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IoT based Smart Waste Management System

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***Abstract*: This project IOT Garbage Monitoring system is a very innovative system which will help to keep the cities clean. This system monitors the garbage bins and informs about the level of garbage collected in the garbage bins via a web page. For this the system uses ultrasonic sensors placed over the bins to detect the garbage level and compare it with the garbage bins depth. The system makes use of AVR family microcontroller, GSM and Wi-Fi modem for sending data. Where as a web page is built to show the status to the user monitoring it. The web page gives a graphical view of the garbage bins and highlights the garbage collected in color in order to show the level of garbage collected. Thus this system helps to keep the city clean by informing about the garbage levels of the bins by providing graphical image of the bins via a web page**

***Keywords*: pin couplers, ultrasonic sensor and arduino**

1. Introduction

The idea struck us when we observed that the garbage truck use to go around the town to collect solid waste twice a day. Although this system was thorough it was very inefficient. For example let's say street A is a busy street and we see that the garbage fills up really fast whereas maybe street B even after two days the bin isn't even half full. What our system does is it gives a real time indicator of the garbage level in a trashcan at any given time. Using that data we can then optimize waste collection routes and ultimately reduce consumption. It allows trash collectors to plan their daily/weekly pick up schedule.

2. Project cost

A. Project cost can be divided into two ways and conclude as follows

1) Hardware cost

Hardware cost for our project can be considered as a moderate amount of money spends. It does not falls under a cheap project neither it is relatively small one. However, having said that, the cost of hardware components are not as significant when compared to it but they do accumulate to considerable amount. But taking into consideration that this is a onetime investment. Cost cannot be said to be too expensive.

2) Software cost

Software cost includes the cost of the required software of our project. We did not have to spend money in getting the necessary software for our project the software we used for our system id free edition version and thus no money was spend on it. The involvement cost in our project is only the human labor, and location for gathering location and also we have not mention cost of electricity that was consumed during the project completion time.

Table 1
Hardware requirements

S. No	List of Components
1	Arduino UNO
2	ESP 82666 Wi-Fi Module
3	HC SR 04 Ultrasonic Sensor
4	Connecting Wire
5	SIM 800L |(GSM Module)
6	Regulator 7805
7	1K resister
8	Arduino Charger
9	Dustbin

3) Connecting Wire

Fig. 1. Connecting wires

Combine this cable with 2 3-Pin Couplers to easily connect from 1 port to 2 Hobby Servos. Sometimes you need to hook a servo or a sensor directly to your Arduino, or minimize the mess of jumper wires on your breadboard. A wire is a single, usually cylindrical, flexible strand or rod of metal. Wires are used to bear mechanical loads or electricity and telecommunications signals. Wire is commonly formed by drawing the metal through a hole in a die or draw plate. Wire comes in solid core, stranded, or braided forms. This is a standard issue USB 2.0 cable. This is the most common A to B Male/Male type peripheral cable, the kind that's usually used for printers Compatible with most like the Uno. SFE designed USB boards as well as USB Arduino boards.

4) HC SR 04 Ultrasonic Sensor

Features

Ultrasonic ranging module HC - SR04 provides 2cm - 400cm non-contact measurement function, the ranging accuracy can

reach to 3mm. The modules includes ultrasonic transmitters, receiver and control circuit. The basic principle of work:-

- Using IO trigger for at least 10us high level signal.
- The Module automatically sends eight 40 kHz and detect whether there is a pulse signal back.
- IF the signal back, through high level , time of high output IO duration is the time from sending ultrasonic to returning. Test distance (high level time x velocity of sound (340M/S)/2

Wire connecting direct as following:

- 5V Supply
- Trigger Pulse Input
- Echo Pulse output
- 0V Ground

Fig. 2. HC SR 04 ultrasonic sensor

Table 2
Parameters

Working Voltage	DC 5V
Working current	15 mA
Working frequency	40 Hz
Max Range	4m
Min range	2 cm
Measuring Angle	15 degree
Trigger Input Signal	10us TTL pulse
Echo Output signal	Input TTL lever signal and the range in proportion
Dimension	45*20*15mm

5) Wi-Fi Module

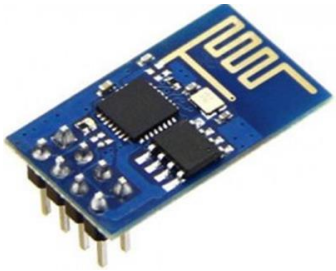

Fig. 3. ESP 8266 Wi-Fi Module

The ESP8266 Wi-Fi Module is a self contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your Wi-Fi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much Wi-Fi-ability as a Wi-Fi Shield offers (and that's just out of the box) The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community .

