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pp. 63-72

Article Title: IoT-Enabled Smartbin with Arduino Technology

IoT-Enabled Smartbin with Arduino Technology

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ABSTRACT

In metropolitan areas, Municipal Solid Waste Management (MSWM) is still a big issuethat causes major health and environmental problems. As a result, numerous locations have garbage cans to dispose of municipal solid waste. Overflowing trash cans are bad for the environment and your health. Our idea aims to address this by maintaining a clean and hygienicenvironment. With Arduino, humidity, ultrasonic, servo motor, wifi, and an LCD display, we have created a smart system that will simplify and improve waste management. The Arduino, a little microprocessor that powers everything, sits at the center of our setup. The bins have ultrasonic sensors placed to determine their level of fill. Arduino receives signals from these sensors informing it of the amount of rubbish in each container. After we have collected all ofthis data, we transmit it to a unique platform known as Ubidots over wifi. We can monitor thewaste levels in real time thanks to this platform. We receive an email alert from Ubidots whena bin fills up, letting us know when to empty it. Because we can more effectively organize ourcollection routes, this greatly simplifies garbage management. But that is not where our systemends. The bins now have a servo motor installed as well. By automatically opening and closingthe bin lid, this motor minimizes the need for manual handling. Maintaining cleanliness and hygiene is greatly improved by this minor adjustment. We have added an LCD display so thateveryone can see all this information. This display indicates the amount of waste in each bin as well as whether it is moist or dry. It is an easy way for folks to check whether the bins needto be emptied and how full they are. Our project is not limited to a simple assemblage of devicesand sensors. It's about utilizing technology to create healthier and cleaner living environments in our communities. We are changing waste management by automating bin lid operations, monitoring garbage levels, and separating wet and dry waste.

Keywords: Arduino Board, Node MCU (esp8266), Power supply, LCD Display, ATmega328PU,Moisture Sensor, Ultrasonic Sensor, Power Supply

1 Introduction

The term "Internet of Things" refers to the computerization of every aspect of people's lives. Thermostats, lightbulbs, refrigerators, and automobiles are already available with Internet connectivity. Everything will soon be available online, including personal property, items

ISSN (Online): 2583-7052

International Journal of Advanced Trends in Engineering and Management (IJATEM)
pp. 63-72

people interact with in public, and independent objects that communicate with one another. The electronic gadgets, automobiles, buildings, and other objects embedded with sensors, actuators, software, electronics, and network connectivity that allow these objects to gather and share data are collectively referred to as the Internet of Things (IoT). Designed and manufactured as single-board microcontrollers and microcontroller kits, Arduino is an open source computer hardware and software company, project, and user community that helps create digital devices and interactive objects that can sense and control objects in both the physical and digital worlds. A humidity sensor detects, gauges, and periodically reports the air's relative humidity. It gauges air temperature as well as moisture content. The ratio of actual moisture in the air to the maximum amount of moisture that air at that temperature can contain is known as relative humidity, and it is stated as a percentage. A decent option to consider when looking for an ultrasonic range module is the HC-SR04.

The majority of Ethiopian cities' municipalities have made every effort to address this issue by placing multiple trash cans across the community. To collect the rubbish, several trucks from the municipal authority are dispatched to the waste bins using a manual approach.The wastes are transported to the predetermined sites after being put onto the vehicle. As a result, the group of individuals responsible for gathering and moving waste is typically insufficiently responsible to complete the task effectively. The municipal authorities frequentlyfail to properly collect rubbish from all waste bins because they lack information on the garbagebins.

One issue with the manual garbage collection and management strategy is that it does not provide enough information about the location and time of collection. As a result, it takes longer and is less efficient; for example, trucks may drive by empty rubbish bins. In general, there is a lack of an appropriate system to track all waste management-related operations and a lack of intelligent bin condition monitoring. This suggested paper provides an efficient waste management option. The Arduino microcontroller and sensors are used to construct this waste monitor.

