DESIGN AND DEVELOPMENT OF SMART GARBAGE SEGREGATION BIN FOR PUBLIC AWARENESS

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***Abstract*—** Segregation of waste has not been taken seriously at many houses even today. We all know how important it is to segregate organic and inorganic wastes as it should be easier to degrade the respective garbage. Organic wastes can be used as fertilizers and inorganic wastes are dangerous because they do not degrade in the soil and remain there for ages. Hence the SMART BIN would be a good option where it only takes the garbage in when it is segregated as organic and inorganic. In other words, the organic bin would accept only the organic waste and inorganic bin would accept only inorganic wastes and the mixture of these two wastes would not be accepted by saying PLEASE SEGREGATE YOUR WASTE. The motto is to make segregation compulsory and people really start segregating their garbage.

The other feature of the Smart Bin is that once the garbage is full, it would send a notification to the respective authority to clear the bin. This feature prevents overflow of garbage creating fussy and uncleanly atmosphere around the bin. A cleanly and social Dust Bin would help making garbage management better than what it is today.

Keywords: Smart bin, waste, segregate, garbage, Sensors, Arduino

I. INTRODUCTION

As we know in our day to day life waste management has become a big issue, in spite lot of efforts neither the government nor the public could come up with the proper solution. Even though the government came out with many ideas of segregation of dry and wet waste, people are failing to follow it. Hence a step forward, we have come across an idea of smart bin whose function is to separate bio-degradable and non-bio-degradable waste using Slide-in operation.

To create a clean and social dustbin by using proximity inductive sensor, proximity capacitive sensor, moisture sensor to segregate the waste. To create a warning when unsegregated waste is dumped using buzzer and led display. To inform the respective authority to clear the bin once the bin is full using an IR Sensor for detecting whether the waste has reached a specific height and GSM Module for sending a message to the authority.

Thereby avoiding overflow of the bin which helps in maintaining a clean environment around it. The main objective of our project is to design and development of smart garbage segregation bin for public awareness. [1]

II. NEED OF THE SYSTEM

Proper segregation of waste for the betterment of the environment and society. As the corporation laborer's [2] spend a lot of time to segregate the waste manually which not only builds work pressure but also affects their health as well. Hence this system would reduce their manual segregation process up to a large extent. Leading to which the non-degradable waste would be collected and recycled. The corporation spends a lot of funds and time to collect garbage from different locations this system would send the filled bin location to authority responsible for garbage collection using GSM module as shown in Fig 1.

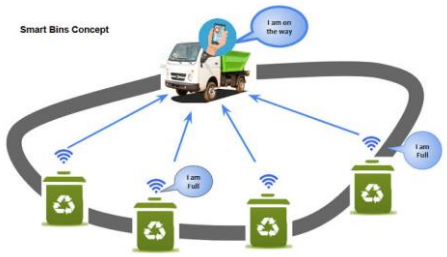


Fig 1: Trash collection concept

III. BLOCK DIAGRAM

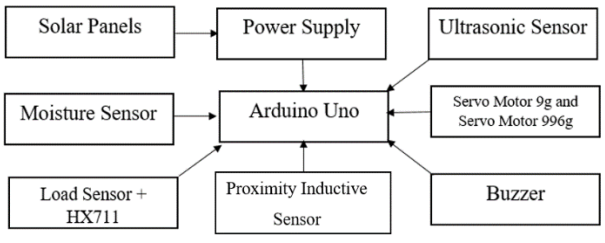


Fig 2: Block Design of Components with Arduino 1

Solar panels are used to charge the batteries which gives power to Arduino Uno as shown Fig 2. Moisture sensor, Load Sensor + HX711, Capacitive Inductive sensor, Buzzer, Ultrasonic sensor, 2 Servo motor 9g and 2 Servo motor 966g are connected to Arduino Uno. Solar panels are used to

charge the batteries which is used as power source. Moisture sensor is used to detect biodegradable waste, Load sensor + HX711 is used to measure the weight of waste and separate based on their weight, Capacitive Inductive sensor is used to detect the metal waste, Ultrasonic sensor are used to identify waste which are not detected by load sensor and servo motors are used for the motion of the lids.

