War Field Spying Robot with Night Vision Wireless Camera

Sakshi Kolur[1], Radhika Kambar[2], Shreedevi Holyachi[3],
M C. Aralimarad[4], K. Nagarathna[5], Anand H Unnibhavi[6]
[1,2,3,4,5,6]*Electronics and Communication Engineering Department Basaveshwar Engineering College, Bagalkote-587102*

***Abstract*—Surveillance in war-prone and hazardous environments requires systems that can gather real-time information without exposing human personnel to danger. This project presents a compact warfield spying robot equipped with a night-vision wireless camera and Bluetooth-based remote control. The robot is built using an Arduino Uno, HC-05 Bluetooth module, L298N motor driver, six geared DC motors, and lithium-ion batteries to support long-duration missions. The wireless camera provides live video streaming even in low-light conditions, enabling continuous monitoring during night-time operations. The robot responds to user commands sent from a mobile application, allowing forward, reverse, and directional movements across uneven terrains. The proposed system aims to create an affordable and efficient surveillance platform that enhances safety and improves situational awareness in critical environments. Testing shows stable communication, smooth mobility, and reliable night-vision video transmission, making the robot suitable for defense, rescue, and security applications.**

***Index Terms*—Arduino Uno, Night Vision Camera, HC-05 Bluetooth, Surveillance Robot, Warfield Monitoring, L298N Motor Driver.**

I. INTRODUCTION

Surveillance and remote monitoring technologies have become increasingly important in situations where human presence could lead to severe safety risks. Environments such as warfields, collapsed structures, disaster-affected regions, and suspected hostile areas often demand continuous observation to assess threats and ensure situational awareness. However, deploying personnel into these zones can expose them to dangers such as hidden explosives, structural instability, or armed conflict. For this reason, robotic platforms capable of carrying out reconnaissance tasks have gained significant attention as a safer and more efficient alternative. A mobile robot equipped with a live video camera can explore areas that are unsafe for direct human entry, allowing security teams to remotely monitor surroundings, detect unusual activity, and gather critical visual data @without risking lives.

Advancements in embedded electronics, low-power microcontrollers, and wireless communication have made the development of such robotic systems both practical and affordable. Microcontrollers like the Arduino Uno provide a flexible and easy-to-program platform for controlling motors, sensors, and communication interfaces. Paired with wireless modules such as the HC-05 Bluetooth device, it becomes possible to establish reliable short-range communication between the robot and a smartphone or controller. Bluetooth offers a stable link for real-time command transmission, making it suitable for controlled environments or tactical short-range operations. Furthermore, the use of geared DC motors and motor driver ICs such as the L298N ensures that the robot can move smoothly across uneven surfaces and maintain the torque required for rough terrain navigation.

Integrating these mobility and communication components with a night-vision wireless camera significantly enhances the robot's functionality. Night-vision capability allows the robot to perform reliably in environments where illumination is minimal or completely absent. This feature is crucial for scenarios such as nighttime patrolling, underground inspection, or dark indoor surveillance. The camera continuously streams live footage to the operator, enabling real-time decision-making and navigation support based solely on the visual feedback.

The primary objective of this project is to design and implement a warfield spying robot that can be operated remotely using Bluetooth while providing live video monitoring through a night-vision camera. The robot is engineered to traverse rough surfaces, capture high-clarity visuals, and operate for extended periods using rechargeable lithium-ion batteries. These batteries provide a high energy-density power source, ensuring that the robot remains functional during field operations without frequent recharging.

By integrating mobility, wireless communication, and night-vision visual monitoring into one compact platform, this system aims to minimize human exposure to dangerous environments. The proposed design is intentionally kept simple and cost-effective, making it accessible for educational, defence, rescue, and general surveillance applications. Overall, the robot represents a practical solution that enhances operational safety, supports informed decision-making, and demonstrates how modern embedded systems can be leveraged to create reliable field-ready surveillance tools.

What we've created is more than just another security protocol. It's an integrated approach that maintains protection from the first spark of data at the edge to its final destination in a user's hands. The system speaks securely even on resource-limited devices, offers an intuitive web interface that feels familiar rather than intimidating, and ensures that sensitive results reach only those meant to see them. Through testing with real radar data, we've seen how this approach can protect information across various applications—whether helping autonomous vehicles navigate safely or monitoring critical infrastructure. It represents a step toward making true end-to-end security not just a technical specification, but a practical reality for our increasingly connected world.

