Path Finding for Autonomous UAS/Drone in 3D Plane

Summer Internship Project Report

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by

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Abstract: In the realm of precision agriculture, autonomous UAVs (Unmanned Aerial Vehicles) are increasingly leveraged for tasks such as mango harvesting, requiring efficient navigation and obstacle avoidance. This research presents a comprehensive pathfinding framework integrating Dijkstra's algorithm, A* algorithm, and RRT* (Rapidly-exploring Random Tree Star) to ensure optimal route planning for UAVs. Our approach synthesizes input from object detection and obstacle detection teams, transforming detected coordinates of mangoes and potential obstacles into actionable data. By employing Dijkstra's algorithm for initial global path planning, A* for heuristic-driven optimization, and RRT* for dynamic obstacle avoidance, the model dynamically computes the shortest and safest path for the UAV. The resultant trajectory is then relayed to the drone mechanism team for execution. This integrative methodology significantly enhances the efficiency and reliability of autonomous mango harvesting, contributing to the advancement of agricultural automation technologies.

Keywords: smart agriculture; autonomous unmanned aerial vehicles; pathfinding; mango harvesting.

Introduction

Worked on the path finding algorithm for three different things which are autonomous harvesting of mango using drone, spray of pesticides on palm tree and scared of monkey and make it move out from the garden. Basically, used hybrid method to finding the shortest from starting point to destination point after getting the inputs like – stating coordinates, coordinates and shape of obstacles and the coordinates of destination point.

Implementation of Algorithms for Path Finding for Autonomous Mango Harvesting

Imagine a mango orchard where an autonomous drone needs to navigate to harvest mangoes efficiently. The drone's task is to find the shortest path from its starting point to each mango tree, avoiding obstacles like other trees, branches, and maybe even workers.

I. Dijkstra's Algorithm (Static Pathfinding)

Purpose: Finds the shortest path between nodes in a graph with non-negative weights.

Mechanism:
Graph Representation: The environment is represented as a graph, where nodes are points, and edges are paths with weights (distances).

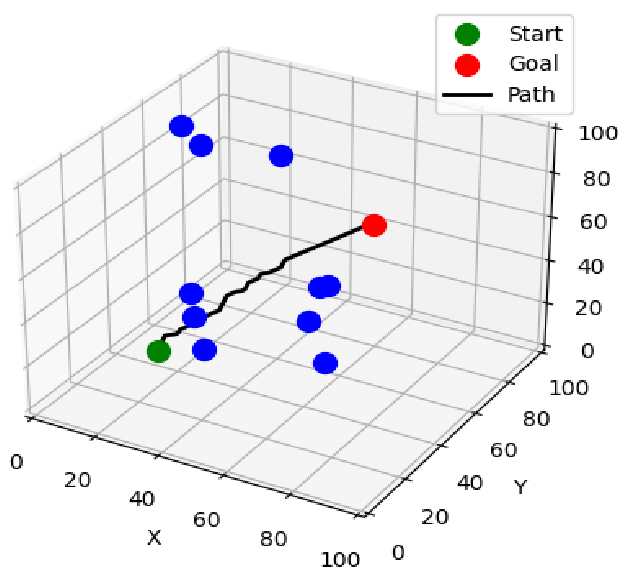

Figure shows D representation of path using Dijkstra's

II. A* Algorithm (Static Pathfinding)

Purpose: Finds the shortest path from a start to a goal node using a heuristic.

Mechanism:

- Combines actual cost from start (g(n)) and estimated cost to goal (h(n)).
- Uses a priority queue to explore nodes based on the lowest f(n) = g(n) + h(n).