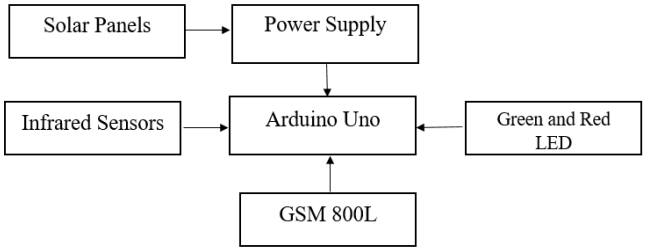


Fig 2.1: Block Design of Components with Arduino 2.

Solar panels are used to charge the batteries which gives power to Arduino Uno as shown in Fig 2.1. Infrared Sensors, GSM 800L, Green Red LED's are connected to Arduino Uno. Solar panels are used to charge the batteries which is used as power source. Infrared sensors are used to detect the level of garbage filled, Green LED are used to indicate the bin has space, Red LED are used to indicate that the bin is filled and no space is available. Gsm 800L module is used to send message and the location in detail.

IV. CIRCUIT DIAGRAM

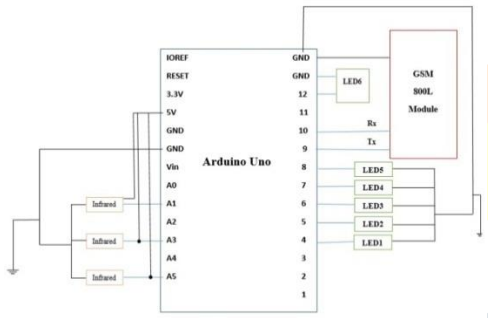


Fig 3: Circuit Diagram of Arduino 1

As shown in fig 3, the three Infrared sensor connected with pin A1, A3 and A5 with power supply of 5v and common ground which is used to detects whether the bin is full or empty as shown in fig 3. These Infrared sensors are added in all three compartments with green led and red led. For led's like led1,led2, led3,led4 led5 and led6 the pin number are 4,5,6,7,8 and 12 given respectively with common ground. The GSM module is connected with pin 9 and 10 for transmitting and receiving the signal respectively. This module is required for communication with a microcontroller over UART which supports baud rate from 1200bps to 115200bps with Auto-Baud detection.

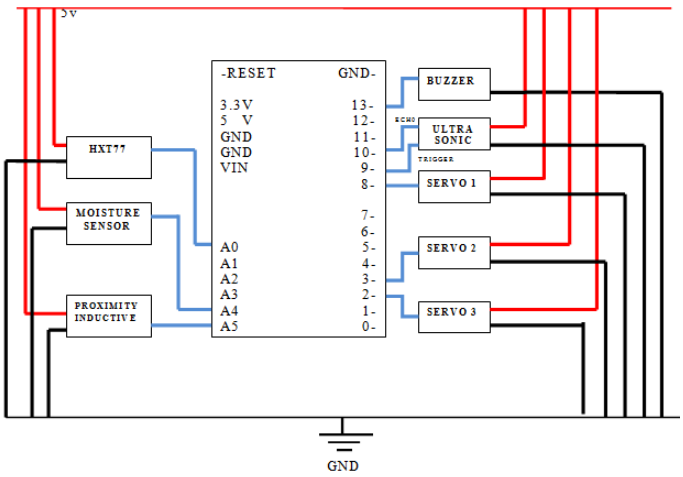


Fig 3.1: Circuit Diagram of Arduino 2

As shown in fig 3.1, the HX711 Load sensor, Moisture sensor and Proximity Inductive sensor are connected with pin A0,A4 and A5 respectively. On another hand side Buzzer are connected to pin 13 and Ultra sonic sensor are connected to pin 9 and 10 for transmitting and receiving the wave respectively. Three sarvo motor are used in all three compartments like sarvo 1, sarvo 2 and sarvo 3 are connected with pin 8,3, and 2 respectively. The all Sensors which are connected are given common power supply with 5v and common ground.

