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Robotic Bin (Ro-Bin)

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Abstract: ***This paper presents the development and implementation of an Arduino-based Robotic bin designed to enhance waste management efficiency. The Robotic bin leverages various components, including an ultrasonic sensor for level detection, an Arduino Nano microcontroller, a servo motor for lid automation, and various other supporting components such as jumper wires, and an ultrasonic sensor. The system is programmed to detect the presence of waste, automatically open the lid, and monitor the fill level in real time. The Robotic bin aims to promote hygienic practices by minimizing human contact, thereby mitigating health risks and providing significant assistance to individuals with disabilities who may have difficulty opening traditional dustbins. Additionally, using the Arduino Nano microcontroller and open-source software facilitates easy customization and scalability. Field tests demonstrate the system's reliability, accuracy, and potential for widespread application in urban waste management, making it a viable solution for smart city initiatives***.

Keywords: ***robotic bin, arduino, iot***

I. INTRODUCTION

The Robotic Bin IoT project aims to revolutionize waste management through the integration of Internet of Things (IoT) technology. By utilizing smart sensors and connectivity, the project enhances the efficiency of waste collection, promotes recycling, and provides real-time data for urban planning. The Robotic Bin IoT project aims to revolutionize waste management by integrating Internet of Things (IoT) technology. By utilizing smart sensors and connectivity, the project enhances the efficiency of waste collection, promotes recycling, and provides real-time data for urban planning.

The Ro-Bin IoT project encompasses the design, development, and implementation of an innovative waste management system that leverages IoT technology to optimize collection processes and enhance recycling efforts. This includes integrating smart sensors into waste bins to monitor fill levels and environmental conditions, establishing a robust communication framework for real-time data transmission, and creating user-friendly interfaces for both waste management authorities and the community. The project will focus on data collection and analysis to inform operational strategies, develop a mobile application to engage residents, and run a pilot program in select neighborhoods to test effectiveness. Additionally, it will incorporate community awareness campaigns and feedback mechanisms to promote responsible waste disposal and recycling practices. Ultimately, the project aims to create a scalable solution that can be expanded to other urban areas, fostering a more efficient and sustainable approach to waste management.

II. LITERATURE REVIEW

The integration of Internet of Things (IoT) technology into waste management systems has emerged as a promising solution to optimize waste collection, promote recycling, and improve urban hygiene. IoT-based smart bins utilize sensors to monitor fill levels, identify

waste types, and transmit data to a central system. This real-time data enables efficient route planning, predictive maintenance, and data-driven decision-making. By optimizing collection routes, reducing unnecessary trips, and promoting recycling through gamification or incentives, smart bins contribute to sustainable waste management. Additionally, they can help monitor public health by detecting anomalies in waste composition or identifying potential hazards. As technology advances, future developments may include self-powered bins, advanced sensor technologies, and integration with autonomous vehicles. By addressing challenges like cost, power supply, and data security, smart bin projects can revolutionize waste management practices and create more sustainable cities. This literature review examines key studies that illustrate the innovative approaches to improving the design and functionality. Recent research by [1] The basic Idea behind project is to implement a smart way of handling the garbage in a smart way which is done by using the IOT protocol for transmitting the dustbin status wirelessly, which can generate email to notify to the concerned person that system is filled with garbage and need to be replaced We have selected the Espresso chip which is a node MCU ESP8266 platform., [2] The ESP8266 is a low cost MCU with built in Wi-Fi. It can be used as a standalone MCU, as it includes a 32-bit 80Mhz processor, 16 GPIO pins (4 PWM enabled), and a built-in analog to digital converter, SPI, I2C interfaces, and more. The MCU has an operating voltage of 2.5V - 3.6V and an average operating current of 80mA., [3] The Bluetooth Controller App is employed for establishing connection with the Bluetooth module. The module is therefore leveraged to detect distance between the user and the bin, and the information enables the planning of an optimal route for the bin to move towards the user., [4] It gives a real time indicator of the garbage level in a trashcan at any given time. Using this information, we can optimize waste collection routes, lowering fuel use in the long run. Trash collectors can use it to arrange their weekly or daily pickups. The dustbin level is filled or not by using an Ultrasonic sensor or IR sensor. Through an internet app or web page, every truck driver knows the real-time data easily., [5] This smart dustbin allows us to keep track of the stocks, and it is easily accessible using the internet. The dustbin top piece includes an ultrasonic sensor at the top of it and uses the ultra-sonic reflected waves to figure out at what extent the bin is filled and the amount of empty space in the bin. Whenever the amount of content changes in the bin, it is sensed by the ultrasonic sensor, [6] Once the trash has exceeded the set threshold value, the information is sent to a specified phone number. For example, if a society's garbage collection hours are 8 a.m. and 6 p.m., the person picking up the trash must keep an eye on and only approach the homes whose number is sent to his cell phone., [7] To send the information on the bins' filling level to the current location, these devices are wirelessly connected to the central hub. The system's main benefit is that it collects waste materials on schedule, preventing bin overflow and protecting the environment from pollution., [8] analyze the effectiveness of obstacle detection in varying conditions, such as low light or crowded environments. Devices with significant computational capabilities and those that are transformed into intelligent objects are used to monitor and gather information about the environment of a city, thereby leading to smart cities., [9]The suggested method consists of a smart trash can with a microcontroller-based system built and attached to the top of the bins to determine the level of the bin and notify drivers and the management office via application and SMS. A work order is created once a utility is full which can be received by the drivers and routing system regarding the state of bins distributed within a specific geographic area that can be assessed on the drivers' phone.

