ÇANKAYA UNIVERSITY FACULTY OF ENGINEERING

COMPUTER ENGINEERING DEPARTMENT

Software Design Description

CENG 407

Innovative System Design and Development I

Team ID: 202311

AI-based Firefighting Vehicle

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1 Introduction

This section serves as the gateway to the Software Design Document (SDD) for our AI-driven fire engine project. It elaborates on the context and the high-level view of the project, providing an overview of the document's layout and summarizing the primary goals, scope, and objectives of the project. This introduction sets the stage for a detailed exploration of the system's design.

1.1 Purpose

The purpose of this document is to meticulously outline the design and architectural blueprint of the AI-driven fire engine control system. It acts as a pivotal guide for the development team, stakeholders, and any involved parties, providing a clear understanding of the system's design philosophy, architectural decisions, and the integration of critical technologies such as Unity and ROS 2.

1.2 Definitions

This section will provide clear definitions for key technical terms and concepts that are crucial for understanding the SDD. It will include terminology related to artificial intelligence, fire engine operations, emergency response scenarios, the Unity game engine, ROS 2 middleware, Lidar data processing, and other relevant technical jargon. This glossary aims to ensure clarity and a common understanding of the terms used throughout the document.

2 System Overview

This section will present an expansive overview of the AI-driven fire engine system. It will detail the system’s composition, highlighting key components such as the AI and machine learning modules, the simulation environment created in Unity, and the data processing and visualization mechanisms facilitated by ROS 2. The overview will also address how these individual elements synergistically interact within the framework to provide a sophisticated solution for autonomous fire engine navigation and emergency response scenarios.

3 System Design

The system design section will offer an in-depth analysis of the architectural choices and design intricacies of the system. This includes a thorough examination of the AI model's structure, focusing on the intricacies of the reinforcement learning algorithms, the integration and processing of Lidar data, and the implementation of these technologies within the simulated environment. Additional focus will be given to the user interface design, ensuring a seamless and intuitive interaction for users. The system's data flow, integration methods, and overall architecture will be dissected to highlight the system's robustness, efficiency, and scalability in real-world applications.

