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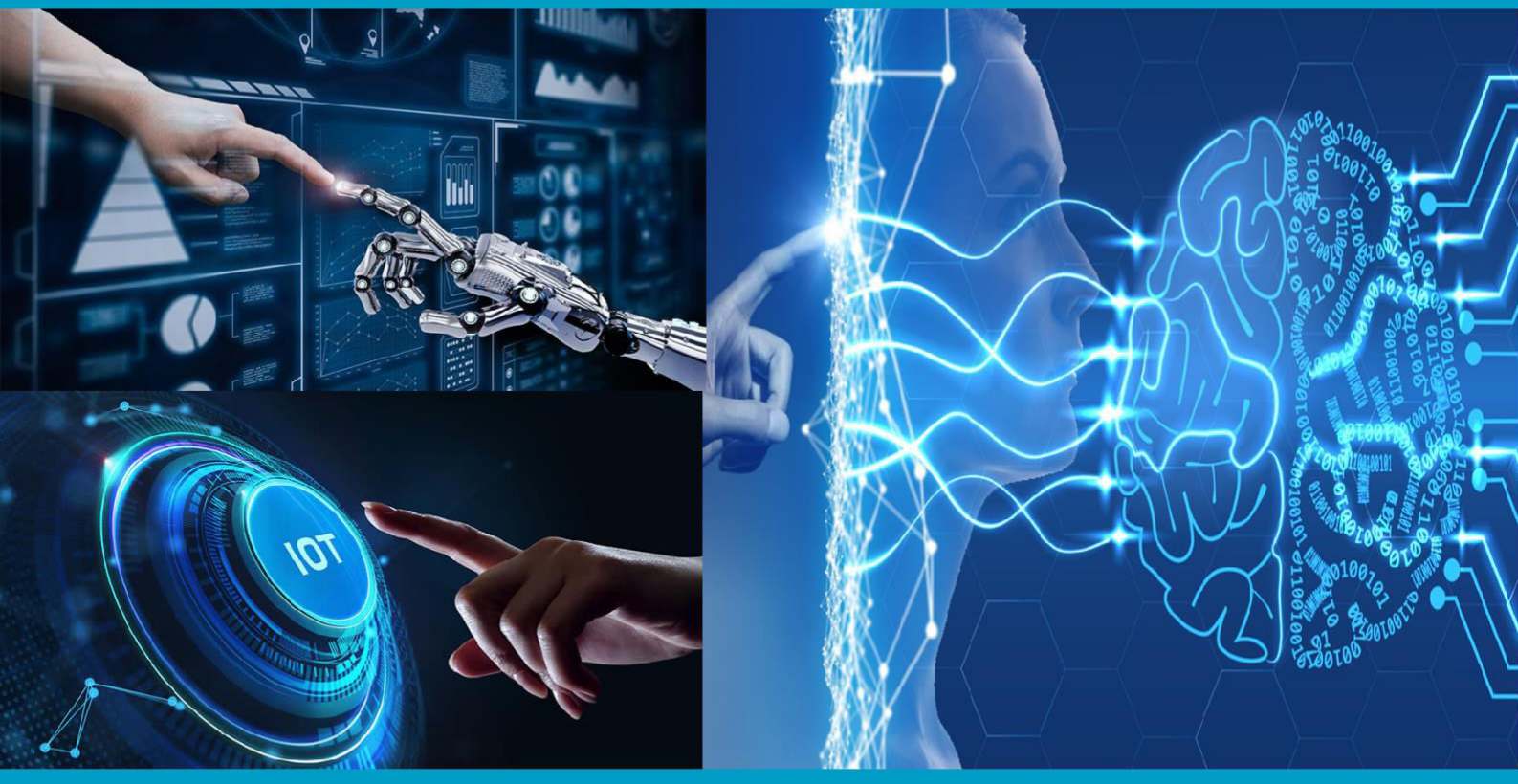

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Autonomous Trash Collection Robot Using IoT

Shashi Kiran S[1], Adeeba Aymen I[2], Manasa H S[3], Venu U[4], Vinay B Sajjanashettar[5]

