Design and Development of a PLC Based Automatic Object Sorting

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Abstract: **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, according to their colours, 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 system to sort objects according to their colour has been designed. PLC controls this LCA system. 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 systematically according to input data sequence. Second is the hardware part, which consists of conveyors, used to transport the objects, sensors used to sense the colour (i.e. colour sensors) of the objects, electronic system used to sort the objects and motors to drive the conveyor belt. The objects are being sorted according to their respective colour. The main conveyor is supported of two branches to load the distinguished object on to the respective one as separated by the electronic system and detected by the proximity sensors.**

Keywords: **Programmable Logic Controller (PLC), LCA (Low Cost Automation), SCADA Supervisory Control and Data Acquisition**

I. INTRODUCTION

This paper here aims in designing a real time application which helps in sorting the objects of any kind using PLC. This system helps in achieving effective communication between objects using multiple sensors to monitor parameters like height, weight, physical and chemical properties etc.

The modules interfaced with the PLC for this system are, Photo sensor and Limit switch are used to detect any object, DVD Drives for placing the objects, Inductive sensor for detecting metal objects. A PLC is used to establish communication between sensors for measuring continuously the above real time process.

This work introduces an Automatic system with a combination of PLC having high impact on Object sorting. In India, Steel Plant is one of the Navarathna Company which has largest units of manufacturing with its various stages. The main aspect of the project is to automate the process of transportation of the materials to the respective destinations using Sensors and PLC.

II. EXISTING SYSTEM

In the recent times, the cranes are operated manually in the industry for the sorting and transportation of products in multiple conveyors. The process results in increased time delay for the products to reach the destination and also needs manpower to control the cranes. The operation of cranes and monitoring the status of the conveyor belt are also tedious for the workers. The efficiency may also not be stable since it depends on the efficiency of the workers.

III. LITERATURE SURVEY

Several articles for our project were studied. Since the products are sorted through the conveyors, the status of the sorting is an important factor in our project. So this is identified in the research paper "Automatic Object Sorting Machine Using PLC", which describes that the objects are sorted using sensors so that the safe and reliable conveyor operation is ensured. For the selection of the appropriate sensors, various studies were made and in the journal "Automatic Industrial Sorting Machine by the different Sensors for Automation-An Innovative Model Based Approach" where the photo sensor register items by contrast, colour, or any property. Since our project is fully automated using PLC and automated DVD Drives are also have significant role, many studies were done and one of the research paper "Automatic Sorting Machine Using Conveyor Belt" helped us. From this research, it was found how PLC can be effectively designed for a wide variety of control tasks with the simple ladder logic to control the entire system.

IV. PROGRAMMABLE LOGIC CONTROLLER

The term 'programmable logic controller' is defined as a digitally operating electronic system which uses a programmable memory for the internal storage of user-oriented instructions for implementing specific functions such as logic, sequencing, timing, counting and arithmetic to control through digital or analogue inputs and outputs, various machines or process. A PLC retains its operating system, user programs, and some data in retentive (non-volatile) memory.PLC has not only replaces the relay but has also extended the logic capabilities of the system. Allen Bradley's automation devices deliver solutions with high performance and flexibility to be effectively deployed within diverse industries and applications.

Programming In PLC

Every PLC has associated programming software that allows the user to enter a program into the PLC. Before a PLC can perform any control task, it must be programmed to do so. The Software used for the PLC is RS LOGIX 2.54v Programming Language. The controller offers two programming languages such as:

1) Ladder Language (LD)
2) Function Block Diagram (FBD)
3) Sequential Flow Chart (SFC)
4) Structured Text Language (STL)

Ladder Language

The Ladder logic is widely used in programming PLC where sequential control of a process or manufacturing operation is required. It is a graphic Language and can be used to transcribe relay diagrams, and is suited to combinational processing. It provides basic graphic symbols, contacts, coils, and blocks. Specific calculations can be executed within the operation blocks.

Any control task modifications are done by changing the program.

V. SYSTEM ARCHITECTURE

The system consists of many functional units such as photo sensor, Inductive sensor, Conveyor belt, DVD Drives as shown in figure1. Here PLC plays vital role i.e. it is heart of this proposed system. The PLC is burnt with program that is necessary (shown in figure 2) to control the sensors and relays, and conveyors interfaced to it. The interfaced units are controlled by the PLC in an efficient and faster manner, thus providing the system to be reliable than the existing ones.
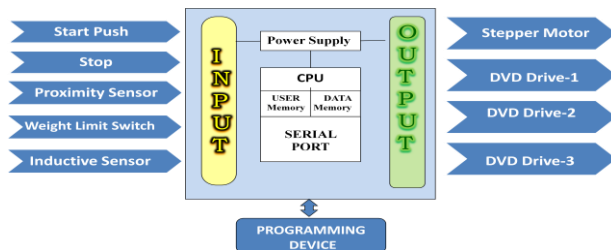
VI. DESCRIPTION OF PROPOSED SYSTEM

Our project is PLC based automatic object sorting machine divided into six cycles namely: Object Detection, Object placing on to conveyor belt, Conveyor starting, Sensory Detection, and Sorting mechanism.

