Simulation Performance Comparison of A*, GLS, RRT and PRM Path Planning Algorithms

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***Abstract*—Path planning is among the essential qualities of an autonomous robot. The ability to build a collision-free pathway from a pre-defined point to another is known as path planning. There are a variety of approaches offered, all of which vary depending on the search pattern and the map representation method. In this study, four robust path planning algorithms, namely: Probabilistic Roadmaps (PRMs), A-star, the Rapidly Exploring Random Trees (RRTs), and Generalized Laser Simulator (GLS), were simulated and their performance was measured and compared according to the total path distance covered, search time and path smoothness. The result obtained reveals that all the four algorithms could navigate and generate a feasible through the 2D map successfully. The GLS algorithm performs better in all the measured parameters followed by the PRM, RRT, and then the A* algorithm.**

Keywords— Path planning, Generalized Laser Simulator, Probabilistic Roadmaps, rapidly exploring random trees, A*

I. INTRODUCTION

Mobile robots depend on computer-designed algorithms with devices and sensors to accomplish autonomous navigation effectively without collision. Environment monitoring, motion control, and trajectory planning are crucial concepts in autonomous vehicles. Path planning is among them, and it is both a product of choice making and automotive navigation. [1] It is also crucial for robots' decision-making and control components to communicate. As a result, path planning significantly impacts autonomous vehicle safety and convenience [2].

The mobile robot path planning problem has many applications in various areas, including autonomous navigation of mobile robots and autonomous underwater vehicles [3]

Path planning is classified into global and local path planning. Global path planning is called static path planning because it generates an optimum path on a static map. In contrast, local path planning is called dynamic path planning since the map's barriers vary dynamically. The path planning process must be done so that the robot finds a feasible path without colliding with any obstacle that may be on the way. As the name suggests, a path planning problem finds A path that begins with an initial configuration and ends with a final configuration, while avoiding any obstacles along the way. A path planning algorithm finds a solution to the path planning problem. It may also be called a path-planner or a guidance algorithm. If a new obstacle pops up in the path planned by the planner, the robot detects the obstacle and replans the path. [4]

Path planning algorithms have been explained in detail by several researchers in the areas of A.I. technology [5], autonomous systems [6], [7], as well as computer science [8]. It was required that in the presence of unseen constraints, the path planning algorithm should plan in a repeating pattern until it accomplishes its objective. [9].

The following is an overview of the paper: Section II covers a brief description of the path planning problems and the analytical path planning algorithms that will be compared in this study. Section III presents the simulation result and discussion of the algorithms. Finally, section VI concludes the analysis.

II. PATH PLANNING ALGORITHMS

A. Path planning problem

In the presence of obstacles, an effective path-planning algorithm will discover a possible path in the minimum amount of time. In complicated situations, exact solutions can be found without accurate information about the robot's working environment. Path planning methods need to overcome various obstacles to manage all constraints and uncertainties in real-world situations.

B. Path planning algorithms

Several algorithms were used to solve the problem of mobile robot navigation in unknown and unknown environments. The efficiency of such algorithms is based on the factors: searching time, path length, and path smoothness. The path length is the distance moved by the robot from point A to point B. On the other hand, the search time can be described as the time used to get to the objective point from an initial position. Evaluating the path generated by the path planning methods determines the path's smoothness.

The classical algorithms are easy to implement, and they perform effectively when hybridised with other approaches in global and local environments.

The classical algorithms discussed and compared in this study are the A* algorithm, PRM, RRT, and GLS.