Assistant Professor, Department of Electronics and Telecommunication Engineering, JNNCE, Shimoga, India[1]

Research Student, Department of Electronics and Telecommunication Engineering, JNNCE, Shimoga, India[2,3,4,5]

ABSTRACT: The primary aim is to introduce a way in which garbage could be collected and disposed efficiently. To analyze the problem of garbage disposal at a school, restaurant, office, hotel, production plant or any other suitable location. To design and develop a system for solving the problem. To test and maintain the implemented system. We have designed a semi-autonomous garbage collector robot which can do multiple functions. This robot has one robotic arm in which it can pick the garbage and dispense it in main basket attached to the robot. The camera placed on robot helps the administrator to remotely monitor the robot while collecting garbage. This robot has installed batteries in which there is no fuel or electricity required to complete the operation.

KEYWORDS:ESP32, Ultrasonic Sensor, Metal proximity Sensor, IoT.

I. INTRODUCTION

Waste management is the big issue globally and it needs serious attention. There is no proper management of waste and garbage in rural and urban area, which may cause threat to health security, hygiene, human safety and wild life safety. Autonomous robot was proposed for cleaning purpose to avoid the boring task. Presently the manual garbage collection system exists in most places, where human intervention is involved. Manual garbage collection and waste management is the good source to generate employment but there are some issues associated with it, like some time there is unavailability of manual labor. The autonomous or semi-autonomous garbage collection unit may have high manufacturing cost but less maintenance cost.

Robotics is an emerging field in the world which is bringing drastic changes in human life. Robots are designed in human interactive way and they are becoming part of lives. Human power is being saved by replacing it by robots in various fields. Cleaning public places is one such field where more human power is required. These include several common tasks such as navigation, path planning, object detection and discrimination, obstacle avoidance, task sequencing. The major public problem faced by many developing countries, especially in India, is lack of uncollected trash littering the streets, roads, sidewalks, shopping malls, railway and bus stations and many other public places. An autonomous robot is a robot which performs behaviors or tasks individually with highest degree of autonomy. The trash is picked up using robotic arm. The picked-up trash is segregated and dumped into bin attached to the robot which has separate partitions for metallic and nonmetallic trashes.

Trash collection robots can be used in a variety of settings, such as public parks, beaches, and city streets. They are often designed to be environmentally friendly, using electric power sources and minimizing their impact on the environment. One of the key benefits of using trash collection robots is that they can help to reduce the amount of waste in public spaces, making them cleaner and safer for people to use. As technology continues to advance, we can expect to see even more sophisticated trash collection robots in the future, with improved sensors, faster speeds, and greater efficiency. Overall, these robots have the potential to make a significant positive impact on the environment and public health.

The aim of a trash collection robot is to automate the process of collecting and disposing of waste in order to improve efficiency, reduce human labor, and minimize the negative impact of waste on the environment. By using a trash collection robot, it is possible to increase the speed and accuracy of waste collection, reduce the risk of injury to human workers, and decrease the amount of waste that ends up in landfills or on the streets. Additionally, by using robotic technology, it may be possible to sort and recycle waste more efficiently, reducing the environmental impact of waste

disposal. Ultimately, the aim of a trash collection robot is to create a more sustainable and environmentally-friendly way of managing waste

II. OBJECTIVES OF THE PROPOSED SYSTEM

Bot moves according to the user instruction which is controlled by the mobile phones or laptop. It detects and collects the paper and plastic items automatically and process it. So, this reduces the requirement of manual clearance of plastic waste.Collected wastes will be dumped into the bin which is attached to the bot. It has separate partition for metal and non-metal wastes. Saving or optimizing the time, energy while collecting or segregating the wastes and to increase overall speed. The objective of this project is to providing automatic control to collect trash or garbage and to clean up waste materials on the coastline beaches and other public places.

III. LITERATURE SURVEY

Waste collection and management is a subject undergoing extensive study, and solutions are being proposed meticulously. The need for a more robust waste management strategy is essential. Presently, waste management techniques either lack efficiency, or incur high costs. Collection of the unorganized and scattered garbage is the preliminary and most vital step of waste management, following proper segregation and disposal. This paper proposes, explains, and implements concept of making cost-effective system for garbage collection.

