iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 **Issue:** IV **Month of publication:** April 2026

DOI: https://doi.org/10.22214/ijraset.2026.80072

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue IV Apr 2026- Available at www.ijraset.com

Autonomous Multi-Terrain Campus Rover

S. Priyadharshini[1], Aswin D P[2], Lokesh S[2]
[1] Assistant Professor, Department of Electronics and Communication Engineering
[2] B.E. Electronics and Communication Engineering, Jeppiaar Engineering College, Chennai

Abstract: Large university campuses often require frequent document transportation, surveillance, and small-load delivery tasks, which consume valuable faculty time and increase dependency on manual manpower. To address these challenges, this project proposes the development of an Autonomous Multi-Terrain Rover capable of efficiently navigating predefined campus routes while minimizing human intervention. Obstacle detection and avoidance are implemented using ultrasonic sensors, ensuring safe and reliable operation in dynamic outdoor environments. Additionally, the rover is equipped with intelligent rerouting algorithms that allow it to adapt to unexpected obstacles or path disruptions in real time.
Keywords: Autonomous Rover, Inertial Measurement Unit, Terrain Navigation, Obstacle Detection.

I. INTRODUCTION

Modern campuses require automated systems for surveillance, delivery of documents or materials, and assistance in transportation. Manual operation of such tasks consumes time and manpower. Unlike ordinary rovers that work only on flat surfaces, this rover can move efficiently on rough and uneven terrain. It combines autonomous movement, sensing, and communication technologies to achieve reliable performance.

II. SYSTEM OVERVIEW

An autonomous multi-terrain campus rover is an intelligent rover vehicle designed to navigate independently across different types of surfaces such as roads, grass, gravel, and uneven terrains within a campus environment. Such systems combine rovers, embedded systems, and basic artificial intelligence to achieve autonomous navigation.

1) Control Unit: The core processing brain is an ESP32 microcontroller, which hosts the asynchronous captive portal and manages the core state machine. It translates logical instructions into physical movement by generating smooth, ramped PWM signals to drive the heavy-duty BTS7960 H-bridge motor controllers, protecting the 6WD chassis from inrush current spikes.
2) Navigation Unit: This unit provides the closed-loop feedback required for precision. Linear travel is tracked via an IR Groove Speed Sensor utilizing microsecond-debounced hardware interrupts. Angular rotation is tracked by bypassing standard 360-degree filters and directly integrating the MPU9250's raw Z-axis gyroscope data, allowing for high accuracy.
3) Obstacle Avoidance System: Serving as the autonomous safety layer, this subsystem protects the rover during "Repeat" mode. By integrating forward-facing proximity sensors (IR modules), it continuously polls the environment and triggers an immediate hardware interrupt to halt the motor drivers if an unmapped physical obstruction is detected in the rover's direct path.

III. WORKING PRINCIPLE

The rover operates on a "Teach and Repeat" architecture, governed by an ESP32 microcontroller that records manual driving inputs via a local web interface. To eliminate skid-steer errors, locomotion is strictly divided into mutually exclusive states of continuous linear movement and in-place rotation. Real-time physical displacement is tracked using an IR speed encoder for linear distance and an MPU9250 gyroscope for continuous, high-precision yaw integration. During autonomous duty, a proportional closed-loop controller reads these binary instructions to dynamically adjust motor PWM, flawlessly replicating the recorded trajectory.

IV. ADVANTAGES

The proposed system offers several advantages: Transport documents and small loads. Deliver items between departments. Patrol or monitor selected areas. Recalculate shortest paths when blocked.

V. APPLICATIONS

Document transport between administrative and academic departments. Parcel and package delivery within the campus. Movement of lab equipment and samples between labs. Library book transfer across library sections or departments. Campus patrol and safety monitoring, especially in low-traffic zones.

VI. EXPERIMENTAL SETUP AND DISCUSSION

The experimental setup consists of the fully assembled autonomous multi-terrain rover integrated with all hardware components such as the ESP32 Dev Kit, motor driver module, high torque DC motors, IR sensors, IMU, ESP32 camera module, and power supply unit with BMS and buck converters.

VII. FUTURE SCOPE

Although the current system demonstrates basic autonomous navigation and multi-terrain capability, several advanced features can be incorporated to improve its performance and expand its applications.

