UNIVERSITY of GREENWICH

Alliance with FPT Education

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Undergraduate Final Year Project Proposal

REPORT

ROBOT SOLUTION FOR AUTOMATIC FIRE MANAGEMENT

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1. INTRODUCTION:

Fires pose a significant threat to lives, property, and ecosystems worldwide, necessitating innovative solutions for effective management and mitigation. In response to this challenge, the Robot Solution for Automatic Fire Management project proposes a groundbreaking system that integrates robotics, IoT (Internet of Things), technologies to autonomously detect, monitor, and extinguish fires in diverse environments. This project aims to develop a fleet of autonomous firefighting robots equipped with advanced sensors, actuators, and AI algorithms, capable of navigating complex terrain, detecting fire incidents, and deploying firefighting agents with precision and efficiency. By harnessing the power of IoT connectivity, the system enables real-time communication, data exchange, and remote management, facilitating enhanced situational awareness and decision support for firefighting operations. Through extensive testing and validation in simulated and real-world scenarios, this project seeks to demonstrate the effectiveness, safety, and scalability of the proposed solution, with the ultimate goal of minimizing fire damage, reducing risks to human firefighters, and enhancing community resilience to fire-related hazards.

2. PROJECT OVERVIEW:

The Robot Solution for Automatic Fire Management aims to develop an integrated system capable of autonomously detecting, monitoring, and extinguishing fires in various environments. This comprehensive solution will combine state-of-the-art hardware and software components to create a robust and versatile platform for fire management.
Key Components:

Robotics: The project will involve the design and development of robotic devices equipped with sensors, actuators, and firefighting mechanisms. These robots will navigate through designated areas, scanning for signs of fire and responding promptly to emerging threats.
IoT (Internet of Things): IoT technology will enable real-time communication and data exchange between the robotic devices, centralized control systems, and cloud-based platforms. This connectivity will facilitate remote monitoring, command execution, and data analytics, enhancing overall system efficiency and effectiveness.
Project Objectives:

Develop and deploy a fleet of autonomous firefighting robots capable of navigating complex terrain, detecting fires, and deploying firefighting agents.
Implement a centralized control system to coordinate the activities of the robotic devices, monitor fire conditions, and facilitate remote management and control.
Integrate IoT sensors and communication modules to enable seamless data exchange and real-time monitoring of fire incidents, environmental conditions, and robot status.
Utilize AI algorithms to enhance fire detection accuracy, optimize firefighting strategies, and improve overall system performance and reliability.
Conduct extensive testing and validation in simulated and real-world fire scenarios to evaluate the system's effectiveness, safety, and scalability.
5. Expected Outcomes:

Increased speed and efficiency in fire detection, response, and suppression, leading to reduced fire damage and loss.
Minimized risks to human firefighters by leveraging autonomous robotic technology for hazardous firefighting tasks.
Enhanced situational awareness and decision support capabilities through real-time data analytics and predictive modeling.
Improved resilience of communities and ecosystems to fire-related hazards, contributing to enhanced public safety and environmental conservation.2. Objectives:

3. METHODOLOGY:

Research and Requirements Gathering:
Conduct a comprehensive review of existing fire management systems, robotics technologies, and IoT applications.
Identify key requirements and objectives based on input from stakeholders, fire safety experts, and end-users.
System Design and Architecture:

Develop a detailed system architecture that outlines the integration of robotics, IoT devices, and AI algorithms.
Define the hardware and software components required for each subsystem, including sensors, actuators, microcontrollers, and communication modules.
Prototype Development:

Build prototypes of firefighting robots equipped with sensors for fire detection, localization, and environmental monitoring.
Implement control algorithms for autonomous navigation, obstacle avoidance, and firefighting maneuvers.
Integrate IoT modules for remote monitoring, data collection, and communication with central control systems.
Sensor Fusion and Data Processing:

Utilize sensor fusion techniques to integrate data from multiple sources, including cameras, thermal sensors, LiDAR, and gas detectors.

Develop algorithms for real-time processing of sensor data to identify fire incidents, assess environmental conditions, and optimize firefighting strategies.
AI-based Fire Detection and Classification:

Train machine learning models using labeled datasets to detect and classify different types of fires, smoke, and heat signatures.
Implement deep learning algorithms for real-time analysis of sensor data and decision-making based on fire severity, location, and spread dynamics.
IoT Connectivity and Cloud Integration:

Establish secure communication protocols for IoT devices to transmit data to cloud-based servers for storage and analysis.
Develop web-based dashboards and mobile applications for remote monitoring, control, and visualization of firefighting operations.
Testing and Validation:

Conduct rigorous testing of the prototype system in controlled laboratory environments to evaluate performance, reliability, and safety.
Perform field trials and simulations in realistic fire scenarios to assess the effectiveness and scalability of the solution.
Collect feedback from users and stakeholders to identify areas for improvement and refinement.
Deployment and Deployment:

Deploy the finalized system in collaboration with firefighting agencies, emergency responders, and community organizations.
Provide training and support to end-users for operation, maintenance, and troubleshooting of the system.
Continuously monitor and evaluate system performance in real-world deployments, incorporating feedback for ongoing optimization and enhancement.

4. EXPECTED OUTCOMES:

Improved Fire Detection Accuracy: The integration of Automatic algorithms and sensor fusion techniques will enhance the accuracy and reliability of fire detection, reducing false alarms and minimizing response times.

Autonomous Firefighting Capabilities: The development of firefighting robots equipped with autonomous navigation and firefighting capabilities will enable rapid and effective response to fire incidents in hazardous environments.

Enhanced Situational Awareness: Real-time monitoring and analysis of environmental data will provide firefighters with enhanced situational awareness, allowing them to make informed decisions and prioritize resources effectively.

Reduced Response Times: By leveraging IoT connectivity and cloud integration, the system will facilitate remote monitoring and control of firefighting operations, enabling faster response times and improved coordination between response teams.

Optimized Resource Allocation: The ability to gather and analyze data on fire dynamics, environmental conditions, and building layouts will enable more efficient allocation of resources, including personnel, equipment, and firefighting agents.

Enhanced Safety for Firefighters: Autonomous firefighting robots will help minimize the exposure of firefighters to hazardous conditions, reducing the risk of injuries and fatalities during fire suppression operations.

Scalability and Adaptability: The modular design of the system will allow for scalability and adaptability to different types of fire incidents, building layouts, and environmental conditions, ensuring versatility and effectiveness across diverse scenarios.

Community Resilience and Safety: By improving the speed, accuracy, and effectiveness of fire management efforts, the proposed solution will contribute to enhancing community resilience and safety, protecting lives, property, and critical infrastructure from the impact of fires.

