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Military Surveillance System Using IR Sensor Technology

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Abstract: *The proposed Military Radar System employing an IR Sensor, Arduino Uno, and SIM800L GSM Module is an economical and automated surveillance solution intended for short-range border monitoring, intrusion detection, and perimeter security. The system detects movement or unauthorized access within a designated area and transmits real-time alerts via GSM technology, ensuring efficient monitoring and rapid response for defense and security applications. Conventional military radar systems are generally complex, bulky, and expensive; therefore, this project provides an economical alternative using easily available electronic components while still*
offering efficient object detection and alert functionality. The system is built around the Arduino Uno microcontroller, which controls sensor movement, processes detection data, and manages communication between different modules.
The system hardware consists of an Infrared (IR) sensor mounted on an SG90 servo motor that continuously scans an area of up to 180 degrees. Unlike ultrasonic sensors, the IR sensor operates by transmitting and receiving infrared radiation, allowing it to identify reflective objects or heat signatures within a detection range of approximately 0–40 cm or higher depending on the sensor specifications. As the servo motor rotates, the IR sensor scans the surrounding environment and sends object detection data along with angular position information to the Arduino Uno for processing.
An important feature of this project is the integration of the SIM800L GSM module, which enables remote alert communication. Whenever the IR sensor detects an object within the predefined critical zone, the Arduino processes the received data and immediately sends commands to the GSM module. The SIM800L module then transmits an SMS alert to authorized security personnel, allowing rapid action in response to potential intrusions or security threats.
To improve monitoring capability, the system also provides a real-time visual representation of detected objects. Using the Processing IDE, the collected sensor data is displayed on a computer screen in a format similar to a traditional Radar Plan Position Indicator (PPI). The display shows important information such as the object's distance, scanning angle, and detected position, thereby enhancing situational awareness and surveillance efficiency.
Overall, this project demonstrates the effective integration of infrared sensing technology, automated motor control, wireless GSM communication, and graphical visualization into a compact and cost-effective surveillance system. By utilizing basic embedded electronics and communication modules, the prototype serves as an educational and practical model for understanding automated detection, security monitoring, and remote alert systems.

Keywords: Military radar, IRsensor, object detection, Arduino, servo motor, surveillance system, intruder detection, defense technology,

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I. INTRODUCTION

Military radar and surveillance systems play a vital role in modern defense and security operations. They are widely used for border monitoring, intrusion detection, battlefield surveillance, target tracking, and protection of sensitive military installations. In recent years, there has been an increasing demand for compact, low-cost, and reliable monitoring systems capable of providing real-time detection and immediate communication. Conventional military radar systems are often expensive, complex, and require sophisticated infrastructure. Therefore, there is a need to develop simplified and economical surveillance solutions that can still provide efficient security monitoring and rapid alert generation [1].

II. LITERARURE REIVIEW

Several researchers and engineers have contributed to the development of radar-based surveillance, intrusion detection, and GSM communication systems for military and security applications. Modern defense systems require reliable monitoring technologies capable of detecting threats in real time and immediately communicating alerts to security personnel. As a result, many studies have focused on integrating sensing devices, embedded systems, and wireless communication technologies to improve surveillance efficiency and response time [2].

One important area of research involves military radar monitoring and fault detection systems. A prototype early warning system for the TPS-70 military radar was developed using Arduino and the SIM800L GSM module to improve radar reliability and preventive maintenance. In this system, different radar parameters and fault conditions were continuously monitored using sensors and embedded controllers. Whenever abnormal conditions or system failures were detected, alert messages were transmitted through GSM communication [3]. This research demonstrated the importance of integrating microcontrollers with wireless communication modules to enhance monitoring capability, reduce maintenance delays, and improve operational reliability in military applications.

Research studies on radar sensing technology emphasize the growing need for combining radar systems with communication networks for real-time defense surveillance [4]. Traditional radar systems mainly focus on object detection and tracking; however, modern systems also require instant information sharing and remote monitoring. Joint radar and communication systems improve operational efficiency by enabling continuous data transmission, faster decision-making, and better situational awareness. These integrated systems are particularly useful in border security, intrusion monitoring, battlefield surveillance, and restricted military zones where rapid response is critical [5].

