AUTONOMOUS NIGHT SAFETY PATROLLING CAR

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Keywords:

Security patrol, Raspberry Pi, Scream detection, Obstacle detection, Night vision camera

Introduction:

This project develops an AI-powered autonomous car for nighttime surveillance. It uses a night vision camera for video monitoring, a microphone for scream detection, and multiple sensors for obstacle avoidance, GPS tracking, and real-time alerts. Powered by Raspberry Pi 5 and machine learning, the car operates independently, enhancing safety in dimly lit or isolated areas like campuses, parks, and residential zones. It offers a smart, scalable solution for modern security needs, reducing reliance on human intervention.

Objectives:

- Develop a self-navigating robot car with obstacle detection.
- Integrate night vision camera and real-time scream detection using AI.
- Use GPS for real-time tracking.
- Collect environmental data like noise and sound.
- Raise alerts in response to threats detected during the partolling.
- Record audio and video for analysis purposes in case of threat detection.

Methodology:

The Autonomous Night Safety Patrolling Car combines hardware and software for real-time surveillance, scream detection, and obstacle avoidance. A Raspberry Pi 5 acts as the central controller, connected to an ultrasonic sensor, GPS, night vision camera, and microphone. The car uses a four-wheel chassis powered by two battery packs—one for motors and one for electronics.

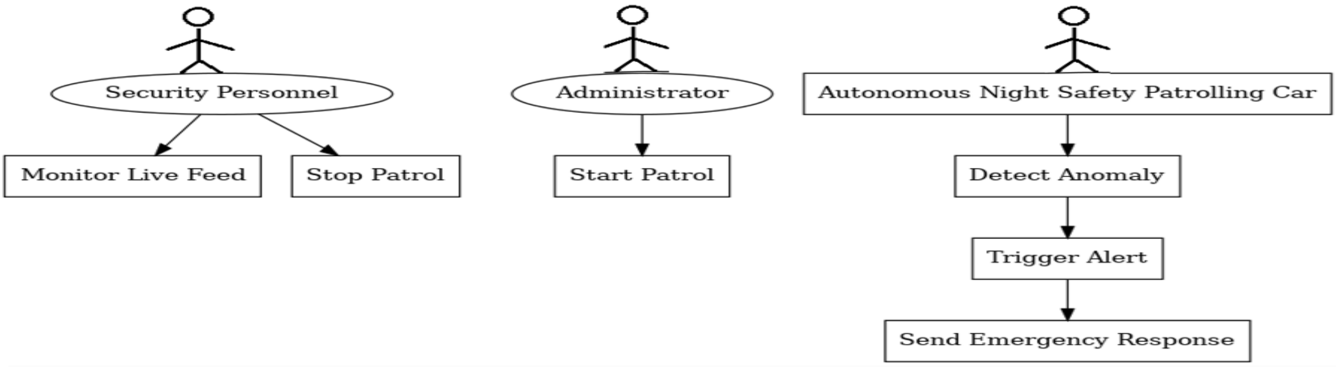
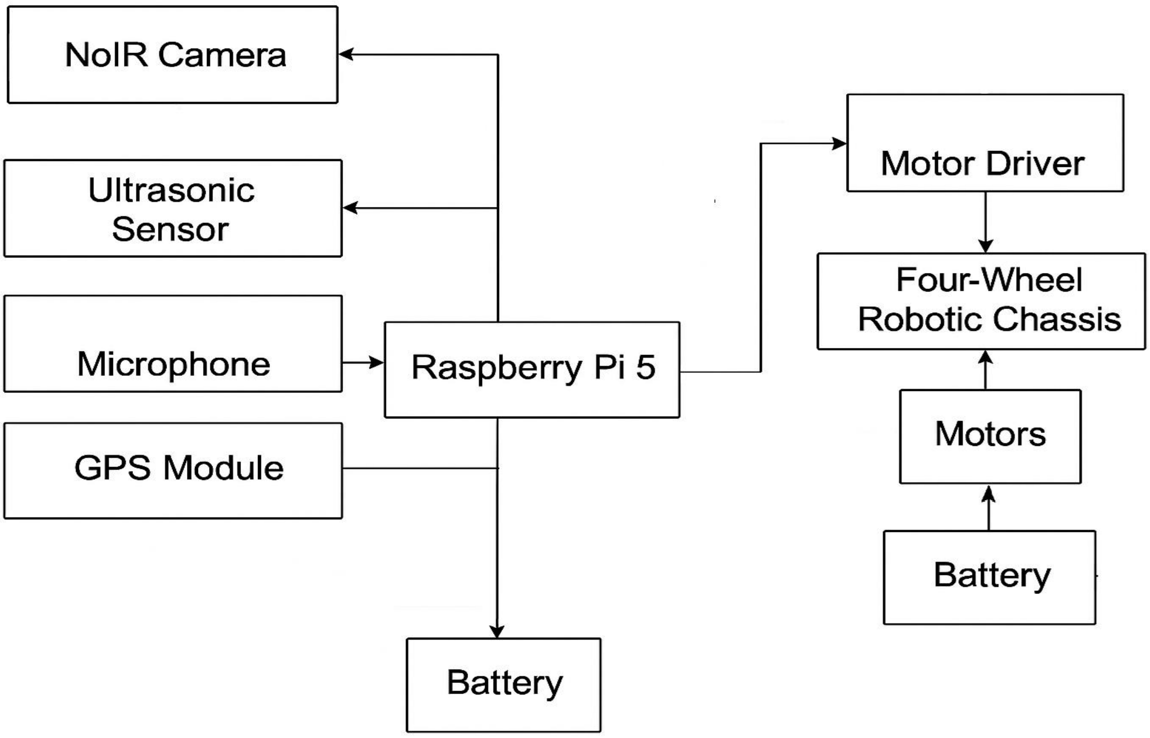


