Enhancing Fire Disaster Search with Multi-Robotic System: Optimizing Rescue Operations Effectively.

R24-098

Project Proposal Report

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February 2024

DECLARATION

I declare that this is my own work and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Name	Student ID	Signature
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Signature of the Supervisor (**Ms. Lokesha Weerasinghe)**

Date

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ABSTRACT

Fire disasters present formidable challenges to traditional search and rescue methods due to risks, time constraints, and limited mobility of human responders. This research suggests employing multi-robotic systems to boost rescue operations' efficiency and effectiveness. Specifically, the proposal centers on crafting a decentralized communication protocol for coordinating robotic units in fire disaster scenarios.

The envisioned protocol aims to foster adaptive coordination among robotic units by leveraging decentralized networking concepts like ad-hoc networks and peer-to-peer communication. It emphasizes robust fault tolerance mechanisms and adaptability to dynamically adjust coordination strategies based on real-time situational awareness.

Developing the communication protocol will involve thorough research and iterative design to ensure compatibility with the dynamic nature of fire disaster scenarios. Implementation will utilize suitable programming languages and technologies, prioritizing scalability and reliability.

Comprehensive testing and validation in simulated disaster scenarios will evaluate the communication protocol's performance and reliability, assessing coordination, responsiveness, and overall mission outcomes across various conditions.

Initial findings indicate substantial improvements in communication efficiency and coordination among robotic units. Real-time simulations demonstrate the protocol's capacity to adapt to evolving disaster scenarios and maintain uninterrupted communication.

The proposed decentralized communication protocol holds promise for enhancing search and rescue operations during fire disasters. Its robust fault tolerance mechanisms and adaptability contribute to improved coordination and responsiveness, ultimately enhancing rescue missions' effectiveness.

Future research and development endeavors should concentrate on refining the communication protocol and conducting field trials to validate its performance in real-world fire disaster scenarios. Collaborating with emergency response agencies and stakeholders will be crucial for ensuring the practicality and adoption of the proposed solution.

Keywords : Search and rescue operations, Fire Disaster, Multi-Robotic System, , Operational Efficiency, Simulation testing, Adaptive communication, Decentralized communication protocol

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LIST OF ABBREVIATIONS

GPS	Global Positioning System
API	Application Programming Interface
IoT	Internet of Things

1. INTRODUCTION

1.1 Background Literature

Recent years have seen significant progress and attention directed towards search and rescue operations, particularly in the context of fire disasters. Challenges such as the safety of human responders, time constraints, and restricted mobility in hazardous environments have spurred innovation in this field. [1] Fire disasters present unique hurdles to traditional rescue methods due to their potential for widespread devastation and loss of life, necessitating the development of efficient response strategies.

Various research efforts have explored ways to improve the effectiveness and efficiency of rescue operations during fire disasters. Technological advancements, especially in robotics and communication protocols, have played a crucial role in driving this progress. However, despite notable advancements, seamless coordination and communication among responders, particularly robotic units, remain significant challenges, especially in dynamic and unpredictable environments like fire disasters.

Efficient communication among robotic units deployed in fire disaster scenarios is vital for the success of rescue missions. [3]The ability to coordinate effectively amidst changing circumstances is crucial for timely and efficient response efforts. However, existing methods often face limitations in adaptability, fault tolerance, and real-time responsiveness, hindering their effectiveness in high-pressure situations.

To tackle these challenges, it is essential to understand relevant studies and master techniques that support effective communication protocols in multi-robotic systems. Decentralized networking concepts like ad-hoc networks and peer-to-peer communication have emerged as foundational elements for facilitating communication among robotic units. Additionally, advancements in deep learning and computer vision techniques have enabled sophisticated methods for object detection and classification, improving situational awareness and decision-making in fire disaster environments.

Currently, ongoing efforts focus on developing robust and adaptable communication protocols tailored to the specific requirements of search and rescue operations during fire disasters. While some approaches show promise in controlled laboratory settings, implementing them in real-world scenarios remains challenging. The lack of communication between researchers and end-users often impedes the practical implementation of these solutions at the operational level, highlighting the importance of collaboration between academia, industry, and emergency response agencies.

Building on previous work, this proposal aims to develop a decentralized communication protocol specifically designed to address the unique challenges of communicating among robotic units involved in search and rescue missions during fire disasters. By leveraging insights from relevant studies and mastering techniques such as deep convolutional neural networks, this approach seeks to overcome the limitations of existing methodologies and provide a scalable, reliable, and adaptive solution for coordinating robotic units in dynamic environments. Through rigorous testing and validation in simulated disaster scenarios, the proposal aims to demonstrate the effectiveness and practical applicability of this approach, ultimately contributing to the advancement of search and rescue capabilities in fire disaster response.

