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Arduino-Based Garbage Monitoring System

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Abstract
In the present-day scenario, many times we see that the garbage bins or dust bin placed at public places in the cities are overflow due to increase in the waste every day. It creates unhygienic condition for the people and creates bad smell around the surroundings this leads in spreading some deadly diseases and human illness, to avoid such attenuation "Arduino based garbage monitoring system is designed. There is a sensor that will automatically open, ones a user approaches the bin for ease of garbage collection, when the level reaches threshold limits, the device will transmit the level. These details can be accessed by the concern authorities from their place with the help of GSM and an immediate action can be made to empty the dustbins. The Garbage monitoring system thought is an improvement of normal dustbin by elevating it to be smart using sensors. Garbage monitoring system is a new idea of implementation which makes a normal dustbin smart using ultrasonic sensors for garbage level detection, display and sending message to the concern department person updating the status of the bin using GSM modem.

Key words: Dustbin, Overflow, Unhygienic condition, Surroundings, Spreading, Attenuation, Arduino, Sensors, GSM modem.

Introduction
Nowadays there are tons of flats and apartments which have been built in the rapid urbanization area. There are several issues faced by the inhabitants of the flats. One of them is the issue of the domestic solid waste disposal, which cause pollution. Thus, an unsystematic and inefficient disposal waste management may cause the bins to be always full with garbage, and further littering from the residents will cause the garbage piles to be scattered outside the bins. Therefore, there will be a question of sanitary as those garbage piles may become the root cause of illness and diseases like dengue, diarrhea, cholera

which can lead to pollution of environment and outbreaks of vector - borne disease that spread by rodents and insects (Eason *et al,* 2012). There are cases where some irresponsible residents, who normally live at the higher levels of the building, and simply threw their domestic waste directly from the floor which they live into the bins, this may cause injuries to people downstairs. The waste disposal can be managed more properly and efficiently by constantly monitoring the bin status and the garbage level. In addition, the municipality can be alerted when the bin is full or almost full, thus promoting dynamic scheduling and routing of the garbage collection.

The manual waste collection and management approach has problems such as lack of information about the collection time and place. Because of this, it is time consuming and less effective. 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 project shows effective solution to manage the garbage. This garbage monitor is implemented using sensors and Arduino micro-controller. The implementation of garbage monitoring system using sensors, micro-controllers 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.

By comparing to the conventional scheduling and routing, this dynamic scheduling and routing are said to allow operational cost reduction, by reducing the number of trucks, the manual labour cost and the transport mileage savings. This project presents an alternative in managing domestic waste especially in flat areas via a smart garbage monitoring system. This system will automatically monitor the garbage level at each bin and will alert the municipality or garbage van driver in the case where the bins are almost full.

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! With all the power at our finger tips this is what we have come up with. The Internet of Things (IoT) shall be able to incorporate transparently and seamlessly a large number of different systems, while providing data for millions of people to use and capitalize. Building a general architecture for the IoT Kumar *et al*. (2014) is hence a very complex task, mainly because of the extremely large variety of devices, link layer technologies, and services that may be involved in such a system. 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 waste are 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. This is our solution, a method in which waste management is automated. This GSM based Garbage Monitoring system, an innovative way that will help to keep the cities clean and healthy.

Aim

The main aim of this project is to design a GSM based Garbage Monitoring System with Arduino and GSM module.

Objectives

i. To ensure the SMS notification send to authority will be delivered when the garbage can is full
ii. To make sure the can automatically open when it senses someone close to drop their trash

Scope of the Study

The research centers on the Design and Construction of GSM based Garbage Monitoring System with Arduino for the computer science department. The device will monitor garbage in the dustbin and send SMS notification when it's filled up. It will also automatically open when someone is close by to enable them drop the garbage and close when garbage has been dropped.

Limitation of Study

The major limitations of this study is the constraint of GSM technology in Nigeria i.e a message sent to a driver may take several hour or day to reach the destination due to poor GSM service

System analysis and design

In this chapter, the design of the circuit and the implementation of the hardware component were discussed. The complete circuit is made up of three parts which are:

i. The Control Panel
ii. The Sensors
iii. The Output.

