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Design and Fabrication of PLC Based Sorting Machine

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ABSTRACT: In this advance era, automatic sorting is highly desirable in approximately every industry. Its main objective is to reduce human efforts and time which can ultimately raise its efficiency. However, perfect sorting machine is still in progress which should be flexible and compatible in design. In this work, the proposed sorting machine is able to corporate compatibility by using conveyer belt and proximity sensors to detect and identifies size of material in three different ranges and finally sort the material separately in assigned basket by using pneumatic cylinder (controlled by Programmable Logic Controller (PLC)). The proposed multi sorting system is able to sort objects of different ranges are sorted with 100% accuracy within the time interval of seconds. The proposed model could be implemented in any industry whose applications are mechatronics-based engineering system. This model can also produce list of sorted objects through enabled sorting program commands.

KEYWORDS:Sorting machine, Proximity Sensor, Pneumatic Cylinder, PLC programming

I. INTRODUCTION

The development of manufacturing industries is dependent upon research in manufacturing process and innovation in new products. The countries that have higher manufacturing rate are known to be developed whereas those with little manufacturing are considered underdeveloped.

During processing, the raw material gets transformed into product. Once this product gets processed it earns a value for sale. Therefore, manufacturing is 'adding value' to the material. The value that is earned by the product should have more cost allowing the organization to make money out of it. Generally, manufacturing industries keep manufacturing same models with little variation in height, colour, weight, shape and thus sorting plays an important role here. In old days it was possible to implement manual labour for sorting similar objects. But nowadays due to increased production and for minimizing the labour expenditure for such unskilled task, industries can't afford human errors for sorting these products. This forced industry to tend towards atomizing the sorting process.

Our aim in this project is to create the electronic material handling system which can be used to reduce the efforts 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.

II. LITERATURE REVIEW

1] RakshamZulifiqar, Bushra Mehdi et. Al, PLC based object sorting system, 2019 4th International Electrical Engineering Conference (IEEC 2019): In this advance era, automatic sorting is highly desirable in approximately every industry. Its main objective is to reduce human efforts and time which can ultimately raise its efficiency.[1]

2] Prof. Nilima Bargal1, Aditya Deshpande, Et. Al. , PLC Based Object Sorting Automation, International Research Journal of Engineering and Technology (IRJET): 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.[3]

3] Dhanraj Shiv And Kamal Niwaria, A STUDY OF PROGRAMMABLE LOGIC CONTROLLERS (PLC) AND GRAPHICAL USER INTERFACE: A SURVEY, International Research Journal of Engineering and Technology (IRJET): PLC controllers in today's day are a staple mechanism to control operation of large number of machines and devices in the industry. This project presents the idea of using programmable logic controller (PLC) in industrial automation. a control system which takes care of operation in automotive way with minimum human interface. This paper presents experiments for students to learn and explore the various industrial applications of PLC’s.[4]

III. METHODOLOGY

The proposed methodology shows complete architecture of our proposed work. Firstly, the conveyer belt is switch on then the testing object is identified through proximity sensor moreover, object is sorted in specific box through PLC which controls position of pneumatic cylinder and purpose of DC gear motor is to control speed of conveyer belt.

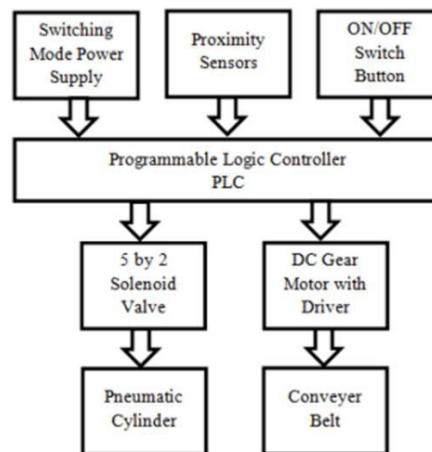


Fig. No. 3.1: Working Phenomenon of the proposed system

IV. KEY COMPONENTS

a) Programable Logic Controller (PLC) :

A programmable logic controller (PLC) or programmable controller is an industrial digital computer which has been ruggedized and adapted for the control of manufacturing processes, such as assembly lines, or robotic devices, or any activity that requires high reliability control and ease of programming and process fault diagnosis.