Our project involves reducing the industrial cost employed in installation and functioning of multiple conveyor belt systems in different industries like Food Processing Industry, Brick Industry etc. for sorting of different objects. This is achieved by setting up a single conveyor belt which carries objects and then the PLC module along with the sensor

module which detects the objects and then the objects are sorted accordingly. With this the operational costs, labour costs and installation costs are reduce in manifold by minimal increase of the inputs for the PLC.

We shall now discuss our project in detail by providing a descriptive analysis of various modules required in our project.

Overview of the Modules

- PLC Module
- Conveyor Belt Module
- Object pushing Module
- Sensor module
- Object placing module

PLC Module

Our PLC module consists of the following

- Allen Bradley MICROLOGIX 1200
- 24V DC power module
- 16 digital I/O Module

Understanding the basic features of MICROLOGIX 1200 in our facility would maximize our productivity by increasing the operation of our project. The MICROLOGIX 1200 includes fault detection with built–in diagnostics. Understanding these features is critical in running an efficient operation. Allen Bradley PLC is widely used in several industrial automation operations across Indian sub – continent.

Conveyor Belt Module

The next concept in our project is of the conveyor belt, on which the objects are kept. Here instead of using multiple conveyor belts for different operation we are using a single conveyor belt which takes the objects to the DVD drives where the objects are separated and the sensing of the objects is done and then sorting operation is done simultaneously.

Object pushing Module

The object sensing module in our project PLC based automatic object sorting machine with User Defined Volume utilized is a weight limit switch in which a rod is fixed to the upper surface of the weight limit switch. When the object is placed on it due to weight of the object a force is exerted on the rod of the weight limit switch and this rod makes a supply to the PLC and the PLC provides the supply to the DVD drive-1 which pushes the object on to the conveyor belt after 5 sec of time delay again the PLC provides the supply to the motor for which the conveyor belt starts rotating.

Sensor Module

In our project PLC based automatic object sorting machine. We are using an IR Sensor for detection of object presence and Inductive sensor for detection of metallic objects. The operation of IR sensor and Inductive sensor here are programmed such that when the object comes and when it is detected the sensor senses it for some time delay and if the

object is removed during that time delay and placed again then the sensor again starts the sensing time delay from the beginning and after that the instruction of bottle being sensed is send to the PLC.

Object placing module

An Object placing module is a mechanism which is used for moving an object which is to be moved in a particular segment based on its material or many other properties from one work station to another work station. An object placing is like a pneumatic piston mechanism that translates a pressure into an intermittent forward or reverse motion for placing the object. Here in this project we are using DVD drives instead of pneumatic pistons by giving 12v instead of the continuous pressure supply. The DVD drives acts accordingly to the signals based on the sensing module. When the object is a metal then both the sensors goes high so the 1st drive gets extracted according to the program given in the ladder programming and when the object is a non-metal then the inductive sensors goes low and the photo sensor goes high according to this commands the other DVD drive takes its extracted position and after a time delay of 5 seconds both the drives take its retracted position.

Figure 1. PLC module

Figure 2. Conveyor module

Figure 3. Sensor module

Figure4:Prototype of Project

VII. CONCLUSION

The main objective of this project was to develop an object sorting system based on certain specifications. This was successfully implemented. We consider this project as a journey where we acquired knowledge and also gained some insights into the subject which we have shared in this report.

PLC was used to control the various operations. More features can be added to this system as follows: depending on the size, shape and weight of the objects, sorting operations can be implemented. Sorting operation can be improvised using a piston arrangement.

VIII. FUTURE SCOPE

It is very useful in wide varieties of industries along with the help of PLC and SCADA, especially in the packaging process. Automatic sorting machine enhances efficiency, practicality, and safety of operators. It ensures remarkable processing capacity as well as peerless performance including colour detection. Of course we need to add high speed DC Motors and sensors with appreciable response to speed up the system for industrial application.

The model can be improved by making some changes in the program and components. Some suggestions are given Below.

- We can add a load cell for measurement and control of weight of the product
- We can also add a counter for counting the number of products
- Speed of the system can be increased accounting to the speed of production
- The system can be used as a quality controller by adding more sensors
- The sensor can be changed according to the type of product
- The DC motor can be replaced with stepper motor.

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BIOGRAPHY

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