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Automated Industrial Waste Separator

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Abstract the amount of waste produced is increasing at a faster rate with the increasing population. Major portion of the waste is dumped as landfill waste and the major problem in solid waste disposal is plastic bottle, metal cans, and glass bottles separation. They are separated manually and recycled so it is necessary to have a suitable solid waste solid waste handling system. Currently there is no such system for it. This paper describes an automated waste segregation, and we are developing a prototype for separating plastic, glass and metal from solid waste material using PLC. This system will use different capacitive, inductive proximity sensors to detect each object which is moving on the conveyor belt and will be segregated into different bins with the help of pneumatic cylinders which will be controlled by PLC.

Keywords —Conveyor belt, PLC, Pneumatic cylinder, Sensors, Waste segregation.

I. INTRODUCTION

Now-a-days the wastes are dumped as landfill waste and the major problem in solid waste disposal is plastic bottles, glass bottles, metal can separation and they are separated manually and recycled. Planning the waste management and recycling for all of the rubbish produced in this country is an enormous task, it involves both logistical planning and scientific knowledge and understanding in order to balance the impact on the environment and the cost effectiveness of the process. There are many challenges facing the waste management and recycling industry but there is also a lot of excellent work going on to ensure that this is an industry to be proud of and one that will continue to secure effective, sustainable and ecologically sound waste management and recycling for many years to come. Waste management and recycling collection can help conserve our planet's natural beauty which can be flawed by thoughtless disposal of waste, fly-tipping and senseless littering.

Literature survey says that the basic method followed usually involves rag pickers who collect and dispose most of the urban solid waste. However, it seems to be time consuming and also segregating waste with their bare hands might cause cuts and bruises due to glassy objects. Infections may also lead to severe illnesses. In addition to a high prevalence of bites of rodents, dogs and other vermin. This system is still at large scale in most parts of the India. Segregation system using RFID is also used where the RFID is considered to be attached to each type of material during manufacturing only to resolve the problem of sorting during the disposal stage of the product. But, the problem arises because of use of RFID scanners in harsh and non-suitable areas, added cost the companies must be ready to bear so that tags are attached to each output product. The other method is making use of microcontroller for segregation. Even this poses some serious problems like more time consumption, not suitable in all types of environments and unable to segregate medical waste, sanitary waste and e-waste properly failing to obey certain rules and regulations imposed by the government in their segregation.

II. AUTOMATED WASTE SEGREGATION SYSTEM

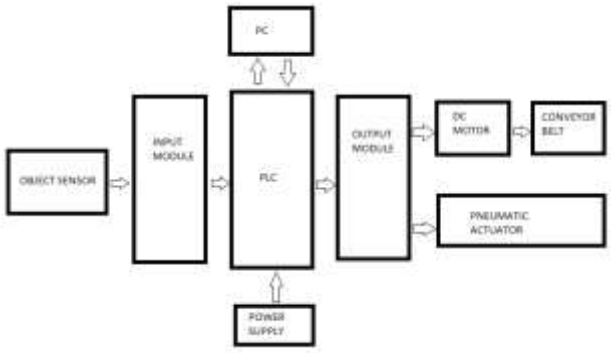


Fig. 1. Block diagram of proposed model

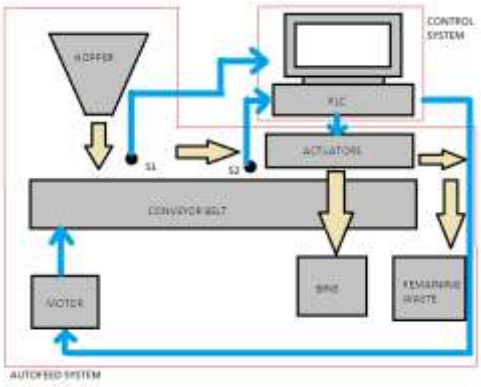


Fig.2. Proposed Model of PLC Based Automatic Waste Segregator

According to above mentioned figure, there are three main systems involved. One is the input module to which the

object detecting, metal, plastic, glass and paper detecting sensors are interfaced.