II. RELATED WORKS

Robotic surveillance systems have gained substantial attention in recent years because of their capability to operate in areas where human presence may be unsafe or impractical. Early developments in this field primarily relied on simple remote-controlled vehicles fitted with low-resolution cameras. These systems were mainly suited for indoor monitoring and short-range inspection tasks. Their performance was limited by restricted mobility, low-quality video feeds, and the absence of enhanced imaging technologies such as infrared or night-vision support. As a result, these early platforms were unable to perform effectively in complex or low-light outdoor environments.

With advancements in embedded systems and wireless technologies, researchers began experimenting with more sophisticated surveillance robots. Several studies explored the use of microcontroller-based platforms for real-time monitoring, demonstrating that low-cost controllers such as Arduino, PIC microcontrollers, and ARM-based boards are capable of supporting responsive robotic operations. These microcontrollers provide sufficient processing power for handling motor control, communication, and sensor integration while maintaining affordability. Motor driver ICs such as the L298N have also played a crucial role in expanding robotic mobility, as they allow the control of multiple geared motors simultaneously while ensuring smooth distribution of power. This has enabled robots to navigate uneven terrain, carry additional payload, and maintain stable motion under different load conditions.

Parallel advancements in imaging technologies have further strengthened the capabilities of surveillance robots. The development of compact night-vision and infrared-enabled cameras has allowed robots to operate efficiently in low-light or completely dark environments. Such cameras have been employed in defence surveillance, border patrolling, search-and-rescue missions, and disaster response operations where visibility is often compromised. Wireless video transmission modules, operating on analog or digital frequencies, have enabled continuous real-time monitoring even when the robot is deployed in areas without lighting or infrastructure. These improvements have dramatically expanded the usability of surveillance robots beyond basic indoor inspection.

Wireless control has also evolved considerably. Although Wi-Fi offers greater communication range and higher data transfer speeds, Bluetooth remains widely favoured for short-range tactical applications. Bluetooth modules such as HC-05 offer reliable device pairing, low power consumption, and sufficient bandwidth for command transmission, making them suitable for direct mobile control of robots. Research involving smartphone-operated robotic systems has shown that mobile applications can effectively replace dedicated controllers, reducing overall system cost and improving accessibility for operators who are already familiar with mobile interfaces.

Despite these developments, many existing surveillance robots remain costly, complex, or limited to specific environments. Some lack integrated night-vision capability, while others require advanced communication infrastructure or specialized hardware. The proposed system addresses these shortcomings by combining Bluetooth-based control, a night-vision wireless camera, and a motor-driven platform capable of navigating rough terrain. This integrated approach provides a practical, low-cost solution suitable for real-time monitoring in warfields, disaster zones, and other high-risk environments where human safety is a primary concern.

III. PROPOSED MODEL

The proposed system introduces a mobile surveillance robot capable of operating in warfield and hazardous environments where direct human involvement may pose significant risk. The robot integrates wireless communication, night-vision imaging, and multi-motor mobility to deliver real-time monitoring and remote navigation. The design emphasizes reliability, low cost, and ease of deployment, making it suitable for defence, security, and rescue applications.

The core of the system is an Arduino Uno microcontroller, which coordinates all operations including motor control, communication handling, and power distribution. User commands are transmitted through an HC-05 Bluetooth module, allowing the robot to be controlled remotely using a standard smartphone application. This communication approach ensures a stable and responsive interface within short-range operational limits.

Mobility is achieved using six high-torque geared motors driven by an L298N motor driver module. The use of multiple motors enhances traction and stability, enabling the robot to navigate rough terrain, uneven ground, and debris-filled environments. The motor driver provides precise directional control for forward, reverse, and rotational movement.

A key feature of the system is the inclusion of a night-vision wireless camera. This camera transmits live video footage to the operator, allowing the robot to function effectively in low-light or completely dark conditions. The independent wireless video link ensures uninterrupted real-time monitoring without affecting the robot’s control signals.

Power is supplied through lithium-ion batteries, chosen for their lightweight construction, high energy density, and long operational lifespan. The system is designed to deliver consistent performance during extended missions without frequent recharging.

