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A Survey of Automatic Dustbin Collecting Robot by using STM32

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Abstract: *The STM32-based Automatic Dustbin Collecting Robot is built to pick up and carry waste without human handling, which lowers manual labour and keeps surroundings cleaner. An STM32 microcontroller serves as the central controller: it reads the sensor inputs and drives both the wheels and the waste-pickup mechanism.*

Infrared (IR) sensors allow the robot to spot objects or stay on a set route, while ultrasonic sensors gauge distance and flag obstacles in its way. Geared BO motors, run through an L298N motor driver, move the robot. MG995 metal-gear servo motors actuate the arm or lifting unit that picks up waste and tips it into the main bin fixed on the chassis.

The proposed design seeks to make waste pickup faster and more dependable, cut down human involvement in repetitive cleaning work, and contribute to smart waste-management solutions. It can later be extended with IoT for remote monitoring and with more capable autonomous navigation. The robot suits classroom demonstrations and can be adapted for colleges, offices, factories and other public spaces.

Keywords: Automatic Dustbin Collecting Robot, STM32 Microcontroller, Waste Management, IR Sensor, Ultrasonic Sensor, Servo Motor, L298N Motor Driver, Autonomous Robot, Smart Waste Collection, Battery Monitoring. Smart City, IoT-Based Waste Management.

I. INTRODUCTION

Keeping surroundings clean and healthy depends heavily on proper waste handling. In colleges, offices, hospitals, factories and public spaces, gathering rubbish and emptying bins still takes considerable human time and effort. Conventional methods tend to be slow and can expose workers to unsanitary conditions, so automation offers a way to make the job simpler, safer and quicker.

The Automatic Dustbin Collecting Robot automates the pickup of waste and its transfer into a main bin carried on the robot's chassis. An STM32 microcontroller is the core controller; it interprets signals from several sensors and uses them to direct the robot's motion and its collection mechanism.

IR sensors are used to detect objects or follow a path, and ultrasonic sensors measure distance and sense obstacles. BO motors, switched by an L298N driver, move the robot, and MG995 metal-gear servos work the arm or lift that gathers and moves the waste. A rechargeable lithium-polymer battery powers the whole system, with buck converters stepping the voltage down to what each electronic part needs.

The central aim is to lessen manual labour, raise the efficiency of waste pickup, and show how robotics can be applied to smart waste management. The design can be upgraded with IoT-based remote monitoring and better autonomy. Overall, the project offers an affordable, practical route to automated waste collection for educational institutions, offices and similar settings.

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II. BACKGROUND AND MOTIVATION BACKGROUND

Collecting waste is vital for cleanliness and public health. Bins in colleges, offices, hospitals, factories and public areas must be gathered, carried and emptied on a regular basis. Since this work has traditionally relied on people, it is slow, repetitive and often unhygienic, which creates demand for automated alternatives.

Progress in robotics and embedded electronics now makes it feasible to build machines that handle waste collection with little human input. By combining microcontrollers, sensors, motors and mechanical lifting parts, an automatic dustbin collecting robot can be constructed.

The STM32-based Automatic Dustbin Collecting Robot was developed in response to these problems. The STM32 reads IR and ultrasonic sensor signals to control the robot. BO motors supply movement under the control of an L298N driver, and MG995 metal-gear servos operate the mechanism that lifts, gathers or moves waste into the main bin on the robot. A rechargeable battery powers every part of the system.

Motivation

The chief reason for this work is to reduce manual effort, speed up waste pickup, and illustrate how robotics can serve everyday cleaning tasks.

The project also gives hands-on exposure to embedded systems, sensor interfacing, motor control and mechanical automation.

Looking ahead, IoT connectivity, better navigation and bin-level monitoring could be added to move toward smarter, more efficient waste management.

III. SYSTEM ARCHITECTURE

The robot combines hardware and software elements that cooperate to automate bin collection and waste transfer. The STM32 microcontroller is the central processor: it takes in sensor signals and commands the motors and the servo-driven collection mechanism.

The architecture splits into five parts: input sensors, the control unit, the motor control system, the waste collection mechanism and the power supply.

3.1 Main Components and Their Functions

1. STM32 Microcontroller: The robot's central controller, handling sensor data and directing movement and collection.
2. IR Sensors: Sense objects or guide the robot along a set path.
3. Ultrasonic Sensors: Gauge the distance to nearby objects and spot obstacles so collisions are avoided.
4. L298N Motor Driver: Sets the direction and speed of the BO motors in response to STM32 signals.
5. BO Motors: Turn the wheels and make the robot move.
6. MG995 Metal Gear Servo Motors: Drive the arm or lifting unit that picks up and moves bins or waste.
7. Main Dustbin: Fixed on the chassis to hold the waste that is collected.
8. Rechargeable Li-Po Battery: Provides the electrical power for the robot.
9. Buck Converters: Lower the battery voltage to the levels needed by the controller, sensors and other electronics.
10. Voltage Sensor: Observes the battery voltage so the remaining power can be tracked.