3.1 Architectural Design

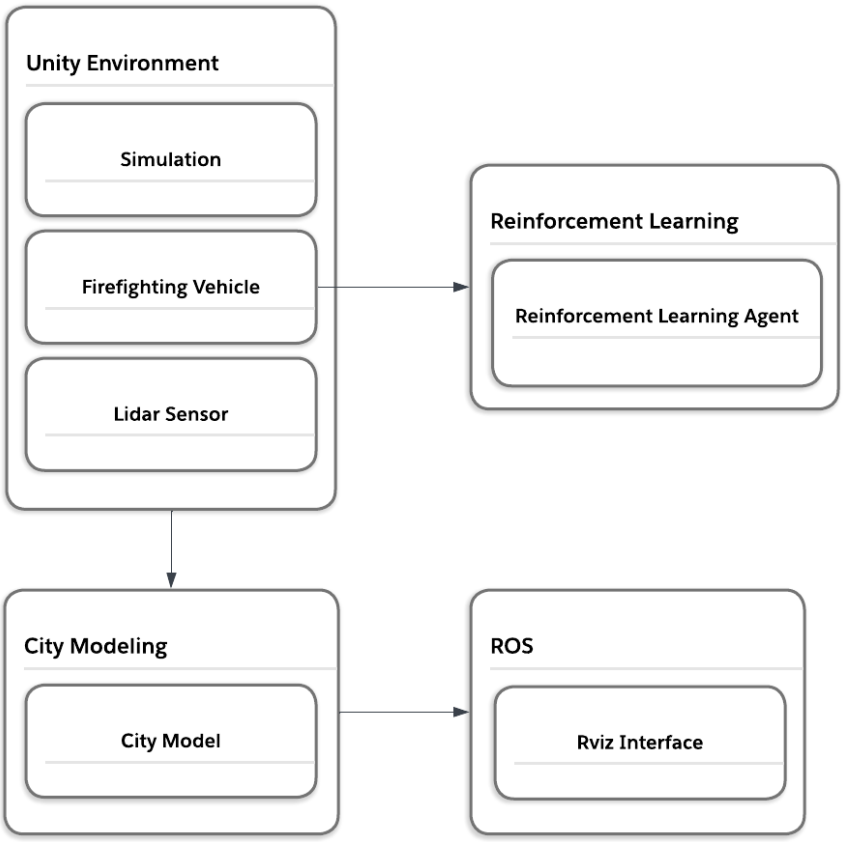

Figure 1. Architecture Design

3.2 Decomposition Description

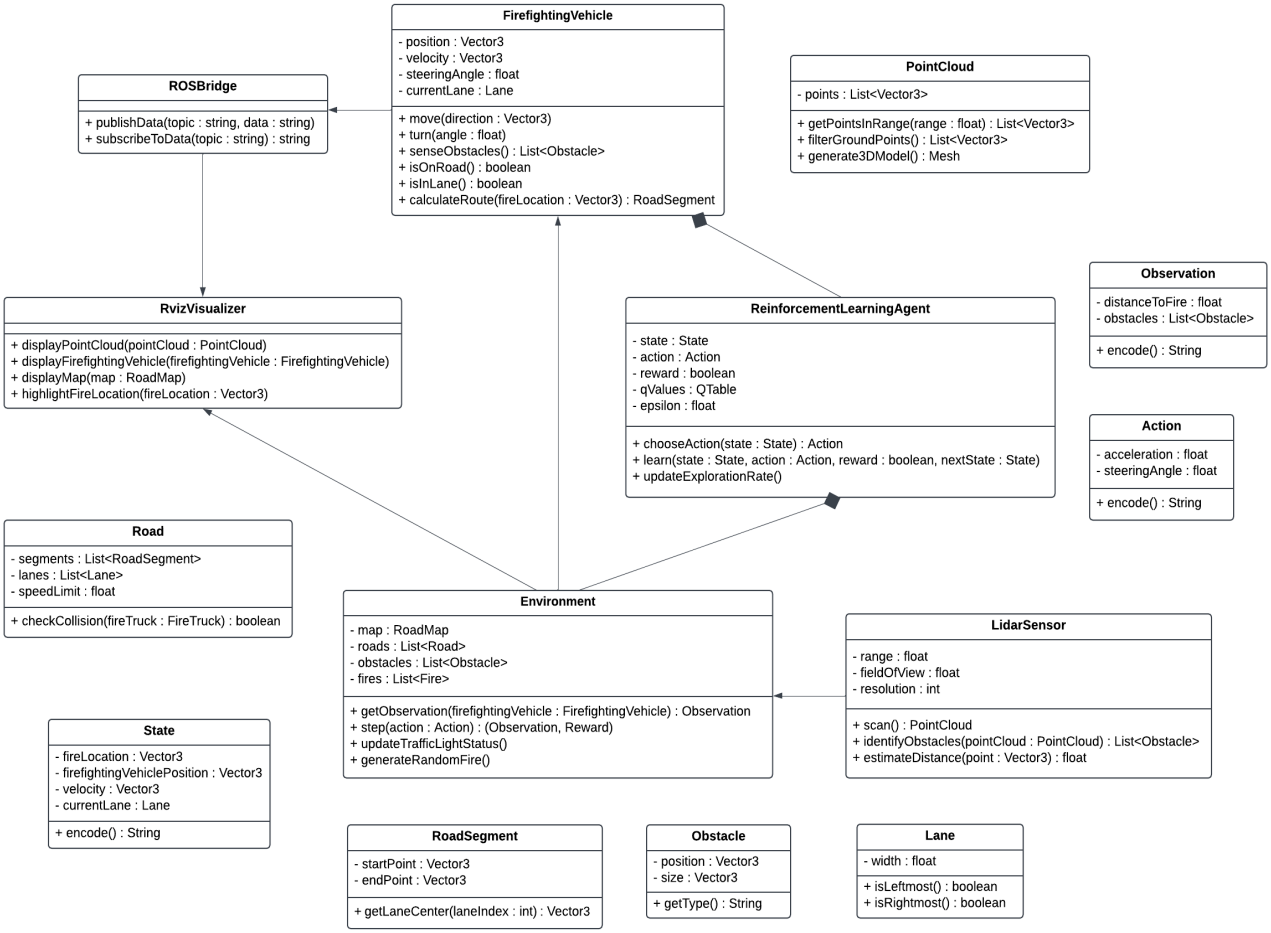

Figure 2. UML Class Diagram

