

IoT BASED WASTE MANAGEMENT SYSTEM

¹Patil Manthan, ²Nadkar Shubham, ³Bhagat Akshay, ⁴Tandel Amey
Department of Mechanical Engineering Vishwaniktan IMEET Navi Mumbai, India^{1,2,3,4}

ABSTRACT

The Collection of waste is a very much needed municipal service that requires huge expenditures and execution of this operation is high-priced. The high pricing is due to the various factors such as man power, navigation of vehicles, fuel, maintenances and environmental costs. The above factor necessitates the design, implementation and execution of the intelligent smart bin for proper management of waste. Our focused on the implementation of an IoT based embedded system which integrates with Wi-Fi module, Radio Frequency Identification (RFID), Node MCU, Arduino controller and weight Sensor and ultrasonic sensor and pressing mechanism for solid waste bin and truck monitoring system with their performance measured in real time environment. Web based android applications were developed to interface with a web server to intimate the municipality regarding the cleaning process performed by the workers. This system provides a database of the information of bin status, amount of waste in the bin, time of the collection of waste are transmitted to monitor and efficiently manage the waste collection strategies. This data was processed by graph theory optimization algorithms to find the shortest path for the purpose of reaching the bin to reduce the cost

Keywords — Internet of things (IoT), Smart bin, Sensors, RFID

INTRODUCTION

In our system, the Smart dust bins are connected to the internet to get the real time information of the smart dustbins. In the recent years, there was a rapid growth in population which leads to more waste disposal. So, a proper waste management system is necessary to avoid spreading some deadly diseases. Managing the smart bins by monitoring the status of it and accordingly taking the decision. There are multiple dustbins are located throughout the city or the Campus (Educational Institutions, Companies, Hospitals etc.). These dustbins are interfaced with Arduino based system with weight Sensors and Wi-Fi-modules. Where the ultrasonic sensor / IR sensor detects the level of the garbage in dustbin and sends the signals to Arduino the same signal is encoded and sends through Wi-Fi module and it is received and decoded by Wi-Fi receiver at the Central System and an Internet connection is enabled through a LAN cable from the modem. The data has been received, analysed and processed in the cloud, which displays the status of the Garbage in the dustbin on the GUI on the web browser.

Reasons of Improper Management of Waste

- Inappropriate planning for the management of waste while scheduling the townships.
- Lack of Integrated System for the efficient monitoring and disposal of waste.
- Lack of scientific and skilled manpower.
- Involvement and awareness of the public towards waste management is in a nominal level.
- Lack in the use of modern techniques and best practices.
- Out-dated Management Information Systems.

RELEATED WORK

1. **Parkash, Prabu V** [1] they developed a system which work on internet of things can be used in waste management Systems with help of microcontroller and Infrared sensor with help of RF module and RF transmitter and Intel Galileo Gen 2. In which they are monitoring the garbage with Inferred sensor for the level

measurement inside the dustbin of garbage so when dustbin is full system send the signal to the concerned person so they will clean it as soon as possible.

2. **Prof. S.A. Mahajan, Akshay Kokane, Apoorva Shewale, Mrunaya Shinde , Shivani Ingale**, [2] they are designing smart dustbin in which they are going to use ultrasonic sensor for level sensing and Raspberry Pi for controlling the system as well as they are using humidity sensor for distinguish between Dry and Wet waste so waste can be separated hence generating of harmful diseases can be avoided.
3. **B. Vinothkumar, K. Sivaranjani, M.Sugunadevi, V. Vijayakumar** [3] in which they have used Ultrasonic sensor for level sensing of the dustbin when the dustbin are full it will send signal to the Raspberry Pi. in which they used Raspberry Pi for controlling the system as well as they placed the flame sensor for if some time fire will be catch in dustbin then Raspberry Pi send the signal to the management that dustbin has catch the fire so they can make surroundings clean and green
4. **Chitluri Sai Srikanth, Tadvika Bhupathi Rayudu, Javvaji Radhika, Raju Anitha** [4] in which they have proposed design sharp garbage bin in which they have used strain gauge weight sensor and Bluetooth module Arduino UNO comparator smoke sensor and NodeMCU in this when the dustbin is full it will send signal via his web application to the waste specialist by sending SMS. These will diminish the flood of the west compartment and suitable keeping nature clean

