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Smart Waste Management System Using Internet of Things (IoT)

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ABSTRACT

Solid waste management, which apart from upsetting the ecological balance also has negative consequences on societal health, has been one of the key environmental issues. The main challenge in waste management is waste identification, monitoring, and management. Unsanitary conditions, a foul smell, dangerous illnesses, and a haven for mosquitoes and flies that harm the environment are all disseminated by the overflowing waste. An Internet of Things-based waste management system was developed to prevent all such instances. The system uses an ultrasonic sensor, Arduino Uno, buzzer, GSM, and Wi-Fi module as an automatic garbage fill alert system. This method makes sure that trash cans are cleaned as soon as they fill to capacity, which eliminates the issue of rubbish piling up in public areas.

Key words: Solid Waste, Waste Management, Unsanitary conditions, GSM, Internet of Things.

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1. INTRODUCTION

The Internet of Things (IoT) is a network of physical objects, devices, vehicles, buildings, and other items that are embedded with electronics, software, sensors, and network connectivity, allowing them to connect and exchange data. A more direct integration between the physical world and computer-based systems is made possible by the Internet of Things, which also increases efficiency, accuracy, and economic gain. Through its embedded computing system, each thing can be uniquely identified, but they can still communicate with one another within the current Internet infrastructure.

Everybody needs a trash can, which is a universal requirement. However, trash leaking into streets from trash cans is a problem that has to be addressed right away. We were motivated to develop the idea after reading the saying "Cleanliness is next to godliness and the clean city is near to paradise." Smart trash cans aid in the reduction of pollution.

In 2018, the informal sector handled garbage disposal, which accounted for just 59% of the waste produced (Statista Research Departmen, 2018). This demonstrates the necessity for proper waste management, which might lessen the negative consequences on the set. In order to prevent some dangerous illnesses, proper care is necessary. Citizens of Nigeria collect rubbish at predetermined locations. The garbage disposal company sends out a vehicle on a regular schedule, like once a month, to collect all of these rubbish. Most of the time, the trash would already be overflowing before the garbage collectors showed there. This project develops a smart waste system that employs an ultrasonic sensor, an Arduino Uno, a buzzer, a GSM module, and a Wi-Fi module to track the amount of garbage in a bin and notify the waste disposal authorities on a regular basis.

2. REVIEW OF LITERATURES

This chapter reviews existing literatures on the topic with the intention of identifying the gaps in the Literature. There are previous researches on roughness in smart dustbin system that has used different circuit and application. The approach adopted in this review is to firstly review related concept for the purpose of clarity and thereafter review related literatures to show connection and trend between existing works.

Dustbin application

In life, trash cans are crucial. Garbage can be placed inside of them. The earth would be littered if it didn't exist. It became a necessary piece of equipment in businesses or large supermarkets since those establishments have trash disposal systems that are crucial to the security of their garbage waste management systems. The dustbin's function as a conduit for altering waste patterns has rarely been thought about, despite being an integral part of our daily routines. The argument is made that bins serve as a telling indicator of changing trash interactions in society when they are reconfigured as environmental devices for modern recycling programs.

Waste Issues

Waste is defined as stuff that is wasted and has no value for regular usage. The unpleasant, pointless, and unwanted materials and substances that result from human and animal activity are referred to as solid wastes. Sometimes what someone throws out can be utilized again by someone else. Depending on the type of material or the local vernacular, waste can also be referred to as rubbish, trash, junk, or garbage. It might be made up of waste products left over from industrial, commercial, mining, or agricultural operations, as well as from daily family and communal activities.

There are several methods to produce waste. Its volume and content are heavily influenced by consumption trends as well as the prevailing industrial and economic systems. Our quality of life is impacted by smells, water and soil pollution, space use, and air quality (www.grida.no, 2013) Wastes are substances that are not primary products (i.e., goods made for the market), which the producer no longer needs for their own purposes of production, transformation, or consumption and which they wish to dispose of. Wastes can be produced during many human activities, including the extraction of raw materials, the processing of those resources into intermediate and final goods, consumption of those products, and other activities.

Everything that has to be disposed of once it has served its intended purpose is considered "waste." The appropriate phrase clearly refers to materials that have been abandoned, but there are certain definitions for trash that influence how garbage is governed and must be managed (www.avma.org, 2013). Diseases and pollution, as well as natural variability and human-induced climate change, are all major threats. Climate change is changing the migration patterns of various species, leading to coral bleaching, etc. Ecosystems keep the balance of the environment on the planet. Everything that changes how ecosystems work leads to an imbalance that affects all life on Earth.

The generation of solid wastes has increased and changed in nature as a result of the rapid population growth and growing industrialization. To save the public's health and to protect the environment, proper solid waste management is crucial in this situation. Better remedies for environmental pollution require a variety of innovative technologies and management strategies. Additionally, we should support Methodology community and private initiatives to recycle waste (http://www.huntingtonstudygroup.org/Portals/BecomingASiteGreenGlobe.jpg).

Classification of Waste

In most rural areas, waste is a severe threat to the public health concern and cleanliness. The absence of disposal of solid and liquid waste are leading through vector borne diseases such as diarrhea, malaria, polio, dengue, cholera, typhoid, and other water born infection such as schistosomiasis. Eighty-eight percentage of the total disease load is due to lack of clean water and sanitation and the improper solid and liquid waste management which intensify their occurrence (Review of solid waste accumulation and management, 2020).

