IOT BASED GARBAGE MONITORING SYSTEM FOR MUNICIPAL BODIES

Dissertation submitted in partial fulfillment of the requirements for the degree of

BACHELOR OF TECHNOLOGY
IN
ELECTRONICS AND COMMUNICATION ENGINEERING

BY

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UNDER THE GUIDANCE OF

MR. MUNISH SOOD

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT
May 2019

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DECLARATION BY THE SCHOLAR

I hereby declare that the work reported in the B-Tech thesis entitled **"IOT BASED GARBAGE MONITORING SYSTEM FOR MUNICIPAL BODIES"** submitted at **Jaypee University of Information Technology, Solan, India,** is an authentic record of my work carried out under the supervision of **Mr. Munish Sood**. I have not submitted this work elsewhere for any other degree or diploma.

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Date: 18 May 2018.

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CERTIFICATE

This is to certify that the work reported in the B.Tech project report entitled **"IOT BASED GARBAGE MONITORING SYSTEM FOR MUNICIPAL BODIES"** which is being submitted by **Sahil Jas(151109), Dhruv Garg(151044) and Abhinandan Gupta(151072)** in fulfillment for the award of Bachelor of Technology in Electronics and Communication Engineering by the Jaypee University of Information Technology, is the record of candidate's own work carried out by him/her under my supervision. This work is original and has not been submitted partially or fully anywhere else for any other degree or diploma.

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ABSTRACT

This project presents the design and implementation of an IOT based Garbage Monitoring System for Smart cities using the Ultrasonic Sensor and Arduino UNO as the MCU (Master Control Unit). The system will continuously monitor garbage levels in public dustbins and thus provide an efficient way for waste management to the municipal bodies. The model is connected to the internet using an ESP8266 WiFi module, which allows communication between the Arduino and another internet supporting device. The project provides an efficient solution to a real world problem.

Keywords

Arduino UNO, ESP8266 Wi-Fi module, Ultrasonic sensor, Garbage monitoring, Water monitoring

CHAPTER 1
INTRODUCTION

It's safe to say that the internet has taken over our generation. Everything is just a click away and as the advancements in technology continue to make progress more and more of our daily tasks are being connected to the internet. There's a new concept of smart cities which is catching pace right now. As we attempt to build these tech-savvy cities it is important to make sure that the basic necessities such as garbage monitoring, waste management, water management etc. are not overlooked. We aim at providing a smart solution to one of these problems using the concept of IOT.

Internet of Things was introduced during the early 2000s. Since then it has been an exponentially increasing industry and has had immense growth all around the globe. The rise in consumer expectations, manufacturing of cheap devices and the advancements in cloud computing have all been pivotal to the IOT revolution. India is expected to account for 5% of the IOT industry meaning a market of around INR 1500 crores by 2020.

One of the biggest problems that still persist in India is the unhygienic environment and waste disposal. According to recent studies the waste management and disposal systems in India are fallacious. If you look at the public dustbins around you, you'll realize why. A lot of them are clogged and overflowing very early during the day and by night time there's garbage all over the street. While you'll also be able to spot some of these dustbins that are almost never full.

THIS STORY IS FROM JUNE 22, 2018

City waste bins overflowing, can lead to epidemic: Locals

B B Nayak | TNN | Updated: Jun 23, 2018, 4:42 IST

A- A+

Picture for representational purpose only.

NAVI MUMBAI: Residents have complained that NMMC garbage collection contractors have not been clearing kitchen waste from overflowing bins placed on roads and bylanes in the town.

The local residents have been complaining about the foul odour and an epidemic can't be ruled out with the advent of the monsoon which has only

Figure 1.1: An article from the times of India about complains regarding overflowing dustbins

Overflowing garbage bins, an eyesore in Fort City

Serena Josephine M.

VELLORE:, JUNE 10, 2016 00:00 IST
UPDATED: OCTOBER 18, 2016 15:10 IST

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Residents complain of irregular clearance and poor sanitation

Overflowing garbage bins have become a common sight in a number of areas in the Fort City. Residents complain that the accumulated waste raises a stench, putting the locality in the grip of poor sanitation.

Figure 1.2: An article in The Hindu about adverse conditions of dustbins in Saidapet, Tamil Nadu

Bins overflow, make Dhakoli colony messy

Aarti Kapur | TNN | Updated: Oct 6, 2018, 5:59 IST

A- A+

MC staff have not been picking up waste strewn around the only two dumpsters in Dashmesh Colony, say area resi... Read More

ZIRAKPUR: The only two dumpsters at Dashmesh Colony in Dhakoli, Zirakpur, are overflowing with garbage and have become an eyesore and a source of nauseating smell for locals.

This is because staff of the municipal corporation (MC) do not lift waste properly in the area. Residents say there have been instances when minor accidents have happened in the area as stray cattle and dogs hover around the waste for food. To make matters

Figure 1.3: Article in the Times of India regarding overflowing dustbins in Zirakpur

Posted at: Dec 17, 2017, 2:05 AM; last updated: Dec 17, 2017, 2:05 AM (IST)

DERA BASSI ILLS

Overflowing bins add to garbage mess

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An overflowing garbage bin at Mubarikpur near Dera Bassi. Photo by writer

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- Tamanna Mohali district topper with 98.31 per cent
- Mohali continues its poor show
- Pay Rs 6.5L to woman, GMSH told
- Undertrial gives cops the slip

Figure 1.4: Article in the Tribune regarding overflowing dustbins in Dera Bassi

Some of the dustbins installed by the Municipal Corporation fill within 2 hours while others remain empty for 2 weeks. There's no proper system to identify when these dustbins will fill which makes the work of these Municipal bodies much more extensive and complex.

We aim at providing a digital system to simplify this tedious job. The garbage monitoring system will help the municipal bodies to govern these garbage bins using the internet as per their convenience. Hence they'll be able to efficiently empty these garbage bins as and when required. This will minimize littering on the streets and hence lead to a much more hygienic environment.

CHAPTER -2
COMPONENTS USED

2.1 ARDUINO UNO:

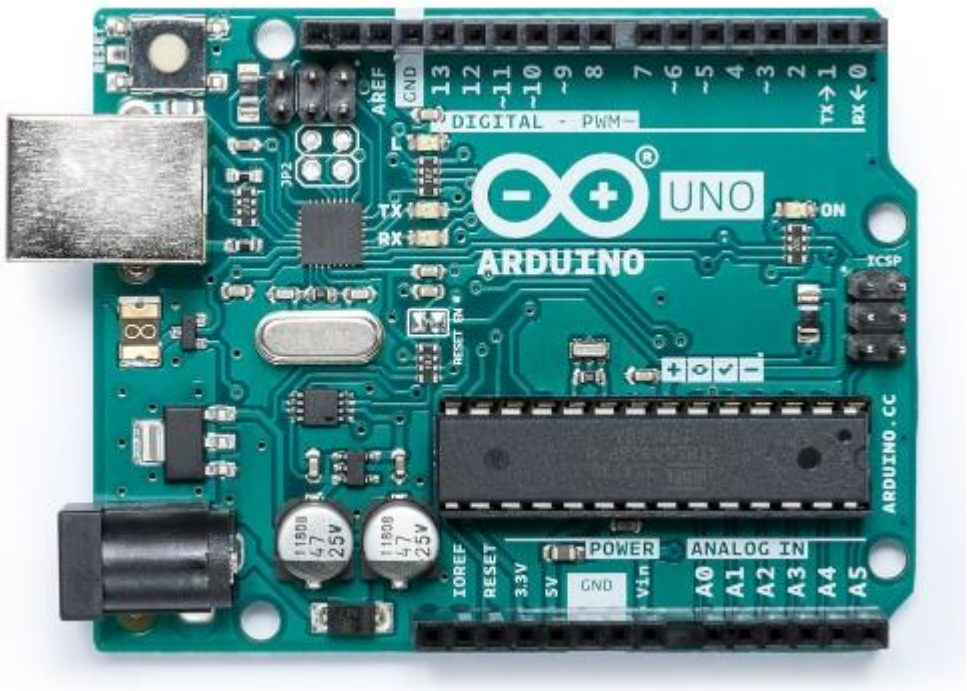


Figure 2.1: Arduino Uno

Arduino Uno is a microcontroller board which depends on the ATmega328P. The word Arduino refers to so many different things. Microcontrollers are integrated circuit that are basically tiny computers that can run small simple software programs, they are low powered enough that they can be powered by batteries for days or months but are able to process data very much faster than a human mind can process or think.