This module has a powerful enough on-board processing and storage capability that allows it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. Its high degree of on-chip integration allows for minimal external circuitry, including the front-end module, is designed to occupy minimal PCB area. The ESP8266 supports APSD for VoIP applications and Bluetooth co- existence interfaces; it contains a self-calibrated RF allowing it to work under all operating conditions, and requires no external RF parts. There is an almost limitless fountain of information available for the ESP8266, all of which has been provided by amazing community support. In the section below you find many resources to aid you in using the ESP8266, even instructions on how to transforming this module into an IOT (Internet of Things) solution

6) SIM 800L (GSM Module)

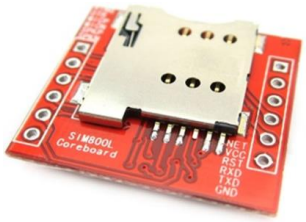

Fig. 4. SIM 800L (GSM Module)

GSM is a mobile communication modem, it is stands for global system for mobile communication (GSM). The idea of GSM was developed at Bell Laboratories in 1970. It is widely used mobile communication system in the world. GSM is an open and digital cellular technology used for transmitting mobile voice and data services operates at the 850MHz, 900MHz, 1800MHz and 1900MHz frequency bands. GSM system was developed as a digital system using time division multiple access (TDMA) technique for communication purpose. A GSM digitizes and reduces the data, then sends it down through a channel with two different streams of client data, each in its own particular time slot. The digital system has an ability to carry 64 kbps to 120 Mbps of data rates. There are various cell sizes in a GSM system such as macro, micro, pico and umbrella cells. Each cell varies as per the implementation domain. There are five different cell sizes in a GSM network macro, micro, pico and umbrella cells. The coverage area of each cell varies according to the implementation environment.

3. Software description

A. Arduino software

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can

be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

B. Technical specification

Table 3
Technical specification

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB
SRAM	2 KB
EEPROM	1 KB

C. Arduino Uno

Fig. 5. Arduino board

Power:

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector. The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

The power pins are as follows:

- V_{IN}*:* The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- *5V:* The regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board regulator, or be supplied by USB or another regulated 5V supply.
- *3V3:* A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- *GND:* Ground pins.

1) Memory

The Atmega328 has 32 KB of flash memory for storing code (of which 0,5 KB is used for the boot loader), It has also 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

2) Input output

The Uno has 6 analog inputs, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analog Reference function.

D. Communication

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication. which is available on digital pins 0 (RX) and 1 (TX). An ATmega8U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '8U2 firmware uses the standard USB COM drivers, and no external driver is needed. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1

A Software Serial library allows for serial communication on any of the Uno's digital pins. The ATmega328 also support I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus.

1) Advantages

- Affordable Project
- This will push the Digital India.
- This will help keep environment safe.
- Its save the time.
- Help keeping society updated & clean.

2) Disadvantages

- Hardware damage needs to replace the particular component
- Need continues power supply.

3) Application

- At every home we can apply this project.
- At Domestic as well as corporate offices we can apply this project
- At food industry it's more applicable.
- At hospitals its must applicable.
- In chemical industries, laboratories we can apply this project.
- We can apply this project on social occasions at public places.

4. Conclusion

The main objective is to maintain the level of cleanliness in the city and form an environment which is better for living by using this system we can constantly check the level of the Garbage in the dustbins which are placed in various parts of the city. If a particular dustbin has reached the maximum level then the employees can be informed and they can immediately take certain actions to empty it as soon as possible. The employees can check the status of these bins anytime on their mobile phones. This can prove to be a very useful system if used properly. The system can be used as a benchmark by the people who are willing to take one step further for increasing the cleanliness in their respected areas. Ultrasonic sensor is being used in this system to check the level of garbage in the dustbins but in future various other types of sensors can be used with the ultrasonic sensor to get more precise output and to take this system to another level. Now this system can be used in certain areas but as soon as it proves its credibility it can be used in all the big areas. As this system also reduces manual work certain changes can be done in the system to take it to another level and make it more useful. For the employees and people who are using it. In future, a team can be made which will be in charge for handling and maintaining this system and also to take care of its maintenances.

A. Future scope

- In future we are able to make automation in whole system.
- We can improve it to sense the E waste detection, processing & sorting also.
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References

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