The control is consisting of the Arduino, the sensors consist of the two ultrasonic sensors, while the output consist of the servo motor, LCD and the GSM module. This chapter will also explain how the hardware interferes with the Arduino using C programming language.

Methodology

The system operation is as follow, the instantaneous depth or level of the dust bin is senses by using HC-SR04 ultrasonic sensor and another ultrasonic sensor is placed in front of the dustbin this is to sense when someone is approaching the dustbin which sends signal to the servo motor to open the lid of the dustbin. This information is then received and processed by the micro-controller which is mounted on the Arduino Nano 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 the third 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

startsthe alarming sound ; when the level exceeds the fourth threshold level, the red LED starts to blink, the SMS module sends a notification message 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 the authorized entity that the garbage bin is full. After the rubbish bin exceeded the maximum threshold level, if anyone tries to add any more garbage or is approaching the dustbin, the lid will not automatically open.

Functional Block Diagram

The functional block diagram is given in figure 2.1 and it shows the overall hardware that made up the circuit and how they are connected to the power supply.

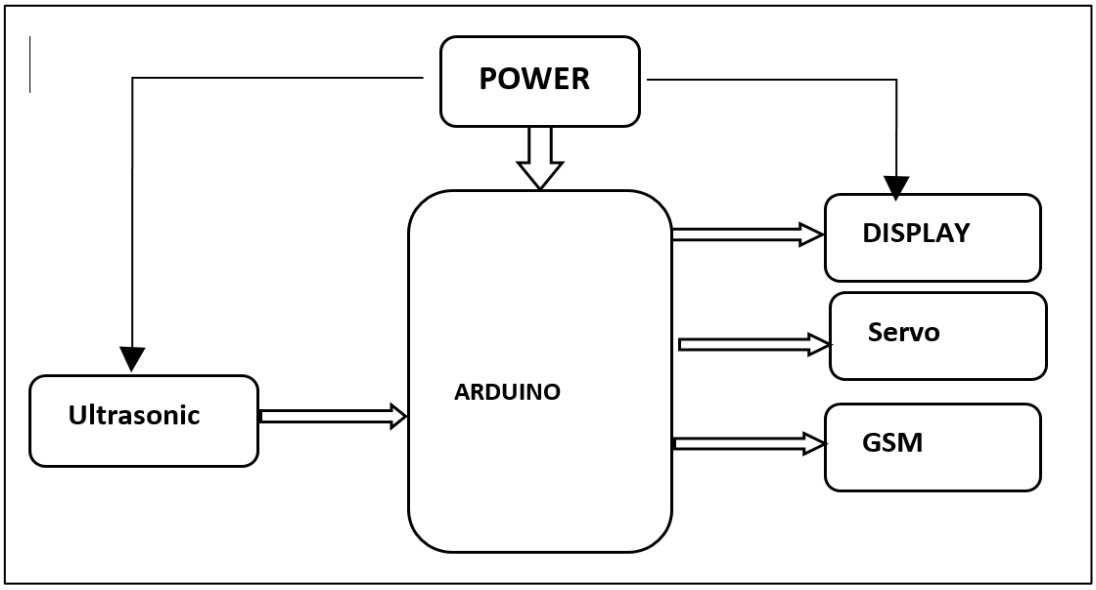


Figure 1: Block Diagram, depicting the various hardware

The power supply unit is based on the requirement of the various hardware used in the circuit. Everything in the circuit was connected to a single 5v Dc power supply.

Working Principle

The ultrasonic sensor, placed on top of the bin and triggered by the Arduino Mega 2560, measures the level of garbage in the bin. When the level of garbage in the bin reaches the threshold value, the sensor sends the signal to the Arduino Mega which in turn activates the GSM Module and the GPS Modem. The GPS Modem captures the location of the bin which sent to the GSM Module. Then the GSM Module combines the message with the captured location (coordinates) of the bin. This combination is now sent to the Truck Driver (garbage collector) as a notification. Besides, another notification is sent to the Central Office to inform them that the collector has been notified. Figure 1 shows the block diagram of the entire system.