Arduino is a company in Italy that designs and sell circuit boards that make microcontroller easy to use, they named these circuit boards Arduinos and there are a lot of different types

of Arduinos which can be used in different ways and have different functionality for disparate applications for example we have got simple Arduino boards like Arduino uno which is economical and quite good for every project.

Arduino uno can be used for different purposes such as to control motors, cameras, lighting or even built a simple robotic system. Then we have some complex Arduinos which have more powerful processors which have wifi, ethernet and many more. There is a programming language that lets you configure Arduino all hardware products in the same way. Arduino uno uses a series of microcontrollers the ATmega AVR they are made by company Atmel which can be bought in parts then assemble on boards which is quite a cumbersome task.

Arduino uno basically contains two microcontrollers first is ATmega 328 microcontroller IC and other is ATmega16U2 microcontroller IC/USB controller in this former is heart of this board and without other microcontroller you are not able to connect laptop or system with this Arduino uno. It's frequency is 16Mhz and unlike 8051 it doesn't have a unique frequency level. ATmega 328 has an inbuilt RC phase shift oscillator which can generate itself 2Mhz to 8Mhz frequency.

ATmega 328 is 8 bit microcontroller here 8 bit represents it can process 8 data lines or bits in single clock pulse and has inbuilt 32 kbits of memory. It has voltage regulator and is a RISC(Reduced Instruction Set Computer) base microcontroller is used in various devices as it is quite power efficient and also uses high optimal set of instructions. It has fourteen information pins of which 6 can be utilized as PWM outputs, I2C connectors, SPI ports, power jack, ICSP header and a reset pin.
Arduino uno contains a power supply (7 to 12V DC input male center positive).It contains a voltage regulator which control the spikes and glitches in voltages. It has a crystal oscillator which generate a 16Mhz of frequency and to its right it contain a USB-B port along with it has a reset button. Aside from USB, battery or AC to DC adopter can likewise be utilized to control the board. The board comes with two capacitors which are used for

voltage regulators. It also contain comparator IC which is used when we have to choose between both power sources, comparator output is given to microcontroller ATmega328. ATmega 328 doesn’t know USB language it only understands I2C protocols and SPI protocols so for it to understand USB language ATmega 16U2 is used to convert language into ATmega 328 compatibility. We can interface USB via ICSP pins.
ICSP for ATmega 328 is used to programme the 8 bit microcontroller.

Arduino Uno boards are very like different sheets in Arduino family regarding the usefulness, in any case, Uno boards don't accompany FTDI USB to Serial driver chip.

There are numerous adaptations of Uno boards accessible, be that as it may, Arduino Nano V3 and Arduino Uno are the most official forms that accompany Atmega328 8-bit AVR Atmel microcontroller where RAM memory is 32KB

2.1.1 ARDUINO UNO PINOUT

Arduino Uno depends on AVR microcontroller called Atmega328. This controller accompanies 2KB SRAM, 32KB of glimmer memory, 1KB of EEPROM. Arduino Board accompanies 14 computerized pins and 6 simple pins. ON-chip ADC is utilized to test these pins. A 16 MHz recurrence precious stone oscillator is prepared on the board. The following figure demonstrates the pinout of the Arduino Uno Board.

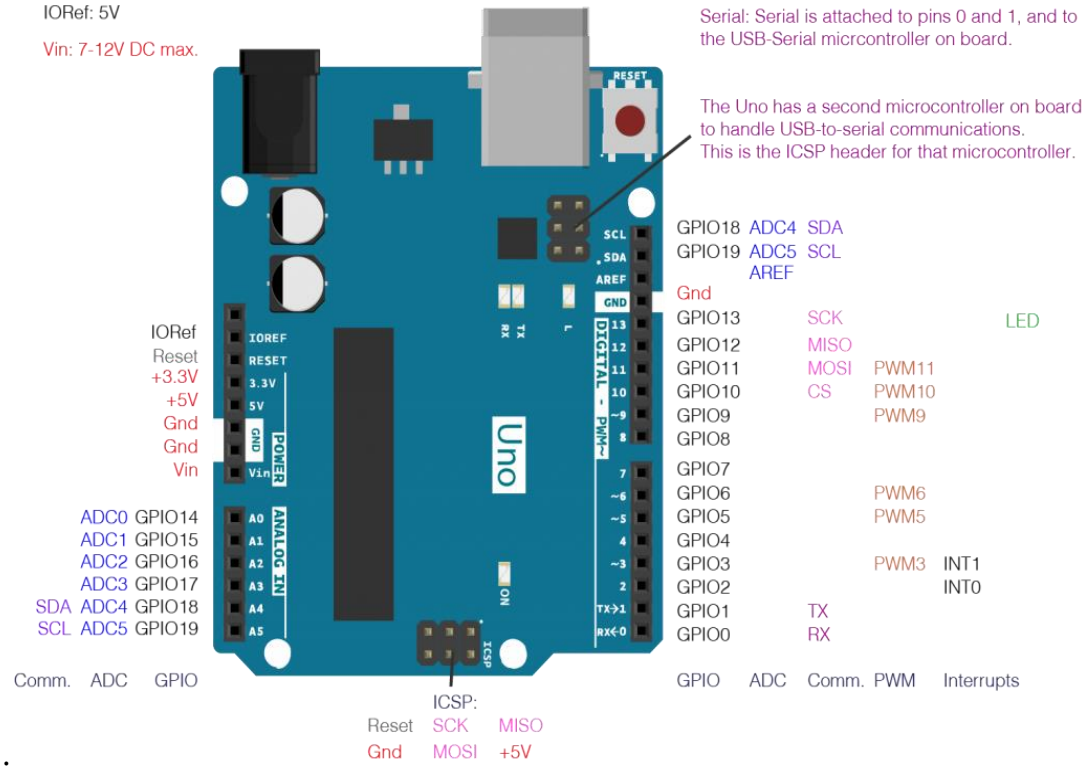


Figure 2.2: Arduino Uno pin diagram

2.1.2 PIN DESCRIPTION

There are a few I/O analog and digital pins set on the board which works at 5V. These pins accompany standard working evaluations extending between 20mA to 40mA. Interior draw up resistors are utilized in the board that restrains the current surpassing from the given working conditions. Be that as it may, an excessive amount of increment in current makes these resisters pointless and harms the gadget.

GPIO 18: This pin uses I2C protocol and act as a serial clock depending on clock pulse bits are given serially. At one time it can transmit and receive.

GPIO 17: This pin uses I2C protocol and act as a serial data, here data is received and transmitted serially but one function at a time.

GPIO 13: In this we have SPI protocol and this pin act as a serial clock.

GPIO 12: It is a MISO pin here at an instant of time it may act as master input and at other as a slave output.

GPIO 11: It is a MOSI pin here at one instant of time it may act as master output and at other as a slave input.

GPIO 10: It is a slave select pin here we can select slave .When slave select is low, pin interface with the master. When pin is high, it neglects the master.

LED: Arduino Uno accompanies worked in LED which is associated through PIN13. Giving HIGH an incentive to the PIN will turn it ON and LOW will turn it OFF.

GPIO 2 –GPIO 3: These are the interrupt pins. The job these pins is to assure that response is quick.

GPIO 0: It is a receiver pin with the help of this we can receive the data.

GPIO 1: It is a transmitter pin with the help of this we can transmit the data.

