, all this drawback of the existing system is overcome, which sort object according to the height.

III. SYSTEM OUTLOOK AND DESIGN

This project includes different divisions like controller, measurement, trouble shooting and safety divisions which are connected by a conveyor which is controlled by PLC. Thus conveyor modelling is predominantly important for the system. The conveyor is energized by a DC Motor controlled by VFD interfaced with Goc-PLC. Systems assembly unit consists of 2 holdings – one for start sensor and other for measurement section

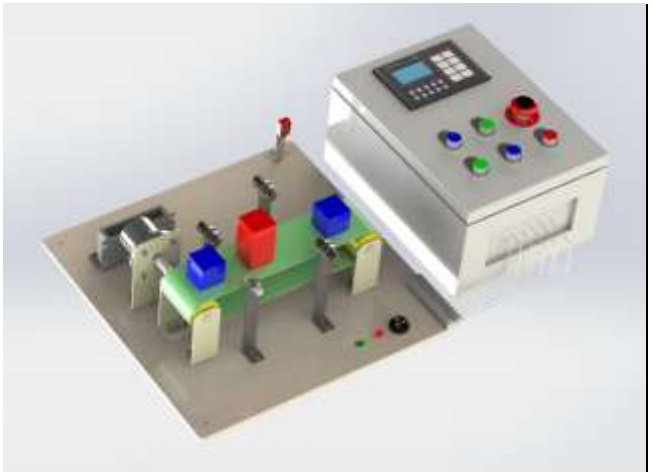

Fig 1 System Outlook

The controller division consists of start, stop, emergency stop push buttons to control the actions and start sensor is used to actuate the conveyor only during the presence of product. Start sensor is also used to sort product based on material type that is metal or plastic product. Through Conveyor product is delivered to measuring division. The measuring division works according to the HMI instructions for selecting and sorting a minimum or maximum height product. This operation is achieved by using level sensors mounted at specific height.If the product does not match the required height then the conveyor stops to indicate a defect product which is to be removed.If the product matches the required height then it moves to the storage bin. For the safety purpose of employee and machinery,Human interrupt analyzer is used for a range of 2 meter which is indicated through buzzer

IV. COMPONENTS DESCRIPTION

1. Mitsubishi GOC PLC

PLC is an easily accessible micro-processor based micro computer.It is evolved by the combination of implements and system programs, devised to direct the operation of industrial hardware and processes. Leading manufactures of PLC include Allen Bradley, Honeywell, Siemens, Mitsubishi, Midcon, Omron etc.

Advantage

There are almost 250 varities of microcontroller and microprocessor accessible from 50 highly preferable semiconductor vendors, but still PLC is of high priority because of these advantages listed below.

(a) Compact in shape and size .
(b) Minimal maintenance .
(c) Online programming .
(d) I / O ports can be extended .
(e) Appreciable operating speed.
(f) Easily programmable as well as reprogrammable

GOC is the first product of its kind in Mitsubishi India's product basket and aims to meet the needs of the Indian and global markets for low-end automation. GOC finds its applications in a wide range of sectors such as Packaging, HVAC, Textile and other SPM its applications in a wide range of applications.

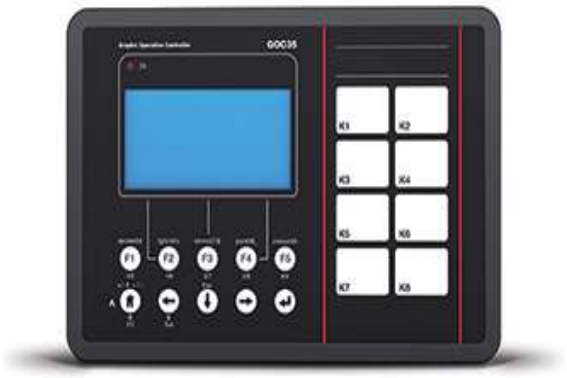

Fig 2. Mitsubishi GOC PLC

Improvement in Goc PLC over other PLC

- Single controller for all automation needs

- Goc is compact and thus reduces the assembly time by eliminate separate wiring for PLC and HMI
- It is easy to debug in single operation
- Can operate in regional language making it user friendly
- Single integrated programming software for PLC and HMI
- Extendable I/O unit

Specification

Model Number	GC35MH-16MR-D
Mounting	On 35mm DIN rail
Supply voltage (DC)	24V
Output type	Relay
Max IO range	48
CPU performance	0.3µsec
Program memory	192Kbytes
Source code and comment memory	1.5Mbytes
Data memory	24Kbytes
Retain memory	1Kbytes
Display	3.2 inch graphic LCD display,
Resolution	128*64 pixels
Keys	10 keys for display navigation and data entry
Illuminated keys	8 (Keys with bicolor LEDs, slide in label)
Memory card	Upto 32GB can be supported.
Dimensions (W*H*D)mm	Cut out – 166.5*107.5(W*H), Front – 177.0*123.0*4(W*H*D)