5. BUDGET AND TIMELINE:

1 Time Line:

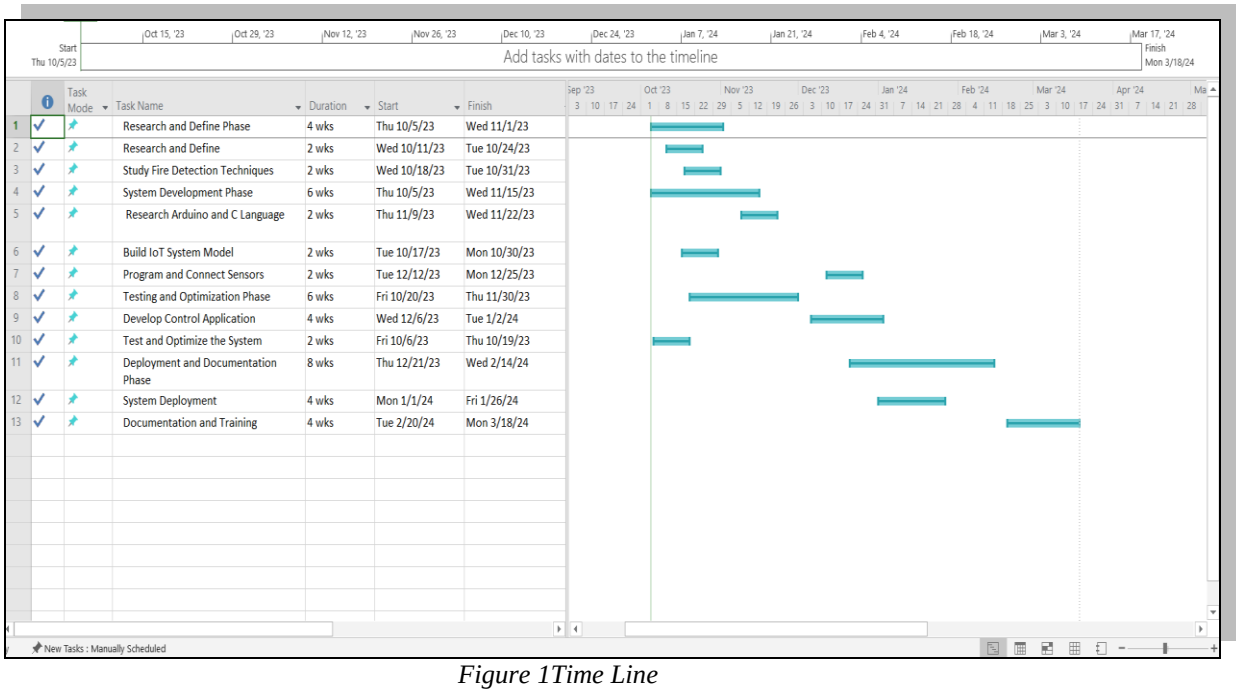

Figure 1Time Line

2 Budget:

Component	Quantity	Price (VND)
Battery	3	165,000 đ
12V Pump	1	47,000 đ
Relay	1	20,000 đ
Fire detection sensor	6	90,000 đ
Esp32 node MCU 32s	2	380,000 đ
Servo motor	2	54,000 đ
Ultrasonic sensor	1	30,000 đ
Circuit testing wire (bundle)	3	84,000 đ
"Strip of 5 Line Detection Sensors TCRT5000 + Obstacle Avoidance Line Follower Sensor BFD-1000"	1	40,000 đ
Water pipe	1	20,000 đ
RFID	1	34,000 đ
RFID card	4	20,000 đ
Ultrasonic sensor mount	1	25,000 đ
Model car	1	225,000 đ
Breadboard	1	16,000 đ
Large copper pillar	8	40,000 đ
Small copper pillar	8	24,000 đ
White tape	2	12,000 đ
Beeswax	4	10,000 đ
Black tape	3	30,000 đ
Battery tray	1	310,000 đ
Mica	12	300,000 đ
4cm copper shaft + screws	8	29,000 đ
Iron adhesive	2	20,000 đ
Male-female copper shafts (35mm and 20mm)	8	20,000 đ
3-battery box	1	10,000 đ
Small breadboard	1	16,000 đ
Electrical wire	1	43,000 đ
Hand saw	1	40,000 đ
Candles	12	32,000 đ
Battery charger box	1	60,000 đ
Total		**2,246,000 đ**

6. CONCLUSION:

In conclusion, the development of a comprehensive robot solution for automatic fire management represents a significant advancement in modern firefighting capabilities. By integrating state-of-the-art technologies such as Internet of Things (IoT), sensor fusion, and autonomous robotics, the proposed solution offers a holistic approach to fire detection, suppression, and management.

Through the implementation of advanced sensor networks and real-time data analysis, the system achieves improved accuracy in fire detection, minimizing false alarms and enabling rapid response to genuine fire incidents. The deployment of autonomous firefighting robots equipped with advanced navigation and firefighting capabilities enhances the efficiency and effectiveness of fire suppression operations, while also reducing the risk to human firefighters.

Real-time monitoring and analysis of environmental data provide firefighters with enhanced situational awareness, enabling informed decision-making and optimized resource allocation. The system's scalability and adaptability ensure versatility across diverse fire scenarios, while also facilitating remote monitoring and control for faster response times and improved coordination.

Overall, the proposed robot solution for automatic fire management promises to revolutionize firefighting practices, enhancing community resilience and safety by protecting lives, property, and critical infrastructure from the devastating impact of fires. Through continued research, development, and implementation, this innovative solution has the potential to make significant strides in mitigating the risks posed by fire incidents and safeguarding the well-being of communities worldwide.

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