Automatic domestic waste segregation and alert system using IOT devices

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Abstract - *Rapid population expansion necessitated increased resource use in everyday living. Because of this, the pace of trash generation has increased dramatically, affecting the environment's hygiene system and other health concerns. Therefore waste overflows in public spaces, and improved management is necessary. The proposed work is to develop a system of an intelligent trashcan for usage in smart cities. And also to identify dangerous gases emitted by dustbins for subsequent management operations, as well as to monitor the amount of trash in the waste bin and warn the municipality through Notification. Most of the present systems cannot manage waste on a scalable level. Segregation needs to be done to manage individual types of waste. Hence same problem is taken for solving, which most of the present-day systems fail to do. The purpose of the study is to segregate the garbage generated in individual households into wet waste and dry waste The system notifies the user whether the bin is full or empties my messages and also by voice command. Proposed system monitors the gas released by garbage to find the severity of the impairment and to notify the concerned authorities. It will also l identify a failed trash drop in the bin and alert the user through alarm for truly considering the reduction of spilled garbage surrounding bins while using the system.*

Key Words: Waste management, , Dry Waste , Wet, waste , Microcontroller, smart bin, sensors

1. INTRODUCTION

Waste segregation and management is a most critical critical aspect of urban living, posing challenges that demand innovative solutions. The conventional waste collection methods often lack efficiency and real-time monitoring, leading to issues an like overflow, unpleasant odors, and environmental hazards. In response to these challenges, the integration of technology, specifically the use of Arduino Uno as the main controller, has paved the way for a smarter and more effective waste management system. The heart of this system lies in the Arduino uno microcontroller, which orchestrates the entire waste management process. An ultra sonic sonar sensor is employed to accurately measure the trash level with in the bins. this real-time data is most crucial for optimizing waste collection schedules, ensuring that bins are emptied at the right time, preventing overflows and reducing the operational cost associated with unnecessary collections. To enhance communication and responsiveness, a WI-FI module is integrated into the system. This module enables the smart bin to send alert messages to designated authorities or waste management teams when the bin reaches a predefined threshold. this proactive approach not only improves efficiency but also aids in maintaining a clean and hygienic environment.

The LCD display provides a user- friendly interface, allowing for easy monitoring of the waste level. this real time information empowers both waste management authorities and the public to make informed decision, contributing to a more sustainable and organized waste disposal process. Moreover, a buzzer is incorporated into the system to serve as an audible alert, drawing attention to the need for waste collection. This additional feature ensures that even in scenarios where visual monitoring might be challenging, the system can still communicate effectively. Addressing the issue of foul smells emanating from waste bins, a gas detection sensor are included the design. this sensor identifies any toxic gases produced within the bin. triggering appropriate responses such as increased ventilation or immediate waste removal. This not only enhances the overall cleanliness of the area but also contribute to the wellbeing of the community. Waste segregation and management are critical components of sustainable urban development, as they directly impact public health, environmental quality, and resource conservation. Conventional waste management systems often face many challenges such as inefficient garbage collection methods, Garbage bin overflow, and limited data for decision-making. In response to these challenges, the integration of Internet of Things (IoT) technology into smart bins offers a transformative solution to optimize waste segregation and management processes. Smart bins equipped with IoT sensors and connectivity capabilities enable real-time monitoring of waste fill levels, allowing for timely and efficient collection. Moreover, these bins can facilitate waste segregation at the source by providing users with intuitive interfaces and guidance on proper disposal practices. By leveraging IoT technology, smart bins not only improve operational efficiency but also promote environmental sustainability and community engagement. In this context, this study explores the idea concept of waste segregation and management using smart bins based on IoT, highlighting their benefits, features, and potential impact on urban environments and public health. We will delve into how IoT-enabled smart bins can revolutionize waste management practices by harnessing data-driven insights, enhancing user experience, and contributing to the creation of cleaner, greener cities.

