

Design on PLC based Automatic Waste Segregator

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ABSTRACT

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. So it is necessary to have a suitable solid waste treatment plant. The economic value of waste is best realized when it is segregated. Currently there is no such system for it. This paper describes an automated waste segregation. We are developing a prototype for separating plastic, glass bottles and metal cans from solid waste material using programmable logic controller (PLC) S7-300. We will be using different capacitive, proximity sensors etc. to detect each object which is moving on a conveyer belt and will be segregated into different bins with help of gate, which will be all controlled by plc.

Keywords—solid waste; plc; automatic conveyer belt; proximity sensor; gate.

I. INTRODUCTION

Solid waste management has become one of the main issues in both urban and rural areas all over the world. Still the social and cultural response and the techno-economic considerations of the issue have not received the required importance in appropriate planning and application of waste management systems in our country.

Waste management is an important requirement for ecologically sustainable development in many countries. Due to rapid urbanization and uncontrolled growth rate of population municipal solid waste management has become acute in India As per the previous data in india per capital waste generation had increased by 1.3 percent annually with urban population increasing between 3-3.5 percent per annum.

Yearly increase in waste generation is around 5 percent. In India the municipal agencies spend 5-25 percent of their budget on solid waste management

Efficient sorting of waste is a major issue in today's society. Selective sorting is another approach, which is often implemented to improve recycling and reduce the environment. When the waste is segregated into simple stream such as plastic bottles, glass bottles, metal cans, tetrapacks it becomes more easy to recycle them and reuse them .We aim in just doing that ,separating this recyclable solid waste and putting them into individual bins so that they can be distinguished and used separately.PLC helps us just doing that under harsh conditions.

II.SYSTEM DESIGN

Block Diagram description:

The below block diagram mentioned in Fig.1 explains the process in which our project is going to work. It has three main blocks namely:-

1) Input block

The input block is used to interface input devices to the PLC i.e. in our case the sensor that we are using to detect different type of waste and switches etc.

2) PLC

The PLC is the core of our project .The inputs from input module are given to the PLC .PLC processes the program loaded into it and accordingly provides output. The power supply is connected to this PLC.

3) Output block

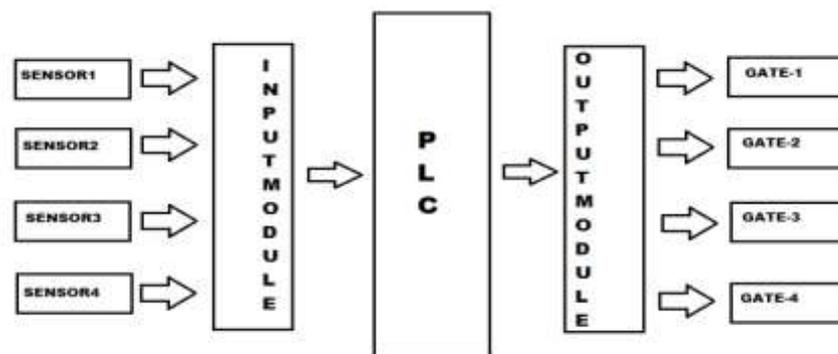


Fig 1: Block diagram of the system

The output block is interfaced with the output giving devices i.e. in our case the conveyor belt and the hydraulic cylinders used as mechanical flaps. It will behave accordingly as commanded by the PLC.

III.LITERATURE REVIEW

1. Normal Waste Segregation method:-

In India, rag pickers play an important role in the collecting, disposing of urban solid waste. This process has its limitation and it was time consuming as well .Rag pickers and conservancy staff have higher morbidity due to infections of skin, respiratory, gastrointestinal tract and multisystem allergic disorders, in addition to a high prevalence of bites of rodents, dogs and other vermin [8].this system is still at large in most parts of India .also there was no emphasis on waste segregation, so segregating recyclable items from amongst other became a tedious task.

2. RFID based Segregation System:-

In this system which applies radio frequency identification for on-line sorting of consumer waste groups can satisfy very important requirement of an efficient waste management system. Not only is the system robust, it is also accurate, can handle vast quantities of plastic and e-waste. The drawback of this system is that 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[6]. Each waste material will have identical types of RFID tags that store the information about the object along with which travels on conveyor belt. So whenever waste comes near the RFID reader it sends the vital information to the RFID reader. Commands and information are exchanged between the RFID reader and RFID tags. This information is used to drop each waste material in their respective bins. Later this information is conveyed to the Arduino microcontroller for further processing. After interpreting the data received from the RFID reader it will be forwarded to remote master embedded system wirelessly. The Zigbee receiver is interfaced with the personal computer which corresponds

Waste material having the RFID tag which contains all information about the product to be coded during manufacturing in the passive tag placed as there are a variety of the tags available to be attached with the material.