Solid Waste:

Waste poses a serious danger to public health concerns and hygiene in the majority of rural communities. Lack of waste disposal is causing vector-borne illnesses such diarrhea, malaria, polio, dengue, cholera, typhoid, and other water-borne infections like schistosomiasis. Eighty-eight percent of all diseases are brought on by poor solid and liquid waste management, a lack of clean water and sanitation, and other factors that exacerbate their prevalence (Review of solid waste accumulation and management, 2020). Solid waste is any trash or refuse, sludge from a wastewater treatment facility, a water supply treatment facility, or an air pollution control facility, as well as other materials that have been discarded. This includes solid, liquid, semi-solid, or contained gaseous waste that results from commercial, industrial, mining, agricultural, and community activities.

Liquid Waste:

Wastewater is unusable and undesirable water. Black water: Wastewater produced in the bathroom is referred to as "Black water." It has germs that are hazardous. Grey water: Wastewater produced in the laundry, bathrooms, and kitchen is referred to as "Grey water." It could also have germs in it. creation of consciousness. For sustainability and financial efficiency, home waste management should take priority. The community should manage certain aspects that cannot be controlled at the home level. The Waste Framework Directive (WFD) defines "bio-trash" as "biodegradable garden and park waste, food and kitchen waste from homes, restaurants, caterers, and retail establishments, as well as equivalent waste from food processing companies."

2.1 Related Works

In order to assess the level of the trash being filled up, the author (Meghana KC, IOT Based Intelligent Bin for Smart Cities, 2018) fitted the smart bins with ultrasonic sensors. Garbage is gathered in the container on three different levels. The sensors get data on the fill level each time the waste crosses a level. The GSM module is then used to send this data as an immediate message to the trash analyzer. The installation of three ultrasonic sensors at three distinct levels of the container may not be advantageous since the sensors raise the price of the trash can and put the sensors at risk of damage from users' harsh handling.

An ultrasonic sensor, an Arduino Uno, a buzzer, and a Wi-Fi module were all used by Kujore (2018). When the rubbish level reaches its peak, this method ensures that dustbins will be cleaned as quickly as possible. With the aid of a piezoelectric device, it will require a power source. The data is transmitted to the Sweeper or higher authority, who can take necessary action against the involved contractor, if the trashcan is not cleaned at the designated time. This approach also aids in keeping an eye on false reports, which can assist to lessen corruption throughout the entire management system. This lowers the overall cost involved with waste collection by reducing the number of trips made by garbage collection vehicles. In the end, it contributes to maintaining cleanliness in society.

The ultrasonic sensor's propagation, which travels through the air at the speed of sound, was used by Patil et al. (2018). If they collide with something, the sensor must get an echo signal from the item. Based on the time difference between emitting the signal and receiving the echo, it then estimates the distance to the target on its own. The inside, or side of the lid facing the solid waste, will be where the ultrasonic sensor is located. The distance between the ultrasonic and the rubbish reduces as there are more items in the bin. This real-time data will be transmitted to our microcontroller, the Arduino Uno. After processing the data, the Arduino Uno delivers it to an app using the Wi-Fi module. Through the website, the officer controls the data and the specifics. Poornachandra and others (2018IoT-based Intelligent Bin for Smart Cities using Raspberry Pi, International Journal for Research in Applied Science & Engineering Technology). noted that Arduino Uno is the platform used by the majority of contemporary creations.

The majority of the works have the same operating premise, which is that their IoT-based system tracks the amount of trash in the trash can using ultrasonic sensors that are already there. The detected data is sent to the PIC controller through RF signals, and the PIC controller then sends the data to the main server. On the webpage shown on the receiver's LCD, which is connected to the server, you may review the data that was captured. When the amount of waste in the trash can exceeds the limit, a buzzer alarm is employed for waste collection. This alerts the appropriate authorities, who then inform the dump truck driver and take additional action. Since less equipment and resources are needed, the complete system is more affordable.

A framework has been developed by Pushan (2019International Journal of Research Studies in Electrical and Electronics Engineering, volume 5 issue 1) in which a camera and a load cell sensor will be installed at each location for garbage pickup. The trash can will be continuously captured by the camera. The output of the camera and the load sensor are compared at a threshold level. A microcontroller is used to aid with the comparison.

The amount of trash in the can may be estimated after picture analysis, and the weight of the trash can be determined using the load cell sensor. As a result, data is processed and the controller checks to see if the threshold level has been surpassed or not. Although easy to use, this is not dependable financially. Although the concept of IoT-based Smart bins is not totally new, no specific and effective solution has yet been established. Therefore, there is still need for improvement in this field of study. More research should be conducted utilizing cutting-edge technology to make use of the smart waste management system and create a smart city.

The author, Alexey Medvedev, conducted a quantitative investigation of the relationship between the population served by the current dustbins. Utilizing GIS's average closest neighbor algorithms, the study first examines the spatial distribution of trash cans in a few regions of Dhaka. Surprisingly, the geographical distribution of the existing dustbins seems to be predominately grouped. The ideal number of extra trash cans was then determined. It is demonstrated that there are not enough trash cans in the research region. The spatial analyst features of GIS were employed to determine the degree of pollution brought on by the current dustbins. It has been discovered that every trashcan contains rubbish that is burned, polluting the environment. The outcomes would aid in comprehending the current state of waste management for the research article (Volume 6 Issue No. 6 International Journal of Engineering Science and Computing, June 2016) and in determining the best location for the necessary number of dustbins to stop further environmental pollution.

IOT-based intelligent bins for smart cities have been fitted by the author (Meghana K. C., 2016) with ultrasonic sensors that gauge the amount of trashcan filling. Garbage is gathered in the container on three different levels. The sensors get data on the level's fullness every time waste crosses it. This information is subsequently delivered through GSM module as an immediate communication to the trash analyzer. The placement of three ultrasonic sensors at three separate levels of the container may not be advantageous since the sensors raise the price of the trash can and can be damaged by users' harsh handling.