Furthermore, it is essential to consider the broader context in which this research operates. Technological advancements have reshaped the landscape of disaster response, offering new opportunities for innovation and improvement. Alongside developments in robotics and communication protocols, progress in areas such as data analytics, remote sensing, and artificial intelligence has also influenced the capabilities and effectiveness of search and rescue operations. Integrating these various technological advancements into a cohesive framework is crucial for enhancing the resilience and responsiveness of emergency response systems.

Additionally, the social and economic aspects of disaster response are significant. While technological innovations hold promise for improving the efficiency and effectiveness of rescue operations, their success depends on factors such as institutional capacity, policy frameworks, and community engagement. Effective disaster response requires a holistic approach that addresses not only technological solutions but also social, organizational, and institutional aspects to ensure a coordinated and timely response to emergencies.

Against this backdrop, this proposal aims to contribute to ongoing efforts to enhance search and rescue capabilities during fire disasters. By focusing on developing a decentralized communication protocol for robotic units involved in rescue missions, this research aims to address a critical aspect of disaster response and mitigation. Through collaboration with stakeholders, including emergency response agencies, technology developers, and affected communities, this research aims to bridge the gap between theory and practice, ultimately contributing to more effective and efficient search and rescue operations in fire disaster scenarios.

In summary, this overview discusses the challenges and opportunities in the domain of search and rescue operations during fire disasters. It emphasizes the importance of effective communication among robotic units and the need for innovative solutions to overcome the limitations of existing methodologies. By proposing the development of a decentralized communication protocol, this research seeks to advance the state of the art in disaster response and contribute to the broader goal of enhancing resilience and preparedness in emergencies.

1.2 Research Gap

In the realm of search and rescue efforts during fire disasters, the integration of multi-robotic systems offers a promising avenue for improving mission outcomes. However, despite significant progress in robotics and communication technologies, there are several areas in research that need attention to fully exploit the potential of these systems in fire disaster response.

Firstly, there's a noticeable gap in existing literature regarding the seamless integration of multiple robotic units into a unified system tailored specifically for fire disaster scenarios. [1]While current research often focuses on individual robotic abilities or specific tasks like mapping or surveillance, there's a lack of comprehensive approaches addressing the complexities of coordinating multiple robots in dynamic and hazardous environments. This study aims to fill this gap by devising communication protocols enabling effective coordination and collaboration among robotic units, thus optimizing search and rescue operations during fire disasters.

Additionally,[4]existing communication protocols may not sufficiently address the challenges posed by dynamic fire disaster situations. Many protocols are designed for static or controlled environments and may struggle to adapt to rapidly changing conditions such as evolving fire behaviour, smoke, and structural collapses. This highlights a significant research gap in developing communication protocols capable of dynamically adjusting coordination strategies based on real-time situational awareness. By tackling this gap, this research seeks to improve the adaptability of communication protocols to dynamic fire disaster scenarios, ultimately enhancing the responsiveness and effectiveness of multi-robotic systems in rescue missions.

Another crucial research gap concerns the fault tolerance and resilience of communication protocols utilized in multi-robotic systems. Reliable and resilient communication is vital for ensuring uninterrupted coordination among robotic units during fire disaster response.[5] However, existing protocols may lack robust fault tolerance mechanisms to handle communication failures or network disruptions effectively. This study will concentrate on developing communication protocols equipped with built-in fault tolerance mechanisms, ensuring the reliability of data transmission and continuous communication even in challenging environments.

Furthermore, there's a research gap in providing decision-making support through real-time data analytics and situational awareness in fire disaster response. Timely and informed decision-making is critical for effective search and rescue operations, yet existing communication protocols may suffer from latency issues or lack support for real-time data exchange and analysis. This research will tackle this gap by creating communication protocols optimized for low-latency communication and offering decision-making support through real-time data analytics, ultimately improving the efficiency and effectiveness of rescue missions.