VIII. CONCLUSION

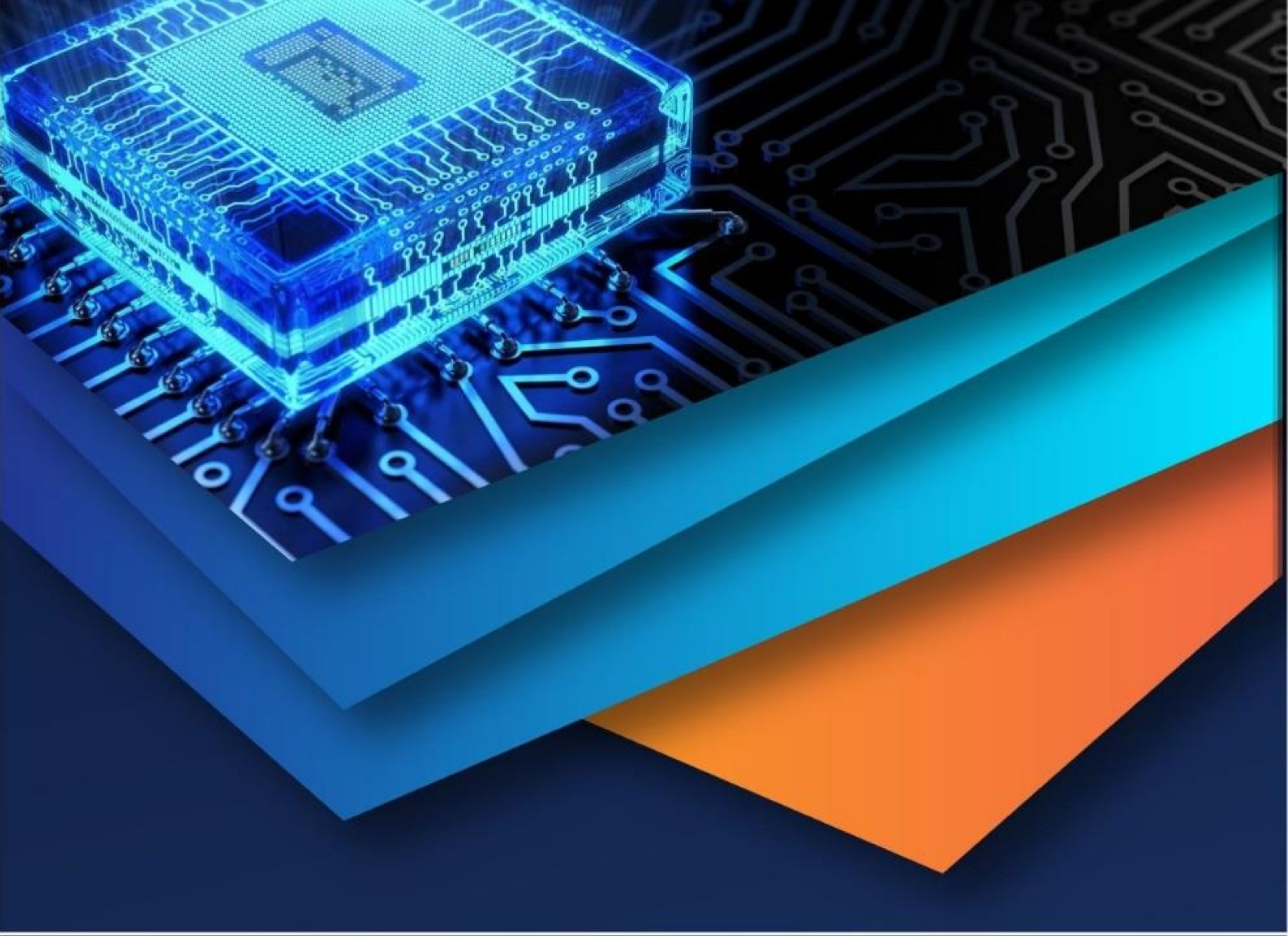
The rover is capable of navigating various surfaces including smooth paths and moderately uneven terrains while detecting and avoiding obstacles in real time. The use of sensors and control logic enables the system to make decisions independently, reducing the need for continuous human intervention.

IX. ACKNOWLEDGEMENT

The author expresses sincere gratitude to the Department of Electronics and Communication Engineering, Jeppiaar Engineering College, Chennai, for providing the necessary facilities and guidance to carry out this work

REFERENCES

[1] A. Gujarathi et al., “Design and Development of Autonomous Delivery Robot,” arXiv:2103.09229, 2021.
[2] Y. Rihan et al., “Campus Courier: An Autonomous Delivery Robot On-Campus,” Proc. ASET, 2024.
[3] Y. S. Kale et al., “Autonomous Terrain Vehicle,” Indian Journal of Science and Technology, vol. 14, no. 25, pp. 2119–2127, 2021.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY