

Advanced Surveillance Rover

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ABSTRACT

This paper presents the design and development of an Advanced Surveillance Rover intended for remote monitoring and security applications in environments where direct human access may be difficult or unsafe. The proposed rover integrates an Arduino Uno based on the ATmega328P microcontroller with an L293D motor driver, ultrasonic sensor, gas sensor, fire sensor, DHT11 temperature and humidity sensor, I2C LCD, HC-05 Bluetooth module, and a 360° Wi-Fi night-vision camera. The rover can be controlled wirelessly through a mobile device using Bluetooth, while the ultrasonic sensor assists in detecting obstacles during movement. The surveillance camera provides a live video stream for remote observation, including night-time monitoring. Environmental conditions such as temperature, humidity, gas leakage, and fire can also be monitored, with alerts provided to the user. A solar panel is incorporated to support battery charging and improve the operational capability of the system. The developed rover can be applied in defence, industrial security, construction sites, and other hazardous environments. The system provides a compact and low-cost approach to wireless surveillance and remote environmental monitoring.

Keywords— Advanced surveillance rover, Arduino Uno, ATmega328P, Bluetooth, 360° camera, obstacle detection, gas detection, fire detection, solar power, remote surveillance.

INTRODUCTION

Robotic technology has become an important part of modern automation, security, defence, and hazardous-environment operations. Robots can perform physical tasks and provide useful information in locations where direct human access may be difficult or unsafe. The proposed Advanced Surveillance Rover is designed to support remote surveillance and reconnaissance while reducing the need for human presence in risk-prone areas.

The proposed rover is a mobile robotic platform controlled remotely through a smartphone or laptop. It integrates an Arduino Uno based on the ATmega328P microcontroller with sensors and communication modules for monitoring the surrounding environment. An ultrasonic sensor is used for obstacle detection, while gas, flame, temperature, and humidity sensors provide environmental information. A 360° Wi-Fi camera enables live remote video monitoring, including night-time surveillance.

The rover also incorporates Bluetooth communication for wireless movement control and a solar panel for battery charging. These features make the system suitable for applications such as security surveillance, mines, borders, construction sites, remote areas, and other hazardous environments. The overall objective is to provide a compact and cost-effective platform for remote observation, environmental monitoring, and safer operation in locations where human intervention may be dangerous.

LITERATURE SURVEY

S. A. Joshi and Aparna Tondarkar proposed a “*Surveillance Robot for Military Applications*” in 2020, presenting a multifunctional robotic vehicle for surveillance in remote and border areas. The system supported autonomous as well as manual operation using wireless communication, with a Raspberry Pi and camera used for remote control and live video streaming. The reported system achieved video streaming of up to 15 frames per second [1]. Dr. Meenakshi et al. proposed a “*Vision Based Robotics System for Military Application—Design Real Time Validation*” in 2014, which used image processing based on the Sum of Absolute Differences (SAD) algorithm for mine and obstacle detection. Although the system enabled autonomous operation, the image-processing time affected the movement speed of the robot [2].

Manjunath Prasad S et al. proposed a “*Surveillance System for National Borders*” in 2019, consisting of a robotic unit for movement and surveillance and a control unit for directing the robot in damaged or war-affected environments. The study suggested improving system accuracy by incorporating additional DC motors [3]. G. Song et al. presented an “*Automatic Docking System for Recharging Home Surveillance Robots*” to address the energy requirements of surveillance robots [4].

Based on these studies, the proposed Advanced Surveillance Rover integrates wireless Bluetooth control, obstacle detection, a 360° camera, environmental sensors, and solar-powered battery charging into a single robotic platform. The system is intended to improve remote surveillance and monitoring in hazardous and inaccessible environments.

PROBLEM STATEMENT

The main problem is to develop a **low-cost, remotely controlled surveillance rover** capable of monitoring hazardous or inaccessible environments where direct human presence may be unsafe. The rover should provide remote movement, live video surveillance, obstacle detection, and environmental monitoring to improve safety and surveillance efficiency.

OBJECTIVES

1. **To design and develop a wireless surveillance rover** with Bluetooth-based mobile control, obstacle detection, and a 360° Wi-Fi night-vision camera for real-time remote monitoring.
2. **To integrate environmental monitoring and energy-support features** using gas, fire, temperature, and humidity sensors along with a solar-powered battery charging system for operation in hazardous and remote environments.

BLOCK DIAGRAM

The Fig 1 shows the overall architecture of the **Advanced Surveillance Rover**, with the Arduino Uno acting as the central controller. It interfaces with the ultrasonic, flame, gas, temperature/humidity sensors, LCD, L293D motor driver, HC-05 Bluetooth, camera, and GSM/GPRS module. The solar panel provides power through the power-supply section to support the rover's operation.