Figure 1: Use Case Diagram

A scream detection model, trained offline and deployed using TensorFlow Lite, analyzes real-time audio and triggers alerts with GPS logging. Obstacle detection ensures smooth navigation, while the camera provides night video monitoring. The system runs on Python with multithreading for real-time processing and supports future upgrades like SLAM, noise monitoring, and remote dashboard integration.



System Architecture

Results & Conclusions:

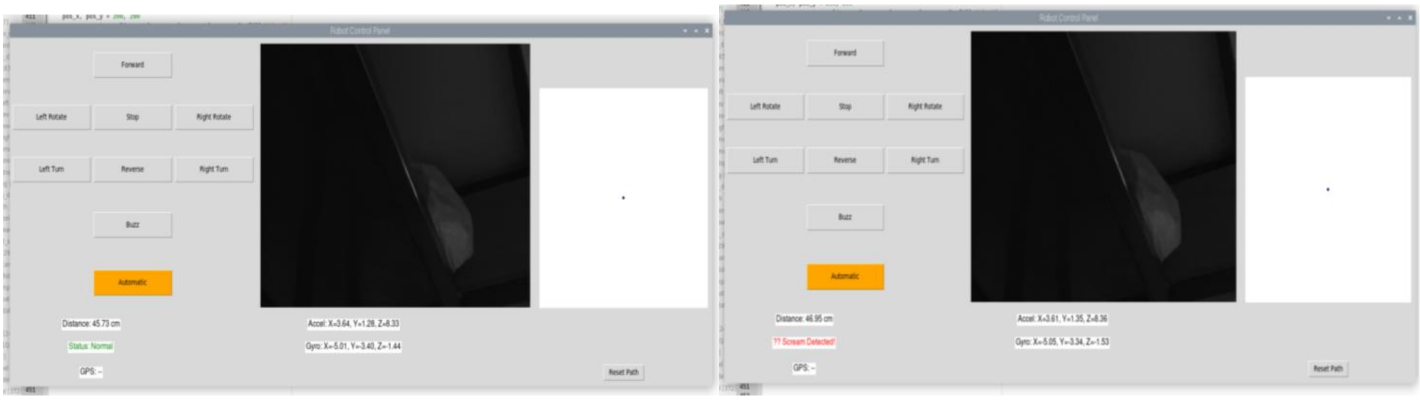


Figure 2: System Architecture

The Autonomous Night Safety Patrolling system was successfully developed and tested under various low-light and night-time conditions. Key outcomes of the project include:

- **Navigation and Obstacle Avoidance:** The patrolling robot effectively navigated predefined routes using GPS or mapped paths, while avoiding obstacles using ultrasonic sensors.

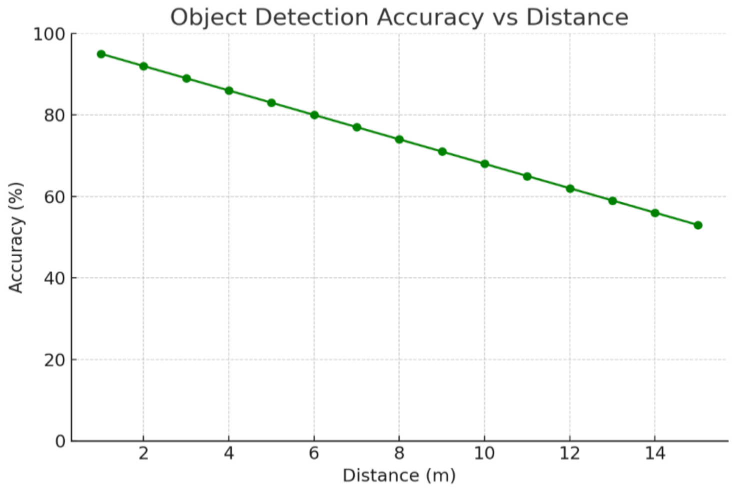
- **Surveillance Efficiency:** Infrared (IR) and night-vision cameras enabled real-time video monitoring and audio recording, ensuring visibility in complete darkness.