3.3 System Modeling

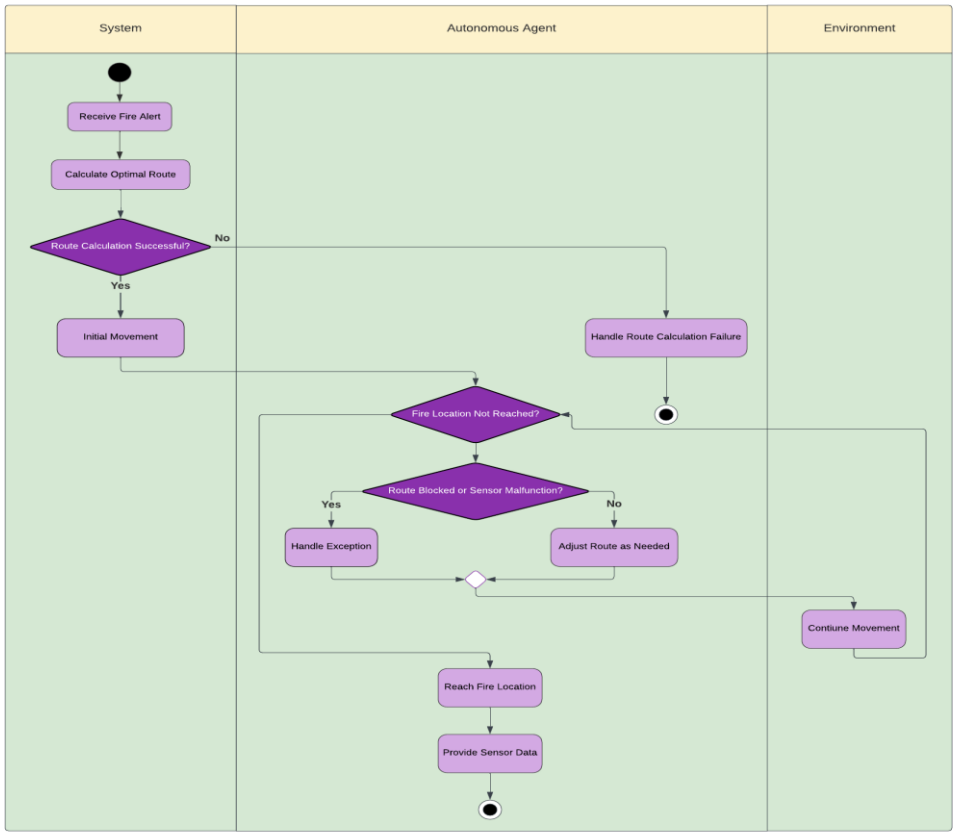

Figure 3. Activity Diagram of Autonomous Navigation to Fire

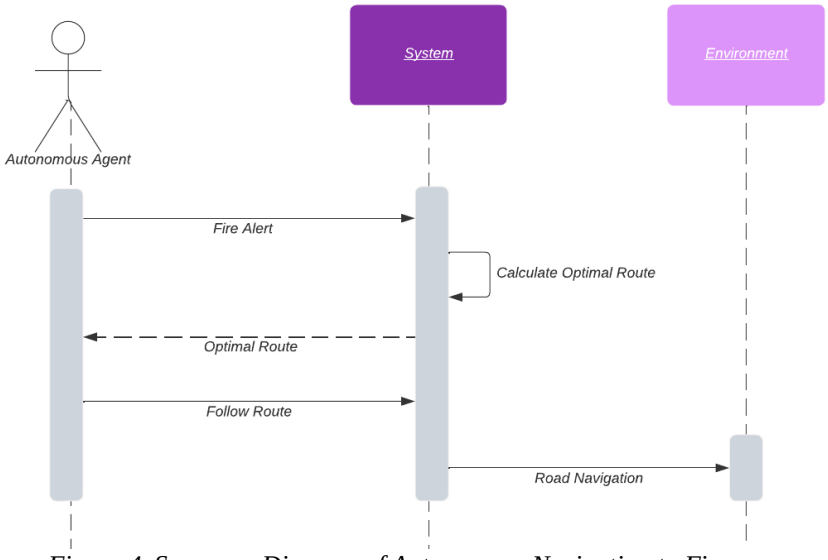