GPIO 14-GPIO 19: These are 6 analog pins which has property of analog to digital converter

IOREF: It is an I/O Reference voltage.

VIN: It is the input voltage given to the Arduino Board. It is unique in relation to 5 V provided through a USB port. This stick is utilized to supply voltage. In the event that a voltage is given through power jack, it very well may be gotten to through this stick.

GND: These are ground pins. More than one ground pins are given on the board which can be utilized according to necessity.

RESET: This stick is fused on the board which resets the program running on the board. Rather than physical reset on the board, IDE accompanies a component of resetting the board through programming.

2.1.3 SOFTWARE USED:

The programming for the Arduino board is done on the Arduino IDE. The Arduino IDE is freelance software designed by the Arduino developers to simplify the process of writing and uploading codes on the Arduino board. It is compatible with all Arduino boards.

The latest version of the software is Arduino 1.8.9. Various new libraries are introduced in each of the new versions. These libraries include support for the new components, sensors, and microcontrollers that are introduced every other day in this ever increasing IOT market.

The software is supportable on Linux, Windows and Mac OS X. The programming environment is based on Java language.

2.1.4 PROGRAMMING AND COMMUNICATION:

Arduino Uno accompanies a capacity of interfacing with other Arduino boards, microcontrollers and PC. The Atmega328 set on the board gives sequential correspondence utilizing pins like Rx and Tx.

The Atmega16U2 fused on the board gives a pathway to sequential correspondence utilizing USB com drivers. Sequential screen is given on the IDE programming which is utilized to send or get content information from the board. On the off chance that LEDs put on the Rx and Tx pins will streak, they demonstrate the transmission of information.

2.1.5 APPLICATIONS:

Arduino Uno accompanies a wide scope of uses. A bigger number of individuals are utilizing Arduino sheets for creating sensors and instruments that are utilized in logical research. Following are some fundamental uses of the board.

-Parking lot counter

-Arduino home automation

-Industrial Applications

-Emergency lights for streets

-Arduino Self balancing robot

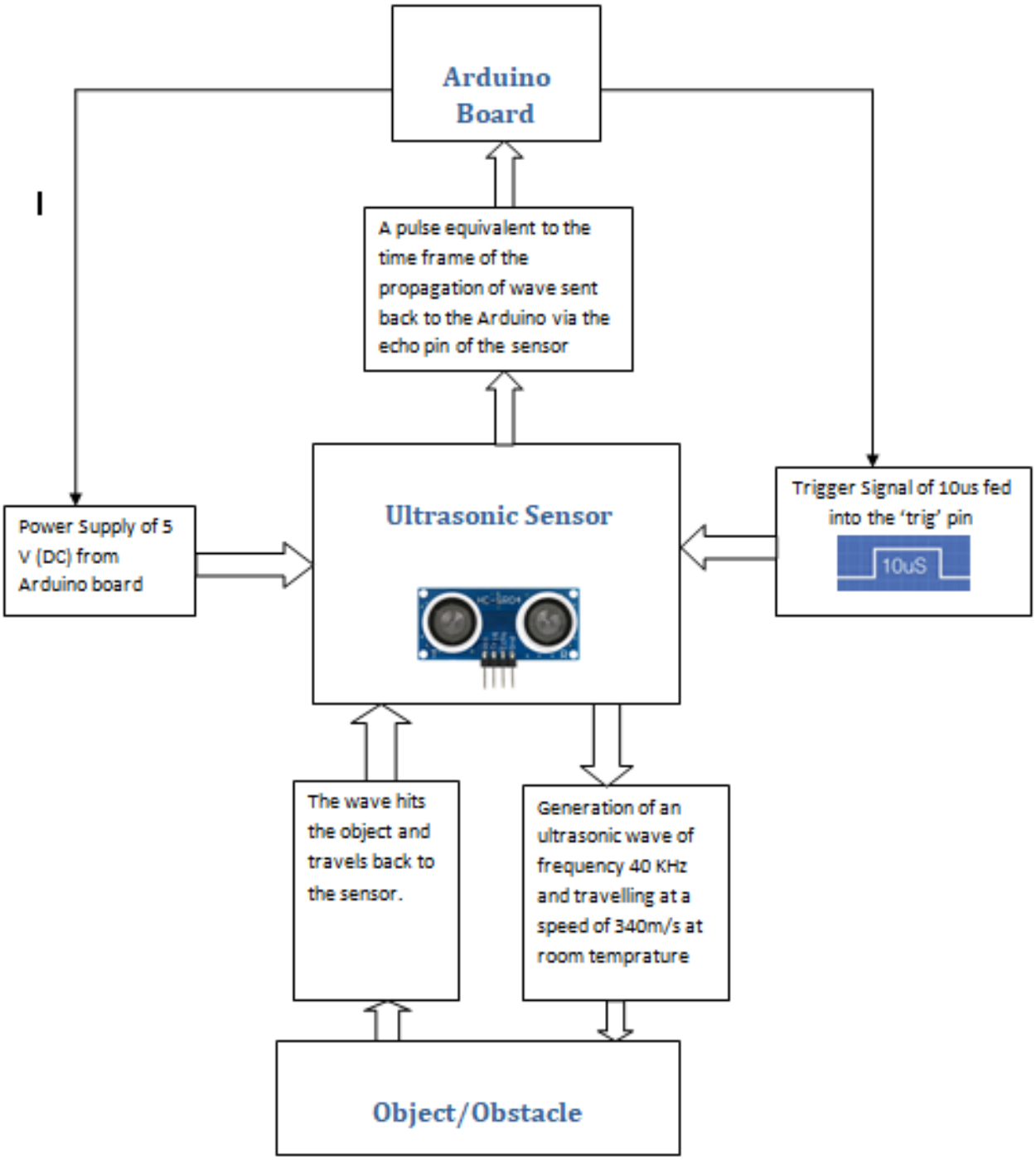
2.2 HC-SR04 ULTRASONIC SENSOR:

Figure 2.3: Ultrasonic Sensor

HC-SR04 uses ultrasonic sound in order to measure the distance between itself and nearer solid object, due to this application it is a very common component of robotics projects. It consists of two ultrasonic transducers, one used as a transmitter and the other as a receiver. The transmitter sends a series of ultrasonic pulses. The ultrasonic signal emitted is very directional hence the corresponding receiver transducer doesn't directly receive any part of the emitted signal.

At the point when an electric pulse of high voltage is sent to the ultrasonic transducer it vibrates over a particular range of frequencies and creates a burst wave. At whatever point any obstruction comes in front of ultrasonic sensor, these sound waves reflected back and produce an electric pulse. The time delay between transmission and receiving signal is used to calculate the distance so a longer time delay will mean a longer distance and a shorter time delay indicates shorter distance.

2.2.1 BLOCK DIAGRAM:



2.2.2 PINOUT:

Pin Number	Pin Name	Description
1	Vcc	The Vcc pin powers the sensor, typically with +5V
2	Trigger	Trigger pin is an Input pin. This pin has to be kept high for 10us to initialize measurement by sending US wave.
3	Echo	Echo pin is an Output pin. This pin goes high for a period of time which will be equal to the time taken for the US wave to return back to the sensor.
4	Ground	This pin is connected to the Ground of the system.

Table 2.1: Pin Functions of an Ultrasonic Sensor

2.2.3 WORKING:

The trigger pin is sent a 5 volt 10uS pulse. The sensor then transmits a burst of 8 ultrasonic (40Khz) pulses. Now the echo pin generated a pulse depending on the time of propogation of the wave. A 150us to 25 ms pulse width is generated if an object is detected within the threshold of the sensor. An output pulse of 38ms is the threshold, meaning that no object could be detected in the range of the sensor.

