Automated Garbage Monitoring System Using Arduino

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Abstract : *Today, one of the challenges of most cities and towns are confronting is the decline in condition of cleanness of the environment regarding the garbage management. This occurs due to the mismanagement of the garbage collection. This mismanagement creates the spread of garbage in community which in turn creates unhealthy condition in the immediate area. It also stimulates several serious diseases amongst the people in close proximity and degrades the beauty of the area. To avoid mismanagement of the garbage and to improve the cleanness of the society, Garbage monitoring system is designed. In the proposed system, the level of the garbage is detected with the help of ultrasonic sensor and sent to the authorized agency for garbage collection through GSM system. PIR sensor is used to detect the motion of the people coming to the garbage bin with trash while the bin is at full status and block adding of any more garbage to the bin through informing them by speaker. The GSM and the peripheral sensors used are interfaced through the Arduino microcontroller. A GUI is also developed to monitor the desired information related to the garbage bins for different selected locations. Depending on the received messages through the GSM at control room it is displayed on LCD and the authorized person inform the drivers to collect the garbage on time. This will capably help to monitor the garbage collection to make the environment smart, clean and safe.*

Keywords: *Arduino, Garbage, Monitoring, Sensor, System*

I. Introduction

1.1 Background

'Learn cleanliness from the cat' is said and appreciated in Ethiopian society. The scenario beyond this proverb is that keeping the environment clean is quite important and it is used to emphases more on giving attention to the cleanliness. Nonetheless, it is not as easy as to speak out the proverb to effectively and properly managing the garbage. We frequently observe garbage bins being filled over and additional waste materials being disposed and accumulated around the bin in different cities of Ethiopia. Those improperly disposed garbage will be the dwelling for various number of dangerous micro-organisms, insects and mosquitoes to breed on. Because of this, severe and contagious disease is stimulated and also bad smell comes out of it and may cause illness to human beings. The municipality of most cities in Ethiopia has strived its best to alleviate this problem by providing several garbage bins throughout the town. However, it is manual approach and a number of trucks from the municipal authority are sent to the waste bins to collect the waste. The wastes are loaded to the truck and conveyed to the pre-specified locations. Because of this the category of the people involved in collecting and transporting the wastes are usually not responsible enough to make the job well done. Very often the wastes are not collected from each and every waste bin properly due to municipal authorities did not have information about the garbage bin. The manual waste collection and management approach has problems such as lack of information about the collecting time and place. Because of this it is time consuming and less effective i.e. trucks go and may get empty garbage bin. Generally, there is lack of proper monitoring system to follow all activities related to waste management and lack of smart monitoring of the condition of the bin. This proposed paper shows effective solution to manage the garbage. This garbage monitor is implemented using sensors and Arduino microcontroller. The details of each dustbin are monitored by the municipal authorities with the help of GUI. The implementation of garbage monitoring system using sensors, microcontrollers and GSM module assures the cleaning of dustbins soon when the garbage level reaches its maximum and also notify the people not drop the dust outside of the dustbin when they try to drop it out of bin by sensing their motion. If the dustbin is not cleaned in specific time, then the record is sent to the higher authorized office who can take appropriate action against the concerned contractor. This system also helps to monitor the fake reports and hence can reduce the corruption in the overall management system. This reduces the total number of trips of

garbage collection vehicle and reduces the overall expenditure associated with the garbage collection. It ultimate helps to keep cleanness in the society and hence the expansion of disease caused by waste material is reduced.

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1.2   Statement of Problem
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Now days in most Ethiopian cities there are many dustbins which are in bad conditions. The garbage in a dustbin are all overflowed and also spelled out of the dustbin. Many people are throwing garbage on that dustbin which are already full or overflowed. Due to this unclean of garbage bins bad smell is created and also toxic and unhygienic gases which are bad for the environment is produced. This creates a very bad look of the city which is a way to support to the air pollution and to some harmful diseases which are easily spreadable.

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1.3   Objective
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1.3.1   General Objective

The main objective of the project is to design, develop and implement automated garbage monitoring system.

1.3.2   Specific Objectives

1. To analyze the works performed so far to monitor the garbage
2. Propose and design a garbage monitoring system that can be controlled with GUI
3. Simulate the design using Arduino microcontroller
4. Implement the simulated design along with hardware and software specifications

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II.   Literature Review
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1.4   Related Works