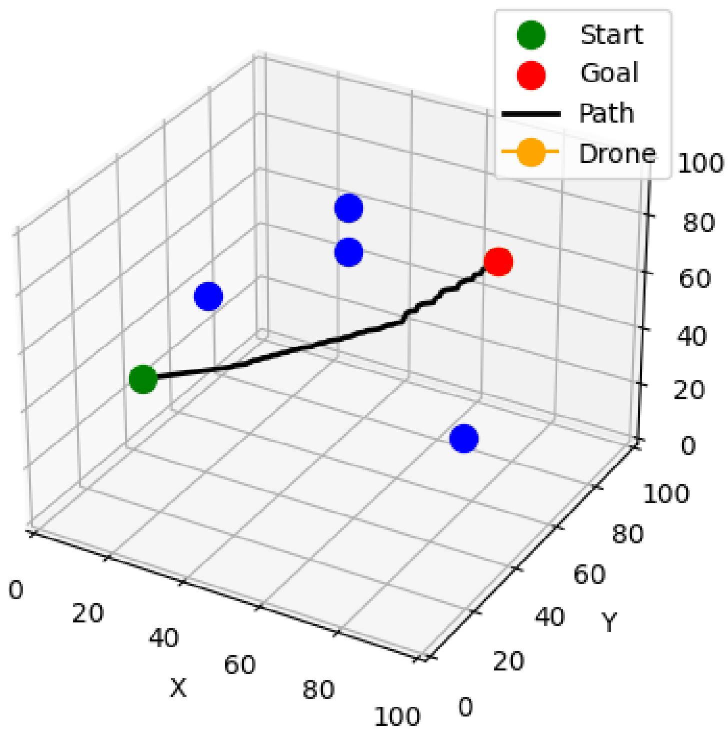

Figure shows 3 D representation of path using A Algorithm*

III. RRT* Algorithm (Dynamic Pathfinding)

Purpose: Finds an asymptotically optimal path in complex, high-dimensional spaces.

Mechanism:

- Iteratively builds a tree of possible paths by randomly sampling points in the space.
- Connects new samples to the tree using a cost function, optimizing paths as more points are added.