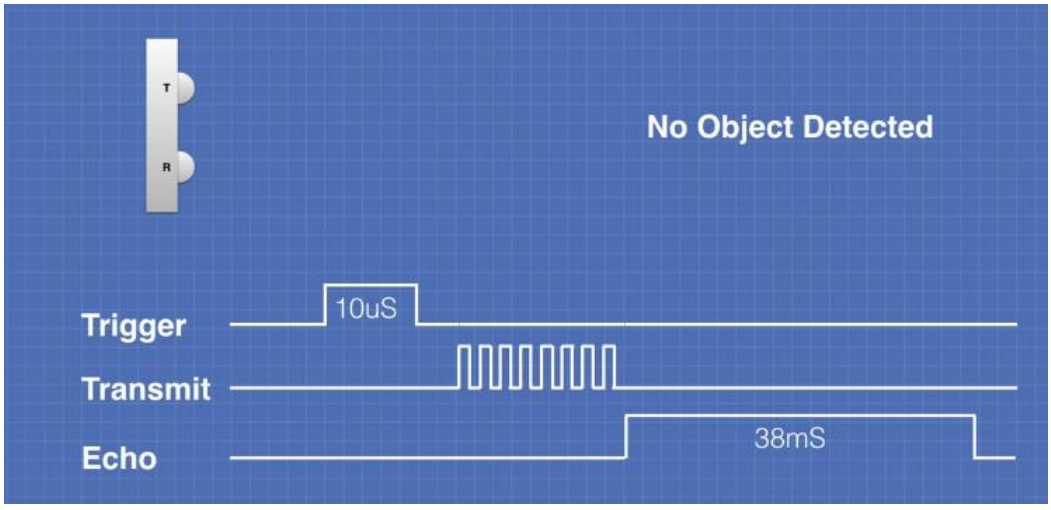


Figure 2.4: Ultrasonic Sensor pulse when no object is detected

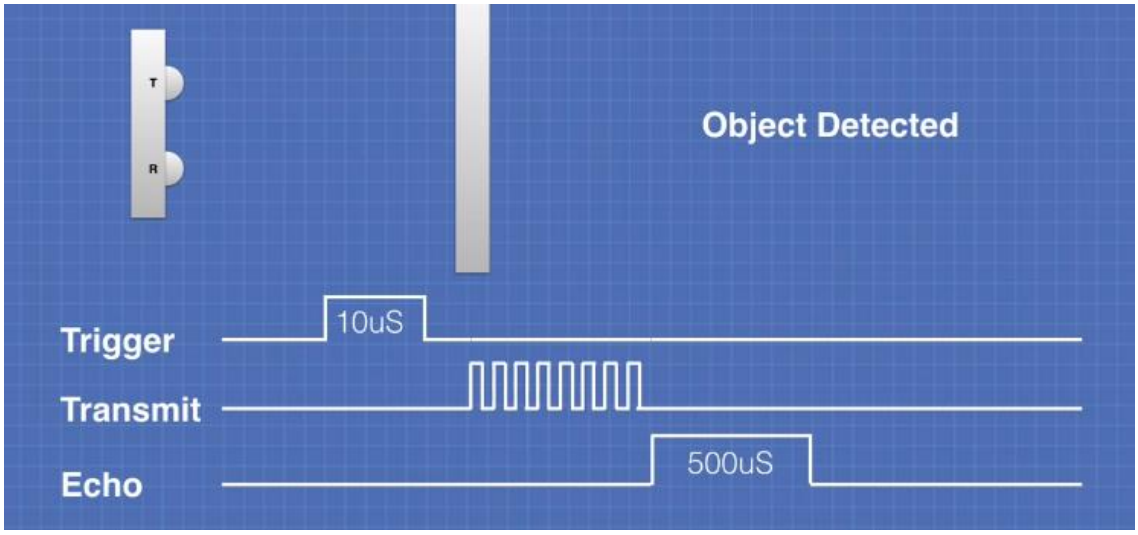


Figure 2.5: Ultrasonic Sensor pulse when an object is detected

2.2.4 DISTANCE CALCULATION

Calculating speed of sound in air:

c: Speed of sound

T: Temperature

c=331.4+(0.606*T)

Speed of sound =343m/s (in dry air at 20 degree celsius)

The distance can be calculated as:

Distance L= 0.5*t*c

where L is the distance, t is the time between the emission and reception. The 0.5 factor is introduced because the sensor sends a sum of transmission and reception times of the wave.

2.2.5 FEATURES

The following list shows typical characteristics enabled by the sensor.

Transparent object detectable: Since ultrasonic waves can reflect off a glass or fluid surface and come back to the sensor, even translucent objects can be detected.

Resistant to mist and dirt: The device is resistible to the accumulation of dust or dirt to a large extent.

Complex shaped objects detectable: Detection is stable even for irregular objects

2.2.6 SPECIFICATIONS

- Working voltage: +5V DC
- Theoretical Measuring Range: 2cm to 400cm
- Practical Measuring Range: 2cm to 100cm
- Accuracy: 3mm
- Measuring angle covered: <=15 degree
- Operating Current: <=15mA
- Working Frequency: 40Hz
- Trigger Input Signal:10us pulse
- Dimensions: 45*20*15mm

2.2.7 APPLICATIONS:

- Used to maintain a strategic distance from and identify hindrances with robots like biped robot, impediment avoider robot, way discovering robot and so on.
- Used as gauge in various applications with a wide scope of 2cm to 400cm.
- The profundity of specific spots like wells, pits and so forth can be estimated since the waves can enter through water.

2.3 ESP8266 Wi-Fi MODULE

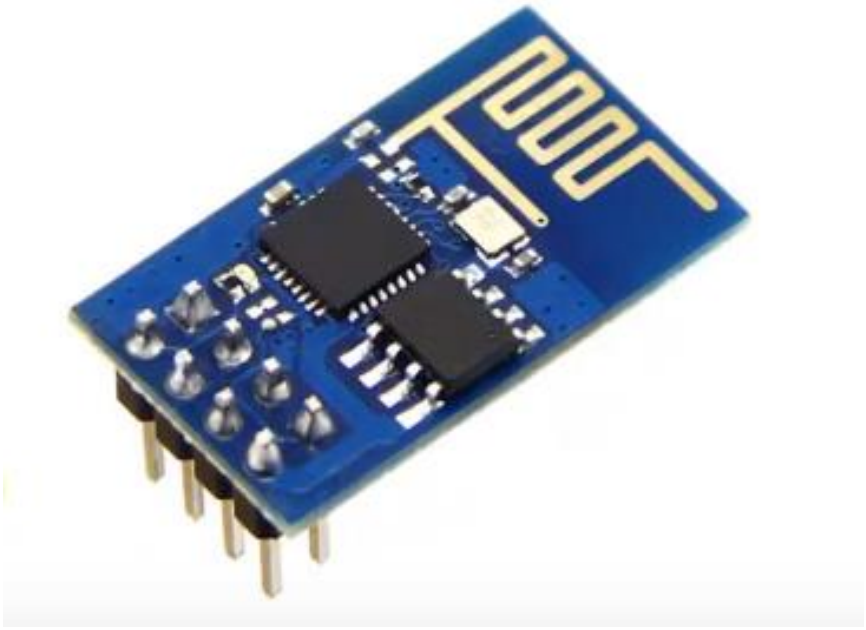


Figure 2.6: ESP8266 Wi-Fi module

ESP8266 is the microcontroller developed by Espressif System and is low cost Serial-to-Wi-Fi module which means it can convert serial information from microcontroller to give it to Wi-Fi routers and intern connected to internet.

This little module enables microcontrollers to interface with a Wi-Fi system and make straightforward TCP/IP associations utilizing Hayes-style directions. Nonetheless, around then there was no English-language documentation on the chip. The low cost and the way that there were not very many outside parts on the module, which proposed that it could in the end be cheap in volume, pulled in numerous programmers to investigate the module, chip, and the product on it, just as to decipher the Chinese documentation.

To communicate with microcontroller it uses 9600 baud rate. Now about module it is self contained SoC with integrated TCP/IP protocol stack which means it is system on chip and uses TCP/IP protocol to communicate with web server for internet purposes.