(Kasliwal Manasi H, 2016) in an SGS, wireless mesh networks developed a smart trash bins powered by battery to share information, and a router and server gather and process the data for service providing. Additionally, the SGS incorporates different IoT capabilities that take into account user comfort and lengthens the battery life through two types of energy-efficient SGB operations: stand-alone operation and cooperation-based operation. For a year, Seoul's Gangnam neighborhood served as the site of the projected SGS's trial project. The experiment shows a 33% reduction in the typical amount of food waste.

A framework has been created by the author (Kurrel, 2016) in which a camera and a load cell sensor will be placed at each location for rubbish collection. The trash can will be continuously captured by the camera. Setting a threshold level allows for comparison of the load sensor and camera output. Microcontroller is used to aid with the comparison. The amount of trash in the can may be estimated from the picture after image analysis, and the weight of the trash can be determined from the load cell sensor. As a result, information is processed so that the controller may determine whether or not the threshold level has been surpassed. Although easy to use, this is not dependable financially.

Table 1: Summary of Related Works

Author	Approach	Limitations	Achievement
Meghana KC	Use of ultrasonic sensor at different levels of the waste Bin	High cost of sensors. Also, sensor could be damaged due to rough handling	Ultrasonic sensor is placed only at the top to reduce cost and avoid damage.
Patil et.al (2018)	Use of ultrasound sensor to detect level of garbage	Depends on echo signals from struck object to calculate the level of garbage which may be altered in case of externally force	Use both ultrasonic and IR sensors to detect garbage level.
Purshan (2019)	Use of camera at the collection point and a load sensor at the base of the waste bin	Not reliable economically	PIR sensor is placed at the top to monitor garbage level.
Kujore (2018)	Use of Wi-Fi module	Depends on only Wi- Fi module to send messages which could be difficult due to distance and network problems	Works with GSM module and Wi-Fi in case of network breakdown.
Meghana KC	Use of GSM module	Depends on only GSM module to send messages	Use GSM module to send messages and map to direction and location of waste bin.

3. METHODOLOGY

The GSM method of message transmission was also employed in the planning and execution of this project, together with an ultrasonic distance measurement system interfaced with a central controller and a motion sensor to prevent erroneous or uncontrolled notification of the waste management authority. The system must gather the trash, and the bin must be emptied in accordance with the established timetable and networked path. An extremely creative method that will aid in maintaining clean towns is the IoT Garbage Monitoring system. Additionally, this system keeps an eye on the trash cans and notifies the authorized user through a web page of the amount of trash that has been put in them.

This method measures the rubbish level and compares it to the depth of the bins using ultrasonic sensors positioned over the bins. The sensors are installed at various areas to repair the smart trash cans. All of them are emptied by collectors, who then put the contents into a garbage truck and take it to a disposal site like a landfill, an incinerator, or a crushing plant for consumption. Reasoning about the structures and behaviors of the system is supported by the formal description and representation of the managed system. Numerous sensors, including weight sensors, IR sensors, and others, can be employed to find the rubbish. The sensor that measures weight is the one that provides data on rubbish weight. But since it can't tell how much rubbish is in the bin, utilizing this is inefficient. In order to measure the level of rubbish, a multifunctional passive infrared sensor (PIR sensor) is employed. PIR sensors emit light that is invisible to the human eye but is detectable by electrical components. Both an IR transmitter and an IR receiver make up the device. The IR sensor generates output in both analog and digital formats. When it detects an item, this sensor outputs logic„1 at the digital output, and logic„0 when it detects no thing.

The sensor generates an analog output voltage that ranges from 0 to 5V, depending on the distance between the item and the sensor. The PIR sensor board includes an LED. It is employed to signal whether an object is present or not. PIR sensors are very perceptive to ambient light. Therefore, these sensors are adequately covered to lessen the impact of light on the sensor.

The Transmitter Section

The block diagram of the transmitter section is shown in Figure 1. The level of the rubbish in the trash can is determined using IR sensors, which are part of the level detector. Microcontroller receives the level detector's output. To show the various levels of waste collected in the dustbin that is situated in a public location, four IR sensors are employed. The fourth IR receiver's output turns low when the trash is full to its maximum capacity. As demonstrated below, the microcontroller receives this output and uses it to deliver the message to the control room through the GSM module.

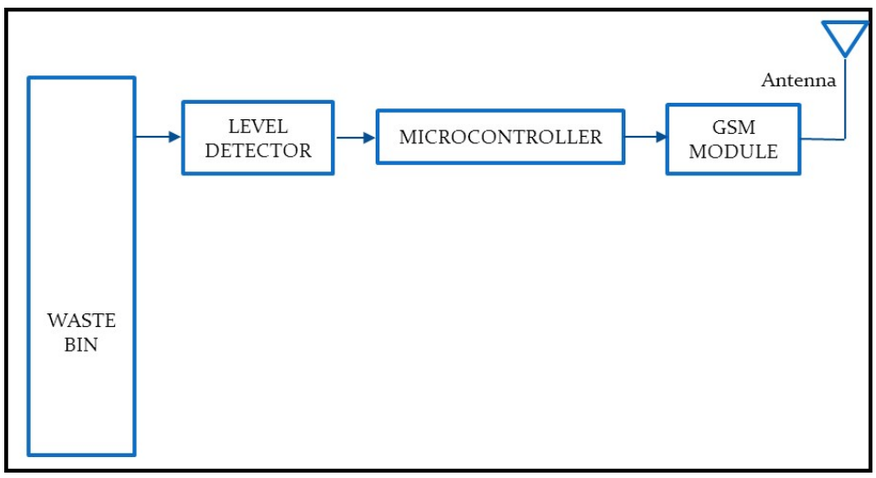

Figure 1: Block diagram of Transmitter Circuit

Components Used

i. Arduino
ii. GSM
iii. PIR Sensor
iv. Ultrasonic Sensor
v. 3.7v 2000mah battery (18650)
vi. 5v 1A charge controller
vii. Dc to DC voltage converter (MT3608)
viii. ON/OFF switch
ix. 3 by 6 patter box with plain cover
x. Medium size outdoor garbage bin