2. LITERATURE SURVEY

S. Murugan et.al[1] introduced us to a similar category of IoT-based smart bins for environmental protection. Paper proposes dispose of several forms of garbage in contemporary life, including sewage waste, home waste, and industrial waste. The main objective of the study is to place a dustbin on every corner of the street, using IoT to keep the environment clean. MSC primarily makes use of IoT (Internet of Things) (Modern System cities). IoT equipment consists of sensors, detectors, and actuators that are integrated into the IS (intelligent system).

Mohammed{2} presents empirical study on the negative impact of rubbish heaps in cities, focusing on individuals who live in flats and areas with a limited number of bins, The trash monitoring system is intelligently led and alerts the organization in real time through Message. The technological components include an ultrasonic sensor, a GSM module and an Arduino Uno for controlling the system's functionalities

Sreejit et.al{3} present that ash be used in agriculture for growing and that the ash be filtered afterwards using a gas filter (carbon filter). That is why a gas sensor is used to detect dangerous gases and alert local residents through a buzzer sound. Additionally,the overall mechanism is comprised of a gas sensor, an infrared sensor, a PIC micro-controller, a carbon filter, and a GSM communication module

S J Ramson [4] exposes us to a smart bin system based on WSNs (wireless sensor networks). Each bin has a central node called a WMU (wireless monitoring unit). Sensors located inside the WMU provide data to the WAPU (wireless access point unit). Finally, WAPU transmits the data to the monitoring system, which then utilizes the bin

3. METHADOLOGY

1.1 Block Diagram

The working of smart bin with dry and wet waste segregation is shown in Figure 3.1

The lid will open automatically when any motion within 30cm is detected, all of the sensors are connected to an Arduino Uno microcontroller. By utilizing the Wi-Fi module from NodeMCU ESP8266, which is linked to Arduino Uno through a serial connection, the sensor values are relayed wirelessly to the web server. Both the Arduino Uno and the NodeMCU are powered by rechargeable lithium-ion batteries

To communicate serially between an Arduino and a NodeMCU. The two dangerous gas sensors are attached to the analogue pins on the Arduino, namely the A1 pin for the MQ-

A breadboard connects the NodeMCU and the sensors to the Arduino's VCC 5V and GND pins. WIFI, servo motor, buck converter, sonar sensor, Arduino Uno, display, and power supply are some of the technical components of the proposed work. To begin, one ultrasonic sensor measures the distance a single person travels before dumping any trash. When the trash is full, one appears with information.

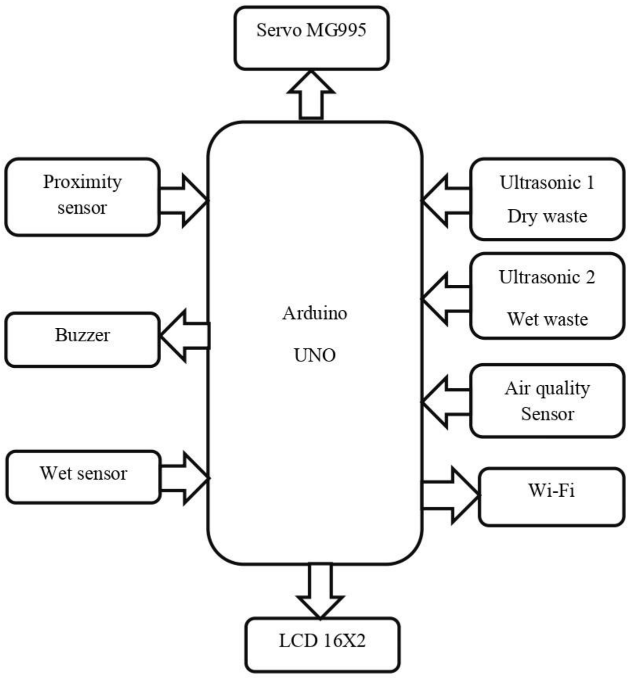

Figure 3.1 Block diagram of smart dust bin

Whereas the waste will cover the bin to a height of 6cm, the authorities will evacuate through notification module. The buck converter is used to reduce the voltage level and convert the AC to DC in this case. The servo motor, on the other hand, is activated when the sonar sensor provides data to spin and open the bin automatically. The other technological components operate in the same manner. Microcontroller, associated switches, and WIFI module are all found in the master controller unit. All motors with sensors and a WIFI module are kept in the smart bin.

Arduino Microcontrollers: Arduino boards are used for monitoring waste levels in bins and controlling the segregation process.

Ultrasonic Sensors: Ultrasonic sensors are employed to measure the level of waste in bins, providing accurate data for waste management decisions

Air Quality Sensors: Air quality sensors detect the decomposition of wet waste, enablingtimely segregation and disposal.

Proximity sensor and Wet Sensors: proximity sensors are utilized for detecting dry waste, while wet sensors identify wet waste, facilitating automated segregation.

NodeMCU: NodeMCU modules are used for connecting Arduino boards to the Blynk platform via Wi-Fi, enabling remote monitoring and control.

Blynk Platform: The Blynk platform serves as the user interface, displaying real-time data from sensors and allowing users to monitor waste levels and control segregation processes.

Ultrasonic Sensors for Waste Level Monitoring: Ultrasonic sensors are placed inside waste bins to measure the level of waste. These sensors emit ultrasonic waves and calculate the time taken for the waves to bounce back from the surface of the waste, thereby determining the level of waste in the bin.

Air Quality Sensor for Wet Waste Detection: An air quality sensor is employed to detect the decomposition of wet waste. This sensor measures various parameters such as humidity, temperature, and potentially harmful gases emitted during the decomposition process.

Proximity and Wet Sensors for Waste Segregation: Proximity sensors are used to detect the presence of dry waste in the bin. Wet sensors are employed to identify wet waste based on the changes in humidity or other relevant parameters.

Arduino Microcontroller for Data Processing : Arduino microcontrollers are programmed to receive data from the sensors, process it, and control the segregation process. Based on the data received from ultrasonic sensors and air quality sensors, the Arduino microcontroller determines the type of waste present in the bin.

NodeMCU for Connectivity: NodeMCU modules are connected to the Arduino microcontroller and provide Wi-Fi connectivity. These modules enable communication between the Arduino-based sensor system and the Blynk platform.

Blynk Platform for Data Visualization and Control: The Blynk platform serves as the user interface, allowing users to monitor waste levels and control segregation processes remotely. Data from the sensors, including waste levels and waste type, are transmitted to the Blynk platform via NodeMCU, Users can view real-time data on waste levels and receive alerts when bins are full or when wet waste decomposition is detected. Additionally, users can remotely trigger the segregation process to separate dry and wet waste as needed. Ultrasonic sensors continuously monitor the waste level in bins, while the air quality sensor detects decomposition in wet waste. Based on the data collected, the Arduino microcontroller determines the type of waste present in the bin and controls the segregation process accordingly. Data from the sensors are transmitted to the Blynk platform via NodeMCU, providing users with real-time insights into waste levels and facilitating remote control of segregation processes.

1.2 Flow Chart

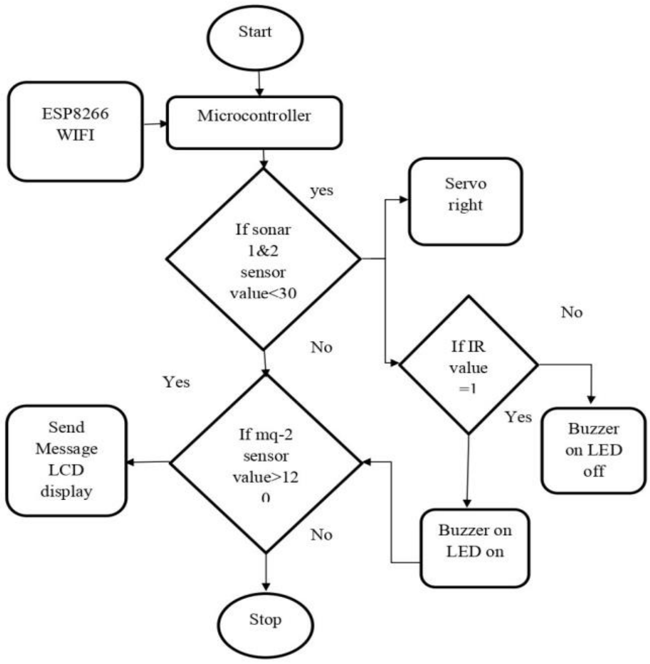

Figure 3.2 Flow Chart

4. HARDWARE

Arduino UNO: It is a is a microcontroller board works on 8-bit ATmega328P microcontroller. It also includes other components such as crystal oscillator, serial communication, voltage regulator, etc. to support the microcontroller.

