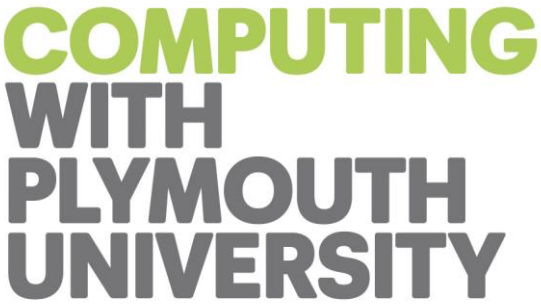


School of Computing and Mathematics

PRCO303

Final Stage Computing Project

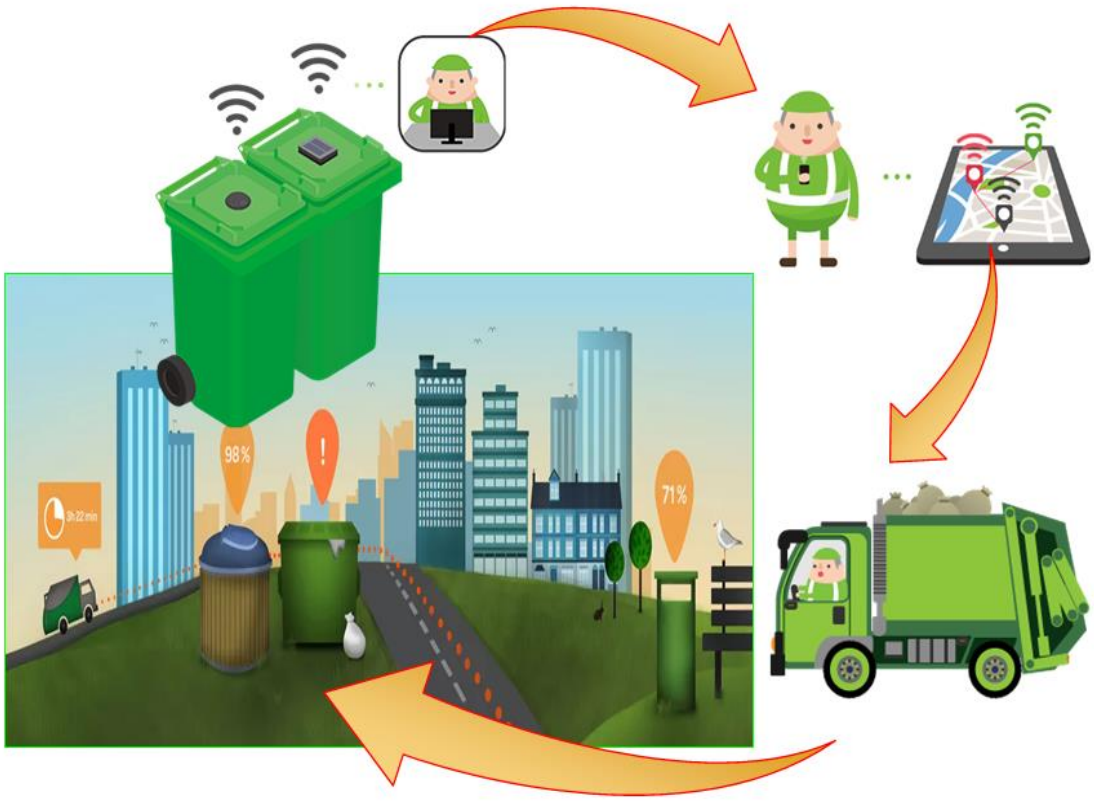
BSc (Hons) Computer Networks

Kanishka Dilshan

Garbage Management System Using IoT

2018/2019

Garbage Management System Using IoT



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BSC-PLY-COM-16.2-053

BSC(Hons)Computer Networks

Contents

1.0 ACKNOWLEDGEMENTS

This “Garbage Management System Using IoT ” project would not have been possible if not for my project supervisor and mentor Mr.Chaminda Rathnayake (Deputy Vice Chancellor / Senior Lecturer) whose constant encouragement, dedication, and commitment enabled me to successfully complete this accomplishment. It is a great pleasure to thank everybody who helped by showing me unwavering support throughout the process.

I am truly indebted and thankful to my friends Uditha, Randika and Yasiru of my batch for all their guidance and patience in helping me solidify my ideas and giving me direction. I would also like to thank all my close friends for their support as well as my parents and siblings for their patience and understanding while I perused my goal. Lastly, I would like to thank NSBM, its faculty and staff for allowing me the opportunity and means to reach the pinnacle of my academic carrier. Finally , I would like to thank all my batchmates for whom sharing this experience with was an honor, and truly one of the greatest chapters of my life.

2.0 INTRODUCTION

2.1 CONCEPT OF IOT

We are living in an age where tasks and systems are fusing together with the power of IOT to have a more efficient system of working and to execute jobs quickly. The Internet of Things is a worldwide network of intercommunicating devices This will provide the basis for many new applications, such as Energy monitoring, transport safety systems or building security. This vision will surely change with time, especially as synergies between Identification Technologies, The Wireless Sensor Networks, Intelligent Devices and Nanotechnology will enable a number of advanced applications . A healthy environment is necessary if we want to stay healthy. However, in the present fast paced life individuals scarcely have time to stop and configure things manually and hence the idea of automation is by and large broadly embraced . Either because of our fast paced life or because of our casual approach often small though critical things like cleanliness gets ignored.

2.2 PROJECT OBJECTIVES

The proposed system was developed from the following objectives, To develop a device that can monitor the state of the garbage bin and the relay the monitored state to a database. To collect Sensor data from each bin and display it on a webpage or mobile device alert the relevant authorities of the states of the different garbage bins in a area. Store sensor data to each of the garbage bins to provide all analytical information for each of the garbage collection areas. So that it can provide route planning for the collection based on the selected fill level and priorities of each bin.

2.3 PROBLEM DEFINITION

In big institutions or a city under a municipal corporation where there are an extensive quantities of garbage bins deployed and workers are kept specifically for this task , the antiquated technique for physically hunting down filled garbage bins is wasteful and does not run well with the technological era we are in. Garbage consists of the unwanted materials left over from city, Urban areas, Educational Institutions, Business organizations, home etc. As we see many times the dustbin are get over flown and concern person do not get the information on a time and due to which unconscious condition form in the surroundings , at the same time bad smell come out from waste and spread out in surrounding . Due to the unclean environment some harmful diseases easily spreadable in given locality. The existing system used for cleaning the dustbin is not effective and which has some disadvantages which as follows

- ✓ Less effective and time consuming
- ✓ Cost is very high
- ✓ Environment become unhygienic
- ✓ Because of bad smell of garbage human beings may cause illness
- ✓ More traffic and noise due to truck used to clean the dustbin

2.4 PROJECT INTRODUCTION

This project also help to understand the developments of research on internet of things to minimize the garbage disposal problem. IoT is a newest communication Technology, in which the objects of everyday life will be equipped with the Arduino family microcontrollers, transceivers for digital communication and suitable protocol stacks, that will make them able to communicate with one another and with the users . This project " Garbage Management System Using IoT " is a very innovative system which will help to keep the cities clean. The system monitors the garbage bins informs about the level of garbage collected in the each of the garbage bins from this system built on a platform which was based Wi-Fi module (ESP8266) board which was interfaced with a ultrasonic sensor. The bin was interfaced with a system based on microcontroller which had IR wireless systems with a central system that showed the current status of the garbage in the bin The status was seen on a mobile device or from web page by using Wi-Fi. The level of garbage in the bin was detected by the ultrasonic sensor which will send the data to the control room using the Wi-Fi module

3.0 METHODOLOGY

This project that demonstrates a system based on Internet-of-Thing (IoT) that allows the waste management to monitor based on the level of the garbage depth inside the dustbin . The system let users being alert the level of garbage on four types of garbage; domestic waste, paper, glass and plastic. The proposed system is using ultrasonic sensor as input and placed at the maximum level of the garbage bin The system consists the ultrasonic sensor which measure the garbage level and an microcontroller which controls system operation.

At the same time, the level of garbage also will display on LCD to allow user to know the level of garbage in the dustbin without open it. At the same, these ultrasonic sensors connect to ESP8266 Wi-Fi module to make sure the data transfer and display . The microcontroller will display the percentage of the garbage for each bins. In this work, the system will try to monitor the depth of the garbage based on garbage type. The domestic waste does not to wait the bin to be 100% full as the longer it will be in the bin; the longer the domestic waste will be rotten and create unpleasant environment .

Here, four ultrasonic sensors are connected to ESP8266 Wi-Fi module. In theESP8266 Wi-Fi module every PIN can accept 3.3V only. If the Wi-Fi module accept more than 3.3V it will make the Wi-Fi module burn. In this system, the ultrasonic sensor need at least 5V to generate the data and display the data on LCD . At the same time, data from sensor will send to mobile app via ESP8266 Wi-Fi module. The mobile app will shown the data in the real time. So, the waste management can monitor based on the level of garbage depth inside the dustbin in.

4.0 LITERATURE REVIEW

Now a days, the level of garbage is heavily increased .so, because of this many People are facing health problems in order to reduce these health problems we use smart dust bins instead of our normal bins .Smart bins means it made with some recent technology. It was provided with some sensors like Ultrasonic sensors inside it with the help of these the respected authorities can monitor garbage level in the bin .Until they squash the bin they will get information continuously. Once they squash the bin people can reuse it. A Smart Dustbin based on IoT in which the smart bin was built on a platform which was based on Arduino Uno board which was interfaced with a Node MCU and an ultrasonic sensor. The sensor was placed on the top of the bin. A threshold level was set as 20 cm. As the garbage reaches the level of threshold, the sensor triggers the Node MCU board which alerts the associated authority till the garbage in the bin is emptied. At the end a conclusion was made that various issues like affordability, maintenance and durability were addressed when these smart bins were designed. It also contributed towards a hygienic and clean environment in the process of building a smart city

The bin was interfaced with a system based on microcontroller which had wireless systems with a central system that showed the current status of the garbage in the bin. The status was seen on a mobile based web browser with a html page by using Wi-Fi. In this system, the level of garbage in the bin was detected by the ultrasonic sensor which will send the data to the control room using the Wireless module . A GUI was also developed to check the information that was related to the garbage for different locations . This paper proposed Decision Support System which would be used for garbage collection in the cities .This system handled the ineffective waste collection in the inaccessible areas of the city. In cities waste management became a particular problem because most of the people living in cities and in future number may increase , because of this over population in cities many problems are arising like pollution, waste management.

The major problem is waste management because of this people facing many health problems to reduce that implemented the smart solar compressed dust bins means even if it full also because of solar power it reduce the content of waste in it so people can use more than two times. In day to day of life urbanization is heavily increased because of this wastage is also increased. It is the one way for the cities to recycle the waste into a resource .In this they are planned to promote broad awareness of reuse and recycling through engagement of all the stakeholders in the urban context, from local and regional authorities to industry, from decision makers to citizens.

In future it will help for the people to develop the concept of smart cities towards the entrepreneurship for economic growth and value. By taking inspiration from the already existed experiences in this field, the future directions for Smart Cities should be targeted towards industrial development. To develop the city as a smart city it has to develop in all the ways .

People are facing so much illness because of heavy increase in garbage in their street bins to dispose that bins is taking so much time for the respected authorities. In order to reduce that smart bin process is implemented by the government .In this used some GPS and Internet enabled smart bins are used to get the information because of these type of bins it is somewhat easy to squash the bins in short time.

4.1 WI-FI SYSTEM

This type of system monitors the levels of the garbage bins within designated equipment, conveying the data via a local Wi-Fi connection to an online server or email address.

Advantages

- Remote monitoring solution that automatically monitors garbage level at all times without the need to physically check equipment or divert manual resources.
- Seamless installation that can be flexible based on the needs of the facility. Through the deployment of wireless sensors and devices, installation may be quick and can be done without professional assistance.
- Provides built-in record keeping that tracks data and verifies inventory is safe and equipment is compliant.
- Can provide an email or text message notification to the user in the event an issue is detected.
- Recorded data is available to be viewed through spreadsheets or online services.