This ESP8266 Wi-Fi Module come pre-programmed with an AT command set firmware which means with AT commands we can communicate to firmware and extract whatever information we want from module and task we want module to do over internet.
In this module we have antenna patch , 8 pinouts which we use for functionality of these boards and a chip which is heart of this module which do all processing which is a company based out of Shanghai. This microcontroller has the ability to perform WIFI related activities hence it is widely used as a WIFI module.

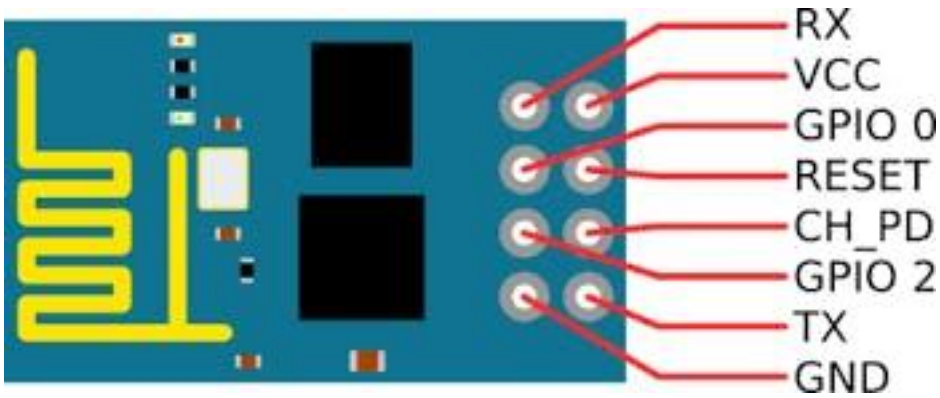


Figure 2.7: ESP8266 Pin-out

ESP8266 has 8 pins, namely:

RXD- Receive data bit Z
VCC- Voltage (+3.3V)
GPIO 0- General-Purpose input/output 0
RST- RESET
CH_PD- Chip power-down
GPIO 2- General-Purpose I/O 2
TXD- Transmit data bit Z
GND- Ground (0V)
VCC and GND pin together they provide power to he ESP8266 module actually this module work on 3.3V so here VCC is 3.3V.

RESET pin whenever put on low it simply reset the ESP8266 module.
CH_PD enables the chip if put high module is enabled otherwise it's disabled.
RXD and TXD together they perform serial communication with the microcontroller or any other controllers that are connected to ESP8266 module.
GPIO 0 and GPIO 2 are digital input-output pins which are used to process digital inputs to further read digital voltage or digital output to give 0V or 3.3V at output.

2.3.1 SPECIFICATIONS:

- It is based on 802.11 b/g/n IEEE standard simply it work on Wi-Fi frequency band.
- It gives Wi-Fi Direct P2P which is peer to peer communication which is decentralised communication model in which each party has same capabilities and either party can initiate communication itself.
- It also has a soft-AP which is a software enabled access point in this software enables computer or microcontroller which is not specifically not made to be a router but by use of software we can convert into wireless access point.
- It has an integrated TR switch which is a transmitted/receive switch which gives access to antenna. Here we have balun that is a type of electrical transformer which is used to connect an unbalanced circuit to balanced.
- It has a Low Noise Amplifier, power amplifier and matching network for high frequency working we need all these circuits.
- It has integrated Phase lock loops to lock the outputs signal of ESP8266 to frequency of inputs to get better results.
- It also have +19.5 dBm power in 802.11b mode due to such output power this module can communicates up to 400m of distance.
- It has a power down leakage current of less than 10uA so it increases efficiency of ESP8266 module
- It has a 1MB of flash memory in which our firmware stored which means codes written are stored here in flash memory.
- It has low powered 32- bit CPU which could be use as an application processor.

- It has also have power down mode if woken up it can transmt bits in less than 2ms and standby power consumption is less than 1.0mW.

2.3.2 FEATURES:

- Wi-Fi Frequency : 2.1Ghz
- Serial Communication
- Connecting controller system to Web
- Internet of things

2.3.3 APPLICATIONS:

ESP8266 is picking up fame in the field of hardware on account of it's minimal effort unwavering quality and effectively accessibility in the market. Let's look at some of it's application:

- IOT home automation using ESP8266
- Fetching geolocation from browser using ESP8266
- Air Pollution Meter
- Home Automation
- Tiny robots using using ESP8266
- Water monitoring system

2.4 CONNECTING WIRES:

Figure 2.8: Connecting Wires

In this case we use jumper wires for making our connections. Jumper wires consist of a connector pin at each end. These connectors help to connect to the other connectors that are available on microcontroller boards, sensors, modules etc.

The wires are available in different colors. These colors don't have any significance as such although they are useful to differentiate connections in the circuits.

There are three types of jumper wires male to male, male to female and female to female. The male end contains a probe that is used to insert in a female end which contains a hole for connection. In our system, we use the male to wires.

CHAPTER - 3

LITERATURE SURVEY

In [1] the authors used Arduino as the brain of their project and other user-friendly interactions like digital display, buzzer and GSM module for enabling mobile alerts in their model. This model is very similar to the one we are creating. As an initial condition, the garbage bin shows a status of 'EMPTY'. This status can be accessed by the user through the mobile message and also in the web portal using the registered login details. As the garbage bin is made available at the accessible sites, the garbage filling starts, based on the level of filling the status is updated. The model accommodated for 4 levels namely empty, medium, nearly full, full and threshold crossed.

In [2], an integrated system of Wi-Fi modem, IoT, GSM, Ultrasonic Sensor is introduced for efficient and economic garbage collection. The developed system provides an improved database for garbage collection time and waste amount at each location. We analyzed the solutions currently available for the implementation of IoT. By implementing this project we will avoid overflowing of garbage from the container in a residential area which is previously either loaded manually or with the help of loaders in traditional trucks. It can automatically monitor the garbage level & send the information to collection truck.

In [3], the authors provide an introduction to the esp8266 Wi-Fi module. They label this module as 'low cost, high performance' chip. The aim of this module is to provide IOT designers to enhance their systems with Wi-Fi capabilities at an economical yet high performance level. The module has various models of the esp8266-xx family with each variant being an upgrade on another. It requires a dc input of 3.3V/250mA.

In [4], the authors provide an in depth look at the HC-SR04 for distance measurement. The sensor is regarded as one of the most economical devices to fulfill this task. In their research they came up with an effective and efficient model with the help of the sensor and an 89s52 microcontroller. The results of the sensor were displayed on an LCD screen after being processed in a microcontroller. The authors came up with some interesting observations. The velocity of the generated wave is 340 m/s at 15^0C. The relation between the velocity and temperature maybe given as V=340+0.6(T-15) m/s. The distance travelled maybe given as a product of velocity and the output pulse duration.

In [5] the authors look at a traditional ultrasonic sensor for distance measurement. The application is using this sensor to measure the distance from some points of a vehicle to the ground. They used piezoelectric transducers for the generation and collection of these waves. It was based on the same principle as the HC-SR04 generation and collection of ultrasonic waves by transducers. They observed that the sensors struggle when in motion, they were able to tone down the error to some extent but as the speeds increased, the errors and uncertainty also increased.

