OBJECT SIZE SORTING USING PLC

Dr.D.O.Patil[1], Siddhi Humbe[2].

Department of Instrumentation and Control Engineering PDEA's College of Engineering Manjari Bk.) Pune, India, 412307

1. ABSTRACT

In today's world of technology and due to speed running industries, the production rate has increased tremendously. Generally, manufacturing industries keep manufacturing same models with little variation in height, colour, weight, shape. And here sorting plays an important role. In such cases industries can't bare human errors for sorting these products. Thus it become necessary to develop Low Cost Automation (LCA) for sorting these products in accurate manner. Industrial automation mainly focuses on developing automations having low cost, low maintenance, long durability and to make systems user friendly as possible. Finally, here we have developed a LCA system for sorting the light weight objects on the basis of height variation using DC geared motors which is controlled by Programmable Logic Controller (PLC) and the conveyor in the system passes the object in front of sensors and thus sorting logic is decided.

In many industrial applications there is need of sorting. Sorting can be done by using many ways like sorting of object according to their dimensions (height, length etc.), according to their colors, according to their weight, using machine vision (image processing), according to the material of an object etc. For example in Thermal Power Station electromagnetic sorting technique is used to sort ferromagnetic materials from coal. In this project, the development of a LCA (Low Cost Automation) system to sort objects according to their height has been designed. This LCA system is controlled by Programmable Logic Controller (PLC). This project consists of two parts, first consisting of software which contains ladder logic programming which is used to program PLC that controls the whole process of the project step by step according to input data sequence. Second is the hardware part which consists of conveyors used to transport the objects, sensors used to sense the height (i.e. laser sensors) of the objects, electronic system used to sort the objects and motors to drive the conveyors.

2. INTRODUCTION

Sorting of objects is extensively used in many industries like food processing industries, toy industries, etc. so as to increase the production rate. Sorting improves the efficiency of system. This system is a Low-Cost Automation System for sorting the light weight boxes on the basis of height variation. It will save the man power as well as increase the consistency and flexibility. This will not only reduce manual efforts and time consumed, but also prevent the danger which might occur when human beings work in hazardous environments such as chemical industries.

In many industrial applications, sorting process is carried out. Sorting can be done on the basis of their dimensions, color, according to their weight and height, using machine vision (image processing) and according to the material of an object. Typically sorting of objects is done manually. In such cases industries can't bare human errors for sorting these objects. Thus, it becomes necessary to develop a Low Cost Automation (LCA) for sorting these products in accurate manner. This paper represents the sorting process. The proposed system could sort the boxes on the basis of height variations and can be implemented in small scale industries. In this

work, the proposed sorting system is able to corporate compatibility by using conveyor belt and limit switches to detect the height of boxes and finally sort them in the assigned direction controlled by Programmable Logic Controller.

In many sorting industries, object sorting is the major task that needs to be done. Manual sorting is the traditional approach that is preferred by industries that involves visual inspection performed by human operators. This traditional approach is tedious, time-taking, and non-affordable for industries. It has become difficult to hire personnel who are trained and willing to undertake the tedious task of inspection. Therefore, in proposed system the efforts are made to design and implement automatic technique for identifying and sorting the products on the basis of their color using Embedded Vision.

In recent years the importance of process automation has increased as the growth of any industry directly depends on it. For precise output and accuracy in industries, robots with sensors and actuators are used.

Our aim in this project is to create the electronic material handling system which can be used to reduce the of workers as well as to reduce the time spent in inspection of the components, during their manufacturing.

It also reduces the efforts in transferring the components manufactured to another workstation. The most apparent reasons that are associated in installing of automatic system
in industry are,

i. Saving Man Power.
ii. Improved Quality and Efficiency.
iii. Increase consistency and Flexibility.

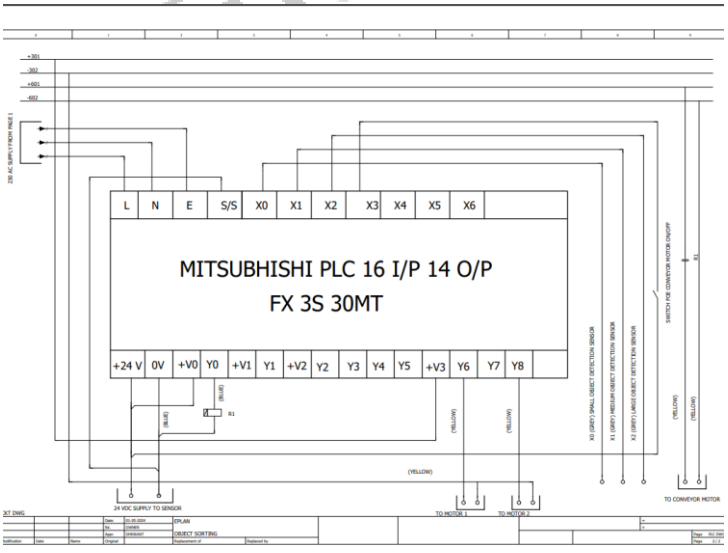
An automatic sorting machine has main task of sorting components according to the sizes. This also consists of conveyor belt, which reduces the efforts of material handling. Also both processes take place simultaneously like material handling and inspection.

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

3. METHODOLOGY

1. *Block Diagram*
2. *Flowchart*

3.1 Block Diagram:



The following components are used in the block diagram

3.2 PROXIMITY SENSOR

A proximity sensor is a device designed to detect or measure objects using the principle of electromagnetic induction. When a current flow through it, an inductor acquires a magnetic field when current flows through it, alternatively, accurate 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 the magnetic field so an inductive sensor can operate under wet or dirty conditions. 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.

