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Mini Review

Path Planning and Obstacle Avoidance using Grasshopper Algorithm

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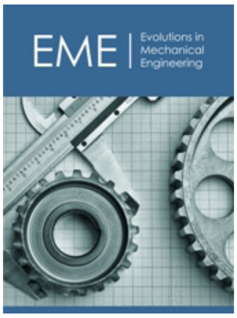

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Abstract

The Grasshopper Optimization Algorithm (GOA) is suggested in this study as a path planning and obstacle avoidance method for mobile robots. The program mimics grasshopper swarming behavior to imitate their movement and interaction and discover the best routes while avoiding obstacles. To direct the robot's movement, the algorithm considers social interaction, gravity, wind advection and obstacle avoidance parameters. Simulations show the algorithm's efficiency in locating the best routes and dodging hazards. The GOA-based method offers a nature-inspired alternative for autonomous mobile robot navigation.

Introduction

The most important navigational problems for autonomous mobile robots are planning a path and avoiding obstacles [1,2]. Robot operation must be safe and successful, which requires successfully navigating through challenging settings while avoiding hazards. Several algorithms, including conventional ones like A* [3] and potential fields [4] and nature-inspired ones like genetic algorithms and particle swarm optimization, have been created to solve these problems [5]. Natural-inspired algorithms have drawn a lot of interest lately because of their capacity to solve challenging optimization issues. The Grasshopper Optimization Method (GOA) [6], which is modeled after the swarming behavior of grasshoppers, is one such method. The GOA has produced encouraging outcomes when used to solve optimization issues in a variety of industries, including engineering, finance, and image processing [7]. Due to their distinct traits of exploration, exploitation and target seeking, grasshopper swarms are well suited for path planning and obstacle avoidance tasks. Grasshoppers travel in a coordinated manner, balancing the exploitation of lucrative zones with the discovery of new areas. These characteristics can be used to create a reliable and effective algorithm for mobile robot navigation. In this study, we suggest that mobile robot route planning and obstacle avoidance employ the Grasshopper Optimization Algorithm. The method uses mathematical models to replicate grasshopper behavior like social interaction, gravitational force, wind advection and obstacle avoidance. These elements are combined by the algorithm to direct the robot in real-time path finding and obstacle avoidance. Extensive simulations were run to assess the efficacy of the suggested strategy. The performance of the GOA-based path planning and obstacle avoidance algorithm was compared with other state-of-the-art algorithms. The results demonstrated the algorithm's ability to generate efficient paths and successfully navigate through challenging environments.

Grasshopper algorithm for path planning and obstacle avoidance

Grasshoppers are renowned for their swarming activity, which happens in both their nymph and adult phases. Grasshoppers travel slowly and take little steps while they are nymphs, but when they are adults, they move abruptly and across great distances. Food source searching motivates swarming behavior, which by default combines both exploratory and exploitative impulses. We can create a novel nature-inspired algorithm by mathematically modeling this behavior for path planning and obstacle avoidance. The Grasshopper Algorithm adapted for path planning and obstacle avoidance involves several key steps. Firstly, the problem domain is defined, including the start position, end position and the positions and shapes of obstacles. An initial population of grasshoppers is generated, representing potential paths from the start to the end position. The fitness of each grasshopper path is evaluated by considering factors such as path length and obstacle avoidance. The movement of grasshoppers is governed by a set of rules. They are attracted to the target (end position), repelled by nearby obstacles to avoid collisions and align their movement with neighboring grasshoppers. This ensures efficient exploration and exploitation of the search space. Neighborhood search is conducted to explore local regions for potential path improvements.

Through an iterative process, the positions and fitness of grasshoppers are updated based on the movement rule and neighborhood search. The algorithm keeps track of the best path found so far. The termination condition is determined, such as reaching a maximum number of iterations or achieving a satisfactory fitness level. By iteratively refining the grasshopper paths, considering obstacle avoidance and optimizing the trajectory, the algorithm eventually converges to the best path from the start to the end position. This optimized path accounts for obstacle avoidance, providing an effective solution for mobile robot path planning in complex environments. The Grasshopper Algorithm harnesses the collective intelligence of grasshoppers to navigate obstacles and find optimal paths, offering a nature-inspired approach for path planning and obstacle avoidance. The Pseudocode for this algorithm is shown in Figure 1.

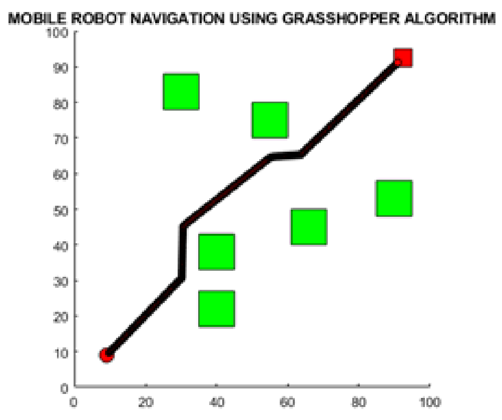
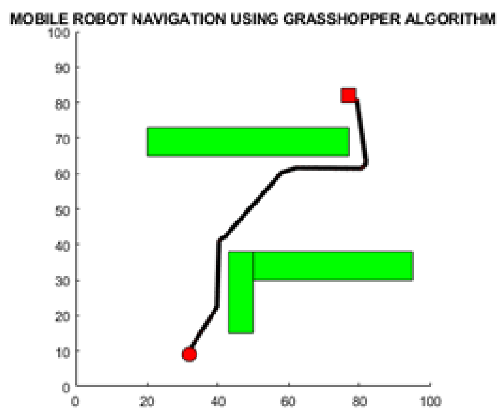
```
1. Define the problem domain: start position, end position, and obstacles
2. Generate an initial population of grasshoppers
3. Evaluate the fitness of each grasshopper path based on path length
and obstacle avoidance
4. Set the maximum number of iterations and termination condition
5. while iteration < max_iterations do
6.     Update the position of each grasshopper based on movement rules
7.     Perform neighborhood search to explore local regions
8.     Update the fitness of grasshopper paths
9.     Keep track of the best path found so far
10.    iteration++
11. end while
12. Return the best path as the optimized solution
```

Figure 1: Pseudocode of Grasshopper algorithm for path planning and obstacle avoidance.

Simulation results of grasshopper algorithm

The effectiveness of the proposed algorithm was demonstrated through simulations in this study. To evaluate the optimality of the suggested approach in terms of path length and navigation time, a MATLAB simulation software was employed to create an environment with obstacles. The Two Scenario are simulated which is shown in Table 1.

Table 1:

			
Scenario 1		**Scenario 2**	
Path Length (Cm)	155	Path Length (Cm)	162
Time (Sec)	14	Time (Sec)	15

Conclusion

In conclusion, this Study has presented a path planning and obstacle avoidance approach using the Grasshopper algorithm. By mathematically modeling the swarming behavior of grasshoppers and incorporating principles of exploration and exploitation, the algorithm demonstrates effectiveness in finding optimal paths while avoiding obstacles. The simulation and result conducted using MATLAB validate the efficiency of the proposed algorithm in terms of path length and navigation time. Future research directions may involve further optimization of the algorithm and its integration with physical robotic systems for various applications in the field of mobile robotics.

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