Fig 4.1: Arduino Uno

International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 11 Issue: 06 | Jun 2024 www.irjet.net p-ISSN: 2395-0072

It has 14 digital input and output pins (06 pins of them can be used as PWM outputs), 6 analog input pins, a USB connection, A Power barrel jack, an ICSP header and a reset button. Arduino boards can be used to control various components of the robotics system, such as the servo motors that control the movement of the camera module. The board can also be used for data logging and communication with other devices

LCD Module: 16×2 LCD consistst has 16 ccolumns and 2 rows. A number of combinations of LCD modules are available such as , 8×1, 8×2, 10×2, 16×1, etc. The most commonly used the 16×2 LCD module. So, Totally it contains (16×2=32) 32 characters and each one character will be made of 5×8 Pixel Dots. A Single character with all its Pixels is shown in the Fig 4.2.

Fig 4.2: LCD Module

Sensor Sonar Sensor : Ultrasonic An ultrasonic sensor can be used to help the robot navigate and avoid obstacles in the. The sensor works by emitting ultrasonic waves and calculate the time that takes for the waves to came back from an obstacle. This data can be used to calculate the distance to the obstacle and provide feedback to the robot's control system. Here we are using two ultrasonic sensor one is for to measure the depth of the bin and another is for to open the bin lid. we are using HC-SR04 ultrasonic sensor,

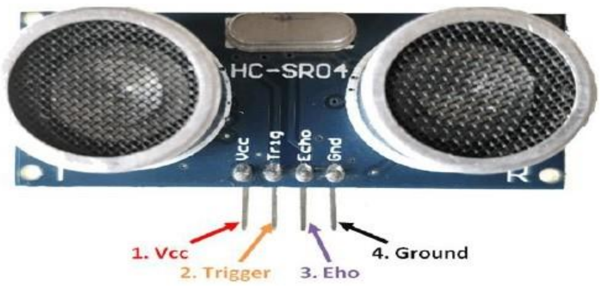

Fig 4.3: Ultrasonic Sonar Sensor

Wet Sensor: Wet drop Sensor is a tool used for sensing wet. It consists of two modules, a wet board that detects the wet and a control module, which compares the analog value, and converts it to a digital value

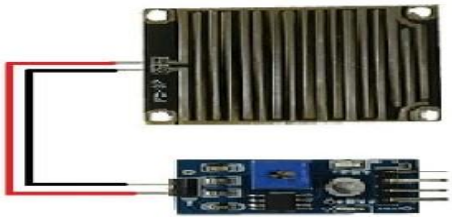

Fig 4.4: Wet Sensor

. The wet drop sensors can be used in the automobile sector to control the windshield wipers automatically, in the agriculture sector to sense wet and it is also used in home automation systems

Gas Sensor: Air quality control equipment consists of MQ-135 gas sensors and are used for for detecting or measuring of NH3, NOx, Alcohol, Benzene, Smoke, CO2. The MQ-135 sensor module consists a digital Pin , which helps this device to function even without a microcontroller. It is portable and very light weight

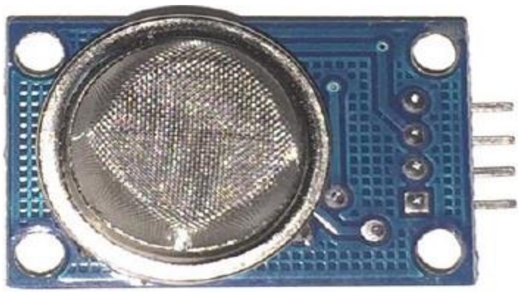

Fig 4.5: Gas Sensor

Servo Motort For precise control of angular or linear position, velocity and acceleration a servo motor is is used because it contains rotary actuator or linear actuator.

