International Journal of Science, Strategic Management and Technology
Volume **02** Issue **10** October-2026 | ISSN: **3108-1762 (Online)** | Impact Factor: 3.8
An International, Peer-Reviewed, Open Access Scholarly Journal Indexed in recognized academic databases

GPS Guided Street Cleaning Robot

1st Chaithrashree, 2nd Rakshitha V, 3rd Rhea A, 4th Darshangowda D, 5th Nagaraj C K,
Assistant Professor, Student, Student, Student, Student,
Department of Electrical and Electronics Engineering,
Vidya Vikas Institute of Engineering and Technology, Mysore, Karnataka, India
chaithrashree@vidyavikas.edu.in, vrakshitha932@gmail.com, rheaaa.028@gmail.com, darsudarshan091@gmail.com, nagarajck46@gmail.com

https://doi.org/10.55041/ijsmt.v2i10.091

Cite this Article: V, R., A, R., D, D. & K, N. C. (2026). GPS Guided Street Cleaning Robot. International Journal of Science, Strategic Management and Technology, *02*(10), 1-9. https://doi.org/10.55041/ijsmt.v2i10.091

License: This article is published under the Creative Commons Attribution 4.0 International License (CC BY 4.0), permitting use, distribution, and reproduction in any medium, provided the original author(s) and source are properly credited.

ABSTRACT

Street cleaning is essential for maintaining public hygiene, but manual cleaning can be time-consuming and physically demanding. This paper presents a conceptual design for a GPS-guided street cleaning robot that combines outdoor location information, obstacle detection, microcontroller-based control, and an automated cleaning mechanism. The proposed system uses a GPS module to estimate its outdoor position, obstacle sensors to detect objects in its path, a motor driver and DC geared motors for movement, and a rotating brush or collector to gather small, dry surface debris into a waste bin. The paper describes the system methodology, conceptual block diagram and circuit flow, major components, working principle, and a proposed testing and evaluation approach. GPS accuracy, cleaning efficiency, obstacle avoidance, and battery operating time are identified as important evaluation measures. As this is a proposed design, measured performance results should be added after prototype testing.

Keywords: GPS navigation, street cleaning robot, obstacle avoidance, microcontroller, automated waste collection, robotics.

INTRODUCTION:

Street cleaning is an important task to maintain and improve the hygiene and aesthetics of any region. Streets, college, and campus grounds, footpaths, parking, and other outdoor surfaces are prone to accumulation of dust, dry leaves, paper, plastic, and other minute materials. These surfaces must be cleaned regularly to prevent pollution, bad odor, and unsightliness. However, manual cleaning of streets can be exhausting and time-consuming. Street cleaners might need to use large and expensive cleaning vehicles to tackle large areas, but these might not be suitable for narrow roadways, footpaths, and other confined regions.

Modern advancements in robotics and automation, electronics and embedded systems, and GPS navigation can be combined together to develop a street cleaning robot to reduce manual effort. Such a robot can navigate through a planned outdoor route and pick up any small and light surface litter automatically.

A GPS Guided Street Cleaning Robot, as the name suggests, uses a GPS module to receive general outdoor location information. It comprises a microcontroller, motor driver, DC geared motors, obstacle detection sensors, cleaning brush, robot body or chassis, wheels, and a dustbin for storing the collected waste. The microcontroller interprets the location and sensor information received and controls the robot movements via the motor driver to navigate the robot across the desired area. Obstacle sensors detect any objects in the line of travel, and the robot controller uses this information to halt the robot or change direction according to the programmed instructions.

Meanwhile, a rotating cleaning brush or another attachment gathers the collected dry debris and

© Author(s). This work is peer-reviewed, openly published, and permanently archived
This article is openly accessible and reusable with proper attribution.

transfers it to the dustbin attached to the robot body. Finally, a battery provides power to all the robot systems and electronics. Such a robot can be programmed or guided to move around the college campus, residential streets, parking, and similar regions, picking up any small and light surface litter without requiring extensive manual labour.

This project aims to propose a design for a robot that can use GPS navigation, obstacle sensors, and microcontroller-based automation to reduce manual effort in street cleaning.

LITERATURE SURVEY:

The literature review for this project covers the fundamental concepts related to cleaning robots, GPS navigation, and similar fields.

