

Dynamic Solid Waste Collection and Management System Based On Sensors

¹Dr. M Nagaratna, ²T Yogendra Charya

¹Associate Professor, Computer Science & Engineering, JNTUH College of Engineering Hyderabad

²M.Tech (C.Sc.E), JNTUH College of Engineering Hyderabad

Abstract-Healthy environment is crucial to a healthy and happy community. With the age-old system to regularly check and empty filled dustbins with humans, the process is more susceptible to human error and neglect. Additionally, due to different frequency of usage of dustbins in different areas, routine checks which are based on regular intervals of time is not efficient because a dustbin might get filled frequently and may need immediate response or there may not be any need of a routine check for a long period of time. This makes present system costly in terms of resources and inefficient, as overflowing, stinking dustbins become more of a problem than a solution.

In this paper we present a solution about this network of dustbins which combines the idea of IoT with Wireless Sensor Networks. We also put forward the concept of a network of smart garbage bins by integrating Wireless Sensor Network with the Cloud computing and how sensor data can be utilized by the system to gain useful insights to improve the effectiveness of the garbage monitoring.

Keywords-Garbage Collection; Internet of things; Arduino Uno; Ultrasonic Sensor; GSM; Wi-Fi; Internet of things.

I. INTRODUCTION

The Internet of Things (IoT), is expected infrastructure for concept of Smart building, brings new hopes for the building management. IoT vision introduces hopeful and viable solutions in terms of economy for massive data collection and its analysis which can be applied in many domains and so make them operate more efficiently. Here we are discussing one of the most challenging issues - waste-collection. Garbage is not collected in the correct time and this leads to the damage of surroundings and resulting in health issues. To optimize the logistic procedure of waste collection, we are implementing a IOT solution, where automation of theclassification of garbage type like dry or wet will be done and update of the dustbin (how much filled) will be send to the server through Wide Area Network(WAN). In this system whenever the dustbin is filled with 80% it will automatically send the SMS (using GSM Module) and will update on the server automatically. The presented solution provides calculation of garbage-truck collection more accurate with

automation. As an output, we provide system with set of sensors to automate this process.

Existing System

In the existing system of garbage collection, garbage is collected by respective city municipalities, weekly once or once in two days. Even though the garbage stinks and overflows from garbage bin and spreads over the surroundings and results in environment pollution. This results in surrounding of garbage bin with foul smell and air pollutions which spreads diseases.

Proposed system

Proposed system automates classification of garbage either as dry or wet and properly dumped into corresponding bin. Control room(Server) is notified with dustbin levels and notifies corresponding personnel whenever dustbin reaches a threshold (80% in this case). This will ensure clean surrounding of dustbin and efficient and economical transportation of garbage using IoT system. This also ensures disposal of the garbage in an environmental friendly way by sending dry garbage to recycle centers and wet garbage to compost centers. This avoid manual separation of garbage.

Block Diagram

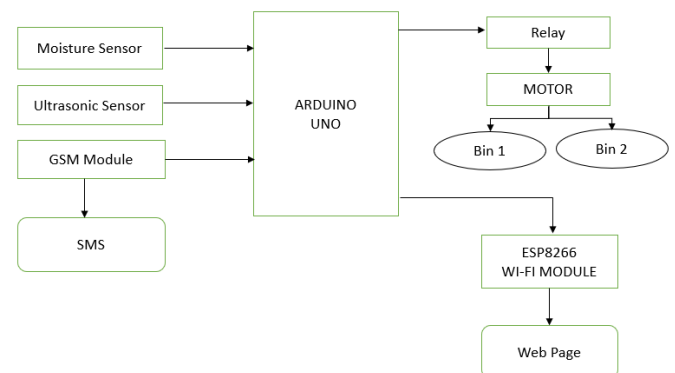


Fig.1:Block diagram

Waste management is one of the difficult challenge with respect to health and Environment issues. This project explains a new way to easily manage waste using automation

and with network data exchange. Here first moisture sensor will be used to detect the waste is dry or wet and accordingly it will put it into the respected two dustbins i.e. DRY or WET. Second part it will keep on updating how much the dustbin is filled using the ultrasonic sensor embedded into them. In the server the status of the dustbins will be update and as the dustbin is filled 90% automatically GSM will send the SMS to the officials who will collect the waste. In this way people don't have to worry about the health issues and automatic system is introduced where Machine will communicate to Machine in order to do the work.

II. HARDWARE COMPONENTS

Arduino Uno



Fig.2:Arduino UNO Board

The Arduino UNO is an open-source microcontroller board which is based on the Microchip ATmega328P microcontroller. It was developed by Arduino.cc. This board is equipped with sets of digital and analog input/output (I/O) pins that can be interfaced to varied expansion boards (shields) and other circuits. The board has fourteen Digital pins, six Analog pins, and programmable using the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by either a USB cable or by external 9-volt battery.