It is not viable as not all companies would add to their cost of applying RFID tags to their products thus implementation of such system is difficult and not economical. Also we are dealing with waste products so to use RFID scanner like devices in such harsh and non-suitable condition would only add to the difficulty.

3. Microcontroller based Waste Segregation:-

A simple 8051 microcontroller forms the heart of the system. It controls the working and timing of all the subsections so as to sort the waste. Inductive proximity sensor is used to detect the metallic waste. The signal from the proximity sensor initiates the push mechanism to discard the metallic waste. The timing and movement of the conveyor belt is controlled by 8051 microcontroller. Continuous and unnecessary operation of any particular section is thus avoided.

The main limitations in this type of system are that the waste segregator device or equipment is more rightfully used in harsh and rough conditions. Different parameters such as heat, dust etc. The microcontroller may be more prone to damage. Also the scope for expansion of this equipment may not be possible due to circuit constraints unlike PLC.

Some other limitations are:

1. Segregation of the waste consumes time.

2. E-waste, Sanitary waste and medical waste cannot be segregated by the proposed system as there are certain rules and regulations specified by government to be followed for their segregation

4. PLC Based Automatic Waste Segregator:-

a) Advantages of PLC over other System

The advantages of waste separation systems lie in the modular design, which allows for any required short-term adjustments to the capacity level. The attributes “affordable and high quality” are characteristic for waste sorting systems and waste separation systems.

Every waste separation system can be used flexibly. Waste separation systems can be put in use for local communities, private investors, industry and commerce. The stress of competition forces companies to produce economically and rationally. A higher level of automation demands more and more programmable logic controllers (PLC). The advantage of PLC is the automation with a relatively small amount of cabling and a low error rate [1]. Productivity, flexibility and efficiency with only a few contactors (heavy duty relay) specify the controller. The system is completed by modifications and extensions of functions (without mechanical intervention) as well as by communication with other devices via analog, digital and serial interfaces. With programmable logic controllers, processes can be monitored and operated via

a PC.

b) Design Consideration

This deals with the work flow of the total system from beginning till the end. As mentioned earlier, different modules have to be interconnected in such a way that they function in a proper sequence in a desired manner.

1. Sensors: Object sensor is used to detect whether the waste is glass bottle, plastic bottle, metal can, tetra pack etc.

2. PLC, Computer and power supply for PLC: To take action on input and output as per program logic feed to PLC.

3. Action performing components: It contains rotating conveyor belt, which keeps rotating .It also contains Hydraulic pumps which are used as flaps to route a particular object amongst the selected items to their respective bin.

The following Fig.2 represents the system architecture of our project.

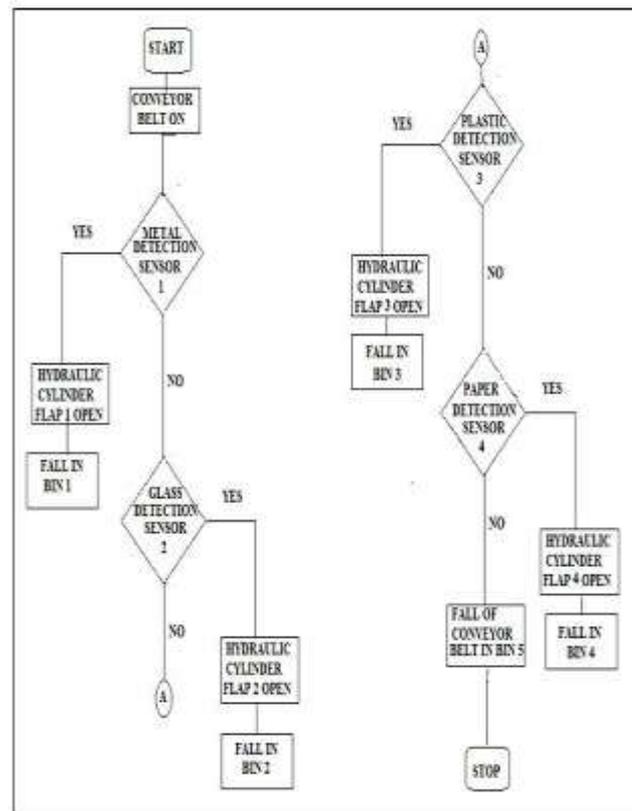


Fig. 2. System Architecture

c) Main components of the system are as follows:-

PLC (Programmable Logic Controller):-

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 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.3 represents the input output module of PLC S7-300

Input output modules of PLC of S7-300 :-

- 16 inputs, electrically isolated in groups of 16.
- 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.

Sensors:-

The objective of the sensor is used to detect the presence of the object on the conveyor belt. When the object is detected the sensor will signal the PLC to start the conveyor. Sensor interfacing is done as shown in following Fig. 4 to the PLC s7-300.