Disadvantages

- Wireless Wi-Fi systems may have backup battery power to temporarily protect themselves against power outages, but the loss of power still causes the Internet service provider to lose power. Wi-Fi systems have no means of offering protection or sending notifications if such an issue occurs.
- Wi-Fi systems will only work where there is Wi-Fi access. If an area that requires monitoring is not currently served by Wi-Fi, then the network would need to be extended into that area, incurring equipment and labor costs.
- Wi-Fi systems are prone to poor performance during Internet downtime or from poor connections. Wireless Internet may also be subject to interference, which can temporarily disable sensors or cause them to respond unpredictably.
- Can cause potentially slow Internet service at the facility if the system suffers from bandwidth issues as a whole

5.0 Method Of Approach

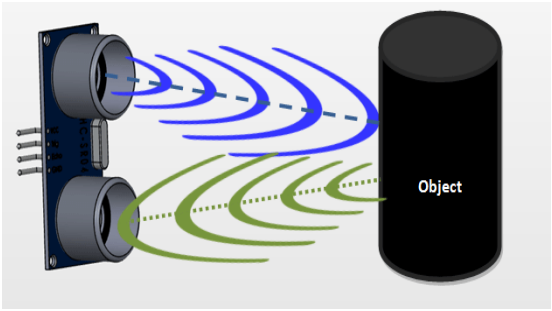
5.1 PROPOSED HARDWARE

- **Ultrasonic Sensor**

Specifications

- Power supply: 5V DC
- Quiescent current: <2mA
- Effectual angle: <15°
- Ranging distance: 2cm – 400 cm
- Resolution: 1 cm
- Ultrasonic Frequency: 40k Hz

An "Ultrasonic sensor is a device that can measure the distance of an object by using sound waves. It measures distance by sending out a sound wave at a specific frequency and waits for that sound wave to bounce back. By recording the time taken between the sound wave being generated and the sound wave bouncing back, it is possible to calculate the distance between the sensor and the object."The circuit connections are made as follows:



- ✓ The HC-SR04 sensor attach to the Breadboard
- ✓ The sensor Vcc is connected to the NodeMCU +3.3v
- ✓ The sensor GND is connected to the NodeMCU GND
- ✓ The sensor Trigger Pin is connected to the NodeMCU Digital I/O D4
- ✓ The sensor Echo Pin is connected to the NodeMCU Digital I/O D3

The module sends out a burst of sound waves, at the same time it applies voltage to the echo pin.The module receives the reflection back from the sound waves and removes voltage from the echo pin. "On the base of the distance a pulse is generated in the ultrasonic sensor to send the data to NodeMCU or any other micro-controller.The starting pulse is about 10us and the PWM signal will be 150 us-25us on the base of the distance. If no obstacle is there, then a 38us pulse is generated for NodeMCU to confirm that there are not objects detected."

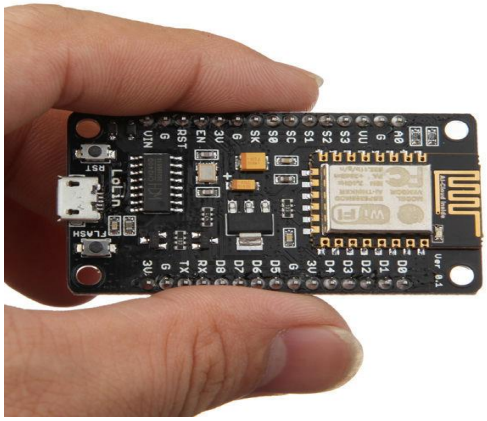
Formula

D = 1/2 × T × C

where D is the distance, T is the time between the Emission and Reception, and C is the sonic speed.

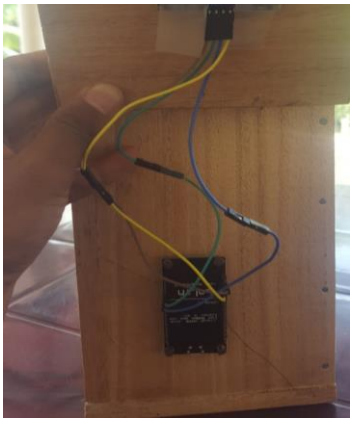
(The value is multiplied by 1/2 because T is the time for go-and-return distance.)

- **Development Boards**



Possible hardware technologies are Arduino uno, Arduino Mega and NodeMCU. Basically the researched of those three boards, I have identified the best solution is NodeMCU board for this system due to the reason of NodeMCU has intergraded Wi-Fi module and explicit Wi-Fi module needs to be integrated to other two and NodeMCU included 5v power port and it can provide via micro USB port. On other hand, cost of the board getting lower than other two. Moreover, execution speed of the board also getting low value (lower is better).

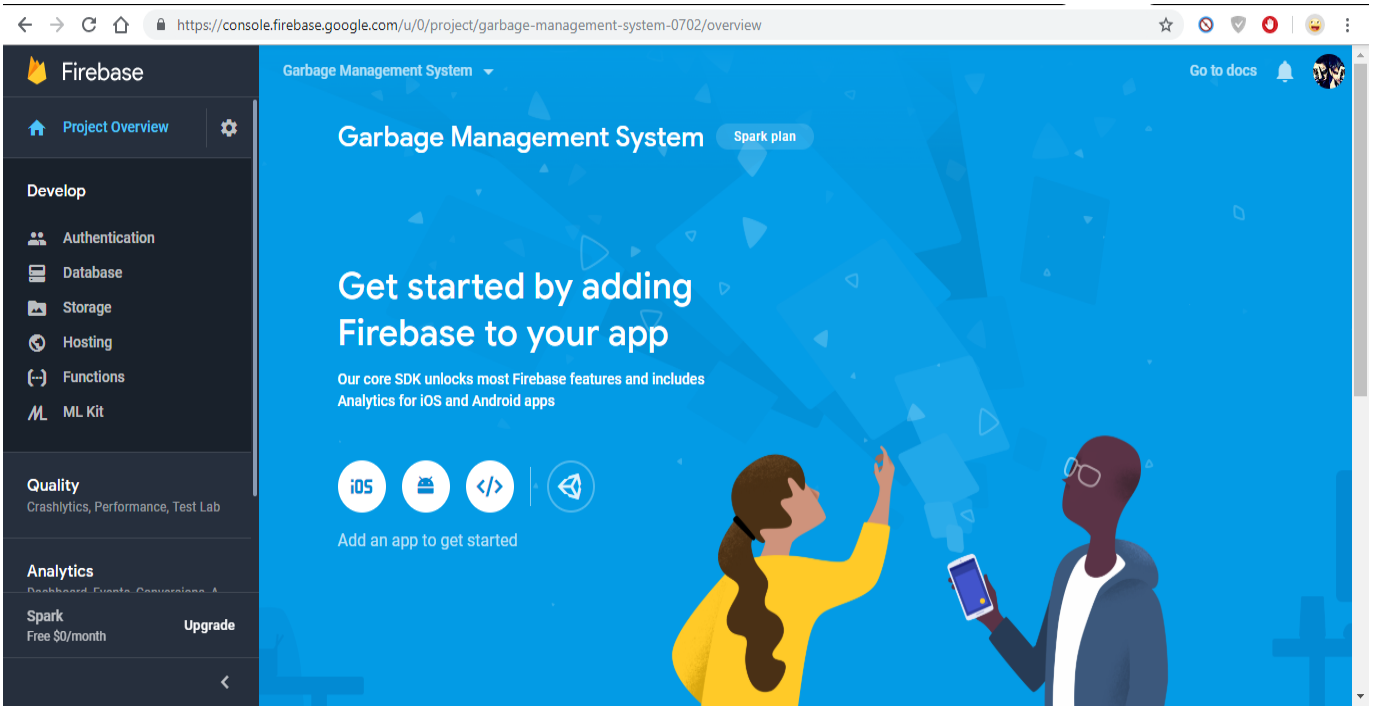
NodeMCU is an enter source IoT platform. It includes firmware which runs on the ESP8266 Wi-Fi module. Basically this NodeMCU board needs value from the sensors and send it to the server. (Cintra, 2017) conclude that, there are lot of advantages of NodeMCU board. Such as integrated supported for Wi-Fi network, low cost, reduced size of boards, low energy consumption state that, the NodeMCU board is consisting of a 32 bit ARM microprocessor with support of Wi-Fi network and built if flash memory. There are three generation boards. Apart from that, the second generation board will be used in this system.



5.2 TECHNOLOGIES

- **Firebase**

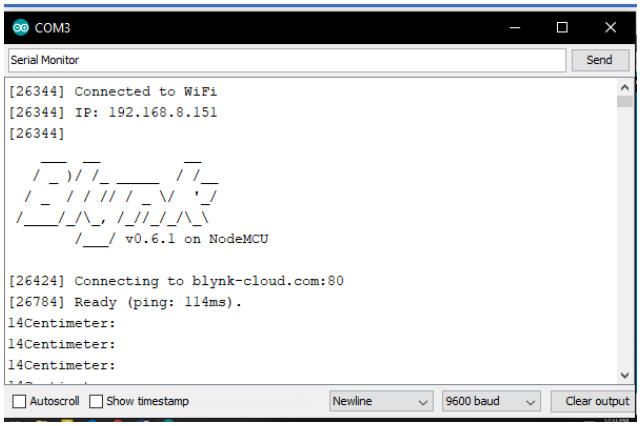
The Firebase Realtime Database is a cloud-hosted database. Data is stored as JSON and synchronized in Realtime to every connected client . When you build cross-platform apps with our iOS, Android, and JavaScript SDKs, all of your clients share one Realtime Database instance and automatically receive updates with the newest data. Instead of typical HTTP requests, the Firebase Realtime Database uses data synchronization—every time data changes, any connected device receives that update within milliseconds . Provide collaborative and immersive experiences without thinking about networking code. Firebase apps remain responsive even when offline because the Firebase Realtime Database SDK persists your data to disk. Once connectivity is reestablished, the client device receives any changes it missed, synchronizing it with the current server state. The Firebase Realtime Database can be accessed directly from a mobile device or web browser ; there's no need for an application server. Security and data validation are available through the Firebase Realtime Database Security Rules, expression-based rules that are executed when data is read or written.



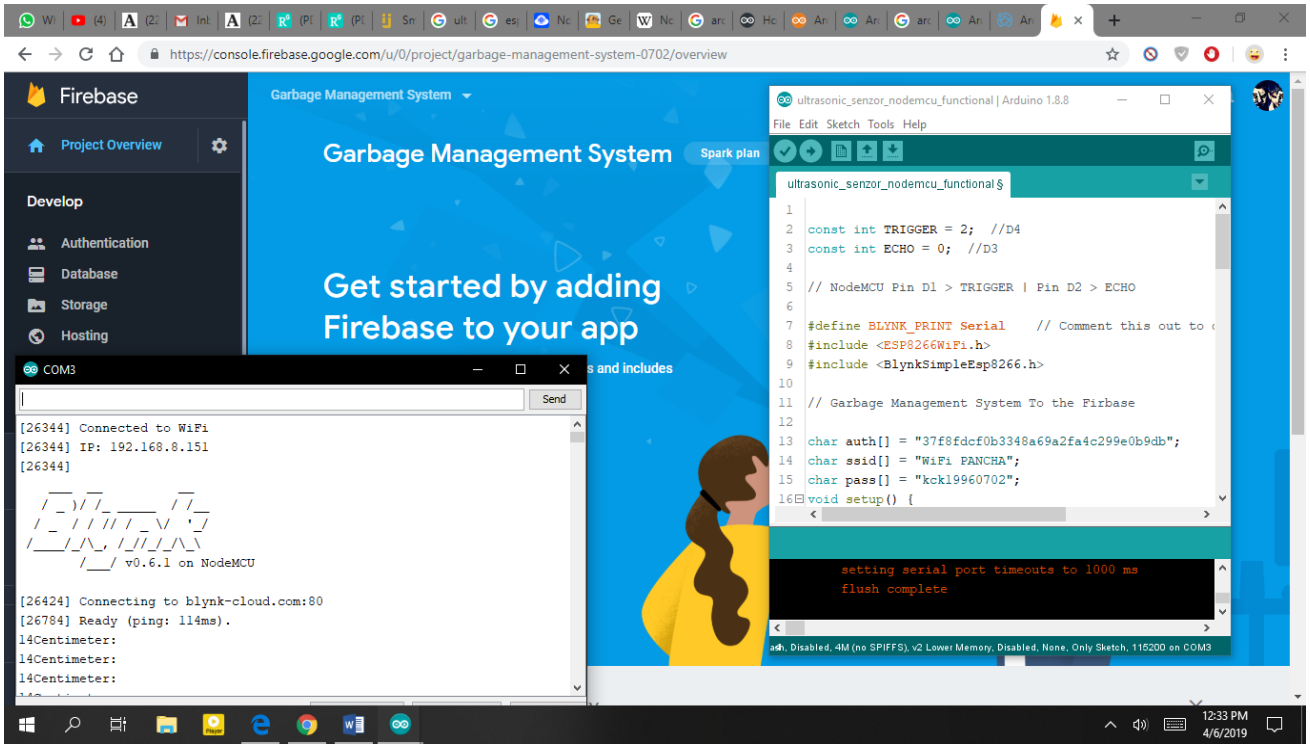
Garbage Management System On Firebase

- **ArduinIDE**

Arduino IDE is an open-source software program that allows users to write and upload code within a real-time work environment As this code will thereafter be stored within the cloud, it is often utilised by those who have been searching for an extra level of redundancy . The system is fully compatible with any Arduino software board.Main Functions and Uses - Arduino IDE can be implemented within Windows, Mac and Linux operating systems. The majority of its components are written in JavaScript for easy editing and compiling . While its primary intention is based around writing codes, there are several other features worth noting. It has been equipped with a means to easily share any details with other project stakeholders. Users can modify internal layouts and schematics when required.Tutorials are likewise available for those who might not have a substantial amount of experience with the Arduino framework .The Serial Monitor is a part of the Arduino IDE. It is also available in the Web IDE. It allows you to send and receive data from the board connected via USB. This is using the concept of Serial Communication.

