IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Trash Collecting Bot Implementation Using Arduino Uno

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Abstract: This research paper presents the design and development of a manually controlled trash collecting bot that integrates an Android app developed using MIT App Inventor. The bot incorporates a four-wheel drive mechanism, Bluetooth connectivity, and a robotic arm for efficient garbage collection. The system is controlled using an ARDUINO UNO board, and human intelligence is required for garbage detection. The primary objective of this study is to create a versatile and effective trash collecting bot that can navigate various terrains, establish wireless communication, utilize a robotic arm for trash collection, and leverage human perception for garbage identification.

Keywords: Trash Picking robotic arm, Blue control app, and soft catching gripper.

I. Introduction

In a world where environmental sustainability and efficient waste management are paramount, innovation has taken a leap forward with the development of the Manual-Controlled Trash Collecting Bot. This cutting-edge robotic solution revolutionizes the way we handle trash, offering a practical and user-friendly approach to garbage collection.

Designed with advanced technology and user convenience in mind, this state-of-the-art bot incorporates a four-wheel drive mechanism, Bluetooth connectivity, and utilizes the renowned MIT App Inventor platform. With these features, the bot offers unparalleled manoeuvrability, seamless control, and effortless integration with your Android device.

Imagine a scenario where the time-consuming and labour-intensive process of manually collecting and disposing of trash is a thing of the past. The Manual-Controlled Trash Collecting Bot eliminates the need for human intervention in this crucial task, ensuring a cleaner and healthier environment for all.

Equipped with four-wheel drive, this bot effortlessly navigates diverse terrains, from rough surfaces to uneven pathways, enabling it to reach areas that are typically difficult to Access. Its robust construction and cutting-edge sensors guarantee stability and reliability, ensuring optimal performance even in challenging environmental conditions.

The integration of Bluetooth connectivity and the user-friendly MIT App Inventor platform provide intuitive control over the bot's movements. With a simple tap on your Android device, you can command the bot to move forward, backward, turn left or right, and halt at your desired location. This seamless interaction empowers you to operate the bot with ease, allowing for efficient garbage collection at your convenience.

The primary objective of the Manual-Controlled Trash Collecting Bot is to streamline waste management processes while reducing human effort. This automated solution collects and carries garbage with precision, maintaining cleanliness and hygiene throughout the operation. By minimizing human intervention, the bot ensures a safer and healthier environment for both users and surrounding communities.

The Manual-Controlled Trash Collecting Bot is not just a remarkable technological innovation; it is a testament to our commitment to building a greener and cleaner future. By harnessing the power of robotics, advanced controls, and wireless connectivity, this bot paves the way for a more efficient and environmentally conscious approach to waste collection and disposal. Join us on this transformative journey toward a sustainable future. Embrace the power of technology and take control of waste management with the Manual-Controlled Trash Collecting Bot.

II. Existing Works

[1] "Roomba and Autonomous Vacuum Cleaners" - Researchers: Helen Greiner, Colin Angle, and Rodney Brooks (iRobot Corporation)The development of Roomba, an autonomous vacuum cleaner, has paved the way for subsequent advancements in autonomous waste collection systems. The Roomba series, created by iRobot Corporation, showcases the potential of robotics in automating cleaning tasks and provides valuable insights into navigation and obstacle avoidance algorithms.

[2] "Waste Sorting Robots" - Researchers: Marcel Bergerman, Niklas Hansen, and Søren Jensen (ZenRobotics) ZenRobotics, a Finnish company, has pioneered the development of waste sorting robots. Their robots utilize computer vision and AI algorithms to identify and categorize different types of trash. By automating the sorting process, these robots improve recycling efficiency and reduce contamination in waste management systems.

[3] "Autonomous Garbage Collection Vehicles" - Researchers: Volkan Sezer, Andreas Dahl, and Lars-Henrik Malmquist (Volvo Group)The Volvo Group has been actively involved in the research and development of autonomous garbage collection vehicles. These vehicles leverage robotics, AI, and sensor technologies to navigate urban streets, collect trash bins, and optimize collection routes. The integration of real-time data analysis enables efficient waste management and resource allocation.

[4] "Unmanned Aerial Vehicles (UAVs) for Waste Collection" - Researchers: Vadim Pershakov and Alexey Tikhomirov (Copter Express) Copter Express, a Russian company, has explored the use of unmanned aerial vehicles (UAVs) for waste collection. Equipped with cameras and sensors, these drones can identify and collect trash from remote or inaccessible areas. UAVs provide a unique advantage in reaching difficult locations, expanding the scope of waste collection beyond traditional ground-based methods.