Several studies have also focused on the use of Infrared (IR) sensors in security and detection systems. IR sensors are widely preferred because they are economical, compact, energy-efficient, and easy to interface with microcontrollers [6]. These sensors operate by transmitting infrared radiation and detecting the reflected signals from nearby objects or moving targets. Due to their fast response time and reliable obstacle detection capability, IR sensors are commonly used in motion detectors, automatic doors, robotics, industrial automation, and surveillance systems. Researchers have shown that IR-based detection systems can effectively identify object movement within short distances and provide quick responses for security applications.

In embedded communication systems, GSM modules such as the SIM800L are extensively used because of their compact design, low power consumption, and reliable wireless communication features. The SIM800L module supports SMS, voice calls, and GPRS communication over GSM850, EGSM900, DCS1800, and PCS1900 frequency bands [7]. Many embedded projects use SIM800L modules to send alert notifications, emergency warnings, and status updates remotely. Studies indicate that GSM-based alert systems are highly effective for real-time monitoring because they allow instant communication between the surveillance system and authorized users regardless of geographical location [8].

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Researchers have also explored the integration of sensors, microcontrollers, and GSM communication into intelligent security systems. These systems are capable of automatically detecting intrusions, processing sensor data, and transmitting notifications without human intervention. Such automation improves system reliability, minimizes response delay, and enhances overall security performance. In military and defense environments, these features are especially important because immediate communication and rapid response are necessary to prevent unauthorized access and potential threats [9].

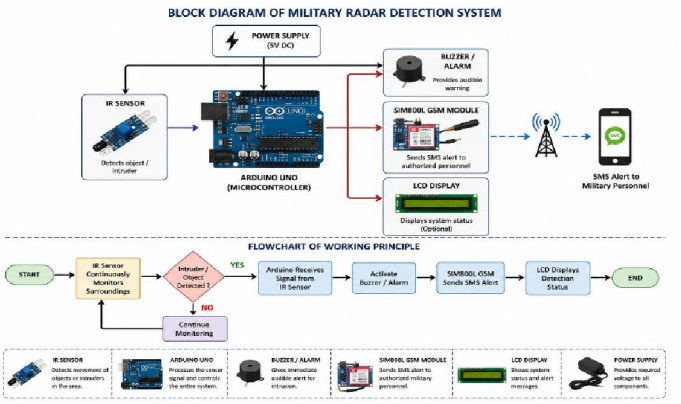
The reviewed literature clearly indicates that combining IR sensing technology with GSM-based wireless communication provides an efficient and practical solution for military surveillance and security monitoring systems. IR sensors offer reliable object detection, while GSM modules enable fast remote alert transmission. When integrated with microcontrollers such as Arduino, these technologies create low-cost, compact, and intelligent surveillance systems suitable for border security, restricted military zones, sensitive installations, and automated defense applications [10].

III. SYSTEM OVERVIEW

The figure given below, illustrates the complete working architecture of the Military Radar Detection System. The IR sensor continuously monitors the surrounding area for the presence of intruders or moving objects. When detection occurs, the sensor transmits a signal to the Arduino Uno microcontroller, which acts as the central processing unit of the system [11].

The controller immediately activates the buzzer/alarm to provide an audible warning and simultaneously communicates with the SIM800L GSM module to send SMS alerts to authorized military personnel. The optional LCD display shows the real-time system status and intrusion information. The power supply unit provides regulated voltage to all hardware components for reliable operation [12-13].

The flowchart section of the figure clearly represents the sequential operation of the system, beginning from environmental monitoring to intrusion detection, alarm activation, SMS transmission, and status display. Thus, the diagram effectively demonstrates the integration of sensing, processing, alert generation, and communication modules for real-time military surveillance and security applications [14].



The working principle of the proposed military radar detection system is based on real-time intrusion monitoring and alert generation. The IR sensor continuously scans the surrounding area to detect the presence of objects or unauthorized intruders. When any movement is detected, the sensor sends an electrical signal to the Arduino Uno microcontroller for processing.

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The controller analyzes the received signal and immediately activates the buzzer alarm to provide an instant warning indication. At the same time, the SIM800L GSM module transmits an SMS alert to authorized military personnel, enabling rapid response and remote monitoring. Additionally, the LCD display module can show real-time system status messages such as “Intruder Detected” or “System Active.” [15].

Thus, the system integrates sensing, processing, alarm generation, and wireless communication technologies to provide an efficient and reliable military surveillance solution.