• Cleaning robots:

Cleaning robots are automated machines capable of performing tedious cleaning tasks with minimal human supervision. Such robots typically comprise electric motors, rotating brushes, wheels, and microcontroller-based systems to control their operation. The cleaning ability of such robots depends on the surface of the region to be cleaned, the size of the debris or dirt, and the mechanism used for collection. The basic idea of a cleaning robot can be scaled and modified to develop a mobile robot with obstacle avoidance and GPS navigation.

• GPS-based mobile robot navigation:

GPS or Global Positioning System is a satellite-based navigation system that provides accurate outdoor location information for human use. A GPS navigation system can be integrated with a mobile robot to provide basic positional commands, although such a system may not be accurate enough for mobile robot navigation.

• Obstacle detection and avoidance in mobile robots: Obstacle detection refers to the ability of a robot to sense any objects in its field of view or line of travel. This information can be used by the controller to modify the robot movement to avoid collisions with objects in the region. Proximity sensors or ultrasonic sensors can be used in such a system to provide distance and position information about nearby objects. These sensors have a limited detection range, and their sensitivity must be set according to the application.

• Automated waste collection:

Automated waste collection systems typically comprise a mobile platform, brushes, conveyor belt, or suction mechanism. Such robots can be programmed depending on the type of waste to be collected and the terrain of the region to be cleaned. For instance, a simple rotating brush and collector mechanism may be sufficient to gather small amounts of dry dirt, whereas wet, heavy, sharp, and large objects may require a different mechanism.

• Embedded systems in robotics:

A microcontroller is an efficient way to process sensor information and control robot movements and other operations. It enables division of labour between individual systems in a mobile robot. Embedded programming can be used in such a system to improve the performance of individual processes. Therefore, microcontrollers and embedded programming are essential components of modern robotics.

The information reviewed in this section forms the basis of the project. A complete and academic submission would require further research and discussion on relevant research papers about robotics, automation, and GPS navigation.

PROBLEM STATEMENT:

Street cleaning is an arduous task requiring continuous manual labour. Additionally, manual street cleaning may leave some regions uncleansed, or large vehicles may be required to clean streets, which may not always be possible. Existing concepts for automated cleaning robots may require further development and modification for practical applications in street cleaning and cleaning of other large outdoor surfaces. Therefore, there is a need to develop a novel robotic system capable of navigating a planned outdoor route, detecting obstacles in its path, and collecting small dry surface litter with minimal manual intervention.

OBJECTIVES:

The primary objectives of this project are as follows:

• To propose a design for a GPS-guided street cleaning robot.

• To enable the robot to navigate a predetermined route using GPS navigation.

• To enable the robot to collect dry dirt and surface litter automatically.

• To implement obstacle detection and avoidance mechanisms.

• To implement microcontroller-based automation to control the robot movement and operation.

© Author(s). This work is peer-reviewed, openly published, and permanently archived
This article is openly accessible and reusable with proper attribution.

• To reduce the overall manual effort required for cleaning.
• To test and evaluate the performance of the developed system.
• To demonstrate the practical application of GPS navigation, embedded programming, and robotics. By completing this project, one would be able to develop a working prototype capable of reducing the manual effort required for cleaning.
•

METHODOLOGY:

The methodology of the proposed system revolves around the primary components: the microcontroller, GPS module, obstacle sensors, motor driver, and DC motors.

The microcontroller receives and processes input from the GPS module and obstacle sensors. It controls and coordinates the robot movement mechanism comprising the motor driver and DC motors and the cleaning mechanism, as discussed later in detail.

The general operation of the robot can be summarised as follows:

• The operator switches on the robot, and the microcontroller performs a system check and initializes the GPS module, sensors, motor driver, and cleaning mechanism.
• The GPS module receives satellite information and relays the outdoor coordinates to the microcontroller.
• The microcontroller compares the current position coordinates with the predetermined position or target and controls the robot movement.
• The motor driver receives signals from the microcontroller and controls the power delivered to the DC motors.
• As the robot moves, obstacle sensors detect any objects in the robot's field of view. The microcontroller processes this information to stop or change the robot's movement.
• The cleaning mechanism gathers the surface dirt and transfers it to the dustbin.
• The robot stops when it reaches the end of the desired cleaning route or when the operators terminate the process.

GPS-based navigation may not always be accurate enough for robot navigation, and thus an additional inertial navigation system may be required.

