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**Rajarambapu Institute of Technology, Sakharale**

(An Autonomous Institute Affiliated to Shivaji University, Kolhapur)



**S.Y. B.Tech**

## **ELECTRONICS & TELECOMMUNICATION ENGINEERING**

**PROJECT ON**

**“Automatic Waste Segregator”**

**BY**

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**UNDER THE GUIDANCE OF**

Ms. Kasturi S. Patil

# DECLARATION

We, the undersigned, hereby declare that this project is a genuine work conducted by us through practical on – site observations, and the data collected by us is true to the extent of our awareness.

**Date:**        /        / **2016-17**

**Signatures of the Students in the Project:**

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# CERTIFICATE

This is to certify that below mentioned students of S.Y.B.Tech have successfully completed the project entitled ***“Automatic Waste Segregator”*** for Environmental Science 2016-17.

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## Automatic Waste Segregator

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## ABSTRACT

Modern world meets lots of challenges that includes Smart waste management system. It is become matter of big concern if proper disposal system is not managed. Managing waste effectively and recycling efficiently, a nation can ahead one step forward. In this work, an automatic sorter machine is developed which can sort out the wastes in various categories to make waste management easier and efficient. It can be possible to sort out Metallic, dry and wet waste by developing an electromechanical system using arduino and servo motor. For sorting metal conventional sensors are used and for sorting wet waste moisture sensor is used. An IR sensor is used to find out the arrival and it can be also used to determine the amount sorted materials. By using the proper recycling system, the curse of waste will turn into blessings for the civilization. The sorting procedure will make recycling more efficient. By means of this waste sorter, the conventional waste management system will be transformed into SMART system. This SMART system will help to make our environment more suitable for living, reducing global warming and making the world healthier.

*Keywords:* Arduino UNO, Moisture Sensor, IR Sensor, Inductive Sensor, Servo Motor.

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# CHAPTER 1

## INTRODUCTION



## 1.1 Introduction:

In recent times, garbage disposal has become a huge cause for concern in the world. A voluminous amount of waste that is generated is disposed by means which have an adverse effect on the environment.

The common method of disposal of the waste is by unplanned and uncontrolled open dumping at the landfill sites. This method is injurious to human health, plant and animal life. This harmful method of waste disposal can generate liquid leachate which contaminate surface and ground waters; can harbour disease vectors which spread harmful diseases; can degrade aesthetic value of the natural environment and it is an unavailing use of land resources.

In India, rag pickers play an important role in the recycling of urban solid waste. 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. Dependency on the rag-pickers can be diminished if segregation takes place at the source of municipal waste generation.

The economic value of the waste generated is not realised unless it is recycled completely. Several advancements in technology has also allowed the refuse to be processed into useful entities such as Waste to Energy, where the waste can be used to generate synthetic gas (syngas) made up of carbon monoxide and hydrogen. The gas is then burnt to produce electricity and steam; Waste to Fuel, where the waste can be utilized to generate bio fuels.

When the waste is segregated into basic streams such as wet, dry and metallic, the waste has a higher potential of recovery, and consequently, recycled and reused. The wet waste fraction is often converted either into compost or methane-gas or both. Compost can replace demand for chemical fertilisers, and biogas can be used as a source of energy. The metallic waste could be reused or recycled.









Even though there are large scale industrial waste segregators present, it is always much better to segregate the waste at the source itself. The benefits of doing so are that a higher quality of the material is retained for recycling which means that more value could be recovered from the waste. The occupational hazard for waste workers is reduced. Also, the segregated waste could be directly sent to the recycling and processing plant instead of sending it to the segregation plant then to the recycling plant.

Currently there is no system of segregation of dry, wet and metallic wastes at a household level. J.S. Bajaj has recommended that a least cost, most appropriate technological

option for safe management should be developed. The purpose of this project is the realization of a compact, low cost and user friendly segregation system for urban households to streamline the waste management process.

### **1.2 Aim & Objectives :**

To design and develop an Automatic Waste Segregator for sorting the waste materials

-  Selection of Components
-  Analyzing the performance of sensors and other components
-  To design and develop the waste segregator
-  To develop a program for segregation of waste
-  To identify the type of waste
-  Rotation of DC motor at the arrival of waste
-  Rotation of the servo motor according to the waste
-  Checking and analyzing the performance of segregator

### **1.3 Concluding Remark:-**

This chapter describes need of automatic waste segregator. It describes use of waste sorter in different fields. Automatic waste segregator requires three sensors IR sensor, Inductive sensor and moisture sensor. It also requires a servo motor which distinguishes the waste in the container which carries the waste. For reducing the human efforts the automated waste segregator is used.

