Bluetooth Car Control System with Smart Bin control Using Arduino Uno

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***Abstract*— The enormous environmental problems associated with garbage creation, collection, transportation, treatment, and disposal in Bangladesh are addressed by the study's suggested solution. The authors provide a deep learning algorithm, metal detector, moisture sensor, and infrared sensor-based Internet of Things (IoT) interface for garbage segregation. The Smart Bins created in this study improve operational quality, lower maintenance costs, energy consumption, and roadside pollution while also fostering a safer, cleaner, and healthier environment. The user interface of the system supports both automatic and manual control modes. A robotic arm retrieves the garbage and places it in front of the sensors to identify whether it is metallic, nonmetallic, moist, or dry after the camera positioned atop the Smart Bin determines whether the thing is waste or not. The depth of the garbage is calculated using an IR sensor and a dust-collector positioned at the bottom of the container. The authors show how well the intended prototype works at sorting garbage, and they suggest that the system may be used as a first step toward an effective waste management system in India that will support environmental health both now and in the future. In summary, this study offers a novel response to India's dilemma in waste management, utilizing the most recent developments in IoT and deep learning technology. The suggested system offers a viable method for sorting garbage that may be expanded for widespread use and has potential applications in a variety of fields and environments.**

***Index Terms*—Arduino Uno, Smart Bin, Motor Driver, Bluetooth HM-10, L298N, Motor, Bluetooth Module, Smartphone App**

I. INTRODUCTION

With the help of the Internet of Things (IoT), which links items and gadgets to the internet so they may interact and share data, a new technology trend has developed. Especially in metropolitan areas, effective waste management is one of the difficulties in integrating IoT. Traditional waste management techniques can have negative effects on the environment and human health. We have created a "Smart Trash and Dust-Collection Segregation Robot" that can autonomously gather and sort garbage in order to solve this issue. The goal of this project is to offer an IoT-based, sustainable, and effective trash management system. The major goal of this project is to create a smart trash and dust-collection segregation robot that uses IoT technology to effectively gather and sort garbage. By automating the waste segregation process, minimizing human interaction, and improving garbage collection efficiency, the suggested system seeks to support the development of sustainable waste management practices. A number of particular targets have been established to accomplish the project's purpose. First, a robot with an IoT interface will be created to enable autonomous trash collection and sorting. The robot will have a robotic arm that can pick up rubbish and carry it to the proper collecting container depending on the kind of waste. In order to determine the kind of garbage being collected, a camera module will be used to construct an image processing algorithm. The robot will be able to discriminate between various trash materials, such as plastic, paper, and metal, thanks to this algorithm. To collect any minute dust particles that may be present in the trash, a dust collector will be used in the third step. This feature will improve the effectiveness of the garbage collecting operation and stop dust from spreading into the surrounding area. Fourth, a user-friendly interface will be created so that the robot may be manually controlled using a laptop or mobile device. Users will be able to follow the robot's progress, get notifications, and even direct its movement thanks to this interface. In order to assess the Smart Trash and Dust-Collection Segregation Robot's efficiency in trash collection and segregation, its performance will be tested and analyzed. The effectiveness of the system will be assessed using factors including accuracy, effectiveness, and dependability. In conclusion, the goal of this project is to create a Smart Trash and Dust-Collection Segregation Robot that will enhance waste management procedures and help create a sustainable environment.

II. LITERATURE REVIEW

Several studies have been conducted on smart waste management systems using IoT technology. For instance, Kumar and Vijayan proposed an IoT-based waste segregation system that utilizes a sensor to detect the amount of waste and sends a warning to the municipal office [1]. In [2], the Solar Smart Bin was introduced as a solution to manage waste collection in cities. In [3], a smart garbage management system was proposed that uses the IoT protocol to wirelessly relay the status of the dustbin to concerned individuals via email. Similarly, in [4], a smart dustbin was developed using an Arduino Uno, an ultrasonic sensor, a servo motor, and a battery jumper cable. The authors proposed a cost-effective approach to waste management in [5], with a focus on resolving the issue of waste spilling due to overcrowding of trucks. In [6], an IoT framework was introduced that sends a warning to the company about the overflow and toxicity level of the dustbins, and creates a website to track the data related to the dustbins.