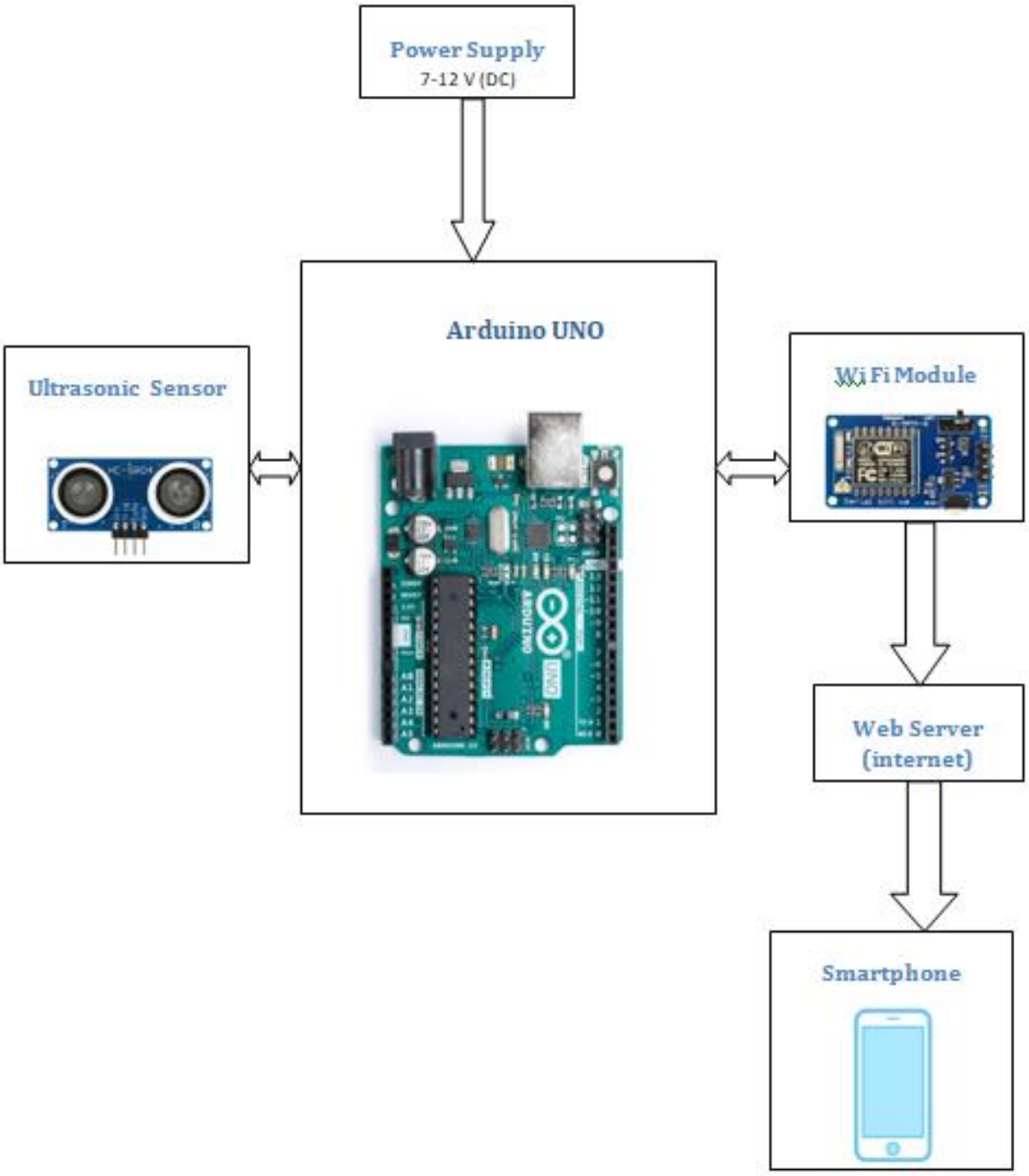
CHAPTER - 4
METHODOLOGY

The IOT Garbage Monitoring system is a very innovative system which will help to keep the cities clean. This arrangement monitors the garbage bins and notifies about the level of garbage collected in the garbage bins via a web page. For this, the scheme uses ultrasonic sensors positioned over the bins to detect the garbage level and relate it with the garbage bins depth. The system makes use of Arduino family microcontroller and a Wi-Fi modem for sending data.

A web page is built to show the status to the user monitoring it. The web page has three levels defined namely empty, garbage detected and full. The scheme puts on the signal when the level of trash composed crosses the customary limit.

The system alerts the users when the garbage thresholds are crossed. This plan helps to keep the city flawless by refreshing the waste of the dustbins and providing the required messages on the website page. The ESP8266 Wi-Fi Module is an independent SOC with consolidated TCP/IP stack that can give any microcontroller access to Wi-Fi technology. The ESP8266 is gifted of either facilitating an accommodation or unburdening all Wi-Fi organizing capacities from another application processor. Each ESP8266 Module comes pre-customized with an AT direction standard firmware. The ESP8266 module is an incredibly cost compelling board with a huge, and consistently expanding market.

4.1 BLOCK DIAGRAM:



4.2 STEP-BY-STEP PROCESS:

- The Arduino board is powered by a dc power supply battery.
- The ultrasonic sensor is powered by the Arduino board.
- The Wi-Fi module is powered by the Arduino board.
- The Ultrasonic Sensor sends the ultrasonic waves which travel at the speed of sound i.e. 340m/s at standard room temperature.
- The waves are reflected back when an object is found in their line of path.
- The duration of travelling wave is then sent back in the form of a pulse.
- This duration is used to calculate the distance between the sensor and the garbage using the equation: Distance=Speed*0.5*Time.
- The Arduino will now measure the level of garbage using the program burnt on it.
- The information will go through different equations and loops in the program in order to come up with the desired garbage levels.
- The Arduino will now establish a TCP/IP connection to the Wi-Fi module.
- This information will now be sent to the Wi-Fi module.
- The Wi-Fi module will process this information with and send it to the webpage.
- The garbage levels will now be displayed on the web page.

CHAPTER - 5
CODE AND OUTPUTS

The Arduino board has its own software kit called Arduino IDE where we use Embedded C as a programming language. It is built for microcontroller applications and has various extra features as compared to C language such as I/O register mapping, multiple memory areas and fixed point arithmetic types.

The word ‘embedded’ portrays that this language has some external features combined into the normal C language. These features come in the form of libraries. Tons of freelance libraries are created to accommodate different sensors, boards, modules etc. These libraries are task-specific. Every device gets its own library to make it relevant in this programming language.

These libraries include commands that enable the user to communicate with the device using the code. The manufacturers of these sensors, boards, modules etc. pre install support for some commands on these devices. These commands can be used in the code to make the connected devices function.

For our system we used the Arduino IDE for programming purposes. This software is designed by the Arduino developers especially for the Arduino boards. It comes with pre installed Arduino libraries. The libraries for other sensors and modules that are connected to the board have to be installed manually. The esp8266 libraries provided by Expressif were installed in order to make the software compatible with the AT commands of the module.

5.1 CODE:

```
#include <SoftwareSerial.h>
#define DEBUG true
SoftwareSerial esp8266(10,11);


const int trigPin1 = 8;
const int echoPin1 = 9;

long duration1;
int distance1;
int per;


void setup()
{
  Serial.begin(9600);
  esp8266.begin(9600);
  pinMode(trigPin1, OUTPUT);
  pinMode(echoPin1, INPUT);


  sendData("AT+RST\r\n",2000,DEBUG);
  sendData("AT+CWMODE=2\r\n",1000,DEBUG);
  sendData("AT+CIFSR\r\n",1000,DEBUG);
```

Figure 5.1: Declaration of variables and setup function

The code begins with the SoftwareSerial library being included. The SoftwareSerial Library is used to enable serial communication in the digital pins of the Arduino board. We immediately use this library to define the Tx and Rx pins of the esp8266 Wi-Fi module on the Arduino board.

Two constant variable functions are designed to set up the trigger and echo pins of the Wi-Fi module on the Arduino board.

We further define the variable for duration distance and percentage for the calculations to be done in the program.

The void setup function is used to setup the components required in the model. This segment only runs once in the program. The esp8266 and the ultrasonic sensor are officially defined in this segment. The baudrate is set to 9600, this may vary from model to model of the esp8266. Although the baudrate can be changed using some commands.