V. REQUIREMENT ANALYSIS

ARDUINO UNO AND IDE:

Arduino Uno [3] is a microcontroller board developed by Arduino. Which is an open-source electronics platform mainly based on AVR microcontroller Atmega328. The current version of Arduino Uno comes with USB interface, 6 analog input pins, 14 I/O digital ports that are used to connect with external electronic circuits. Out of 14 I/O ports, 6 pins can be used for PWM output. It allows the designers to control and sense the external electronic devices in the real world. This board comes with all the features required to run the controller and can be directly connected to the computer through USB cable that is used to transfer the code to the controller using IDE software, mainly developed to program Arduino [4]. Programming languages like C and C++ are used in IDE. Apart from USB, battery or AC to DC adopter can also be used to power the board. Arduino Uno are the most official versions that come with Atmega328 8-bit AVR Atmel microcontroller where RAM memory is 32KB.

ULTRASONIC SENSORS:

Ultrasonic sensor uses sound wave to determine the distance to an object. Here this sensor is used in order to detect the obstacles which comes in front of the bin in some range [5]. If any obstacles come in between the range then sensor will determine the distance to a target by measuring time laps between the sending and receiving of the Ultrasonic pulse. The advantages [6] of this sensor that it doesn't depend on light, smoke, dust and color.

***SERVO MOTORS*:**

Servo motors are self-contained electric devices that rotate or push parts of a machine with great precision. Servos are found in many places: from toys to home electronics to cars and airplanes. A servo [7] motor can also be explained as linear actuator or rotary actuator that allows for precise control of linear or angular position, acceleration, and velocity. It consists of a motor coupled to a sensor for position feedback. It also requires [8] a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors. Here in this project the servo motors are used for the rotation of the thrash sensing plate.

PROXIMITY INDUCTIVE SENSOR:

A proximity inductive sensor is an electronic proximity sensor, which detects metallic objects without touching them. Hence it can be particularly useful for applications where access presents challenges or where dirt, oil and water etc. are prevalent. Proximity Inductive [9] sensors emit an alternating electro-magnetic sensing field. When a metal target enters the sensing field, eddy currents are induced in the target, reducing the signal amplitude and triggering a change of state at the sensor output. As the output of inductive sensor is in the form of pulses it does not require any digitization. [10, 11]

IR SENSORS:

An infrared sensor is an electronic instrument that is used to sense certain characteristics of its surroundings. It does this by either emitting or detecting infrared radiation. Here [12] this sensor is used to check level of the object inside the compartment. When an object is close to the sensor, the light from the LED reflects off the object and into the light sensor. This results in a large jump in intensity, and considered as object detected. When the object is far away from the sensor there is no reflection of back light hence it gives high output. The operating angle of the sensor is about 35 degrees. [13]

GSM MODULE:

SIM800L [14] is a miniature cellular module which allows for GPRS transmission, sending and receiving SMS and making and receiving voice calls. Low cost and small footprint and quad band frequency support make this module perfect solution for any project that require long range connectivity. After connecting power module [15] boots up, searches for cellular network and login automatically. On board LED displays connection state (no network coverage - fast blinking, logged in - slow blinking).

BUZZER:

A buzzer [16] is a small yet efficient component to add sound features to our project/system. It is very small and compact 2-pin structure hence can be easily used on breadboard, Perf Board and even on PCBs which makes this a widely used component in most electronic applications. In this project it is used to alert the people if they put the garbage without segregation.

LOAD CELL:

When pressure or a load is applied, the electrical resistance will change in response to this applied pressure and by taking this information and after some calibration we can determine the precise weight. Load cell like this one come in different weight limits, the one we will be using today is rated up to 1KG, but you can get others that will support more weight if needed. [17, 18]

HX711:

HX711 module [19] is a Load Cell Amplifier breakout board for the HX711 IC that allows you to easily read load cells to measure weight. This module uses 24 high precision A/D converter chip HX711. It is a specially designed for the high precision electronic scale design, with two analog input channel, the internal integration of 128 times the programmable gain amplifier. The input circuit [20] can be configured to provide a bridge type pressure bridge (such as pressure, weighing sensor mode), is of high precision, low cost is an ideal sampling front-end module.