Aspect of Research	***Research A***	***Research B***	***Research C***	***Proposed System***
Integration of multi-robotic systems	*Lack of comprehensive approaches for coordinating multiple robots in dynamic and hazardous environments.*	*Focus on improving adaptability of communication protocols to dynamic fire disaster scenarios.*	*Lack of robust fault tolerance mechanisms in existing communication protocols for multi-robotic systems.*	*Proposed system aims to optimize coordination and collaboration among robotic units in fire disaster scenarios*
Adaptability to dynamic fire disaster situations	*Identified research gap in developing communication protocols capable of dynamically adjusting coordination strategies based on real-time situational awareness*	*Addressing the need to improve adaptability of communication protocols to rapidly changing fire disaster conditions.*	*Lack of robust fault tolerance mechanisms to handle communication failures or network disruptions effectively in dynamic environments.*	*Proposed system aims to enhance adaptability of communication protocols to dynamic fire disaster scenarios for improved responsiveness.*
Fault tolerance and resilience of communication protocols	*Research gap in developing communication protocols with robust fault tolerance mechanisms for uninterrupted coordination among robotic units.*	*Emphasizing the importance of robust fault tolerance mechanisms in communication protocols for multi-robotic systems.*	*Lack of existing protocols with built-in fault tolerance mechanisms to ensure continuous communication in challenging environments.*	*Proposed system focuses on developing communication protocols with built-in fault tolerance mechanisms for reliable data transmission.*
Decision-making support through real-	*Identified research gap in providing decision-making support through*	*Addressing the need for real-time data analytics and decision-making*	*Lack of support for real-time data exchange and analysis in existing*	*Proposed system aims to offer decision-making support through real-*

time data analytics	*real-time data analytics and situational awareness in fire disaster response.*	*support in fire disaster response.*	*communication protocols.*	*time data analytics and low-latency communication for improved efficiency in rescue missions.*

Table 1Research Gap Comparison Chart

1.3 Research Problem

The research issue in the aspect of Communicating Among Robots Regarding Rescue Missions" concerns the inefficiencies and obstacles related to communication between robotic units during search and rescue operations, particularly in fire disaster scenarios. Currently,[3] there's a lack of smooth coordination among deployed robotic units in such missions, which can lead to delays, mistakes, and compromised safety outcomes. Existing communication protocols often struggle to adapt to dynamic environments, lack robust fault tolerance mechanisms, and don't offer sufficient real-time responsiveness, all of which impede effective collaboration among robotic units. These deficiencies present significant challenges to the success of search and rescue missions, underscoring the necessity for innovative solutions to improve communication and coordination among robotic units in hazardous and rapidly changing conditions.

2. OBJECTIVES

2.1 Main Objectives

The primary goal of the "Communicate Among the Robots About the Rescue Mission" component is to enhance communication and coordination among robotic units engaged in search and rescue operations during fire disasters..

2.2 Specific Objectives

- Development of a Decentralized Communication Protocol:

  Create and implement a decentralized communication protocol to facilitate smooth communication among robotic units.
  Design the protocol to support adaptive coordination and real-time responsiveness in dynamic and hazardous environments.
- Integration of Ad-Hoc Networking Concepts:

  Integrate ad-hoc networking concepts into the communication protocol to improve robustness and fault tolerance.
  Ensure compatibility with peer-to-peer communication for efficient data exchange among robotic units.
- Real-Time Situational Awareness:

  Embed real-time situational awareness capabilities into the communication protocol to deliver accurate and timely information to robotic units.
  Enable dynamic adjustment of coordination strategies based on evolving disaster scenarios.
- Testing and Validation:

  Conduct comprehensive testing and validation of the communication protocol in simulated fire disaster scenarios.
  Evaluate protocol performance and reliability across various conditions to ensure effectiveness in real-world deployments.
- Scalability and Reliability:

Design the communication protocol with scalability and reliability features to accommodate different numbers of robotic units and communication nodes.

Implement fault tolerance mechanisms to mitigate the impact of communication failures and ensure uninterrupted operation during rescue missions.