The sendData function is used to communicate with the Wi-Fi module. To make this possible we had to pre-install the libraries of esp8266 in the Arduino IDE kit. The command AT+RST was used to reset the module. AT+CWMODE=2 configures the module as an access point. AT+CIFSR is used to get the IP address of the module. AT+CIPMUX=1 will configure the module for multiple connections. AT+CIPSERVER=1,80 will turn on the server port at 80.

```
  sendData("AT+CIPMUX=1\r\n",1000,DEBUG);
  sendData("AT+CIPSERVER=1,80\r\n",1000,DEBUG);
}

void loop()
{
digitalWrite(trigPin1, LOW);
delayMicroseconds(2);
digitalWrite(trigPin1, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin1, LOW);

duration1 = pulseIn(echoPin1, HIGH);


distance1= duration1*0.034/2;
per=100-((distance1-11)*100/11);

Serial.print("Sensor reading of distance=");
Serial.print(distance1);
Serial.print("cm");
Serial.print("\n\n\n");
```

Figure 5.2: The void loop function

The void loop segment consists of the segment that is supposed to run over and over again. This segment is responsible for making sure the sensor continuously takes reading and those readings are carried out to the output side. The digitalWrite keyword is used to set the trigger pin low or high. delayMicroseconds keyword is used to provide the necessary delay between the sensor operation. The output is collected from the sensor use the pulseIn keyword since the output is in the form of a pulse.

Now that the sensor operation has been successfully completed, we move on to the calculation and the output processing part. The variables that were defined in the beginning will now be used for the calculation purpose. A specific equation has been designed with respect to our prototype model. The term '11' in the given equation signifies the distance between the top and the fully filled level of the dustbin. This can be changed as per the dimensions of the given dustbin. The Serial.print is used to print some output on the serial monitor of the Arduino IDE.

```
if(esp8266.available())
{
  if(esp8266.find("+IPD,"))
  {
   delay(1000);
   int connectionId = esp8266.read()-48;


   String webpage = "<h1>IOT Garbage Monitoring System</h1>";

     webpage += "<p>Made by: 151044 151072 151109";
     webpage += "<p><h2>";

     if(per>100)
     {
      webpage+= "<br>Alert!!! Dustbin is full. Please empty";
      }

     if (per>10 and per<=100)
     {
      webpage+= "Garbage detected";
     }
```

Figure 5.3: The If statements

Now we use to if statement in an attempt to make sure that the esp8266 is available to accept our calculated outputs. The esp8266.available is a function from the esp8266 library used to check if the module is available to send the next message.

We define a string named webpage. This webpage string will be used to store and send html commands to our output webpage. We've set 3 stages for the dustbin- full, garbage detected and empty, accordingly the if statements have been implemented.

```
        if (per<=10)
        {
         webpage+= "Dustbin less than 10% filled. Dustbin is Empty.";
         }

        webpage += "</h2></p></body>";

      String cipSend = "AT+CIPSEND=";

      cipSend += connectionId;
      cipSend += ",";
      cipSend +=webpage.length();
      cipSend +="\r\n";

      sendData(cipSend,1000,DEBUG);
      sendData(webpage,1000,DEBUG);
      String closeCommand = "AT+CIPCLOSE=";
      closeCommand+=connectionId;
      closeCommand+="\r\n";
      sendData(closeCommand,3000,DEBUG);
    }
  }
}
```

Figure 5.4: Forming the TCP/IP connection

The AT+CIPSEND is used to create a TCP or UDP connection for sending data. A string named cipSend is created to fulfill this purpose. The AT+CIPCLOSE is used to close this connection.

```
String sendData(String command, const int timeout, boolean debug)
{
    String response = "";
    esp8266.print(command);
    long int time = millis();
    while( (time+timeout) > millis())
    {
      while(esp8266.available())
      {
        char c = esp8266.read();
        response+=c;
      }
    }

    if(debug)
    {
      Serial.print(response);
    }
    return response;
}
```

Figure 5.5: The sendData function

A function sendData of type string is created to communicate with the module. We've used this function numerous times in the above code, now we'll define it. The message on the module is read character by character using a char type variable c. The values read by this variable are stored in a string named response. The response string is returned.

5.2 SERIAL MONITOR OUTPUT:

The output of the Serial Monitor is shown in the figure. The Dustbin as shown is filled. The Serial Monitor first displays the AT+RST command which gives a response OK, meaning the module has been successfully reset. The corresponding commands set up the module as an access point and obtain the IP address. The distance reading of the sensor is also displayed.

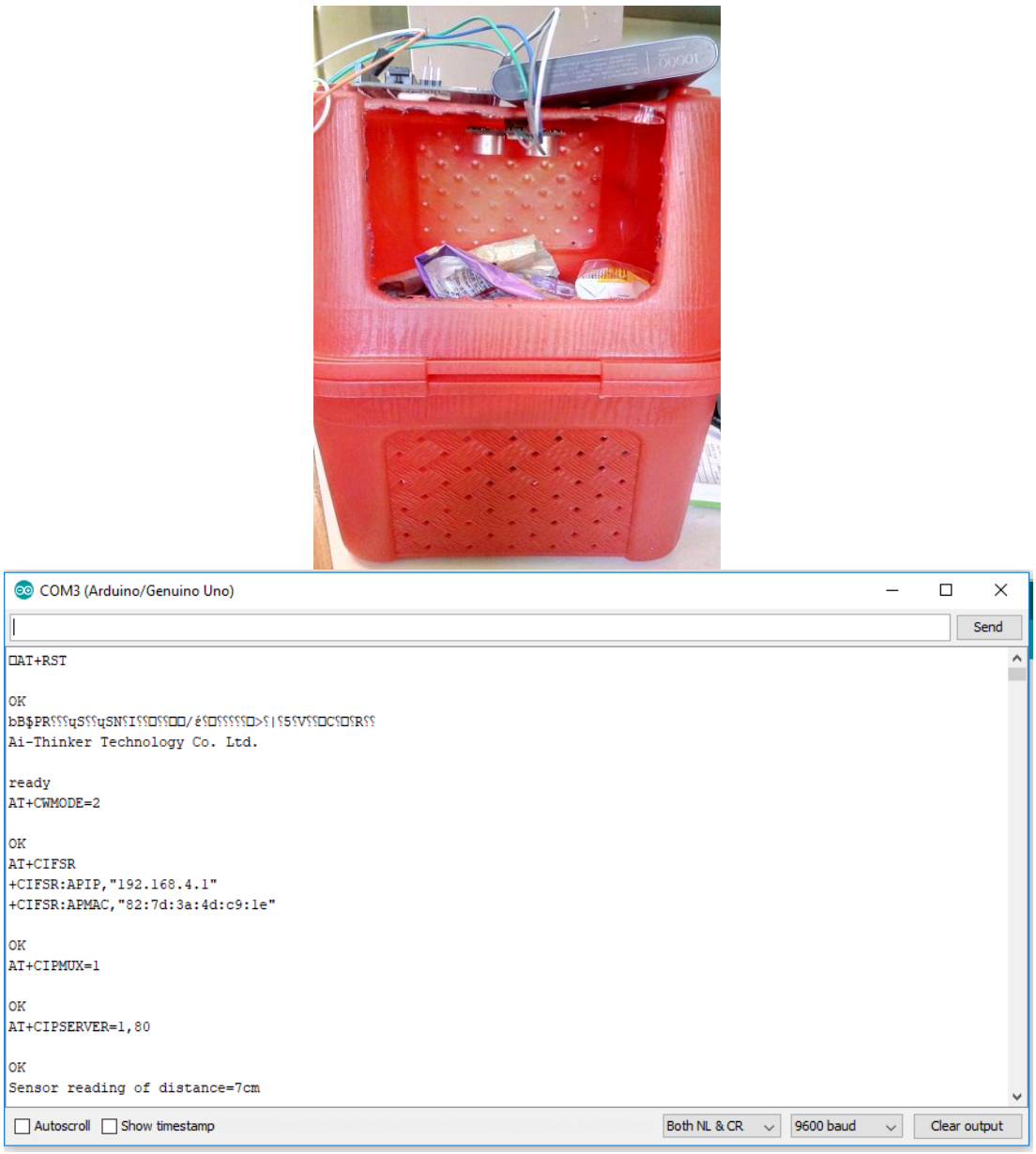


Figure 5.6: Serial Monitor Output

5.3 WEBPAGE OUTPUT:

The IP address that was obtained on the Serial Monitor is now inserted into a web browser. The commands that were set up in the code will now be displayed as per the readings of the sensors.