Pollution is a serious issue that goes alarming every now and then. Pollution increases subsequently with increase in population. Garbage has to be strictly discarded to avoid pollution. “Garbage Collecting Robot” can clean up all the garbage that are thrown on the roads using Raspberry Pi. This robot will be built on a metallic base and powered by a battery and contains a Picam to segregate wastes on image processing. The bot will contain a sensor for obstacle detection and hence has a good path determination.

Litter disposal has emerged as a challenging task for the railway department, especially for the sanitary workers of the railway department. The concept of an autonomous trash cleaning bot is a level up from standard garbage collection methods. In this project, the proposed concept of an automated railway lane cleansing machine contains an autonomous bot with four major components Trash management unit, a control unit, a motor unit, and a power supply. The trash collecting unit is made up of three sub- units collection storage and disposal in which the collection sub-unit is equipped with two rotating brushes which intake the trash and send it to the storage sub-unit and the storage sub-unit also acts as a disposal unit that can be lifted using a spur gear and stopped at a certain point using stop switch and the trash can be disposed of using another standard trash collection vehicle outside the track. This bot makes the trash collection process even simpler because of its small size, easy operation methods, and can easily be lifted on and off the track using a manual stacker

IV. METHODOLOGY

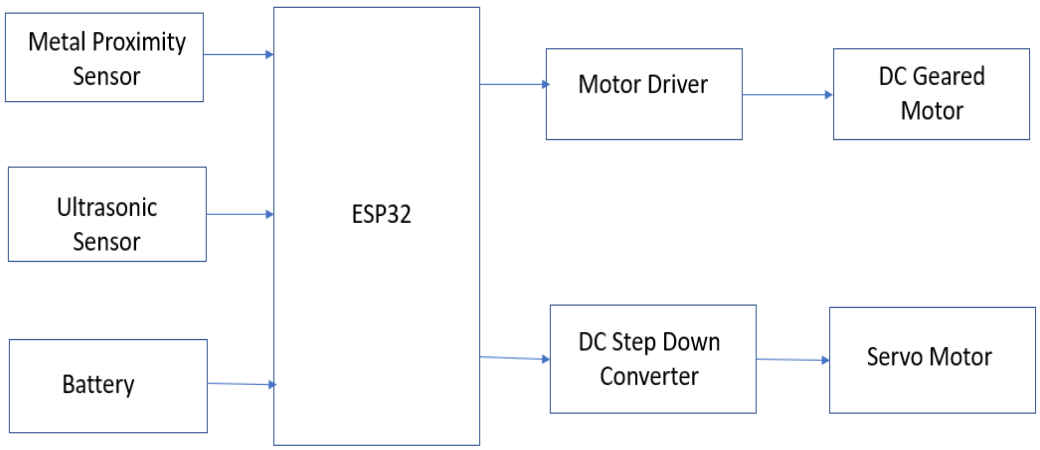


Fig : Block diagram of Autonomous Trash Collection Robot

Trash-bot has an IOT interface with autonomous and manual mode of control. The trash is picked up using robotic arm. The picked-up trash is segregated (metallic and nonmetallic) and dumped into bin attached to the robot which has separate partitions for metallic and nonmetallic trashes. In manual mode the robot locomotion and trash pickup is operated using an android phone. The collected trash is transferred to a trash bin attached to the robot platform. Another Servo motor attached to the trash bin will rotate the bin so that the collected waste will fall into the corresponding partition of the bin. In autonomous mode the robot locomotion and waste pickup is done without human intervention. The robot is placed at the centre of the workspace. Then it follows a coverage path planning algorithm/random path planning algorithm. The trash detection is made possible using ultrasonic sensors. Using this ultrasonic sensor configuration, the robot will be able to distinguish between big objects(walls) and objects that it may be able to pick. Metal detectors placed in the arm check the trash picked to be metallic or nonmetallic and are dumped to its corresponding partition .Ultrasonic sensor placed in the trashbin monitor the level of the waste in the bin. If the bin is full it is notified to the operator.