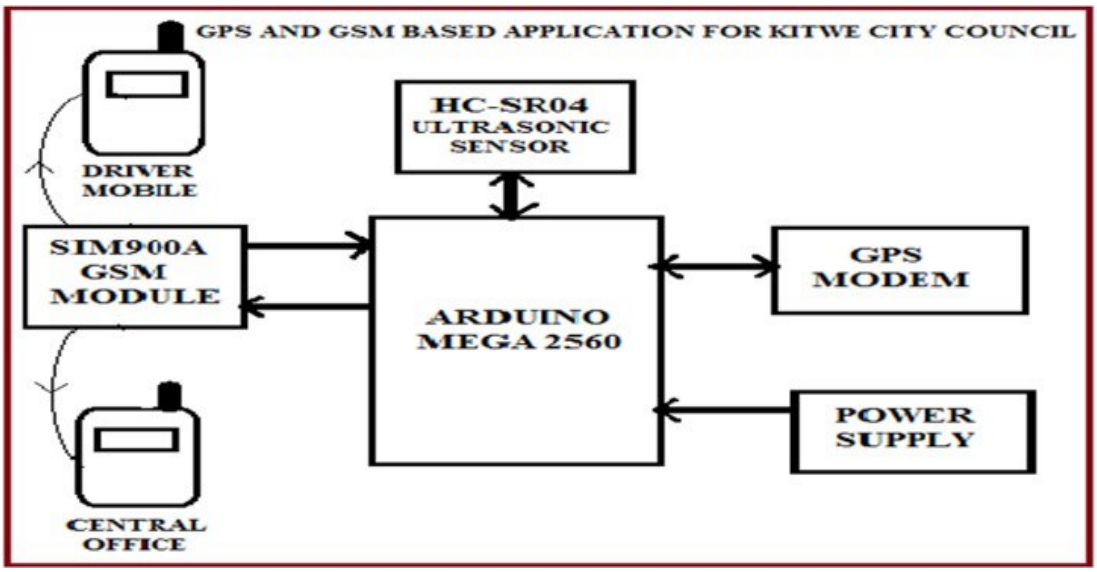


Figure 2: *Block diagram depicting the entire system*

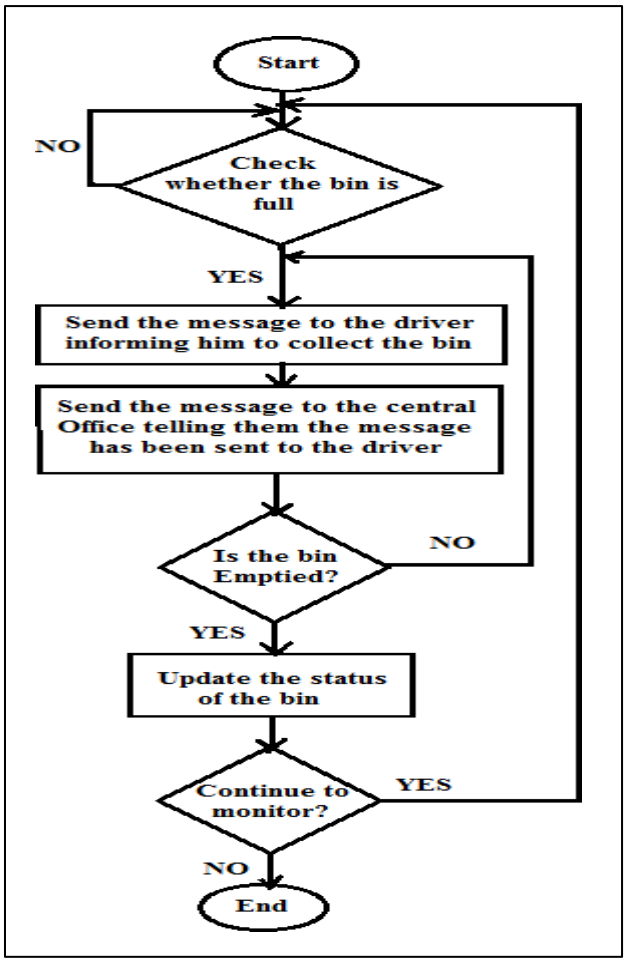


Figure 3: *Signal flow graph of the GSM Based system.*

Project Model

The model of the project is shown in figure .4

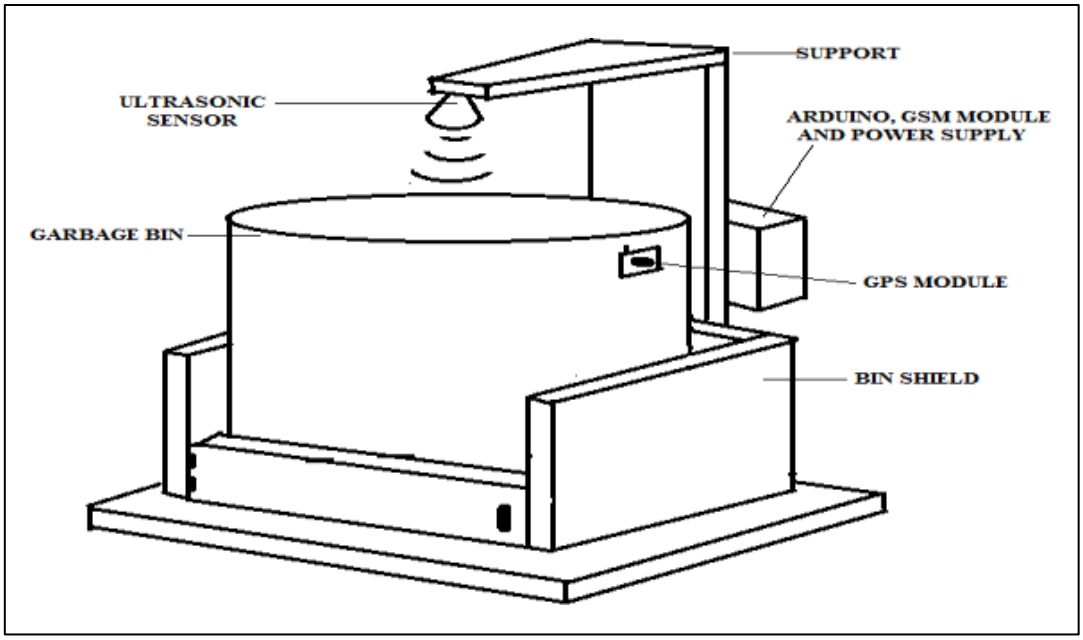


Figure 4: *GSM and GPS Based Garbage Management System Model.*

It is seen from the model that the GPS Module is attached to the bin. When the bin is ready to be collected, the bin shield is opened and the bin is taken out for disposal of garbage. In case more bins have been collected, when returning them, the collector can place them in any order. That is, the bins can be swapped but the system is able to give the precise location because each bin has its own GPS receiver. The bin shield holds the bin in place.

Schematic Diagram

The principle operation of the entire project is fully explained using the schematic diagram in figure 5.

