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Garbage Segregating and Alerting Nexus

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Abstract*: *Waste management is the collection, transport, treatment and disposal of waste. Waste segregation at source is the crux of waste management solution as it improves efficiency in processing of waste and resource recovery. The strategies for waste segregation differ from one region to another depending on the financial and technological resources available. Here in this paper, we design and discuss a simple prototype that segregates the generated waste into three categories: wet waste, metal waste and other waste using different type of sensor. The prototype further notifies the user using GSM, to empty the bin.

Index Terms*: *Actuators, Arduino, Modules, Raspberry Pi, Sensors

I. INTRODUCTION

According to the Press Information Bureau, India generates 62 million tons of waste annually, out of which only 60% is collected and less than 15% is processed [1]. A traditional reductionist approach is no longer acceptable. We need to look at methods that incorporate the concept of recycling, embodies flexibility and plans for long term sustainability. This requires identification of problematic areas and better technological sophistication to manage and segregate waste efficiently. It is important for the people in charge of waste management to understand and bear the impact of their business on the environment. The management of waste in metropolitan and rural areas is general responsibility of the local government. But citizens need to take ownership of their own role in garbage collection by practicing segregation [2-6], recycling of dry waste and composting of wet wastes at the initial levels. Our prototype helps people do exactly as stated above. The prototype also lets the user know when each section of the bin is filled to capacity. This unit can replace the normal dustbin. The prototype uses very simple and cost efficient sensors, actuators and controllers. This system also increases efficiency in the larger scale and hence the manpower can be used in a more constructive purpose.

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II. DETAILED DESCRIPTION OF THE PROPOSED WORK

Here the dustbin is designed with the help of some basic sensors and actuators with Raspberry Pi and Arduino Uno as controllers.The Raspberry Pi is connected to an ultrasonic sensor, stepper motor, servo motor, GSM module and HX711 Load Cells Amplifier modules. They perform functions like person detection, opening of flap to drop the waste, rotation of dustbin, and weight measurement of the bins and sending alerts to the user regarding the bin's capacity, respectively. The Arduino is connected to the moisture sensor and proximity sensor, which are responsible for detecting the type of waste dropped. The dustbin is divided into wet waste, metal waste and other waste. Each sector of the dustbin is 120^{o} apart.

A stepper, after proper calibration, is used to rotate the dustbin accordingly.

The circuit has three parts:

- Sensors
- Actuators
- Modules

The sensors used are:

- Ultrasonic sensor
- Moisture sensor
- Proximity sensor
- 1 kg Load cell (x3)

The actuators used are:

- Stepper motor
- Servo motor

The two modules used are:

- HX711 Load Cell Amplifier module (x3)
- GSM module

The ultrasonic sensor has a threshold for detecting the presence of a user near it. Once detected the circuit powers up. When the user drops the waste, the moisture and proximity sensor obtain their readings. The sensors send their values to the Arduino based on the readings. The Arduino then sends a signal to the Raspberry Pi. The Raspberry Pi rotates the stepper motor to the particular sector in which the waste has to be dropped. The servo at the top opens the flap to drop the waste into the dustbin and then rotates back to its original position. The load cell measures the weight of each section and sends these values to the GSM module. The GSM module sends alerts to the user regarding the sectional capacity calculated when each section weighs at 75%, 90% and 100% of the total capacity.

III. HARDWARE IMPLEMENTATION

The Block diagram in Fig1.1 shows the different components used in the Smart Dustbin System i.e. Raspberry Pi, Arduino Uno, power supply, ultrasonic sensor, moisture sensor, inductive proximity sensor, servo motor, stepper motor, GSM module, Load cell and HX711 Load Cell Amplifier Module. To consume power, all the sensors except for ultrasonic sensor are in sleep mode. The ultrasonic sensor is positioned such that it detects the presence of user in front of the dustbin and sends a signal to fire up the whole system. The Arduino then activates the moisture and proximity sensors that are connected to it. When user drops waste into the dustbin, the waste is collected into a container containing these sensors. The moisture and inductive sensors are connected to Arduino using three pins (Vcc, Gnd, and Signal) [7, 10]. Three Separate storage based dustbin is designed for automatic waste collection and segregation. If there is any moisture in the waste, the moisture sensor sends wet waste activation signal to the Arduino, which activates the pi. Arduino is connected to Raspberry pi using two digital pins. The stepper motor which is initially at 0 degree now rotates to make a 60-degree angle [8, 11]. This action is followed by the servo motor to make a 180-degree angle forward and then backward, to drop the waste into the wet waste container. The process ends with stepper motor retrieving back to its original position by making a negative 60-degree angle. The same process is repeated when metal waste is detected by the inductive sensor but the stepper motor makes a positive 180-degree angle to collect the waste in the metal waste container. When none of the sensors send any signal to the Arduino after the user is detected by ultrasonic sensor, then Arduino activates Raspberry pi to drop the waste into the Other Waste section. For this, the stepper has to make a negative 60-degree angle. The separation of the dustbin parts is explained in Fig 1.3. The load cells are clamped to the bottom of each section. The load cell is connected to HX711 via four pins; the red, black, white and green wires of the load cell is connected to the E+, E-, A-, A+ wires of the HX711 module respectively.