3.2 Hardware Requirements

The robot is assembled from the hardware listed below:

1. STM32 Microcontroller: Manages the robot's overall operation.
2. IR Sensors: Sense objects and let the robot stay on a set path.
3. HC-SR04 Ultrasonic Sensors: Measure distance and sense obstacles.
4. Buck Converter: Steps 12V DC down to 5V DC for the electronics.

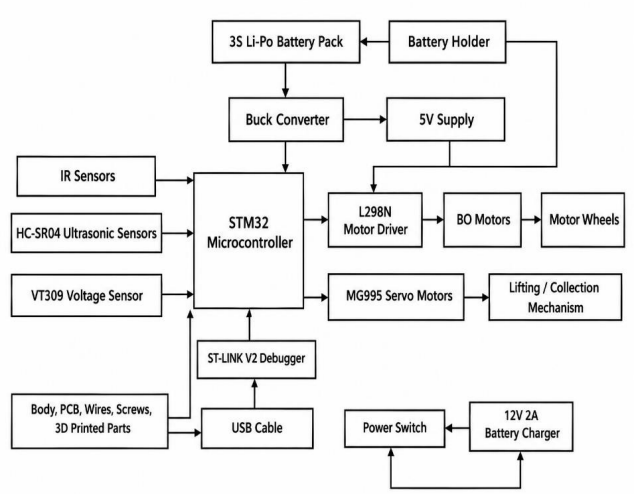
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5. Battery Holder: Keeps the battery packs firmly in place.
6. BO Motor Wheels: Let the robot travel over the ground.
7. L298N Motor Driver: Regulates the speed and direction of the DC motors.
8. MG995 Servo Motors: Power the mechanical lifting and waste-collection mechanism.
9. 3S Li-Po Battery Pack: Delivers power to the robot.
10. Switch: Turns the robot's power on and off.
11. USB Cable: Links the controller to a computer for programming.
12. 12V 2A Battery Charger: Recharges the battery pack when its specifications match.
13. Body, PCB, Wires, Screws: Give structural support and make the electrical connections.
14. ST-LINK V2 Debugger: Used to program and debug the STM32 microcontroller.
15. VT309 Voltage Sensor: Tracks the battery voltage.

3.3 Software Requirements

Programs for the robot are written, compiled and uploaded to the STM32 through the Arduino IDE, with the STM32 Arduino Core supplying the needed board support. The control code for the sensors, BO motors and servo motors is developed in embedded C/C++. Firmware is loaded with STM32CubeProgrammer, and debugging tools help locate and fix coding errors. Where suitable component models exist, Proteus Design Suite can be used to design and simulate the circuit. Together, these tools make it easier to build, test and operate the robot.

3.4 Block diagram



IV. OPEN ISSUES AND CHALLENGES

Designing and building the robot raises a number of difficulties. The principal ones are dependable object detection, obstacle avoidance and steady movement over varied surfaces. The servo-driven lifting unit needs enough torque to pick up and move waste correctly. Power use is a further concern, because the motors and servos draw substantial current, and careful voltage regulation is needed to shield the STM32 and the sensors. Mechanical stability, sensor accuracy, wiring complexity and the coordination of hardware with software also need attention. These problems can be tackled by choosing components wisely, writing efficient code, designing circuits carefully and testing repeatedly.

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V. APPLICATIONS

1. Colleges and Schools: Assists in gathering waste and keeping campuses tidy.
2. Offices: Aids waste pickup inside workplaces.
3. Hospitals: Helps collect general waste in suitable zones.
4. Industries: Collects light waste materials in working areas.
5. Public Places: Usable in parks, gardens and other open public spaces.
6. Smart Waste Management: Supports automation within waste-collection systems.
7. Research and Education: Helps students learn about robotics, sensors and embedded systems.

VI. CONCLUSION

The Automatic Dustbin Collecting Robot is intended to automate waste pickup and lessen manual labour. An STM32 microcontroller, IR and ultrasonic sensors, BO motors, an L298N motor driver and MG995 servo motors together control the robot's motion and run the waste-collection mechanism. A rechargeable Li-Po battery powers the system, and buck converters supply the voltage levels required.

The work shows how robotics, embedded systems and sensing technology can be applied to waste management, and it can improve cleanliness and collection efficiency in appropriate settings. Future versions could add IoT-based monitoring, better navigation and waste-level detection to become more efficient and intelligent.

VII. FUTURE ENHANCEMENT AND DIRECTION

The robot can be upgraded in future by incorporating newer technologies and features.

1. IoT Integration: Allow remote monitoring and control through a mobile app.
2. Improved Navigation: Apply more advanced sensors for better autonomous movement and obstacle avoidance.
3. Dustbin Level Detection: Fit sensors that report when the main bin is full.
4. Battery Monitoring: Refine battery-level tracking and add low-battery alerts.
5. Waste Classification: Use suitable sensors or image processing to sort waste by type.
6. Improved Collection Mechanism: Build a sturdier and more dependable servo-driven lifting unit.
7. Energy Efficiency: Tune motor control and power use to extend running time.

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