3. METHODOLOGY

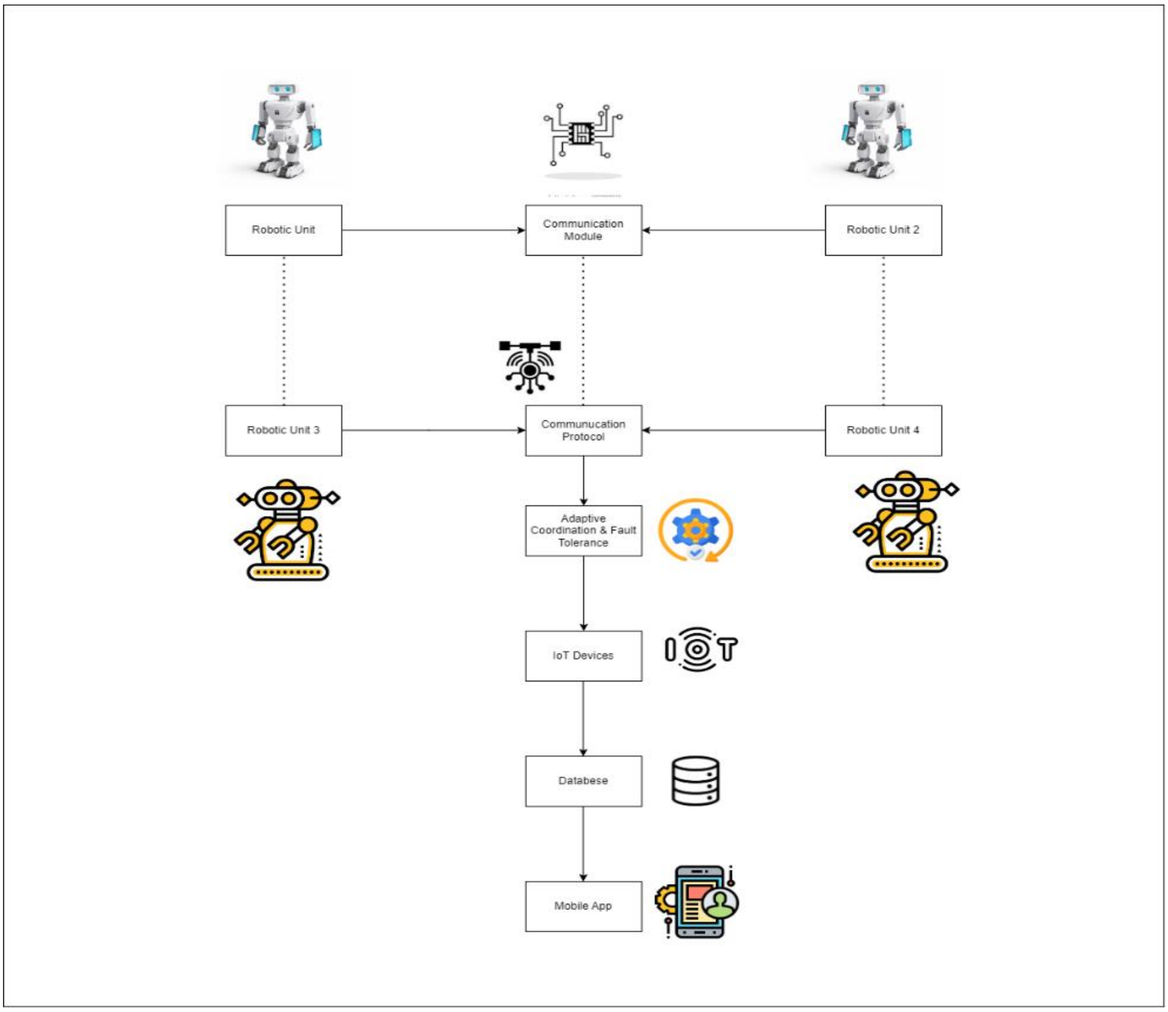

Figure 1: System Diagram

Robotic Units: These are physical robots utilized in disaster management scenarios. Each robotic unit comes equipped with a variety of sensors like cameras, temperature gauges, and gas detectors to gather environmental data. Additionally, they possess actuators enabling them to carry out tasks such as object manipulation or fire suppression.

Communication Module: Serving as the central communication hub, this component facilitates seamless interaction between the robotic units and other system elements like the database and mobile app. Its primary function is to ensure efficient data exchange, promoting coordinated actions among the robotic units.

Communication Protocol: [4]This element oversees communication across different system components, establishing rules and formats for data exchange to ensure compatibility and interoperability. Tasks such as data routing, error handling, and synchronization fall under its purview, ensuring smooth communication within the system.

Adaptive Coordination & Fault Tolerance: Responsible for orchestrating the actions of robotic units and maintaining system resilience, this component dynamically allocates resources, adjusts task assignments, and adapts to changing conditions to optimize system performance. It ensures the system remains operational even in the face of failures or disruptions.

IoT Devices: These additional sensors or devices are integrated into the system to collect real-time environmental data, including temperature, humidity, gas levels, and motion. This data enhances decision-making and situational awareness in disaster management scenarios.

