UNIVERSITI TEKNOLOGI PETRONAS

TEB1113/TFB2023: ALGORITHM & DATA STRUCTURE

Performance Report on Drone Swarm Simulation

(Homework 3)

Prepared By:

Num.	Full Name	Student ID
1.	Manas Ismail Abdylas	22008600
2.	Syahir Amri bin Mohd Azha	22007728
3.	Adam Marwan bin Husin Albasri	22009203
4.	Safiqur Rahman bin Rowther Neine	22008929
5.	Danish Harith bin Ahmad Nizam	22009489

TABLE OF CONTENTS

1.0 DEVICE SPECIFICATIONS

Model: Legion S7
RAM: 32 GB
Storage: 1 TB
Processor: AMD Ryzen 9 5900HX
GPU: Radeon Graphics
Operating System: Windows 11

2.0 APPLICATION DOMAIN

2.1 Introduction

The purpose of this project is to create a fire-extinguishing drone swarm simulation in Unity, designed to mimic real-world scenarios where autonomous drones are deployed to fight fires in large, complex environments. Each drone in the swarm is equipped with a fire extinguisher, and the simulation focuses on monitoring and dynamically adjusting the swarm's behavior based on each drone's fire extinguisher capacity. This allows the simulation to showcase how these drones can effectively distribute resources during emergency situations.

One key aspect of the project is the implementation of an efficient O(N) algorithm to partition the drone swarm into two subgroups based on their fire extinguisher capacities. This partitioning ensures that drones with higher capacities are grouped separately from those with lower capacities, enabling the system to prioritize resources when needed. Drones with higher capacities are assigned blue sprites, while those with lower capacities are assigned red sprites for easy visualization of their roles within the swarm.

The simulation also integrates real-time performance monitoring, capturing key metrics such as partitioning time and frames per second (FPS) to assess the efficiency of the drone swarm in handling firefighting tasks. Additionally, visual enhancements have been made to the drones and the environment to improve the overall realism of the simulation, making it a more accurate representation of a fire emergency response system. The project not only demonstrates the potential of autonomous drone swarms in firefighting but also highlights the importance of optimizing resource allocation and maintaining performance in real-time operations.

2.2 Perfomance Analysis

The performance of the system depicted in the screenshots can be evaluated by analyzing key metrics such as frames per second (FPS), operation time, and overall response during specific tasks. Across all three scenarios, the FPS remains consistent at around 36–37, indicating that the graphical rendering and computational workload are well-optimized to maintain a steady refresh rate. This suggests that the application performs efficiently even with large datasets or complex operations involving multiple agents.

A crucial aspect of performance is the computation time for finding the shortest path between agents. While the screenshots do not explicitly display the operation time for this task, the consistent FPS and the fast display of results (e.g., shortest distances of 11.21, 7.70, and 6.70 units) indicate that the underlying algorithm is likely implemented efficiently. This is particularly important given the complexity of tasks such as pathfinding in spatial networks.

Additionally, the visualization of drone agents clustered in distinct formations suggests that spatial data and search operations are efficiently managed. This performance is critical when dealing with hundreds of agents, as delays in rendering or processing could significantly hinder user experience. The system appears to handle clustering and pathfinding operations without bottlenecks, which is a positive indicator of scalability.

Lastly, the consistent "Result" display demonstrates the application’s ability to process queries and deliver outputs promptly. While there are no visible metrics for time complexity or specific algorithmic details, the stable performance metrics imply that the system could handle an increase in the number of agents or more complex search conditions without a noticeable drop in responsiveness.