In solid waste bin monitoring system garbage bin set the public place t hen Camera set for garbage bin location. The camera captured image for garbage bin. Radio Frequency Identification (RFID), GPS and GIS send image for work station. The RFID reader and camera are mounted in the truck, when truck comes closer to the bin RFID reader communicated RFID tag. & send all information. The System is use controlling Hut. This Controlling Hut is SMS Technology. The GPS and GPRS mapping server to analyzing data of various location. The control station compiled all the information and stored in the system database. The bin status and waste truck was monitored. [1] In [2], they came to a point It is important to understand the societal concerns over the increased rate of resource consumption and waste production and consequently the policy makers have encouraged recycling and reuse strategies to reduce the demand for raw materials and to decrease the quantity of waste going to landfill. In [3], it is being proposed in this paper that introduction of an integrated system combined with an integrated system of Radio Frequency Identification, Global Position System, General Packet Radio Service, Geographic Information System and web camera will solve the problem of solid waste They also analyzed the actual performance of the system. In [4] described that major challenge in urban areas throughout the world is management of solid waste. In that system, introduced an integrated system combined of Radio Frequency Identification (RFID), Global Position System (GPS), General Packet Radio Services (GPRS), Geographic Information System (GIS) and Web camera. The RFID reader is built in truck would automatically retrieve all sorts of customer information and bin information from RFID tag, mounted in each bin. GPS is used to give the information of location of collection truck. All the information of the center server would update. The information is updated through GPRS communication system. GIS map server is used for truck monitoring. In this System bin as well as database has developed in the way that information of not only bin but also truck ID, data and time of waste collection, bin and truck GPS coordinates information. Bin status and amount of waste are compiled in data packet. The syste is showed that real-time image processing and other bin information have been displayed in the GUI.n [5] described system used two technologies. Zigbee and Global System for Mobile Communication (GSM) are the latest trends. This combination is one of the best combinations which is used in that system. There are number of techniques which are used as well as are being build up for well management of garbage. To give description of the system, the sensors are placed in common garbage bins, which are place at public places. In that ARM7 controller is used when the garbage reaches the level of the sensor, then the indication will be given to microcontroller. This ARM7 controller will give information to the driver of garbage collection truck as to which garbage bin is completely filled. ARM7 will give indication with the help of GSM technology by sending SMS.In [6] described a system is developed for to mainly, concentrate on eradicating not only ugliness but also disorder. The smart trash uses two sensors namely IR and gas sensor. IR sensor is used for to sense the level of the trash inside the bin and gas sensor will sense toxic gases. Once the trash is filled, the RFID placed inside the trash will give information about overflowing of trash to the corporation office.The existing garbage monitoring system throughout the country is fully manual. The collection process is a kind of try and error. The garbage truck visits the garbage bins at fixed interval duration. This process have a lots of disadvantages because based on the residence number and their consumption some garbage bins might get full before a week and others might get full in two weeks and so on

as a result it is being a cause for time dissipation and an appropriate economic expenditures. These and other unmentioned phenomenon's depict the inefficient aspect of the existing system. We believe that our new automated garbage monitoring system can avoid the raised problem in an effective way through applying Arduino Microcontroller and Sensor based technologies.

III.   System design

1.5   Block Diagram of the System

The entire system consist a transceiver system, means that it involved both the transmitting and receiving units. On implementation process the transmitting part of the system placed along with the garbage bin while the receiving part of the system located at the controlling room of the authorized administrator, at the municipality office.

Figure 1: block diagram of the proposed system at transmitter side
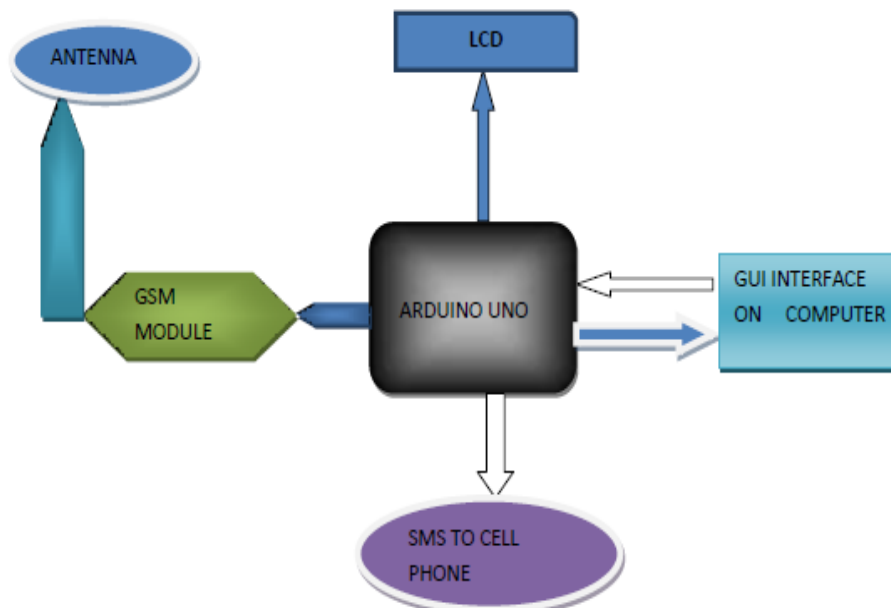
Figure 2: block diagram of the system at receiver side

1.6 Description of Block Diagram

The first block diagram represents the system at the transmitting part or the place of the garbage bin. In this part as the ultrasonic sensor sense the level of the bin and sends the data to the Arduino and the Arduino processes the data from ultrasonic sensor. Depending on the data processed the status of the garbage in the garbage bin is informed to the society through the LED. When the garbage status is high or full the information is passed to the control room through GSM and the PIR sensor starts to sense the motion around the bin and inform the surrounding people not to drop the garbage outside the bin while the bin is full.

