

# A Review on PLC based Automatic Waste Segregator

Subhasini Dwivedi

Michael Fernandes

Rohit D'souza

**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 hydraulic cylinder flaps, which will be all controlled by plc.

**Keywords**—solid waste; plc;automatic conveyer belt; proximity sensor;mechanical hydraulic cylinders.

## 1.INTRODUCTION

Solid waste management has become one of the main issues in both urban and rural areas all over the world[4]. 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[1].

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

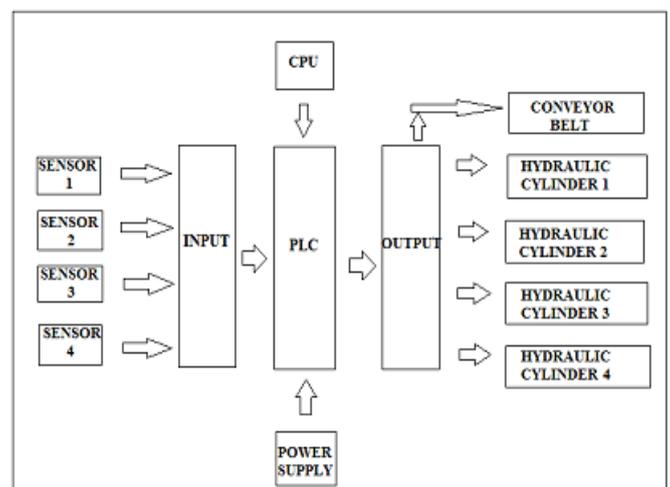


Fig.1. Block Diagram of PLC based Automatic Waste Segregator

### Block Diagram description

The above 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

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Prof. Subhasini Dwivedi, Electronics & Telecommunication, St. John College of Engineering & Technology, Palghar, India, Mobile No-+91-8652518267,

Michael Fernandes, Electronics & Telecommunication, St. John College of Engineering & Technology, Palghar, India, Mobile No-+91-9833805854,

Rohit D'souza, Electronics & Telecommunication, St. John College of Engineering & Technology, Palghar, India, Mobile No-+91- 9970846282.

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 stores the information about the object along with which travels on conveyer 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 the each waste material in their respective beans. 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 the corresponded Waste material having the RFID tag which contents the 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. [7]

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 is 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 Systems

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.

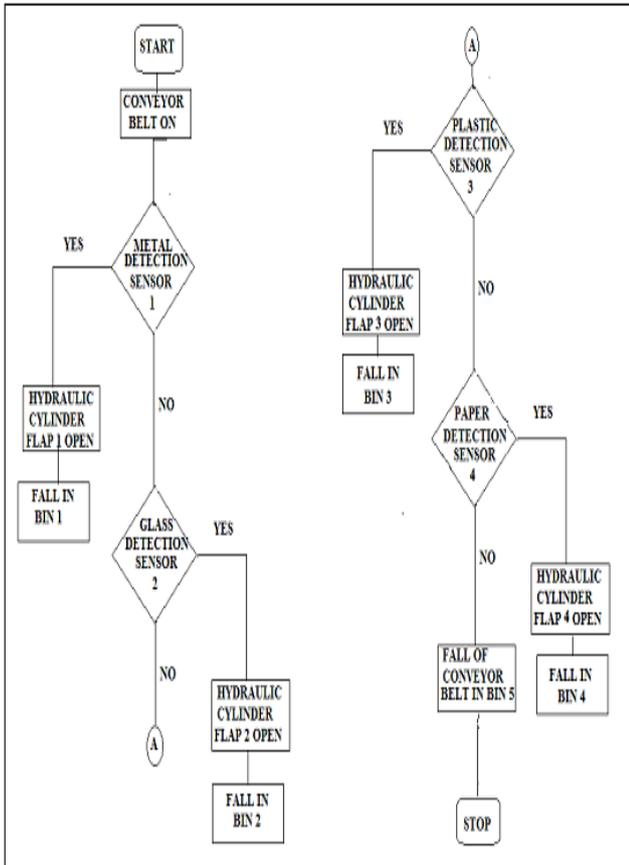


Fig. 2. System Architecture

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.