Table 1 GOC PLC specification

2. *Inductive sensor*

An inductive sensor is a device designed to detect or measure objects using the principle of electromagnetic induction. When a current flows through it, an inductor acquires a magnetic field when current flows through it, alternatively,a cuurent will flow through through the circuit containing a inductor when a magnetic field through it changes. This effect can be used for the detection of metal objects interacting with a magnetic field. Non-metallic substances like liquids or some kind of dirt do not interact with the magnetic field so an inductive sensor can operate under wet or dirty conditions.

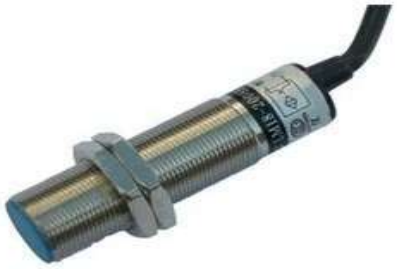

Fig 3 Inductive sensor

In this project inductive sensor is used as a start sensor which enable the system operation when a metal type product is to be sorted based on height.

Specification

Type	Inductive proximity
Housing	Barrel type
Connection Type	M12
Light type	LED, orange
Sensing distance	4 mm
Connection type	Cable 2m, 3-wire

Table 2 Inductive sensor specification

3. *Capacitive proximity sensor*

Fig 4 Capacitive sensor

Capacitive proximity sensors are non-contact devices that can detect virtually any object without regard to the material. They utilize the capacitance electrical property and capacitance change based on a change in the electrical field around the sensor's active face.

In our project we use capacitive sensor as start sensor which enable the system operation when a

non-metal or plastic product to be sorted based on height

Specification

Type	Capacitive proximity
Housing	Barrel type
Connection Type	M18
Light type	LED, orange
Sensing distance	8 mm
Connection type	Cable 2m, 3-wire

Table 3 Capacitive sensor specification

4. Photoelectric sensor

Fig 5 Photoelectric sensor

A photoelectric sensor, or photo eye, is typically used to detect an object's separation, presence or absenceby using infrared radiation as transmitter, and a photodetector as reciever. It is largely used in manufacturing industries and of three differentl types namely,

1. opposed (through beam)
2. retro-reflective and
3. proximity sensing.

This project uses diffused type sensor, in which emitter and receiver are located in same housing and the target acts as a reflector. This type of sensor is used to sort the products based on minimum and maximum height.

Specification

Type	Capacitive proximity
Housing	Barrel type
Connection Type	M18
Light type	LED, orange
Sensing distance	8 mm
Connection type	Cable 2m, 3-wire
Model number	F18-MD-100 N0-2M
Product characteristic	Photo electric sensor

Table 4 Photoelectric sensor specification

5. Photo electic sensor with background suppression(BGS)

BGS is a diffused mode photoelectric sensors, uses seperate sensing element to detect object close to the sensor front end without detecting the background material. It's range of sensing for black is just 5% less than white targets, and can be operated for variable distance.

Features

- Small difference in height can be detected.
- Effect of sensing object colour are minimized.
- Effect of background object are minimized.

This sensor is used in this system to sense the trespasser in the authorized work station and also for safety concern of the employee.

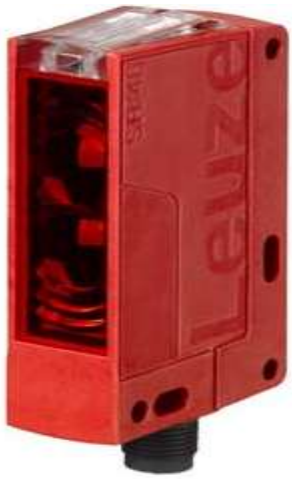

Fig 6 Background Suppression sensor

Specification

Type	Photo electric with background supression
Housing	Cube type
Connection Type	M12 connector
Light type	LED, Red
Sensing distance	3 m

Table 5 Background suppression sensor

V. FUTURE ENHANCEMENT

- This system can be advanced to sort product based on other parameters like weight, color
- This system can also be used for Labeling, Bar-code scanning for enabling quality of production
- Defect rejection section can be enhanced by installing a robotic arm (or) pneumatic actuator**.**

VI. CONCLUSION

The methodology used in this system for modeling this automatic sorting device can support and model other types of sensors having the same sensibility. This work illustrates a basic strategy to model and manufacture automated machines.

There are some unavoidable limitations because of complications in programming of the PLC according to material and component availability.

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