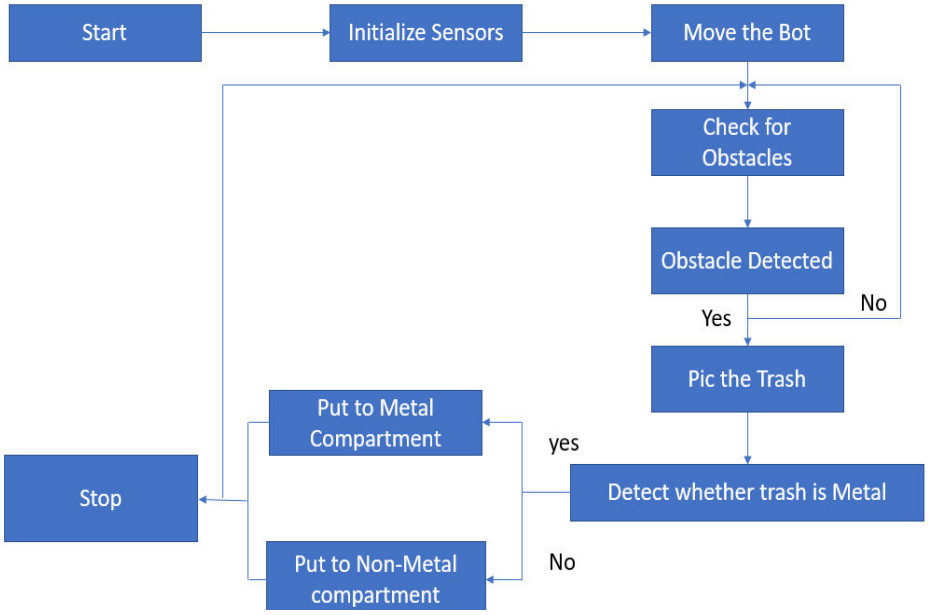


Fig : Flow chart of Autonomous Trash Collection Robot

ESP32 is the heart of this project. ESP32 is the microcontroller which gets the input from the two sensors metal proximity sensor and ultrasonic sensor. The battery is used to charge up the ESP32 micro-controller. The controller is the main part of the bot. It contains the Arduino code that the bot needs to operate. It controls the movement of the motor. There are four motors present in the bot. It is used to control the movement of the bot in a forward, reverse, left and right direction. Motor driver, DC geared motor, DC step-down converter and servo motors are connected to the microcontroller. Servo motor is used for the movement of the arms connected to the bot and for the rotation of the bin. DC geared motor is connected to the wheel for the movement of the bot. Step-down converter is connected to the servo motor and it is used to step-down the voltage of the battery

V. CIRCUIT DIAGRAM

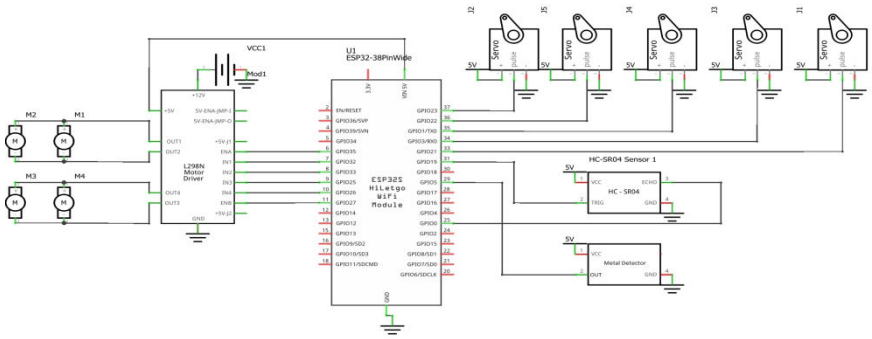


Fig Circuit diagram

VI. HARDWARE AND SOFTWARE DESCRIPTION

A. ESP32

ESP32 is a low-cost System on Chip (SoC) Microcontroller from Espressif Systems, the developers of the ESP8266 SoC. It is a successor to ESP8266 SoC and comes in both single-core and dual-core variations of Tensilica's 32-bit Xtensa LX6 Microprocessor with integrated Wi-Fi and Bluetooth. ESP32 has a lot more features than ESP8266 and it is difficult to include all the specifications in this Getting Started with ESP32 guide. So, I made a list of some of the important specifications of ESP32 here. Single or Dual-Core 32-bit LX6 Microprocessor with clock frequency up to 240 MHz.

