Automatic Scrap Segregation using PLC

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***Abstract*— This paper deals with the problems faced while segregation of waste in urban and rural areas. Rapid surge in bulk and different types of metal and nonmetal scrap is serious issue due to urbanization and industrialization in the countries. Hence, we have segregate the scrap materials into metal and nonmetal categories using PLC mechanism. Also the aim of using PLC mechanism or any other type of separation of waste on a machine is to perform work. This system describes an Automated Scrap Segregation; we are developing a prototype for separating out metal and nonmetal particles using Programmable Logic Controller. In this system the scrap will be fed to the conveyor belt. Object Sensors will detect the Scrap material on the conveyor belt and start the rotation of conveyor belt. After this, metal Sensors which are clamped below the conveyor belt, will sense the metal particles and in turn stop the conveyor belt. A robotic arm attached to the system will extract the metal and will deposit it into a metal bin. The scrap material will be carried on further once the metal is extracted and dumped into a metal bin.**

Keywords **— Programming Logic Controller (PLC), Sensors, Relays, Robotic arm, Conveyor belt and DC Motor.**

I. INTRODUCTION

There are certain wastes / garbage items are kept aside to be sold to Kabadiwala or the Person who Buy old items. These can newspaper, used bottles, magazines, carry bags, old books, Oil cans, Glass, Paper Etc. This is one form of Segregation of waste, which is done at almost all households. Segregation our waste is essential as the amount of waste being generated today caused immense problem. There are certain items are not Bio Degradable but can be reused or recycled in fact it is believed that a larger portion of the waste can be recycled, a part of can be converted to compost, and only a smaller portion of it is real waste that has no use and has to be discarded. Household waste should be separated daily into different dustbins for the different categories of waste such as Wet & Dry Waste which should be disposed of separately. Wet wastes, which consist of leftover foodstuff, vegetables, peels etc. should be put in a compost pit and compost can be used as manure in the garden. Dry waste consisting of cans, aluminum foils, plastics, metal, glass and paper could be recycled. One should also keep a dustbin for toxic wastes such as medicines, batteries, dried paints, old bulbs and dried shoe polish. If we do not dispose of the waste in a systematic manner than more than 1400 sq. km of land which the size of the city of Delhi would be required in the country by the year 2047 to dispose of it. 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, tetra packs 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. A PLC is a digitally operating electronic device which uses a programmable memory for internal storage of instructions for implementing specific functions, such as logic sequencing, timing, counting and control through digital or analog input/output modules. PLC's are real-time controllers with cyclic behavior. Each cycle consists of three steps. The first step scans the inputs to the controller and maps a picture of the input status into the controller memory. After that a program stored in the controller memory is processed, taking into account the memory image of the inputs. As a result, an image of the outputs is produced. In the third step the image of the output variables is mapped to the actual outputs.

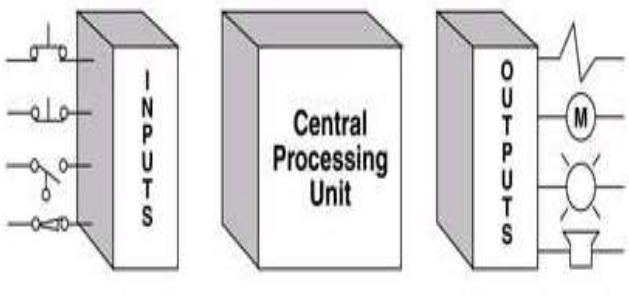

Fig.1 PLC System

II. LITERATURE SURVEY

- M.K Pushpa [9] describes paper about microcontroller based automatic waste segregator. The proposed system uses an inductive proximity sensor to detect metal waste and blower mechanism to segregate between wet and dry wastes. A simple 8051 microcontroller forms the heart of the system. It controls the working and timing of the entire sub sections.
- Dipak Aphale and Vikas Kusekar [11] described paper on "PLC Based Pick and Place Robot with 4 DOF". In this project, the robot picks the object using electromagnetic gripper which is simple in construction and also cost effective.
- Sanjay Prakash Dabadea and Rohan Prakash Chumbleb [12] described paper on "Automatic Sorting Machine

Using Conveyor Belt". This project designs the automated sorting machine using conveyor belt to need the manufacturing industry in many fields.

- Kelvin Erickson's [13] described paper on "Programmable Logic Controllers" gives necessary knowledge about the PLCs, their architecture and functioning.
- Nidhi Mishra, Rakhi T. Waghmare, Rani B. Phulpagar, Pooja A. Londhe [14] described paper on "Plc Based Scrap Management System". This paper describes a scrap management mechanism for scrap storage using PLC.
- Pavithra [10] describes paper deals with a smart trash system with the integration of communication technologies like ZigBee, for truck monitoring system. The system consists of IR sensor to sense the level of trash, gas sensor to sense the amount of toxic gases and ZigBee for the communication purpose. The technologies which are used in the proposed system are good enough to ensure the practical and perfect for solid waste collection process monitoring and management for green environment. The smart trash receptacle, gives a solution for unsanitary environmental condition in a city. This prevents many diseases caused due the toxic gases emanating from the overflowing trash can.
- S.M Dudhal [2] describes paper deals with waste segregation using programmable logic controller. The system is developed for separating out metal from waste materials. The system consists of an automatic feed system through which waste is fed into a conveyor belt, sensors and a robotic arm to which an electromagnet is attached will extract the metal from the waste and will deposit it into a bin.