II. SYSTEM ARCHITECTURE

The project automates waste segregation using sensors and a smart system. It has four main functions: detecting hand motion, identifying the type of waste (wet or dry), segregating it into appropriate compartments, and notifying waste collectors when the bin is full.

1. Hand Detection and Lid Mechanism:

- Sensor Used: Ultrasonic sensor or infrared (IR) sensor.
- Function: The sensor continuously monitors for a hand (or an object) near the bin.
- Working: When a hand is detected:
  - The sensor sends a signal.
  - The motor connected to the lid, opening it automatically.
- Advantage: This ensures a touch-free system, promoting hygiene and convenience.

2. Waste Type Identification:

- Sensor Used: Soil Moisture Sensor.
- Function: This sensor checks the moisture level of the waste.
- Working:
  - Once waste is dropped into the bin, the soil moisture sensor measures its wetness.
  - Output:
    - If the waste is wet (e.g., food scraps, liquids), it falls into the wet compartment.
    - If the waste is dry (e.g., paper, plastic), it falls into the dry compartment.
  - The sensor's reading and activates a motorized mechanism (like a flap or conveyor) to direct the waste into the correct compartment.

3. Monitoring Bin Capacity:

- Sensor Used: Ultrasonic sensor (for level detection).
- Function: This sensor monitors how full the bin compartments are.
- Working:
  - The sensor measures the distance between the top of the waste and the lid.
  - When the bin reaches a predefined "full" level, the sensor sends a signal to the microcontroller.
- Output: The system triggers an alert to notify waste collectors.

4. Notification System:

- Technology Used: IoT module (e.g., GSM, Wi-Fi, or LoRa).Function: Sends a message or notification to the waste collectors.
- Working:
  - The microcontroller, integrated with the IoT module, sends a message to the waste management team indicating that the bin is full.
  - This can be done through:
    - SMS using a GSM module.
    - A mobile app or server notification via Wi-Fi.

Benefits of the System:

1. Automated Waste Segregation**:** Reduces human intervention, saving time and effort.
2. Improved Hygiene: Touch-free operation minimizes the spread of germs.

3. Efficient Waste Management: Proper segregation helps with recycling and composting.
4. Real-time Notifications: Ensures timely waste collection, avoiding overflow.

III. METHODOLOGY

The **methodology** for implementing a Robotic Bin IoT-Based System involves several steps to design, develop, and deploy the solution effectively. Identify the specific needs of the waste management system, such as the type of waste to be handled, environmental conditions, and scalability. Define the functional and technical requirements for the robotic bin and IoT integration. Regularly maintain the robotic bin, update the software for improved performance, and replace or repair any faulty hardware components. Continuously improve the system based on feedback and performance analysis.