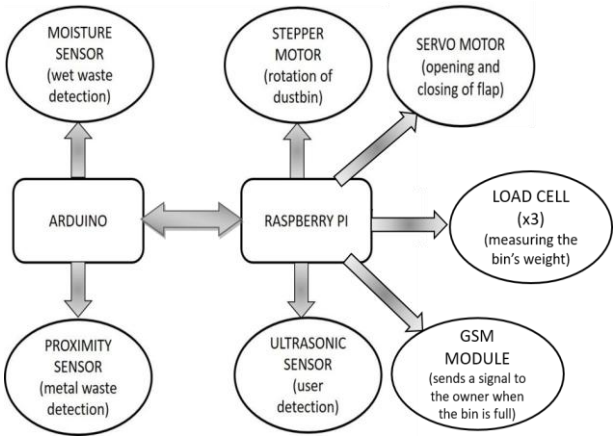

Fig 1.1 Block diagram of the prototype

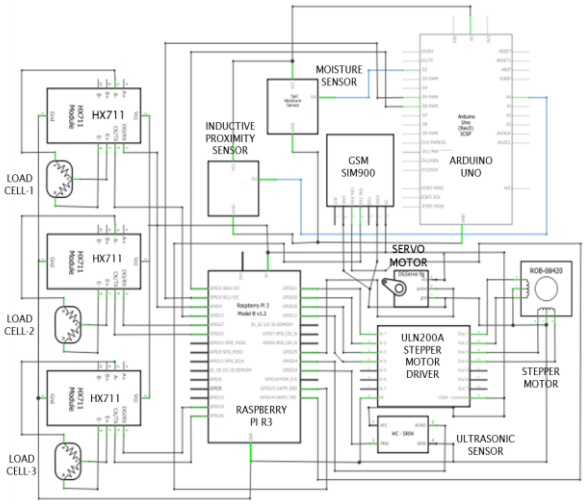

Fig 1.2 Circuit diagram of the prototype

The value obtained from the module is processed to obtain the weight percentage filled individually. The GSM module sends alerts to the user when each section is filled to 75%, 90% and 100% of the capacity. The wet waste is assumed to be bio-degradable and can be composted, whereas the metal waste can be recycled. Fig 1.2 explains the circuit diagram of the prototype that was built.

Fig 1.4 depicts the skeleton of waste segregation dustbin. It has three sections; one container for collecting waste, one for storing them and another one to hold the circuit. The dustbin is divided into three parts for storing metal, wet and other wastes. These three sections each have a load cell attached to the bottom. This is then kept inside another outer dustbin that sits on the knob of stepper motor in the box as shown above. This arrangement facilitates the 360-degree rotation of the dustbin. The circuit is embedded into a plastic box at the bottom of the dustbin. A flat metallic plate runs from the bottom of the base to the top of the dustbin at the back. Another small metallic "container A" is connected to this plate, which holds the sensor part (ultrasonic and inductive proximity sensor) of the circuit. The user is expected to drop the waste into this small "container A." A servo motor is connected to the bottom opening of the "container A" for dropping wastes into the dustbin automatically.

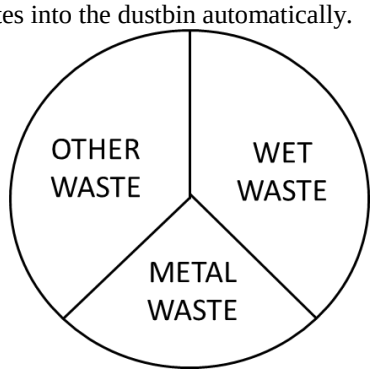

Fig 1.3 Partition of the bin

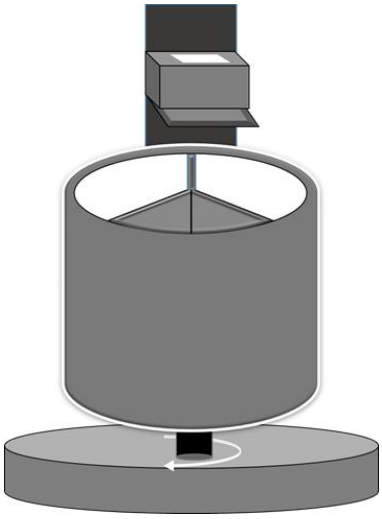

Fig 1.4 Design of the prototype

IV. SOFTWARE IMPLEMENTATION

The software implementation is divided into two parts. One uses and Arduino and the other uses the Raspberry pi. These are connected by two dedicated digital pins so that information about the two parts is conversed in the system. The Arduino connects to the inductive sensor, load sensor and moisture sensor. The Raspberry pi is connected with the Ultrasonic sensor, Servo motor and Stepper motor. This is mainly done for the sake of reducing loads on both the boards. The raspberry pi is mainly the actuator part and the Arduino is purely sensor oriented.