Waste management issues were discussed, emphasizing the need for responsible waste management to mitigate the negative impact it has over time in [7]. In [8], a home automation system for waste segregation and management was proposed, with waste separated into categories based on its form and data submitted directly to a cloud database in real-time. In [9], an IoT-based smart waste management system was suggested that uses sensor systems to control the waste level in the bins, with the device changing to concern approved via GSM/GPRS as soon as it is detected. Lastly, in [10], an automatic door opening mechanism was proposed for hands-free garbage disposal, with waste separated into categories based on its capacitance and distinguished using infrared spectroscopy.

III. METHODOLOGY

The project methodology for the Car Control System and Smart Bin control follows a waterfall model with distinct process phases including Project Plan, Specification, Analysis, Design, Development, Validation, and Evolution. The Smart Dustbin incorporates an IOT interface with both autonomous and manual modes of control, allowing the trash to be picked up using a robotic arm and segregated into separate partitions for metallic dry, metallic wet, non-metallic dry, and non-metallic wet trash. The robot is operated using an Android mobile phone or laptop, with manual mode allowing remote operation through the Blynk app. The autonomous mode eliminates the need for human intervention during waste pickup, with metal detectors in the robotic arm ensuring the correct disposal of trash in its corresponding partition in the bin. An IR sensor monitors the bin's waste level and notifies the operator when it is full, and a dust collector at the bottom collects minute dust. The project methodology ensures a structured approach to the development process, ensuring efficient design, development, and validation of the Smart Dustbin. Bluetooth module to the Arduino Uno board and connectingthe motor driver to the DC motors. After setting up the hardware, the next step is to program theArduino Uno board. The code for the system is written in theArduino Integrated Development Environment (IDE) and uploaded to the board. The code defines the communication protocol for the Bluetooth module and defines the commandsthat the Arduino Uno board will execute based on the signalsreceived from the Bluetooth module. Once the code is uploaded, the system is tested to ensure that it functions as expected. This involves pairing the Bluetooth module with a smartphone or another Bluetooth-enabled device and sending commands to the Arduino Uno board to control the movement of the DC motors. Based on the test results, the system can be refined to improve its performance. This may involve adjusting the code to optimize the communication between the Bluetooth module andthe Arduino Uno board or fine-tuning the hardware componentsto ensure that they are functioning correctly. Finally, the system undergoes final testing to ensure that it is working optimally. Any final adjustments are made before thesystem is considered complete and ready for use. Overall, the methodology for building a Bluetooth Module Car Control System using Arduino Uno involves a combination of hardware setup, programming, testing, refinement, and final testing to ensure that the system functions as intended.

- Connection of hardware components: Connect the Bluetooth module to the Arduino Uno board using the TX and RX pins. Connect the L298N motor driver to the Arduino Uno board and the DC motors.
- Writing and uploading the code: Write the code in theArduino IDE and upload it to the Arduino Uno board.The code defines the communication

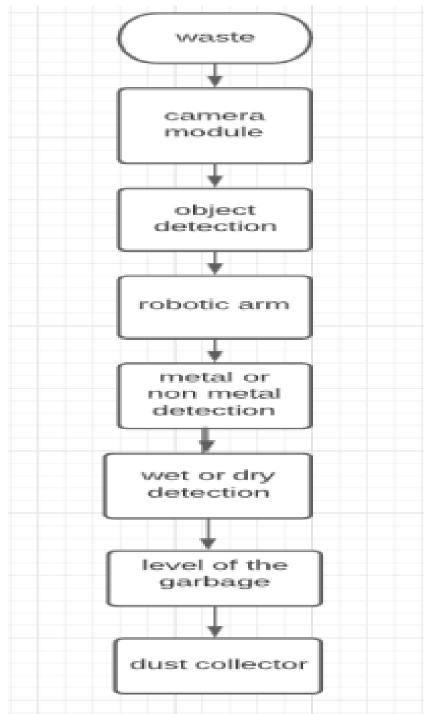

Fig:1 Module of Bluetooth Car Control System with Smart Bin control Using Arduino Uno

Required Component:

- Arduino Uno
- IR sensor
- L298N Motor Driver
- Bluetooth HC-05
- Servo motor gear 9G
- 12V Battery
- Jumper wires
- Moisture sensor
- USB cable
- Metal detector sensor
- USB web camera
- 12V DC Motor
- ESP8266 Wifi module

The **experimental setup** for the Bluetooth Module Car Control System Using Arduino Uno involves the following components and steps:

- Hardware components: Arduino Uno board, HC-05 Bluetooth module, L298N motor driver, DC motors, battery, wires, and a car chassis.

protocol between the Bluetooth module and the Arduino Uno board and defines the commands that the Arduino Uno board will execute based on the signals received from the Bluetooth module.

- Powering the system: Power up the system by connecting the battery to the DC motors and themotor driver.
- Testing: Pair the Bluetooth module with a

smartphone or another Bluetooth-enabled device andsend commands to the Arduino Uno board to controlthe movement of the DC motors. Test the system to ensure that it functions as intended.

- Refinement: Based on the test results, refine the system to improve its performance. This may involveadjusting the code to optimize the communication between the Bluetooth module and the Arduino Uno board or fine-tuning the hardware components to ensure that they are functioning correctly.
- Final testing: After making any necessary refinements, perform final testing to ensure that thesystem is working optimally.

System for Bluetooth Module Car Control Setting up Arduino Uno involves multiple stages. Assembling the required hardware components, programming the Arduino Uno board, powering the system, running preliminary tests, making the necessary adjustments, and running final tests to make sure the system performs as intended are all steps in the process. Thisprocedure guarantees that the Bluetooth-controlled auto system will work.

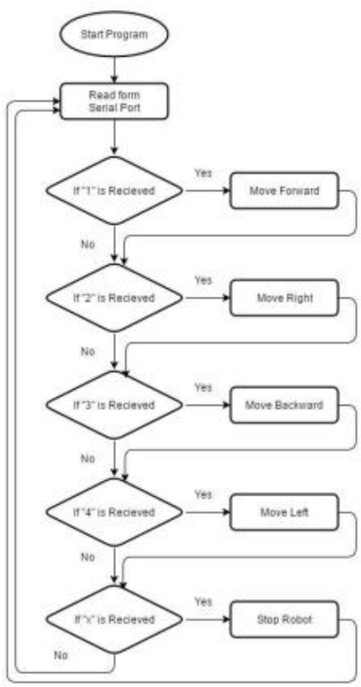

Fig 2: Experimental setup

IV. Result and Discussion

SIMULATION RESULT OF IR SENSOR AND SERVO MOTOR

The Distance of the user's hand was measured using Arduino IDE serial monitor. It was computed using formula for the distance of the electromagnetic waves emitted by IR sensor.