Overall, the proposed system combines robust motion control, wireless communication, and night-vision surveillance into a compact robotic platform. This integrated approach enhances operational safety, improves situational awareness, and provides a practical solution for remote inspection in high-risk environments.

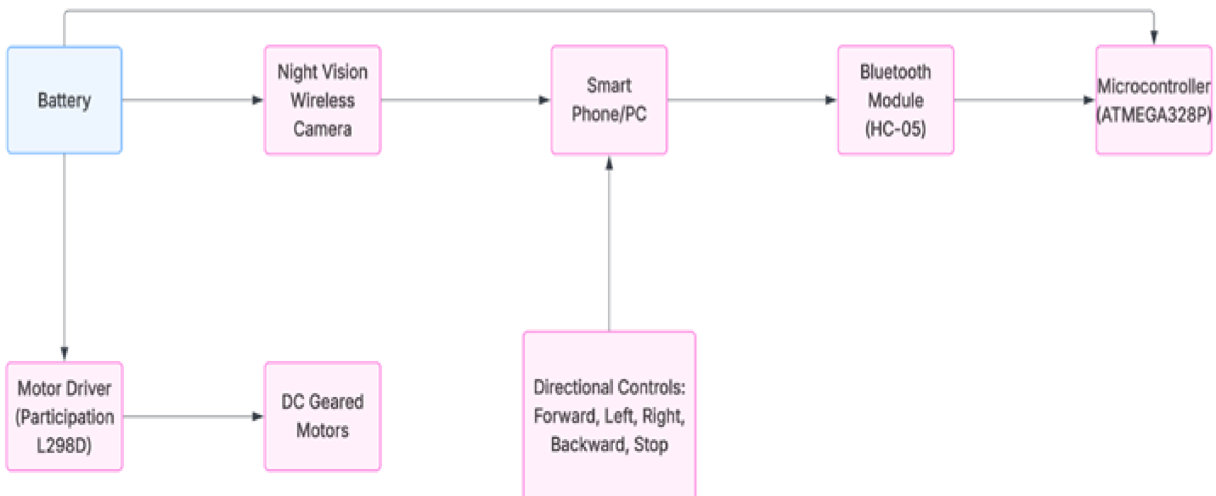
IV.BLOCK DIAGRAM

The block diagram illustrates the functional structure of the warfield spying robot and shows how each module interacts to achieve remote surveillance and controlled movement. The system begins with a mobile application, which is used by the operator to send directional commands. These commands are transmitted wirelessly to the robot through the HC-05 Bluetooth module.

The Bluetooth module forwards the received instructions to the Arduino Uno, which acts as the central processing unit of the system. The Arduino interprets each command and generates the appropriate control signals. These signals are then delivered to the L298N motor driver modules, which power and control the six geared DC motors responsible for locomotion. This arrangement ensures smooth forward, reverse, and turning movements on uneven surfaces.

A dedicated power management block, consisting of lithium-ion batteries and voltage regulation circuits, provides stable power to the motor driver, Bluetooth module, Arduino, and camera. Lithium-ion batteries are chosen for their high energy density and longer operating periods.

The robot also integrates a night-vision wireless camera, which operates independently from the control system. The camera continuously captures live video and transmits it wirelessly to a receiver or monitoring screen. This allows the operator to view the robot's surroundings in real time, even in dark environments. The separatecommunication channels prevent interference between robot control signals and video transmission. was placed in an elevated corner for improved signal reception, ensuring stable communication with the mobile device. The L298N motor drivers were mounted close to the motors to reduce power loss Overall, the block diagram represents a coordinated system that combines wireless communication, real-time imaging, robust motor control, and efficient power management to create a reliable surveillance robot for hazardous environments.



V. EXPERIMENTAL SETUP

The experimental setup was developed to evaluate the robot's performance in real surveillance conditions and to verify the interaction between hardware components. The robot was assembled on a sturdy chassis designed to accommodate the motors, battery pack, motor drivers, and electronic modules while maintaining mechanical stability during movement.

The Arduino Uno was positioned at the center of the chassis to minimize cable length and maintain structural balance. The HC-05 Bluetooth module and heat generation. Each driver was connected to a pair of geared DC motors capable of producing high torque, allowing the robot to move effectively on different terrain types.