PLC programs are typically written in a special application on a personal computer, and then downloaded by a directconnection cable or over a network to the PLC. The program is stored in the PLC either in battery-backed-up RAM or some other non-volatile flash memory. Often, a single PLC can be programmed to replace thousands of relays. Currently five programming languages for programmable control systems: function block diagram (FBD), ladder diagram (LD), structured text (ST; similar to the Pascal programming language), instruction list (IL; similar to

assembly language), and sequential function chart (SFC). These techniques emphasize logical organization of operations. We used function block diagram (FBD) programming language for our PLC programming.



Fig.No.4.1 Programable Logic Controller

Specifications:

- PLC CPU – Schneider SR2 B121BD / Zelio
- PLC Software – Somachine Basic 3.1/ Zelio Soft

b) Conveyor Belt :

A conveyor belt consists of two or more pulleys, with a continuous loop of material which rotates over them. One or both of the pulleys are powered, moving the belt and material on the belt forward. There are two main industrial classes of belt conveyors; those in general material handling such as those moving boxes along inside a factory and bulk material handling such as those used to transport industrial and agricultural materials, such as grain, coal, ores etc.

Essential properties of Belt are: Flexibility, Transverse rigidity, Low mass per unit length, High strength, Simplicity, Longer life, Wear resistant, Fire resistant

Belts are typically made from:- Canvas, Kevlar, Nitrile, Steel cord, Teflon, Rubber, Wire mesh, Rubber.



Fig.No.4.2 Conveyor Belt

c) Pneumatic Double Acting Actuator:

Pneumatic cylinders are mechanical devices which use the power of compressed gas to produce a force in a reciprocating linear motion. Double-acting cylinders (DAC) use the force of air to move in both extends and retract strokes. They have two ports to allow air in, one for outstroke and one for instroke.

Specifications:

- SMSN Pneumatic cylinder.
- Model: MC16X100.
- Pressure: 1.5- 8 kgf /cm square.



Fig.4.3. Pneumatic Double Acting Actuator

d) Solenoid Valve:

A solenoid valve is an electromechanically operated valve. The valve is controlled by an electric current through a solenoid: A solenoid valve has two main parts: the solenoid and the valve. The solenoid converts electrical energy into mechanical energy which, in turn, opens or closes the valve mechanically.

Specifications:

- SMSN 5/2 Single Solenoid Valve AC220V Coil
- V52006SS – 24VDC ¼”

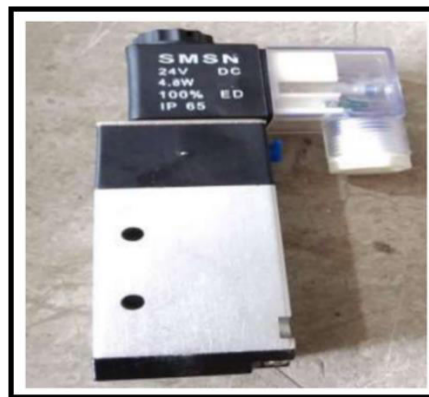


Fig.4.4. SMNS Solenoid Valve

e) Photoelectric Proximity Sensor:

A proximity sensor is a sensor able to detect the presence of nearby objects without any physical contact. A proximity sensor often emits an electromagnetic field or a beam of electromagnetic radiation (infrared, for instance), and looks for changes in the field or return signal. The object being sensed is often referred to as the proximity sensor's target. Different proximity sensor targets demand different sensors. For example, a capacitive proximity sensor or photoelectric sensor might be suitable for a plastic target; an inductive proximity sensor always requires a metal target. We used Photoelectric Proximity Sensor in our project. A photoelectric sensor, or photo eye, is equipment used to discover the distance, absence, or presence of an object by using a light transmitter, often infrared, and a photoelectric receiver.

Specifications:

- JG 8/12/18/30 TYPE
- Detection Range: 1- 30CM
- Detecting Object: Metal, Non-metal, Plastic, Wood etc.