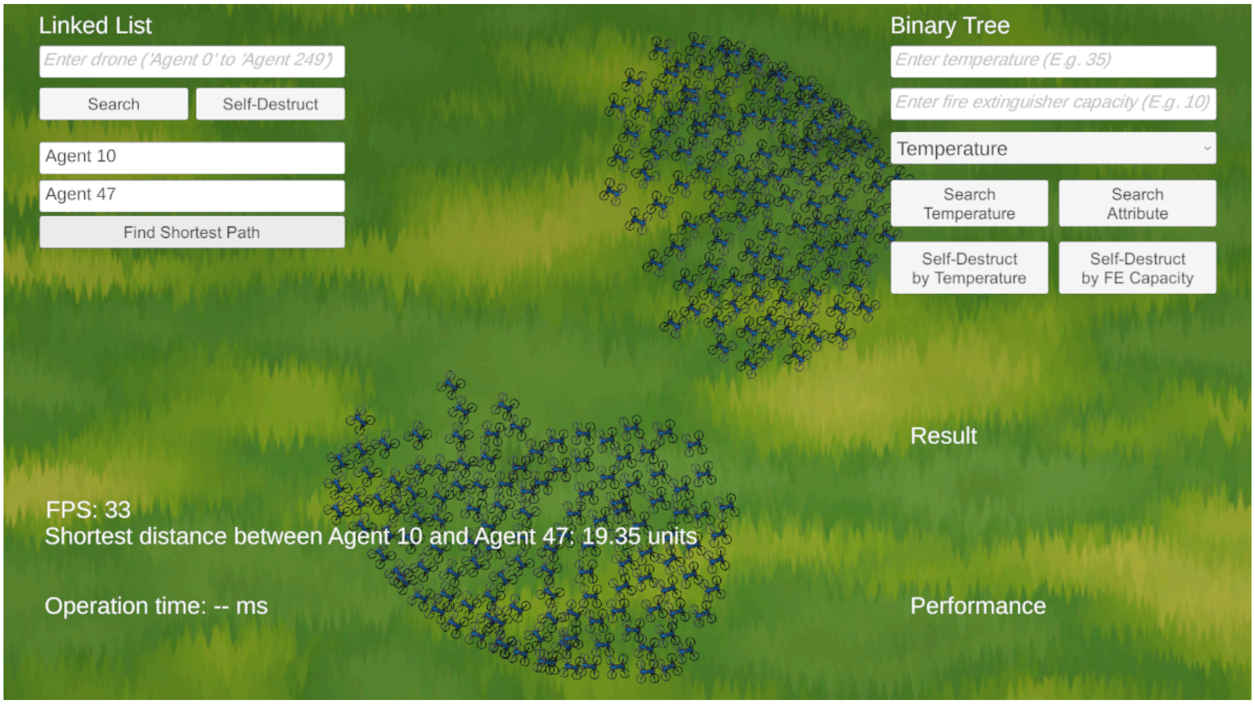
2.3 Functionality Analysis

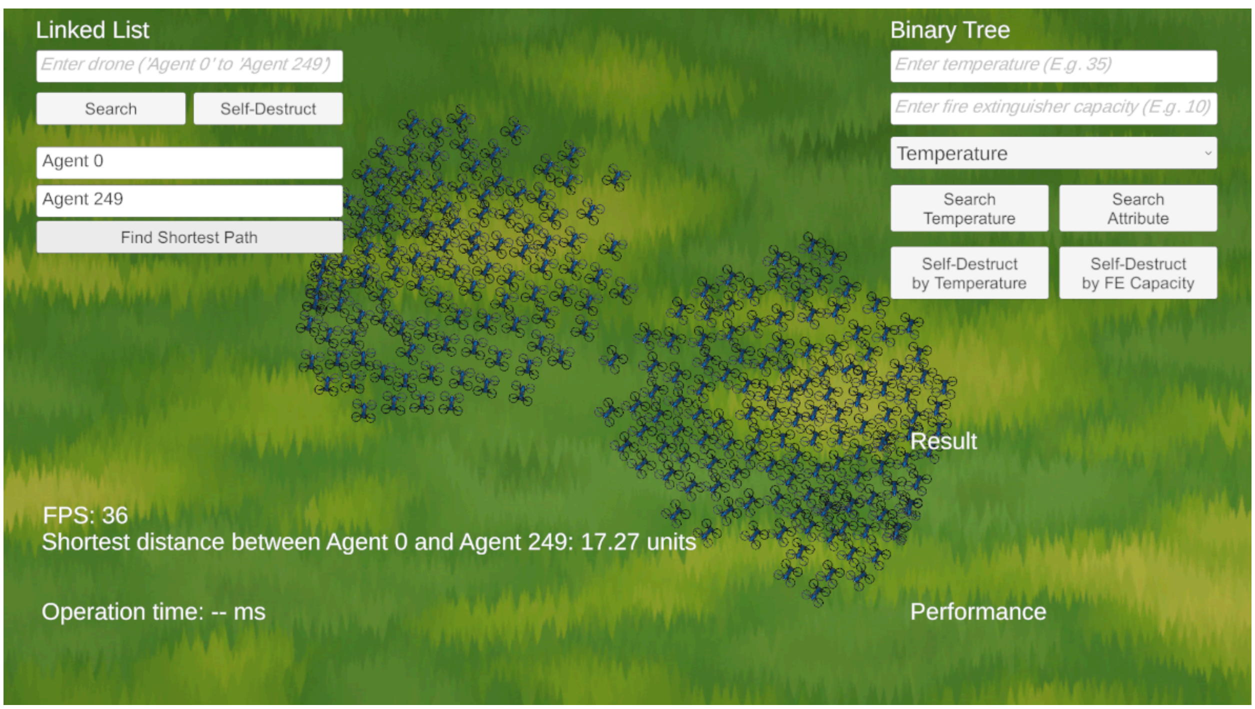
The application supports functionality centered around managing and querying a network of drone agents. The "Linked List" section allows users to interact with specific drones by entering their identifiers. This feature enables searching for specific drones and triggering actions such as self-destruction, suggesting functionality tailored toward granular control over individual entities within the system.