The ATmega328 on the Arduino Uno comes preprogrammed with a bootloader that enables uploading new code to it without the using an external hardware programmer. It communicates using the original STK500 protocol. The Uno conjointly differs from all preceding boards in which, it doesn't use the FTDI USB-to-serial driver chip. Instead of that, it uses the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

III. ULTRASONIC SENSOR

The Ultrasonic Sensor sends out a high-frequency sound pulse and then calculate time taken for the echo of the sound to reflect. The sensor has 2 openings, one opening emits ultrasonic waves, and the other receives them. The speed of sound is ~341 meters per second in air. It uses this information along with the time difference between transmitting and

receiving the sound pulse to determine the distance of the object.

Ultrasonic ranging module HC - SR04 is used in this solution and this module can provides 2cm - 400cm non-contact measurement function, (accuracy could be up to 3mm). The module has an ultrasonic transmitter, receiver and control circuit.

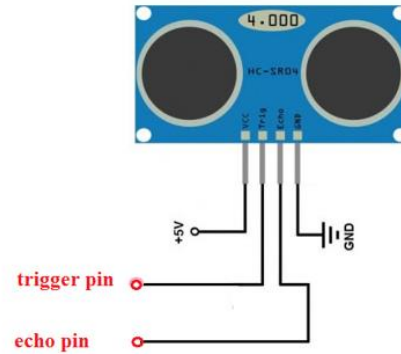


Fig.3:Ultrasonic Sensor

The basic principle of work:-

- A. Uses IO trigger for a duration of 10us high level signal
- B. The Module sends eight 40 kHz and detect if there is a pulse signal back received.
- C. When the signal is back, through high level, time of high output IO duration is the time from sending ultrasonic to receiving.

Distance = (high level time × sound velocity i.e. 340M/S) / 2
The HC-SR04 Ultrasonic Module has 4 pins, GND, VCC, Trig and Echo.

IV. GSM MODULE

Global system for mobile communication (GSM) is a digital cellular communication standard which is accepted worldwide.

The GSM network can be classified as

- A. switching system (SS),
- B. base station system (BSS)
- C. operation and support system (OSS).

GSM Network basic architecture is shown in above figure.

A GSM modem is a wireless modem which is used to send and receive data through radio waves to/from GSM wireless network. AT commands are used to communicate with modems.

SIM800L module is used in this solution and it supports quad-band GSM/GPRS network, available for GPRS for data and SMS message remote transmission. The SIM800L talks with microcontroller through UART port, and has support for commands including 3GPP TS 27.007, 27.005 and SIMCOM enhanced AT Commands. It can work with

microcontroller of higher voltage than 2.8V default since it has built-in level translation. It also supports A-GPS technique for supporting mobile positioning and gets position using mobile network it is connected to. Hence, it also works as a tracker module.

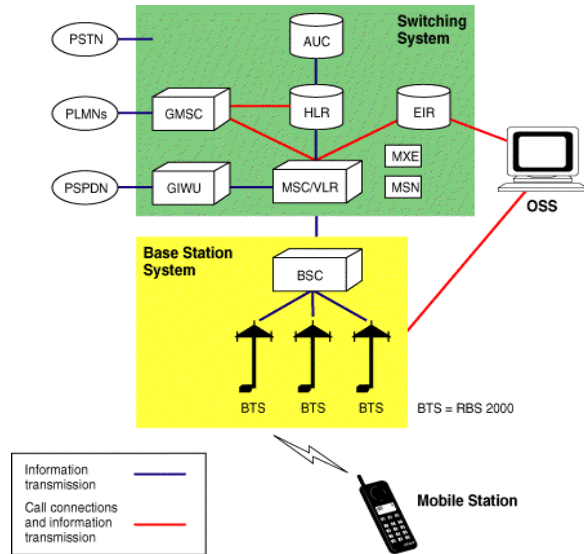


Fig. 4: GSM Network



Fig.5: GSM Module

Wi-Fi Module

The ESP8266 is a low-cost Wi-Fi microchip which has full TCP/IP stack and microcontroller capabilities. This Wi-Fi module enables microcontrollers to communicate with a Wi-Fi network and make TCP/IP connections.