Database: Acting as a centralized repository, the database component stores and manages data generated by the system, including sensor readings, system status updates, and user information. It supports efficient data storage, retrieval, and analysis, aiding decision-making processes and system optimization.

Mobile App: Providing a user-friendly interface for remote system interaction, the mobile app enables users to monitor robotic unit status, receive alerts about detected disasters, and initiate emergency response actions. It enhances situational awareness and empowers users to make informed decisions in real-time, regardless of their physical location during a disaster

3.2 Project requirements

3.2.1 Functional Requirements and Non-Functional Requirements

Functional Requirements	Non-Functional Requirements
1. The system should enable real-time communication among robotic units involved in search and rescue missions during fire disasters..	1.**User-Friendly Interfaces** -Interfaces should be intuitive and easy to use, facilitating efficient communication and collaboration among rescue personnel.
2. It should facilitate seamless coordination and information sharing among robotic units to optimize rescue operations..	2**. Scalability and Reliability** - The system should be scalable to support varying numbers of robotic units and communication nodes. It should demonstrate high reliability, ensuring uninterrupted communication and coordination throughout rescue missions.
3.It should provide accurate and timely updates on mission progress, including location updates, task assignments, and status reports..	3.**Adaptability**- The system should be adaptable to different disaster scenarios and environmental conditions, allowing for effective response in diverse situations.
.	4.**Performance**- The system should demonstrate high performance,

	minimizing latency and ensuring efficient data transmission and processing.

Table 2 Functional Requirements and Non-Functional Requirements and Non-Functional Requirements

3.2.2 Software Requirements

- Sensor Fusion Software:

  This software integrates data from various sensors to offer comprehensive situational awareness for the robotic system.

- Communication Protocols:

  Specific communication protocols are being designed to enable real-time data exchange and coordination between robotic units and the central control system.

- Machine Learning Algorithms:

  Machine learning and artificial intelligence algorithms are being developed to enhance the system's adaptability and decision-making capabilities in unpredictable and dynamic situations.

- Human-Robot Interface:

  User-friendly interfaces are provided for human operators to monitor and control robotic units, interpret data, and make informed decisions.

- Simulation Software (We-Robots):

  We-Robots Simulation Software serves as a comprehensive platform designed to facilitate the simulation and optimization of disaster identification processes within the context of multi-robotic systems. This software integrates advanced algorithms, sensor fusion techniques, and simulation environments to enhance the efficacy of search and rescue operations during fire disasters.

We-Robots operates by creating virtual environments that mimic real-world scenarios affected by fire incidents. Within these simulated environments, multi-robotic systems equipped with various sensors are deployed to autonomously navigate and gather sensor data.

- Key components of We-Robots Simulation Software include:

1) Scenario Setup: Users can configure the simulation environment by defining parameters such as terrain, building layouts, fire dynamics, and the presence of survivors.

2) Robot Deployment: Multi-robotic systems are deployed within the simulated environment, each equipped with specialized sensors for disaster identification. These robots collaborate autonomously to navigate through the environment and gather sensor data.

3) Sensor Data Fusion: We-Robots integrates data from multiple sensors, including visual imagery, thermal signatures, and gas concentrations, using advanced fusion algorithms to enhance accuracy and reliability.

4) Disaster Identification: The software analyses the fused sensor data to identify potential fire incidents, locate survivors, and assess disaster severity in real-time.

5) Simulation Analysis: Users can analyse simulation results to evaluate system performance in various scenarios, providing insights into response time, detection accuracy, and resource utilization.

6) Iterative Optimization: Based on simulation analysis, users can optimize the behaviour of the multi-robotic system and fine-tune parameters to improve overall performance and responsiveness.

By leveraging We-Robots Simulation Software, researchers and practitioners can conduct virtual experiments, test strategies, and validate algorithms for disaster identification without real-world deployment risks. This approach accelerates innovation and enhances emergency response teams' preparedness in mitigating the impact of fire disasters.

- Data Analytics:

  The robotic system utilizes analytics tools to process and analyse vast data, providing valuable insights for rescue operations.

3.2.3 Personnel Requirements

Various skills and knowledge are essential for developing and operating the multi-robotic disaster identification system. Typically, the team comprises professionals with expertise in robotics, software development, data analysis, and project management. Each team member is committed to collaborating effectively to accomplish project tasks and deliverables. As the external supervisor, we seek an individual experienced in robots and IoT.