On the other hand, the second block diagram depicts the receiving side of the system in such a way that it receives the data from the transmitting part and processes it. The buzzer gives an alarm when data is received and displays the data on LCD. As soon as the data is displayed on LCD the controller from the control room send the SMS to the mobile of driver to collect the bin quickly through GSM.

1.7 Methodology
1.7.1 Software Methodology

For developing the software part of the system we use Rapid Application Development (RAD) model because this models takes iterative ideas to the extreme and instead of using iterations lasting years. The fig below shows the phase of RAD model.
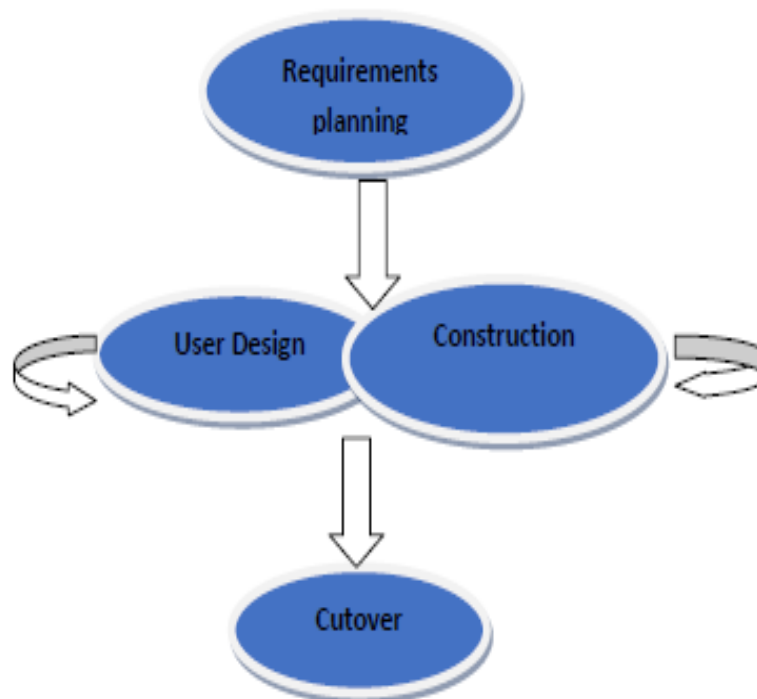

Figure 3: RAD model phases

Requirements planning—the entire group member agrees on the project's objective on designing developing and implementing the graphical user interface at receiving part. The requirements are specified in a way that they don't restrict later developmental change.
User design—team members work together to convert the requirements into a functioning design.
Construction—all members of the group participate on building an application.
Cutover— lastly we provide a finished windows application