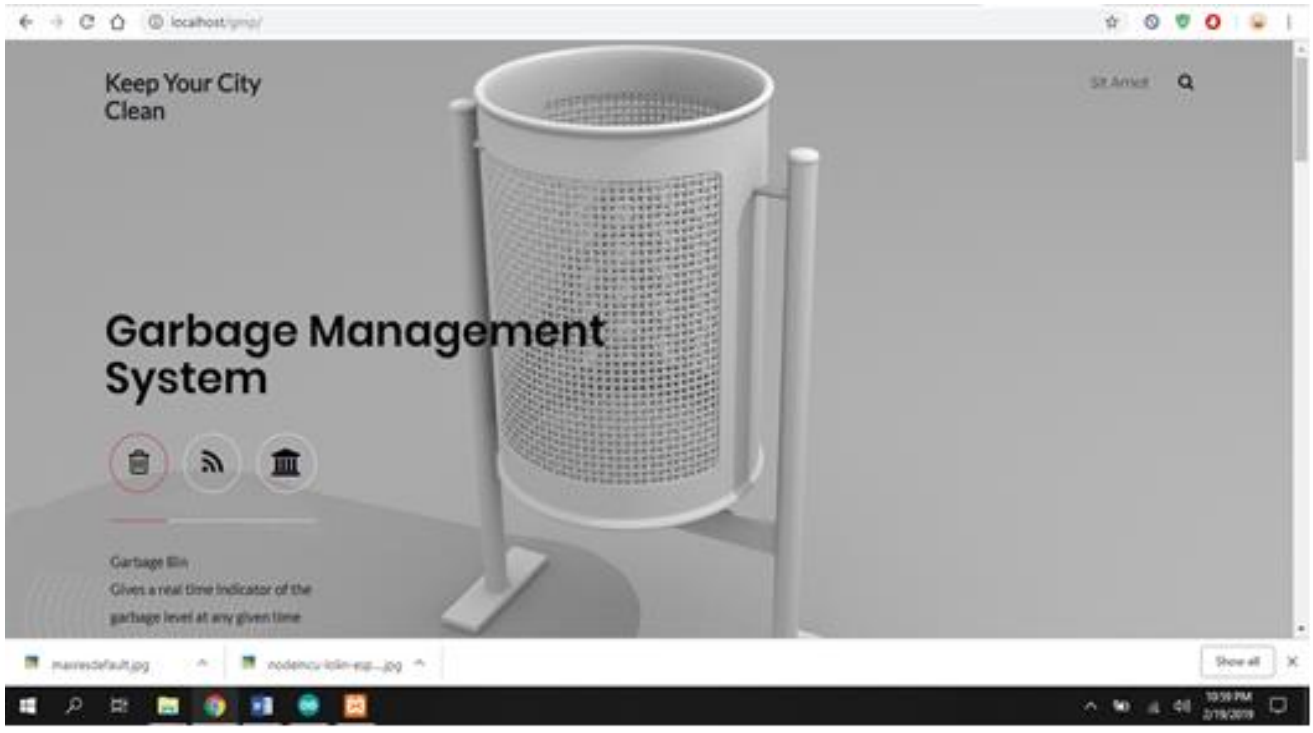


Serial Monitor



Connecting Node MCU And Arduino IDE Using Firebase And Blynk

- **Web Interface**



Web Interface Using WordPress

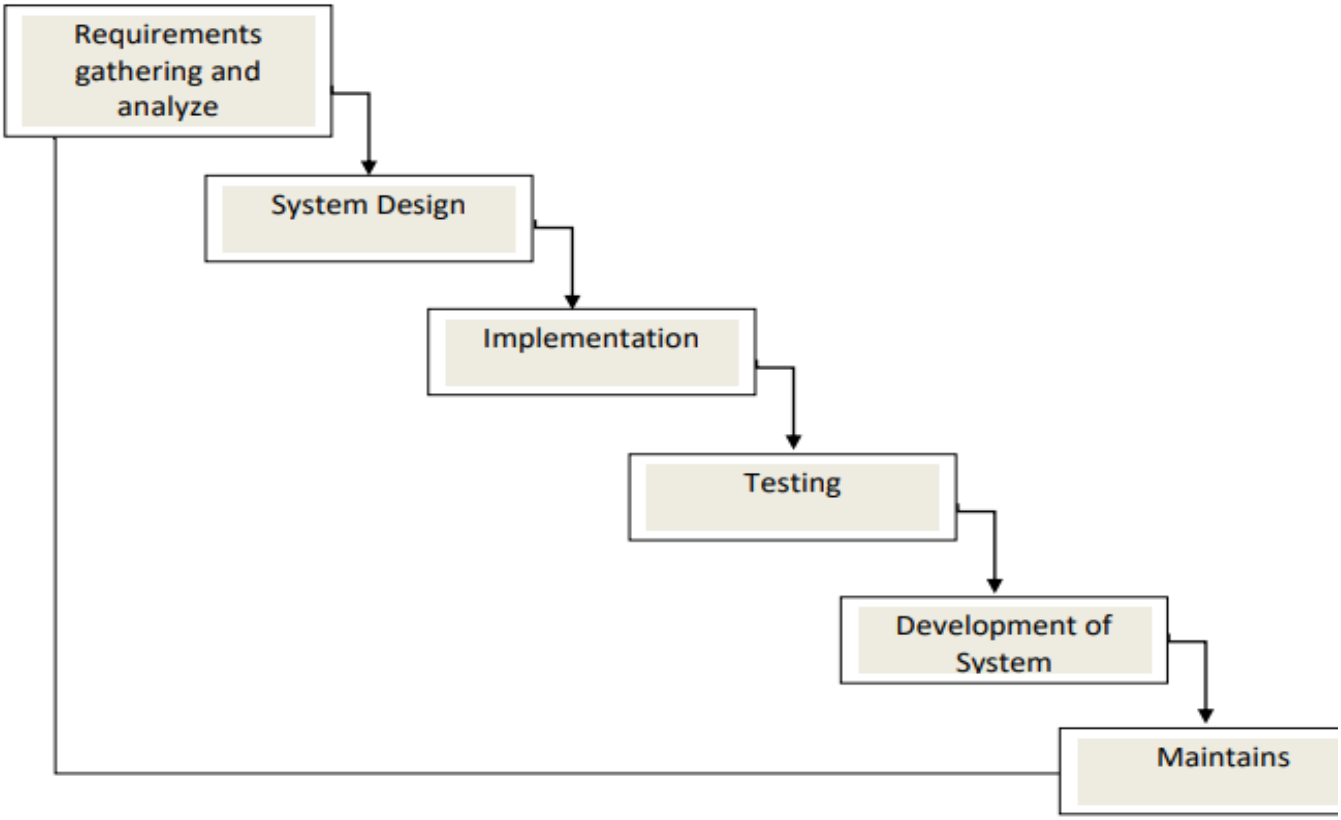
5.3 PROJECT MANAGEMENT

This project was stared in early December and carried out over approximately four months. The project has been split into few stages to allow the management to be more efficient. PID was created at the beginning for project explanations and development requirements to identify. But some of the changes were done during the development period. It's was useful to provided more features to the system. The first major factor was the project research of similar systems. During the research period helped me to identify the components, materials, technologies and etc. After comparing the similar systems, I have identified the best solution to develop more effective temperature measuring system. The same thing has been done to each process to identify the best solution to develop this system. The supervisor meeting are helped me to develop this system in a better way. There were number of new features added to the system with the help of meetings. The two interim reports were written to document the current progress and revise the development schedule where necessary. The first major element of the project was the research number of garbage bins in the cities and identify the progress clearly. After gathering all the relevant information's, tried to improve the system in better way to providing effective features. The next stage was the research about materials, components, technologies, etc. This part was required to develop the system in effective way. The hardware tools were ordered and model was created within three weeks. During the materials order time, I have created the diagrams related to this system. At that time, the supervisor meetings helped me to change a few diagrams in a better way.

Some of the technical issues were raised during that time. But that issues were cleared in few days. The basic functions are coded by using the Arduino IDE. The Firebase account also created that time period. After hardware tools are connected and retrieve the data using the Firebase. In the model part, all the functions are created and tested using the Firebase. The data sent to the firebase through the NodeMCU board. Tested all the hardware tool connections and data send to the firebase.The next stage is to develop the mobile application, which is the most important part of this system. The research articles and other materials are helped me to develop the mobile application in a better way. Before created the mobile application, the researched articles and other materials are helped me to develop this application. At the first stage, I have develop only the data retrieve part using the firebase. That part was done within a month. Most of the ideas taken from the supervisor meetings to improve the mobile application. Supervisor advices are helped me to improve the mobile application in much better way. At the final stage of the system was tested by connecting all the parts together. During the testing period, I have started the reporting part as well. Finally the system was finished after the testing period. Overall report has been done after the system finished.

5.4 DEVELOPMENT APPROACH

To develop this system, the waterfall methodology was used. In this methodology, each phase must be completed fully before the next phase can began. Waterfall methodology is used only, when the requirements are well known, clear and fixed. There are few advantages by using this approach. Such as simple and easy to understand, phases are processed and completed one time phases don't overlap, easy to manage due to the rigidity of the module



According to the system, mainly I have used waterfall model to develop this application using this steps.

1. Requirement Analysis

First of all I have discovered several ultrasonic measurements of the system to get an idea about the progress of systems and analyse previous systems that is already implemented. I have discovered the hardware and software requirements that is needed to develop this system and features of this kind of systems. After I have identified filled garbage cans smelling out in the towns needs and main requirements of that should be implementing within the system.

2. System Design

I have designed the diagrams according to information's that I have gathered. There were hardware parts included in this system, which is helped to show the measurements .Database is created to insert and retrieve data through Wi-Fi. After I have identified the relevant hardware tools and connected it to Node MCU boards which are used in the model to get the values to the system. All the components are connected in the final stage of the system design.

3. Implementation

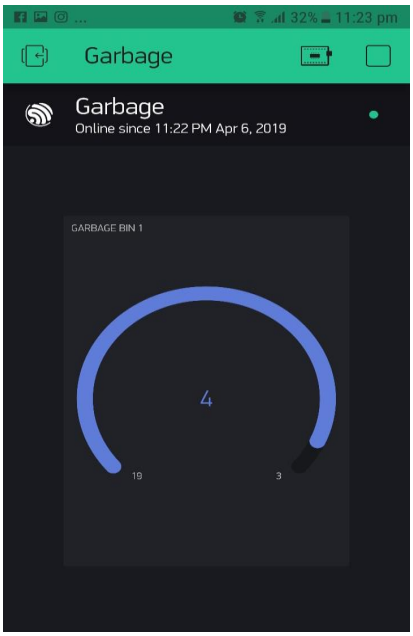
I have implemented android application to an android mobile phone. The other parts are implemented to a pc which has Arduino IDE.