2 Objective

In order to monitor and separate waste into wet and dry categories, the "RevolutionizingWaste Management: Arduino-Driven IoT Trash Bin Monitoring System" presents a revolutionary method to waste management by merging Arduino microcontrollers, IoT technologies, and sensors. The system offers real-time data on trash composition and buildup through moisture sensors that identify different forms of garbage and ultrasonic sensors that measure fill levels. This data is wirelessly transferred to a centralized platform using WiFi, enabling remote monitoring and prompt intervention. Every bin has an LCD display that offers easy-to-use feedback, promoting community involvement and appropriate garbage disposal methods. The technology lowers health hazards, improves recycling efforts, and creates cleanersurroundings by efficiently controlling waste levels and trash segregation. In the end, this ground-breaking solution seeks to transform urban waste management procedures whiletackling environmental.

International Journal of Advanced Trends in Engineering and Management (IJATEM)
pp. 63-72

3 Existing Systems

The self-powered, lorawan iot-enabled Trash Bin Level Monitoring System (iot- TBLMS) is an established system that has been created and implemented in response to the urgent difficulties of Municipal Solid Waste Management (MSWM) in urban areas. To increasethe effectiveness and efficiency of waste management, it is imperative that the amount of wastein trash cans be continuously monitored, and this system satisfies this need.

The current system consists of Trash Bin Level Measurement Units (TBLMUs), whichare placed inside each bin and furnished with humidity sensors to differentiate between wet and dry garbage and ultrasonic sensors to monitor empty levels. These TBLMUs gather location and waste level data, which are subsequently sent over a LoRaWAN gateway to a central server. The system guarantees long-range data transmission using this wireless communication protocol, allowing for remote monitoring and analysis.

Receiving and processing data from the TBLMUs, the IoT-Trash Bin Level Monitoring(IoT-TBLM) server is the central component of the system. Authorities and stakeholders involved in waste management can obtain up-to-date information on the locations and statusesof bins by using an intelligent graphical user interface. Proactive waste management techniquesare made easier and better decision-making is facilitated by this intuitive interface.

In addition, the current system has been rigorously tested to determine its cost- effectiveness, accuracy, wireless range, power consumption, and battery life. The system's scalability and applicability in actual waste management scenarios are largely dependent on these characteristics.

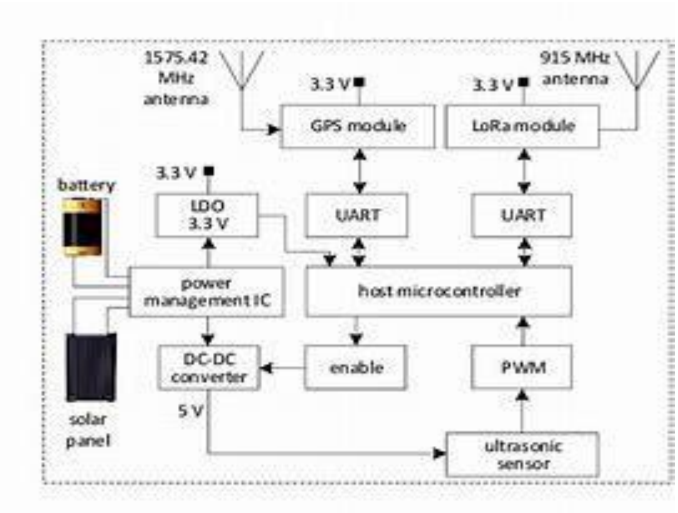

Figure 3.1: *Existing Block Diagram*

In summary, the current LoRaWAN IoT-enabled, self-powered Trash Bin Level Monitoring System is a major improvement over previous MSWM procedures. This device helps create cleaner, healthier urban settings by giving real-time information into rubbish levelsand enabling

International Journal of Advanced Trends in Engineering and Management (IJATEM)
pp. 63-72

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proactive waste management solutions. By means of ongoing assessment and improvement, the current system establishes a model for subsequent advancements andexecutions of waste management solutions across the globe.

4 Proposed Systems

This IOT Garbage Monitoring system is very unique system which will help to keep thecities clean. This arrangement keeps a watch on the garbage bins and notifies about the level of garbage collected in the garbage bins via a web page. The ultrasonic sensors positioned overthe bins to detect the garbage level and relate it with the garbage bins depth. The system makesuse of Arduino i.e microcontroller and a ESP8266 modem for sending data. GPS detects the location of garbage full through IoT. An ultrasonic sensor is placed on the interior side of the bin, the one facing the solid waste. Moisture sensor detect the wet and dry the garbage. As garbage increases, the distance between the ultrasonic and the trash decreases. This live data will be send to our microcontroller. Microcontroller then processes the data and sends to Ubidots (cloud) with the help of Wi-Fi Module.