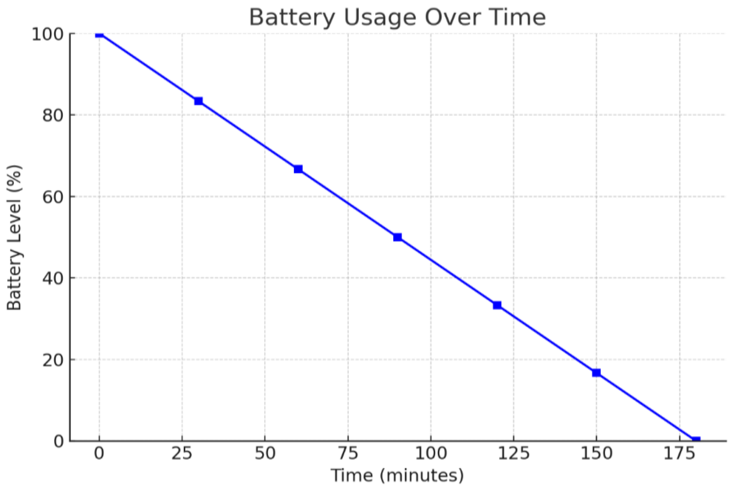
- **Anomaly Detection:** The system utilized basic AI/ML or sensor-based logic to detect unusual activities such as high pitch noise or screams.

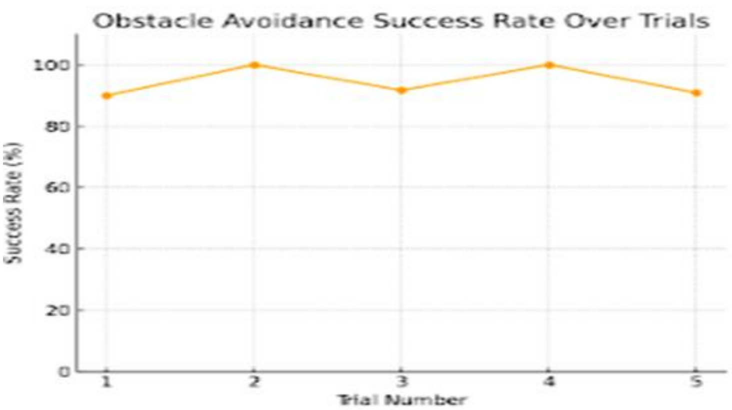
- **Enhanced Public's Safety**: It is primarily focused to aid the children, women and elderly peoples.It provides real-time tracking, monitoring, and emergency alerts, ensuring greater security in public and private spaces.

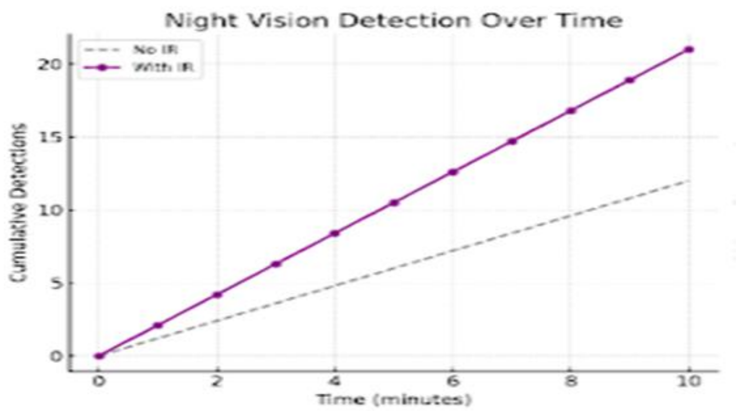
Conclusion:

This project proves that autonomous night patrolling is a practical and cost-effective solution for enhancing safety in areas like campuses, industrial zones, and residential neighborhoods. Using sensors, AI-based scream detection, and night vision, the system provides reliable, real-time surveillance without human intervention. Testing showed accurate scream detection, clear night footage, precise obstacle avoidance, and efficient power usage. The dual power system ensures uninterrupted operation. Future upgrades could include smart city integration, advanced threat detection, and better energy optimization. The prototype met all key objectives and demonstrated strong real-world potential.









