ARDUINO BASED NIGHT PATROLLING ROBOT FOR WOMEN'S SAFETY

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ABSTRACT

The Arduino-based Night Patrolling Robot is designed to enhance public security in isolated areas, especially during night time when surveillance is limited. Even CCTV cameras can only be fixed in a single position and cannot move. This robot is equipped with components, like an Arduino board, motors, sensors, night vision camera, to enable the robot to patrol autonomously. The main feature is its ability to detect sounds using a sound sensor. When noise is detected, the robot will send an ALERT message using the GSM module to the authorities with the location through GPS, and the buzzer will be activated in case of emergency, signaling immediate help. The camera helps in live footage monitoring. Additionally, GPS is used to track the robot's location and ensure the effective patrolling of the isolated areas. As the robot patrols in low-light conditions, it avoids obstacles using an IR sensor. This system ensures rapid response and help by alerting nearby people, making it an efficient tool in providing security. This paper explains the technologies to provide continuous surveillance in environments covering areas with limited human presence.

Keywords:

Arduino Nano, GSM module, GPS module, IR sensor, Sound sensor, Motor driver, Motors, Buzzer.

1. INTRODUCTION:

In today's world, ensuring security in remote or isolated areas, mainly during nighttime time makes it even more challenging. These areas are often far away from city centers, and those areas lack the necessary infrastructure for continuous human monitoring and immediate help. Traditional security methods, like CCTV cameras, are limited to a fixed position and cannot move, which makes them ineffective in

covering larger areas. Additionally, the CCTV cameras face difficulties due to low-light conditions. They fail to detect sounds. This limitation exposes communities to a great danger that are already vulnerable to crimes or emergencies in isolated environments.

To solve these issues, this project proposes an Arduino-based night patrolling robot that is designed to patrol autonomously and monitor specific areas during nighttime, especially in places where security resources are limited. The robot is equipped with a variety of sensors and communication systems, which ensure it can effectively respond and provide immediate help. This robot's core feature is its sound detection sensor, which triggers the system's monitoring functions upon detecting unusual noise; the live video footage will be activated. The robot provides live footage using a camera (ESP32). Even in low-light conditions, the robot can send real-time alerts to authorities, along the buzzer will be activated, which alerts nearby people.

This project helps in ensuring that the isolated or remote areas are protected. This helps in reducing crimes, especially during nighttime. This makes it a significant step to improve safety by reducing the rate of crimes or delays in emergency responses.

2. LITERATURE SURVEY:

In recent years, a lot of efforts have been made to enhance security using autonomous systems and IOT technologies. These systems aim to reduce crime rates, providing real-time alerts and monitoring environments. Many automated surveillance methods, like CCTV cameras and drones, are either limited to a particular place or are cost-effective. These automated systems are facing troubles due to low-light conditions or remote environments. They can't provide real-time alerts in response to any unusual activities. Several efforts have been made in developing a night patrolling robot to improve safety and security.

Sonali Patil proposed a system by combining hardware, AI algorithms, various sensors, and communication technologies to develop a night patrolling robot. Although it's effective, it also suffers from limitations like low-light performance, limited AI accuracy, and restricted battery life[1]. Sandeep Bhatia introduced an AI-powered IoT night patrolling system. This work mainly focuses on simultaneous localization and mapping (SLAM) with automation in navigating and path planning. However, this system has challenges like high power consumption, signal interference, and battery constraints were noted [2].

B. Dharshana developed a smart night patrolling robot integrating both hardware and software components using IOT. The system faced some issues related to connectivity, delayed response during emergencies, and it works by depending on the charging infrastructure [3]. Gavali Dhanshri Shivaji proposed an autonomous robot aimed at women's safety during nighttime. Their system featured autonomous navigation and

patrol mechanisms, but it had drawbacks like false positives, data security concerns, and network issues [4].

3. PROPOSED SYSTEM:

A. Overview of the Proposed System:

This proposed project is an autonomous patrolling robot, especially to enhance safety for women during nighttimetime time, especially in remote or poorly lit areas. This robot is integrated with the sound sensor, IR sensor, night vision camera, buzzer, GPS, GMS, etc. This robot is integrated with emergency alert features like a buzzer. When the sound above a set level is detected, the system performs the following:

- Activates the camera to capture the scene,
- Sends an SMS alert with the GPS location using a GSM module,
- Triggers a buzzer to alert nearby people.

This system helps in monitoring remote areas and gives a faster response in emergencies. This discourages criminal activities against women and ensures real-time crime reporting.

B. Overall System Architecture:

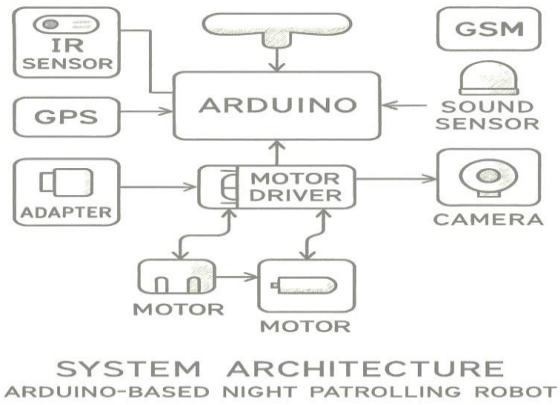

Fig.1: System Architecture

The system architecture includes core hardware, a communication layer, and a control interface. The modules include:

i. Sensing Module: It consists of IR sensors, sound sensors, which are used to detect motion, abnormal sounds.
ii. Processing Unit: An Arduino Nano is used to process input data, and it also controls overall system behavior.
iii. Communication Module: The GSM module with the GPS module is used for sending alerts with their location. This helps in tracking the robot
iv. Surveillance Module: It includes the camera (ESP32) for real-time monitoring, and it also performs video capturing in low-light conditions, which helps in remote areas.
v. Alerting System: The buzzer is used to draw the attention of nearby people for immediate help or response. This helps in emergencies

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vi. Mobility Unit: DC motors and driver for path navigation.