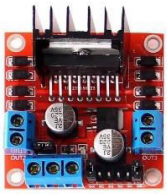
- 520 KB of SRAM, 448 KB of ROM and 16 KB of RTC SRAM.
- Supports 802.11 b/g/n Wi-Fi connectivity with speeds up to 150 Mbps.
- Support for both Classic Bluetooth v4.2 and BLE specifications.
- 34 Programmable GPIOs.
- Up to 18 channels of 12-bit SAR ADC and 2 channels of 8-bit DAC
- Serial Connectivity includes 4 x SPI, 2 x I^2C, 2 x I^2S, 3 x UART.

B. Motor Driver

The L298N chip contains two standard H-bridges capable of driving a pair of DC motors, making it ideal for building a two-wheeled robotic platform.
The L298N motor driver has a supply range of 5V to 35V and is capable of 2A continuous current per channel, so it works very well with most of our DC motors.

Specifications

- Driver Model: L298N 2A
- Driver Chip: Double H Bridge L298N
- Motor Supply Voltage (Maximum): 46V
- Motor Supply Current (Maximum): 2A
- Logic Voltage: 5V
- Driver Voltage: 5-35V



C. **Ultrasonic Sensor**

This sensor is a very popular sensor used in many applications where measuring distance or sensing objects are required. The module has two eyes like projects in the front which forms the Ultrasonic transmitter and Receiver. The sensor works with the simple high school formula that

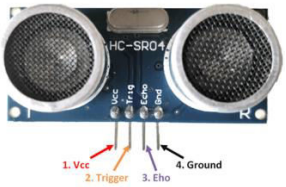
Distance = Speed × Time

The Ultrasonic transmitter transmits an ultrasonic wave, this wave travels in air and when it gets objected by any material it gets reflected back toward the sensor this reflected wave is observed by the Ultrasonic receiver module.

Now, to calculate the distance using the above formulae, we should know the Speed and time. Since we are using the Ultrasonic wave, we know the universal speed of US wave at room conditions which is 330m/s. The circuitry inbuilt on the module will calculate the time taken for the US wave to come back and turns on the echo pin high for that same particular amount of time, this way we can also know the time taken. Now simply calculate the distance using a microcontroller or microprocessor.

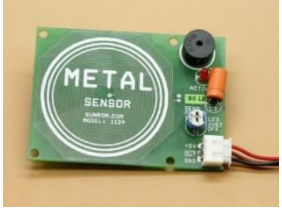
HC-SR04 Sensor Features

- Operating voltage: +5V
- Theoretical Measuring Distance: 2cm to 450cm
- Practical Measuring Distance: 2cm to 80cm
- Accuracy: 3mm
- Measuring angle covered: <15°
- Operating Current: <15mA
- Operating Frequency: 40Hz



D. **Metal Proximity Sensor**

It is a sensor which is connected as input to the NodeMCU, which is placed in the arms of the bot and it is used to check whether the trash picked up is a metal or nonmetal.



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E. **Servo Motor**

A servo motor is a type of motor that can rotate with great precision. Normally this type of motor consists of a control circuit that provides feedback on the current position of the motor shaft, this feedback allows the servo motors to rotate with great precision.

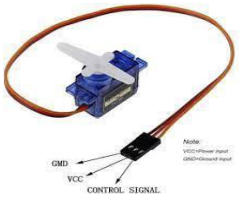
1: ULTRA TORQUE DUAL SHAFT METAL GEAR 35KGCM CORELESS SERVO- This is the main servo which pulls the robotic arm up and down.

2: HIGH TORQUE DIGITAL SERVO MOTOR- This servo is used to rotate the trashbin based on whether the picked-up trash is a metal or nonmetal.

3: MG995 METAL GEAR SERVO 180 DEGREE ROTATION- 2 of this servos are used to grab the trash by rotation of arm.