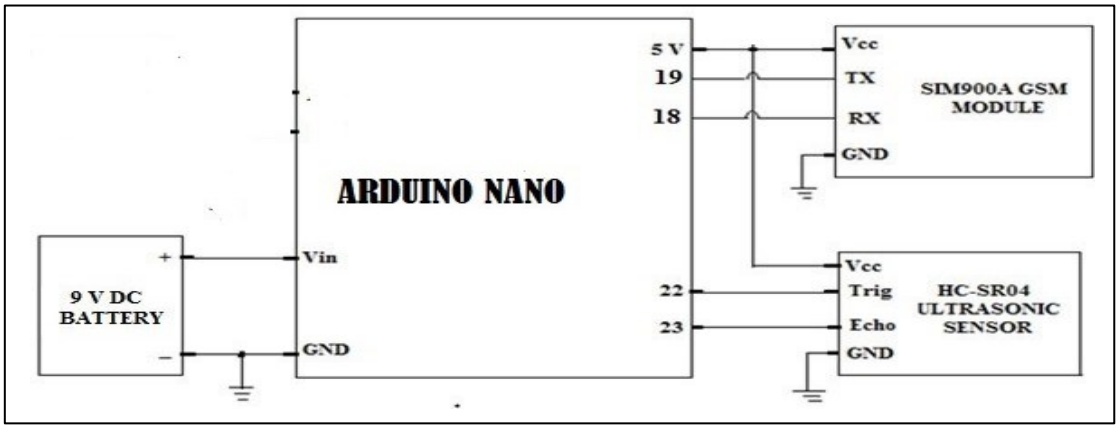


Figure 5: *Schematic Diagram of the System*

Schematic Diagram of the GSM Based Garbage

The diagram can be explained as follows: The 9V DC source powers the Arduino Nano via the **Vin** pin. Then the Arduino Mega powers the Ultrasonic Sensor, SIM808 GSM Module using the **5V** pin. Once the circuit is turned on, the Arduino triggers the sensor through pin **22** so that the sensor transmits pulses to an object, in this case the garbage in the bin. Pulses get reflected and received by the sensor as echoes. The sensor calculates the time taken from when the signal is transmitted to when it is received. It then calculates the distance *D* in *cm* using equation (2)as

$$D = \frac{S * t}{2} * \frac{1}{100} \frac{340 * t}{2} * \frac{1}{10}\ cm$$

Where *S* is the speed of sound in air in meters per second, t is time in seconds taken for the signal to travel from the transmitter to the receiver of the sensor. The division by 100 converts the measured distance from metres into centimetres. This distance is fed to the Arduino through the digital pin**23**.

When the measured distance *D* reaches the threshold value, the Arduino activates the GSM Module into the texting mode, at the same time the GPS Modem is also activated through pin

System implementation and documentation

The proposed system integrates the following components: Arduino Mega 2560, HC-SR04 Ultrasonic Sensor, GPS Modem, SIM808A GSM Module and the 9 V DC supply.

Implementation of the Project

This project was achieved through the interface of hardware with the Arduino. However, this interface cannot be achieved without communicating with the Arduino using C programming language.