All components are powered by a rechargeable battery, and they are managed by an onboard program that ensures continuous operation. This enables real-time detection, communication, also alerts nearby people for immediate response.

C. Data Collection Module:

Gathers data from the robot's onboard sensors, the IR sensor detects motion, and the sound sensor detects if there are any unusual sounds. Using these, the robot can also avoid obstacles. All sensor readings are recorded and processed in real-time by the Arduino. In addition, any abnormal readings can trigger immediate alert generation. Data is transmitted via GSM to a mobile device, supporting immediate response. Until the response is reached, it may take time, so the buzzer helps by alerting nearby people to get an immediate response.

4. METHODOLOGY:

Step 1: Problem Identification

Due to the rise of crimes, mainly during nighttime in isolated areas, safety concerns are the main concern for women. The biggest problem is due to low light conditions; therefore, there is a need for an autonomously patrolling robot to ensure safety by assisting through surveillance and sending alerts in case of danger.

Step 2: Component Selection

Microcontroller: Arduino Nano

Sensors: IR (motion), Sound sensor

Modules: GSM to send SMS alerts, GPS for location tracking.

Other components: Camera (ESP32), motors, motor driver, buzzer

Component	Purpose
Arduino Nano	Works like the brain of the robot – it controls and connects all the other components.
IR Sensor	Helps the robot detect if something is moving or blocking its path.
Sound Sensor	Picks up any sudden or unusual sounds that might be a sign of trouble.
Night Vision Camera	Records live video even in dark places, so nothing is missed.
GSM Module	Sends text message alerts to authorities when something suspicious is detected.
GPS Module	Finds and shares the robot's current location for easy tracking.
Buzzer	Makes a loud sound to warn nearby people when something unusual happens.
Motor Driver	Tells the motors how to move – whether to go

	forward, backward, or turn.
DC Motors	These make the robot move around and do its patrolling job.

Table 1: Components and purpose

Step 3: Connecting the Hardware

All the parts were put together as shown in the circuit plan. Once the wiring was done, we attached everything firmly to the robot's base. This helps the robot move around without any issues.

Step 4: Writing the Code

We wrote the code for the Arduino so it can do these tasks:

- Spot movement, loud noises, and low-light surroundings
- Change its path if there's something in the way
- Make a sound with a buzzer when it notices something unusual
- Send warning messages using the GSM part
- Share its current position using the GPS module

Step 5: Checking the Sensors

Before using the robot as a whole, we tested each sensor by itself to make sure it works well:

- The IR sensor was used to check if someone was nearby
- The sound sensor helped us notice unexpected or loud sounds

Step 6: Setting Up Communication

We added features to allow the robot to communicate:

- The GSM module sends warning messages to a mobile phone
- The GPS module gives the robot's exact location when needed

Step 7: Testing the Robot

We tested the robot in a small indoor area made to feel like a dark and quiet place. We found the following during testing:

i. **Motion Sensing:**
The IR sensor also worked reliably and didn't take too long to detect someone.

ii. **Sound Alerts:**
The sound sensor accurately triggered the alert.

iii. **Location Tracking:**
The GPS gave fairly accurate results, usually within 5 meters of the real spot.

iv. **SMS Alerts:**
Unusual activity triggered a message within seconds.

The above results confirm that the robot performs well in detecting unusual activities and provides real-time alerts with the location. This system is integrated with smart sensors and communication modules.

5. FUTURE SCOPE:

In the future, the following improvements can be integrated with additional features to get more accurate results:

- AI-powered facial recognition for suspicious activity detection.
- Using solar panels for continuous battery recharge.
- Compact design to reduce weight.
- Deployment of multiple robots coordinated via IoT cloud.

This current prototype of the night patrolling robot successfully addresses several challenges related to women's safety in isolated or remote areas. However, future enhancements can significantly expand the security capabilities. Integrating artificial intelligence (AI) can allow the robot to recognize specific gestures, persons, and faces, which enables a more intelligent threat-detection system. Integration with cloud-based platforms can provide real-time video streaming and remote data analysis. Additionally, implementing solar charging systems will allow for continuous operation without manual intervention. Future versions can also support voice recognition, allowing victims to activate alerts through specific keywords. These improvements can make this robot more autonomous, reliable, and efficient.

6. CONCLUSION:

This paper presents an Arduino-based night patrolling robot aimed at enhancing women's safety in isolated areas during nighttime. The robot is integrated with several modules, including an IR sensor, a sound sensor, a GPS module, a GSM module, and a camera (ESP32) module, so it can autonomously patrol, detect unusual sounds, and send emergency alerts with the location. This system is mainly cost-effective, scalable, and performs well. Its successful implementation can help in crime prevention and timely response in remote areas with low-security zones. As this system is integrated with a buzzer, the nearby people can also provide their response for emergency help. With minor improvements and wider deployment, this system has the potential to reduce crime and enhance safety in vulnerable zones.

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