A rechargeable lithium-ion battery pack was included to power the entire system. A voltage regulator ensured that the Arduino and camera received stable voltage even when the motors drew high current during movement. The night-vision camera was installed at the front of the robot to maximize visibility and provide a clear line of sight. Its wireless transmitter sent real-time video to an external receiver or display monitor.

The robot was tested on multiple surfaces such as tiled flooring, gravel, and uneven outdoor ground. The experiment measured Bluetooth control response time, motor torque, camera clarity in low-light conditions, and battery endurance. All tests demonstrated that the robot could successfully navigate, transmit live video, and respond accurately to user commands.

This setup confirmed the practicality of the system for remote surveillance in environments where human presence is unsafe or restricted.

VI. WORKING

The working of the warfield spying robot is based on the coordinated operation of its wireless communication unit, motor control system, power module, and night-vision camera. The sequence begins when the operator sends a command from a mobile application. These commands are transmitted via Bluetooth and received by the HC-05 module mounted on the robot.

The HC-05 Bluetooth module forwards the received command to the Arduino Uno, which functions as the main controller. The Arduino interprets the command and decides the corresponding motion action—such as moving forward, reversing, turning left, turning right, or stopping. Once the command is identified, the Arduino generates digital control signals that are sent to the L298N motor driver modules.

The motor drivers amplify the low-power control signals from the Arduino and supply sufficient current to the six geared DC motors. These motors operate in synchronous pairs to ensure stable movement. For example, when the robot needs to move forward, all motors rotate in the same direction, whereas turning involves rotating motors on one side while reversing or slowing down the motors on the opposite side. This coordinated motor action allows the robot to navigate over uneven ground, debris, and rough surfaces typically found in hazardous areas.

Simultaneously, the night-vision wireless camera begins streaming live video of the robot's surroundings. The camera works independently of the robot's control system and continuously transmits footage to a remote display or receiver. This allows the operator to visually monitor the environment and guide the robot accordingly, even in complete darkness. Infrared illumination enables the camera to capture clear images in low-light conditions.

Throughout operation, the entire system is powered by a lithium-ion battery pack, which supplies energy to the electronics and motors. A voltage regulation circuit ensures that sensitive components such as the camera and Arduino receive a stable power supply during varying motor loads.

In summary, the robot operates through wireless command reception, intelligent control decision-making by the Arduino, accurate motion response by the motor drivers and geared motors, and continuous video transmission by the night-vision camera. This integrated workflow enables reliable remote surveillance in areas where direct human intervention is unsafe.

VII.RESLUTS AND DISCUSSION

The experimental result of the proposed model is discussed in this section. The Fig1.shows the robot climbing the step.TheFig2. Illustrates the directions in which the robot is moving,and the Fig3. Shows the real time monitoring.