INDICATING LED:

A light-emitting diode (LED) [21] is a semiconductor device that emits visible light when an electric current passes through it. The light is not particularly bright, but in most LEDs it is monochromatic, occurring at a single wavelength. The output from an LED can range from red (at a wavelength of approximately 700 nanometers) to blue-violet (about 400 nanometers). Some LEDs emit infrared (IR) energy (830 nanometers or longer); such a device is known as an *infrared-emitting diode* (IRED) An LED or IRED [22] consists of two elements of processed material called *P-type semiconductor*s and *N-type semiconductor*s. These two elements are placed in direct contact, forming a region called the *P-N junction*. In this respect, the LED or IRED resembles most other diode types, but there are important differences. The LED or IRED has a transparent package, allowing visible or IR energy to pass through. Also, the LED or IRED has a large PN-junction area whose shape is tailored to the application.

SOIL MOISTURE SENSOR:

A typical Soil Moisture Sensor [23] consist of two components. A two legged Lead, that goes into the soil or anywhere else where water content has to be measured. This has two header pins which connect to an Amplifier/ A-D circuit which is in turn connected to the Arduino. The Amplifier has a Vin, Gnd, Analog and Digital Data Pins. This means that you can get the values in both Analog and Digital forms. Here, this sensor [24] is used in order to detect whether the waste/object is dry or wet. If it detect the dry waste/object then the thrash plate of the compartment will get tilt toward dry side or else it will get tilt towards wet side.

SIM800L:

SIM800L GSM/GPRS module is a miniature GSM modem, which can be integrated into a great number of IoT projects. You can use this module to accomplish almost anything a normal cell phone can; SMS text messages, Make or receive phone calls, connecting to internet through GPRS, TCP/IP, and more! To top it off, the module supports quad-band GSM/GPRS network, meaning it works pretty much anywhere in the world. [25]

VI. WORKING:

There are three aspects wet, dry, and unsegregated waste. In the first aspect to detect wet waste or biodegradable waste there is a moisture sensor placed on the top of the bin which

ranges from 0 to 1024 and if the value is less than 1000 then it detects the wet waste and the top plate opens and the second plate waits for more 3 seconds and tilts towards the wet compartment. Suppose it is raining and the moisture sensor detects the water drops and the led can open to avoid that ultrasonic sensor is placed which will detect the presence of the object. Second aspect which is dry waste is divided into two plastic and metal waste. There is a load sensor placed below moisture sensor which detects the wait less than certain amount which h can be changes as per required. If it passes the process the lid opens and in the next plate proximity inductor sensor is placed where it detects it is metal or not. The value of the metal ranges from 0 to 1024 and if the value is less than 900 then it detects metal and tilts towards metal compartment else it tilts towards plastic compartment. There is some plastic which is the load sensor cannot detect hence the ultrasonic sensor will detect and the process goes on. Third aspect is the unsegregated waste if the load cell detects the object more than certain amount which is entered then the lid does not open instead the buzzer turns on and does not stop till the waste is picked and separately dumped. In the next application it detects whether the bin is full or empty. Infrared sensor is placed in each compartment and two led green and red led is placed in each compartment to detect whether the bin is full or empty. If the bin is empty or if there is some space in the bin the n the green led glows if the bin is completely full then the red led glows and send message to nearest garbage collector with location saying **"The bin is full collect as soon as possible"** And the other compartment can be used to dump the garbage. There is solar panel and rechargeable batteries of 2700mah which is used to give power supply to the smart bin. From morning till evening it has an ability to charge the batteries as well as power the smart bin and from evening till next day morning it runs from the batteries so this smart bin does not require current and works from solar energy.