## CHAPTER 2

### LITERATURE REVIEW

## 2.1 Introduction:-

In this chapter literature survey is included. Automatic waste segregator has been developed using arduino as well as 8051 micro-controller, recent papers journals, references and reference books etc.

## 2.2 Literature Review:-

**Subhasini Dwivedi** proposes a solid waste treatment plant for separating plastic, glass bottles and metal cans from solid waste material. The system uses different capacitive, proximity sensors to detect each object which is moving on a conveyer belt and segregate into different bins with the help of hydraulic cylinder flaps. The entire system is controlled by a programmable logic controller (PLC) S7-300.

**S.M .Dudhal** 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.

**Ruveena Singh** describes about a smart waste sorting system which automatically segregate waste into two categories namely degradable and biodegradable wastes. The proposed system consists of a lid, on which the waste material is placed. There is a sensor which transmits the signals and that signal is received by the microcontroller, depending on the signal received the lid of the system works and put the waste into corresponding bin.

**Pavithra** 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 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.

**M.K Pushpa** 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.

These were the some of the research papers and journals at international level. In the journals they have used various different methods to sort the waste materials. Some of the methods are explained below:

#### 1. *Normal Waste Segregation method:-*

In India, rag pickers play an important role in the collecting and 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. 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. 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 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 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. Micro-controller 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 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:-

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 PC.

### 2.3 Concluding Remark :-

In this chapter literature survey is carried out. From this we conclude that need of Automatic Waste Segregator which reduces time, cost and human efforts. In this chapter we have seen various techniques for segregation of the waste.