Simulation Results

The system was simulated using Proteus Design Suite 8.0 as shown in figure 6

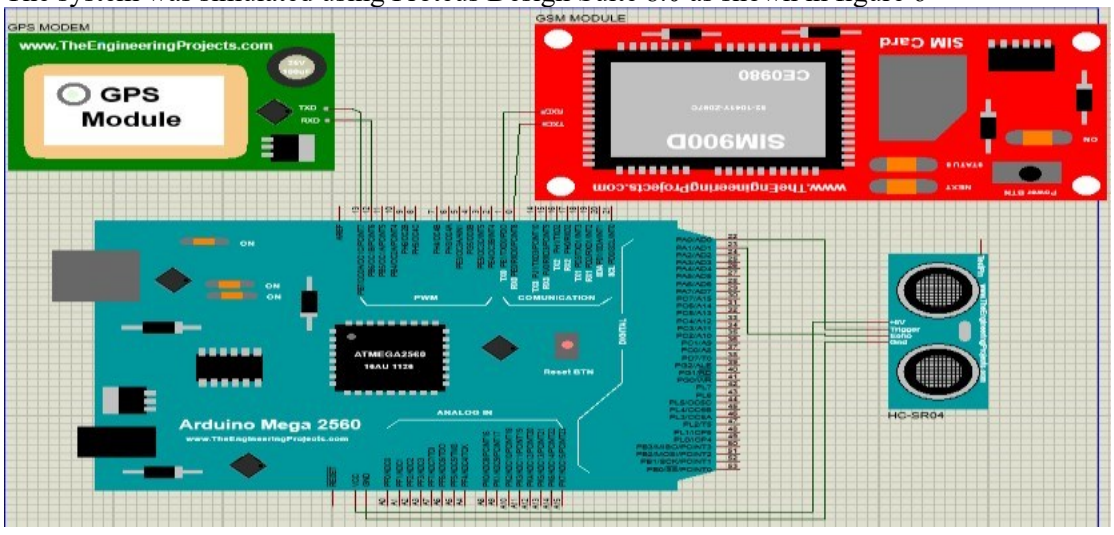


Figure 6 : *Interfacing the Arduino Mega 2560 with GPS and GSM* Module, and HC-SR04 in Proteus 8 Professional.

It is quite hard to simulate the GPS and GSM Modules, and the Ultrasonic sensor at once. Thus, in order to see the results, push buttons together with the Liquid Crystal Display (LCD) are used to simulate an instant when the threshold level is reached. Pressing the push button indicates that the bin is full and is ready to be picked. Figures 6 and 7 show the simulation results of two bins at different locations using push buttons and LCD in Proteus.