Fig.4.4. Photoelectric Sensor

V. CONSTRUCTION AND WORKING

Construction:

The unit consists of the conveyor belt which is driven by electric motor. The conveyor belt is mounted on the mild steel frame which is fabricated using the angles and channels. At the two ends of the frame, using journal bearing, two drum pulleys are bolted to the frame over which the belt runs. For the drive, the electric motor is used. For the speed reduction, the sub frame is fabricated which is having intermediate shafts. This speed reduction system contains two stage reduction using belt pulley assemblies. For the purpose of idling, the sheet metal is used which also acts as scrubber to reduce the dust on the belt. Then sensors are located on the conveyor belt. For the wiring and electronic assembly, the separate sheet metal block bolted to frame. For the pushing and sorting purpose, the pushing mechanisms are mounted on the frame. This mechanism consists of pneumatic cylinders operated by solenoid valve.

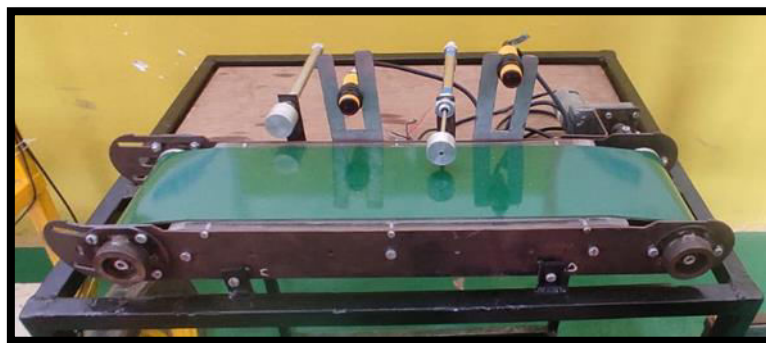


Fig.5.1. Construction of Sorting Machine

Working:

Our working mechanism comprises of objects passing through conveyor belt and their detection according to their size and material and sorted into assigned box through pneumatic system.

- The system is powered ON and the items are fed on conveyer belt.
- Once an item arrives on the conveyer belt, proximity sensors i.e. inductive sensor, capacitive sensor and photo reflective sensors detect the article and differentiate among the construction material of the object (metal, wood and plastic).
- As the material is recognized, the object is then identified by photo reflective sensors placed on three different heights. The sensors' height facilitates in the recognition of small, medium or large sized object.
- If the object is small sized metal, it is pushed by solenoid valve 1 (controlled by PLC) in to the concerned box. Similarly, for large sized metal valve 2 is functioned.



VI. ADVANTAGES

1. Students Understand to how PLC Rejector work.
2. It is useful to mass production.
3. Maintenance cost is low.
4. Less manpower required.
5. More output in Less time.

VII. APPLICATIONS

1. Water Bottle Packaging Plant: The filled water bottles in industry during dispatched can be sorted according their volume capacity.
2. Brick Manufacturing Process: In Brick manufacturing Process the quality of bricks considering their height as a parameter can be checked. If the height is more or less from the original size then the defective bricks can be sorted out.
3. Quality Checking of Solid Objects: If the height of the solid material is taken as a criteria in quality check of that object then this system can be used effectively.
4. In Food Processing Industries: The food packing of the food stuffs of different sizes can be sorted in such type of industries where various quantities of packed food are running on a single line.

VIII. FUTURE SCOPE

It is very useful in wide varieties of industries along with the help of PLC, especially in the sorting process. It ensures remarkable processing capacity as well as peerless performance including color detection. Of course, we need to add high speed DC Motors and sensors with appreciable response to speed up the system for industrial application. Following developments can be done in the system to increase the production rate as well as to minimize cost.

1. Using high quality sensor like Laser sensor we can increase the speed of the process.
2. Objects sorted can be distinguished easily by improving extra circuitry. It is also economical.
3. This system can be used to sort more than one object in one cycle by suitably altering the hardware and software of the system.

IX. CONCLUSION

In this project report, we have tried to create a setup that will decrease human effort and succeeded to an extent by using the low-cost automation system (LAC) to avoid risk, improve accuracy, increase speed of production and reduce the cycle time. Limitations will be there due to the practical difficulties in programming of the project according the availability of the materials and components. This setup can be further improved to a sorting system that sorts the items based on the other physical consideration. This can be achieved using the various sensors. In industry it can be used for sorting of various objects, tools, with high degree of accuracy and quality with an automation. The study and development of PLC Controlled Multilevel Object Sorting System has been performed. Thus, the completion of project work brought better results and let us to study the PLC system

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