i. Arduino

The Arduino is an open-source computing device for electronic prototyping Arduino board (Hardware part): The Arduino Uno board is based on the ATmega328, high- performance Atmel 8-bit AVR RISC-based microcontroller [figure 5]. The device operates between 1.8-5.5 volts. It has 14 digital input/output pins with 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. The Arduino Uno can be powered via a USB connection or with an external power supply. The Arduino IDE (Software part): Arduino environment is a java based on open-source software and runs on various platforms such as Windows, Mac OS X, and Linux. The Arduino integrated development environment (IDE) comes with a software library called 'Wiring' rendering many common input/output operations much easier. Figure 2 shows the Pin diagram of the Arduino device

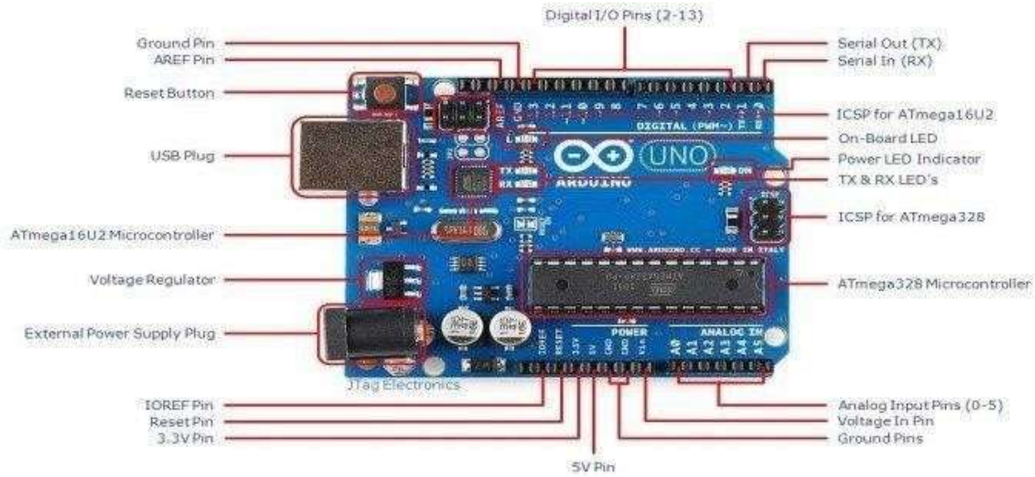

Figure 2: Pin diagram of Arduino

ii. GSM module (Sim 800l)

SIM800L is a miniature cellular module which allows for GPRS transmission, sending and receiving SMS and making and receiving voice calls. Low cost and small footprint and quad band frequency support make this module perfect solution for any project that require long range connectivity. After connecting power module boots up, searches for cellular network and login automatically. On board LED displays connection state (no network coverage - fast blinking, logged in - slow blinking). This module has two antennas included.

First is made of wire (which solders directly to NET pin on PCB) - very useful in narrow places. Second - PCB antenna - with double sided tape and attached pigtail cable with IPX connector. This one has better performance and allows the putting of module inside a metal case - as long the antenna is outside.

Specification

- Supply voltage: 3.8V - 4.2V
- Recommended supply voltage: 4V
- Power consumption:
  - sleep mode < 2.0mA
  - idle mode < 7.0mA
  - GSM transmission (avg): 350 mA
  - GSM transmission (peek): 2000mA
- Module size: 25 x 23 mm
- Interface: UART (max. 2.8V) and AT commands
- SIM card socket: microSIM (bottom side)
- Supported frequencies: Quad Band (850 / 950 / 1800 /1900 MHz)
- Antenna connector: IPX
- Status signaling: LED
- Working temperature range: -40 do + 85 ° C

Figure 3 shows the component off the GSM module (Sim 8001). The Set includes:

- SIM800L module
- goldpin headers
- wire antenna
- PCB antenna with pigtail and IPX connector

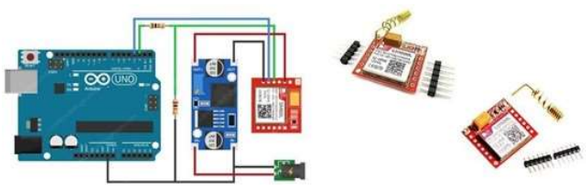

Figure 3: GSM module (Sim 800l)

- Pinout (bottom side - left):
- RING (not marked on PBC, first from top, square) - LOW state while receiving call
- DTR - sleep mode. Default in HIGH state (module in sleep mode, serial communication disabled). After setting it in LOW the module will wake up.
- MICP, MICN - microphone (P + / N -)
- SPKP, SPKN - speaker (P + / N -) Pinout (bottom side - right):
- NET - antenna
- VCC - supply voltage
- RESET - reset
- RXD - serial communication
- TXD - serial communication
- GND - ground

iii. IR SENSOR

Danny (2022) defined an infrared (IR) sensor as an electronic device that measures and detects infrared radiation in its surrounding environment. Infrared radiation was accidentally discovered by an astronomer named William Herchel in 1800. While measuring the temperature of each color of the light (separated by a prism), he noticed that the temperature just beyond the red light was the highest. IR is invisible to the human eye, as its wavelength is longer than that of visible light (though it is still on the same electromagnetic spectrum). Anything that emits heat (everything that has a temperature above around five degrees Kelvin) gives off infrared radiation.