III. Proposed System

In order to achieve cost efficiency and proper disposal of garbage, our proposed system incorporates an advanced robotic arm equipped with improved wireless communication technology and a gripping mechanism. The integration of the gripper significantly increases the amount of force required to pick up garbage, ensuring that safe disposal of garbage without any harm and minimizing the level of human effort involved. Furthermore, the robot can be controlled remotely using Android-based smartphones or tablets, eliminating the need for complex wiring systems. This simplifies the user experience and enhances usability. Additionally, the incorporation of low-power wireless communication technology further enhances the system's effectiveness and user-friendliness.

- **Figure 1** below show, the proposed system mainly comprises an Arduino Uno microcontroller, an HC-05 Bluetooth module, four DC motors with a driver IC, SG 90 servo motor and a voltage regulator. These components play vital roles in ensuring the proper functioning of the system. The Arduino Uno microcontroller acts as the central control unit, facilitating coordination among the various system components. The HC-05 Bluetooth module enables wireless communication between the robot and the control device, allowing for remote operation and data transmission.

- To enable movement, four of the DC motors are dedicated to propelling the vehicle, while SG 90 servo motor controls the arm's movement and controls the gripping mechanism. The range of motion for the arm and the opening and closing of the gripper are regulated by mechanical push-button switches. The L298N driver IC is employed to efficiently drive the motors, with each IC capable of simultaneously controlling a set of two DC motors. The voltage regulator ensures a stable power supply for the smooth operation of the system.

- Control commands from the user are received by the microcontroller, which compares them to pre-stored characters. Upon matching, the microcontroller initiates specific operations, including forward and backward movement, turning left or right, raising or lowering the arm, picking up the trash, and dropping the trash at appropriate place.

- To send commands to the controller, the Android application is employed. This application functions as a fundamental all-in-one remote control for serial devices with Bluetooth capabilities, such as controller-connected Bluetooth modules. Whenever a button is pressed within the application, the relevant ASCII code is transmitted to the microcontroller, initiating the intended operation.

- The integration of the Arduino Uno microcontroller, HC-05 Bluetooth module, DC motors with a driver IC, SG 90 servo motor and voltage regulator in our proposed system provides an elaborate and effective solution for trash collection. The gripper, enhanced wireless communication technology, and remote control capabilities enhance the system's efficiency, ensuring safety disposal of trash and reducing human effort, and improving user-friendliness.

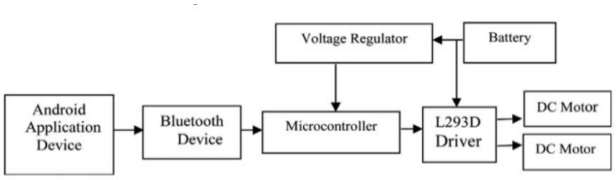

Figure 1. Block Diagram

IV. Hardware

In this section, an overview to the hardware tools used in making the Trash Collector Bot. The project focuses on developing a trash collecting bot that can be manually controlled using an Android app. The hardware components selected for the project include the Arduino Uno microcontroller, HC-05 Bluetooth transceiver module, L298n motor driver module, DC motor with wheel, SG 90 servo motor, jumper wires, and a 9V battery with a battery clip connector. These components form the foundation of the trash collecting bot and enable its functionality.

1. Arduino Uno Microcontroller: The Arduino Uno is a popular microcontroller board that serves as the brain of the trash collecting bot. It provides the necessary computational power and input/output (I/O) capabilities to control and coordinate the various components of the bot. The Arduino Uno is programmable and allows for easy integration of sensors, actuators, and communication modules.

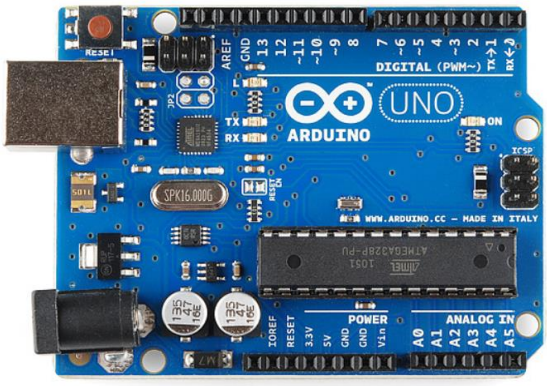

Figure 2. Arduino Uno Microcontroller

2. HC-05 Bluetooth Transceiver Module: The HC-05 Bluetooth transceiver module enables wireless communication between the trash collecting bot and an Android device. It allows for remote control and data transmission, facilitating user interaction with the bot. The HC-05 module supports the Bluetooth Serial Port Profile (SPP) and is widely used for wireless communication in robotics and IoT projects.