VII. FLOW CHART OF THE SYSTEM

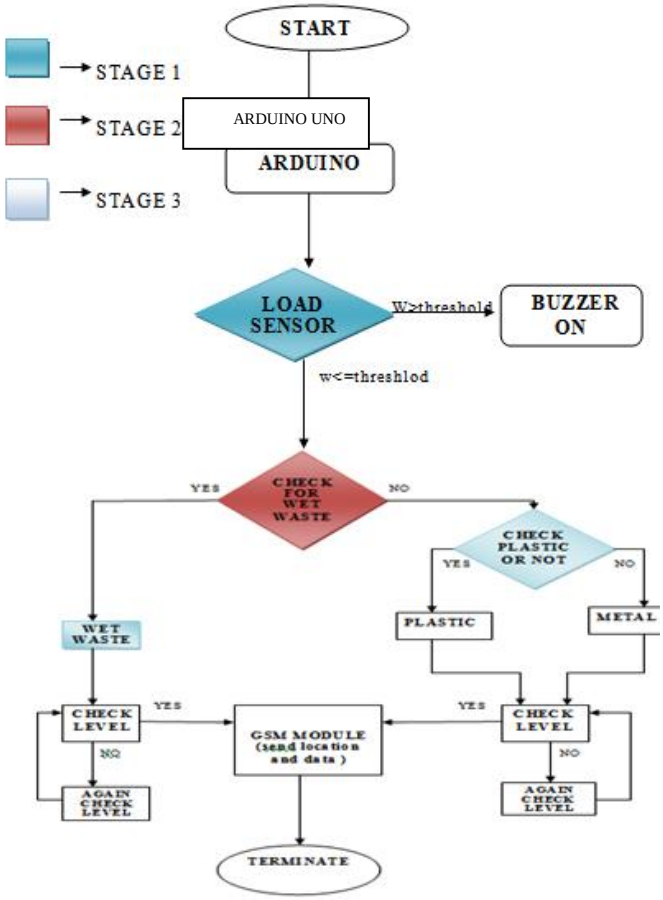
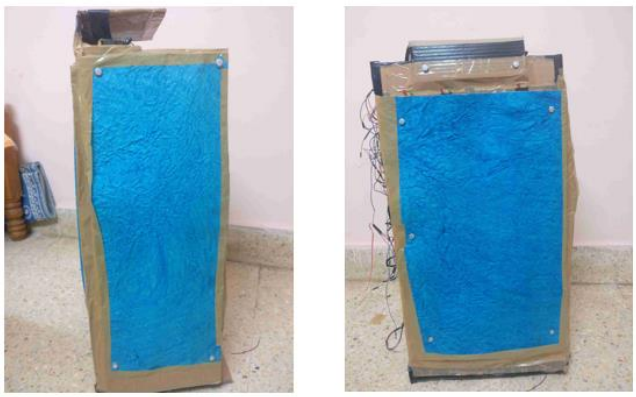


Fig 4: Flow diagram of system

VIII. DESIGN:



Side View Front View

Fig 5: Side and top view of the system

The Fig 5 shown above describes the front and side view of the proposed system whose aim is to design and develop of smart garbage segregation bin for public awareness and also to create a clean and social bin by using proximity inductive sensor, moisture sensor to segregate the waste.

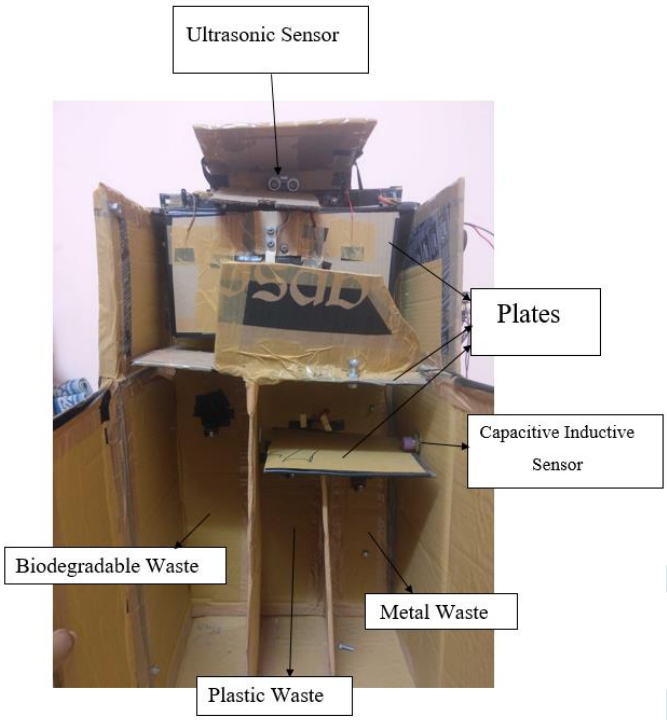


Fig 6: Design of Compartments

The Fig 6 diagram represents the Design of Compartments. Here,total three compartments are there i.e for wet and dry. In dry compartment it is further devided into two i.e for plastic and matellic part.The hardware component like proximity inductive sensor and Moisture sensor detect the waste in onrder to determine whether the waste is wet or dry and if it is dry then whether it is matellic or plastic.