This IOT garbage monitoring system is a really special tool that will contribute to maintaining clean cities. This setup monitors the trash cans and provides an online update on the amount of waste gathered within them. The waste level and the depth of the garbage bins are connected by ultrasonic sensors placed over the bins. For data transmission, the system uses an ESP8266 modem and an Arduino microcontroller. GPS uses IoT to locate garbage that is full. The inside side of the bin—the side facing the solid waste—is equipped with an ultrasonic sensor. Moisture sensors identify dampness and dry out waste. The ultrasonic's range from the trash reduces with the amount of waste.

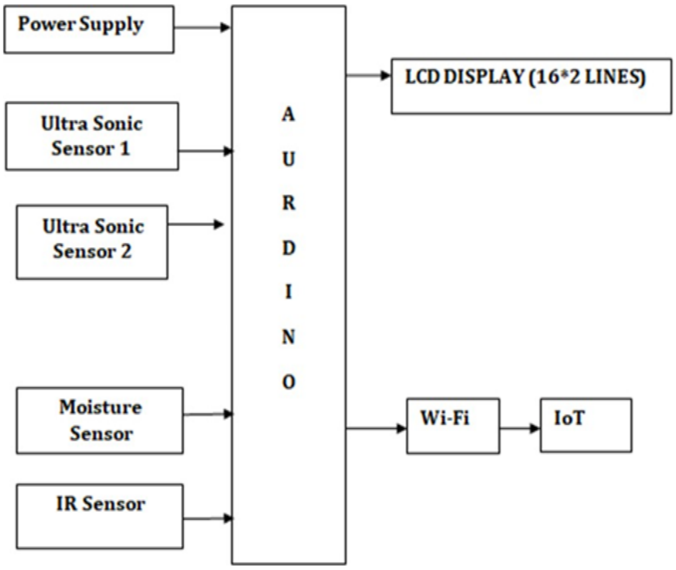

Figure 4.1: *Proposed Block Diagram*

ISSN (Online): 2583-7052

International Journal of Advanced Trends in Engineering and Management (IJATEM)
pp. 63-72

5 Methodology

Design the system: The first step is to design the system by identifying the requirements and components needed. The system should have an Arduino board, ultrasonic sensors, GPS, moisture sensor, IR sensor, LCD module, esp8266, and IoT module.
Build the hardware: Once the design is finalized, the next step is to build the hardware. This involves connecting the sensors, modules, and other components to the Arduino board.
Program the Arduino board: After the hardware is built, the next step is to program the Arduino board. This involves writing code in the Arduino Integrated Development Environment (IDE) to enable the sensors to collect data and send it to the IoT module.
Connect to the IoT module: The next step is to connect the Arduino board to the IoT module. This involves setting up the Wi-Fi connection and configuring the IoT module to receive data from the Arduino board.
Deploy the system: Once the system is built and tested, it can be deployed in the desired location. The system should be placed in a garbage bin, and the sensors should be configured to detect the level of garbage, moisture, and other parameters.
Monitor the data: The IoT module should be configured to monitor the data received from the Arduino board. This data can be analyzed to identify patterns and trends in garbage generation and to optimize waste management strategies.
Display the data: Finally, the data collected by the system can be displayed on an LCD module or a web-based dashboard. This allows users to monitor the system and make informed decisions about waste management

6 Required Components

Arduino board

Arduino is a model stage (open-source) in light of an easy to-use hardware and programming. It incorporates a circuit board, which can be modified (suggested as a microcontroller) and a possible programming called Arduino IDE (Integrated Development Environment), which is worn to casing and exchange the PC code to the physical board. The key sections are: Arduino sheets can read fundamental or pushed data signals from different sensors and change it into a yield, for instance, starting a motor, turning LED on/off, join to the dull and diverse obvious exercises.