Figure 4. Sequence Diagram of Autonomous Navigation to Fire

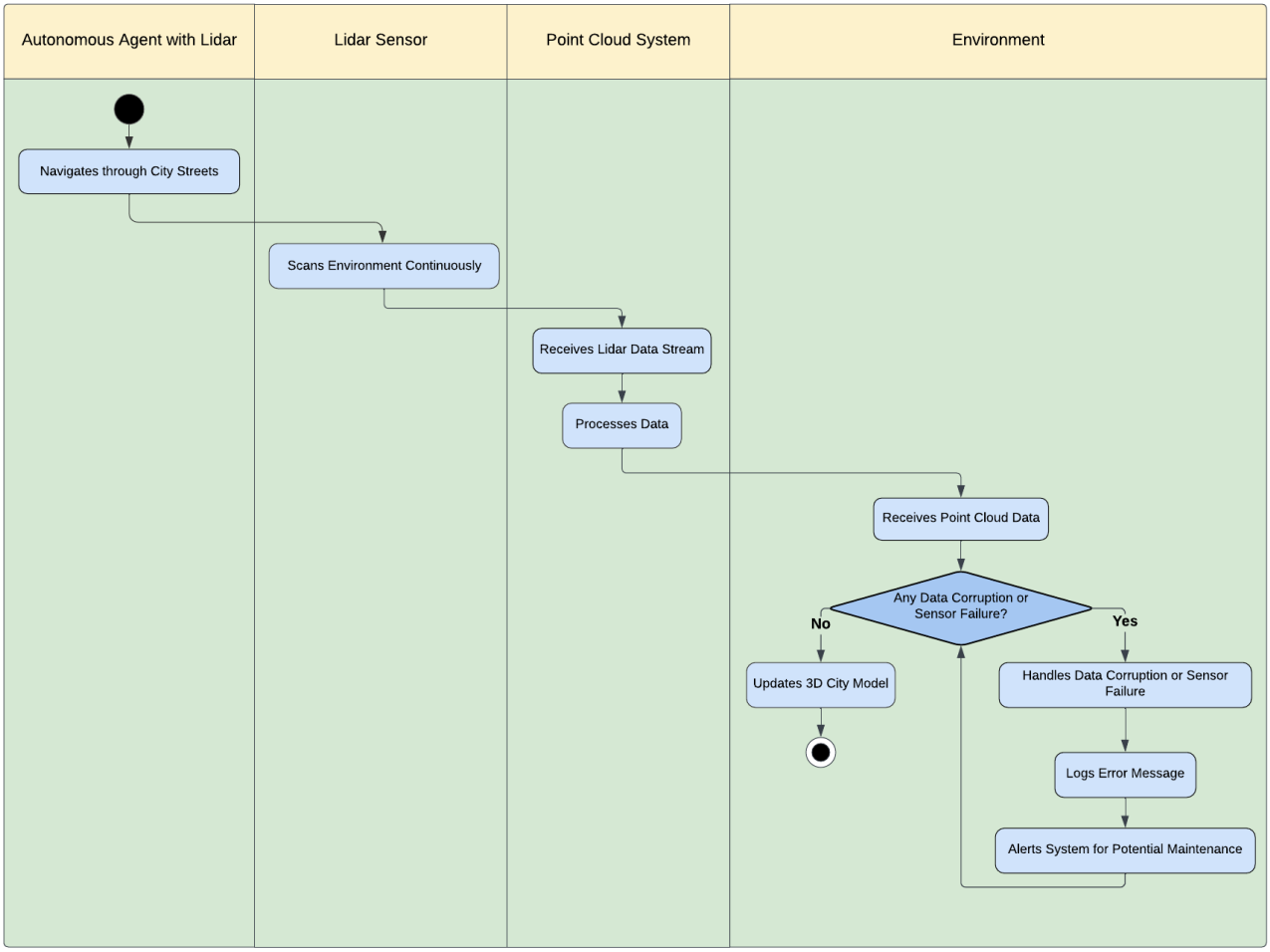

Figure 5. Activity Diagram of Lidar Data Acquisition for City Modeling

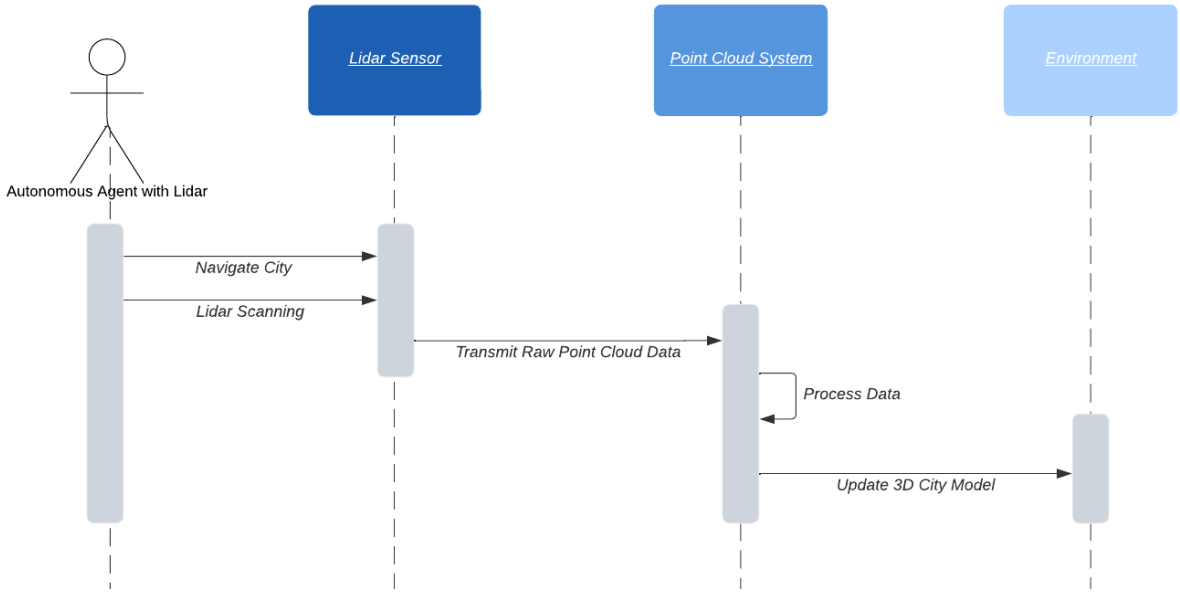