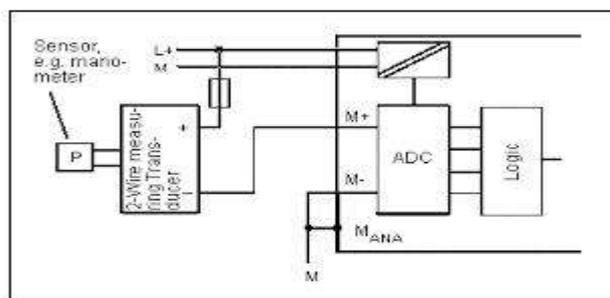


Fig.4 Sensor interfacing with PLC

a) Plastic detection sensor:-



Fig.5.E3FA DP-12 Photoelectric Sensor

Photoelectric Sensor with Built-in Amplifier for Detecting Clear, Plastic Bottles. Reliable Detection of Transparent Objects, Including Thin-walled Clear, Plastic Bottles. Uses OMRON's unique optical system ("Inner View") that can detect various shapes of clear, plastic bottles.

The above Fig. 5 is an image of this photoelectric sensor used to detect plastic in our project. Detect a wide range of bottles from 500-ml bottles to 2-l bottles, and from single bottles to sets of stocked bottles. Provides a high degree of protection (IP67) mutual interference prevention, and EN standard compliance.

b) Metal detection sensor:-

When a metallic object is introduced in the vicinity of the coil, eddy currents are induced on its surface. The eddy currents are a function of the distance, size, surface area and composition of the target.

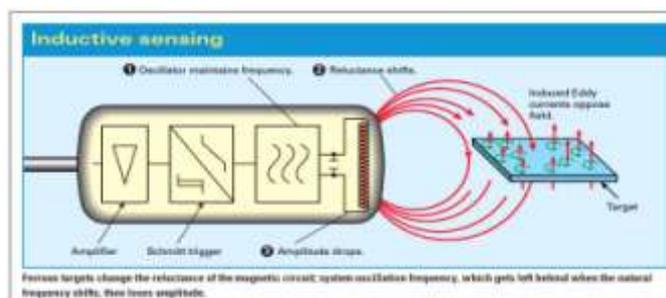


Fig.6 Inductive Sensor

The above Fig. 6 represents the working of inductive sensor. The inductive coupling between the coil and the object creates a mutual inductance effect on the coil which decreases the parallel resonant impedance of the circuit which in turn is reflected by an increase in the proximity count value. Magnetic fields do not affect the metal detection system. It can detect any conducting material irrespective of its magnetic properties

c) Proximity Capacitive sensor to detect glass and paper :-

Capacitive proximity sensors are similar in size, shape, and concept to inductive proximity sensors. However, unlike inductive sensors which use induced magnetic fields to sense objects, capacitive proximity generate an electrostatic field and reacts to changes in capacitance caused when a target enters the electrostatic field. When the capacitance reaches a specified threshold, the oscillator is activated, triggering the output circuit to switch states between ON and OFF. The following Fig. 7 represents the working of capacitive sensor

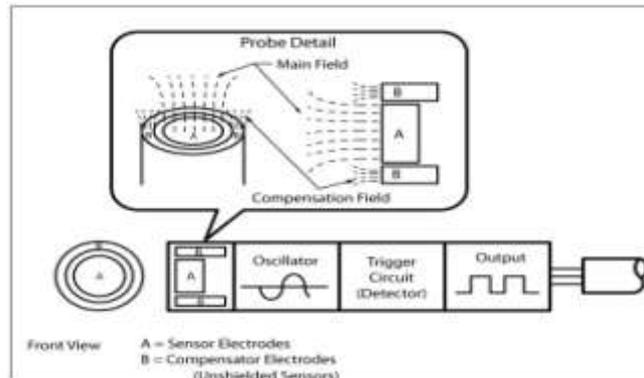


Fig.7.Capacitive Sensor

The larger the target's sizes, the stronger the capacitive coupling between the probe and the target. Materials with higher dielectric constants are easier to detect than those with lower values. The shorter the distance between target and probe, the stronger the capacitive coupling between the probe and the target.

□ Conveyor Belt :-

The system consists of conveyor belt with object sensors clamped on it. The material passes over the conveyor belt get detected by sensor and pushed by hydraulic pump flaps into respective bins.

IV. CONCLUSION

In this paper we presented our work on developing an affordable and efficient method that can sort different categories of plastics bottles, glass bottles, metal cans, and tetra packs quickly and accurately using PLC. The system can segregate only one type of waste at a time as the solid waste material object moves on a conveyor belt one at a time behind each other. The entire sensing module can be placed along a single platform where the object is stable to ensure better result. Automated waste segregation can be largely implemented in various municipal corporations, taking into consideration various factors such as reduction in manpower, avoid risk at hazardous places, improve accuracy, increase speed of waste management etc. **REFERENCE**

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