Project Outcome & Industry Relevance:

The Autonomous Night Safety Patrolling Car project was successfully implemented and tested to ensure security and surveillance during nighttime with minimal human intervention. Key outcomes include:

1. **Autonomous Operation:**
   The car demonstrated the ability to navigate patrol routes without manual control, using GPS algorithms for pre-programmed paths.
2. **Night-Time Vision and Monitoring:**
   Infrared (IR) and low-light camera systems enabled effective monitoring in complete darkness, allowing detection of unusual activities or intrusions.
3. **Obstacle Detection and Avoidance:**
   Using ultrasonic sensors, the vehicle was capable of identifying and navigating around obstacles

in its environment.

4. **Energy Efficiency and Charging:**
   Efficient power management was achieved through low-energy components and an optional auto-charging feature, ensuring uninterrupted patrolling.
5. **Data Logging and Surveillance Recording:**
   Surveillance footage and environmental data were stored for review and analysis, supporting evidence-based responses and investigations.

Industry Relevance:

The Autonomous Night Safety Patrolling Car is highly relevant to current trends in smart security and robotics, offering a cost-effective and scalable solution to multiple sectors:

1. **Industrial and Manufacturing Plants:**
   Provides after-hours surveillance in large factories or warehouses, reducing the need for human guards and improving coverage in hazardous areas.
2. **Smart Cities and Residential Communities:**
   Can be integrated with smart city infrastructure to patrol neighborhoods, parking lots, and gated communities, enhancing urban safety.
3. **Educational Institutions and Campuses:**

   Assists campus security during night time, ensuring student and staff safety in open or low-traffic areas.

4. **Logistics and Transportation Hubs:**
   Secures high-traffic areas like ports, airports, and depots during off-hours, monitoring for unauthorized access or theft.
5. **Event Management and Temporary Security Zones:**
   Deployed at large events or temporary installations where 24/7 surveillance is needed.

Working Model vs. Simulation:

The project involved the development of a physical working model. All core functionalities—such as autonomous navigation, scream detection, obstacle avoidance, real-time video monitoring, and GPS tracking—were implemented and tested on a robotic chassis using Raspberry Pi 5, sensors, and actuators. The scream detection AI model was trained separately and deployed on the hardware for real-time inference. The integration of all hardware components and real-world testing confirms that the system operates as a fully functional prototype, beyond mere simulation or theoretical study.

Project Outcomes and Learnings:

1. **Autonomous Operation using Night-Time Vision and Monitoring:**
   The car demonstrated the ability to navigate patrol routes without manual control, using GPS, using algorithms for pre-programmed paths.Infrared (IR) and low-light camera systems enabled effective monitoring in complete darkness, allowing detection of unusual activities.
2. **Obstacle Detection and Avoidance:**
   Using ultrasonic sensors, the vehicle was capable of identifying and navigating around obstacles in its environment.
3. **Energy Efficiency and Charging:**
   Efficient power management was achieved through low-energy components and an optional auto-charging feature, ensuring uninterrupted patrolling.
4. **Data Logging and Surveillance Recording:**
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Learning and Skill Development:

1. **Embedded Systems & Robotics:**
   Gained hands-on experience working with microcontrollers (Raspberry Pi), sensors, motors, and real-time systems.
2. **Autonomous Control Logic and Sensor Integration:**
   Learned how to program logic for path following, decision-making, and error handling under dynamic conditions.Understood how to interface and calibrate various sensors for environmental awareness (e.g., IR, ultrasonic, GPS, camera modules).
3. **Problem-Solving & Debugging:**
   Faced and resolved real-world challenges related to hardware limitations, sensor inaccuracies, and power management.
4. **Team Collaboration and System Design Thinking:**
   Worked effectively in a team environment, dividing tasks, communicating progress, and integrating components into a functional system.Applied knowledge to design a real-world solution from idea to execution while balancing cost, performance, and functionality.
5. **Documentation & Reporting:**

Improved skills in technical writing, report preparation, and presenting project findings effectively.

Future Scope

Future enhancements include advanced AI for detecting complex threats like suspicious behavior or abandoned objects. All-terrain mobility can expand use to rural or disaster-prone areas. The system aims to evolve into a fully autonomous, scalable, and 24/7 security solution, transforming traditional surveillance. With improved reliability, it holds strong potential for adoption in commercial and public sectors:

- Airports and transportation hubs.
- Warehouses and logistics parks.
- Large residential societies.
- Universities and research campuses.