Project Report

Robot Path Planning

Team Members:

1-Ali Ahmed Hamed Shaker 20201701725

2-Ahmed Medhat Mahfouz 20201701703

3-Mina George Raouf 20201701741

4- Diaa Eldin Amr Ibrahim 20201701720

Course: Genetic Algorithm

Department: AI

Content:

1-Introduction:

The implemented Genetic Algorithm (GA) is designed to solve the problem of path planning for a robot navigating through a 2D space with obstacles. The GA aims to find an optimal path from a defined start point to an end point, considering a set of obstacles in the environment.

2. Problem Definition:

2.1 Objective

The objective is to discover the most efficient path for a robot to traverse from the given start point to the end point while avoiding obstacles.

2.2 Constraints

- The path must be continuous and composed of discrete waypoints.
- The waypoints are represented as (x, y) coordinates.
- The environment includes obstacles that the robot must navigate around.

3. Genetic Algorithm Implementation:

3.1 Classes

- Individual: represents a potential solution (path) with a chromosome of waypoints. The fitness of an individual is determined by the total distance travelled along its path.
- Genetic Algorithm: Manages the genetic algorithm parameters, initialization of the population, fitness calculation, selection, crossover, and mutation operations.
- Graph: Contains methods for visualising the obstacles and plotting the robot's path.

3.2 Workflow

1. Initialization: A population of individuals with random paths is generated.
2. Fitness Calculation: The fitness of each individual is evaluated based on the total distance travelled.
3. Selection: Individuals are selected probabilistically based on their fitness for crossover.
4. Crossover: Pairs of parents are combined to produce offspring with a mix of their characteristics.
5. Mutation: Random changes are introduced to the offspring's paths.
6. Evolution: The new population is created, and the process is repeated for a specified number of generations.

4. Results, Analysis, and Appendix

4.1 Results

The algorithm provides a series of robot paths over generations. The fitness values, representing the total distance, decrease over time.

4.2 Analysis

- The algorithm demonstrates an evolutionary process where paths become progressively more optimized.
- The impact of genetic operations (crossover and mutation) can be observed in the trade-off between exploration and exploitation.

4.3 Appendix

Included are visualisations of obstacles, fitness over generations, and the final optimised robot path.

5. Conclusion

The genetic algorithm successfully addresses the path planning problem for a robot navigating through a dynamic environment with obstacles. The optimization process, driven by evolutionary principles, leads to the discovery of efficient paths, demonstrating the algorithm's potential for real-world applications in robotics and autonomous systems.