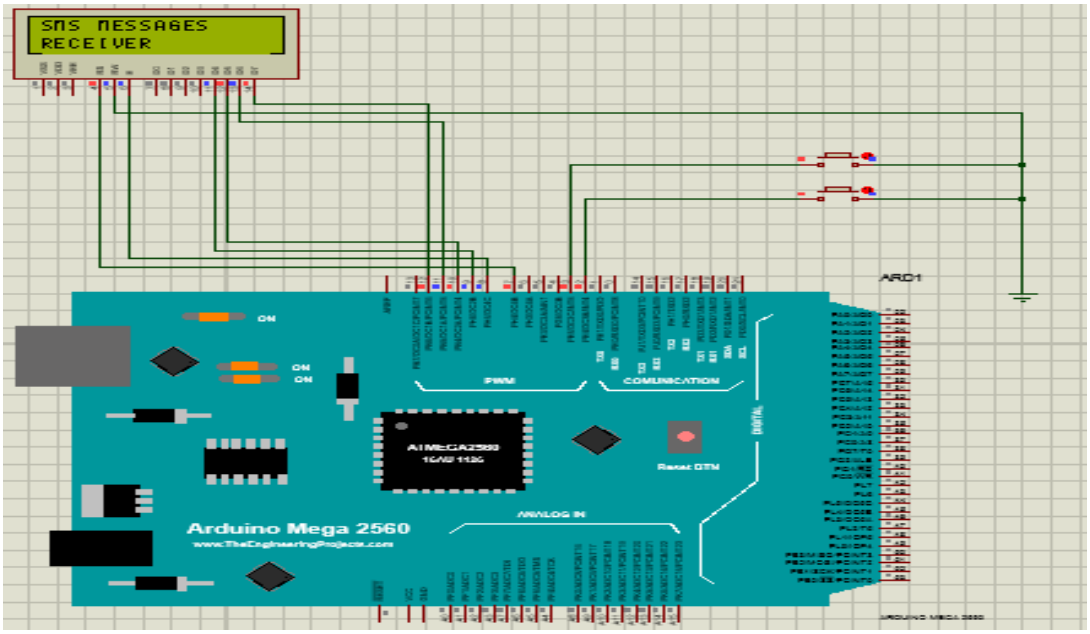


Figure 7 : *Simulation Results of Empty Bins. Source: Author.*

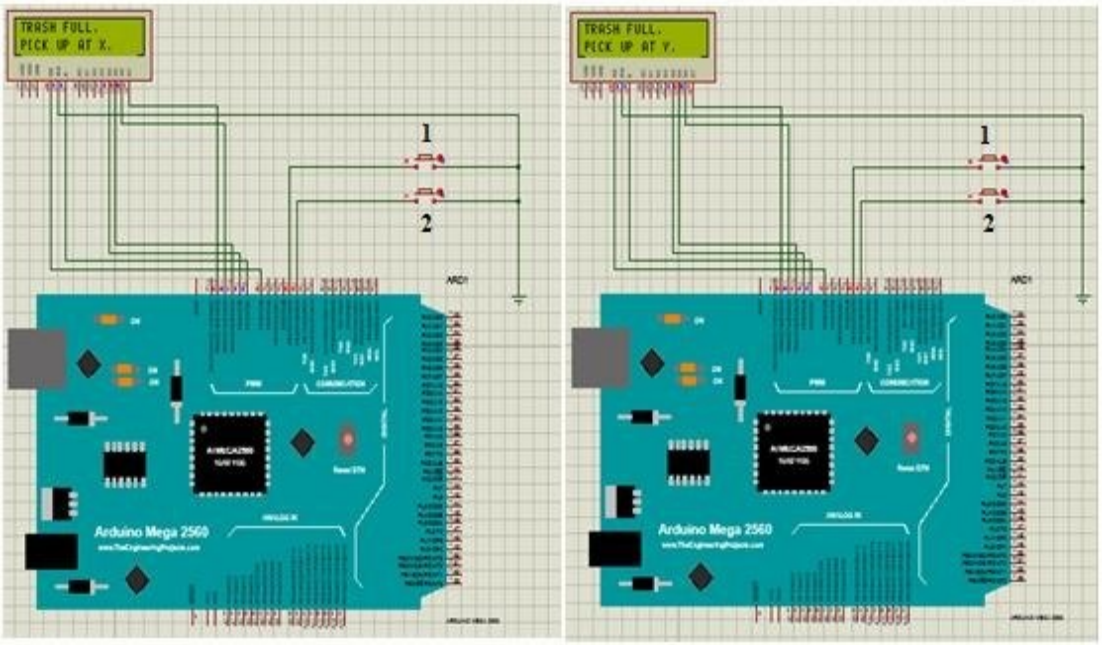


Figure 8: *Simulation Results of Full Bins at Different Locations X and Y.*

Before the bin is full (no button is pressed), the results in figure 17 were shown. The receiver does not receive a notification. But in figure 18, the receiver gets a notification "TRASH FULL PICK UP AT X OR Y" when

- The bin at location X is full; simulated by pressing push button 1 (lowerbutton)
- The bin at location Y is full; simulated by pressing push button 2 (upperbutton).

System Testing

Before assembling all the components into one system, individual components were tested. The program code was uploaded to the assembled system. Then the assembled system was tested as shown in figure 9.

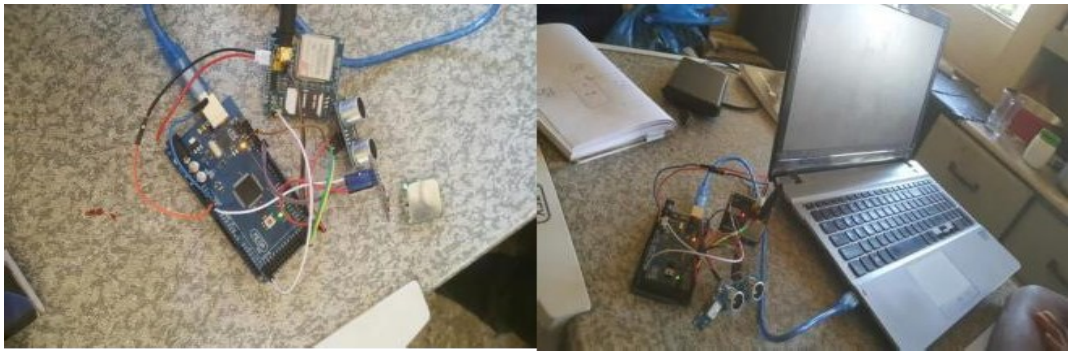


Figure 9: *Assembled System Powered by the Computer.*

System Prototype

After a thorough testing, a physical model was built to represent a manufactured design. The bin shield supports the garbage bin, the main circuit board and the Ultrasonic sensor supporter. Figure 10 shows the system prototype.