BLOCK DIAGRAM:

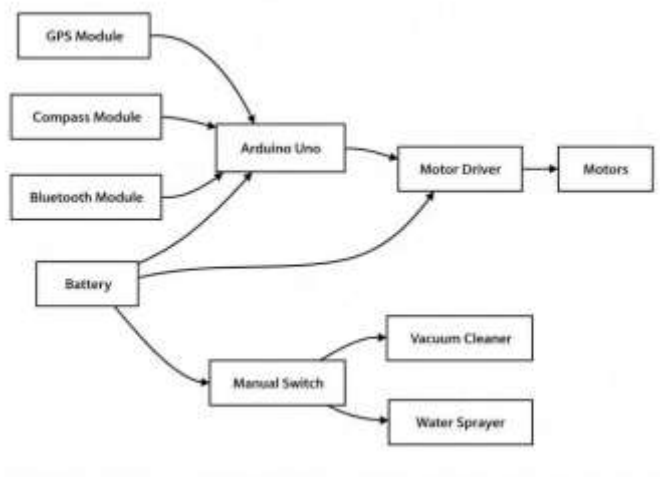


Fig 1 : Block diagram of GPS guided street cleaning robot

Explanation of the Block Diagram:

• Battery and power supply: The battery provides power to all the systems and electronics in the robot.
• GPS Module: The GPS module provides the approximate outdoor coordinates of the robot.
• Obstacle Sensors: Obstacle sensors provide information about the objects in the robot's field of view or path.
• Microcontroller: The microcontroller processes the information received from GPS and sensors and controls robot movement.
• Motor Driver: The motor driver controls the power supplied to the DC motors.
• DC Motors and Wheels: The motors and wheels enable the robot movement and rotation.
• Cleaning mechanism and collection bin: The cleaning mechanism gathers the debris and transfers it to the bin.

The block diagram provides a conceptual representation of the robot design and does not show the actual pin connections between individual components. The exact circuit diagram would have to be drawn for the selected controller, GPS module, sensors, and other components.

© Author(s). This work is peer-reviewed, openly published, and permanently archived
This article is openly accessible and reusable with proper attribution.

International Journal of Science, Strategic Management and Technology
Volume **02** Issue **10** October-2026 | ISSN: **3108-1762 (Online)** | Impact Factor: 3.8
An International, Peer-Reviewed, Open Access Scholarly Journal Indexed in recognized academic databases

CIRCUIT FLOW:

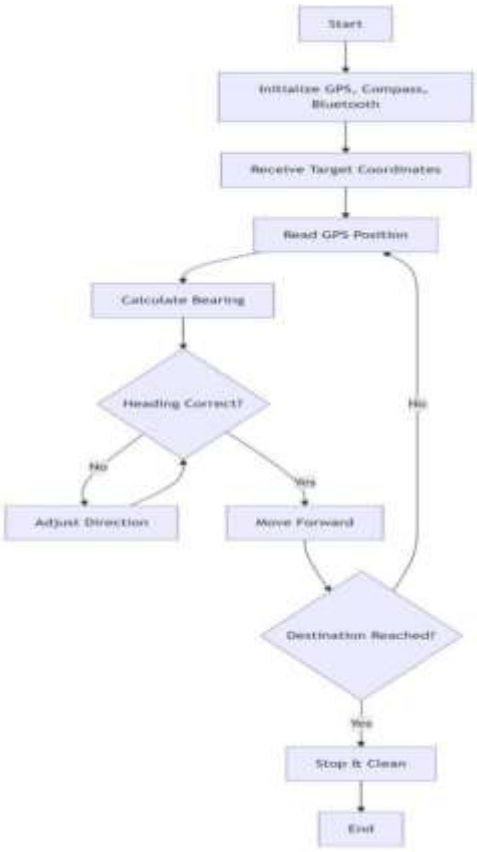


Fig 2 : Circuit flow of GPS guided street cleaning robot

Explain the circuit flow:

The battery is the primary power source for the robot. The voltage regulator or the power distribution circuit provides the required voltage, and the motor driver provides the necessary high current to the DC motors. The cleaning motor can be driven by a separate motor driver or switching circuit with a rating equal to or higher than the motor's current rating.

The GPS module provides position information to the microcontroller through a serial communication interface, typically UART. Similarly, the obstacle sensors provide the distance or proximity information through a serial or digital interface. Based on the received data, the microcontroller sends appropriate signals to the motor driver to adjust the robot movement.