There are two types of infrared sensors: active and passive. Active infrared sensors both emit and detect infrared radiation. Active IR sensors have two parts: a light-emitting diode (LED) and a receiver. When an object comes close to the sensor, the infrared light from the LED reflects off of the object and is detected by the receiver. Active IR sensors act as proximity sensors, and they are commonly used in obstacle detection systems (such as in robots). Passive infrared (PIR) sensors only detect infrared radiation and do not emit it from an LED.

Passive infrared sensors are comprised of:

- Two strips of pyroelectric material (a pyroelectric sensor)
- An infrared filter (that blocks out all other wavelengths of light)
- A Fresnel lens (which collects light from many angles into a single point)
- A housing unit (to protect the sensor from other environmental variables, such as humidity)

PIR sensors are most commonly used in motion-based detection, such as in-home security systems. When a moving object that generates infrared radiation enters the sensing range of the detector, the difference in IR levels between the two pyroelectric elements is measured. The sensor then sends an electronic signal to an embedded computer, which in turn triggers an alarm. PIRs are made of pyroelectric sensors, a round metal can with a rectangular crystal in the center, which can detect levels of infrared radiation. Everything emits low-level radiation, and the hotter something is, the more radiation is emitted. The sensor in a motion detector is split into two halves.

Figure 4: PIR Sensor

This is to detect motion (change) and not average IR levels. The two halves are connected so that they cancel out each other. If one-half sees more or less IR radiation than the other, the output will swing high or low. PIRs have adjustable settings and have a header installed in the 3-pin ground/out/power pads.

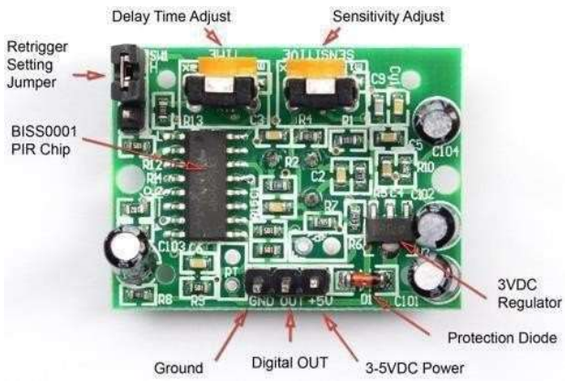

Figure 5: PIR Sensor Diagram

The output of the PIR sensor is acquired by The National Instruments myRIO-1900. It is an input-output device that is portable and reconfigurable. This can be used by the students in the design of robotics, controls, and many other designs. The NImyRIO-1900 has a ZYNQ chip. This ZYNQ chip is a combination of processor (ARM Dual-core) and FPGA(Xilinx). The NI myRIO-1900 consists of analog input, digital input, analog output, digital output, power output, nonvolatile memory, and audio input and output in an embedded device. USB acts as a connector between the NImyRIO-1900 and the host computer.

It has connectors A and B that act as an expansion port and a connector C that acts as a mini-system port, they carry the signals and these signals are distinguished by different connector names. Here the most used connector is mini-system port connector C. This device can even connect to the wireless network and create a wireless network. It has an inbuilt option to connect to Wi-Fi The HC-SR04 ultrasonic sensor uses SONAR to determine the distance of an object just like the bats do. It offers excellent non-contact range detection with high accuracy and stable readings in an easy-to-use package from 2 cm to 400 cm or 1” to 13 feet. The operation is not affected by sunlight or black material, although acoustically, soft materials like cloth can be difficult to detect. It comes complete with an ultrasonic transmitter and receiver module.

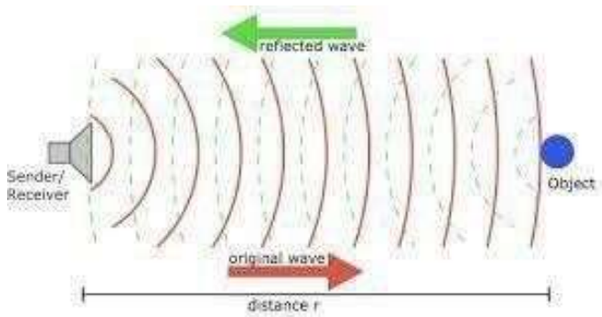

Figure 6: Ultrasonic Sensor

iv. Ultrasonic Sensor

Ultrasonic Sensor

An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves. An ultrasonic sensor uses a transducer to send and receive ultrasonic pulses that relay back information about an object's proximity. High-frequency sound waves reflect from boundaries to produce distinct echo patterns.

v. 3.7v 2000mah battery (18650)

This battery (rechargeable) lithium-ion strong> can be used in various flashlights, specially developed for this type of battery. the battery must be charged using an external charger, which has the advantage that you can use the flashlight with a second battery, while the other is in the charger. lithium-ion batteries 18650 type guarantee a long service life and they work well at low temperatures.

Figure 7: 5v 1A charge controller

vi. Dc to DC voltage converter (MT3608)

DC-DC converters are widely used to efficiently produce a regulated voltage from a source that may or may not be well controlled to a load that may or may not be constant. This paper briefly introduces DC-DC converters, notes common examples, and discusses important datasheet parameters and applications of DC-DC converters. DC-DC converters are high-frequency power conversion circuits that use high-frequency switching and inductors, transformers, and capacitors to smooth out switching noise into regulated DC voltages. Closed feedback loops maintain constant voltage output even when changing input voltages and output currents. At 90% efficiency, they are generally much more efficient and smaller than linear regulators. Their disadvantages are noise and complexity. DC-DC converters come in non-isolated and isolated varieties. Isolation is determined by whether or not the input ground is connected to the output ground.