1.7.2 Hardware Methodology
The fig below describes the methodology we use the to design hardware part of the system
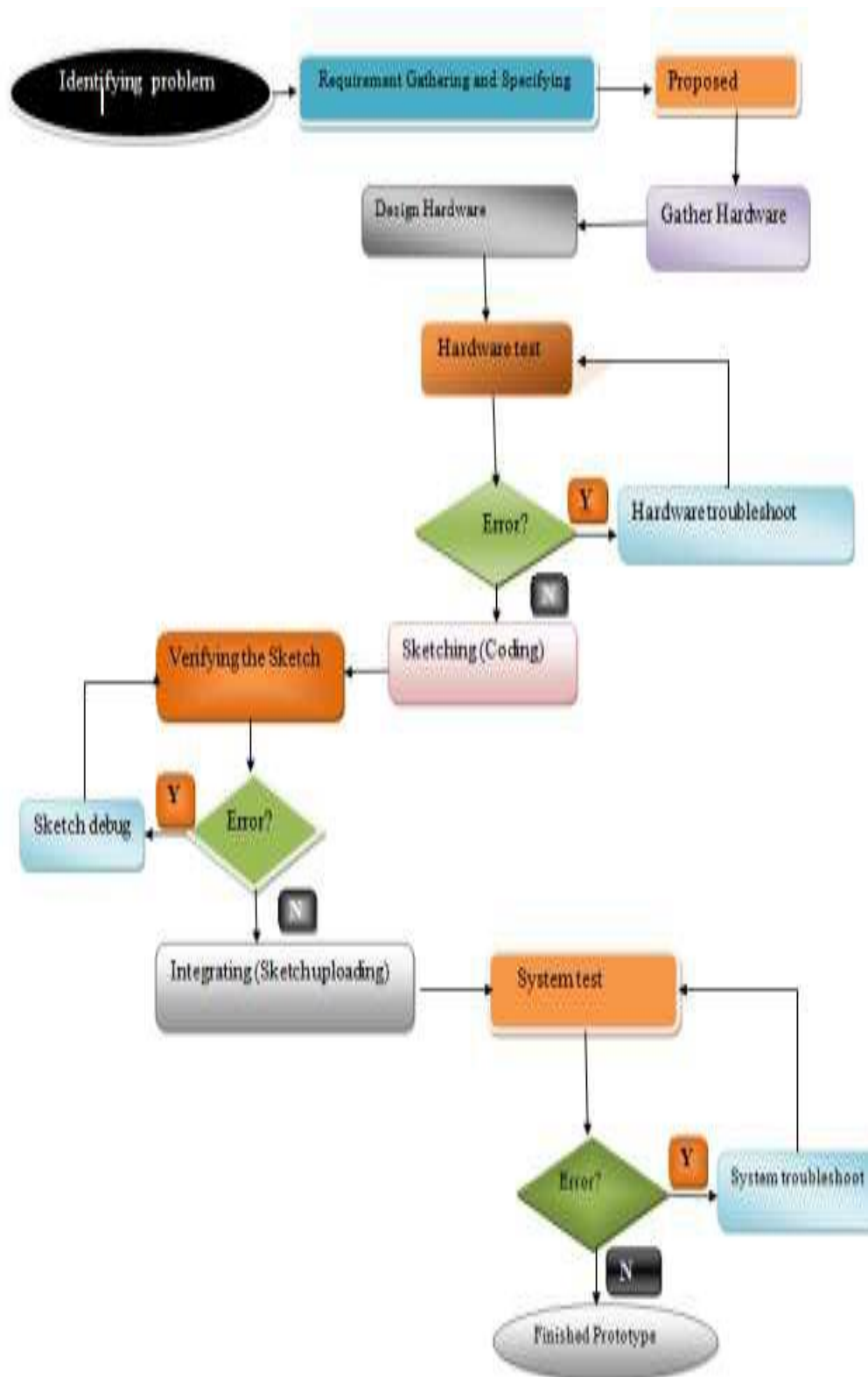
Figure 4: flowchart for hardware design methodology

1.8   Flow Chart of the Overall System
The figure below shows that the overall flowchart diagram of the implemented automated garbage monitoring system.
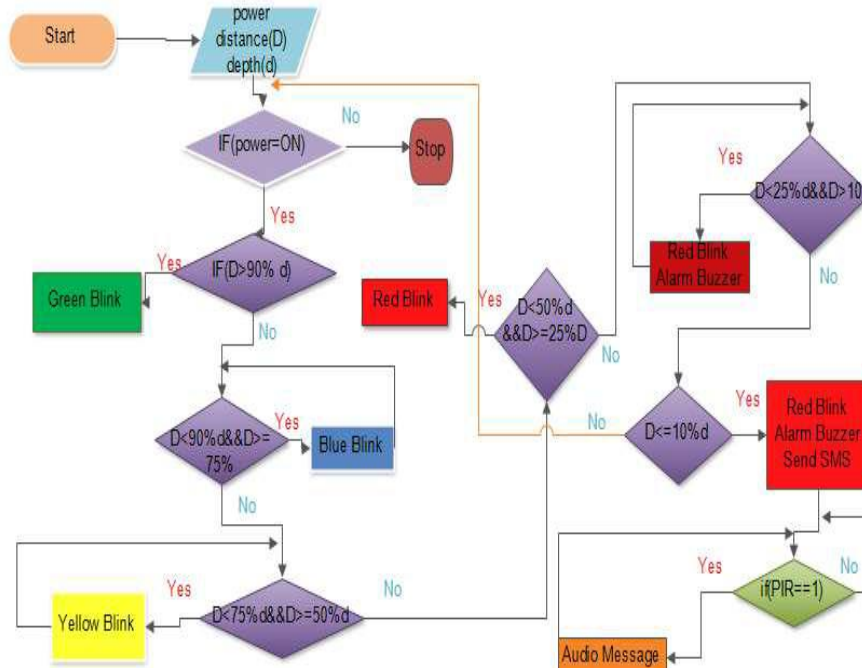
Figure 5: flow chart of the overall system

IV. System Design And Implementation

1.9 Circuit Design of the System

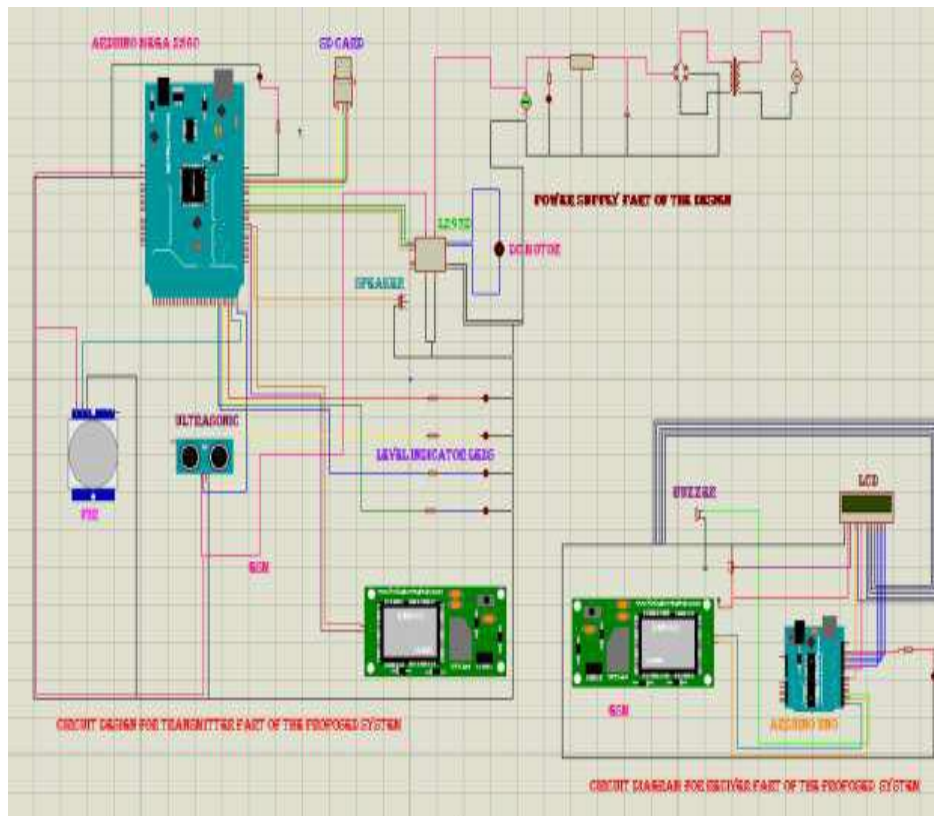Below there is a circuit diagram of the overall system which was designed by using proteus software.

Figure 6: circuit diagram of the overall system

1.10   Software Requirement Specification of the System
1.10.1   Functional Requirements
        Functional requirements are statement of services the system should provide, how the system should react to particular inputs and how the system should behave in particular situation.
This system provides:-
1.   It measure the Level of the Garbage and display it through LCD and LED
2.   It gives a notification through the speaker not to drop the garbage if bin is full
3.   It sends a message when condition is reached.
4.   It display the information of garbage location and Drivers information
5.   Able to send SMS through connection of GUI, Arduino and GSM

1.10.2   Non functional Requirement
        Non functional requirements describe user visible aspects of the system that are not directly related with the functional behavior of the system. But it can support and give more quality for new system to develop. This system works only when there is a network connection between garbage bin location and control room to inform the municipal authorities.

1.11   Entity Relationship diagram
        An entity relationship model, also called an entity relationship(ER)d diagram is a graphical representation of entities and their relationships to each other typically used in computing in regard to the organization of data within databases or in regard to the organization of data within databases or information systems. This model allows to sketch the design of a database informally.
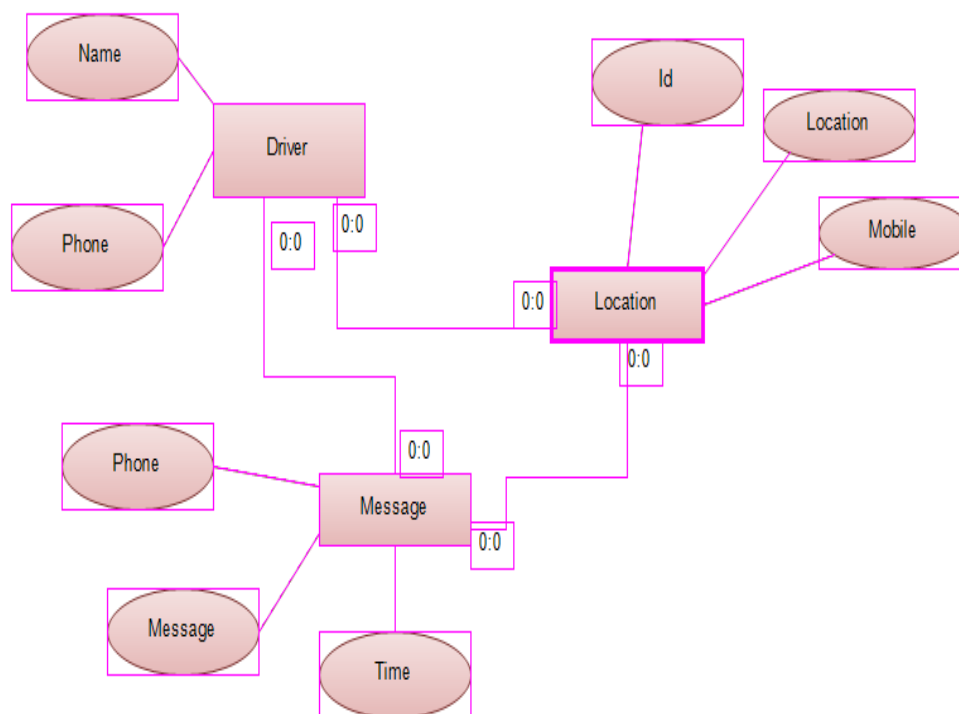

