A MONOTONOUS CYBORG FOR AN ASSESSMENT OF SOLID WASTE MANAGEMENT IN MULTI STORIED BUILDINGS

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Abstract—Ever since the age of robotics, robots have been utilized in various fields. Solid waste management is one of the key area in the environment and health division that also aids for infrastructure development of the cities. Available Solid waste management technique does not support effective disposal and also requires lot of man power and expenditure. In this paper, new technique in which cyborgs can be applied for solid waste management in multi storied buildings is proposed. Various components of solid waste management involve collection, transportation, Sorting and Disposal. All these sections have an integrated sensor network that is controlled by a microcontroller unit. A monotonous cyborg has been introduced to sort the solid wastes. The sorted degradable waste generated by the people living in the multi-storied buildings has been utilized to produce green energy.

Keywords—solid waste management system(swm);cyborg;multi storied building

INTRODUCTION

Waste is anything that is unwanted, unused or cleavage of any products which is found enormous in society. Solid waste is classified based on the nature of the waste. 0.1 Ton million solid wastes is generated in India every day. In which major solid waste is generated from multi-storied buildings. It is not properly handled and leads to land pollution, air pollution etc.. Due to the increase in number of multi-storied buildings, the generation of solid waste has been increased daily in the multi-storied buildings. There is a need for an automatic solid waste management system. Mixing of organic and inorganic waste lead to generation of bad odour and production of hazardous gas. Hence initiative must be taken to sort out the solid waste more carefully. Sorting of solid waste at dump site is not possible due to the amount of solid waste present. Hence initiative must be taken to sort solid waste in multi-storied buildings community. Thus, a system to collect the solid waste from each floor and dispose it in chute system, which connects every floor to the ground floor is introduced. The solid waste is sorted out automatically with help of a monotonous cyborg, sorting it out into organic and inorganic material and to reuse organic material to generate biogas. The obtained organic waste is used to generate biogas by fermentation of organic material. Scraps like plastics can be sold to scrap dealer and can be recycled. A recent study found that each household in a multi-storied building generates 437 Kg of waste in a year on an average. This waste when not handled properly may cause serious damage to the environment in terms of land and air pollution. This in turn may pose a great threat to human life. Thus, an effective use of robots in the field of solid waste management is a major step forward in environmental protection.
I. SOLID WASTE MANAGEMENT SYSTEM

The proposed system consists of sections such as floor section, chute section, sorting section, biogas and green energy section.

![Overall block diagram of proposed system](image)

Fig. 1. Overall block diagram of proposed system.

Fig.1 shows the overall block diagram of our proposed system of solid waste management in multi-storied building.

**Floor section:**
In the floor section, solid waste is collected by a smart bin equipped with loadcell, ultrasonic and IR sensor. The floor section aims to monitor the level of the smart bin.

![Block diagram of floor section](image)

Fig.2 shows the various components used in the floor section.

**Chute section:**
Chute section is a specially designed vertical structure. It acts as a passage for transferring the solid waste dumped by the smart bin present in various floors, to reach the sorting section. Thus, sorting section needs to be designed based on the number of floors and with respect to the infrastructure of the building.

**Sorting section:**
Sorting section is the place where, a monotonous cyborg consisting of various sensors is used to sort out solid waste into organic and in-organic material.

![Block diagram of sorting section](image)

The block diagram of sorting section is shown in Fig. 3. The sorted material is stored in separate bins.

**Biogas section:**
Biogas is mixture of different gas such as methane and carbon di oxide produced by the decomposition of organic waste. Biogas can be produced from the organic material such as agricultural waste, manure, plant material etc. In the proposed system the sorted organic waste is supplied to biogas section, where it is stored in a closed container for 10-15 days, which results in production of methane and other gases.

**Green-energy section:**
Heat is generated by burning the biogas. This heat energy is supplied to the hot junction of the Peltier module to create a temperature difference. This temperature difference is converted into an equivalent green energy based on the principle of seebeck effect.

**modules used in proposed system**
The various components used for constructing floor and sorting sections can be classified into integrated sensor network and mechanical components, which are briefly explained below.

**Integrated sensor network:**
Various sensor modules are utilized to obtain inputs. These sensors form the base for the controller to carry on actions in the mechanical components. The various sensor integrated modules are discussed below.

**Loadcell:**
Load cell is an electro-mechanical device that converts the applied force into electrical output. It consists of internal wheat stone bridge arrangement in it. If no force is applied, the bridge is in balanced condition thus the output voltage is zero. When the force is applied, the beam deforms and there is a change in variable resistance. According to the change in resistance, a proportional output voltage is obtained.

In the proposed system, loadcell is used to measure the quantity of solid waste present in the smart bin. The loadcell used here is of single beam strain gauge type and can measure up to 6Kg. The output obtained from various loads during the experiment is given in table1.

<table>
<thead>
<tr>
<th>LOAD (grams)</th>
<th>OUTPUT VOLTAGE (mv)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>250</td>
<td>4.4</td>
</tr>
<tr>
<td>400</td>
<td>4.6</td>
</tr>
<tr>
<td>650</td>
<td>4.8</td>
</tr>
<tr>
<td>800</td>
<td>5</td>
</tr>
<tr>
<td>1025</td>
<td>5.3</td>
</tr>
<tr>
<td>1200</td>
<td>5.8</td>
</tr>
</tbody>
</table>

Table. I - output voltage of loadcell for various loads

Fig. 2. load vs output voltage graph

Table 2. Shows the plot between load and output voltage obtained during the period of experimentation of loadcell. From the graph, it can be inferred that voltage-load variation is linear in nature.