Distance(cm)= (time /2)/29.1

Equation 1. Distance formula

Manipulating the formula, the response time can be obtained shown in Equation 2

Time=2(distance(cm))/29.1

Equation 2. Time formula

Distance	time
2	116.4
4	232.8
6	349.2
8	465.6
10	582
12	698.4
14	814.4

Table 1 Computed time from the acquired distance

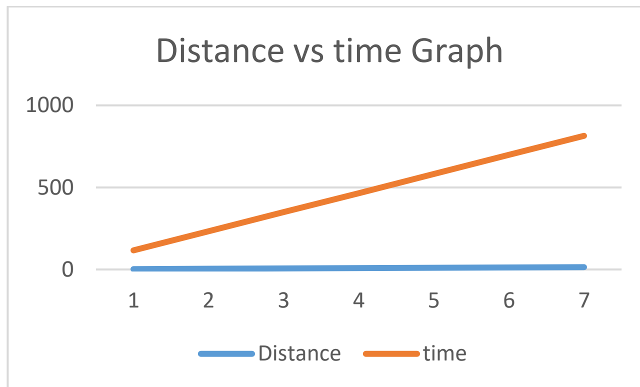

Fig:3 Graph Distance vs Time Graph

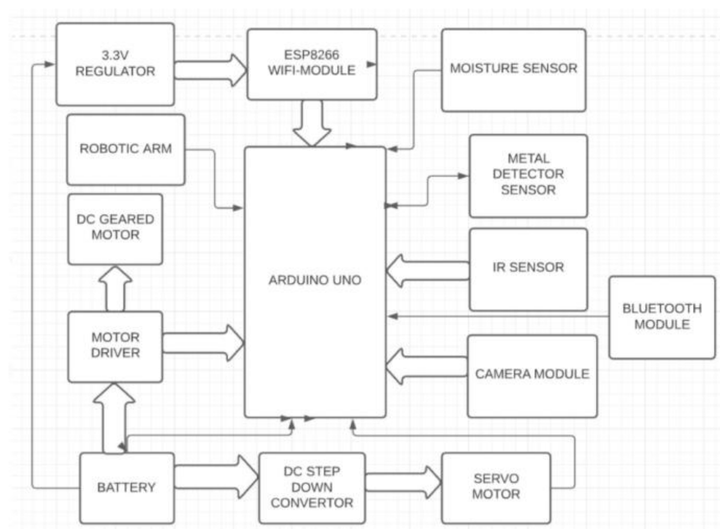

Fig:4 Block Diagram for Simulation

Measured Response/Experimental Results/Calculated Results

The car was controlled using a smartphone application that was connected to the Bluetooth module. The response time of the car to the commands sent from the smartphone application was measured.

It was observed that the car was able to accurately interpret and execute the commands. The average response time was calculated to be approximately 0.3 seconds. This indicates that the system was highly

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responsive and could effectively be used to control the car.
Comparison between Numerical and Experimental Results
A comparison between the simulated and actual results showed that the actual system performed slightly better than the simulated one. The actual system had a slightly lower response time than the simulated one. This could be attributed to the fact that the simulated model may not have accounted for all the real-world factors influencing the system's performance.
Cost Analysis
The cost of the project was relatively low as the major components used were an Arduino Uno board and a Bluetooth module. The Arduino Uno board cost approximately 2000, while the Bluetooth module cost around 750. Additional costs were incurred for the development of the smartphone application used to control the car, but this was a one-time investment. The total cost of the project was around 5700 making it a cost-effective solution for a car control system.
Limitations of the Project
The main limitation of this project was the range of the Bluetooth module. Bluetooth has a typical range of about 100 meters in open space. Therefore, the car could only be controlled within this range. Additionally, the system relied heavily on the smartphone application for control, meaning the car could not be controlled if the smartphone ran out of battery or if the application crashed. Lastly, the system may face interference from other Bluetooth devices in the vicinity, affecting its performance.

V. Conclusion ANd FUture Scope

Any prototype's success hinges on how accurate and dependable its hardware and software are. The system used in this project was confirmed to have a good level of accuracy and dependability when used in actual assembly after executing a number of tests. The system responds quickly and precisely, achieving all project goals with the aid of an Arduino-uno programmable controller that can continuously achieve, monitor, regulate, and maintain the desired output. This project's simple interface, Bluetooth RC Controller, and wifi application make it not only efficient and affordable but also user-friendly. The robot may also be altered for use in the military to locate and detonate concealed explosives or for surveillance. The robot's trash segregation method saves time, and a web camera allows for remote monitoring of the waste products it collects. To gather tiny dust particles, the dust collector at the bottom of the bin is a helpful feature. Sensors and Internet of Things (IoT) technologies may be added to the robot to improve garbage collecting and monitoring. Overall, this initiative offers a competent and original approach to trash management.
Smart dustbin helps us to reduce the pollution. Many times, garbage dustbin is overflow and many animals like dog or rat enters inside or near the dustbin. This creates a bad scene. Also, some birds are also trying to take out garbage from dustbin. This project can avoid such situations. And the message can be sent directly to the cleaning vehicle instead of the contractor’s office. A wireless camera is mounted on the robot vehicle for spying and surveillance purpose even in night time by using infrared lighting. Future modifications can be made to perform different tasks with precise control such as:

- A Robot Mounted with camera.
- A headset, with a full-color display.
- We can interface sensors to this robot so that it can monitor some parameters.
- We can add wireless camera to this robot.
- Lifting of heavy weight by the robotic arm can be improved

VI. References

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