4. Testing

I have completed the testing part by using the several android mobile phones and giving the mobile application to several people and get their comments.

5.5 CONFIGURING BLYNK APP

To connect to the internet we make use of a prebuilt platform called Blynk app. After the user installs the Blynk app on the smartphone, an account to be created in the app to access its services.The services are enabled for the signed users. Let us create an account and add a new project to get started. An unique authentication code is used by the code to communicate with the project . The Blynk needs to be running in the background for the user to get real time notifications.

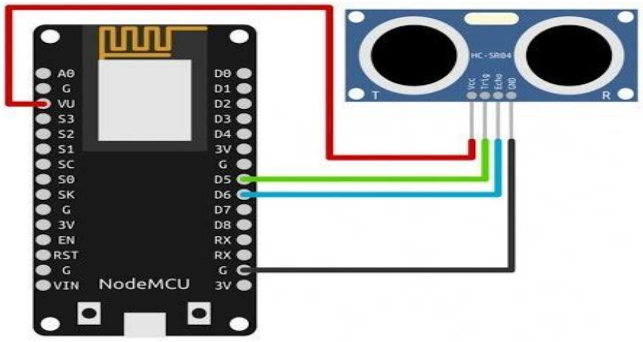


The user can use mobile application very easily. Because the interfaces are not overly complex. The mobile application has been organized in a simple way. The application able to provide fast updates, When the Ultrasonic Sensor data sends, the mobile application can view the new updates quickly. Data will insert quickly to the online database.

5.6 BENEFITS OF THE SYSTEM

The garbage will be collected on time-to-time basis. There would not be any bad smell around the bin. Real time notification to collect the garbage. Saving on fuel consumption, thus reducing the threat to the environment. Our smart waste logistics solution reduces waste collection frequency dramatically , which enables you to save on fuel, labor, and fleet maintenance costs. The solution optimizes waste collection routes and schedules based on real-time and historical data, provides predictive analytics to enable decision making ahead of time, and offers consultation on waste bin allocations . In densely populated areas, a rapid waste generation often leads to overflowing waste bins and unsightly streets . Our solution enables waste collection staff to read fill levels in real time and receive notifications of waste overflows. Collecting garbage is a very pollutant heavy proposition. Our solution offers you the means to have less trucks on the road for less time, which means less greenhouse gas emissions, less noise pollution, and less road wear.(CO2 Reduction)

6.0 WIRING



6.1 CODING PART ARDINO IDE

The Arduino will first read the ultrasonic sensor ， It will send the signal with the speed of sound. It revert back after striking the object and the travel time is store based on equation . Thus the distance of the object is calculated. Based on the distance we can identify the garbage level to be low or high. We used the term “overflow” to indicate

The code given below implemented in the proposed work

Firstly I add the four libries ESP8266 sensor library,Blynk, ThingSpeak, ESP8266WiFi, Firebase Arduino as below include libraries

```
#include <ESP8266WiFi.h>

#include <ThingSpeak.h>

#include <BlynkSimpleEsp8266.h>

#include <FirebaseArduino.h>
```

After define firebase connectivity use the firebase URL and firebase API key as below

```
#define FIREBASE_HOST "final-arduino.firebaseio.com" #define FIREBASE_AUTH
"2lfuHlukp0hIjwW0o9pWqgkVgrTWT0Mxyb1ZUPhc"
```

Then define connectivity

```
char ssid[] = "WiFi PANCHA";

char pass[] = "kck19960702";

void setup() {

  Serial.begin (9600);

  Blynk.begin(auth, ssid, pass);

  pinMode(TRIGGER, OUTPUT);
```

```
  pinMode(ECHO, INPUT);
  pinMode(BUILTIN_LED, OUTPUT);
}
```

Getting Values From Ultrasonic Sensor

```
void loop() {
  long duration, distance;

  digitalWrite(TRIGGER, LOW);
  delayMicroseconds(2);
  digitalWrite(TRIGGER, HIGH);
  delayMicroseconds(10);
  digitalWrite(TRIGGER, LOW);

  duration = pulseIn(ECHO, HIGH);
  distance = (duration/2) / 29.1;
```

Connecting to the Blynk

```
   if (distance <= 5) {
    Blynk.virtualWrite(V0, 255);
}
  else {
    Blynk.virtualWrite(V0, 0);
  }
 if (distance <= 8) {
    Blynk.virtualWrite(V1, 255);
}
  else {
    Blynk.virtualWrite(V1, 0);
  }
   if (distance <= 12) {
    Blynk.virtualWrite(V2, 255);
}
```

```
  else {
    Blynk.virtualWrite(V2, 0);
  }
   if (distance <= 15) {
    Blynk.virtualWrite(V3, 255);
}
  else {
    Blynk.virtualWrite(V3, 0);
  }
   if (distance < 17) {
    Blynk.virtualWrite(V4, 255);
}
  else {
    Blynk.virtualWrite(V4, 0);
  }
```

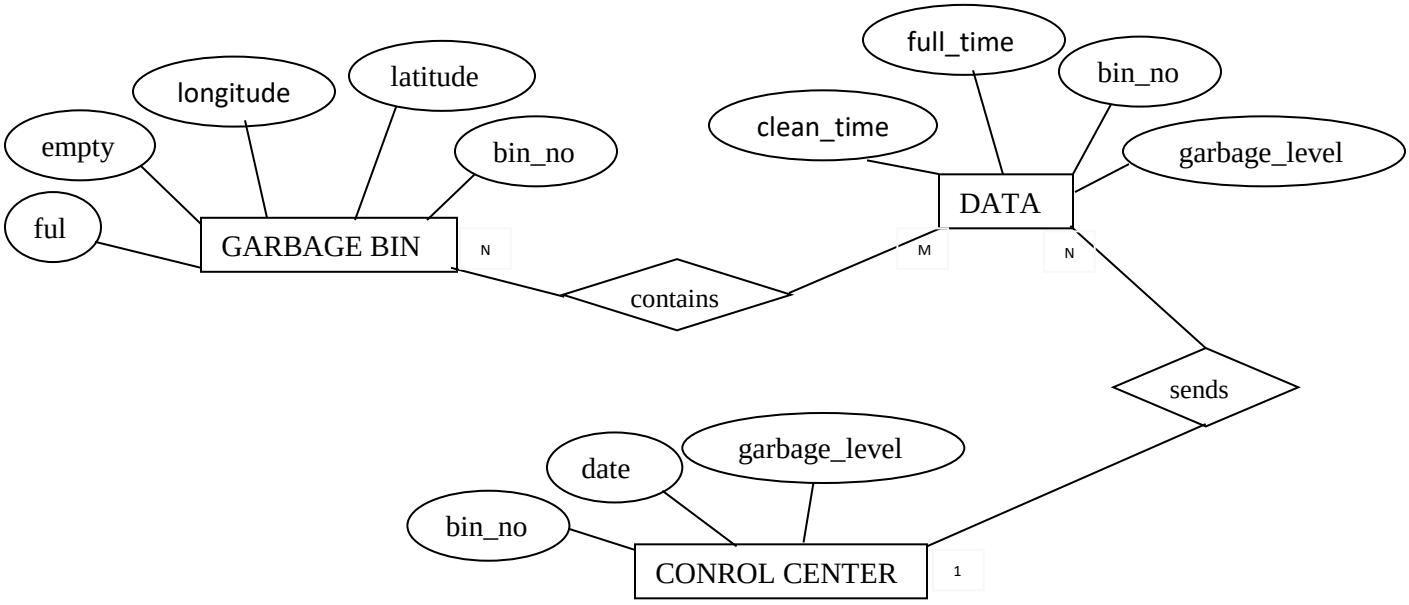
Display values on Serial Monitor

```
  Serial.print(distance);
  Serial.println("Centimeter:");
  Blynk.virtualWrite(V5, distance);
  delay(200);
  Blynk.run();
}
```

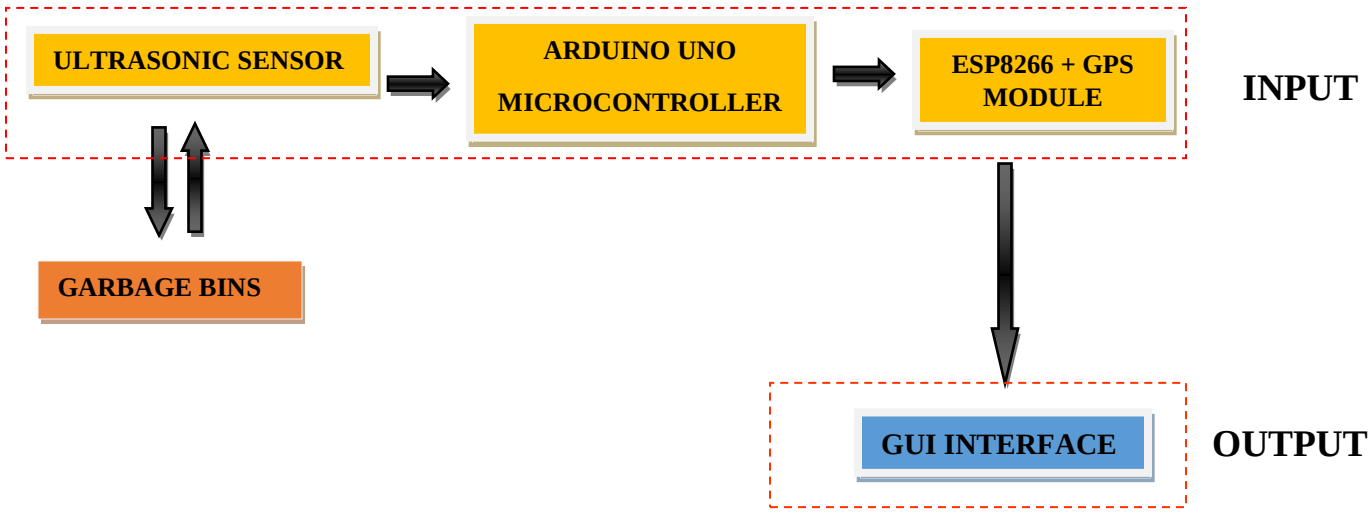
After uploading the program “Serial monitor” running code starts to run, then it connect to ESP8266 to the access point pre-defined in the code. if the ESP8266 connects the model starts via the Blynk servers by sending a ping message