The voltage regulator circuit, motor driver circuit, and other electronics must be selected based on the voltage and current ratings provided by the manufacturer. The controller and motor driver circuits must share a common ground. Furthermore, the voltage and current ratings of all the components must be checked to ensure that they are compatible with the circuit. The diagram represents a conceptual view of the circuit flow; the actual circuit would require an appropriate schematic diagram.

WORKING MODEL:



WORKING:

The working of the GPS-based street cleaning robot can be explained as follows.

- The robot is switched on, and the microcontroller performs a system check and initializes the GPS module, motors, sensors, and the cleaning mechanism.
- The GPS module receives the satellite data and provides the outdoor coordinates of the robot to the controller.
- The microcontroller compares the current coordinates with the target coordinate and activates the motor driver to control the robot movement.
- The motor driver activates the DC motors, and the robot moves forward or rotates accordingly.
- Meanwhile, the obstacle sensors are active and provide information about the objects in the robot's field of view or path.
- When the obstacle sensors detect an object, the microcontroller modifies the robot movement to avoid the obstacle.
- The robot movement is stopped when it reaches the end of the cleaning route or when the user terminates the process.
- The cleaning mechanism gathers the surface litter and transfers it to the collection bin.

© Author(s). This work is peer-reviewed, openly published, and permanently archived
This article is openly accessible and reusable with proper attribution.

The GPS navigation system may not provide sufficient accuracy for robot navigation, and therefore an additional inertial navigation system may be required.

SOFTWARE IMPLIMENTATION:

Program used for GPS guided street cleaning robot Java is a high-level, object oriented and platform independent programming language which was developed by Sun Microsystems and launched in 1995. It is designed with the WORA principle (Write Once Run Anywhere) that allows programs to be run on various platforms via the Java Virtual Machine. Java provides many features including security, portability, multi-threading and automatic memory management

MAJOR COMPONENTS:

MAJOR COMPONENTS AND FUNCTIONS:

Major Components of GPS Guided Street Cleaning Robot

Sl. No.	Component	Function
1	GPS module	Provides approximate outdoor position coordinates.
2	Microcontroller	Processes sensor inputs and controls robot operation.
3	Motor driver	Controls motor direction and power.
4	DC geared motors	Drive the wheels and move the robot.
5	Obstacle sensors	Detect nearby objects in the robot's path.
6	Cleaning brush or collector	Gathers suitable dry debris.
7	Waste collection bin	Stores collected waste.
8	Rechargeable battery	Supplies electrical power to the system.
9	Voltage regulator	Provides suitable voltage to electronic components.
10	Chassis and wheels	Support the components and provide mobility.
11	Connecting wires and switches	Connect components and support power control.

TESTING AND EVALUATION:

Testing and evaluation are crucial to determining the success of the project. Several tests can be performed to understand the performance of the robot, such as GPS navigation capacity, accuracy of obstacle detection, efficiency of the cleaning mechanism, and battery performance. Some of the tests that can be performed on the proposed robot are as follows:

- Testing the GPS navigation system: The robot can be tested for its ability to navigate a predetermined path. The robot must be tested under similar conditions, and the deviation between the intended path and the actual path must be recorded.
- Test the robot's ability to complete a cleaning route: The robot's ability to complete an intended cleaning route without manual intervention must be tested. The test must be performed multiple times to obtain an average result.
- Obstacle detection and avoidance testing: The robot must be tested for its ability to detect and avoid obstacles. This test can be performed by placing obstacles in front of the robot at varying distances and recording whether the robot stops or avoids the obstacle.
- Testing the cleaning mechanism: The cleaning efficiency of the robot must be determined by performing the following test: A known amount of dirt or small surface debris must be placed on a flat surface, and the robot must be run over the debris. The amount of debris collected by the robot must be weighed and compared to the initial amount of debris. The cleaning efficiency can be calculated using the following formula:

Collection Efficiency (%) = (Mass of waste collected / Initial mass of waste) × 100

- Battery performance testing: The robot must be run for a sufficient amount of time to obtain the operating time before the battery runs out of power. This provides an estimate of the battery performance.

The report must include a detailed explanation of the testing environment and conditions, the number of trials performed, and observations and calculations, such as those shown for the cleaning efficiency test. These are just a few of the tests that can be performed; one may add or remove tests depending on the components used in the project. A detailed description of the results obtained from these tests must be included in the final report.