Figure 6. Sequence Diagram of Lidar Data Acquisition for City Modeling

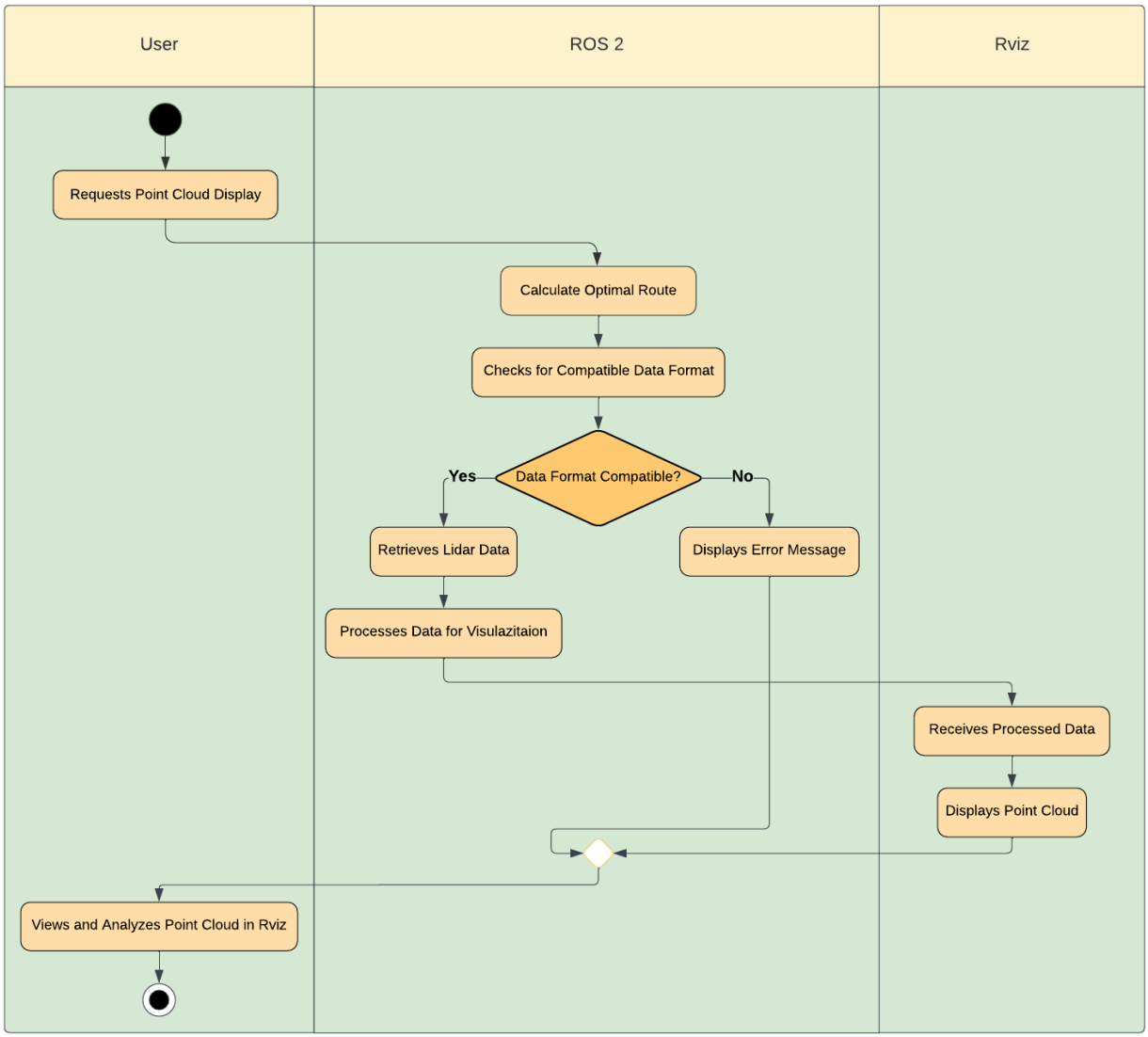

Figure 7. Activity Diagram of Rviz Visualization of Point Cloud

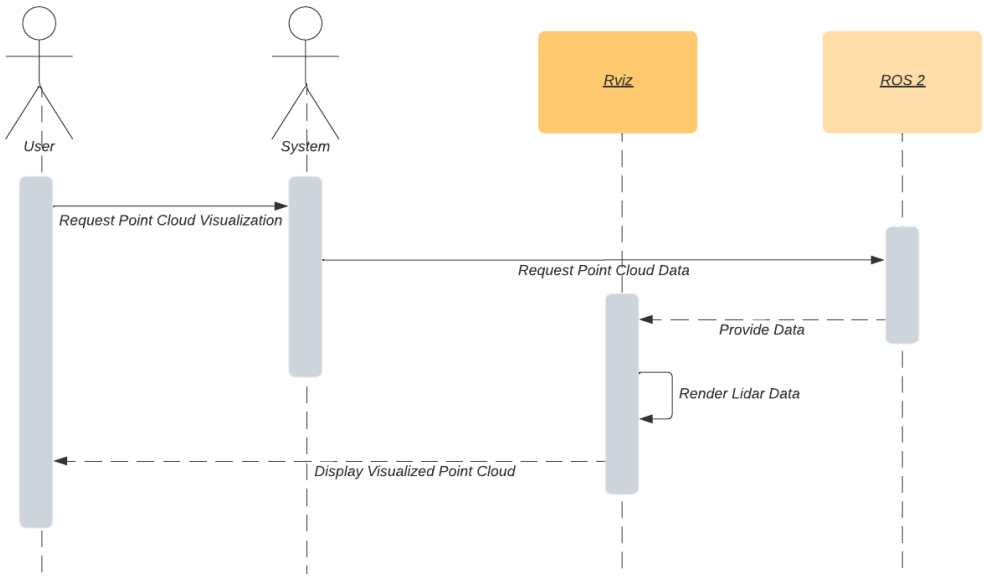