PROBLEM STATEMENT

Commonly we see that the trash receptacles which are set at open places in the urban areas are flooding because of increment in the waste each day. As we have seen number of times the dustbins are getting overflowed and concern person don't get the information within a time and due to which unsanitary condition formed in the surroundings, at the same time bad smell spread out due to waste, bad look of the city which paves the way for air pollution and It makes unhygienic condition for the individuals and makes terrible stench in the encompassing. This leads in spreading some savage infections and human disease

METHODOLOGY

In this scenario, garbage bins will be Placed at different location and it will be equipped with arduino UNO and IoT module. Every dustbin will have to be given a unique id. A database will be maintained containing the information about which dustbin to be placed in which area by their corresponding ids. The dustbin has ultrasonic sensor for level detection and load cell for weight detection. Every dustbin will have to communicate with arduino, where arduino UNO will act as a broker. The work of arduino UNO 3 will be to collect the data from sensors attached to dustbins, apply noise removal algorithm and send data to server using Wi-Fi module which is Node MCU the message has to be sent to server by Node MCU through the blyk app about levels of garbage in a bin, Server matches ids with database of dustbins, and will find levels of dustbins located in different areas of city. Different IoT protocols can be used for data transmission like MQTT or COAP. The collected data in cloud will be analyzed by using analytic tool like Hadoop or Storm, and useful information regarding waste management will be extracted. From the collected the data, user will get to know about real-time garbage level, and the garbage collection van can find optimized route for collection of garbage. Whenever the garbage level crosses threshold level, the alert will be generated for urgent collection of garbage. The simple Web GUI will help the user to use this system efficiently.

DISADVANTAGES OF EXISTING SYSTEM

- Time consuming and less effective: trucks go and empty containers whether they are full or not.
- Unhygienic condition

- High cost.
- Bad smell spreads and may cause illness to human beings.
- More traffic and noise occurrence.

PROPOSED DESIGN

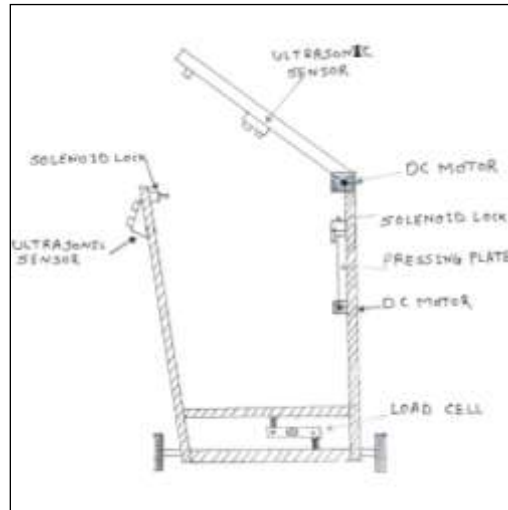


Fig. 1 Open view of dustbin

DESIGN CALCULATION

- **DIMENSION OF MODEL**
 - Height of the dustbin is 2 feet = 60cm
 - Length of the dustbin is 1 feet = 30cm
 - Width of the dustbin is 1 feet = 30cm
- Working Size of the dustbin
 - Length= 28 cm
 - Width= 28 cm
 - Height = 51 cm
- VOLUME OF THE DUSTBIN. (in cm)
 - Volume = Length * width * height
 - = 28 * 28 * 51
 - = 39984 cm³
- VOLUME OF THE DUSTBIN (in kg)
 - 1000 cm³ = 1 kg.
 - 39984 cm³ = 39.98 kg.
 - .i.e., volume of the dustbin is =40kg
- MOTOR TORQUE CALCULATION
 - Diameter = 20 mm
 - Weight of plate = 0.250 kg
 - Torque = Force * Radius
 - = Weight * Gravity * Radius
 - = 0.250 * 9.81 * 10
 - = 24.525 N mm