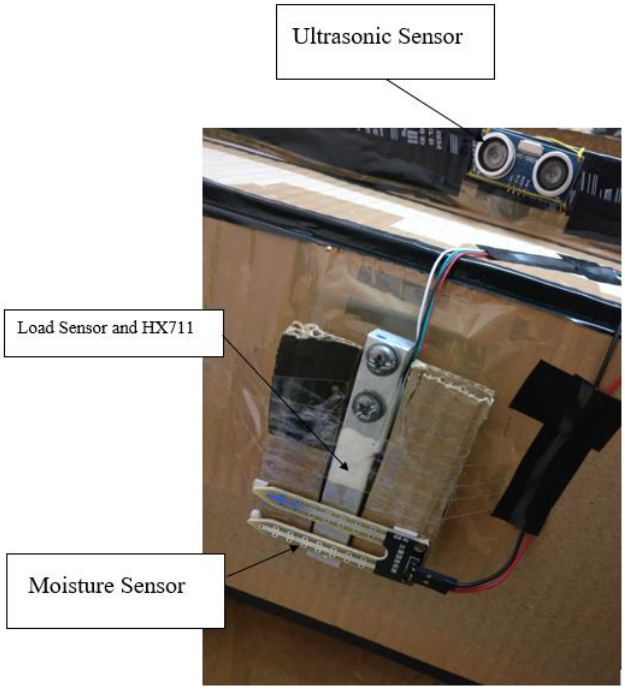


Fig 7: Ultrasonic Sensor, Load sensor and Moisture Sensor

The Fig 7 diagram represents the placement Ultrasonic Sensor, Load sensor and Moisture Sensor whose main aim is to detect the obstacles, measures the weight of waste and to detect whether the waste is wet or dry respectively.

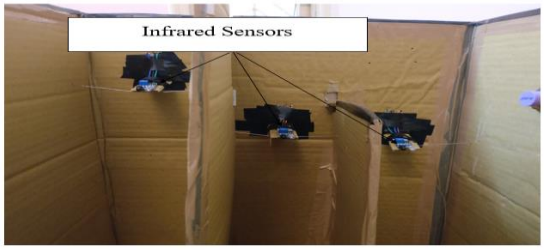


Fig 8: front view of the system

The Fig 8 diagram represents the front view of the system where Infrared sensor is placed in each compartment with two LED i.e green and red LED to detect whether the bin is full or empty. If the bin is empty or if there is some space in the bin then the green led glow if the bin is completely full then the red led glow.

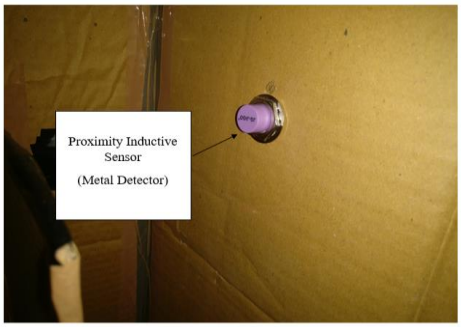


Fig 9: placement of proximity inductive sensors

The Fig 9 diagram represents the placement of inductive sensor in dry compartment for the purpose of detecting whether the waste is metal or not.

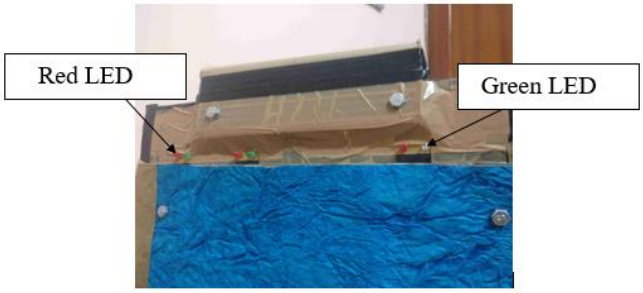


Fig 10: Red LED and Green LED

The Fig 10 diagram represents the placement of Red LED and Green LED. Each compartment is having with green and red LED which indicates the space present inside the bin. Red LED will glow when the bin gets full. and send message to nearest garbage collector with location saying “The bin is full collect as soon as possible”