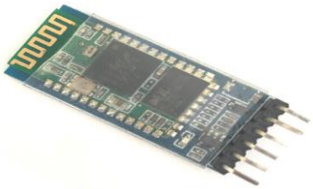

Figure 3. HC-05 Bluetooth Module

3. L298N Motor Driver Module: The L298N motor driver module is utilized to control the DC motor that powers the wheels of the trash collecting bot. It provides the necessary voltage and current regulation to operate the motor, allowing for precise control of its speed and direction. The L298N module can handle up to two motors, making it suitable for controlling the bot's movement.

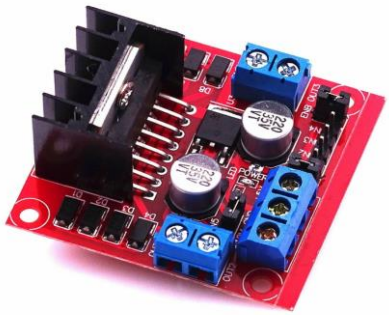

Figure 4. L298N Motor Driver Module

4. DC Motor with Wheel: The DC motor with a wheel is responsible for propelling the trash collecting bot. It converts electrical energy into mechanical energy, enabling the bot to move forward, backward, and turn in different directions. The wheel attached to the DC motor ensures smooth movement and traction on various surfaces.

Figure 5. DC Motor with Wheels

5. SG 90 Servo Motor: The SG 90 servo motor is used to control the movement of the robotic arm in the trash collecting bot. It provides precise angular control and can rotate within a specific range. The servo motor allows the arm to pick up and release objects with accuracy, enhancing the bot's garbage

collection capabilities

Figure 6. SG 90 Servo Motor

6. Jumper Wires: Jumper wires are used to establish electrical connections between different components of the trash collecting bot. They provide a convenient and reliable means of connecting the microcontroller, motor driver module, sensors, and other components together. Jumper wires come in various lengths and can be easily plugged into the appropriate pins or connectors.

Figure 7. Jumper Wires

7. 9V Battery with Battery Clip Connector: The 9V battery with a battery clip connector serves as the power source for the trash collecting bot. It supplies the necessary electrical energy to drive the Microcontroller, motors, and other components. The battery clip connector ensures a secure and reliable connection to the bot's power circuitry.

Figure 8. 9V Battery with Battery Clip Connector

These hardware components, including the Arduino Uno microcontroller, HC-05 Bluetooth transceiver module, L298N motor driver module, DC motor with wheel, SG 90 servo motor, jumper wires, and 9V battery with a battery clip connector, are essential for the functioning of the trash collecting bot. They enable communication, control, movement, and power supply, facilitating the efficient operation of the bot in collecting and managing trash.

V. Experimental Setup and Results

The Arduino Uno microcontroller is utilized to implement the proposed system. It boasts 14 digital input/output pins and 6 analog input/output pins. The operating voltage of the Uno microcontroller is 5 volts. The microcontroller interfaces with a Bluetooth module, four motors, and SG 90 servo motors. A motor driver, the L298N, receives 12 volts from the power supply and drives the motors. Each DC motor is connected to the IN1, IN2, IN3, and IN4 pins of the driver IC. The movement of both the robotic vehicle and arm is controlled via an Android application.