3.3 Software Solution

The chosen software development life cycle is the Agile Scrum methodology, known for its iterative approach to software development aligned with the principles of the Agile Manifesto. Scrum is characterized as a lightweight method that emphasizes transparency and adaptability. Given its flexibility, Agile enables accommodating frequent changes in component requirements during implementation. Therefore, utilizing Agile Scrum ensures efficient support for modifications throughout the development process, enabling the proposed solution to be implemented in line with this framework, allowing for constant adjustments and rapid adaptation..

Figure 2: Agile Methodology

3.3.1 Requirement Gathering and Analysis

During the phase of gathering and analysing requirements, our team extensively consulted stakeholders, conducted literature reviews, and performed domain analysis to fully understand the specific needs and challenges related to identifying disasters within fire scenarios. Our main aim in this phase was to establish clear goals, scope, and limitations for developing simulation software tailored to address these requirements.

In close collaboration with Mr. Solomon Jayasena, Chairman of Arya Labs (Pvt) Ltd., we engaged in thorough discussions to clarify their precise needs and gain insights into their expectations. These discussions helped us identify crucial parameters essential for effectively identifying disasters within their facilities. They provided invaluable input for comprehending the complexities of their operational environment and critical aspects of disaster response.

An important aspect of our collaboration with Arya Labs (Pvt) Ltd. involved obtaining blueprints and architectural schematics of their actual locations. By integrating these blueprints into our system, our goal is to recreate the physical layout and characteristics of their facilities within the simulation environment. [3]This ensures that our simulation software faithfully replicates real-world conditions and challenges encountered during disaster scenarios.

Through incorporating stakeholder feedback and utilizing architectural data, we are well-positioned to develop a simulation solution that closely meets Arya Labs' requirements and facilitates efficient disaster identification and response. This collaborative approach underscores our dedication to delivering customized solutions that address the distinct needs of our clients and improve their readiness for emergency situations.

3.3.2 Feasibility Study

The process of deciding whether or not a project is worthwhile is called feasibility analysis.

- **Technical Feasibility**

  Determining whether the suggested communication system can be implemented technically with the resources and technologies now in use. This entails determining if it is feasible to integrate different communication protocols, making sure that they work with the robotic platforms that are currently in use, and resolving any technical issues with real-time data transmission and coordination.

- **Economic Feasibility**

  Examining how affordable it would be to create and implement the communication infrastructure. This include figuring out how much hardware, software, maintenance, and operating charges will cost. Doing a cost-benefit analysis is another way to assess if the system's possible advantages outweigh the money needed to execute it.

- **Schedule Feasibility**

  Assessing the feasibility of developing and implementing the suggested communication system in the allotted time. To guarantee the project is completed on time, this entails developing a thorough project schedule, identifying important milestones, and allocating resources effectively.

- **Operation Feasibility**

  Evaluating how useful and feasible the communication system is for actual rescue operations. This entails assessing elements including user acceptance, deployment simplicity, rescue personnel training needs, and the system's flexibility in adapting to various operating circumstances and settings.

3.3.3 Design

3.3.3.2 Dataset

The dataset is needed for developing a regression model for identifying the dispersion factors. To identify the parameters the data is needed. The data requirement will be fulfilled from retrieving data from the OpenWeatherMap API. The historical data of five days prior the current data and weather forecasting data for coming five days will retrieved from the available API based on the longitude and latitude of the infected area which is extracted from the uploaded image.