Figure 6.1: *Arduino Board*

ISSN (Online): 2583-7052

International Journal of Advanced Trends in Engineering and Management (IJATEM)
pp. 63-72

ATmega328P-PU with Arduino Boot loader

The name says everything on this one. An Atmega328 in DIP bundle, pre-stacked with the Arduino (16MHz) Boot loader. This will engage you to utilize Arduino code in your especially presented connects without using a genuine Arduino board.

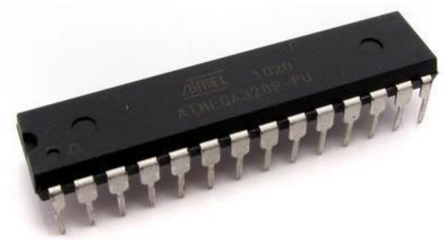

Figure 6.2: *ATmega328P-PU*

Wi-Fi Module:

Wi-Fi is an innovation for remote neighborhood with gadgets in light of the IEEE 802.11 guidelines. Wi-Fi is a trademark of the Wi-Fi Alliance, which confines the utilization of the term Wi-Fi Certified to items that effectively total interoperability accreditation testing.

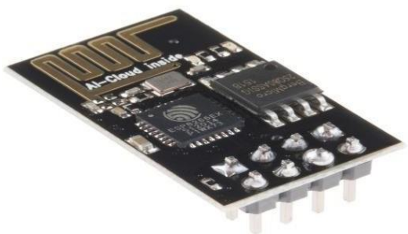

Figure 6.3: *Wi-Fi Module*

LCD Display:

The 16x2 LCD display is a standard alphanumeric liquid crystal display with 16 columnsand 2 rows, commonly used in electronics for presenting text-based information and messages

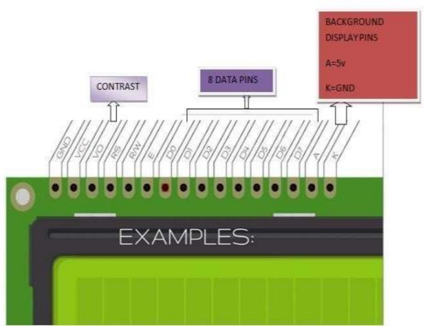

Figure 6.4: *LCD Display*

International Journal of Advanced Trends in Engineering and Management (IJATEM)
pp. 63-72

Servo Motor:

A servo motor is a type of motor that helps control the precise movement of mechanical components in various devices, such as robots and remote-controlled vehicles

Figure 6.5: *Servo Motor*

Ultrasonic Sensor:

Ultrasonic sensors are in available for the past many decades and these devices continueto hold huge space in the sensing market because of their specifications, affordability, and flexibility. As the automation industry has been progressing, the employment of ultrasonic sensors in multiple domains such as drones, EV vehicles is emerging.

Figure 6.6: *Ultrasonic Sensor*

IR Sensor

IR sensor is an electronic device that emits the light in order to sense some object of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. Usually, in the infrared spectrum, all the objects radiate some form of thermal radiation. These types of radiations are invisible to our eyes, but infrared sensor can detect these radiations.

Figure 6.7: *IR Sensor*

ISSN (Online): 2583-7052

International Journal of Advanced Trends in Engineering and Management (IJATEM)
pp. 63-72

Moisture Sensor

A moisture sensor is a device that measures the moisture content in soil or other substances. It is commonly used in agriculture and gardening applications to monitor

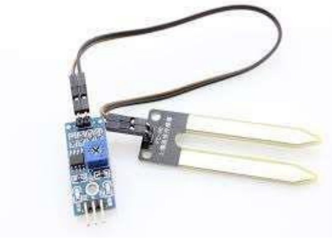

Figure 6.8: *Moisture Sensor*

7 Implementation

To implement an IoT based garbage monitoring system using Arduino, ultrasonic sensor, GPS, moisture sensor, IR sensor, LCD module, esp8266 (Wi-Fi), and IoT (Ubidots), you can follow the below steps:

Step 1: Gather the required components:

- Arduino Uno/Nano board
- Ultrasonic Sensor
- GPS Module
- Moisture Sensor
- IR Sensor
- LCD Module
- esp8266 Wi-Fi Module
- Breadboard and jumper wires
- Ubidots IoT Platform Account