Figure 8. Sequence Diagram of Rviz Visualization of Point Cloud

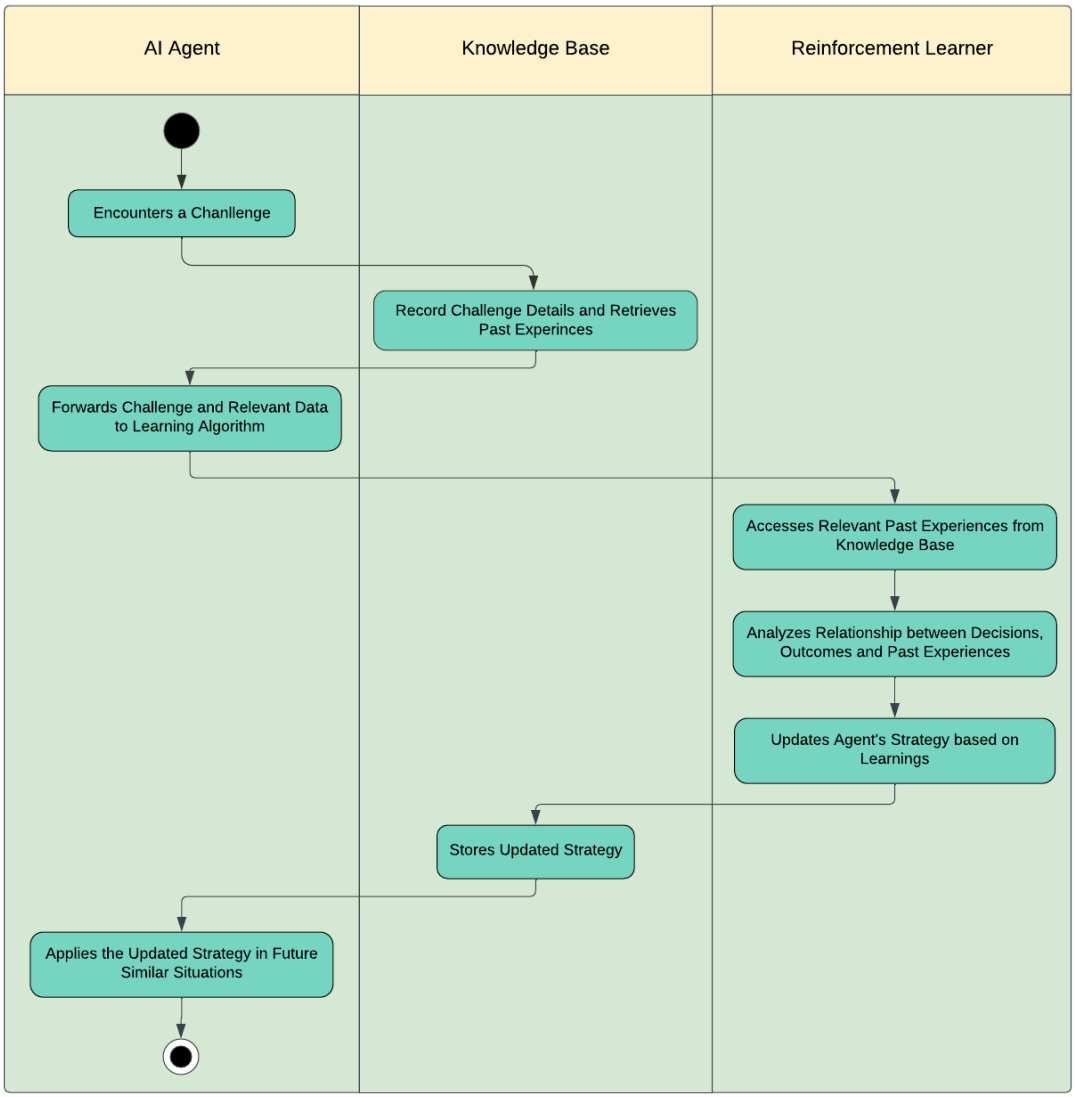

Figure 9. Activity Diagram Iterative Learning on Encountered Challenges