3.3.3.3 Work Breakdown Structure

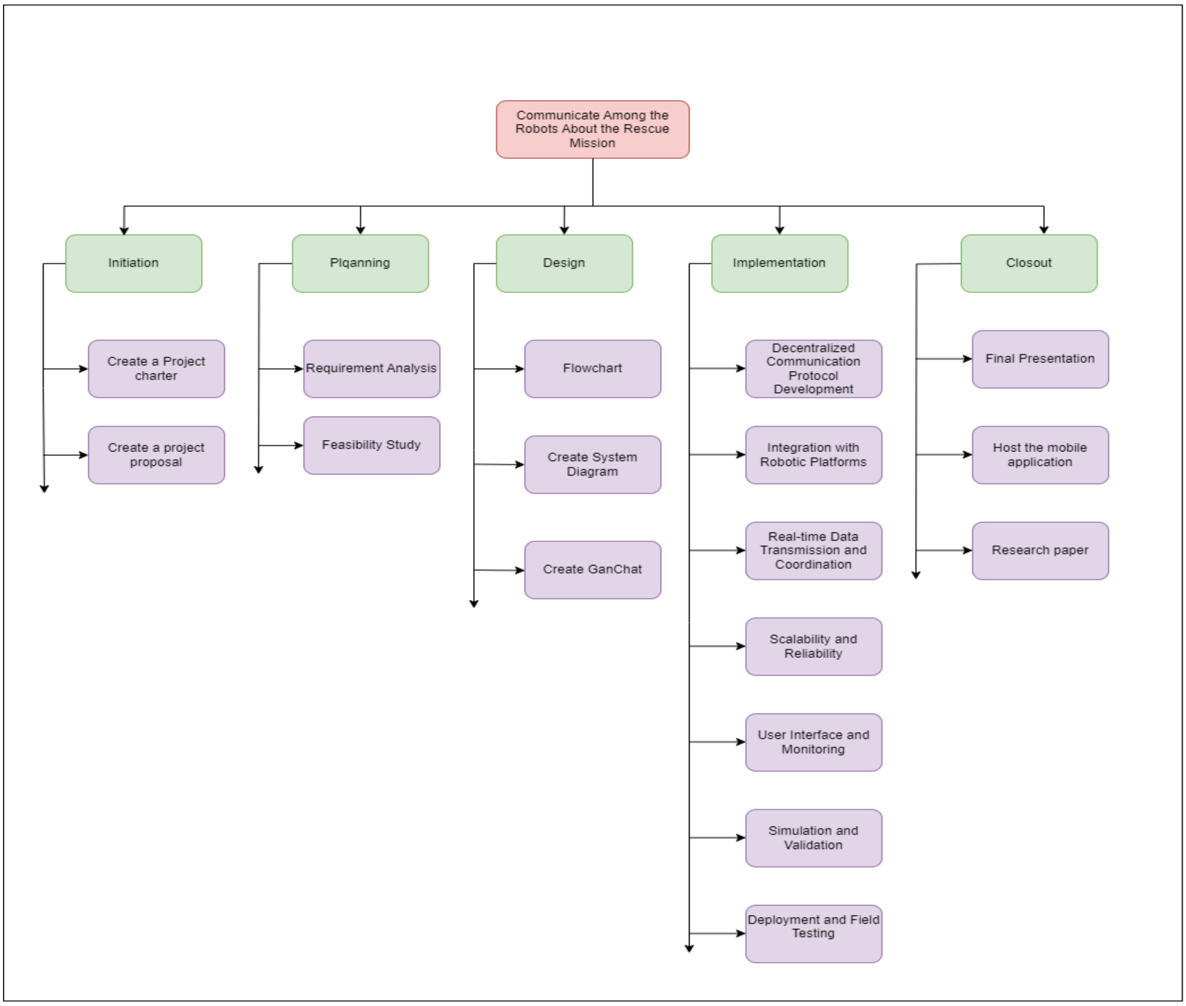

Figure 3: Work Breakdown Chart

3.3.4 Implementation

The system under consideration ought to adhere to the requirements gathered, as outlined below.,

- Employ a decentralized communication protocol to facilitate seamless communication among robotic units during fire disaster rescue missions.
- Establish a robust event-driven architecture to ensure efficient data transmission and coordination among subscribed components.
- Integrate real-time data processing capabilities to dynamically analyze mission requirements and environmental conditions.
- Develop a user-friendly interface for rescue personnel to interact with the system, promoting intuitive communication and collaboration.
- Utilize advanced algorithms and machine learning techniques to optimize resource allocation and decision-making processes.
- Ensure compatibility with existing robotic platforms and communication devices to support interoperability and scalability.
- Incorporate security measures to safeguard sensitive mission information and prevent unauthorized access.
- Conduct thorough testing and validation procedures to guarantee the reliability and effectiveness of the communication system in real-world scenarios..

- **Mobile Application**

The mobile application serves as a pivotal link in the fire disaster simulation solution, enabling seamless communication and monitoring throughout the crisis. Upon detecting a disaster, the application triggers an immediate notification to the admin, prompting inquiry into the cause and nature of the incident. The admin gains real-time visibility into the robotic unit's operations via the app, monitoring its actions and responses throughout the disaster scenario. As the crisis unfolds, the app facilitates the identification and assessment of solutions proposed by the robotic unit, providing insights into the efficacy of rescue efforts. Users can track the progress of the disaster response until its resolution, ensuring comprehensive oversight and informed decision-making. By centralizing communication, observation, and analysis capabilities, the mobile app enhances coordination and situational awareness, optimizing rescue operations in fire disaster scenarios.

