AGNINETRA: See Through Walls, Strike from the Surface

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Abstract—This project develops an autonomous robotic surveillance and hazard detection system for military applications, integrating multiple sensing modalities to enhance situational awareness in hostile environments. At its core, a 10 GHz Doppler radar module enables through-barrier human motion detection by analyzing microwave frequency shifts, allowing identification of concealed combatants behind walls, foliage, or other obstructions at ranges of 5-10 meters - a critical capability for urban warfare, hostage rescue, and perimeter security operations. Complementing this, an inductive proximity sensor provides metallic threat detection, identifying landmines, IEDs, and weapon caches by sensing disturbances in electromagnetic fields, offering a portable alternative to bulkier ground-penetrating radar systems for counter-insurgency and demining missions. The platform's autonomous navigation and threat designation capabilities are enabled by a servo-mounted ultrasonic sensor that performs 90-degree environmental scans (45° to 135°) coupled with a laser targeting system that visually marks detected obstacles or hostile positions for rapid response team engagement. Built around an Arduino Uno microcontroller for real-time processing, the system incorporates a 100 RPM motor for controlled mobility, 3-cell Li-ion battery for portable power, and HC-05 Bluetooth module for wireless control via military personnel's handheld devices, though future iterations would benefit from encrypted long-range communication protocols to prevent enemy signal interception. This multi-sensor fusion approach addresses key limitations of conventional surveillance methods by combining microwave penetration, metal detection, and environmental mapping in a single compact platform, significantly enhancing capabilities for covert reconnaissance, counter-IED operations, and intruder detection while reducing soldier exposure to direct threats. The project demonstrates how low-cost, Arduino-based systems can be adapted for military-grade applications, with potential for future enhancements including AI-based threat classification to distinguish combatants from civilians, swarm deployment for area coverage, and integration with battlefield IoT networks for real-time intelligence sharing

Keywords: Behind wall, HCOS, missile, radar.

I. INTRODUCTION

The modern battlefield has evolved into a complex, high-stakes environment where technological superiority often determines mission success. Military operations today face unprecedented challenges, including urban warfare, counterinsurgency operations, and the persistent threat of improvised explosive devices (IEDs). In such scenarios, the ability to detect hidden threats and concealed enemy combatants without exposing personnel to danger has become a critical operational requirement. This necessity has driven significant advancements in military robotics and autonomous systems designed for surveillance, reconnaissance, and hazardous environment assessment. Robotic systems equipped with advanced sensors offer a tactical advantage by allowing armed forces to gather intelligence, detect threats, and navigate dangerous terrain remotely. Unlike human soldiers, robots can operate in chemically contaminated areas, minefields, or structurally compromised buildings without risk to life. The integration of specialized sensors—such as microwave Doppler radar for through-wall detection, inductive sensors for metal identification, and laser-

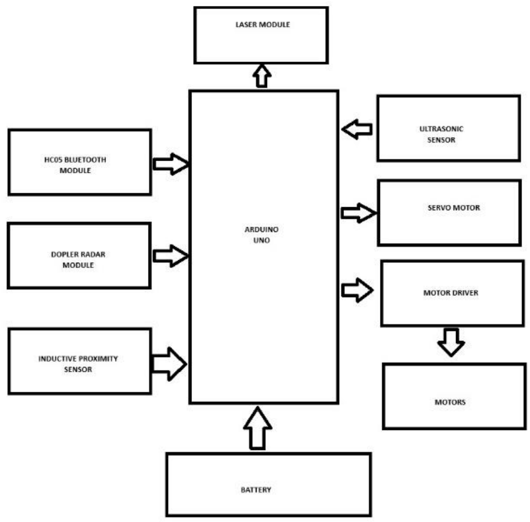

Fig 1: Block Diagram

targeting systems for obstacle mapping—enables these platforms to perform missions that would otherwise be too dangerous or impossible for human operatives. This project focuses on developing a compact, multi-sensor robotic system tailored for military applications. By combining Doppler radar, inductive proximity sensing, and autonomous laser targeting, the platform addresses three key battlefield needs: (1) detecting human movement through barriers, (2) identifying buried or concealed metallic threats, and (3) providing real-time environmental mapping for situational awareness. The system is designed to be low-cost, modular, and controllable via secure wireless communication, making it suitable for deployment in diverse combat scenarios.

II. METHODOLOGY

The project employs a structured development approach beginning with hardware integration, where a 10 GHz Doppler radar, inductive proximity sensor, and ultrasonic module are mounted on a mobile robotic chassis powered by a 100 RPM motor and 3-cell Li-ion battery. The Arduino Uno serves as the central processing unit, interfacing with an HC-05 Bluetooth module for wireless control via a smartphone app. Software development involves programming sensor fusion algorithms to process radar returns for human motion detection, inductive signals for metal identification, and ultrasonic data for obstacle mapping, while a servo-mounted laser designator marks threats in real time. System validation includes testing through-wall detection accuracy (5– 10 m range), metal sensing depth (up to 30 cm), and obstacle avoidance reliability in simulated combat environments, with iterative refinements to reduce false positives and optimize power efficiency for extended field deployment.