It consists of motor coupled to a sensor for position feedback. It needs a very precise sophisticated controller, preferably a dedicated module designed specifically for use with servomotors. Servomotors are not a specific class of motor, although the term servomotor is often used to refer to a motor suitable for use in a closed loop control system.

Fig 4.6: Servo Motor

Proximity Sensor: E18-D80NK is a non-contact detection sensor providing a digital output when an object comes into a specific range of it. It is a low-cost, easy to assemble sensor with very little interference with the surrounding lights and environment. Below are some features and specifications of the E18-D80NK infrared proximity sensor. E18- D80NK is a variable range non-contact detection sensor. It comes with a transmitter and receiver in a single module setup.

Fig 4.7: Proximity Sensor

Node MCU: Node : MCU is an open-source firmware and development kit that helps in building Internet of Things (IoT) applications. It is based on the ESP8266 Wi-Fi module, which integrates a microcontroller, Wi-Fi capabilities, and GPIOs (General Purpose Input/Output pins) into a single chip

Fig 4.8: Node MCU

Jumper Wires : A jump wire (also known as jumper, jumper wire, DuPont wire) is an electric wire, or group of themin a cable, with a connector or pin at each end (or sometimes without them – simply "tinned"), whichis normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.

I2C Serial Interface Adapter Module for LCD: Due to limited pin resources in a microcontroller/ microprocessor, controlling an LCD panel could be tedious. Serial to Parallel adapters such as the I2C serial interface adapter module with PCF8574 chip makes the work easy with just two pins. The serial interface adapter can be connected to a 16x2 LCD and provides two signal output pins (SDA and SCL) which can be used to communicate with an MCU/MPU

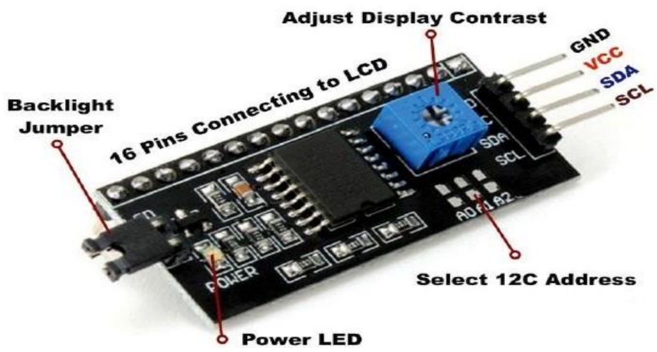

Fig 4.9: I2C Serial Interface Adapter

5. RESULT AND DEISUSSION

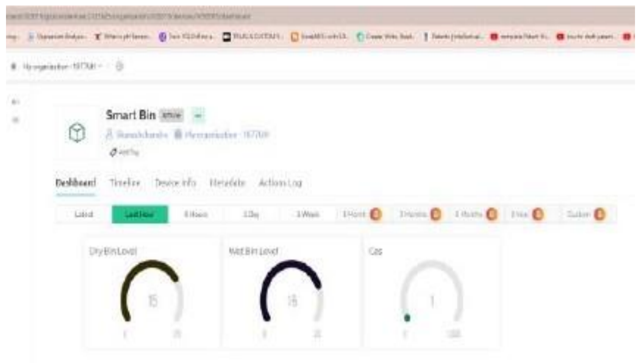

Fig: 5.1 Result Notification

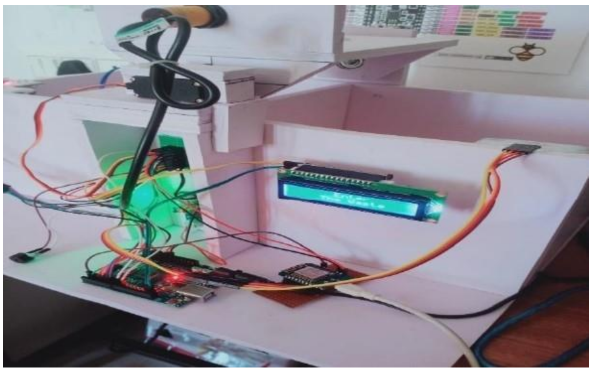

Fig 5.2 Working model

Efficient Waste Segregation: The IoT-based smart waste segregation system effectively segregates dry and wet waste based on real-time data collected from sensors. By accurately identifying the type of waste present in the bins, the system ensures that recyclable materials are separated from organic and non-recyclable waste, facilitating proper disposal and recycling processes.