Figure 7: ER diagram of the system

1.12   Sequence Diagram
A sequence diagram is an interaction diagram that shows how objects operate with one another and in what order. It is a construct of a Message Sequence Chart. A sequence diagram shows object interactions arranged in time sequence. It depicts the objects and classes involved in the scenario and the sequence of messages exchanged between the objects needed to carry out the functionality of the scenario. Sequence diagrams are typically associated with use case realizations in the Logical view of the system under development. Sequence diagrams are sometimes called event diagram or event scenarios. Below there are sequence diagram of the system.In figure below to add the garbage location to the controller go to the home view and click on Add button and then fill the form, after that the system responded that it add the location to the database.
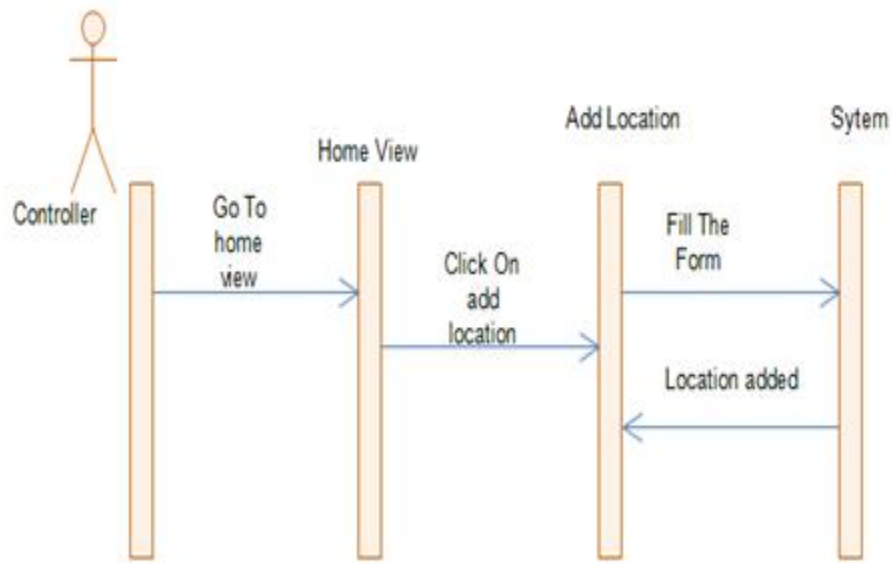
Figure 8: sequence diagram of add location