A. Algorithm (for the Arduino part where moisture sensor and proximity sensor)

1. Start the program
2. Initialize the values of the sensors to zero and also declare the digital pins.
3. Set the baud rate and the digital pins as output.
4. Start the main program.
5. Keep reading the sensor readings and keep printing the output values in the serial window or any output or display device after conversion into a readable value.
6. After detection of the type of the waste dropped the respective signals are sent to the raspberry pi to process further.
7. Print an appropriate message in the serial window or respective display device.
8. Give appropriate delays everywhere after every process.

B. Algorithm (for the Raspberry pi with the Ultrasonic sensor, Servo motor and Stepper motor connected)

1. Start
2. Initialize and set the necessary pins as input and output respectively.
3. Start an infinite loop
4. Keep checking for the ultrasonic sensor for a human to be detected.
5. If true,

- Check for the reading to make sure and also give some delay so that the Arduino collects data as well.
- Once collected and received by the raspberry pi the stepper has to be rotated by a degree such that the waste is dropped into the particular chamber.
- This is done by the half step sequence of the stepper motor.
- Collect necessary data from the three load sensors connected to Raspberry Pi.

6. If false, let it sleep and keep reading further.
7. Once the stepper motor rotates, the servo motor opens and closes so that the waste is dropped.
8. Print the necessary output.
9. Calculate for the percentage weight in each section by using the load sensors and if the bin is 75% or 90% or 100% filled send a message to the registered GSM device.

The flowchart shown Fig 1.5 explains the procedure.

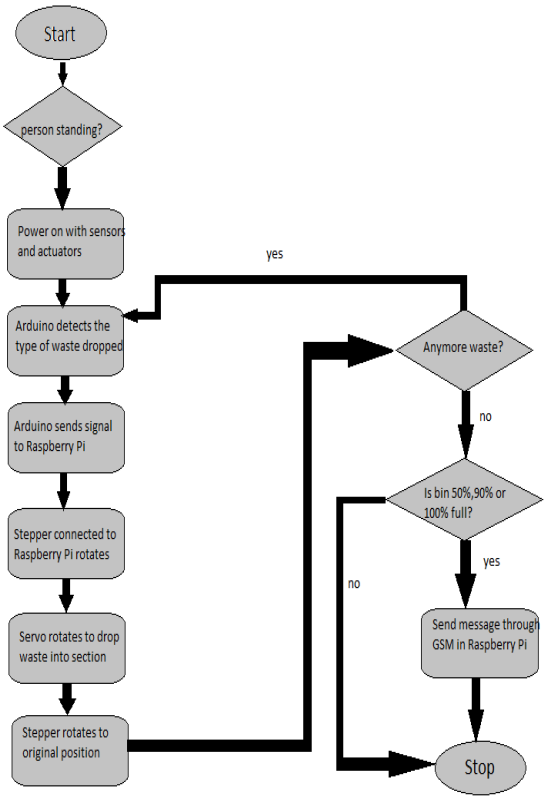

Fig 1.5 Flow chart of the prototype

V. RESULT AND ANALYSIS

The unit with three divisions for wet, metal and dry waste was tested with various waste products. The accuracy of detection is mentioned in Table I. When wet waste with less moisture content was dropped, the moisture sensor was unable to detect the moisture and therefore it was categorized as other waste. Similarly, when the metal waste dropped does not fall in-line with the proximity sensor, the unit categorized it as other waste. The alert system was also tested. Here 1kg load cells were used and it sends an alert to the user when the capacity of each section reaches to 75%, 90% or 100% which is 0.75 kg, 0.9 kg and 1 kg respectively. A picture of the received SMS notification is given in Fig 1.6. The prototype is shown in Fig 1.7

Type of Waste	Accuracy
Wet Waste	72.7%
Metal Waste	81.8%
Other Waste	90%

Table I

Fig 1.6 SMS Notification

Fig 1.7 Picture of the prototype

VI. CONCLUSION

With the world dumping more and more waste every day, waste segregation is crucial to conserve the environment for posterity. Therefore, to ease the tedious process of waste separation, we built a smart dustbin (Fig 1.7) that automatically segregates waste. The prototype built can be used for small scale applications like home and office. The preliminary test results are promising. The capacity of the prototype should be increased and should support segregation of many more categories in order to be implemented in a larger scale. A voice operated system can be implemented to add confirmation commands using voice recognition. The system can be programmed to move and collect waste on its own. In conclusion, the prototype should further be worked on and has a lot of scope for real world application.

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