3.2.1 Specification

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

3.3 DC GENERATOR MOTOR AND GEAR BOX

A DC motor is an electrical machine which converts electrical energy into mechanical energy. The basic working principle of the DC motor is that whenever a current carrying conductor places in the magnetic field, it experiences a mechanical force.
Fleming's left-hand rule and its magnitude decide the direction of this force.
According to the fundamental law of nature, no energy conversion is possible until there is something to oppose the conversion. In case of generators, magnetic drag provides this opposition, but in the case of dc motors, there is back emf. Presence of the back emf makes a dc motor 'self-regulating'.
When the armature of a motor is rotating, the conductors are also cutting the magnetic flux lines and hence according to the Faraday's law of electromagnetic induction, an emf induces in the armature conductors.
The direction of this induced emf is such that it opposes the armature current (Ia). The circuit diagram below illustrates the direction of the back emf and armature current.

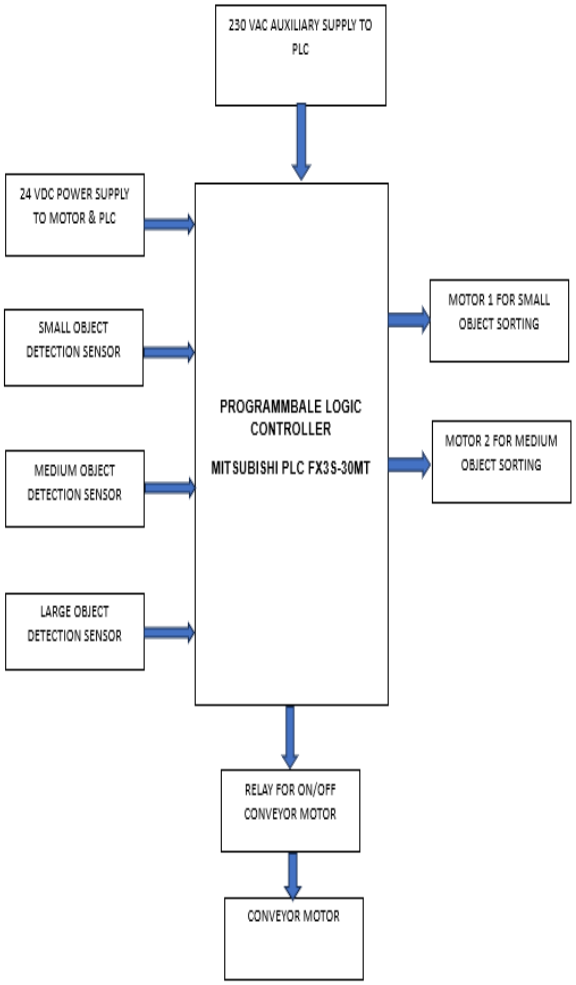
A DC motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. We used DC motor with gear box for speed reduction purpose.
DC Gear Motor Specifications:
Model: 60RPM, 12VDC Power Supply
Load carrying capacity: 3-5kg @ 60RPM

4 MOTOR DRIVE ULN 2003

ULN2003 is a high-voltage, high-current composite transistor array series product. It has high operating voltage, high current gain, wide temperature range and strong load capacity, so it is very suitable for various systems that require high-power drive.

ULN2003 is a high-voltage and high-current driver that is commonly used in various circuits for electronic lock control, motor drive, stepper motor drive, LED display conversion, smart home equipment, and other occasions where high-voltage and high-current devices need to be controlled. It consists of seven silicon NPN composite transistors, with each pair of Darlington transistors connected in series with a 2.7K base resistor. At an operating voltage of 5V, it can be directly connected to TTL and CMOS circuits, so it can directly process data that originally required standard logic buffers. Therefore, ULN2003 can control multiple devices simultaneously. It has the advantages of high reliability, convenient interface, etc., and is easy to be integrated into various circuits.

Flowchart


230 VAC AUXILIARY SUPPLY TO PLC
24 VDC POWER SUPPLY TO MOTOR & PLC
SMALL OBJECT DETECTION SENSOR
MEDIUM OBJECT DETECTION SENSOR
LARGE OBJECT DETECTION SENSOR
PROGRAMMBALE LOGIC CONTROLLER
MITSUBISHI PLC FX3S-30MT
MOTOR 1 FOR SMALL OBJECT SORTING
MOTOR 2 FOR MEDIUM OBJECT SORTING
RELAY FOR ON/OFF CONVEYOR MOTOR
CONVEYOR MOTOR

5 CONCLUSION

Efficiency: PLC-based object sorting systems offer high efficiency in industrial settings. They can rapidly process large volumes of items, leading to increased productivity and reduced labor costs.

Accuracy: With precise programming and sensor integration, PLCs ensure accurate sorting based on predefined criteria such as size, shape, color, or weight. This accuracy minimizes errors and improves overall quality control.

Flexibility: PLCs allow for flexibility in sorting various types of objects without extensive reconfiguration. This adaptability is crucial in dynamic manufacturing environments where product specifications may change frequently.

Integration: PLCs can seamlessly integrate with other automation systems, such as conveyor belts, robotic arms, and sensors, enabling a fully automated sorting process from start to finish.

Cost-effectiveness: While the initial investment in PLCs and associated equipment may be significant, the long-term cost savings through increased efficiency and reduced manual labor justify the expenditure for many industries.

However, there are also challenges to consider:

Complexity: Designing and programming PLC-based sorting systems require specialized knowledge and expertise. Integration with existing infrastructure can also be complex and time-consuming.

Maintenance: PLCs require regular maintenance to ensure optimal performance. This includes software updates, troubleshooting, and periodic hardware inspections, which can add to the overall cost of ownership.

Scalability: While PLCs are suitable for many applications, scaling up operations may require additional investment in hardware and software upgrades to accommodate higher throughput and expanding product lines.

6 REFERENCES

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