Figure 8: ON/OFF switch

viii. ON/OFF switch

An ON/OFF switch or button (on an electrical appliance, etc) which has an 'on' position and an 'off' position.

Figure 9 by 6 patter box with a plain cover

FLOW CHART

The flowchart of the project as shown in Figure 10 provides the idea of this project. The flow of the project begins with the start. IR sensor is used which senses the garbage level when it reaches the threshold. When the threshold level has reached the information of how much level the bin is filled, location of the bin, date, and the current time when the dustbin gets filled are all obtained. Then the level of garbage is examined, if it is filled 100% a message is sent to the respective person to clean the bin as soon as possible via GSM. If it is not filled the process repeats as shown in figure

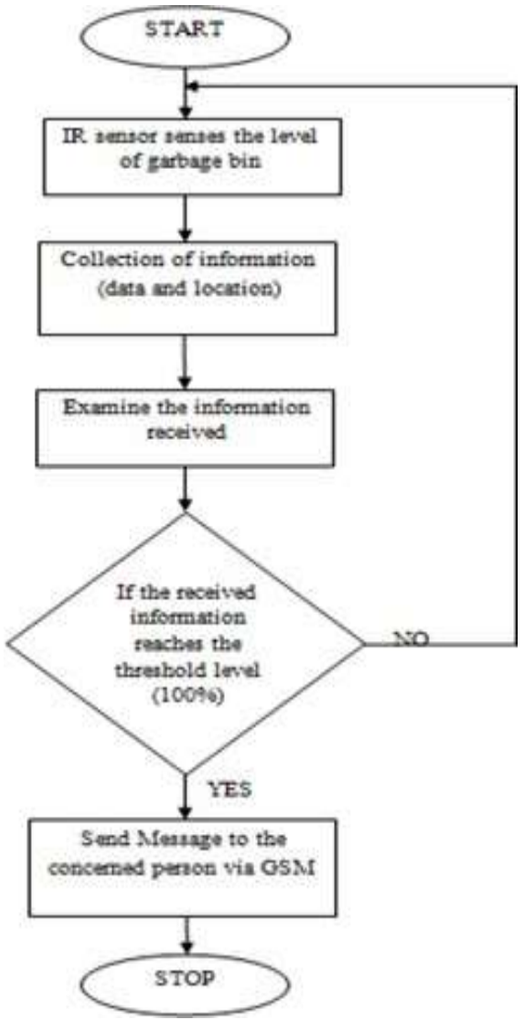

Figure 10: Flow chart diagram

4. CONSTRUCTION PROCESS

First find the best position suitable for you to mount the listed components be in the patter box except for the garbage bin itself and make carvings for the following components - charging port of the charger controller, switch, sim800l, programing port of the Arduino pro mini, terminal block for the PIR (at the external side of the patter box), ultrasonic sensor (on the plain cover).

5. SYSTEM IMPLEMENTATION

Construction of the Hardware

On how to organize components and rank them based on availability, we generated a schematic design. Then we chose where to place our components in a case (we used a 3 by 6 size parter box) and made the appropriate openings for switches, USB charging ports, Arduino programming ports, and sim card slots. Using electrical wires and solderings, we began to connect the components as shown on the schematic diagram, but outside of the box (patrex box). We also estimated the length of wire required to comfortably move from one point in the box to the next (wire length not more than 10cm).

Connections Components

SIM 800L	Arduino Nano
RX	011
TX	010
GND	GND

VCC (To 3.7V battery +)

HC-SR04	Arduino Nano
Trigger Pin	D5
Echo Pin	D6
GND	GND

VCC (To +5V out of MT3608)

PIR	Arduino Nano
Output Pin	D9
GND	GND

VCC (To +5V out of MT3608)