ADVANTAGES:

- Manual effort required for street cleaning can be significantly reduced.
- The robot can be programmed to navigate a predetermined route using GPS navigation.
- Combines GPS navigation, obstacle avoidance, and automated cleaning into a single system.
- The robot can be small enough to navigate narrow roadways, footpaths, and other confined regions.
- Demonstrates the application of GPS, robotics, and embedded programming.
- Can be modified by adding additional features.
- Can be used to develop automated cleaning systems for modern smart cities.

© Author(s). This work is peer-reviewed, openly published, and permanently archived
This article is openly accessible and reusable with proper attribution.

APPLICATIONS:

- College, campus, and university grounds
- Residential streets and localities
- Industrial and commercial premises
- Public gardens and footpaths
- Parking areas
- Robotics laboratories and engineering faculties
- Testing and demonstration purposes in the robotics industry

The robot can find applications in the regions listed above; however, its suitability for a particular region depends on several factors, such as the size of the robot, accuracy of the GPS navigation, cleaning efficiency, safety, and battery life.

FUTURE SCOPE:

There are several ways in which the proposed system can be improved, as follows:

- Artificial intelligence and computer vision: An advanced AI-enabled system with a camera and an image recognition model can be used to identify the type of debris, which can enhance the efficiency of the system.
- Navigation accuracy: Additional sensors such as an inertial measurement unit and LiDAR can be added to improve navigation accuracy.
- The Internet of Things (IoT): The robot can be connected to the IoT to monitor and control the robot remotely.
- Self-charging mechanism: The system can be equipped with a self-charging mechanism that allows the robot to return to a charging station when the battery level reaches a threshold.
- Monitoring of the waste bin: A separate sensor can be used to monitor the filling level of the bin so that the robot can be directed to an emptying station when the bin is full.
- Enhanced cleaning mechanism: The cleaning mechanism can be redesigned to improve cleaning efficiency and reduce power consumption.
- Multi-robotic system: Multiple robots can be used in a multi-robotic system where robots can communicate with each other and share information, thereby improving the efficiency of the cleaning process.

CONCLUSION:

The GPS Guided Street Cleaning Robot is a proposed system that combines GPS navigation, obstacle avoidance, and automated cleaning to reduce manual effort in cleaning. The system comprises a microcontroller connected to a GPS module, obstacle sensors, a motor driver, DC motors, and a cleaning mechanism that gathers small dry surface debris and deposits it in a dustbin. The overall system uses the GPS navigation system to automatically navigate the robot across a predetermined route. However, the accuracy of the GPS navigation can be a limitation, and therefore an additional inertial navigation system can be added to enhance the performance of the navigation system.

The design of the robot can be further modified by adding additional features, such as those described in the Future Scope section. On the other hand, the performance of the robot also depends on the components that will be used in the project, such as the GPS module, microcontroller, sensors, and battery. Therefore, the block diagram and the circuit diagram represent a conceptual understanding of the robot design. Once the project is completed, an appropriate analysis of the results and a discussion on the limitations of the project must be included in the report. Hence, the report presented here contains a conceptual description of the project; after the project is completed, a detailed description of the project along with the results and the necessary calculations must be included to prepare the final report.

REFERENCES:

[1] GPS.gov, “GPS: The Global Positioning System,” U.S. government information resource. [Online].
Available: https://www.gps.gov/

[2] Arduino, “Arduino Documentation,” hardware and programming documentation. [Online]. Available: https://docs.arduino.cc/

[3] Microchip Technology Inc., microcontroller documentation and application resources. [Online].
Available: https://www.microchip.com/

[4] Pololu, motor driver and robotics hardware documentation. [Online].
Available: https://www.pololu.com/

© Author(s). This work is peer-reviewed, openly published, and permanently archived
This article is openly accessible and reusable with proper attribution.

[5] National Instruments, technical resources on sensors, measurement, and control systems. [Online].
Available: https://www.ni.com/

[6] Add verified peer-reviewed research articles on autonomous cleaning robots, GPS-based mobile robot navigation, obstacle avoidance, and automated waste collection before submitting the paper to an academic conference or journal.

© Author(s). This work is peer-reviewed, openly published, and permanently archived
This article is openly accessible and reusable with proper attribution.