$$= 2.4525 \text{ N m}$$

$$= 24.525 \text{ Kg cm}$$

- POWER OUTPUT OF DC MOTOR

$$= \text{Voltage} * \text{Current}$$

$$= 12 * 0.8$$

$$= 9.6 \text{ watt}$$

BLOCK DIAGRAM

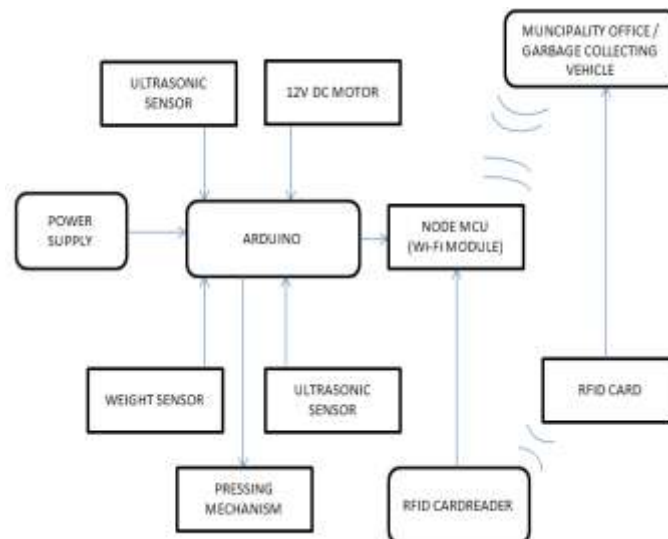


Fig.2 Block Diagram of System

HARDWARE REQUIRED

1. ARDUINO UNO MICRO CONTROLLER

- The Arduino UNO is an open-source microcontroller board dependent on the Microchip ATmega328P microcontroller made by Arduino..
- The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE through a sort B USB associate.
- It can be empowered by a USB associate or by an outside 9-volt battery, at any rate it perceives voltages some spot in the extent of 7 and 20 volts.
- The information that gets into Arduino is PWM (pulse width rule) type.

2. NODE MCU

- Node MCU is an open source IOT compose.
- The chip utilized in this module is esp8266 which is utilized to exchange the information to the helpful application.
- Node MCU provides a way to connect different sensors to their controllers wirelessly via Wi-Fi. Since, it is an improved version of the ESP8266 it has better and easier programming, with better voltage stability and more reliability

3. LOAD CELL

A load cell is a transducer that is used to create an electrical signal whose magnitude is directly proportional to the force being measured. The various types of load cells include hydraulic load cells, pneumatic load cells and strain gauge load cells.

- The electrical signal output is typically in the order of a few millivolts and requires amplification by an instrumentation amplifier before it can be used. The output of the transducer is plugged into an algorithm to calculate the force applied to the transducer.
- Type – Single point load cell
- Rated load – 40 Kg

4. LTRASONIC SENSOR (HC-SR04)

- The HC-SR04 Ultrasonic (US) sensor is a 4 pin module, whose pin names are Vcc, Trigger, Echo and Ground respectively. This sensor is a very popular sensor used in many applications where measuring distance or sensing objects are required. The module has two eyes like projects in the front which forms the Ultrasonic transmitter and Receiver. The sensor works with the simple high school formula that
- Operating voltage: +5V
- Theoretical Measuring Distance: 2cm to 400cm
- Distance = Speed × Time

5. 12V DC GEARED MOTOR 27 kgcm 100 RPM

SPECIFICATION OF MOTOR:

- 6mm Diameter shaft with M3 thread hole.
- Gearbox diameter 37 mm.
- Motor Diameter 28.5 mm.
- Length 63 mm without shaft.
- Shaft length 30mm.
- 180gm weight.
- 27.18kgcm Holding Torque,
- No-load current = 800 mA,
- Load current = up to 7.5 A (Max).
- Recommended to be used with DC Motor Driver 20A or Dual DC Motor Driver 20A.