Along the conveyor belt these all are appropriately arranged with the respective pneumatic cylinders below them and the collecting bins in-front.

Second one which is the heart of whole system is PLC which processes the signals from input modules and performs actions according to the logic diagram written for it. The last is the output module interfaced with the output giving devices. In our case, conveyor belt which starts running as soon as the IR sensor is actuated and cylinders which will expand to act as a flap to push waste into bin.

III. COMPONENTS USED

The main components used in the proposed system are discussed below:

1. Hopper

A hopper is a funnel-shaped device used to move material over the conveyor belt.

Fig. 3. Hopper

2. PLC

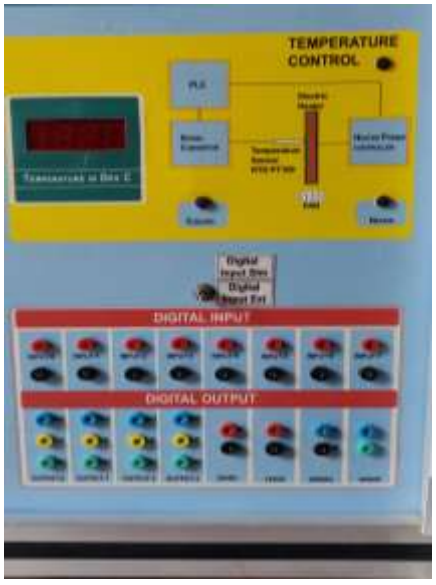


Fig. 4. PLC

PLC s7-300 works as the core of the project. The PLC controls the final control elements. The main function of the s7-300 is to acquire the digital and analog data from input module and vary the output of the system as the input conditions change, this is necessary as the system designed is a real time system.Fig.4 represents the input output module of PLC S7-300.

Input output modules of PLC of S7-300:-

- 16 inputs, electrically isolated in groups of 8.
- 16 outputs, electrically isolated in groups of 8
- Rated input voltage 24 VDC.
- Rated load voltage 24 VDC.
- Inputs suitable for switches and 2-/3-/4-wire proximity switches (BEROs).
- Outputs capable of driving solenoid valves, DC contactors and indicator lights.

The software used for programming the S7-300 PLC is SIMATIC manager as provided by the manufacturer. The program is downloaded from PC into the PLC using a RS232 cable.

3. Sensors

In order to detect few of the materials in the waste considered to either re-use them or to re-cycle, various sensors are used.

(a) IR sensor:

The main motto of this sensor is used to detect the presence of any object on the conveyor belt by emitting the infrared radiations. When the object is detected, it will signal the PLC to start the conveyor if the start button is made on already.

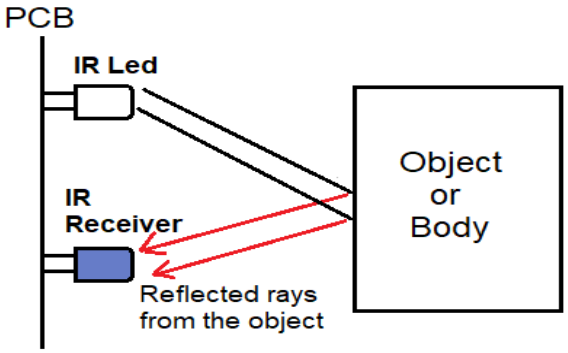


Fig. 5. IR sensor

(b) Metal detection sensor:

Inductive proximity sensors operate on the principle that the inductance of a coil and the power losses in the coil vary as a metallic (or conductive) object is passed near to it.

Thus, is used to sense the metallic wastes and is insensitive to non-metallic wastes.