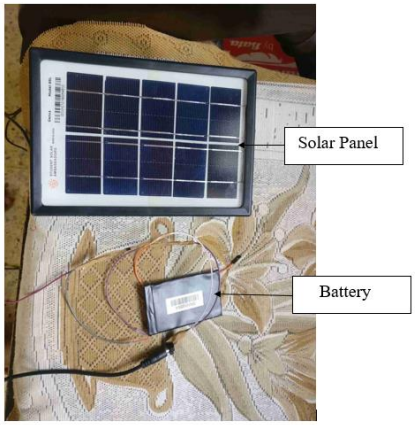


Fig 11: Solar panel and Battery

The Fig 11 diagram represents the Solar panel and rechargeable battery of 2700mah which is used to give power supply to the smart bin. From morning till evening it has a ability to charge the batteries as well as power the smart bin and from evening till next day morning it runs from the batteries so this smart bin does not require current and works from solar energy.

Final Smart Bin

Fig 12: Final Overview of Smart Bin

The Fig 12 diagram represents the Final Overview of Smart Bin fitted with all the components at their required place and the system is successfully tested.

IX. RESULT

I. Arduino uno is a simple microcontroller board through which all the components/sensors are connected and work according to their specifications.

II. Load sensor is act as a transducer which converts physical quantity(compression) into electrical signal that can measures easily.

III. Red and Green LED are used which indicates the space present inside the bin. Red LED will glow when bin gets full where as Green LED will continue to glow when space is present as shown in fig 13.

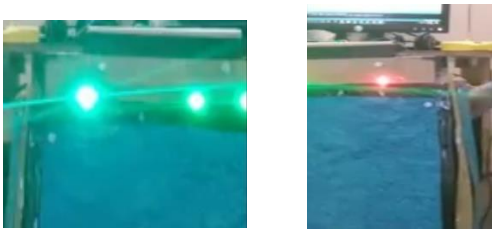


Fig 13: Indication of space present inside the bin

IV. Ultrasonic Sensor is used to detect the obstacles, the bin gets open if any obstacle is detected.

V. Sarvo motor 9g is basically used for rotation purpose. Due to its control feature we are using this component.

VI. Proximity Inductive sensor is used for detecting the metal and plastic without any physical contact.

VII. Moisture is used to detect the water content present in the garbage.

VIII. Buzzer is used to give a beep sound which will alert the people to segregate the waste if it is not.

IX. Infrared sensor is used to check the level of the waste inside the compartment.

X. GSM Module is used in order to send the SMS with location to the particular authority like BBMP so that they will come at particular location and can collect the garbage before overflow.

Fig 14: Received SMS from GSM Module

XI. Here as shown in fig 14 below, we used Arduino IDE software with basic language i.e c , so that all the components work accordingly.

X. CONCLUSION

A practical system for monitor the level and segregation of garbage is being presented in this paper. This project implementing real time waste management system by using sensors to segregate the garbage and check the level of garbage in the bin. In this system, the information of the bin can have accessed from anywhere and anytime. This system will help to inform the status of each bins in real time. So, waste management can

send the garbage collector to pick up the garbage when the bin is full. Hear Infrared sensor is used to detect the level of the garbage. As soon as the system gets full, this sensor will collect the data and send to microcontroller where at the same time this sensor will send data to thingSpeak via GSM 800 Module. The data in ThingSpeak will show the data in real time. Therefore, waste management can be monitor.

The development of the system can improve living lifestyle by making our environment neat and clean and also we can avoid the infections which we are facing in our day to day life.

By implementing this proposed system, it will reduce cost, man power and indirectly reducing traffic in that place.

XI. APPLICATIONS

The system can be used in public places like railway stations, airports, metro stations, apartments, streets and public parks to maintain cleanliness around the place.
At places like Public parks and streets solar panels can be used to supply power required for the system thereby using naturally available eco-friendly source of power.

XII.ACKNOWLEDGMENT

We would like to express our special thanks and gratitude to our project guide *Dr. CHETHANA K* who gave us the golden opportunity to do this wonderful project on the topic **"**DESIGN AND DEVELOPMENT OF SMART GARBAGE SEGREGATION BIN FOR PUBLIC AWARENESS**"** which also helped us in doing a lot of Research, through which we gained knowledge on current technologies.

We also thank our HOD, ECE *Dr. K CHANDRASEKHAR* for giving us the opportunity and all the support to develop the system that we planned.

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