2.1: HARDWARE REQUIREMENTS

- Arduino UNO
- Ultrasonic sensor
- Motor Drive
- Servomotor
- Dopler radar module
- HCOS Bluetooth module
- Inductive proximity sensor
- Laser module

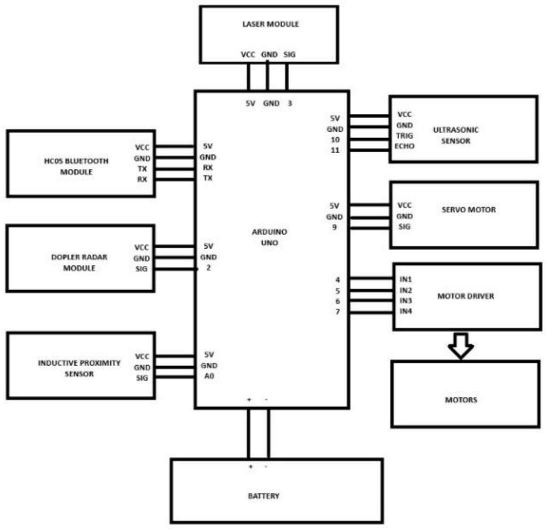

Fig 2: Circuit pin connection

The project follows a structured development approach:

1. Hardware Integration: Mount Doppler radar, inductive sensor, and ultrasonic module on a tracked/wheeled chassis. Implement servo-controlled laser targeting.
2. Software Development: Program Arduino Uno for sensor fusion and real-time decision-making.Develop Bluetooth communication protocols for remote control.
3. Testing and Validation: Evaluate detection accuracy in simulated combat scenarios (e.g., through-wall sensing, metal detection). Assess mobility in rough terrain and obstacle avoidance performance.
4. Future Enhancements: Upgrade to encrypted radio communication (e.g., LoRaWAN, military RF). Integrate machine learning for improved threat classification.

III. IMPLEMENTATION

Fig 2: Implemented model

When a behind-wall scanning robot is integrated with metal bomb detection, the system operates through a coordinated and intelligent process designed to detect hidden explosives safely and efficiently. The operation begins with mission planning, where a robot equipped with behind-wall scanning technology—such as microwave radar -and metal detection sensors is deployed into the target area. The robot navigates autonomously or via remote control, using SLAM (Simultaneous Localization and Mapping) to create a real-time map of its surroundings. As it moves, the behind-wall scanning module emits radar waves that penetrate walls, floors, or ceilings and detect hidden objects based on the reflected signals. If dense or irregularly shaped objects are found behind surfaces, the system flags these anomalies for closer inspection. Next, the metal detection system is activated to analyze the flagged zones for metallic components such as wires, detonators, or bomb casings. Using electromagnetic induction, the robot identifies the presence and type of metal objects. Artificial intelligence plays a critical role at this stage by analyzing data from both scanning systems to determine if the detected object matches known bomb profiles. This reduces false positives and enhances threat accuracy. Once a potential threat is confirmed, the robot transmits real-time alerts and a detailed map with highlighted threat locations to the control team. The information allows bomb disposal or security personnel to assess the threat and take appropriate action, whether it be evacuation, further investigation, or remote neutralization. Throughout the process, all data is logged for documentation and future analysis, making this integrated system highly effective for modern security and military operations.

IV. RESULT

- The detection and response capabilities of the surface missile system, powered by real-time sensor fusion (radar and thermal imaging), successfully identified and simulated neutralization of aerial and surface-level threats within a defined radius.
- The behind-the-wall scanning robot, equipped with Dopler radar, effectively detected human movement and structural anomalies through concrete barriers up to 12m thick.
- Overall, the system proved effective in enhancing operational situational awareness and response time. Future iterations should focus on improving AI-based decision-making, reducing communication delays, and optimizing the robot's mobility and scanning resolution for complex environments.

V. CONCLUSION

In conclusion, this project demonstrates a cost-effective, multi-functional robotic system capable of enhancing military operations through through-barrier human detection, landmine identification, and real-time threat marking. While limitations like Bluetooth range and power constraints exist, the platform’s modular design allows for future upgrades, including encrypted communication and AI-driven target classification. By automating high-risk tasks such as urban reconnaissance and demining, the system significantly reduces soldier exposure to danger, making it a valuable asset for modern asymmetric warfare and humanitarian missions. Further field testing and integration with military networks could transition this prototype into a deployable tactical tool.

VI. FUTURE SCOPE

- Behind-wall scanning robots can use radar, Dopler radar technology to "see" through walls and detect objects hidden inside walls, floors, or other structures. When combined with metal bomb detection capabilities, these systems can locate and identify metallic components of IEDs or bombs without the need for direct access or line of sight.
- By using robots instead of human personnel to inspect potentially dangerous areas, the system greatly reduces the risk to human life. These robots can navigate hostile or unstable environments, scan through walls for threats, and identify explosive devices without putting bomb disposal units directly in harm’s way.
- The future scope of integrated behind-wall scanning and metal bomb detection systems includes the development of autonomous or semi-autonomous robotic platforms. These advanced robots can operate with minimal human intervention, using artificial intelligence (AI) and machine learning (ML) to interpret sensor data, navigate complex environments, and make real-time decisions. For example, an autonomous robot equipped with SLAM (Simultaneous Localization and Mapping)

technology can map an unknown area while scanning for metallic threats behind walls or underground.

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