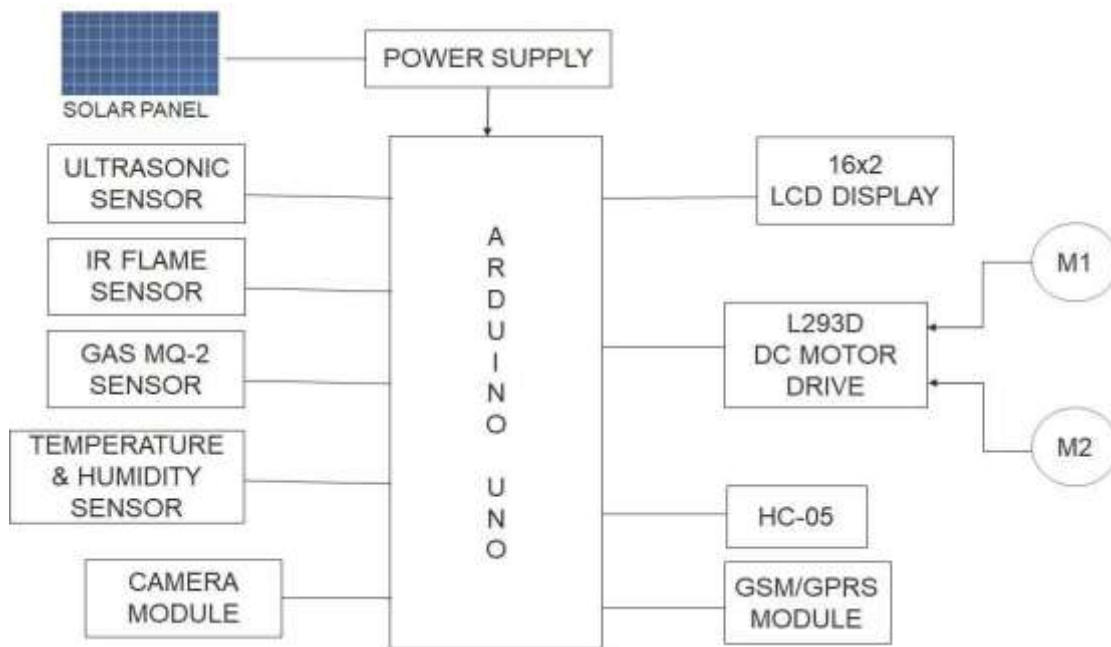


Fig 1 Block Diagram

CIRCUIT DIAGRAM

The Fig 2 shows the interfacing of the **Arduino Uno** with the LCD, ultrasonic sensor, flame sensor, MQ-2 gas sensor, DHT11, HC-05 Bluetooth module, and L293D motor driver. The solar panel and battery supply power to the system, while the L293D controls the two DC motors for rover movement and the sensors provide environmental and obstacle detection.