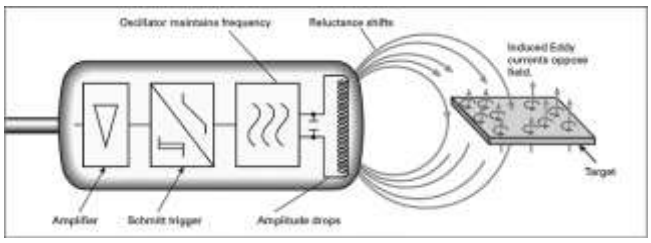


Fig. 6. Inductive sensor

(c) Plastic detection sensor:

Photoelectric sensor with built-in amplifier for detecting clear, plastic bottles. Reliable detection of transparent objects, including thin-walled clear, plastic bottles.

Fig. 7. Photoelectric sensor with built-in amplifier

(d) Proximity capacitive sensor to detect glass and

Paper:

The principle of operation of the sensor is that an internal oscillator will not oscillate until a target material is moved close to the sensor face. The target material varies the capacitance of a capacitor in the face of the sensor that is part of the oscillator circuit.

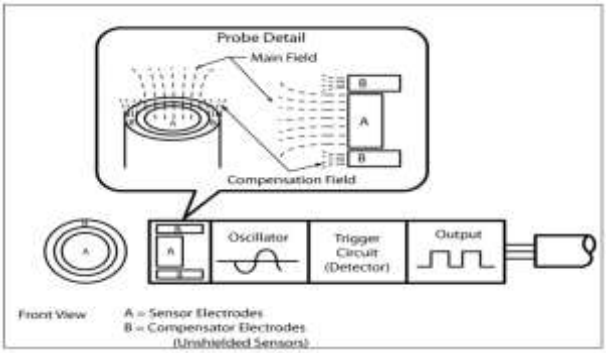


Fig. 6. Capacitive proximity sensor

4. Conveyor belt

A continuously moving conveyor belt is used to which the different object detecting sensors are attached. The materials move over this and are put into respective bins after the sensing mechanism is over with the help of pneumatic cylinders.

Fig. 7. Conveyor belt

5. Pneumatic cylinders

Spring return type single acting cylinder is used in which cylinder is pressurized from only one side due to high force being exerted by fluid during both the extension as well as the retraction process.

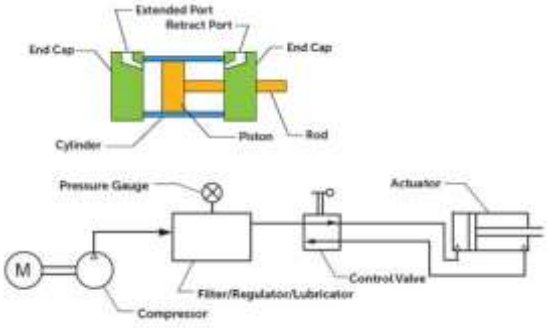


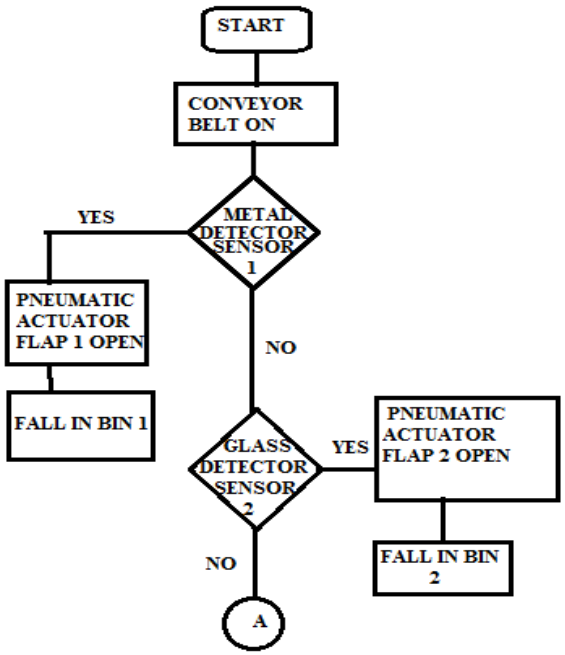
Fig. 7. Pneumatic Cylinder

IV. WORKING AND SIMULATION

The process begins with the waste collection and dumping waste into a large hopper.

At the output of this stage, the waste starts moving on to the long conveyor belt installed. Initially, conveyor starts moving only when the IR sensor is sensed.

Further, upon sensing of individual sensors attached at different locations along the belt, the conveyor belt halts for about 10s and then respective pneumatic cylinders are energized and waste material is pushed to respective bin. Note that at a time only one sensor can sense.



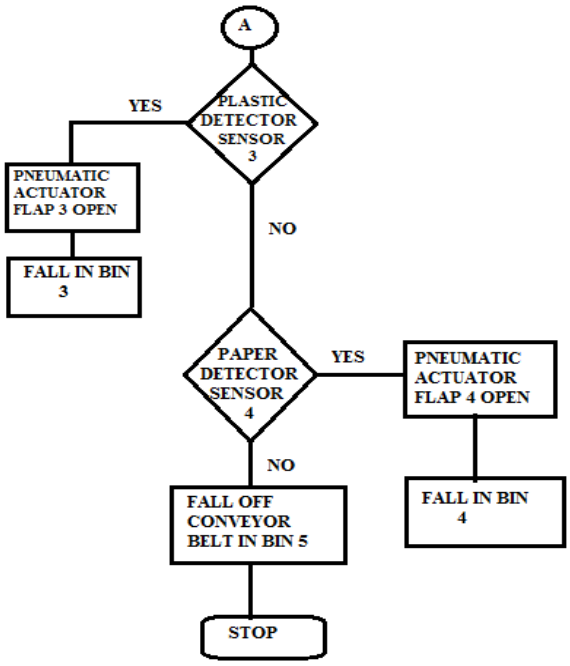


Fig. 8. Process Flow

The ladder diagram for the execution of our logic is as shown in figure 9.

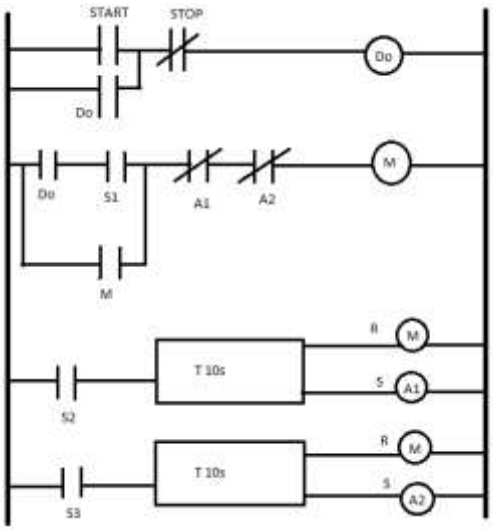


Fig. 9. Ladder diagram

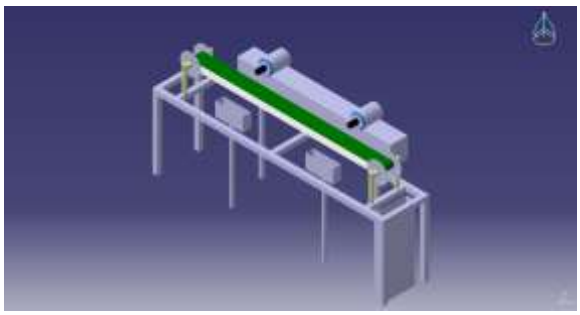


Fig. 10. CAD Model

V. Conclusion

In this paper, we proposed an automatic industrial waste segregating system using the PLC. This system can be implemented in some small and large scale industries to segregate out the metallic, plastic, glass and paper wastes more efficiently at an affordable cost. Use of PLC has added advantages like reduction in manpower with improved accuracy and speed of waste management, also avoiding the risk of working at hazardous places.

VI. Future Scope

In Future, the work can be implemented by making use of a robotic arm to pick and place certain materials which can be re-used. Also, limit sensors can be placed at the top of each of the collecting bins to unload them when they are full. Furthermore we can separate wet and dry waste. Camera sensors can also be used instead of proximity sensors.

Acknowledgment

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