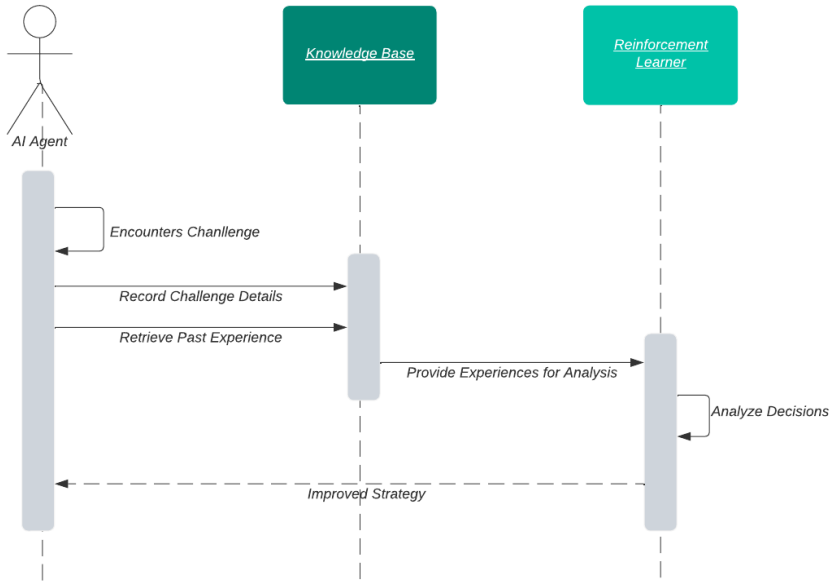

Figure 10. Sequence Diagram Iterative Learning on Encountered Challenges

4. User Interface Design

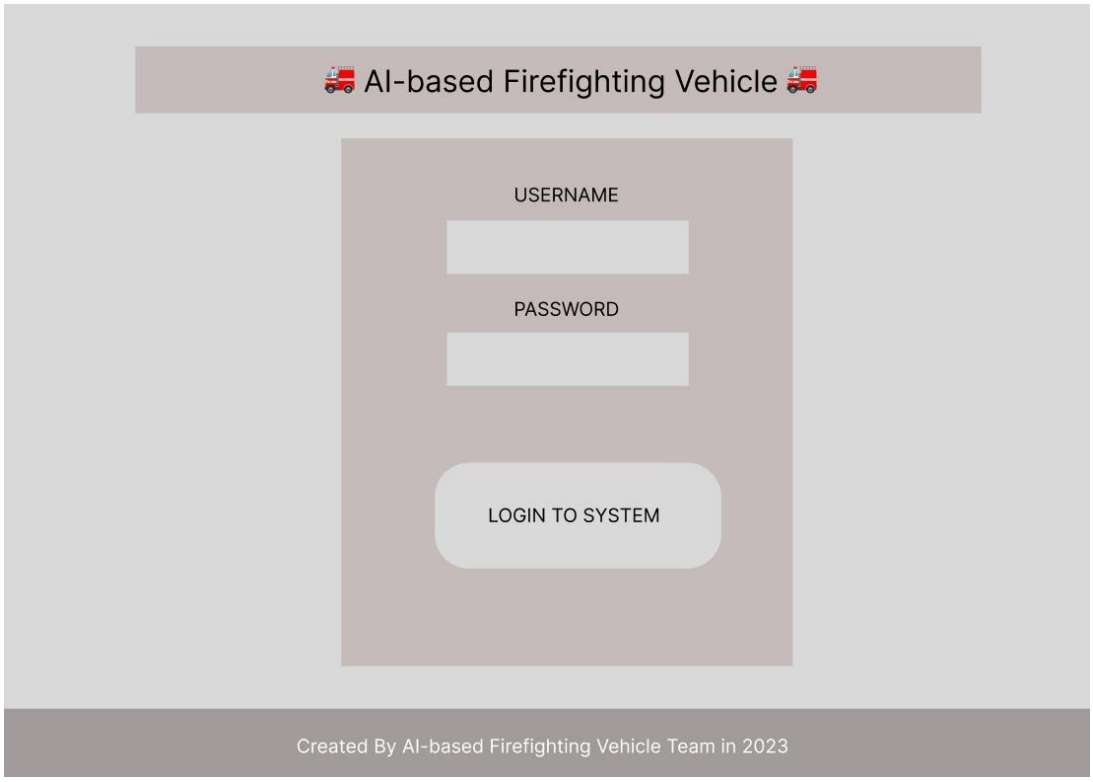