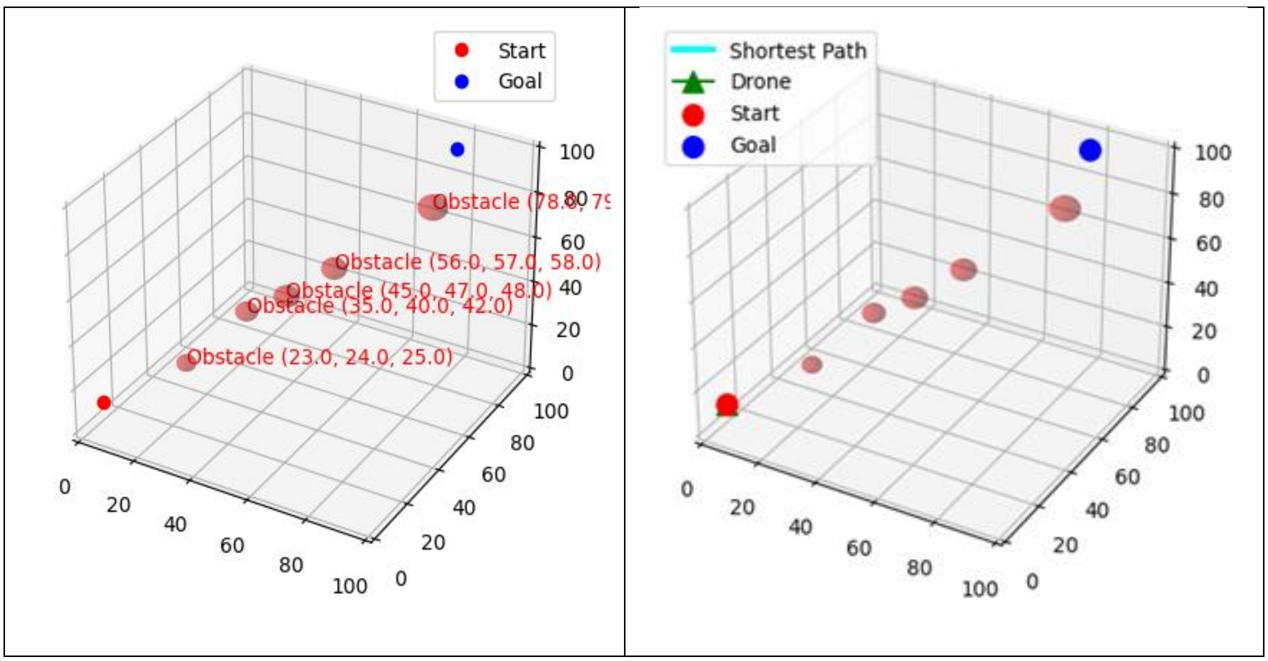

Figure shows 3 D representation of coordinates of obstacles, starting point and goal point with drone

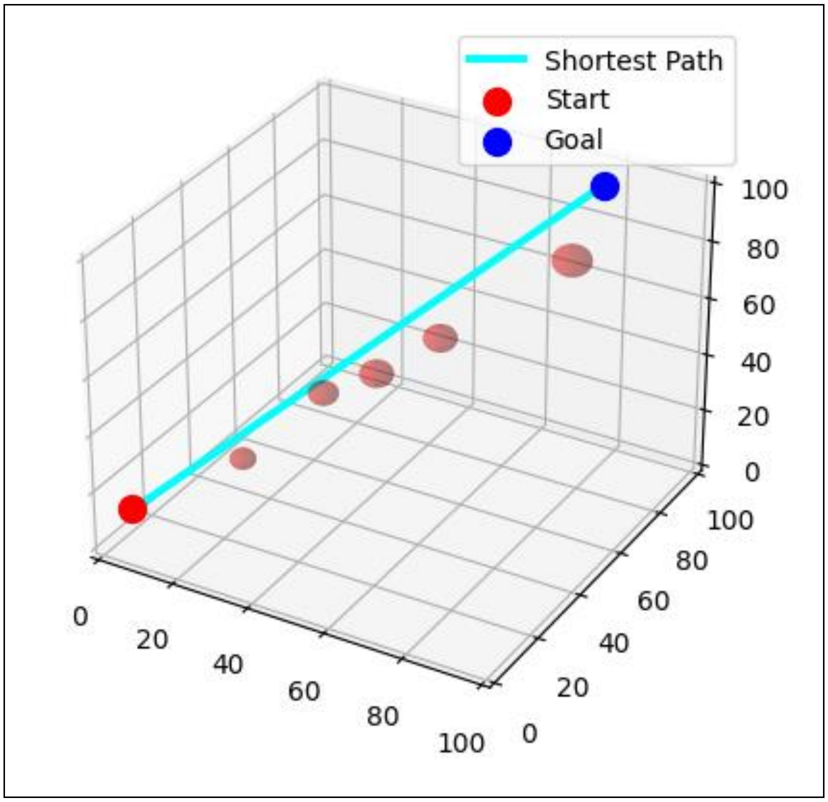

Figure shows 3 D representation of shortest path using RRT Algorithm.*

Conclusion:

In this study, presented a comprehensive pathfinding framework for autonomous UAVs, specifically designed for efficient mango harvesting. By integrating three robust algorithms—Dijkstra's, A*, and RRT*—our approach effectively addresses both static and dynamic obstacle avoidance. The system takes real-time input from object detection and obstacle detection teams, ensuring precise navigation and optimal path planning in the ever-changing environment of a mango orchard. The utilization of Dijkstra's algorithm provides a reliable foundation for initial global pathfinding, while A* enhances the route with heuristic-driven precision. RRT* further refines the path, dynamically adapting to new obstacles that may emerge during the UAV's operation. This multi-algorithm strategy ensures that the UAV can navigate the orchard efficiently, minimizing travel time and maximizing harvesting productivity.