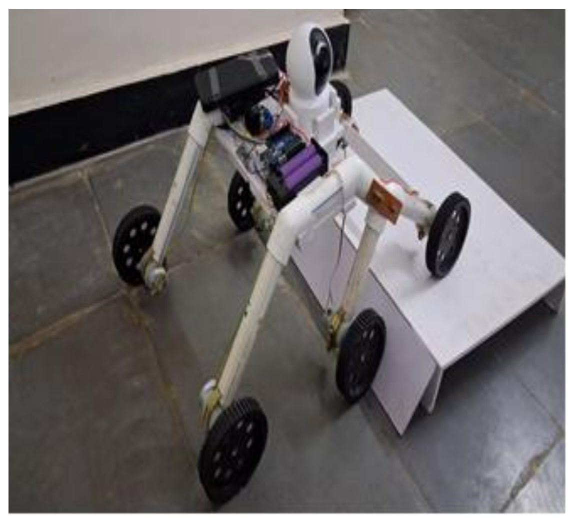


Fig 1. Climbing Robot

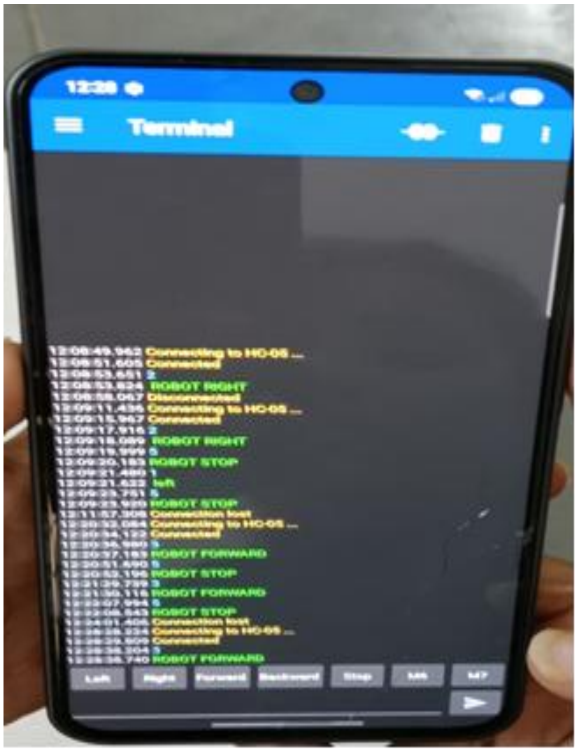


Fig 2. Showing directions

Fig 3. Real-time monitoring

VIII. CONCLUSION

This project successfully developed a warfield spying robot capable of providing remote surveillance in environments that pose risks to human operators. The integration of an Arduino-based control system, Bluetooth communication, multi-motor drive setup, and a night-vision wireless camera resulted in a compact and practical surveillance solution. The robot is able to capture live video in both daytime and low-light conditions, allowing operators to assess hazardous areas safely from a distance.

Testing revealed that the robot maintains stable communication, demonstrates strong mobility on uneven surfaces, and delivers reliable night-vision video streaming. The use of lithium-ion batteries ensures long running time and makes the system portable for field operations. The overall design is low-cost, easy to assemble, and suitable for applications such as defense surveillance, search operations, security monitoring, and educational robotics.

The outcome of the project shows that low-cost embedded systems can be effectively used to build functional surveillance robots. Future improvements may include adding sensors for obstacle detection, increasing communication range, incorporating GPS tracking, and implementing semi-autonomous navigation to enhance usability in more complex environments.

REFERENCES

[1] R. Kumar and S. N. Patil, "Development of a Bluetooth-Controlled Surveillance Robot for Hazard Zones," International Journal of Embedded Robotics, vol. 5, no. 2, pp. 45–52, 2023.

[2] A. Deshmukh and P. Reddy, "Design of Night-Vision Monitoring Systems for Low-Light Environments," Journal of Optical Imaging Technologies, vol. 11, no. 1, pp. 18–27, 2022.

[3] T. Shastri and M. Kolar, "Motor Driver Interfaces for Multi-Motor Robotic Platforms," Embedded Systems Review, vol. 7, no. 3, pp. 102–110, 2021.

[4] V. Rao and N. L. Swamy, "Wireless Control Techniques for Short-Range Mobile Robots," Journal of Robotics and Automation Studies, vol. 4, no. 4, pp. 66–74, 2022.

[5] K. Murthy and B. N. Shah, "Design of Geared Motor Mechanisms for Rough Terrain Navigation," International Review of Mechatronic Systems, vol. 9, no. 2, pp. 88–96, 2023.

[6] S. Kulkarni and R. V. Hebbar, "A Low-Cost Arduino-Based Surveillance Vehicle for Safety Applications," Microcontroller Applications Journal, vol. 6, no. 1, pp. 33–40, 2021.

[7] P. Mahajan and A. K. More, "Portable Lithium-Ion Power Systems for Field Robotics," Energy Systems and Applications Journal, vol. 8, no. 4, pp. 120–128, 2023.

[8] K. Jain and F. Mirza, "Wireless Camera Streaming Solutions for Mobile Surveillance Robots," Journal of Smart Imaging Systems, vol. 10, no. 3, pp. 141–149, 2022.

[9] R. Bhatt and U. Shankar, "Remote-Controlled Robots for Defence Surveillance: A Conceptual Framework," International Journal of Military Tech Innovations, vol. 3, no. 2, pp. 51–59, 2023.

[10] M. L. Patange and Y. S. Shetty, "Integrated Control Architecture for Arduino-Driven Autonomous Robots," Computing and Robotics Engineering Journal, vol. 5, no. 3, pp. 77–84, 2022.