1) **HX711:**

HX 711 is an dedicated ADC used in load measuring application. Output of the loadcell is analog in nature thus the HX 711 is used to convert the analog signal into a digital signal, because microcontroller works only in the digital signal. It is an 24 bit analog to digital converter, has an ON CHIP oscillator. The operating voltage is about 2.6-5.5v and can be powered by the microcontroller.

2) **Peltier module:**

Peltier module is based on the principle of Seebeck effect or inverse Peltier effect, states that a temperature change between two dissimilar conductors induce a voltage difference between the two conductors. In the proposed system thermos electric material TEC1-03105 that works on basis of seebeck effect is utilized. A heat sink and cooling fan is added to the thermos material for better performance of the Peltier module. The module has no moving parts and the temperature difference acting upon it can generate green-energy.

3) **IR Sensor module:**

An IR sensor sense the characteristics of other objects by emitting or detecting infrared radiation. The change in amount of infrared radiation detected helps in knowing the characteristics of the material. For example, black colour absorbs all the infrared and doesn’t emit back, leading to zero output in IR sensor. The IR sensor is used to move the smart bin over specified path by detecting the black line.

4) **Ultrasonic sensor:**

Ultrasonic sensor sends out high frequency sound pulse and calculate the duration of the echo to reflect back. It generates sound waves at specific frequencies normally above human audible range. Ultrasonic sensor is used for obstacle detection and to find distance between objects without making any contact with it. In the proposed system, HC-SR04 ultrasonic sensor is used to detect the presence of obstacle in the path of the smart bin.

The following equation is used to convert duration taken by the sound pulse into distance in cm
Here, duration is the time taken for sound pulse to reflect back. Using the formula, the output of the ultrasonic sensor is tabulated as given in Table 2.

**TABLE II-**

<table>
<thead>
<tr>
<th>Time (µs)</th>
<th>Distance (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>199</td>
<td>3</td>
</tr>
<tr>
<td>330</td>
<td>5</td>
</tr>
<tr>
<td>450</td>
<td>7</td>
</tr>
<tr>
<td>520</td>
<td>9</td>
</tr>
<tr>
<td>660</td>
<td>11</td>
</tr>
<tr>
<td>760</td>
<td>13</td>
</tr>
</tbody>
</table>

![Graph showing Time vs Distance](image)

Fig. 3. Time vs distance

Fig. 5 shows the plot drawn against time and distance taken by ultrasonic sound to travel.

5) **Inductive proximity sensor:**

Inductive proximity sensor works on the basis of faraday's law of induction. It is used in the detection of metallic component present in the solid waste without making contact with the metal. In the proposed system, an inductive proximity sensor is placed in the chute system and helps to identify the presence of metallic waste mixed up with the solid waste generated by people living in multi-storied buildings.

B. **Mechanical components:**

1) **Dc motor:**

Dc motor is an electro mechanical device used to convert the input electrical energy into mechanical or rotational movement. In the proposed system, DC geared motors with 200rpm driven by a motor driver circuit is used. With help of DC motor, the smart bin is moved from the initial position to final position.

L298 motor driver circuit is used to control the motor. It can handle high input current up to 2A which is enough to drive two Dc motor. Two motors can be controlled simultaneously in both directions. Enable pin allows to vary the speed of the Dc motor.

2) **Actuator:**

Actuator is used to perform linear operation in a system. Electro mechanical type actuator, that consists of a motor that converts the applied electrical energy into a mechanical movement. In the system, actuator is used for opening and closing smart bin door to dispose the solid waste into the chute system.

II. **Controller section**

Controller is the brain of any system which perform actions such as control, data acquisition, monitoring etc. Atmega 2560 integrated in Arduino mega is used as the proposed system. The general process flow that occur inside a microcontroller is shown in the figure 6.
Fig. 4. General flow process involved in microcontroller

Microcontroller receives input variables from various sensors. A suitable coding is written to obtain the processed output. This processed output is able to control the different sections of the proposed system.

III. HARDWARE INTEGRATION AND IMPLEMENTATION

The various integrated network and hardware are integrated to manage solid waste in an elegant manner. Loadcell is used to monitor the solid waste level and when a certain load is reached, the smart bin moves near the chute room with guidance given received from the IR sensor and ultrasonic sensor. From the chute room a monotonous cyborg consisting of inductive proximity sensor and IR sensor, solid waste is sorted out. Inductive sensor is used to detect metal waste and IR sensor is used to identify plastic material. Rest of the solid waste is assumed as organic waste and sent to biogas section. The biogas is burned to generate heat and the heat is supplied to the Peltier module to produce temperature difference, which in turns generate green-energy.

IV. SIMULATION

Proteus software is used in simulation of floor section. Simulation of floor section is done via proteus and the circuit drawn using the software is shown Fig. 7.

Fig. 5. Simulation of floor section

V. CONCLUSION

In the proposed system, an idea has been implemented to fully automate the solid waste management process in multi-storied buildings. The various process of solid waste management such as collection, transportation, sorting and disposal has been taken care by using a monotonous cyborg. The generated green energy from the degradable waste can be utilized to power the pathway lights present in the multi-storeyed buildings. Various threat posed by unhandled solid waste will be reduced by implementing the proposed system which could reduce land and air pollution. In near future an advanced monotonous cyborg can be involved in the management of solid waste throughout the city.

acknowledgements

This research was supported by Institute of Engineers, India. We thank Dr. V. Jamuna, Ms. S. Sivajothi Kavitha who provided insight and expertise that greatly assisted our research.

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