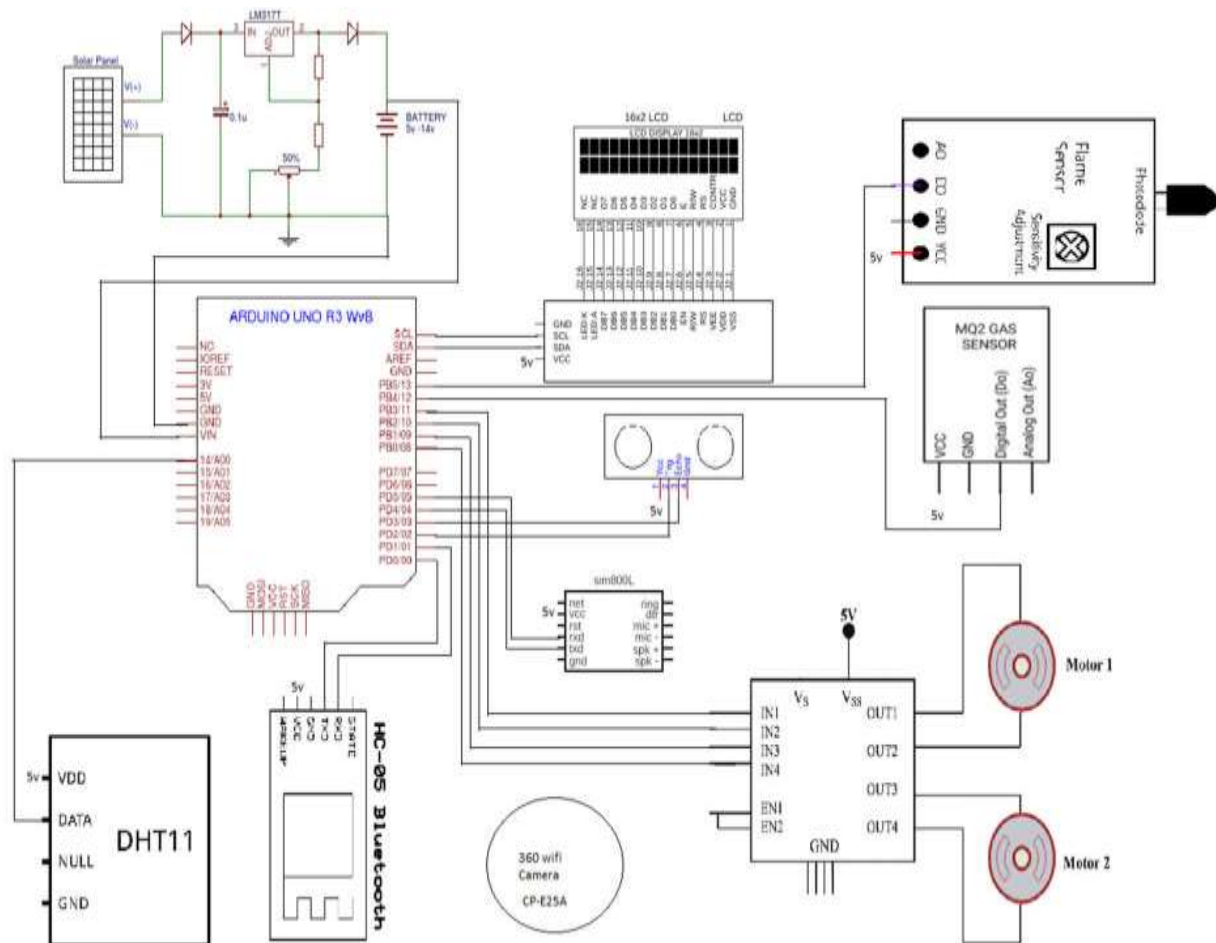


Fig 2 Circuit Diagram of Advanced Surveillance Rover

METHODOLOGY

The proposed Advanced Surveillance Rover is developed using an **Arduino Uno based on the ATmega328P** as the main controller. The controller interfaces with the L293D motor driver, ultrasonic sensor, MQ-2 gas sensor, flame sensor, DHT11 temperature and humidity sensor, I2C LCD, and HC-05 Bluetooth module. The rover receives wireless movement commands and controls the two DC motors accordingly, while the ultrasonic sensor assists in obstacle detection.

For surveillance, a **360° Wi-Fi camera** is mounted on the rover to provide live video monitoring through a mobile application. Environmental conditions are monitored using the gas, flame, temperature, and humidity sensors, and the obtained information can be displayed to the user. A solar panel is incorporated to charge the rechargeable battery, enabling continued operation of the rover in remote locations.

The overall methodology consists of **power supply, sensing, processing, wireless control, motor actuation, and live surveillance**. Sensor data are processed by the Arduino, movement commands are transmitted through Bluetooth, and the motor driver controls the rover's direction. This integrated approach enables remote monitoring and operation in hazardous or inaccessible environments.

RESULTS AND DISCUSSION

Fig. 3 shows the developed Advanced Surveillance Rover, which successfully demonstrates remote movement and surveillance functions. The rover can be wirelessly controlled in forward, backward, left, and right directions, while the 360° Wi-Fi camera provides live video streaming for remote observation. The solar panel charges the battery, with an automatic battery cut-off system for effective power management.

The integrated sensors enhance the rover's monitoring capability by detecting obstacles, fire, gas leakage, temperature, and humidity. Bluetooth communication enables wireless control through a mobile device, while the camera supports surveillance during both daytime and nighttime. The developed rover is suitable for surveillance and monitoring in remote, industrial, mining, border, and other hazardous environments.



Fig 3 Hardware Setup

CONCLUSION

The Advanced Surveillance Rover successfully integrates wireless control, obstacle detection, environmental sensing, and real-time video surveillance into a single mobile platform. The Arduino Uno acts as the central controller, while Bluetooth enables remote movement and the 360° Wi-Fi camera provides live monitoring. The gas, fire, temperature, humidity, and ultrasonic sensors further improve the rover's surveillance and monitoring capabilities.

The proposed rover provides a compact and cost-effective solution for monitoring hazardous and inaccessible environments. The inclusion of a solar-powered battery charging system supports extended operation in remote locations. The system can be applied in areas such as mines, industrial sites, construction sites, borders, and other locations where human presence may involve safety risks.

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