IT4010 – Research Project - 2024

Topic Assessment Form

Project ID: 24-25J-053

1. Topic (12 words max)

Enhancing Outdoor Security with Autonomous Patrol Robot (Improving Facility Surveillance with Multi-Sensor Fusion, Dynamic Path Adaptation, and Adaptive Environmental Response)

2. Research group the project belongs to

Autonomous Intelligent Machines and Systems (AIMS)

3. Research area the project belongs to

Internet of Things (IoT)

4. If a continuation of a previous project:

Project ID	
Year	

Patrolling is an essential component of preserving security, order, and safety in a variety of settings, including metropolitan areas, borders, and important infrastructure locations. Human patrolling, though a traditional and common method of maintaining security, has several drawbacks that can limit its effectiveness, especially in large-scale industrial settings. These challenges underscore the need for more advanced and reliable solutions, like robotic patrol systems.

One of the main issues with human patrolling is that security personnel can easily get tired, leading to mistakes. They often work long shifts, which can cause both physical and mental exhaustion. As they become fatigued, it gets harder for them to stay alert and respond quickly to potential security threats. This increased risk of oversight and slower reaction times can put the overall safety of the facility at risk.

Human patrolling is not only labor-intensive but also quite expensive. It demands a significant investment in hiring, training, and retaining a skilled security team. On top of that, the ongoing costs for salaries, benefits, and continuous training programs can add up quickly. These expenses can be particularly tough for industries that need round-the-clock surveillance over large areas.

Human patrolling is restricted by physical restrictions. Industrial sites frequently encompass extensive and diverse terrains, including locations that are difficult or dangerous for humans to reach. This can cause gaps in surveillance, leaving some locations unprotected. Furthermore, human patrols have limited speed and agility, making it difficult for them to respond swiftly to occurrences occurring far away.

The safety of security staff is a major concern, particularly in hazardous industrial areas. Human patrollers face a variety of risks, including exposure to hazardous materials, operating machinery, and potential encounters with intruders. Ensuring the protection of security personnel necessitates additional safeguards and protocols, which can complicate security operations and raise costs. Human performance can be inconsistent for a variety of reasons, including health, motivation, and environmental conditions. Factors like the weather, time of day, and personal well-being can significantly impact how effectively security personnel can do their jobs. This inconsistency can result in unreliable surveillance and protection, weakening the overall security strategy.

Human patrolling, despite its longstanding use, presents several disadvantages that can impede the efficiency and effectiveness of security operations in industrial settings. Fatigue, high costs, limited coverage, safety risks, inconsistent performance, and technological limitations all contribute to the need for more advanced solutions. Transitioning to robotic patrol systems can address these challenges, providing continuous, efficient, and reliable security coverage while reducing the reliance on human patrols.

5. Brief description of the research problem including references (200 – 500 words max) – references not included in word count.

References

[1] *Night Vision Patrolling Robot for Security Patrolling Using Raspberry Pi,* p. https://www.academia.edu/49083767/Night_Vision_Patrolling_Robot_for_Security_Patrolling_Using_Raspberry_Pi.

[2] H. ,. M. &. L. A. Andreasson, "Autonomous difference detection for security patrol robots," *EEE/RSJ International Conference on Intelligent Robots and Systems ,* 2007 October.

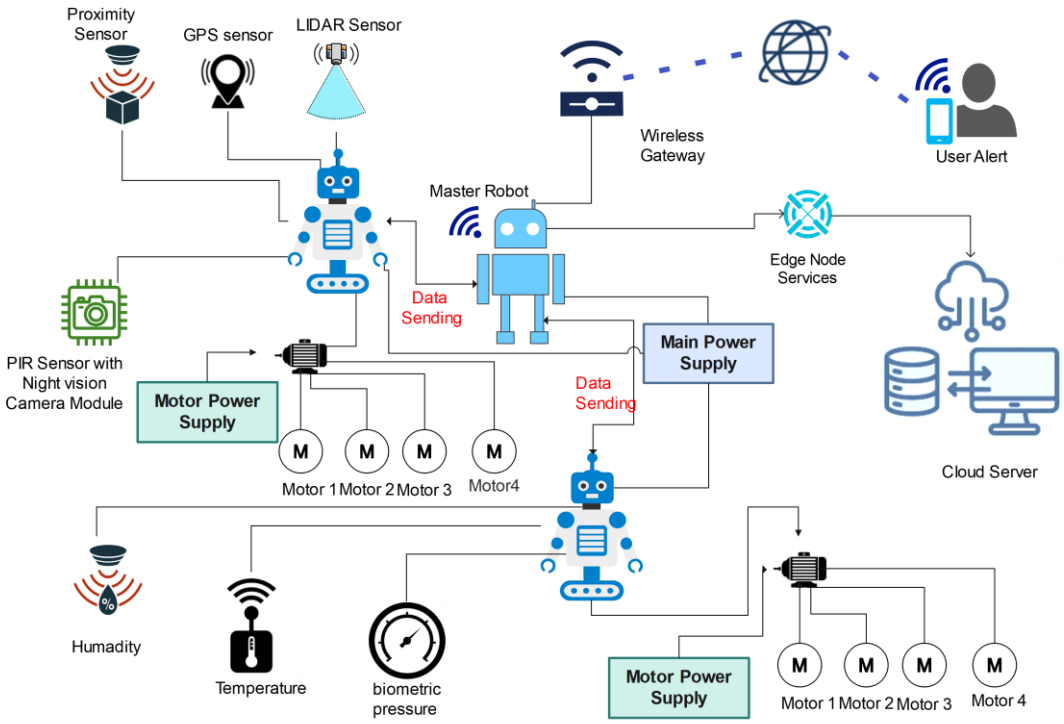
[3] A. S. M. &. T. P. Di Fava, "Visual navigation of mobile robots for autonomous patrolling of indoor and outdoor areas," 2015.

[4] F. A. I. H. R. D. A. A. P. &. S. K. Khalid, "Night patrolling robot.," no. International Conference on Robotics, Electrical and Signal Processing Techniques (ICREST), 2021.

[5] Y. P. L. E. &. M. R. Guo, "Collaborative robots for infrastructure security applications. In Mobile robots," 2007. https://ieeexplore.ieee.org/abstract/document/1626823/

6. Brief description of the nature of the solution including a conceptual diagram (250 words max)

Our solution for instant intrusion detection involves deploying a robot that patrols a predefined path around the facility. Unlike human guards, this robot offers a wider field of view, enabling more effective coverage. Equipped with advanced sensors, adaptive algorithms, and seamless connectivity, it is designed to monitor and navigate complex environments efficiently. The robot features PIR and LIDAR sensors, night vision cameras, and edge computing capabilities to accurately detect motion and minimize false alarms. It can follow predetermined patrol routes while adapting to environmental changes. A stationary Master robot coordinates multiple Slave robots, enhancing the system's efficiency. Additionally, the robots are fitted with sensors that track temperature, humidity, and barometric pressure, ensuring optimal performance across varying weather conditions. This approach not only enhances motion detection and environmental adaptability but also simplifies the surveillance process, reducing the need for human oversight and providing scalable coverage for large, intricate areas.



7. Brief description of specialized domain expertise, knowledge, and data requirements (300 words max)

- Proficiency in creating and utilizing robot with the ability to navigate on their own. To maintain safe and effective operations in a variety of contexts, this involves having a solid understanding of robot hardware, flight dynamics, and control systems

- GPS and Location-Based Services: Accurate positioning and route planning for robot to depend on an understanding of GPS technology and how it is incorporated into the robot navigation system which is used for following a pre-defined path

- Networking and Wireless Communication: Proficiency with network optimization and wireless communication protocols, such as Wi-Fi and LTE, is necessary to configure robot to communicate with the Server for sending a summary report, footages and configured triggers based on the condition

- Geospatial and Mapping Data For precise location-based services and GPS guidance for both indoor and outdoor situations to avoid the issue of getting crash into structures in the facility

- Ability of implementing a function that can used for Real-time data processing of all the data that is going to capture by the different types of sensors In order to generate an alert and a report immediately based on the pre-defined conditions.

- The knowledge of edge computing principles enables robots to interpret sensor data locally, reducing latency and maximizing bandwidth use before sending it to the cloud.

- Environmental Monitoring: The study of environmental parameters such as temperature, humidity, and barometric pressure, and how these affect robot performance.

8. Objectives and Novelty

Main Objective Our main goal is to deploying outdoor patrol robot can greatly improve security and surveillance by addressing challenges in mobility, detection, navigation, communication, and weather conditions. These robot enable continuous and efficient monitoring, reducing the reliance on human patrols and offering a scalable solution for large areas.			
Member Name	Sub Objective	Tasks	Novelty
G.I Ashinshana	To detect relative motion to the patrol robot we are using a combination of PIR sensor and LIDAR sensor to improve accuracy and to improve visibility using the night vision camera and send the image to the server in a cloud and design and develop a user interface	Develop a function that can get an output from the data of both the PIR and the LIDAR sensor Capture the images from the night vision camera ensuring the quality and low latency feeds for real-time warehouse monitoring Set up secure real-time transmission of processed data to a cloud server	Using the data from both PIR sensor and the LIDAR sensor to increase the accuracy of the motion capture by the patrol robot to decrease the probability of false notification and use the edge computing principle to locally process all the data from the sensors and camera before transferring it to the server in the cloud

Madhusankha W.V.S	Creating an algorithm that enables robots to follow both pre-defined patrol routes and adapt to dynamic changes in the warehouse environment like when there is intense light or motion and use GPS and Waypoints to implement Proximity Sensors and Lidar for navigation and mapping the new path by detecting the obstacles	Develop and implement algorithms that allow robots to automatically follow established patrol route Develop and implement an algorithm that can change the patrol route dynamically based on the data from the camera and sensors. Integrate mechanisms to adapt the path in response to unexpected obstructions and obstacles in the environment	Dynamically change the path of the patrol robot for further investigation based on the intense light or motion from the camera and the sensors and combining Lidar and GPS (outdoor) to precisely avoid obstacles and obstructions by mapping the new path for future investigations
Gunawardhana K.A.S.H	Equip the slave robots with multiple onboard sensors like temperature, humidity, and biometric pressure and by combining the outputs maintain optimal performance and reliability under varying environmental conditions	Creating a function to get an output from multiple sensors to precisely predict the change in the weather Create different types of mechanisms to overcome the different types of weather conditions	With the help of the data gathered from the different types of sensors slave robots intelligently change the physical mechanisms based on the weather condition (ex: When there is snow or rain it will increase the traction to navigate on slippery surfaces and when there is fog it will be going to

			activate the night vision for better visibility)
D.L.B.S Liyanaarachchi	Creating a stationary Master robot and establishing a seamless connection with the Slave robots and coordinating them (ex: when a slave robot investigates a recorded motion sends another slave patrol robot to cover the predefined route)	Implement a method to establish a seamless connection with the slave patrol robots Creating a function to coordinate the slave patrol robots to efficiently monitor the facility Setup and implement a function to locate all the slave robots and acquire their newly discovered paths	Based on the information that is gathered from the slave robot master robot can intelligently communicate with the slave robot to change the patrol routes to efficiently and effectively monitor and cover a large facility without affecting the ongoing inspection

9. Supervisor checklist

a) Does the chosen research topic possess a comprehensive scope suitable for a final-year project?

Yes		No	

b) Does the proposed topic exhibit novelty?

Yes		No	

c) Do you believe they have the capability to successfully execute the proposed project?

Yes		No	

d) Do the proposed sub-objectives reflect the students' areas of specialization?

Yes		No	

e) Supervisor's Evaluation and Recommendation for the Research topic:

10. Supervisor details

	Title	First Name	Last Name	Signature
Supervisor				
Co-Supervisor				
External Supervisor				
Summary of external supervisor’s (if any) experience and expertise				

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Topic Assessment Form

<u>This part is to be filled by the Topic Screening Panel members.</u>

Acceptable: Mark/Select as necessary

Topic Assessment Accepted	
Topic Assessment Accepted with minor changes (should be followed up by the supervisor)*	
Topic Assessment to be Resubmitted with major changes*	
Topic Assessment Rejected. Topic must be changed	

* Detailed comments given below

Comments

The Review Panel Details

Member's Name	Signature

*__Important__:

1. According to the comments given by the panel, make the necessary modifications and get the approval by the **Supervisor** or the **Same Panel**.
2. If the project topic is rejected, identify a new topic, and follow the same procedure until the topic is approved by the assessment panel.