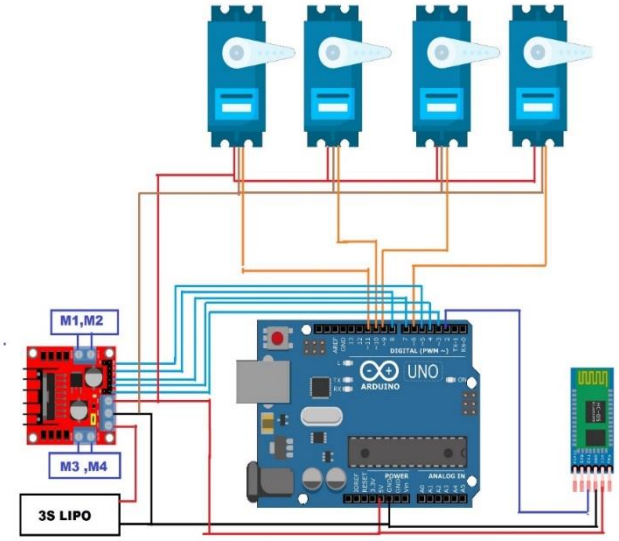

Figure 9. Circuit Layout

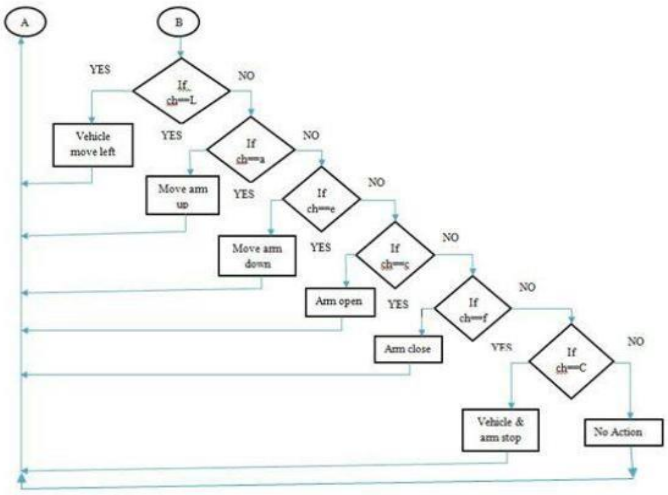

Figure 10. Flow chart

The overall functioning of the system is depicted in Figure 10 through a flow chart. Upon system power-up, Bluetooth communication is enabled. Once the two devices are paired, the controller awaits commands from the user. When a button is pressed on the Bluetooth control application, the corresponding ASCII code is sent to the controller. The controller verifies this code with the pre-stored value, and if they match, the corresponding operation is performed. For example, if the user presses "U," the vehicle moves forward. Similar operations are executed for other commands. After each command, the controller awaits the next one.

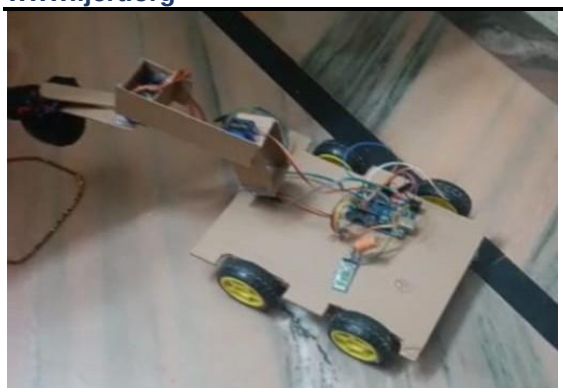

Figure 11. Final Product

Figure 11 illustrates the hardware setup of the final product. The system comprises a vehicle equipped with a robotic arm. The arm is responsible for picking up trash and disposing of it in the appropriate location based on user commands. To facilitate this, communication is established between the user's phone and the system via Bluetooth. When the controller receives a command, it compares it with the pre-stored value and executes the corresponding action. This includes moving the vehicle forward, backward, left, or right. Additionally, the arm can be raised or lowered, and the gripper can open or close to collect garbage.

VI. Conclusion

The trash collecting bot project aimed to develop a bot that could be manually controlled using an Android app created with MIT App Inventor. The bot incorporated several features, including four-wheel drive, Bluetooth connectivity, a robotic arm for garbage collection, and human intelligence for garbage identification. The project yields the following findings:

1. The integration of four-wheel drive mechanism provided the bot with excellent mobility and manoeuvrability, enabling it to navigate through various terrains and obstacles effectively.

2. The Bluetooth connectivity facilitated seamless communication between the Android app and the bot, allowing users to control the bot's movements and functionalities in real-time.

3. The inclusion of a robotic arm in the bot proved to be highly effective in collecting and disposing of garbage. The arm's precision and adjustability allowed for proper handling of different types of waste.

4. The incorporation of human intelligence for garbage identification improved the bot's functionality and efficiency in waste sorting and management.

Overall, the trash collecting bot demonstrated its potential in enhancing waste management practices by providing an efficient and user-friendly solution for garbage collection.

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