## **CHAPTER 3**

### **HARDWARE SELECTION FOR PROJECT**

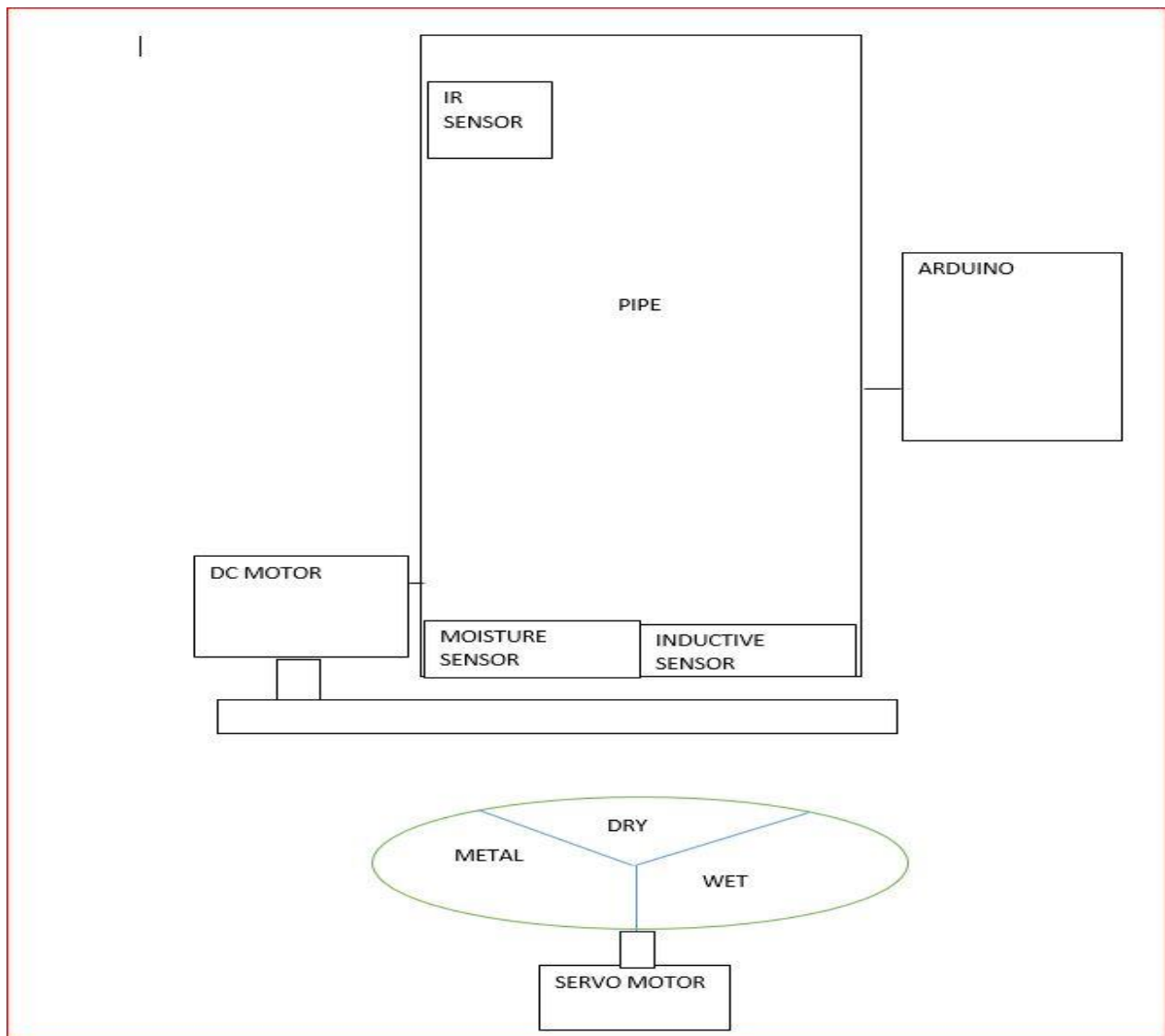


### 3.1 Introduction:-

This section describes the outline of the proposed work, proposed block diagram of the system. Hardware implementation includes selection of sensors, arduino, dc motor and servo motor. In this system, sensors acts as input to the arduino and the motors are the output to the arduino.

### 3.2 Outline of project:-

The proposed system is about separation of garbage. For separation of garbage, sensors are used. Here sensors play important role in separation.



**Figure 3.1 Typical Block Diagram of Proposed System**

### 3.3 Hardware Details:

It consists of following parts:-

#### 1. IR SENSOR:

Infrared technology addresses a wide variety of wireless applications. The main areas are sensing and remote controls. In the electromagnetic spectrum, the infrared portion is divided into three regions: near infrared region, mid infrared region and far infrared region. The wavelengths of these regions and their applications are shown below:

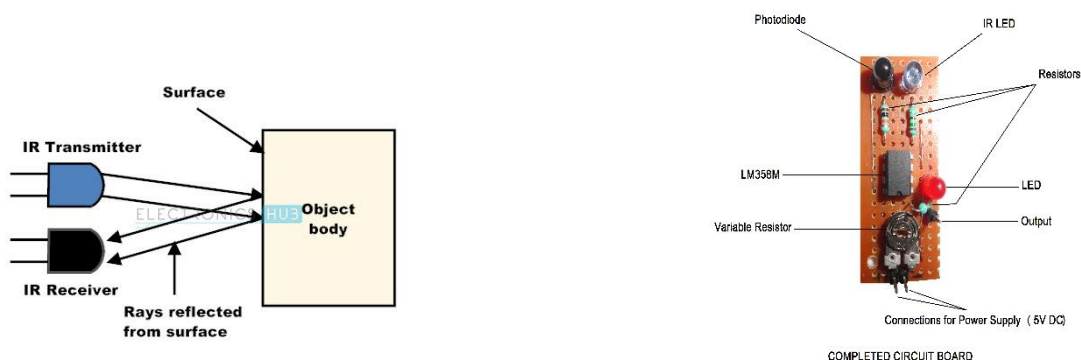
Near infrared region — 700 nm to 1400 nm — IR sensors, fiber optic

Mid infrared region — 1400 nm to 3000 nm — Heat sensing

Far infrared region — 3000 nm to 1 mm — Thermal imaging

#### Principle of Working

The principle of an IR sensor working as an Object Detection Sensor can be explained using the following figure. An IR sensor consists of an IR LED and an IR Photodiode; together they are called as Photo – Coupler or Opto – Coupler.



**Figure 3.2 a) Block Diagram of IR Sensor, b) IR Sensor**

When the IR transmitter emits radiation, it reaches the object and some of the radiation reflects back to the IR receiver. Based on the intensity of the reception by the IR receiver, the output of the sensor is defined.

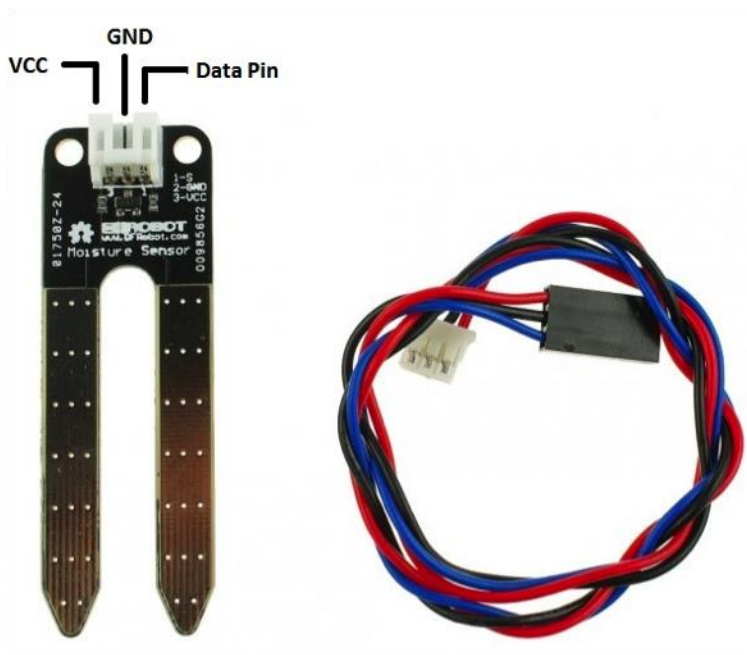
## 2. MOISTURE SENSOR:

### Introduction:

This sensor detect any wet object by measuring its resistance.