7.0 DESIGN

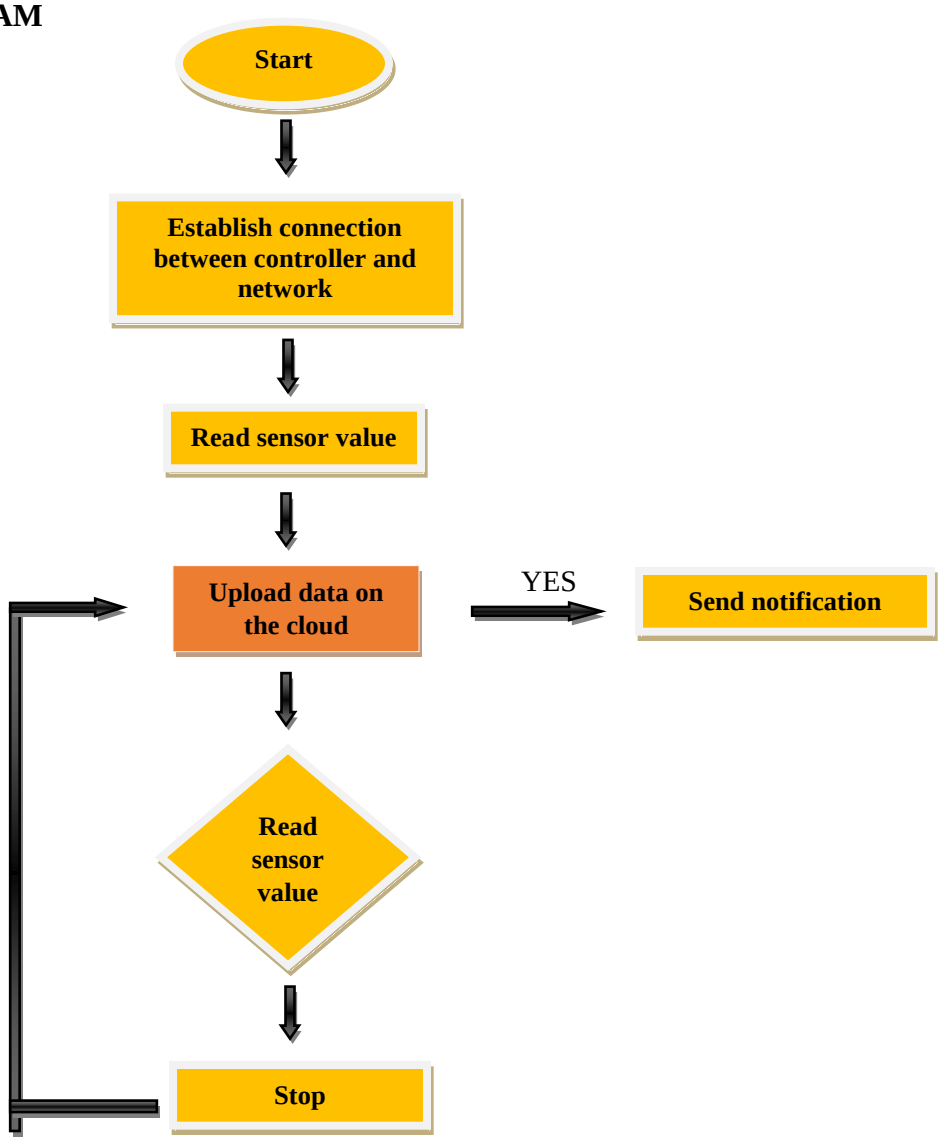
7.1 ER DIAGRAM



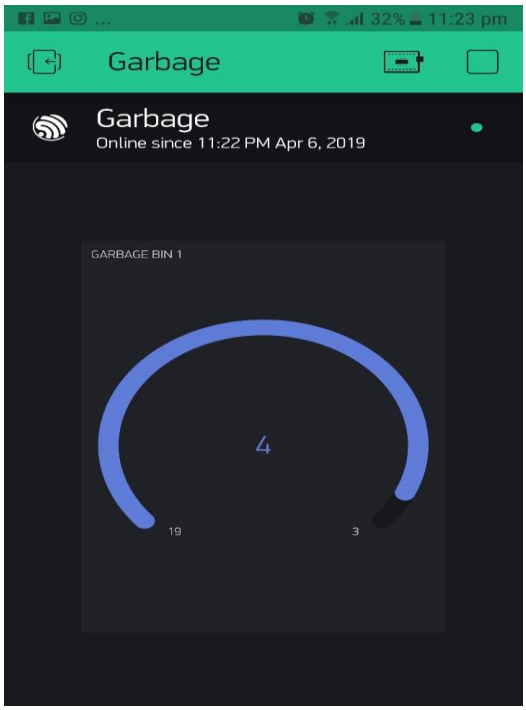
7.2 BLOCK DIAGRAM



7.3 ACTIVITY DIAGRAM

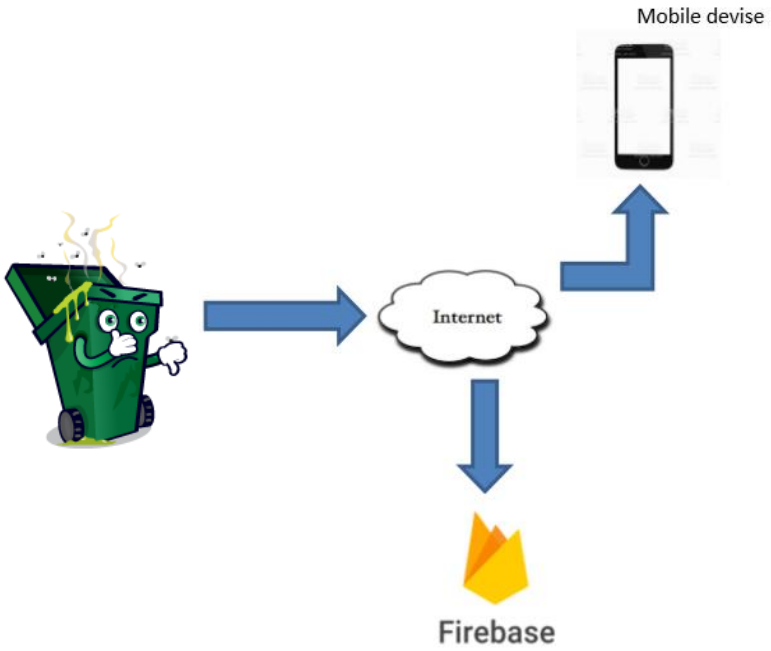


7.4 MOBILE APPLICATION GUI DESIGN



The system was checked repeatedly by increasing and decreasing the level of garbage in the bin. Notification was sent each time the level got changed. The user checked the notification was checked by the user on the blynk app , so it can be said that the system has worked in the way we planned. Proper security was also given to the hardware components so that the output which comes is accurate because further actions have to be taken based on the output. The result of the notification is provided as above GUI interface

7.5 SYSTEM ARCHITECTURE DESIGN



8.0 IMPLEMENTATION AND DEVELOPMENT STAGE

The development processes are detailed in the PID, but some of the changes are made while developing the system. The project proposal was the started point of this system. The two interim reports are helped to show the current progress of the system. The system updates are made during the development stages. This project helps us to save time. It is more efficient over manual process. It is little bit expensive but it saves continuous labour costs and human efforts. We could have been using Raspberry Pi instead of arduino system, but it is more costly than Node MCU.

8.1 PROJECT PLAN

Stage	Deadline	Products/Deliverables/Outcome
Investigation and requirements	02-12-2019	Analysis of existing system and Identification of possible development technologies
Constructing the Model	12-02-2019	Hardware configurations
Installing Drivers and Libraries Necessary	25-02-2019	Programming the Arduino board
Stage 1	28-02-2019	Design the GUI
Stage 2	13-03-2019	Setting up the GUI
Testing	30-03-2019	Report submission
Complete final report	08-04-2019	Submission of final system

8.2 DEVELOPMENT STAGE 1

The PID report was created at the first stage to identify the requirements, investigation, technologies, etc. Analysis of existing systems are helped to identify the possible development technologies to each section. First of all I created the system diagrams to identify the possible factors that needed to improve this system.

At the end of this stage, I have identified how the system architecture work for this system. Finally the model was created and connected sensors, Node MCU board.

Algorithm Of Working Principle

Start Step 1: Go to the target or garbage bin.

Step 2: Connect through ultrasonic sensors.

Step 3: Check the garbage level. Is the bin empty?

If YES Go to Step 8 Else Go to Step 4.

Step 4: Connect through ultrasonic sensors.

Step 5: Is the bin Full? If YES Go to Step 6 Else Do Nothing.

Step 6: Sends garbage levels to the internet using Node MCU

Step 7: Show the graphical view of garbage level via webpage.

8.3 DEVELOPMENT STAGE 2

The second development stage started to develop the connection between board and the fire base. Furthermore, sensor reads and the firebase should be updated through Wi-Fi technology. The different frequency of usage of dustbins in different areas, routine checks which are based on time crevices is inefficient because a dustbin might get filled early and may need immediate attention or there might not be any need of a routine check for a long period of time. So that any smart method by which we can integrate hardware and software resources . I have used the cloud computing technique effectively with the sensor network .

That is the optimized way to use the shortest path for the garbage collection machine so that throughput of system can be increased. Machine learning techniques also used in cloud computing scenario to enhance the performance

Database

To identify each bin, each Sensor is given a unique Identification number (ID), this ID allows each bin to be identified. A table of the data stored for each bin as follows

Data Item	Type	Description
bin_id	VARCHAR	Unique identification number of the bin
location	VARCHAR	The name of the location of the bin
bin_type	VARCHAR	The type of bin
latitude	FLOAT	Latitude position of the bin
longitude	FLOAT	Longitudinal position of the bin
zone	VARCHAR	The zone in which the bin lies
status	BIT	Activation status of the bin
update_frequency	INT	How frequent sensor data is captured

Upon each upload the data is stored in a single table. Each upload into the table contains the fields that are shown in the table. Using the information uploaded into the database, it is possible to generate analytical information on each of the bins that are within the network. This allows the city authorities to have access to information that would otherwise be absent. In addition, this information is also used in the route planning algorithms to determine the best route that is to be taken by each collection vehicle during the collection process.

Data Item	Type	Description
entry_id	INT	The record number of the row in the table
fill_level	INT	The fill level of the bin
tilt	BIT	Orientation of the bin
entrydate	DATETIME	Date&Time of upload
date	DATE	Date of data capture
time	TIME	Time of data capture

8.4 DEVELOPMENT STAGE 3

The 3rd stage was consist of to develop the mobile application. In the mobile application, all the user functionalities have been developed at this stage. The first part was to find the companies that were involved in collecting the waste and owned trucks and who could also organize some drivers for collecting the garbage from various parts of the city in the truck and pass on the city dumps or the recycling organizations. The second part was to make a system which could handle all the communications of all the people involved and could also maintain the data which will be collected while working around in the city Finally the system test was done and started to finalize the documentation of the project.

8.5 IMPLEMENTATION

Implementation was done by using a mobile phone and the pc. I have implemented android application to an android mobile phone. The other parts are implemented to a pc which has Arduino IDE. Various issues were raised during the project development period. But somehow I managed to solve all the issues during the development period. Some of the issues had to solve by doing more research. Due to that, could have more experience about the project implementation.

8.6 FUTURE DEVELOPMENT

I have implemented real time waste management system by using smart dustbins to check the fill level of smart dustbins whether the dustbin are full or not. In this system the information of all smart dustbins can be accessed from anywhere and anytime by the concern person and he/she can take a decision accordingly. By implementing this proposed system the cost reduction, resource optimization, effective usage of smart dustbins can be done.This system indirectly reducing traffic in the city . In major cities the garbage collection vehicle visit the area's everyday twice or thrice depends on the population of the particular area and sometimes these dustbins may not be full. Our System will inform the status of each and every dust bin in real time so that the concerned authority can send the garbage collection vehicle only when the dustbin is full. The scope for the future work is this system can be implemented with time stamp in which real-time clock shown to the concern person at what time dust bin is full and at what time the waste is collected from the smart dustbins.

Route planning

There exist several methods by which the route planning can be done. Of those identified, the ones most desirable are route planning based on the fill level of the bins and route planning based on the priority of the bins. A high priority bin is one that may contain harmful substances or be in areas such as schools. The route planning algorithm simply takes into account the starting location of the collection vehicle, the drop-off location, and the bins that are of a selected level. The User is therefore able to select a level (e.g. more than half filled) and the algorithm will plan the route passing through only the bins that are above the selected level as well as the high priority bins.

This allows a more optimal route to be taken by the collectors and thus allows many resources to be conserved. A feature that is to be implemented is one that alerts the collectors of bins that are below the specified collection level, but have not been collected over a given duration. This mitigates the risk of items such as food waste in a low-traffic area rotting before they are collected. The route taken when bins with a fill level of over 50 percent are taken into account, while other bins only considers those filled above 75%. The path taken is significantly shorter and hence the advantage of the monitoring system displayed. Both routes have the same start and end locations

Anyway the main objective is that maintain the level of cleanliness in the city and the environment which is for better for living. With the help of this system we can check the level of the garbage in the dustbins which are placed in various parts of the city. If a one of the 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 related employees can check the status of these bins anytime on their mobile phones. So this can prove to be a very useful system if used properly.

9.0 END PROJECT REPORT

9.1 PROJECT ACHIEVEMENTS

Garbage level detection is the done by ultrasonic sensors (HC-SR04).The ultrasonic sensors is placed on top of the dustbin facing the bottom. The sensors continuously emits the sonic waves, when the sonic waves hit the object and reflect back, the echo in the sensors senses the waves and calculates the distance of the object. Node MCU is used for controlling whole the process detecting garbage in different places and depending on the program first display in LCD to reminding the garbage level in the bin even though the garbage is not take out from the bin then the particular bin information is sent to higher officials through

9.2 CHANGES OF THE SYSTEM

During the first phase of the design, I initiated the GSM module process, when the system was developed, the GSM module was discarded from the problem and the NODEMCU Module was used. Because the GSM Module cannot be connected via firebase. Then I have attempted to develop the GUI and developed the system.

However, the GUI and the connection with the NODMCU caused a problem. How often it was impossible to solve. Using the same sensor, the ESP8266 sensor was used and the system was stitched.