- As shown, the sensor detects the dustbin being empty, hence a message conveying the same is displayed on the screen

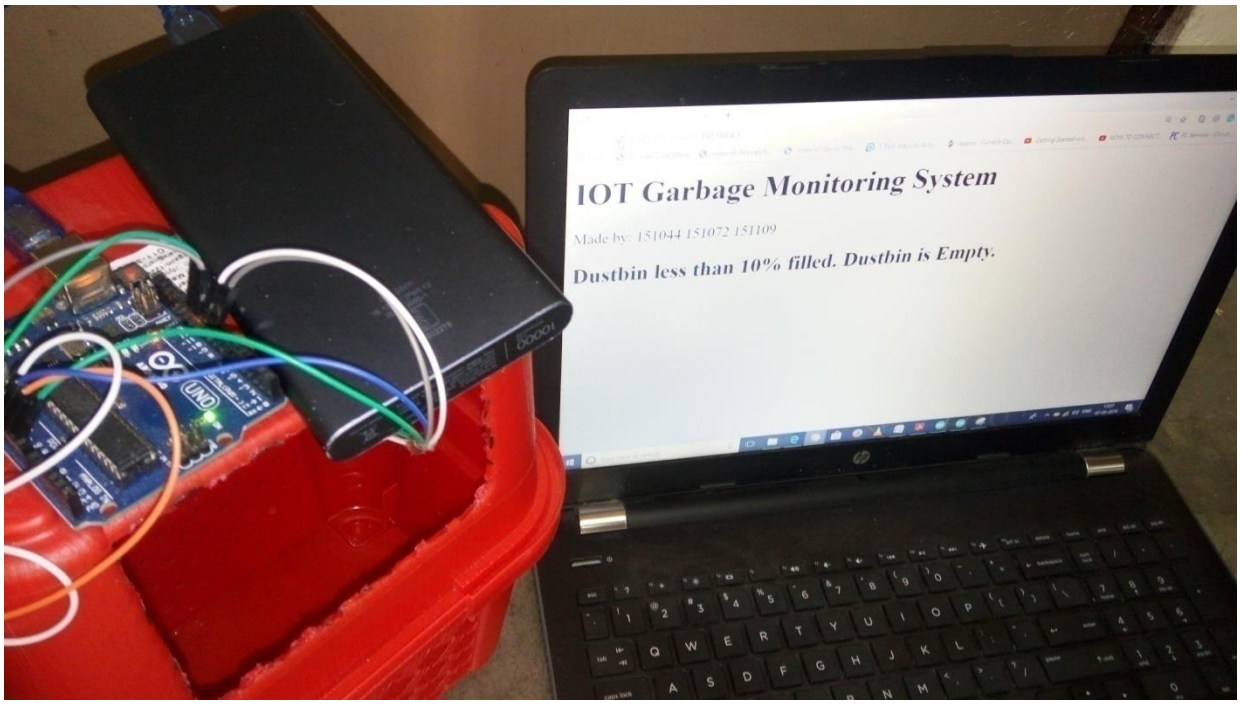


Figure 5.7: Empty dustbin output

- When the dustbin is filled above 10% of its volume, the browser starts showing garbage detected. The threshold for this reading is from 10% to 100% of the dustbin volume. The reading will only change when the threshold is crossed on either sides.

Figure 5.8: Garbage detected output

- When the dustbin is completely filled i.e. above 100%, the output message will change to an alert, conveying the dustbin is completely filled. This would be the signal for the authorizing bodies to empty the dustbin.

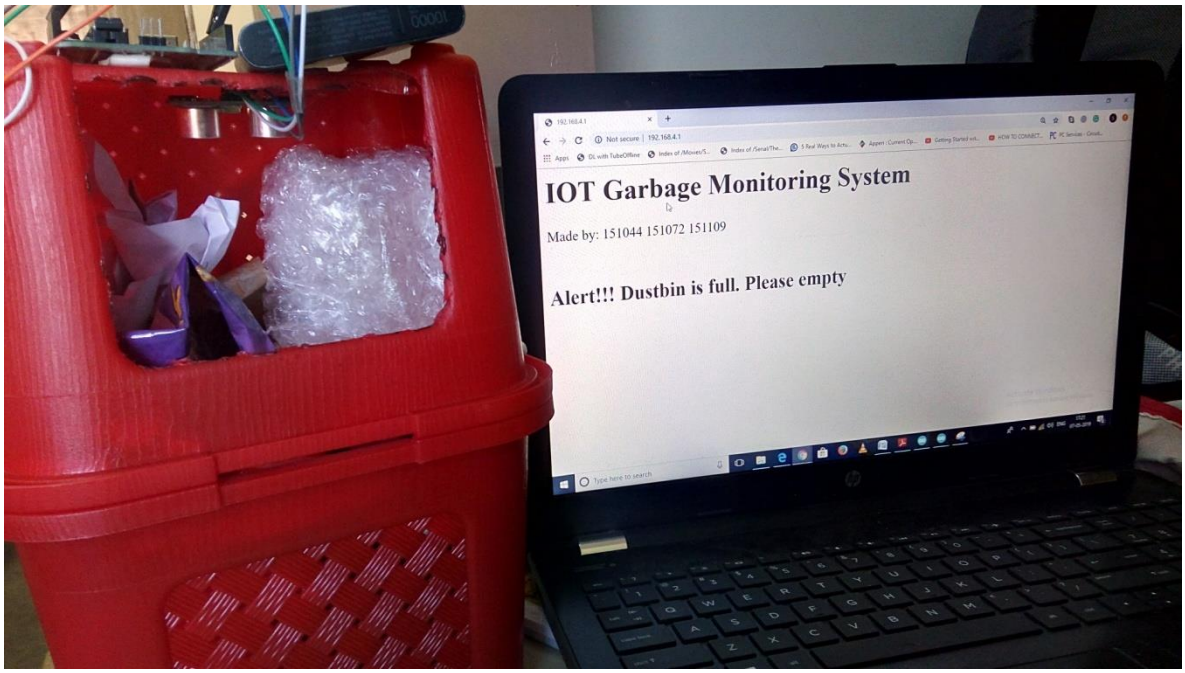


Figure 5.9: Dustbin full output

CHAPTER - 6

APPLICATIONS AND FURTHER DEVELOPMENTS

6.1 APPLICATIONS:

The applications of this project are easily visible.

- The Garbage Monitoring system can be implemented in all big or small cities.
- The Garbage system will help in keeping our cities clean and is an excellent waste management technique.
- The labor will be able to function more efficiently and hence, in the long run, the cost of labor will be reduced.
- With the upcoming concept of smart cities we can use this project as an attempt to digitalize our way of living.

6.2 FURTHER DEVELOPMENT:

The system can be further updated by using following methods:

- Rather than using a single ultrasonic sensor we can use multiple ultrasonic sensors to measure the quantity of garbage accurately.
- If reliability is a primary issue and we need long range transmission then instead of using Wi-Fi module we can use a GSM module.
- An infrared sensor can be used to compliment the ultrasound sensor in measuring distance as it can measure soft objects with high accuracy.
- A weight sensor can be added to the project for precisely monitoring the garbage in bins and sending data to operator.
- Raspberry pi can be used instead of Arduino uno as you can connect former to the internet quite easily and can work with different languages on raspberry pie.

6.3 LIMITATIONS:

Every system has its limitations and so does ours.

- The system requires an active Wi-Fi connection in its surrounding range in order to function.
- The system needs protection from damage due to any external sources. Hence it requires a good cover for protection.
- If the sensor front get’s covered in garbage, the sensor might not give accurate readings.
- When multiple sensors are installed, interference of one wave into another could lead to errors in readings.

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