The "Binary Tree" section provides a structured approach to searching based on attributes like temperature and fire extinguisher capacity. This hierarchical search functionality ensures that users can efficiently query drones based on specific conditions or thresholds. The inclusion of self-destruct options tied to these attributes highlights the system's versatility in managing drones for specialized tasks, such as firefighting or other operations requiring conditional responses.

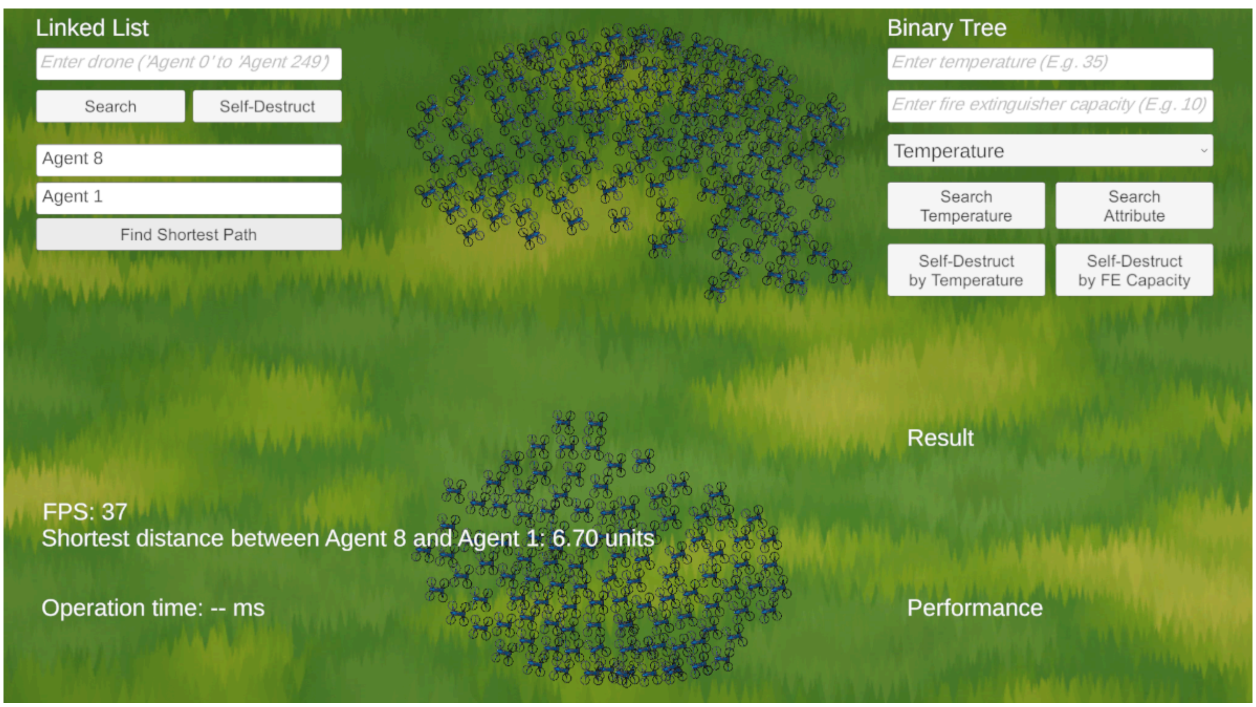
The integration of shortest-path computation between agents is a key feature that enhances usability for spatial planning or coordination tasks. This functionality allows users to calculate distances between selected agents, facilitating decision-making in scenarios where proximity or navigation is critical. The results are displayed promptly, underlining the system's capacity to handle dynamic queries and provide actionable insights in real time.