Ultrasonic sensor is being used in this system to check the level of garbage in the dustbins, but in the future various other types of sensors can be used with the help of the ultrasonic sensor to get more precise output and to take this system to another level. In the present 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, this can be made which will be in charge for handling and maintaining this system and also to take care of its maintenances.

10.0 PROJECT POST MORTEM

10.1 KEY ACCOMPLISHMENT

The primary targets has been done and utilized as a guideline throughout the entire project. Mobile application part and Arduino part main target to finish in a higher standard. The mobile application have been guaranteed that the most important data gave to the users. This project has been delivered a user friendly mobile application that runs smoothly and provided more effective data for the system users. The system has been provided all the essential functionalities that want to make it usable. Additional features can be added to this system to provide more and more services to user.

10.2 KEY ISSUES

There were few issues raised during project development period. The biggest issue was the tight schedule for the entire six months. During the mobile application period, there were few issues raised. The data did not retrieve to the mobile application from fire base. The solution for that issue was to send data using the POST method.I haven't any experiences work in an Arduino IDE. At the beginning it was really hard get the outputs, the researched articles and other materials helped me to improve my knowledge. These are the issues raised during the system development time.

10.3 PROJECT MANAGEMENT

The system was stared with the project proposal. There were another three reports displayed during the developing time. The Project initiation document (PID) provide the details of project explanations and development requirements to identify. The other two Interim reports are created to show the current progress of the system and to show the updates of the system.

10.4 TECHNOLOGIES

Adruino used to connect the model tools with firebase. Android studio has been used to create the mobile application part. The coding part is done by using C language. Adriano IDE has been used to create connection between NODEMCU board and Ultrasonic sensor.

10.5 WHAT HAS LEARNED ACCORDING TO THE SYSTEM ?

I have learn about the Arduino concepts. The success of a project is depend on the effort that you give throughout entire the project. Before start a project, you need to have research information's for various factors. The research information will help me to develop the system in much better way. The project management is one of the key aspect for a developing any kind of system. I have learn, how to create a mobile application using the android studio. There are the things that I have learn throughout this entire project.

11.0 LIMITATIONS

- This system will fail if the sensors stop working.
- Internet connection needed to use the mobile application.
- Wi-Fi connection need to send data for firebase
- It requires a well structured hardware.
- The onetime cost of installation will be higher than the present technique.
- Need of good sensor for regular sense dust.

Application

- ✓ Domestic
- ✓ Hotels
- ✓ Malls
- ✓ Railway Station
- ✓ Bus Stop
- ✓ Gardens
- ✓ Colleges

12.0 CONCLUSION

The developed system is one that provides many useful features for any city that wants to optimize its solid waste collection process as well as reduce the overall cost of running the collection. This not only gives the city's waste authorities the ability to handle their waste better, but also gives them the ability to predict and plan better their resources. In addition, the system will mitigate the risk of overfilled bins and unsanitary conditions that are caused by the lack of information that is present in the current collection process.

And this survey has been done to find out the details of smart garbage management system and to collect effective methods which will be useful to keep our environment neat and hygienic. As the garbage level reach to its maximum, it will be immediately informed to the respective authority. The natural environment requires protection to remain healthy for all inhabitants. To protect and keep our environment hygienic and sustainable environment requires the collective efforts of the people, the authorities and the private sector. Environmental pollution is causing a lot of problem to the humans as well to the animals, driving many animal species to endangerment and even extinction. Thus we have implemented the real time waste management system so that we can easily trace dustbin vehicle as well the location of it and keep the surrounding hygienic. Everyone should remember these three words: REDUCE, REUSE, RECYCLE in order to keep our environment hygienic.

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15.0 APPENDICES

User guide User guide section will describe how to use this system.

System requirements for the installation

- ✓ Arduino IDE
- ✓ Fire base account
- ✓ Android Mobile phone/tab
- ✓ Any Desktop OS

To run the NodeMCU board, you need to add additional board manager (Arduino IDE/File/Preferences), after you need to install the esp8266 module to Arduino IDE. When the board is installed, you need to select the right board manager. (Arduino IDE/Tools/Boards/ESP8266 Modules)

15.1 PID

Project Initiation Document (PID)

INTRODUCTION

We are living in an age where tasks and systems are fusing together with the power of IOT to have a more efficient system of working and to execute jobs quickly. This project IOT Garbage Monitoring system is a very innovative system which will help to keep the cities clean. The system monitors the garbage bins and informs about the level of garbage collected in the garbage bins.

This system built on a platform which was based on Arduino Uno board which was interfaced with a Node MCU and an ultrasonic sensor.This bin was interfaced with a system based on microcontroller which had IR wireless systems with a central system that showed the current status of the garbage in the bin. The status was seen on a mobile based web browser with a html page by using Wi-Fi. The level of garbage in the bin was detected by the ultrasonic sensor which will send the data to the control room using the Microcontrolller. A GUI was also developed to check the information that was related to the garbage for different locations.

BUSINESS NEED

One of the main concerns with our environment has been solid waste management which impacts the health and environment of our society. The detection, monitoring and management of wastes is one of the primary problems of the present era. The traditional way of manually monitoring the wastes in waste bins is a cumbersome process and utilizes more human effort, time and cost which can easily be avoided with our present technologies.

BUSINESS OBJECTIVE

In this system, 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 fuel consumption. It allows trash collectors to plan their daily/weekly pick up schedul

PROJECT OBJECTIVES

Cost reduction - our smart waste logistics solution reduces waste collection frequency dramatically, which enables you to save on fuel, labor, and fleet maintenance costs.

Dynamic routing - the solution optimizes waste collection routes and schedules based on real-time and historical data, provides predictive analytics to enable decision making ahead of time, and offers consultation on waste bin allocations.

Improved cleanliness - in densely populated areas, a rapid waste generation often leads to overflowing waste bins and unsightly streets. Our solution enables waste collection staff to read filllevels in real time and receive notifications of waste overflows.

INITIAL SCOPE

The system worked in two parts, the first part was to find the companies that were involved in collecting the waste and owned trucks and who could also organize some drivers for collecting the garbage from various parts of the city in the truck and pass on the city dumps or the recycling organizations. The second part was to make a system which could handle all the communications of all the people involved and could also maintain the data which will be collected while working around in the city.

The transmitter section consists of a microcontroller and sensors which check the level of the garbage and the data is passed onto the system with the help of the RF Transmitter, then RF Receiver receives the data and sends it to the client associated so that the bin can be emptied quickly.

METHOD OF APPROACH

With the rise in the urbanization of cities and growing population there has been a major concern for improving health, hygiene and quality of environment. One of the important challenge is garbage management. Accumulation of garbage causes health hazards, environment pollution and in turn spoil the area. Various initiatives has been taken with an objective of promoting sustainable environment using smart system

INITIAL PROJECT PLAN

Stage	Deadline	Products/Deliverables/Outcome
1. Initiation	28-11-2018	PID
2. Investigation and requirements	02-12-2019	Analysis of existing system and Identification of possible development technologies
3. Constructing the Model	12-02-2019	Hardware configurations
4. Installing Drivers and Libraries Necessary	25-02-2019	Programming the Arduino board
5. Stage 1	28-02-2019	Design the GUI
6. Stage 2	13-03-2019	Setting up the GUI
7. Testing	20-03-2019	Report submission
8.Complete final report	30-03-2019	Submission of final system

CONTROL PLAN

The project Follows Critical path project management mythology to step-by-step accomplish the project.

COMMUNICATION PLAN

To successfully complete this project I have arranged few meetings with the supervisor. I am planning on meeting my supervisor at least 6 times and hope to improve and add new features and get supervision for failed parts. All the little information required will be discussed via emails.

INITIAL RISK LIST

Ensuring the Ultrasonic distance sensor are correctly placed. If the pile of dump increased in the middle the sensor could be giving misleading data.

There could be liquid/water thrown in to the bin. The design needs to have water proof electronics and embedded software.

The biggest issue availability of 3G/4G Cellular networks. The fact that we made a model at home bypassed this issue as we used WiFi. This in fact is this only main issue, although personally I feel in a couple of years every corner of the world will have Internet Connection

INITIAL QUALITY PLAN

INITIAL QUALITY PLAN	
Quality check	Strategy
Requirements	Checking all the requirements are in a good working Conditions and all the information , getting through the system will correct.
Sub-system usability and validation	To be conducted at the end of each increment
Testing	Checking all the information get though the system are valid.

15.2 INTERIM REPORT 1

TASKS UNDERTAKEN AND OUTCOMES

The project can be divided into two modules, one is detection of garbage level and then the second module is send the information to the corresponding officials through internet. From the first module, I have construct the basic model of this project as follows

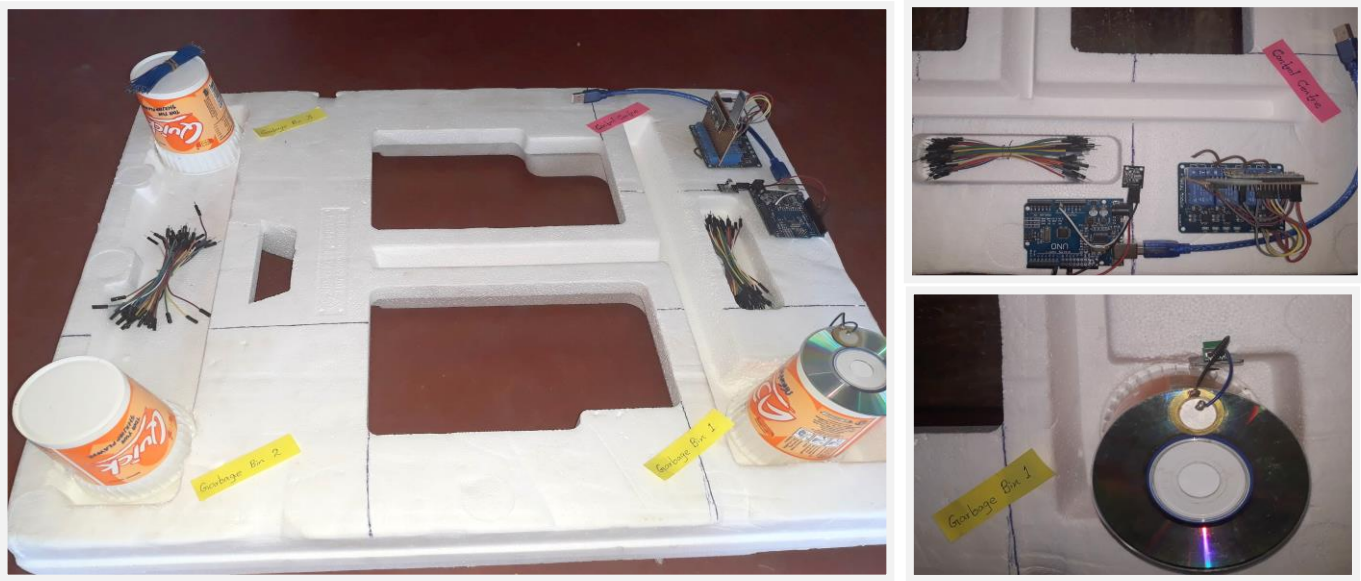
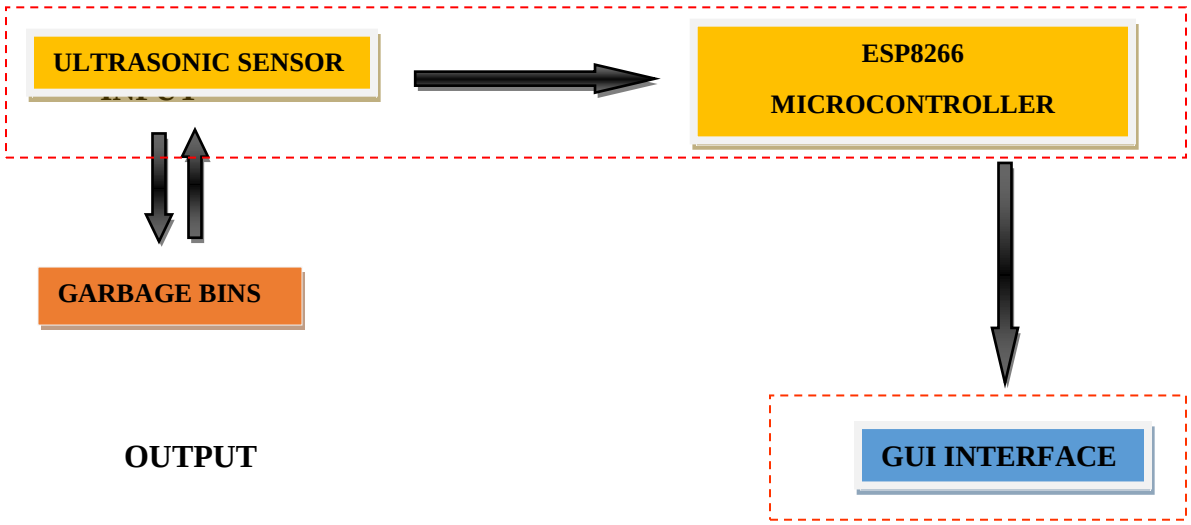