III. ARCHITECTURE DESIGN

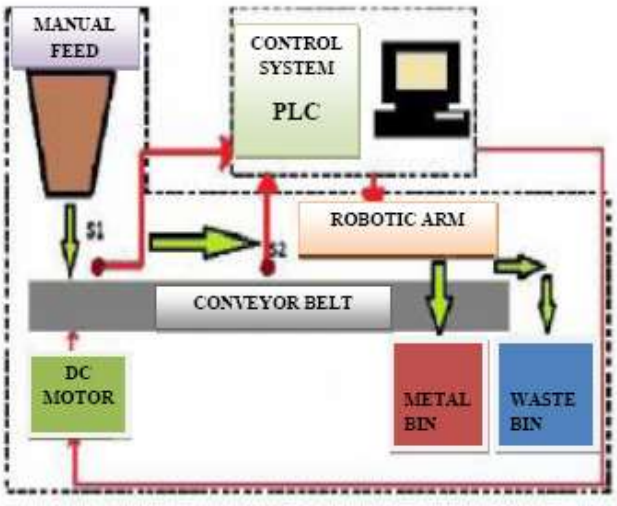

Fig. 2 Design Consideration of Scrap Segregation using PLC

A. Delta PLC

Fig. 3 DVP-14SS Type Delta PLC

Features:

- PLC is compact and easy-to-use.
- Its operation is easy, anyone understands its operation easily.
- We can easily modify functions without consuming more time.
- The controller can use in any ambient condition without damaging it.
- It has temperature range from -40/-25 °C to +70 °C
- We can simulate the ladder logic using WPL soft simulation.

Specifications:

- Supply voltage: 24VDC (-15%~20%)
- Digital inputs: Total 8, 4 are used for analog
- Digital outputs: 6 digital outputs
- Fuse 2A/250VAC
- Power Consumption 3.5W
- Insulation Resistance > 5 MΩ at 500 VDC (Between all Inputs / Outputs and earth)
- Expandable with additional Module.

B. Conveyor Belt

The system consists of conveyor belt with object sensors clamped on it. The material passes over the conveyor and metal present it is extracted with the help of robotic arm. A 12V DC servomotor is used to move the belt. This high torque motor derives the necessary 12V and 2A current from an AC to DC converter. The start and stop of the belt is controlled using sensors. The sensor makes and breaks the circuit between the converter and motor to start and stop it respectively.

1) Nylon Fabric (NN): Nylon fabric is the principal material of the carcass, which nearly has all necessary properties as the tension member of conveyor belt.

- High tensile Strength
- High Impact Resistance
- High Bending Resistance
- Wide Selection Available
- Little Flexuous Fatigue
- Light Weight
- High Adhesion Strength
- Excellent Resistance to Water

2) Polyester-Polyamide (EP): The EP fabrics have Polyester as the warp and Polyamide as the weft. This combination gives the best possible fabric characteristics with the following advantages:

- High strength in proportion to weight
- High resistance to impact
- Negligible elongation
- Great flexibility, excellent trough ability
- Not susceptible to humidity and micro-organisms

C. DC Motor

10 RPM Side Shaft 37mm Diameter Compact DC Gear Motor is suitable for small robots / automation systems. It has sturdy construction with gear box built to handle stall torque produced by the motor. Drive shaft is supported from both sides with metal bushes. Motor runs smoothly from 4V to 12V and gives 10 RPM at 12V. Motor has 6mm diameter, 22mm length drive shaft with D shape for excellent coupling.

Fig. 5 DC Gear motor

Important Note: This motor will be bit noisy while running. For long life, this motor is not recommended for application requiring dynamic torque of more than 3 kg-cm.

Specifications

- RPM: 10 at 12V
- Voltage: 4V to 12V
- Stall torque: 38 Kg-cm at stall current of 1.3 Amp.
- Shaft diameter: 6mm
- Shaft length: 22mm
- Gear assembly: Spur
- Brush type: Carbon
- Motor weight: 150gms
- Dimension: Refer to diagram below

D. Sensors

Sensors allow a PLC to detect the state of a process. Logical sensors can only detect a state that is either true or false. Examples of physical phenomena that are typically detected are listed below.

1) Photoelectric sensor: It is type of position sensing device. Photoelectric sensors use a modulated light beam that is either broken or reflected by the target. The control consists of an emitter (light source), a receiver to detect the emitted light, and associated electronics that evaluate and amplify the detected signal causing the photo electric's output switch to change state. We are all familiar with the simple application of a photoelectric sensor placed in the entrance of a store to alert the presence of a customer. This, of course, is only one possible application. Siemens offers a wide variety of photoelectric sensors, including thru-beam, retro reflective scan, and diffuse scan sensors. There are many photoelectric sensors to choose from. Choice depends on many factors such as scan mode, operating voltage, environment, and output configurations. Most of these sensors can be used with some or all scan techniques. In addition, specialized sensors such as fiber optic, laser, and color sensors are available.