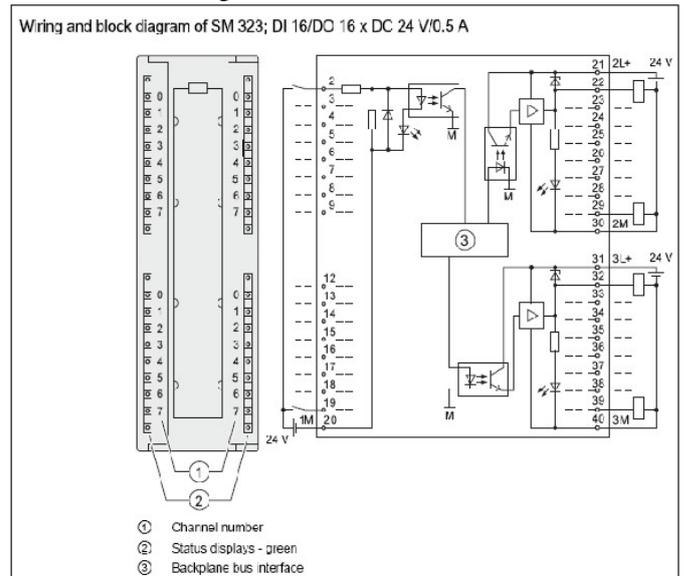


Fig. 3. Input/Output module of PLC S7-300

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.

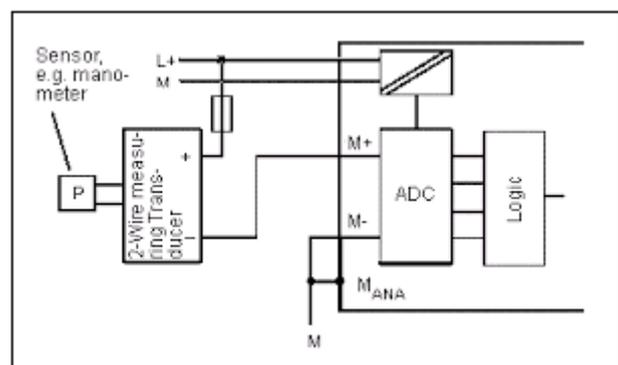


Fig.4 Sensor interfacing with PLC

a) Plastic detection sensor:-

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.



Fig.5.E3FA DP-12 Photoelectric Sensor

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.

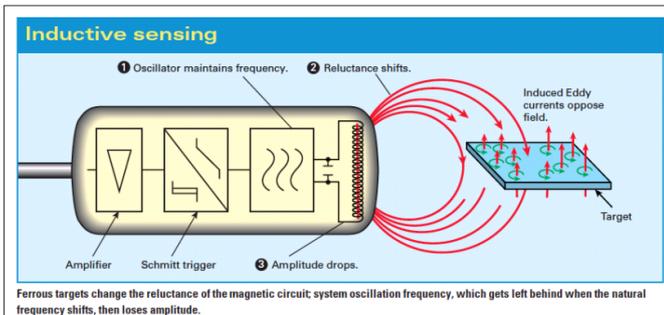


Fig.6 Inductive Sensor

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

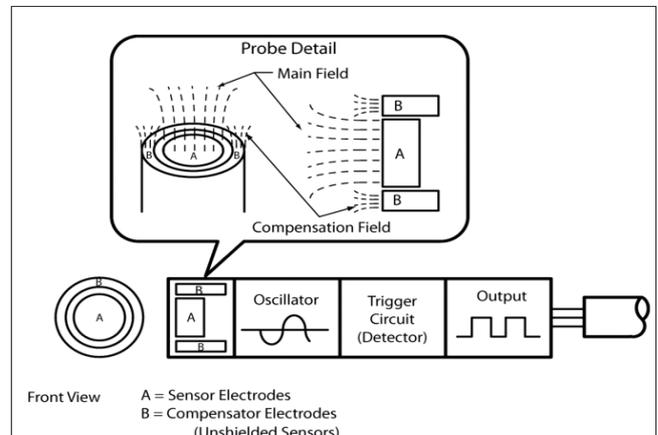


Fig.7.Capacitive Sensor

The larger the target's size, 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.

- Hydraulic cylinders :-

The hydraulic pressure in these cylinders is in the form of hydraulic fuels that are stored under pressure in these cylinders. The energy stored in these oils is converted into motion. In a complete hydraulic system, a hydraulic motor consists of one or more hydraulic cylinders. A pump regulates the oil-flow in the hydraulic system. The hydraulic cylinders initiate the pressure of the oil, which cannot be more than that required by the load.

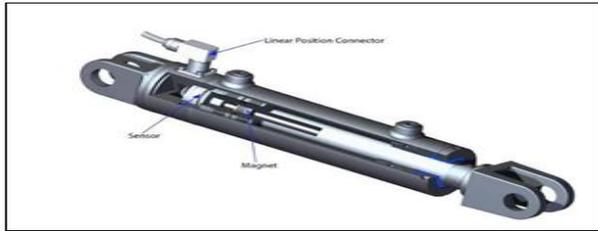


Fig .8. Hydraulic Cylinder

The above Fig. 8 represents the image of an hydraulic cylinder. In single acting cylinders the fluid is pressurized from only one side of the cylinder during both the expansion as well as the retraction process. A spring or an external load is used to return the cylinder top to its original position i.e. when pressure of the fluid is cut off. We are using this hydraulic cylinder as mechanical flap to route the particular waste to its respective bin.