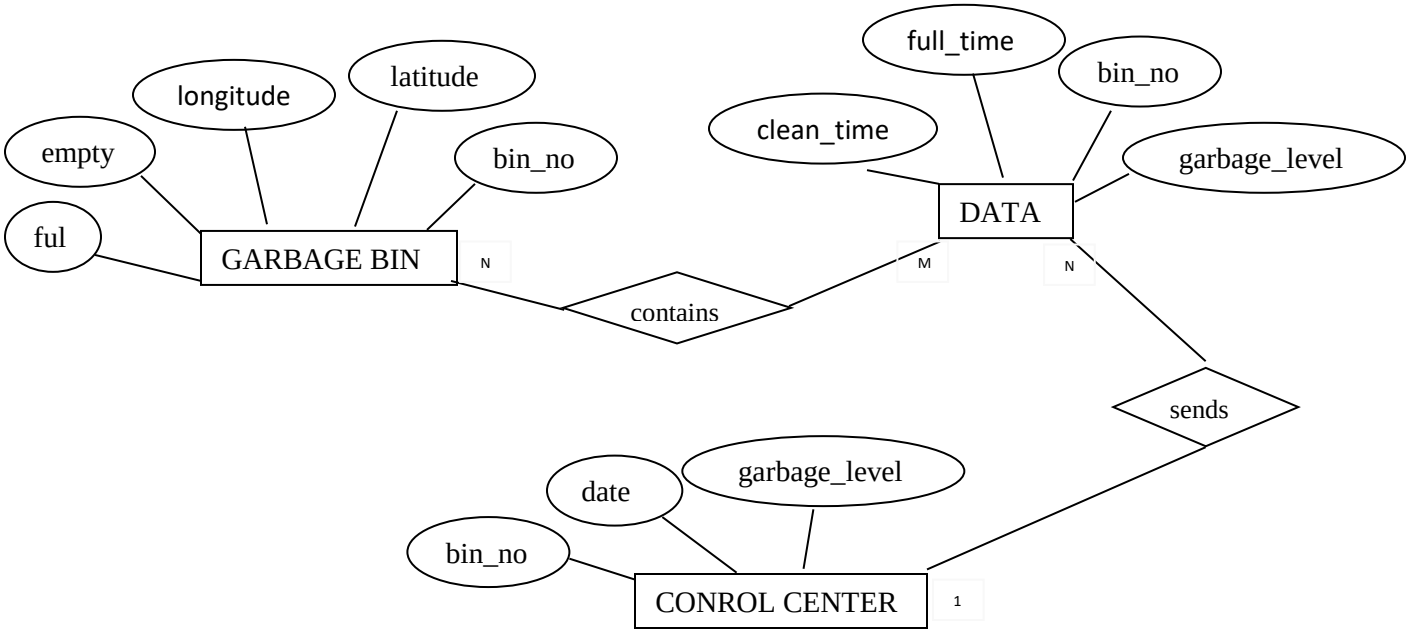
Figure 1 - Basic Model

Figure 1 – This model consist of three garbage bins which can indicate the garbage level and a control center which connects to the garbage bins and the GUI .

11.1 BLOCK DIAGRAM



ER DIAGRAM



PRODUCTS PRODUCED AND PRODUCT QUALITY

The system 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 fuel consumption. It allows trash collectors to plan their daily/weekly pick up schedule.

RISK LIST

Difficulty in learning new technologies became the main risk when I'm doing this project. The complications of working with Google Maps is hard to apply the mapping process to the system.

There is a limited number of resources for the implement this project and hard to find techniques and tutorials for improve knowledge at limited time period.

Ensuring the Ultrasonic distance sensor are correctly placed. If the pile of dump increased in the middle the sensor could be giving misleading data.

There could be liquid/water thrown in to the bin. The design needs to have water proof electronics and embedded software.

15.3 INTERIM REPORT 2

INITIAL SCOPE

The whole system worked in two parts, the first part was to find the companies that were involved in collecting the waste and owned trucks and who could also organize some drivers, For collecting the garbage from various parts of the city in the truck and pass on the city dumps or the recycling organizations, The second part was to make a system which could handle all the communications of all the people can involved and could also maintain the data which will be collected while working around in the city.

The second section consists of Arduino microcontroller and sensors which check the level of the garbage and the data is passed onto the system with the help of the Node MCU , then From the firebase receives the data and sends it to the client associated so that the bin can be emptied quickly.

CHOICE OF TECHNOLOGIES

Developer tools used

Arduino IDE

(Evans, 2007) state that, Adruino is an enter source software (IDE). Arduino (IDE) makes easy to write code an upload to the boards. The basic structure off this arduino programming is simple and there are two parts. Such as setup() and loop(). Setup() function is used to initialize the pin modes. The loop() function will code after the set() function. This loop() function allow program to change, respond and control the Arduino board. According to the system, Arduino (IDE) is the software that I have used to connect sensors, NodeMCU boards, Servomotor and connect to the Wi-Fi as well."

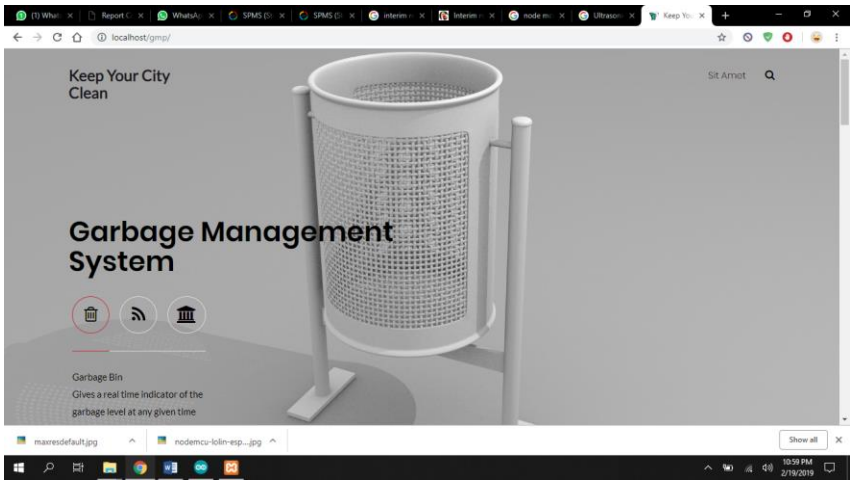
Android Studio

Android studio is used to develop android apps. There are some features in this studio. Such as flexible gradle based system, having fast & feature rich emulator, extensive testing tools and frameworks. This studio gives a rich application system that permits to assemble creative applications and games for mobile phones in a java language environment. I have developed the mobile application using java language with android studio.

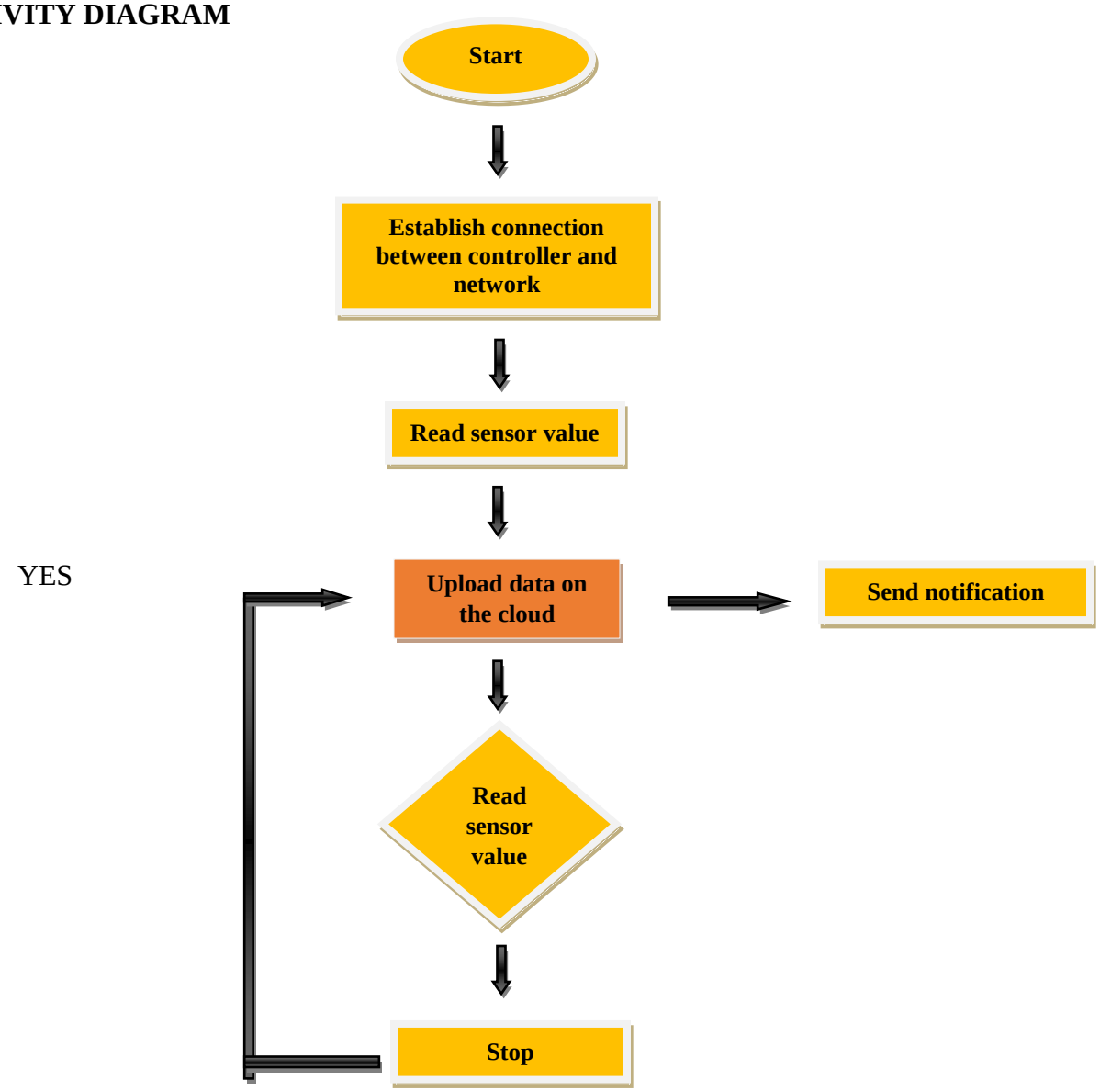
Basic Model Of The System

"The project can be divided into two modules, one is detection of garbage level and then the second module is send the information to the corresponding officials through internet. From the first module, I have construct the basic model of this project as follows"

WEB APPLICATION OF THE SYSTEM

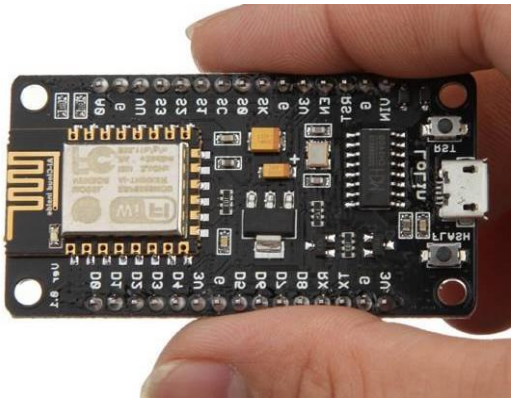


ACTIVITY DIAGRAM



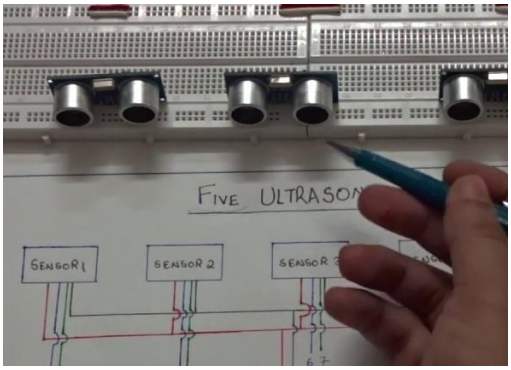
COMPONENTS USED

Node MCU



Possible hardware technologies are Arduino uno, Arduino Mega and NodeMCU. Basically the researched of those three boards, I have identified the best solution is NodeMCU board for this system due to the reason of NodeMCU has intergraded Wi-Fi module and explicit Wi-Fi module needs to be integrated to other two and NodeMCU included 5v power port and it can provide via micro USB port. On other hand, cost of the board getting lower than other two. Moreover, execution speed of the board also getting low value (lower is better).