Step 2: Connect the components to the Arduino board as follows:

- Connect the ultrasonic sensor to the digital pins of the Arduino board (Trig to D7 and Echo to D8)
- Connect the GPS module to the Arduino board's serial pins (RX to D0 and TX to D1)
- Connect the moisture sensor to the analog pin of the Arduino board (A0)
- Connect the IR sensor to the digital pin of the Arduino board (D2)
- Connect the LCD module to the Arduino board's digital pins (RS to D3, EN to D4, D4 toD5, D5 to D6, and D6 to D7)
- Connect the esp8266 Wi-Fi module to the Arduino board's digital pins (RX to D9 and TX to D10)

Step 3: Install the necessary libraries for the sensors and modules used in the project.

Step 4: Write the Arduino code to read the sensor data, send it to Ubidots IoT Platform, and

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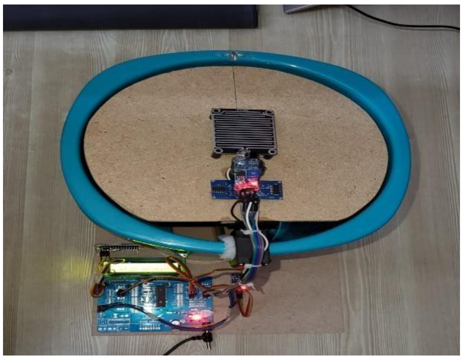
International Journal of Advanced Trends in Engineering and Management (IJATEM)
pp. 63-72

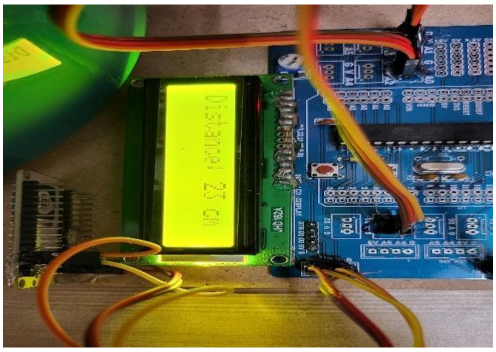
display it on the LCD module. The code should include the following functionalities:

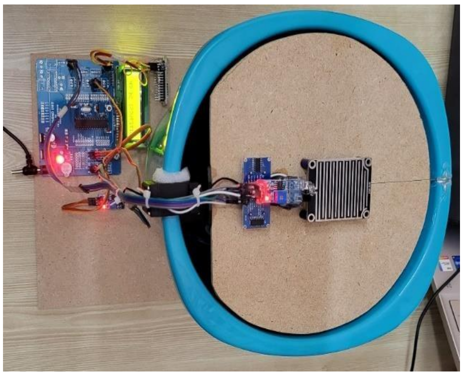
- Initialize the sensors and modules
- Read the sensor data and store it in variables
- Send the sensor data to Ubidots using the esp8266 Wi-Fi module
- Display the sensor data on the LCD module

Step 5: Upload the code to the Arduino board using the Arduino IDE.
Step 6: Create a dashboard on Ubidots to visualize the sensor data and set up the alerts for the garbage level, moisture level, and IR sensor.
Step 7: Power up the garbage monitoring system and place it in the garbage bin.
The system will continuously monitor the garbage level, moisture level, and IR sensor and send the data to the Ubidots platform. The dashboard will display the garbage level, moisture level, and IR sensor data, and the user will receive alerts when the garbage level is high, the moisture level is low, or the IR sensor is triggered.

8 Experimental Results







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International Journal of Advanced Trends in Engineering and Management (IJATEM)
pp. 63-72

9 Conclusion

In conclusion, the IoT based garbage monitoring system using Arduino, ultrasonic sensors, GPS, moisture sensor, IR sensor, LCD module, and esp8266 is an efficient and effective way to manage waste in a smart city. This system uses various sensors to monitor thegarbage level, moisture content, and temperature of the waste bins. The collected data is then transmitted to a centralized server via the internet using the esp8266 module.

10 FUTURE SCOPE

In Future As more cities adopt smart city technology, smart waste management will become an integral part of the infrastructure. An IoT-based garbage monitoring system can helpto optimize waste collection routes, reduce littering and improve overall efficiency.

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