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AUTOMATED HEIGHT BASED BOX SORTING SYSTEM USING PLC

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ABSTRACT

Inmany 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.

Keywords: Programmable Logic Controller (PLC), Box Sorting, Conveyor Belt, Stepper Motor, Limit Switch.

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 andtimeconsumed,butalsopreventthedangerwhich might occur when human beings work in hazardous environments such as chemical industries.

The modules interfaced with the PLC for this system arelimit switches, DC motors and Stepper motor which are used to detect height and sort accordingly. A PLC is used to establish communication between switches for measuring the height of the boxes continuously. This work introduces an automatic system with a combination of PLC having high impact on Object sorting. The main aspect of this system is to automate the process of sorting the boxes to the respective destinations using switches, sorter arm andPLC.

LITERATURE REVIEW

KadiyamSasidhar, ShaikFaiz Hussain,Syed Ali Safdar, MohdAleem Uddin, published paper entitled as "Design and Development of a PLC BasedAutomatic Object Sorting". This paper represents sorting the objects as metallic and nonmetallic by using two DVD drives. The DVD drives acts accordingly to the signals based on the sensing module. If the object is a metal then the first drive pushes the object out of conveyor according to the program given in the ladder programming and if the object is a non-metal then the second drive pushes the object. And they both get to their initial position after some time delay.

Sushrut Kulkarni, Sanjay Singh, published paper entitled as "Object Sorting Automated System using Raspberry Pi". They have used Raspberry Pi and ultrasonic sensor for detection of the object. Webcam is used to detect the shape and color of object. On this basis of detection the controller gives command to robotic arm, thus it sorts the objects as per their respective compartments.

Rakhshan Zulfiqar, Bushra Mehdi, RumaisaIftikhar, Tahmina Khan, et al., published paper entitled as "PLC Based Automated Object Sorting System". This system distinguish metal, wood and plastic based on their sizes viz., small, medium and large. They have used pneumatic double acting cylinders for sorting theobjects.

R.Aravind, M.Arun Kumar, et al. published paper entitled as "Automatic Sorting In Process Industries Using PLC". This system comprises of two conveyors for sorting. Both the conveyors are perpendicular to each other. Sorting is based on the height of object. The object will be sensed and moved forward on the next conveyor.Then the sorting will be done by forward or reverse movement ofconveyor

I. METHODOLOGY

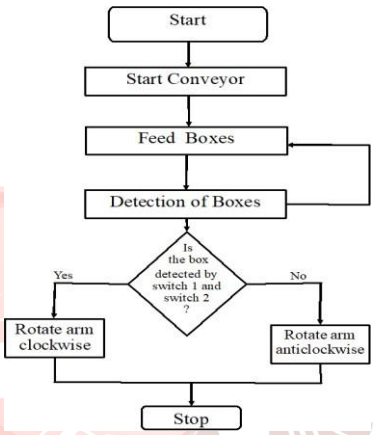

Fig.1. Flowchart of proposed system

The Fig.1 represents the basic step by step working of sorting process. Initially the processwill start, then the boxes that are to be sorted are placed on the conveyor. The conveyor will start to move the boxes. Two limit switches at certain heights are placed. If the box is detected by limit switch 1 and limit switch 2, the PLC will give command for stepper motor to run in clockwise direction. And if the box is detected by only switch 1, the motor will run in anticlockwise direction. In this way the boxes will be sorted as per the height variations. When toggle switch is turned off, whole system willstop.

I. PROPOSED SYSTEM

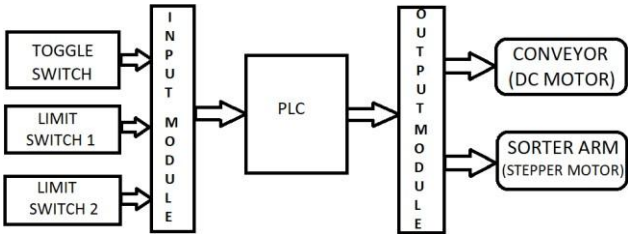

Fig.2. Block Diagram of Overall System

The sorting process involves the interfacing of the conveyor system with the PLC. The block diagram mainly consists of input module, PLC and output module.

Input Module: The input module consists of limit switches and toggle switch. Toggle switch is used to start the process. The limit switches are used for detecting the boxes according to their heights. The output of this switches is given to PLC for sorting the boxes accordingly.