Figure 11. Login Page

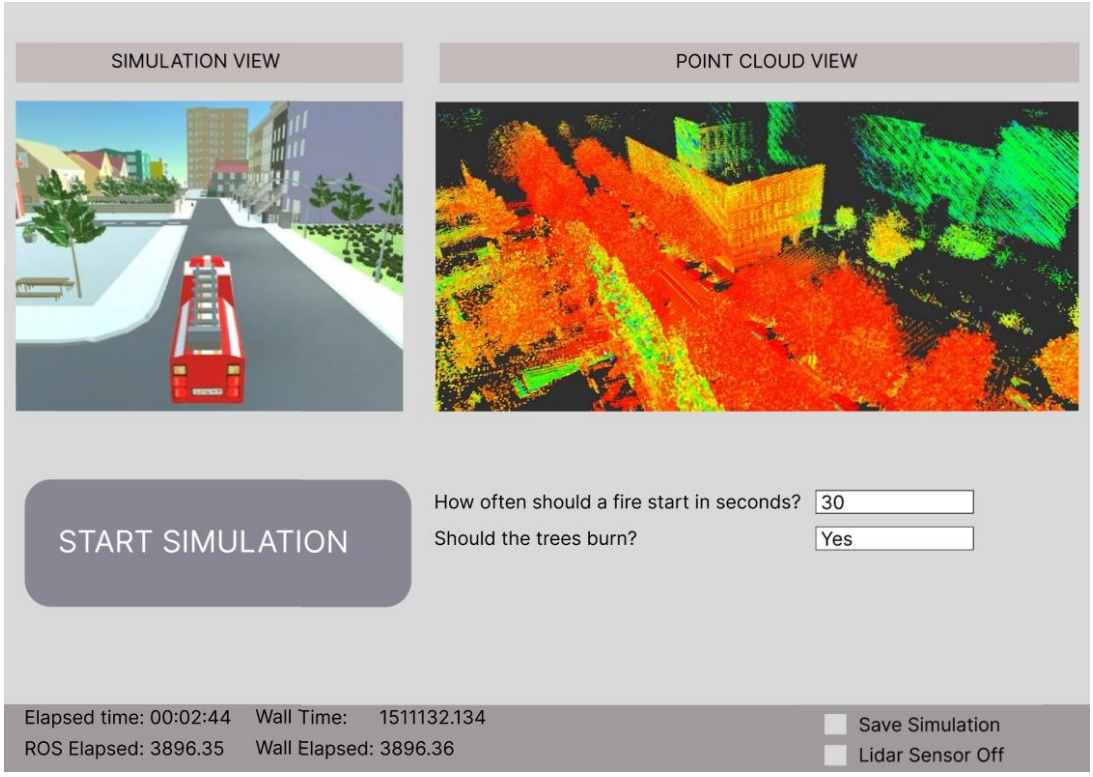

Figure 12. Simulation Start Page

Figure 13. Simulation View Page

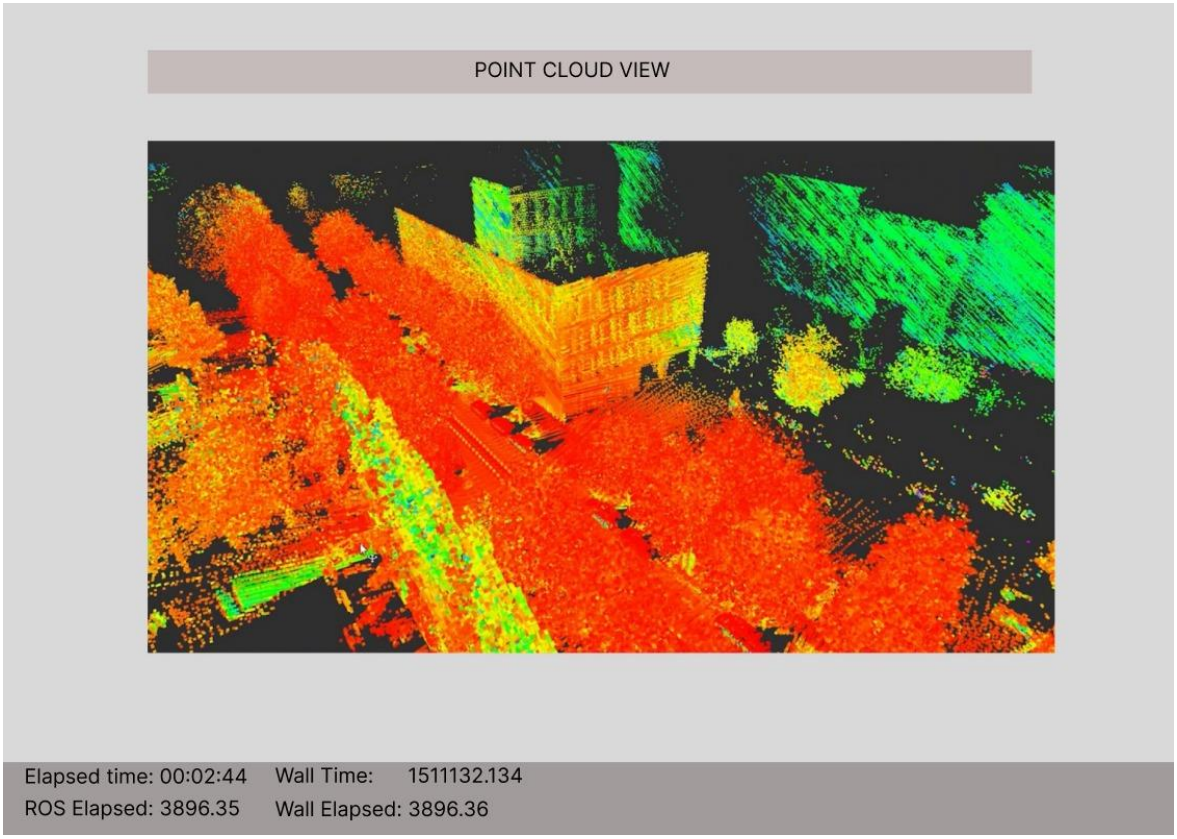

Figure 14. Point Cloud View Page