2.4 Screenshot(s)



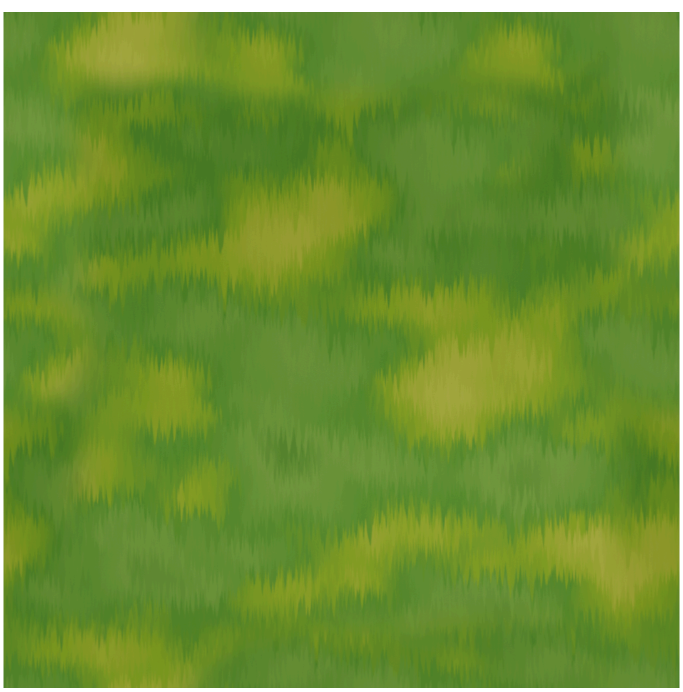



Linked List
Enter drone ('Agent 0' to 'Agent 249')
Search
Self-Destruct
Agent 1
Agent 26
Find Shortest Path
FPS: 36
Shortest distance between Agent 1 and Agent 26: 15.49 units
Operation time: -- ms
Binary Tree
Enter temperature (E.g. 35)
Enter fire extinguisher capacity (E.g. 10)
Temperature
Search Temperature
Search Attribute
Self-Destruct by Temperature
Self-Destruct by FE Capacity
Result
Performance

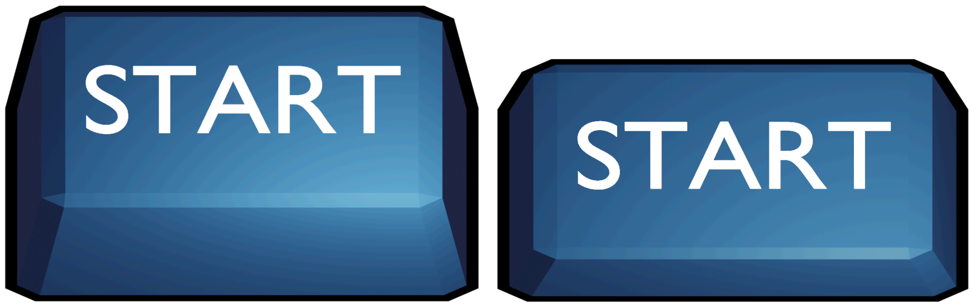

Linked List
Enter drone ('Agent 0' to 'Agent 249')
Search
Self-Destruct
Agent 8
Agent 1
Find Shortest Path
FPS: 37
Shortest distance between Agent 8 and Agent 1: 6.70 units
Operation time: -- ms
Binary Tree
Enter temperature (E.g. 35)
Enter fire extinguisher capacity (E.g. 10)
Temperature
Search Temperature
Search Attribute
Self-Destruct by Temperature
Self-Destruct by FE Capacity
Result
Performance

2.5 Asset Images

Drone Models (Isometric and Top View)



Background (Seamless Stylised Grass Texture)



Start Button (Unpressed and Pressed)

Title