Ultrasonic Sensor

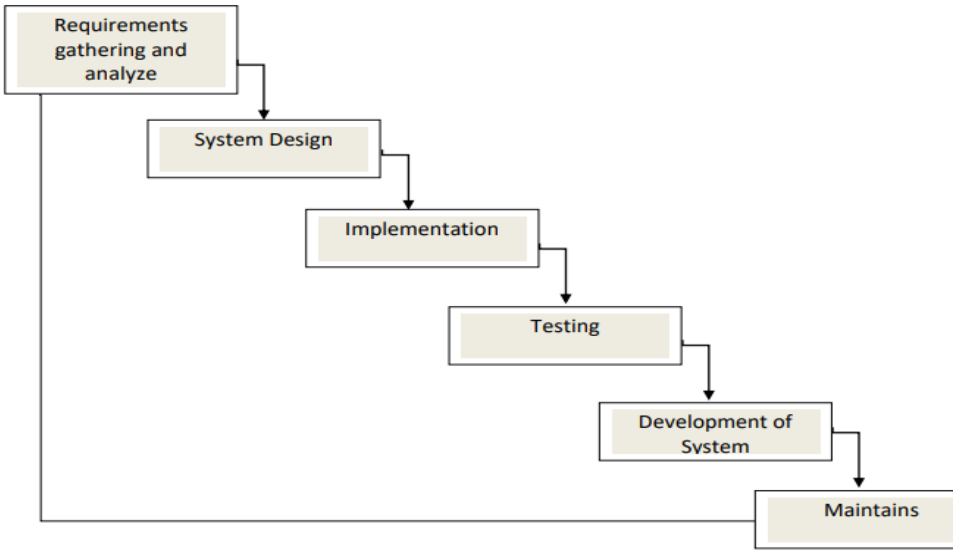


An optical sensor has a transmitter and receiver, whereas an ultrasonic sensor uses a single ultrasonic element for both emission and reception. In a reflective model ultrasonic sensor, a single oscillator emits and receives ultrasonic waves alternately.

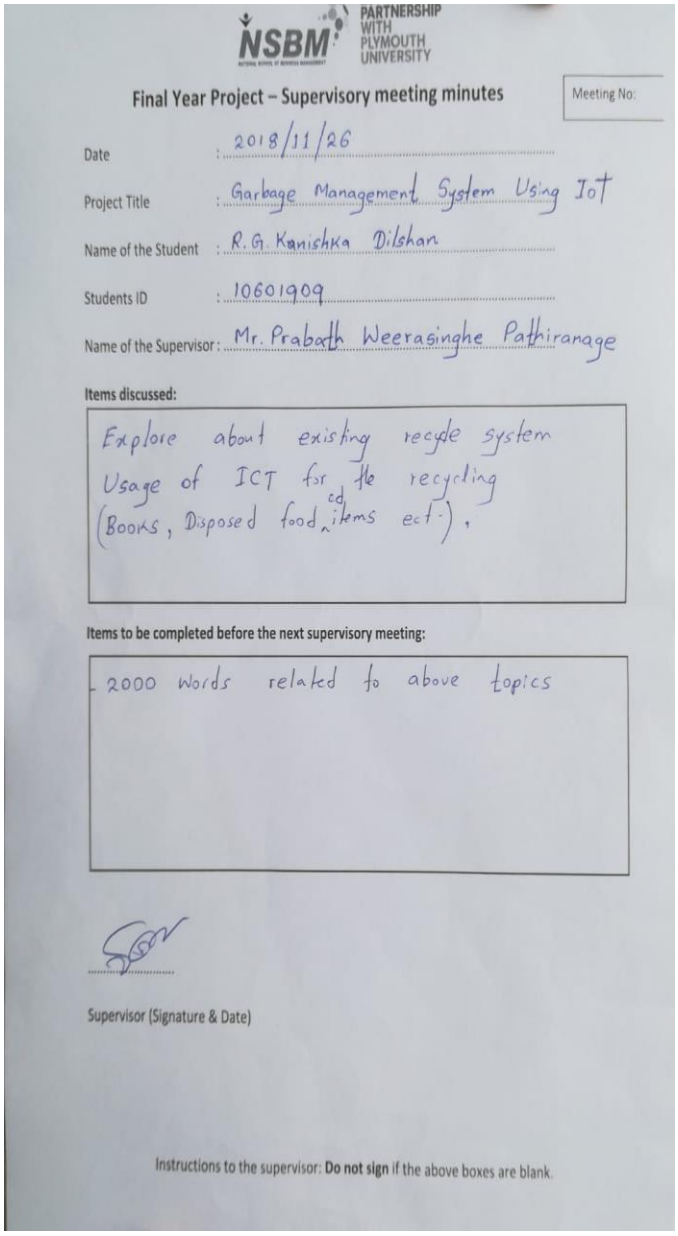
Distance L = 1/2 × T × C .where L is the distance, T is the time between the emission and reception, and C is the sonic speed. (The value is multiplied by 1/2 because T is the time for go-and-return distance.)

DEVELOPMENT APPROACH

To develop this system, the waterfall methodology was used. In this methodology, each phase must be completed fully before the next phase can began. Waterfall methodology is used only, when the requirements are well known, clear and fixed. There are few advantages by using this approach. Such as simple and easy to understand, phases are processed and completed one time phases don't overlap, easy to manage due to the rigidity



15.4 MEETING MINUTES



NSBM IN PARTNERSHIP WITH PLYMOUTH UNIVERSITY

Final Year Project – Supervisory meeting minutes

Meeting No:

Date : 2018/11/26

Project Title : Garbage Management System Using IoT

Name of the Student : R.G. Kanishka Dilshan

Students ID : 10601909

Name of the Supervisor : Mr. Prabath Weerasinghe Pathiranage

Items discussed:

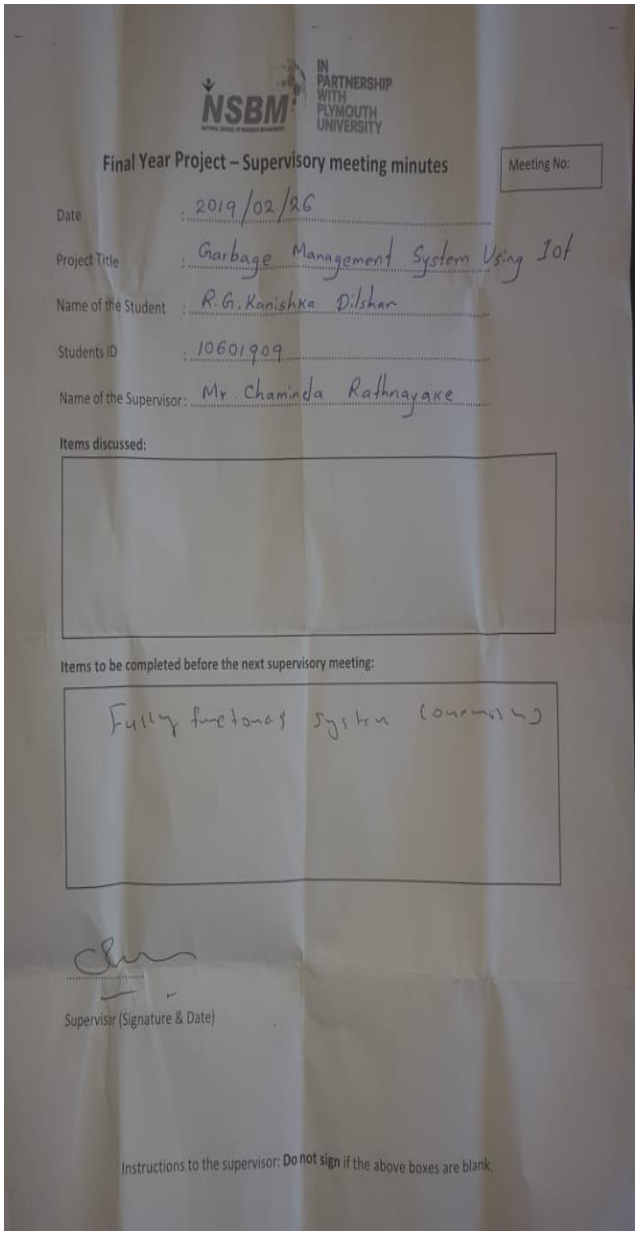
Explore about existing recycle system
Usage of ICT for the recycling
(Books, Disposed food items ect.).

Items to be completed before the next supervisory meeting:

- 2000 words related to above topics

Supervisor (Signature & Date)

Instructions to the supervisor: **Do not sign** if the above boxes are blank.



NSBM IN PARTNERSHIP WITH PLYMOUTH UNIVERSITY

Final Year Project – Supervisory meeting minutes

Meeting No:

Date : 2019/02/26

Project Title : Garbage Management System Using IoT

Name of the Student : R.G. Kanishka Dilshan

Students ID : 10601909

Name of the Supervisor : Mr. Chaminda Rathnayake

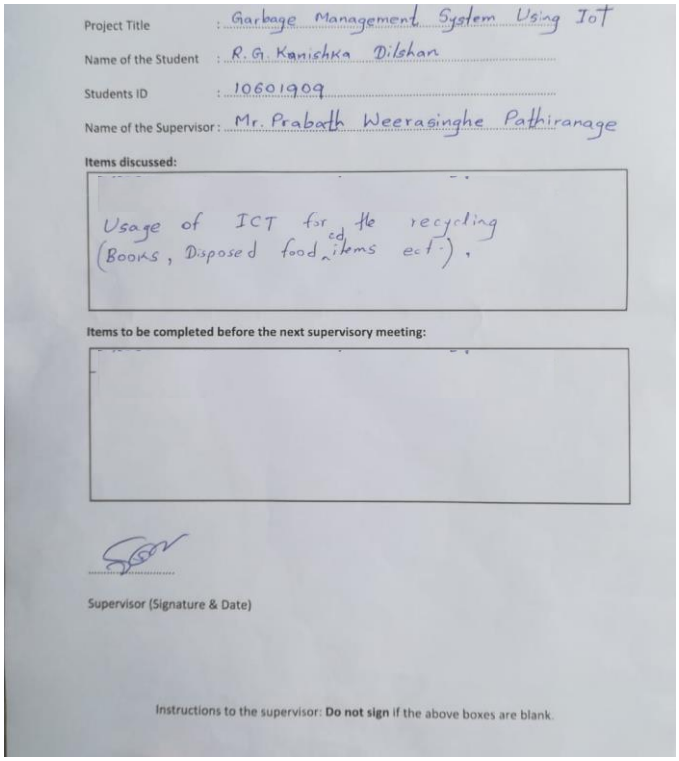
Items discussed:

Items to be completed before the next supervisory meeting:

- Fully functoning system (coverning)

Supervisor (Signature & Date)

Instructions to the supervisor: **Do not sign** if the above boxes are blank.



Project Title : Garbage Management System Using IoT

Name of the Student : R.G. Kanishka Dilshan

Students ID : 10601909

Name of the Supervisor : Mr. Prabath Weerasinghe Pathiranage

Items discussed:

Usage of ICT for the recycling (Books, Disposed food items ect.).

Items to be completed before the next supervisory meeting:

Supervisor (Signature & Date)

Instructions to the supervisor: **Do not sign** if the above boxes are blank.