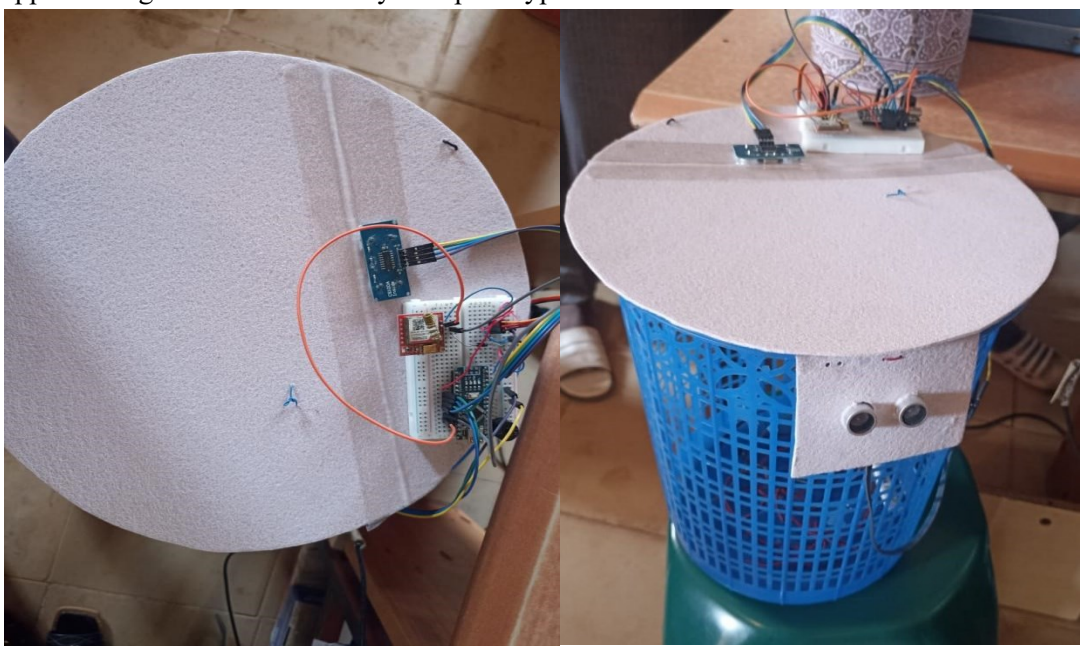


Figure 10 : *System Prototype, showing* the main circuit board and the Ultrasonic sensor

Implementation

To implement the design, the system was powered; the program code was uploaded to Arduino Nano and the Bin was filled with waste up to the threshold level. The results of the implementation were seen as shown in figure 10.



Figure 11: *Messages Received by the Driver's Phone when the bin is full.*

Observations and System Results

The system is able to monitor the level of the empty bin. The system gives the location of the bin as seen from the coordinates in figure 3.6. The message is not sent when the bin is still empty.

As garbage is thrown into the bin, the monitor is able to display the different levels of garbage. When the threshold level is reached, after Ten (10) predetermined counts, the message is sent as seen from figure 9. If the bin is not emptied after ninety (90) predetermined counts the same message is resent.

At the time of activation of the system, the GPS Modem takes a longer time to be activated as compared to other system components. After activation, the GPS is able to capture the location while at some instances it is unable to capture the location, hence the difference in coordinates as seen from figure.

Conclusion

In this project an Arduino sensor based automated garbage monitoring system is developed to monitor the garbage in the department and can be extended to work for the whole school and city respectively. 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 interface and software can be modified and redeveloped according to the requirement of the system for different use case with further research to boost its efficiency and performance. The data collected from routine collections can be further used to plan garbage collection trips more efficiently, ultimately reducing overflowing bins and helping have better public sanitation.

Recommendation

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 will be used for penalty and to add smell sensor and moisture sensor to sense the environment.

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