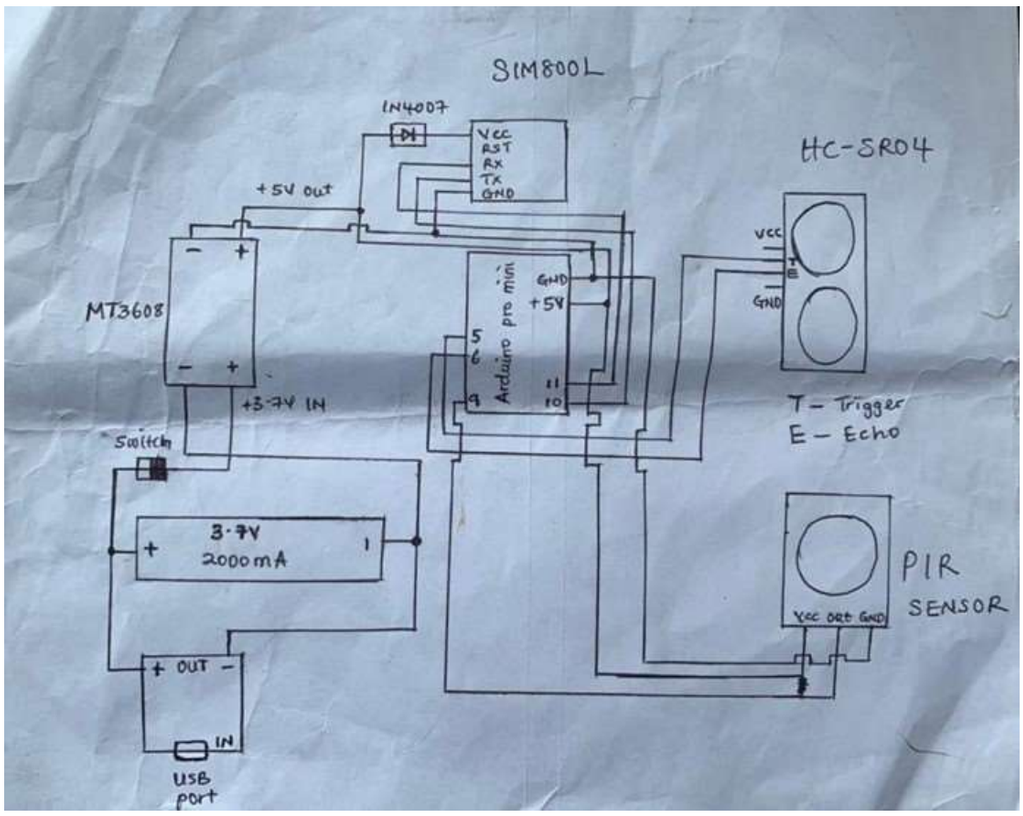

Figure 11: Schematic Diagram

Power Supply Unit Connections

We connected the positive (+ve) of our 3.7V battery to both (+ve out) of our charge controller and (+ve in) of our MT3608. Then the output of the boost converter (MT3608), the positive and negative will go to the circuit. To get 5V output from the boost converter, connect your digital multimeter to the (+ve) and (-ve) output of the booster and set your meter to DC voltage. Then use a flat small screwdriver to turn the booster carriable resistor (the blue box-like shape) on the module anti-clockwise until (sometimes clockwise) and read the effect on the meter till it gets to 5V. Finally, we arrange the connected components inside the casing into the places created for them and hold it with hot glue (you will plug your hot glue gun, insert the candle stick and as you press it the glue melts to hold the components. When arranging the components, insert the switch from the outside and then solder the wires

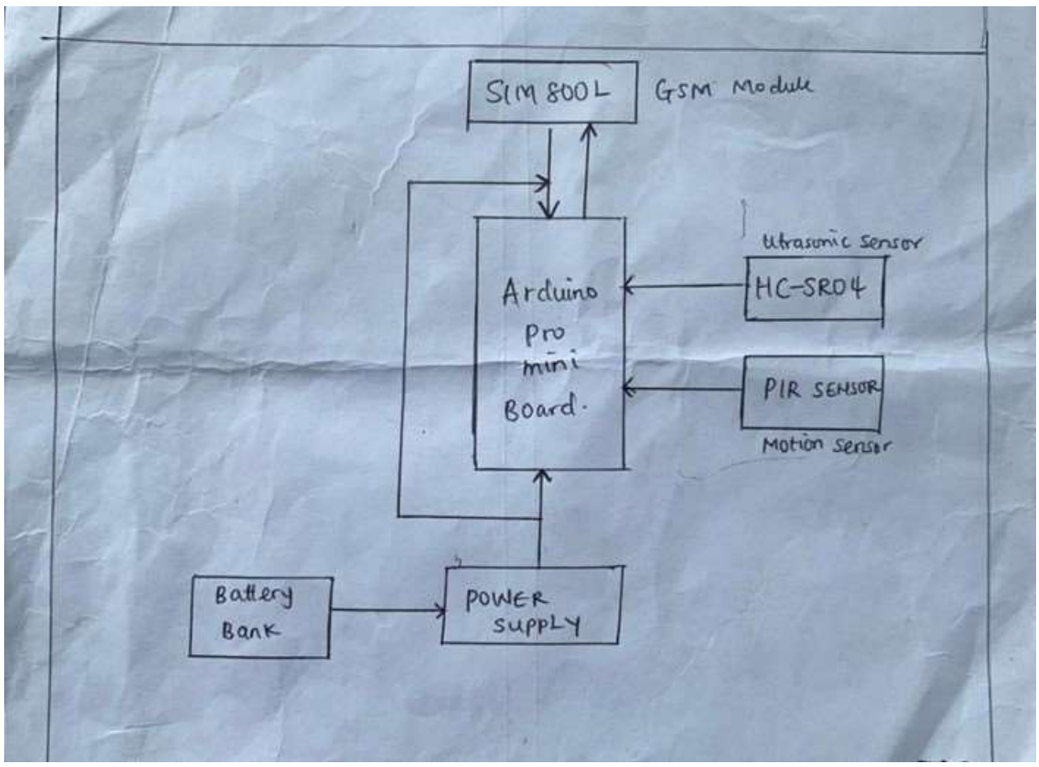

Figure 12: Block Diagram

Construction of the software

Coding: The main property of this device is the code. Without the code, the device will not function well. We installed Arduino IDE in our system to write the code, we declared our connections on the code and the language used in Arduino coding is C++.

Software/Hardware Specifications

The system architecture of this prototype consists of the sensor nodes, the Arduino pro mini board, and the ultrasonic sensor:

Arduino

An open-source computer platform called the Arduino is used for electronic prototyping. The high-performance 8-bit Atmel AVR RISC-based ATmega328 microprocessor serves as the foundation for the Arduino Uno board. The gadget runs on 1.8 to 5.5 volts. It contains a 16 MHz ceramic resonator, 14 digital input/output pins with 6 analog inputs, a USB port, a power connector, an ICSP header, and a reset button. Both an external power supply and a USB connection are options for powering the Arduino Uno.

GSM module (Sim 800l)

The SIM800L is a tiny cellular module that supports GPRS transmission, SMS sending and receiving, and voice call making and receiving. This module is the ideal choice for any project that needs long distance connectivity because of its low price, compact size, support for four bands of frequencies, and low cost. The power module starts up after being connected, looks for a cellular network, and logs in automatically. LEDs on board show the connection condition (no network coverage - fast blinking, logged in - slow blinking).