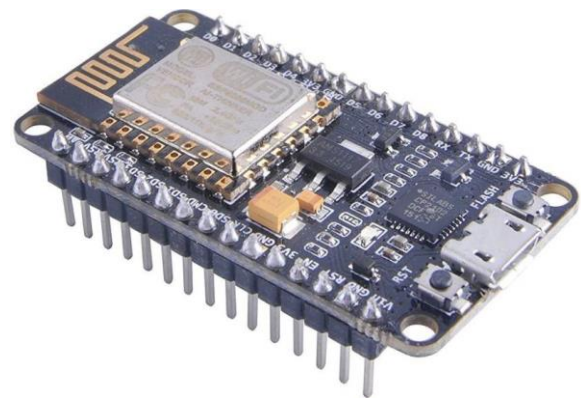


Fig.6: Wi-Fi Module

V. MOISTURE SENSOR

Moisture sensor FC-28 is used with Arduino in the proposed solution. This sensor measures volumetric content of water inside the garbage and gives us the moisture level as output. The sensor can be used in both analog and digital

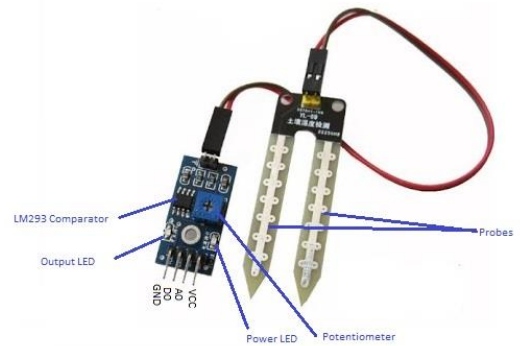


Fig.7: Moisture Sensor Module

mode.

The moisture sensor consists of two probes which are used to measure the volumetric content of water. The two probes allow the current to pass through the material/garbage and then it gets the resistance value to measure the moisture value.

Motor Driver IC

L293D is used in the solution to connect Arduino with Motor that rotates downwards either left or right direction to throw dry/wet garbage in respective dry/wet dustbin. This is a motor driver integrated circuit (IC) of type dual H-bridge. This is a current amplifier. It works by taking a low-current control signal and provides a higher-current signal which used to drive the motors.

Software Components

Arduino IDE

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for

common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.

VI. RESULTS

The proposed system consists of various sensors placed different positions of the dustbin. As per the program, these sensors will keep sensing data like whether waste thrown is dry or wet and whether dustbin is full or not. As per the trigger points, this data will be sent to the corresponding centralized location/server and action will be taken like if the dustbin is full, then respective garbage collecting vehicle can be sent to clear the garbage.

Proposed system improved upon the existing solution in many ways.

- A. Firstly, it optimizes the waste management system by sending the real time alerts to the concerned authorities in two ways.
 - 1) SMS sent to concerned authority when dustbins fills up to 80%
 - 2) Real time data (level of garbage in dustbin) can be monitored through webpage.
- B. Secondly, this system improves the cleanliness of the surroundings since garbage collected immediately when a bin fills and eventually this is resulted better health of the surrounding people living there.
- C. Third improved is waste thrown is segregated into wet waste and dry waste which improves disposal of the waste in environmental friendly manner. Wet waste can be composted, and dry waste can be recycled. So, this avoid manual separation of waste into dry and wet.

Below figure shows the alert SMS sent to the mobile phone. Below figure shows the garbage level in dustbin whether garbage thrown is dry or wet.



Fig.9: Real Time Alerts in Mobile Phone

Fig.10: Data Monitoring viaWebpage

Below figure shows the logs collected in the output terminal for testing.

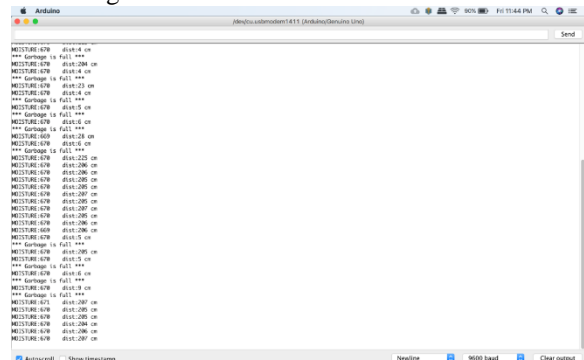


Fig.11: Sensors data in Terminal

VII. CONCLUSION

In this solution, we tried to optimize the logistic procedure of waste collection. This is realized by implementing an IoT solution with sensors, GSM, Wi-Fi and other modules. This solution provides various features, first one is automation of segregation of waste into dry waste and wet waste. Second one is updating/monitoring of the dustbin levels through the GSM and Wide Area Network(WAN) with a cloud. So, this solution improved environmental issues and health of the people and optimizes route mapping the garbage

collection vehicles which is a helpful to city municipal organizations economically. This solution definitely improves the developing and developed cities and turns them into a smart city. This solution is a first step in turning cities into smart cities. Hence, our solution presents a better, improved, economically viable solution compared to existing solutions.

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