#### 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.

#### V. FUTURE SCOPE

- The use of PLC gives this project a vast scope for future.
- We can implement additional sensors to detect more objects and segregate them depending upon the input output module of the PLC.
- A robotic arm can be used to reposition an object in certain direction.
- Feeder can be used to first separate the waste first into dry and wet waste.
- Camera sensors instead of analog sensors can be used where the camera will detect an object based on object defined in its program

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#### REFERENCES

- [1] S.M .Dudhal1, B. S. Jonwal2, Prof. H. P. Chaudhari3, "Waste Segregation Using Programmable Logic Controller", International Journal For Technological Research In Engineering Volume 1, Issue 8, April-2014 ISSN
- [2] Shubham Thakker , R.Narayanamoorthi , "Smart and Wireless Waste Management", IEEE Sponsored 2nd International Conference on Innovations in Information Embedded and Communication Systems ICIIECS'15
- [3] John W Carson ,Greg Petro, "How to design reliable and efficient feeders for Bulk Solid Bulk conveyors for bulk materials", Second edition, Conveyor Equipment Manufacturers Association (CEMA).
- [4] Joice Johny1, Abin Joy2, Della Sunny3, Basil M Joseph4 & Shaji M Jamal5 , "Automatic Plastic Separating Technology For Solid Waste Disposal", International Journal of Civil, Structural, Environmental and Infrastructure Engineering Research and Development (JCSEIERD)ISSN 2249-6866Vol. 3, Issue 2, Jun 2013, 99-108 © TJPRC Pvt. Ltd
- [5] Nidhi Mishra1, Rakhi T. Waghmare2, Rani B. Phulpagar3, Pooja A. Londhe4 , "Plc Based Scrap Management System",Rani B. Phulpagar et al Int. Journal of Engineering Research and Applications ISSN : 2248-9622, Vol. 4, Issue 3( Version 1), March 2014, pp.26-2.
- [6] Prof. Mr. P. Balramdu, Prof. Mr. Manoj Kumar, Mr. Chape Laxman Murlidhar, Mr.Wankhade Sachin Sudamrao, Mr.Phalka Ulhas,Mr.Kotkar Narhari Ramkrushna, " Remote Monitoring and Sorting System for Waste Material Management Using RFID",International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 3 Issue 10, October 2014.
- [7] M.K.Pushpa1, Aayushi Gupta2, Shariq Mohammed Shaikh3, Stuti Jha4, Suchitra V5, "Microcontroller Based Automatic Waste Segregator",International Journal Of Innovative Research In Electrical, Electronics, Instrumentation And Control Engineering vol. 3, Issue 5, May 2015.
- [8] Amrutha Chandramohan, Joyal Mendonca, Nikhil Ravi Shankar, Nikhil U Baheti, NitinKumar Krishnan Suma M S, "Automated Waste Segregator",Rashtrreeya Vidyalaya College Of Engineering (R.V.C.E)
- [9] Yann Glouche ,Paul Couderc, "A Smart Waste Management with Self-Describing objects", SMART 2013 : The Second International Conference on Smart Systems, Devices and Technologies.

#### Authors



**Prof. Subhasini Dwivedi** has completed her Master's degree in Electronics and Telecommunication at Vidyalankar Institute of Technology, Wadala, India. She has completed her Bachelor degree in 2011 from Mumbai University in EXTC. She is currently working as an Assistant Professor at St.John College of Engineering & Technology, Palghar, India and has total 3yrs of teaching experience. She has published two paper's in International journal and one paper in International conference linked with IEEE digital library Her area of interests lie's in the field Wireless Communication & Automation .

Telecommunication from St.John College of Engineering & Technology. He is working & on



**Michael Fernandes** is an under Graduate student pursuing his bachelor's degree in Electronics &

current project mentioned in this paper under the guidance of Prof. Subhasini Dwivedi, Assistant Professor in EXTC Department.



**Rohit D'souza** is an under Graduate student pursuing his bachelor's degree in Electronics Telecommunication from St.John College of Engineering & Technology. He is working & on the current project mentioned in this paper under guidance of Prof. Subhasini Dwivedi, Assistant Professor in EXTC Department.