In figure below to add the Driver data to the controller go to the home view and click on Add button and then click on Add driver button and then fill the form, after that the system responded that it driver is added to the database.
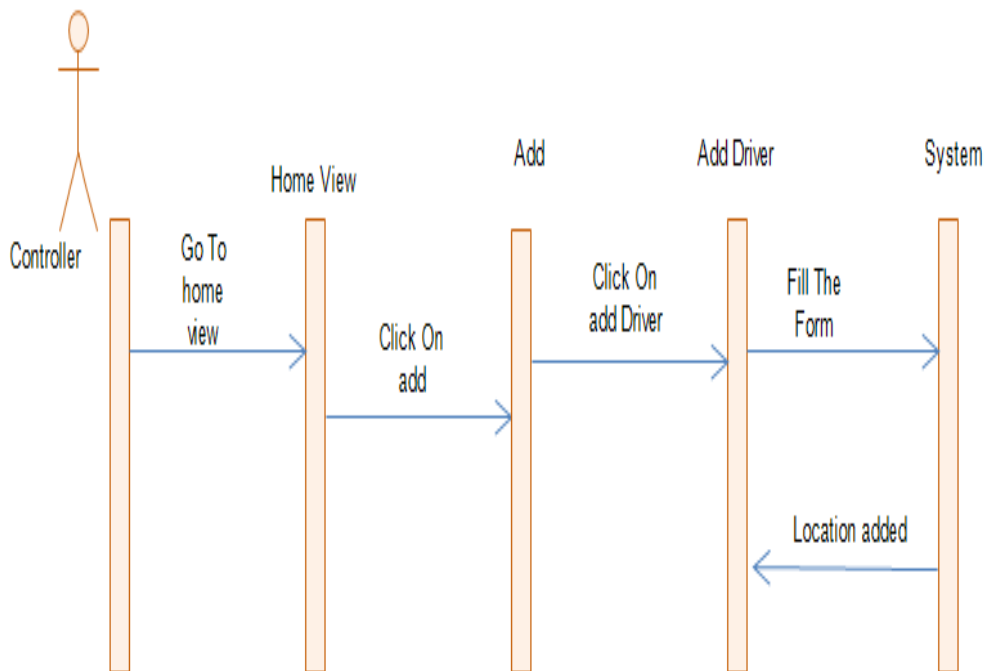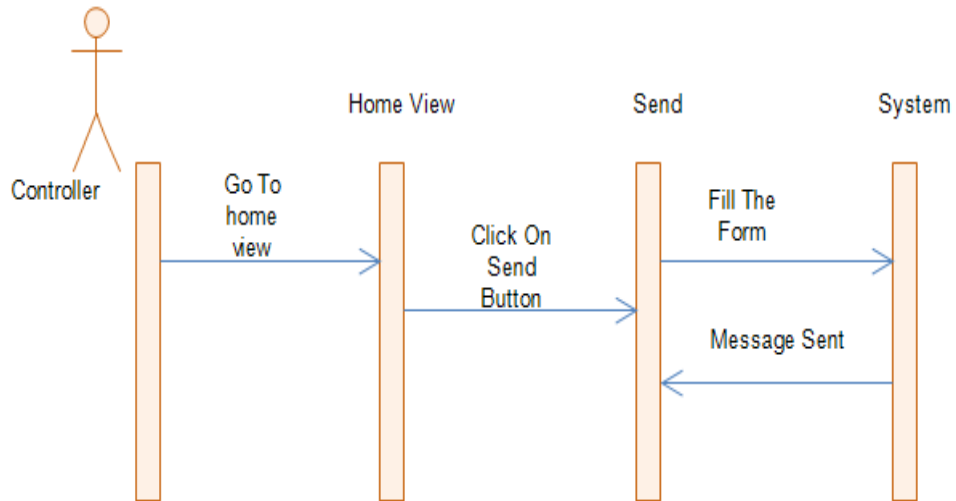

Figure 9: sequence diagram of add driver

In figure below to send the message to the controller go to the home view and click on Send button and then fill the form, after that the system responded that it message is sent.

Figure 10: sequence diagram of send message

1.13   Prototype of the Project
Below the figures show that the prototype we designed to implement our System.

Figure 11: front and back view of the prototype

Figure 12: prototype for garbage bin

1.14   System Implementation

The figure below shows that the overall hardware circuit diagram of the designed System.

Figure 13: overall hardware design for the transmitting side

The system operation is as follow, the instantaneous depth or level of the rubbish bin is senses by using HC-SR04 ultrasonic sensor. This information is then received and processed by the microcontroller which is mounted on the Arduino Mega 2560 board. Then based on the processed output, it will determine instantaneous level of the rubbish bin. On our developed system, there are four predefined threshold levels: the first level is 0 to up to 25%, the second level is up to 50%, the third level is up to 75% and the fourth level is up to 90% of the rubbish bin's depth. When the rubbish bin's level is in between the first range, the first level indicator
green LED starts to blink ; When the rubbish bin's level is in between the second range, the second level indicator blue LED starts to blink ; When the rubbish bin's level is in between thethird range, the third level indicator yellow LED starts to blink ; When the rubbish bin's level is in between the fourth range, the fourth level indicator red LED starts to blink in addition to that the buzzer starts to ringing the alarming sound ; When the level exceeds the fourth threshold level, the red LED starts to blink, the buzzer starts to ringing the alarming sound and the notification message will generate from the system and send to the receiver at the administrator's office of the city municipality every 24 hours till the rubbish bin got collected and replaced with another empty rubbish bin. The level indicator LED is used in order to notify the instant status of the garbage bin level for the users. The message notification used to inform he authorized entity that the garbage bin is full. As soon as the notification message arrived to the receiver, the administrator can send a message to the truck driver from the GUI. After the rubbish bin exceeded the maximum threshold level, if anyone tries to add any more garbage or if any pet animals (like dogs and cats) jump over the garbage bin and try to pull out the garbage from the thrush bin, by using PIR, (motion detector sensor) and the speaker gives a sound will generate to ban those phenomena.