Real-Time Monitoring: The system provides real-time monitoring of waste levels and decomposition status, allowing waste management personnel to promptly respond to changing conditions. Users can access the Blynk platform to view up-to-date information on waste levels and receive alerts when bins are full or when decomposition is detected in wet waste.

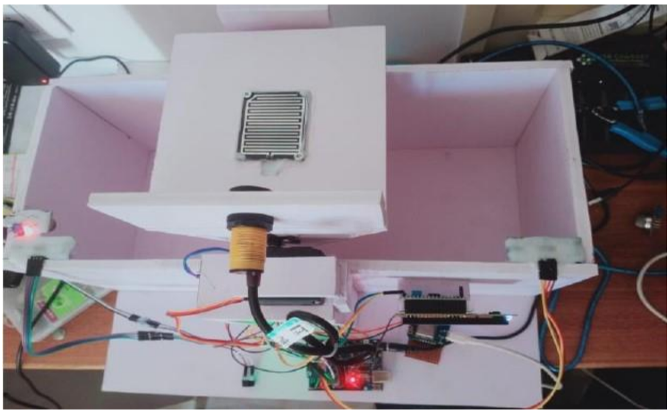

Fig: 5.3 Top view of working model

Remote Accessibility: The integration of NodeMCU modules enables remote access to the system via the Blynk platform, allowing users to monitor waste levels and control segregation processes from anywhere with internet connectivity. This remote accessibility enhances the efficiency of waste management operations, as personnel can monitor and manage waste bins without the need for physical presence at each location.

Optimized Waste Collection: By providing real-time data on waste levels and types, the system facilitates optimized waste collection schedules and routes.Waste management personnel can prioritize collection efforts based on the fill level of bins and the type of waste present, minimizing unnecessary trips and reducing operational costs.

Environmental Impact: The implementation of the IoT-based smart waste segregation system contributes to environmental sustainability by promoting proper waste management practices. By segregating waste at the source and facilitating recycling of recyclable materials, the system reduces the amount of waste sent to landfills and minimizes environmental pollution.

6. CONCLUSIONS

Proposed IoT-based smart waste management system offers an innovative solution to the challenges of traditional waste management practices. By leveraging Arduino microcontrollers, sensors, and the Blynk platform, we enable real-time monitoring and automated segregation of dry and wet waste streams. The integration of Internet of Things (IoT) technology into smart dustbins presents a promising solution to revolutionize traditional waste management practices. By harnessing the power of real-time data monitoring, remote connectivity, and intelligent analytics, smart dustbins offer a myriad of benefits ranging from optimized waste collection to enhanced environmental sustainability. Through the implementation of smart dustbins, municipalities and communities can streamline waste management operations, reduce operational costs, and mitigate environmental impacts associated with inefficient waste disposal practices. Moreover, by promoting responsible waste disposal behaviors and fostering community engagement, smart dustbins play a vital role in raising awareness about the importance of sustainable living and environmental stewardship.

7. FUTURE SCOPE

Future enhancements may include the integration of additional sensors for comprehensive waste characterization, the implementation of machine learning algorithms for predictive analytics, and the expansion of the system to larger-scale deployments in urban environments. the functionality of the system can be further extended by adding more features and capabilities. For example, machine learning techniques can be applied to the collected data to predict waste generation patterns and provide insights into the effectiveness of waste management policies. Additionally, the system can be enhanced by incorporating more sensors to monitor factors such as temperature and humidity, which can affect the rate of waste decomposition and odor control. The proposed study can be combined with other smart city initiatives to develop a more holistic approach for waste management. For instance, the system can be connected with smart traffic management systems to optimize garbage collection routes and schedules based on real-time traffic information. Furthermore, the system can be used to promote public awareness and education about the importance of proper waste disposal and recycling, through various media and outreach programs.

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