Ultrasonic Sensor

The way ultrasonic sensors operate is by emitting sound waves at frequencies that are too high for humans to hear. To receive and transmit ultrasonic sound, the sensor's transducer functions as a microphone. Like many other ultrasonic sensors, ours uses a single transducer to emit and receive pulses. The sensor measures the amount of time that has passed between delivering and receiving an ultrasonic pulse in order to calculate the target's distance. Simple logic underlies this module's operation. It uses a 40kHz ultrasonic pulse that passes through the air and, in the event of an obstruction or item, bounces back to the sensor. The distance may be estimated by multiplying the transit time by the speed of sound.

Figure 13: Smart Bin

The identification of transparent objects is an excellent application for ultrasonic sensors. Applications that employ infrared sensors, for example, have difficulty with this particular use case while measuring liquid levels because to target translucence. Ultrasonic sensors can detect items for presence independent of their color, surface, or composition (unless the material is very soft like wool, as it would absorb sound.). Ultrasonic sensors are a viable option for detecting translucent objects and other things where optical methods might not work.

6. RESULTS

The following result is obtained from our Developed System.

- Dustbin level is detected
- Data is transmitted in real time and accessed frequently
- Overflow of dustbin is reduced
- Send a message to authority through Way 2sms

When the garbage is filled inside the dustbin the ultrasonic sensor sends the message though the network to authority. The message will be sent only if the ultrasonic sensor reaches the threshold value. Due to this the transportation is reduced and time is saved.

Figure 14: Smart Bin displaying the Micro-Controller

Message to Authority through GSM

When once the bin is full, the particular message will be sent to the authority person, indicating the level of bin and informing them of the location of the bin.

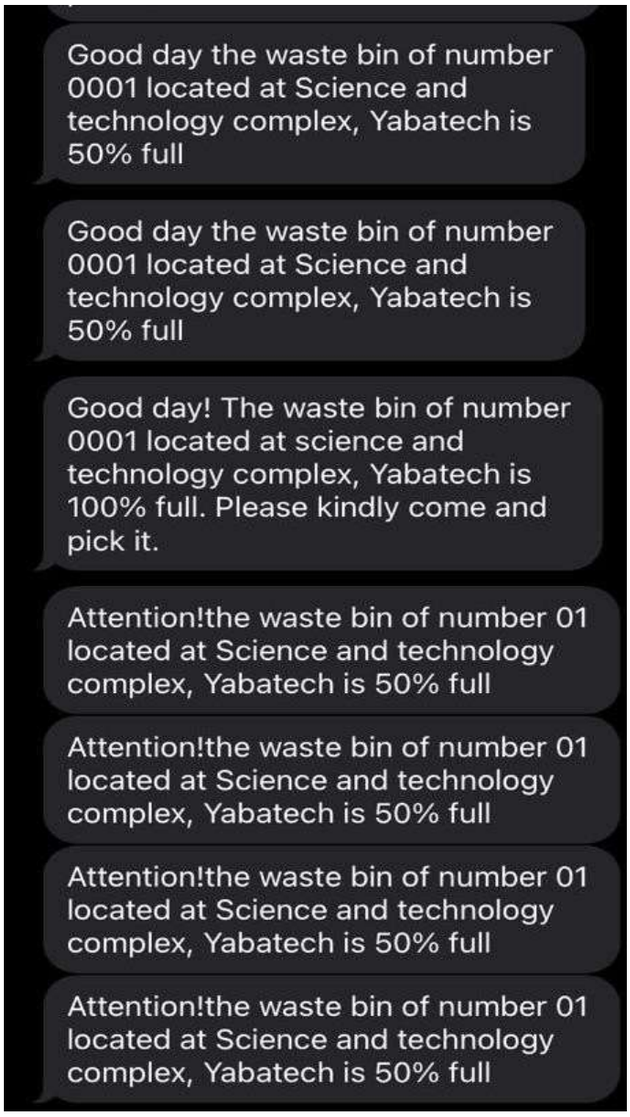

Figure 15: Message to Authority through SMS

7. CONCLUSION

In this work, an automatic garbage fill alarm system is being implemented utilizing an ultrasonic sensor, an Arduino Uno, a buzzer, a GSM module, and a Wi-Fi module. When the rubbish level reaches its peak, this method ensures that dustbins will be cleaned as quickly as possible. With the aid of a piezoelectric device, it will require a power source. Additionally, this project offers a method for achieving waste management. When the trash can is full, this technique aids in keeping it clean. Currently, neither the waste collection facility nor the garbage management system meet the needs of the situation. Better transportation and garbage collection facilities should be offered as a result. The frequency of the visit of the waste collection vehicle is decreased since this system alerts users when the trash can is full. Finally, this technique contributes to environmental preservation. As a result, waste collection is improved in efficiency. Due to the tendency toward the existence of intelligent technology, the development of smart systems, particularly in the creation of smart trash cans, tends to expand.

Overall, according to the test findings, the small and super-smart dustbin system works and performs as intended. The evaluation of the application for smart dustbins yielded results with an average value of 87.80% of the 50 respondents involved, indicating that the presence of smart dustbins distributed throughout the room strongly agreed to provide benefits and attracted very high interest in raising awareness of disposing of trash in the proper place. However, it is necessary to improve the smart dustbin system to improve its performance as well as cooperation with the entire academic community, which is a crucial step. because this research, which is the first of its kind on campus, has several flaws. In order to develop a smart campus environment in the future, it will be necessary to improve the performance of smart trash cans, determine when a can is full, monitor waste, manage real-time information, and be able to distinguish between organic and inorganic waste. These improvements will be made in conjunction with Internet of Things (IoT) devices and other smart systems.

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