Fig.7 12V DC Geared Motor 27kgcm 100rpm

6. RFID CARD AND CARD READER

- Radio-frequency identification (RFID) uses electromagnetic fields to automatically identify and track tags attached to objects. An RFID system consists of a tiny radio transponder, a radio receiver and transmitter. When triggered by an electromagnetic interrogation pulse from a nearby RFID reader device, the tag transmits digital data, usually an identifying inventory number, back to the reader. This number can be used to track inventory
- Communication distance: 5cm~7cm.
- Built-in PCB Antenna, with 4cm~6cm communication distance

7. HALL EFFECT SENSOR (MODEL - RKI-3101)

- The Hall Effect Magnetic and Proximity Sensor Module can be used to detect presence (or absence!) of nearby objects such as magnets. This sensor accepts a GND and +5V supply, and has a single digital output which goes low (GND) when a magnetic field is detected.
- Features wide range voltage comparator LM393.
- Power: 2.3V ~ 5.3V

8. SOLENOID LOCK

- 12V Solenoid lock has a slug with a slanted cut and a good mounting bracket. It's basically an electronic lock, designed for a basic cabinet, safe or door. When 9-12VDC is applied, the slug pulls in so it doesn't stick out and the door can be opened. It does not use any power in this state. It is very easy to install for automatic door lock systems like electric door lock with the mounting board. This solenoid in particular is nice and strong.
- Operating voltage : 12VDC
- Designed for 1-10 seconds long activation time
- Draws 650mA at 12V, 500 mA at 9V when activated

9. RELAY

- A relay can be defined as a switch. Switches are generally used to close or open the circuit manually .Relay is also a switch that connects or disconnects two circuits. But instead of manual operation a relay is applied with electrical signal, which in turn connects or disconnects another circuit.
- These are used to control the high voltage circuit with low voltage signal in applications audio amplifiers and some types of modems.

PROTOTYPE MODEL



Fig.11 Prototype model.

TESTING

• TEST APPROACH

We will test the project in two stages: software and hardware. The software part is to be tested via the Arduino IDE, whereas the hardware part has to be tested physically. It is necessary to check whether the system is working properly or not. We will check the distance pointed out by the sensor by a meter tape.

• FEATURES TO BE TESTED

After building the project we test it. This project should satisfy some features. Features to be tested as follows

- The ultrasonic sensor should give proper output.(when object come in front of the dustbin it should give signal to open the door of the dustbin)
- Load cell gives signal when load is reach to its limit.
- Arduino and node MCU should give the signal when dustbin is full.
- Pressing mechanism should be checked.

RESULT

- Motor rotates about 70 degrees in time frame of 0.60 seconds to open and close the door of the dustbin.
- When load is not full but level is reach to its limit then the pressing mechanism work.
- The Blynk app will show the real time data which is given by the sensors and the Motors through the arduino.



Fig.12 Result of system

Advantages:

- Will help to municipality for garbage collection and keeping city clean.
- It will help to not create Unhygienic & bad odour Around the Surrounding.
- It will avoid spreading some Deadly Diseases & human illness.

Disadvantages:

- Cannot detect liquid waste

FUTURE SCOPE

- Hydraulic pressing addition - In the big size dustbin we can add hydraulic pressing so more space will be available for garbage.

CONCLUSION

This project work is the implementation of IoT based waste management system in which we are using ultrasonic sensor, load cell, Arduino, and pressing mechanism and Wi-Fi module. This system assures the cleaning of dustbins soon when the garbage level reaches its maximum. Therefore, the Iot based waste management system makes the garbage collection more efficient. In real time, this setup can be implemented in the environment. This set up can also be implemented in Industry based areas. The future work may be implemented by interfacing the devices with Google maps to find the optimal (shortest) path.

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