PLC: A PLC can be defined as a digital electronic device that uses a programmable memory to store instructions such as logic, sequencing, timing, counting and arithmetic to control machines or processes.[7] All control operations are done using the PLC. The entire box sortingprocess is automated by feeding the necessary conditions into thePLC

usingladder logic. Ladder logic is one of the methods of programming a PLC. Thus, depending on the logic developed the various operations takes placeand the sorting of boxes are done.

Output Module: The output module includes DC motor, stepper motor. The DC motor is used to run the conveyor in forward direction. The stepper motor will sort the boxes according to their heights. If the box is larger in height, then it will rotate in clockwise direction and if the box is smaller, it will rotate in anti-clockwisedirection.

TECHNICAL DETAILS

The process requires programmable logic controller as a main controller. The various components required for a system are:

1. Programmable LogicController
2. DCMotors
3. Conveyer BeltAssembly
4. Limitswitches
5. Stepper Motor andDrive

PROGRAMMABLE LOGIC CONTROLLER:

The S7-200 CPU combines a microprocessor, an integrated power supply, input circuits, and output circuits in a compact housing to create a powerful Micro PLC. Refer Fig.3. After you have downloaded your program, the S7-200 contains the logic required to monitor and control the input and output devices in your application. Siemens provides different S7-200 CPU models with a diversity of features and capabilities that help you create effective solutions for your variedapplications.

Fig.3. Siemens S7-200 PLC TrainerKit

Technical Specifications of PLC are as follows: PLC CPU Type: CPU-226(AC/DC/Relay)

Digital Input - 24 Digital Output - 16

Program Size - 4096 words Internal Memory Bits – 256

Boolean Execution Speed – 0.37 ms/instruction No. of Ports – 2 No

Interface – USB

Expansion Module – Expandable

DC MOTOR

A DC Motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The very basic construction of a DC motor contains a current carrying armature which is connected to the supply and through commutator segments and brushes. The armature is placed in between north south poles of a permanent or anelectromagnet.

Fig.4. DC Motor

Technical specifications of DC Motor are as follows: Base motor RPM- 18000

Operating Voltage- 6 to 18V Rotor RPM- 10

Rated Voltage- 12V

STEPPERMOTOR

A stepper motor, also known as step motor or stepping motor is a brushless DC electric motor that divides a full rotation into a number of equal steps. They consists of multiple coils that are organized in groups called phases. By energizing this phases in sequence, the motor will rotate one step at atime.

Technical specifications of stepper Motor are as follows:

Step angle- 1.8^0

Steps per revolution- 200 Current rating- 1.7A per coil Shaft diameter- 5mm

Voltage rating- 2.8V

Holding Torque- 3.7 kg-cm STEPPER DRIVER:

Fig.6. Digital Stepper DriveSEA442

The SEA422 is a new generation digital 2-phase stepper motor driver, based on a 32-bit DSP processor, combination of the anti-resonance, low noise, micro-step andlow temperature rise technology significantly improve the performance of the steppermotor, has low noise, small vibration, low temperature rise and high-speed torque.The driver use online adaptive PID technology, without manual adjustment can be automatically generated optimal parameters for different motors, and achieve the best performance.

Features of stepper drive are as follows:

1. High-performance, lowprice.
2. Micro-step.
3. Automatic idle-currentreduction.
4. Optical isolating signalsI/O.
5. Max response frequency up to75Kpps.
6. Low temperature rise, smoothmotion.
7. Online adaptive PID technology

Ⅱ. RESULT ANDANALYSIS

Sr.no	***Height (cm)***	***Sorting Status***
1.	5	Short
2.	7	Short
3.	10	Short
4.	12	Long
5.	14	Long

Fig.7. Analysis Table

Above table illustrates the result analysis. As per height the sorting status is mentioned. Two limit switches at a height of 5cm and 12cm are placed on a conveyor table. The boxes of height less than 12cm are detected as small box from PLC and those of 12 and above are considered to be large box. As per the height i.e. long and short, the sorter arm will rotate clockwise and anti-clockwise.

CONCLUSION

In this paper, boxes of particular height are sorted using PLC. This system is time effective and have reduced labor work, increase speed of production, increase accuracy resulting in automation. This system can be further improved to sort the boxes based on different physical considerations and can be implemented in manufacturing industries, food processing industries and luggage sorting.

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