3.3.5 Testing (Track and Monitor)

The [3]software development lifecycle encompasses various testing phases aimed at ensuring the quality and dependability of the application. Unit testing involves independently testing individual components to uncover any bugs early in the development process. Integration testing assesses the interactions between different units to ensure smooth functionality. System testing examines the integrated system, focusing on end-to-end functionality, performance, and reliability. Acceptance testing confirms the software's adherence to acceptance criteria and fulfilment of user requirements. Regression testing verifies that recent changes do not negatively impact existing functionality. Performance testing evaluates the application's responsiveness, throughput, scalability, and stability under diverse workload conditions. Security testing gauges the application's resilience against potential threats. User acceptance testing (UAT) entails end-users testing the software to ensure it aligns with their business needs and expectations. The application will undergo assessment at relevant stages, as applicable.

4. GANTT CHART

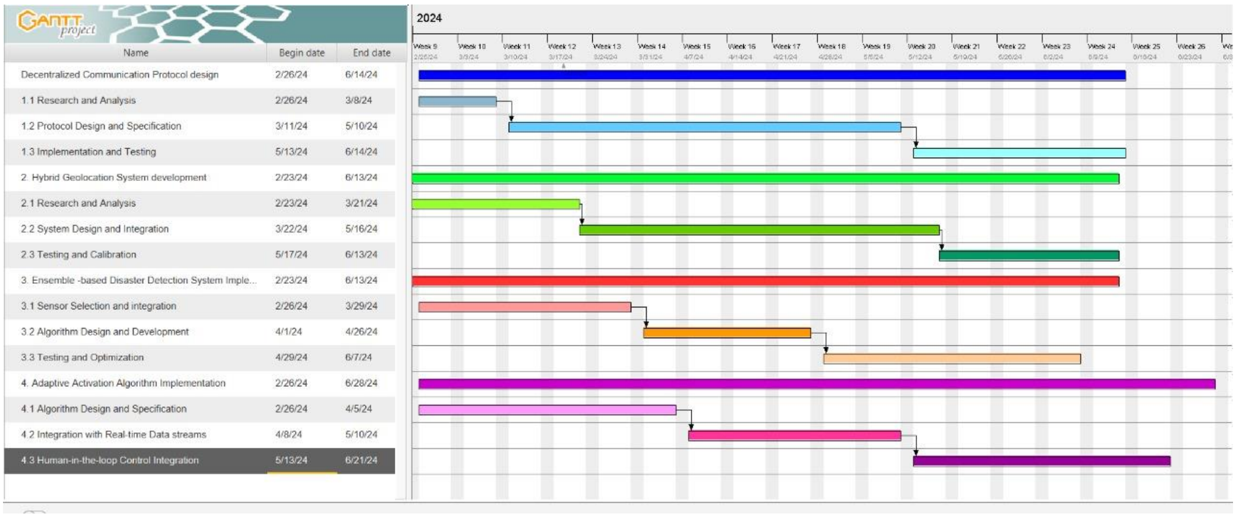

Figure 4: Gantt Chart

5. DESCRIPTION OF PERSONAL AND FACILITIES

Facilitators:

- Mrs. Lokesha Weerasinghe – Sri Lanka Institute of Information Technology (SLIIT)

- Miss.Rivoni De Zoysa - Sri Lanka Institute of Information Technology (SLIIT)

- Mr. Nelum Chathuranga - Sri Lanka Institute of Information Technology (SLIIT)

- Mr. Solomon Jayasena - Arya labs (Pvt) Ltd. (Arya Labs)

Facilities:

- Arya labs (Pvt) Ltd.

6. BUDGET AND BUDGET JUSTIFICATION

Feature	Price
Database Cost	Rs.14000
Cloud Infrastructure	Rs.7000
User Interface Design	**-**
Testing and Quality Assurance	Rs.4000
Marketing and Promotion	Rs.7000
Transportation	Rs.5000
Contingency	Rs.2000
Total	Rs.39000

Table 3 Budget Plane

7. COMERCIALIZATION

7.1 Target Audience and Market Space

7.1.1 Target Audience

- Researchers
- Arya Labs (pvt) limited Company.
- Fire Fighters

7.1.2 Market Space

- o. Some Knowledge of robotics is required.
- There is age limitations.
- Need a instructions before use this.

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APPENDICES

- Plagiarism Report