TowerPro SG-90 Features

- Operating Voltage is +5V typically
- Torque: 2.5kg/cm
- Operating speed is 0.1s/60°
- Gear Type: Plastic
- Rotation: 0°-180°
- Weight of motor: 9gm
- Package includes gear horns and scre**ws**



F. **DC-DC Step down Converter**

This DC-DC switching boost converter is capable of driving a 4A load with excellent line and load regulation. The main switching componentXL6009 ICis available in fixed output voltages of 3.3 V, 5V, 12V, and an adjustable output version. It is an efficient switching regulator and the output efficiency is significantly higher in comparison with the popular boost regulators. At higher input voltages, the regulator operates at a switching frequency of 400kHz thus allowing the overall board size to be smaller and space-saving.

The XL6009 module is a DC to DC BUCK-BOOST converter module that operates at a switching frequency of 400kHz. In such high frequency, it provides smaller sized filter components compared with low frequency switching regulators. It is the upgraded version of the LM2577 based module.

specification

- Input voltage: 3 - 32V
- Output voltage: 5 - 35V (adjustable)
- Output current: Maximum output current 4A

G. **DC Geared Motor**

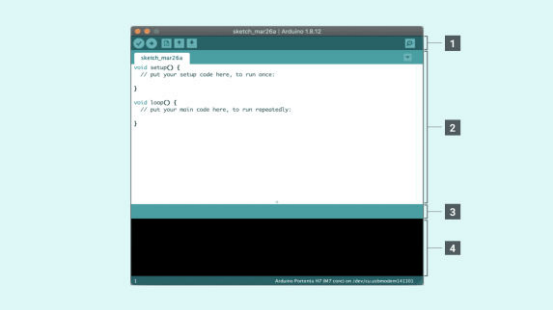
BO (Battery Operated) lightweight DC geared motor which gives good torque and rpm at lower voltages. This motor can run at approximately 200 rpm when driven by a single Li-Ion cell. Great for battery operated light weight robots. It can do reverse and forward directions. Great for battery operated light weight robots. A specific type of DC geared motors that can be operated through a battery and that is why it is known as Battery Operated (BO) motors. It is used for lightweight applications mostly. Available in different torque and RPM.

Features:

- Input Voltage(V): 4.5 - 9 V
- Current rating: 0.07A (maximum on load)
- Speed (RPM): 100 RPM+-10%

H. **Arduino IDE**

It is used for programming the audio. Arduino IDE is an open-source software that is used for writing the code into the Arduino module. IDE stands for "INTEGRATED DEVELOPMENT ENVIRONMENT", where it can be used to edit, compile and upload the code to the Arduino device. It supports both C and C++ languages. The IDE environment mainly consists of two parts, editor andcompiler where it is used for writing the code and later used for compiling and uploading the code into the given Arduino module. The overview of the software is as shown in the



VII. RESULTS

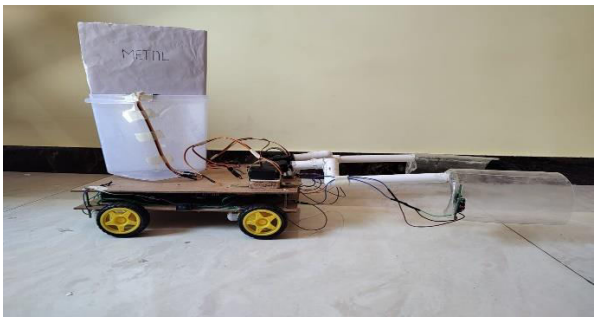


Fig : Detects metal .

Fig : Detects Non- metal

VIII. CONCLUSION

We have designed a semi-autonomous garbage collector robot using ESP32 which can do multiple functions the basic reason of completion of this task is to implement a well-organized way of garbage compilation and to trim down the production cost. Intelligently handling garbage waste can help for clean environment and to reduce environment pollution and also reduces the requirement of manual clearance.The development of a trash collection robot is a promising solution to address the growing problem of waste management. A well-designed robot can efficiently navigate through different environments, collect and sort various types of waste, and significantly reduce the workload of human waste collectors

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