✧ SOFTWARE COMPONENTS

ARDUINO IDE

Arduino IDE is a common choice for programming robotic bins due to its simplicity and versatility. It allows you to write code to control the sensors, motors, and communication modules of the bin. However, the specific software used can vary depending on the complexity of the project and the choice of components. Other options might include specialized robotic software or cloud-based platforms for IoT integration.

✧ HARDWARE COMPONENTS

1. ULTRASONIC SENSOR

Purpose: Measures distances
Project Application: Detects the proximity of objects to the bin.
Trigger actions like opening/closing the lid or sending alerts when the bin is full.

Fig : Ultrasonic sensor

2. SERVO MOTOR SG 900

Purpose: Controls the movement of objects.
Project Application: Opens and closes the bin's lid automatically.
Can be used for other robotic movements within the project.

Fig : Servo Motor

3. GSM SIM 800

Purpose: Enables communication over cellular networks.
Project Application: This can be used for remote control or monitoring.

Sends SMS alerts to users about bin status (e.g., full, low battery).

Fig: GSM SIM 800

4. ARDUINO UNO

Purpose: Microcontroller board for controlling other components.
Project Application: Processes data from sensors.
Controls the servo motor and GSM module based on sensor inputs and user commands.

Fig: Arduino uno

5. SOIL MOISTURE SENSOR

Purpose: Measures soil moisture levels.
Project Application: Monitors the moisture content in the bin's contents. Can be used for automatic watering or waste decomposition monitoring.

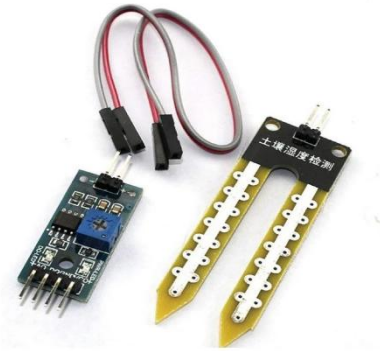

Fig: Moisture sensor

V. CONCLUSION

The integration of IoT technology with robotic bin systems presents a promising solution to address the challenges of traditional waste management. By leveraging the power of sensors, microcontrollers, and wireless communication, these systems offer a range of benefits. Enhanced Efficiency**:** Real-time monitoring of bin levels and automated collection optimize waste management

operations**.** Improved Hygiene**:** Minimized human interaction with waste reduces the risk of disease transmission. Environmental Sustainability**:** Reduced carbon emissions and resource consumption through efficient waste collection and disposal. Data-Driven Insights**:** Collected data can inform data-driven decision-making for optimizing waste management strategies**.** Community Well-being**:** Cleaner and more hygienic environments contribute to a better quality of life. As technology continues to advance, we can anticipate further innovations in

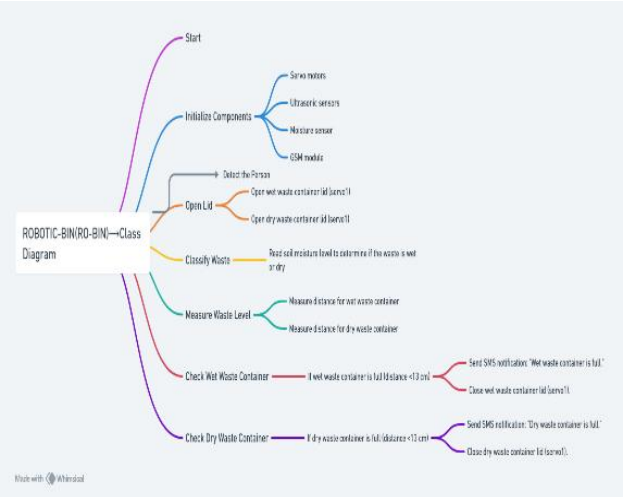

Fig: Class Diagram

robotic bin IoT systems. Future developments may include advanced sensor technologies, AI-powered analytics, and autonomous waste collection robots. By embracing these technologies, we can create smarter, more sustainable, and more resilient cities.

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