TABLE I
TYPES OF PHOTOELECTRIC SENSORS

Types	Advantages	Disadvantages
Through-Beam	Most accurate Longest sensing range Very reliable	Must install at two points on system: emitter and receiver Costly - must purchase both emitter and receiver
Reflective	Only slightly less accurate than through-beam Sensing range better than diffuse Very reliable	Must install at two points on system: sensor and reflector Slightly more costly than diffuse Sensing range less than through-beam
Diffuse	Only install at one point Cost less than through-beam or reflective	Less accurate than through-beam or reflective More setup time involved

2) Inductive Sensors: Inductive proximity sensors enable the detection, without contact, of metal objects at distances of up to 60 mm. Their range of applications is very extensive and includes: the monitoring of machine parts (cams, mechanical stops, etc.), monitoring the flow of metal parts, counting, etc. Advantages of inductive sensors are:

- No physical contact with the object to be detected, thus avoiding wear and enabling fragile or freshly painted objects to be detected.
- High operating rates.
- Fast response.
- Excellent resistance to industrial environments (robust products, fully encapsulated in resin).
- Solid state technology: no moving parts, therefore service life of sensor independent of the number of operating cycles.

Inductive proximity sensors are solely for the detection of metal objects. They basically comprise an oscillator whose windings constitute the sensing face. An alternating magnetic field is generated in front of these windings.

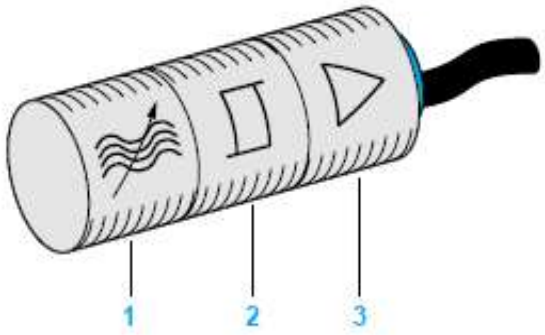

Fig. 7 Internal Design of Inductive Sensor

Composition of an inductive proximity sensor
1 Oscillator
2 Output drivers
3 Output stage
When a metal object is placed within the magnetic field generated by the sensor, the resulting currents induced form an additional load and the oscillation ceases.
This causes the output driver to operate and, depending on the sensor type a NO, NC or NO + NC (complementary) output signal is produced.

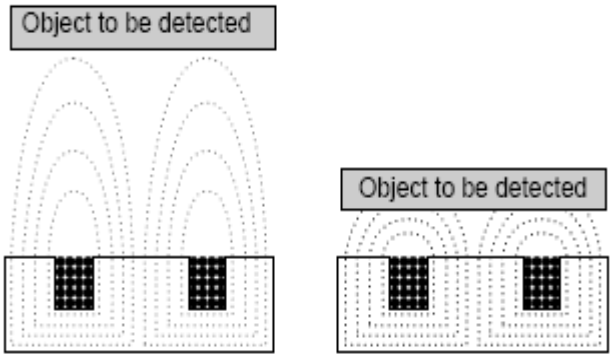

Fig. 8 Object Detection Techniques of Sensor

E. Robotic Arm

A Robotic Arm attached to the system delivers fast, accurate and repeatable movement. When metal is detected by the metal detector, the conveyor belt stops and control signal given to the Robotic arm by PLC is drop/push the metal particles into its respective bin.

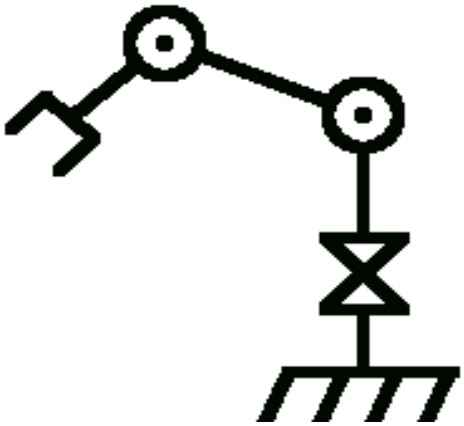

Fig. 9 Design of Robot Arm

IV. Applications And Advantages

This prototype result in various applications such as industries, homes, offices, hospitals and other places taking into consideration of various Advantages such as:
1. Reduction in manpower
2. Avoid risk at hazardous places
3. Improve accuracy
4. Increase speed of production
5. Minimizes raw materials wastage
6. Reduced manufacturing costs.
7. Keeps the environment clean and fresh
8. Reduces the environment pollution.

V. Conclusion

In this paper, we proposed an automatic waste segregating system using the PLC. The system separates out the metal and nonmetal scrap along with few components detection and separation. This system can be implemented at the municipal level or in some small scale industries to segregate out the metallic, plastic, glass and paper wastes more efficiently at an affordable cost. Use of PLC has added some advantages. An efficient waste management system is the need of the hour. This automatic waste segregator is one small step towards building an efficacious and economic waste collection system with minimum amount of human intervention. The use of PLC gives this project a vast scope for future.

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