### Sensor description:

This DFRobot moisture sensor has two probes through which current passes in soil, then read the resistance of wet garbage for reading moisture level. We know that water make the garbage more prone to electric conductivity resulting less resistance in garbage where on the other hand dry garbage has poor electrical conductivity thus more resistance in garbage. Using these properties of electricity the sensor is designed. Inside the sensor there are circuitry for measuring the resistance and converting it into voltage as output.



**Figure 3.3 Moisture Sensor**

### Features:

- ✚ Supply voltage: 3.3v – 5v
- ✚ Output voltage: 0- 4.2 v
- ✚ Current: 35mA
- ✚ Low power consumption

### Application:

- ✚ Irrigation controller
- ✚ Gardening
- ✚ Water sensor
- ✚ Wet object sensing

### 3. INDUCTIVE SENSOR:

This metal sensor are inductive sensors. Which means that it induces current when metal is near to it. This sensor is a non-contact electronic sensor that is used detect positions of a metal objects. The sensing range depend on the type of metal being detected. Ferrous Metal, such as iron and steel, allow for a longer sensing range, while nonferrous metal objects such as aluminum, copper, can reduce the sensing range by 60 percent. Since the output of an induction sensor has two possible states, an inductive sensor sometimes referred to as an inductive proximity switch.

This sensor consist an induction loop, electric current generates a magnetic field, which collapses generating a current that falls toward zero from its initial trans when the input electricity stops.

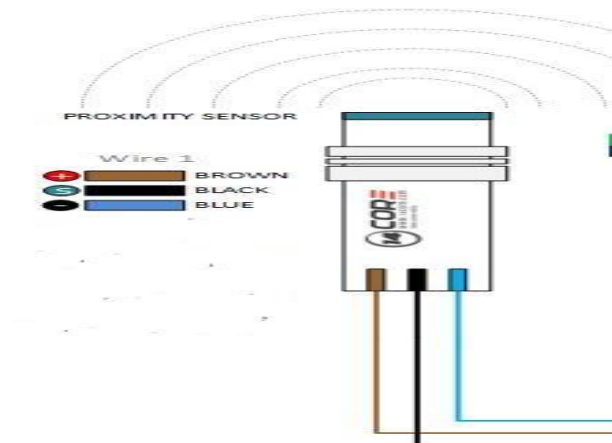
The inductance of the loop changes according to the material inside it and since metals are much more effective conductors that other materials the presence of metal increases the current flowing through the loop. This change can be detected by sensing circuitry which signal pass true to some other device whenever metal is detected.



**Figure 3.4 Inductive Proximity Sensor**

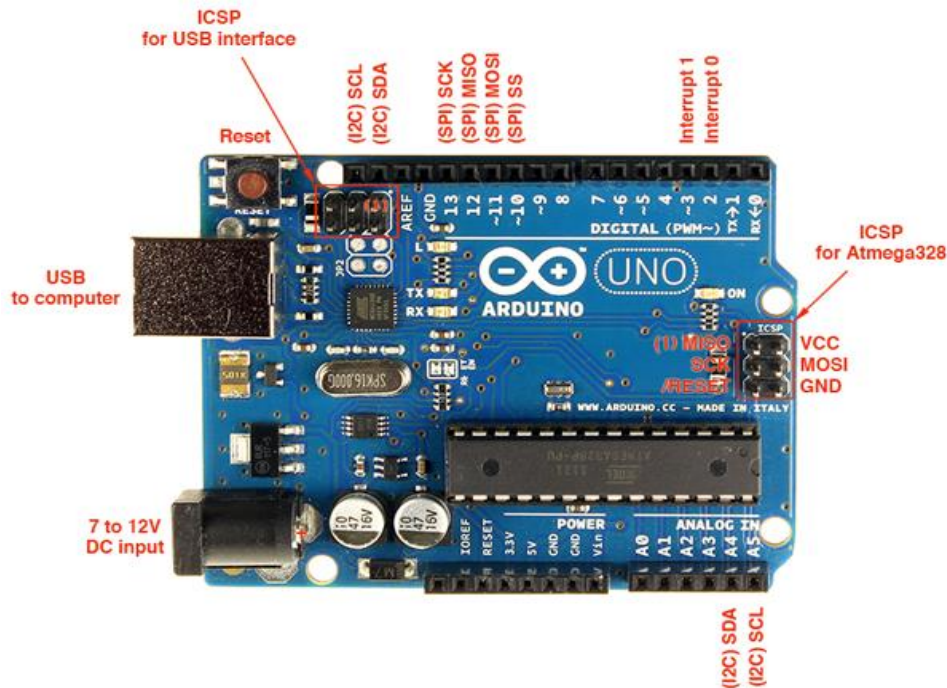
### APPPLICATIONS:

This device is commonly used in traffic lights, car washes, manufacturing machinery, automated industrial machinery, elevators and building automatons this device is mostly used because can adopt in a rugged and dirt environment.



**Figure 3.5 Pin Configurations of Inductive Proximity Sensors**

#### 4. ARDUINO:



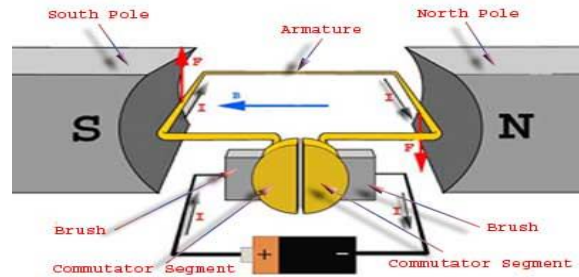
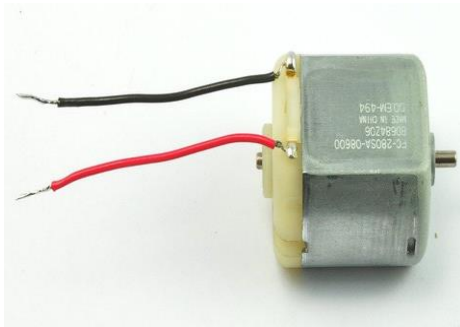
**Figure 3.6 Arduino UNO kit**

Arduino is an open source, computer hardware and software company, project, and user community that designs and manufactures microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world. The project's products are distributed as open-source hardware and software, which are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL), permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially in preassembled form, or as do-it-yourself kits.

##### Feature of Arduino

- 🚦 Microcontroller Atmel ATmega328 or ATmega8L.
- 🚦 Operating Voltage (logic level) 5 V.
- 🚦 Input Voltage (recommended) 7-12 V.
- 🚦 Input Voltage (limits) 6-20 V.
- 🚦 Digital I/O Pins 14 (of which 6 provide PWM output)
- 🚦 Analog Input Pins 8.

### 5. DC MOTOR:



**Figure 3.7 a) DC Motor, b) Block Diagram of DC Motor**

A DC motor in simple words is a device that converts electrical energy (direct current system) into mechanical energy. It is of vital importance for the industry today, and is equally important for engineers to look into the working principle of DC motor in details that has been discussed in this article. In order to understand the operating principle of DC motor we need to first look into its constructional feature.

### 6. SERVO MOTOR:



**Figure 3.8 Servo Motor**

Servo motor works on PWM (Pulse width modulation) principle, means its angle of rotation is controlled by the duration of applied pulse to its Control PIN. Basically servo motor is made up of DC motor which is controlled by a variable resistor (potentiometer) and some gears.

### 3.4 Software Details:

WE USE ARDUINO SOFTWARE AND RESULTS ARE OBSERVED ON SERIAL MONITOR OF ARDUINO SOFTWARE

### 3.5 Concluding Remark:-

Hardware and software selection is done in this chapter. Selection of appropriate sensors is done according to which the goal can be achieved.