IV. RESULT

The developed Military Radar Detection System demonstrated effective and reliable performance during experimental testing. The system was designed to detect unauthorized movement in restricted areas using an IR sensor integrated with an Arduino Uno microcontroller and a SIM800L GSM communication module. The obtained results confirmed that the proposed system can successfully perform real-time surveillance, threat detection, and remote alert generation.

V. DETECTION PERFORMANCE

The IR sensor continuously monitored the surrounding environment and accurately detected moving objects within its predefined sensing range. During testing, whenever an intruder or object passed in front of the sensor, the sensor immediately generated a detection signal. The response time of the sensor was very fast, allowing the system to react almost instantly to intrusion events.

The detection mechanism operated efficiently under normal environmental conditions and showed stable performance for short-range military surveillance applications. The sensor successfully differentiated between the presence and absence of moving objects, thereby reducing unnecessary alarms during operation.

VI. CONTROLLER OPERATION

The Arduino Uno microcontroller effectively processed the signals received from the IR sensor and coordinated all system activities. Once an intrusion signal was detected, the controller executed the programmed instructions without delay. The controller simultaneously activated the buzzer alarm and communicated with the GSM module for alert transmission.

The microcontroller provided stable operation throughout the testing phase and ensured proper synchronization between all hardware components. No major processing or communication failures were observed during repeated experimental trials.

VII. ALARM SYSTEM PERFORMANCE

The buzzer alarm responded immediately after intrusion detection and generated a clear audible warning signal. This alarm mechanism is highly useful in military or restricted security zones because it provides instant local notification to nearby personnel.

The quick activation of the buzzer demonstrates the effectiveness of the embedded control logic implemented in the system. The alarm also helps reduce response time during emergency situations.

VIII. GSM COMMUNICATION PERFORMANCE

The SIM800L GSM module successfully transmitted SMS alerts to predefined mobile numbers whenever intrusion was detected. The messages were delivered with minimal delay, typically within a few seconds depending on network availability.

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The SMS alerts contained intrusion warning information, enabling authorized military personnel to monitor the protected area remotely. This feature significantly enhances the reliability and practicality of the system for border surveillance and remote security applications.

The GSM module maintained stable communication with the Arduino controller throughout the experiment. The serial communication between the controller and GSM module functioned efficiently without major data transmission errors.

IX. LCD DISPLAY OBSERVATION

The optional LCD display module correctly showed real-time system messages such as:

- "System Active"
- "Intruder Detected"
- "SMS Sent Successfully"

This feature improved user interaction and allowed operators to monitor system status directly from the hardware setup.

Experimental Justification

Parameter	Observation	Justification
Object Detection	Successfully detected movement	IR sensor provided reliable sensing capability
Alarm Activation	Immediate buzzer response	Fast processing by microcontroller
SMS Transmission	Alert sent successfully	Efficient GSM communication
System Stability	Stable operation observed	Proper hardware integration
Response Time	Very low delay	Real-time embedded processing
Communication Errors	Negligible	Reliable serial interfacing

The experimental results validate that the proposed military radar system is capable of performing real-time intrusion detection and alert notification efficiently. The integration of sensing, processing, alarm generation, and wireless communication technologies makes the system suitable for military camps, border areas, restricted zones, and high-security environments.

The system achieved the following objectives successfully:

- Continuous environmental monitoring
- Accurate intrusion detection
- Immediate alarm generation
- Wireless SMS notification
- Real-time status display

X. CONCLUSION

The proposed Military Radar Detection System provides an effective, reliable, and low-cost solution for real-time intrusion detection and security monitoring. The system successfully integrates the IR sensor, Arduino Uno microcontroller, SIM800L GSM module, buzzer alarm, and LCD display to achieve continuous surveillance and rapid alert generation.

Experimental results demonstrated that the system can accurately detect object movement, activate warning alarms instantly, and transmit SMS notifications to authorized military personnel with minimal delay. The efficient

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coordination between hardware components ensured stable operation and reliable communication throughout the testing process.

The system enhances military and border security by reducing manual monitoring efforts and enabling faster response to potential threats. Due to its simple design, low power consumption, and easy implementation, the proposed model can be deployed in restricted zones, military camps, border areas, and other high-security locations.

Future enhancements may include radar-based long-range detection, IoT connectivity, GPS tracking, wireless camera integration, and AI-based threat analysis to further improve surveillance accuracy and intelligent defense capabilities.

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