1.15   Software Design of the System

The figure below shows that the snapshot of the home views of the graphical user interface which was found at the receiving part. It shows the data of garbage bin location to the controller.

Figure 14: home page of the graphical user interface

The figure below shows the form for sending the message to the driver when message comesfrom garbage bin is displayed on the LCD.
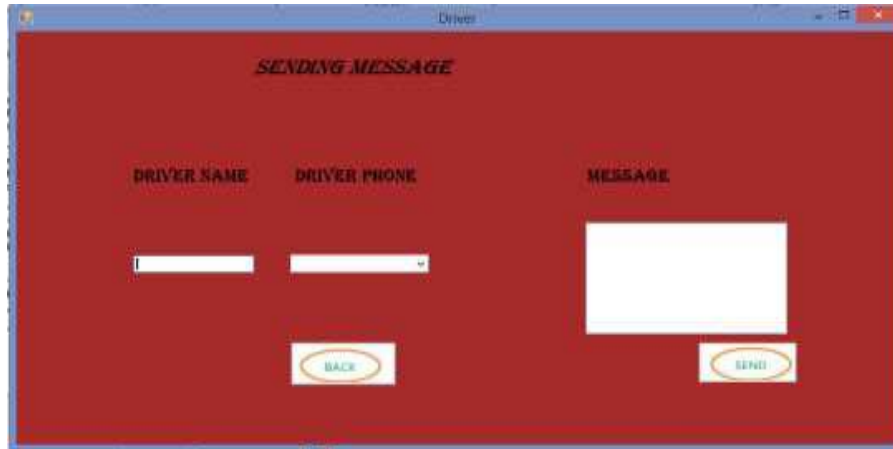

Figure 15: send message view

The figure below shows that the view for adding the information regarding to the new garbage bin location. The controller fills the form and clicks save button, then the location is added to the database.
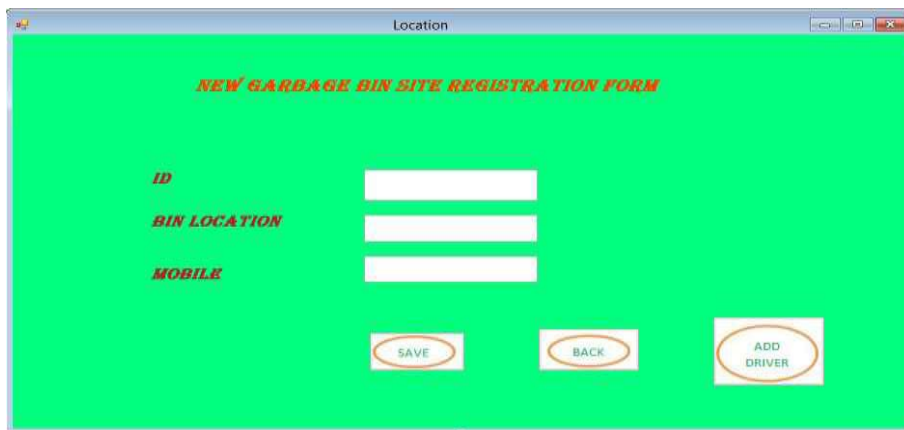

Figure 16: view of new location

V.   Results And Discussion
The figure below show that when the garbage bin is at low level means that he amount of garbage in the garbage bin is at less.

Figure 17: low level (Green LED blinking)

The figure below shows that the garbage bin level is between 25% of the depth and 50% of depth of the bin. Here the blue LED is blinking.

Figure 18: middle level (blue LED blinking)

The figure below show that the garbage bin level is a fourth level means that it is full.

Figure 19: high level (red LED blinking)

The figure below shows the messages from garbage bins displayed on LCD at the receiving part.

Figure 20: message on LCD display at receiving side

VI.   Conclusion And Recommendation

In this paper an Arduino sensor based automated garbage monitoring system is developed to monitor the garbage through the city. The system is more effective in informing the municipalities about the status of the garbage at garbage bin location when the status of the garbage becomes full. Measuring the level of the garbage and informing the society and municipalities about at which level the garbage is and informing the driver to collect the garbage is the main feature that is developed in the project which makes the system more reliable and efficient. The motion detection mechanism is done by PIR sensor to that makes use of infrared waves to find the presence of an object towards the bin while the garbage is full.The interface and software can be modified and redeveloped according to the requirement of the system for different city municipals with further research to boost its efficiency and performance.Although the development of the automated garbage monitoring system is good, there are things to be recommended to work on it in the future. First of all it is recommended to add camera to the system to capture the image of the surrounding while the people try to drop the garbage outside the bin which we will be used for penalty and to add smell sensor and moisture sensor to sense the environment and bin moisture so that it will have more efficiency and simple usability.

VII.   Acknowledgements

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