## CHAPTER 4

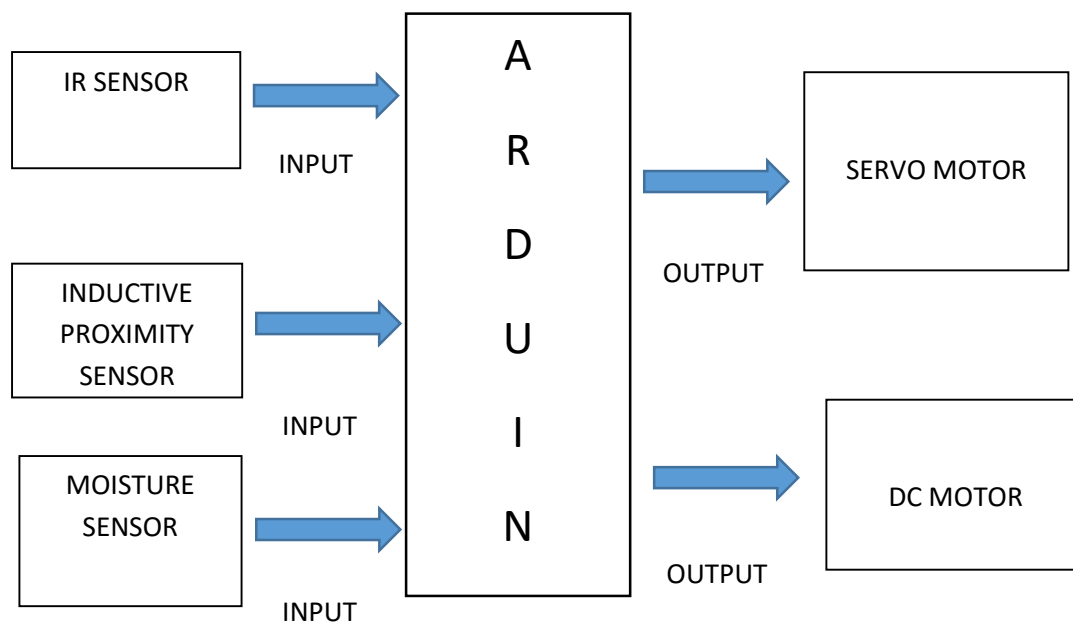
### METHODOLOGY

#### 4.1 Introduction:-

In this chapter, we will study the actual working of the proposed system. From this we can understand the whole assembly of the system.

#### 4.2 Proposed Work:

As discussed earlier, in chapter 3, the sensors acts as input to the arduino and the motors gives us the output. The following block diagram can explain it:



**Figure 4.1 Input/output Block Diagram**

The working of the system consists of four sections which are as follows:

**1. Entry system and initialization:**

The waste is dumped into the Automatic Waste Segregator which marks the entry of the waste, as the IR Proximity Sensor detects the waste and starts up the system. It then initializes the sensor modules. The initialization of all modules ensures that any dynamic changes in the environment do not affect the sensing.

**2. Metal detection system:**

The object falls on the inductive proximity sensor which contain an inductive coil. The inductive coil is a part of a parallel inductance and capacitance (LC) circuit. This measures the parallel resonance impedance of a parallel LC circuit and returns data as a proximity value. This data changes whenever another metallic object is introduced in the vicinity of the coil. When an alternating current is passed through a coil it generates a magnetic field. When a metallic object is introduced in the vicinity of the coil, eddy current is induced on its surface. The eddy current is a function of the distance, size, surface area and composition of the target. This generates a magnetic field which opposes the original magnetic field which is generated by the coil. 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. The object also falls on the moisture sensor at the same time but it prioritizes the metal.

**3. Moisture detection system:**

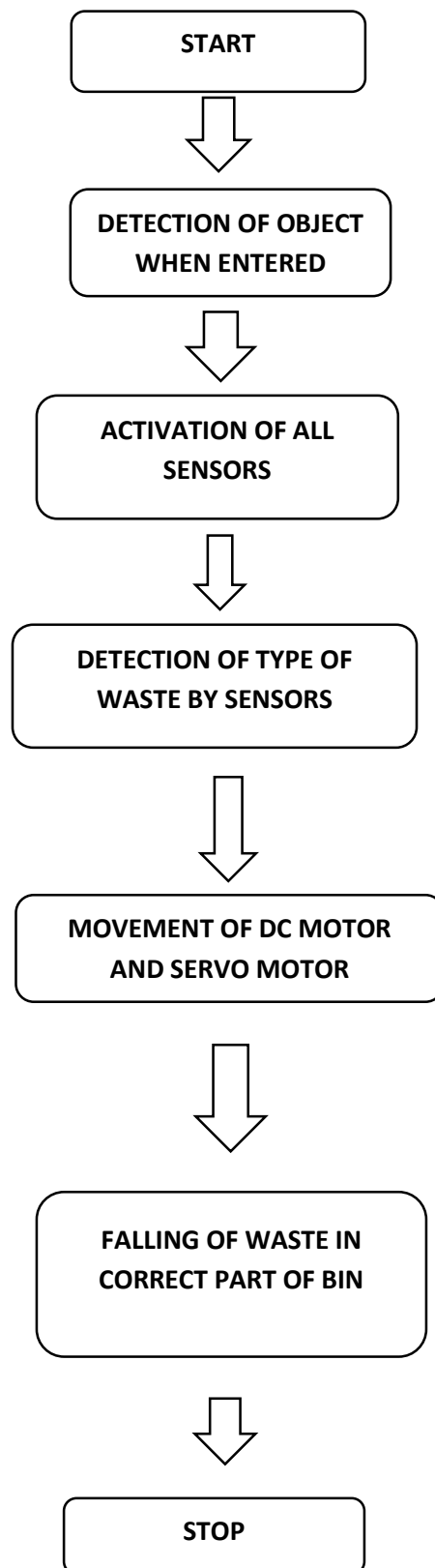
When the object falls on the moisture sensor detects the moisture in the waste and provides input to the arduino. This moisture sensor has two probes through which current passes in soil, then read the resistance of wet garbage for reading moisture level. We know that water make the garbage more prone to electric conductivity resulting less resistance in garbage where on the other hand dry garbage has poor electrical conductivity thus more resistance in garbage. Using these properties of electricity the sensor is designed. Inside the sensor there are circuitry for measuring the resistance and converting it into voltage as output. Then, the waste is ready to be dumped into the appropriate part of bin.

If both the detection system doesn't give the output, then the waste is considered as dry waste.

**4. Segregation module:**

To achieve the segregation, one servo motor and one dc motor is used. The container is mounted on the axle of a servo motor. The container rotates as the axle of the servo motor Rotate. If the part of the container corresponding to the type of garbage is not under the flap then the motor is rotated clockwise or anticlockwise. The servo motor is given three different positions or angles for the three types of wastes detected. The motor thus always comes to the required position according to the signal obtained. The default part of container is the dry part. To avoid overshooting of the container due to the momentum of the base of container, the servo motor is rotated at lower speeds by using pulse width modulation (PWM) which is generated from the microcontroller's timer. Once the required part of the container is positioned under the flap, the DC motor rotates the flap by rotating the motor clockwise by 180° it then waits for 2 seconds to ensure that the waste falls down and finally, the flap comes back to the initial position by rotating the motor anti clockwise. PWM is used to rotate the motor. Thus the segregation is completed.

## 4.3. FLOW CHART:



#### 4.4. Concluding Remark:

In this chapter, we have studied the working of the proposed system. The detection of waste is done by using the inductive proximity sensor and moisture sensor into dry, wet and metal. The servo motor rotates the container according to the waste.

## CHAPTER 5

### RESULTS

## 5.1 Introduction:-

This chapter includes the experimental results of proposed system. Software and hardware part of proposed system is shown here. Sensors network are of very low cost, small and simple so they can communicate with arduino easily. System can extract relevant information from available data and perform proper action.

## 5.2 Results:

Results we got of all sensors on serial monitor as follows

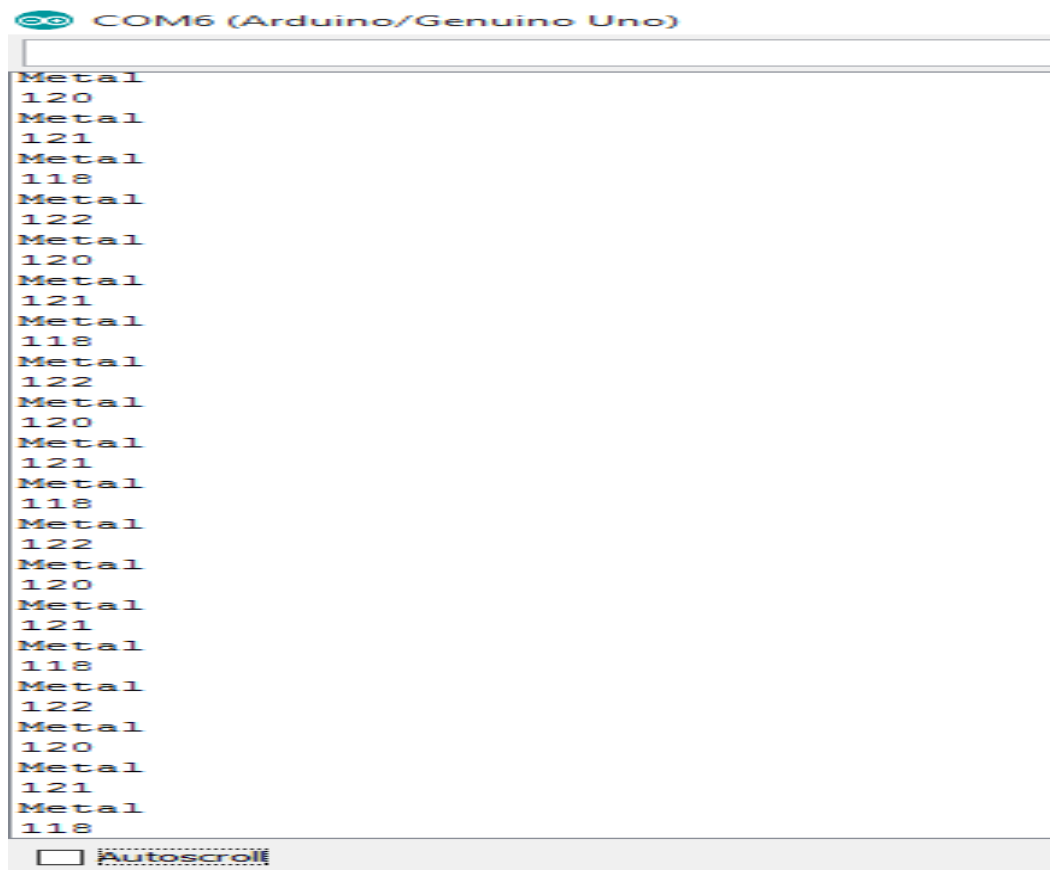
✚ Inductive Sensor. (Metal garbage):



**Figure 5.1 Inductive proximity sensor detecting metal**

When the metal is applied on the inductive sensor as shown in Fig. 5.1, at the serial monitor of arduino we obtain the following result as shown in Fig. 5.2





**Figure 5.2 Detection of metal on arduino**

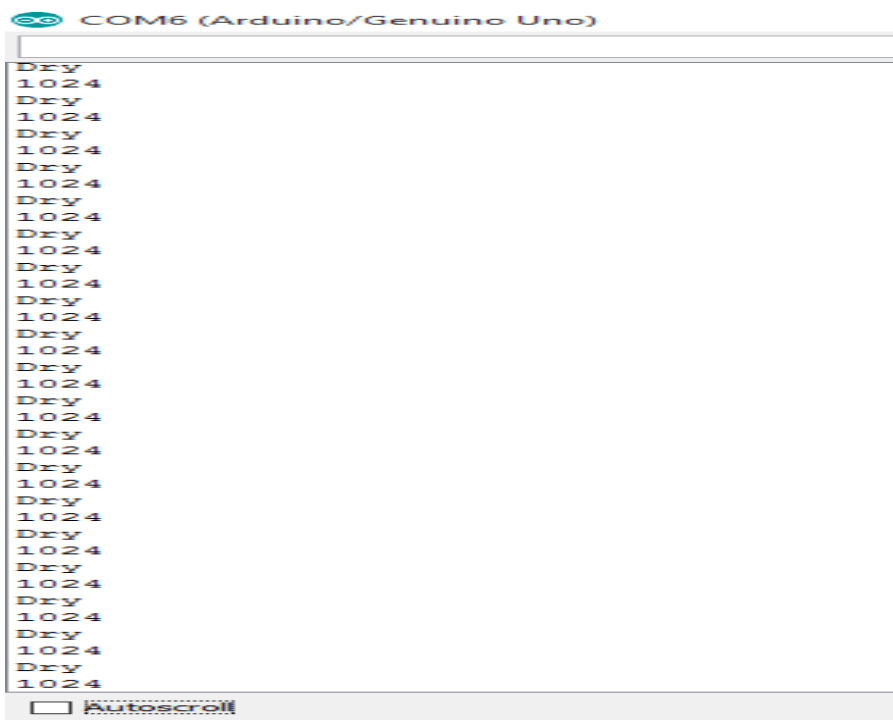
✚ Moisture Sensor(Wet garbage):



**Figure 5.3 Moisture sensor detecting the wet paper**

When wet waste is applied on moisture sensor as in Fig.5.3 we obtain the below results as shown in Fig.5.4

If none of the sensors are on then, at the output we obtain dry waste as shown in Fig. 5.5



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S.Y.BTECH [2016-17]

### 5.3 Concluding Remark:

Sensors communicate with arduino and operations are performed by using the data applied by the sensors. Accordingly, the servo motor rotates with an appropriate angle and brings the particular bin below the proper waste material. Thus we have implemented a smart garbage segregator system.

## CONCLUSION

Automated Waste Segregator has been successfully implemented for the segregation of waste into metallic, dry and wet waste at a domestic level. However, it cannot segregate ceramic into dry waste because of its higher relative dielectric constant when compared to other dry wastes. Noise can be eliminated in the sensing module to increase accuracy and overall efficiency. The system can segregate only one type of waste at a time with an assigned priority for metal, wet and dry waste. Thus, improvements can be made to segregate mixed type of waste by the use of buffer spaces. Since, the time for sensing metal objects is low the entire sensing module can be placed along a single platform where the object is stable to ensure better results.

Nowadays very big amount of waste is produced. Thus separation of this waste, is a complex task by traditional way so by this automated way this task may be simple. It also reduces the health effects to the people who are collecting the waste.

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