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Multi-Robot Navigation in Unknown Environment Using Strawberry Algorithm

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ABSTRACT

Path Planning focuses on the robot motion from the initial position to final position such that it must avoid the hurdles and finally reach the goal in optimal path. But it is not an easy task because many conditions are included for the efficiency of final result like working on different environments, known or unknown target etc. In this paper the authors have proposed an algorithm inspired by the strawberry plants, and is applied in the path planning. The algorithm can efficiently work for different optimization parameters like Path Length, Energy and Number of Turns. The proposed algorithm is compared with RRT, A-star, PSO and the results obtained are satisfactory. The work can be applied in the real life challenges faced during area exploration

KEYWORDS

Multi Robots, Optimization, Path Planning, Strawberry Algorithm

1. INTRODUCTION

Path planning is one of the major research areas in robotics, which represents the optimal path between the starting position to goal position. The environment consists of obstacles, so the collision with obstacles should be taken care of. The path planning algorithms solve the real time problems in which there is no human intervention. These algorithms involve designing efficient methods to solve problems in robust applications. Path planning implemented in different applications like industries, automobile, manufacturing, medical (LaValle, 2006). The environments considered in path planning are the static and dynamic. In static environment obstacles are stationary and in dynamic environment obstacles may move in a random direction. The optimization regularly comes across the mathematical problems in various disciplines. It is nothing but finding the best solution. Optimization problems can be deterministic or stochastic. There are two methods for solving the problems, exact and heuristic. The exact method includes mathematical and logical programming. Some of the conventional methods for path planning are A-star (Hart, Nilsson & Raphael, 1968), RRT (LaValle, 1998). Metaheuristics involve the problems that solved inefficient manner such that computational efficiency achieved. Nature-inspired algorithms (NIA's) are one of the sets of algorithms which can solve the multi-objective optimization problems which inspired by the collective behavior of different types of species of plants, insects, birds. These algorithms can perform well in various applications in many fields for solving the complex optimization problems so that fitness function is developed depending upon the application, in which the final result gives the optimal solution. Evolutionary and Swarm intelligence algorithms are the best examples of NIA's. These algorithms follow Darwin's theory, survival of fittest. Numerous number of NIA's are evolved such as Particle

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Swarm Optimization (PSO) (Kennedy, 2011), Invasive Weed Colony (IWO) (Mehrabian & Lucas, 2006), Ant Colony Optimization (ACO) (Dorigo, Birattari & Stutzle, 2006), Artificial bee colony optimization (ABC) (Karaboga & Basturk, 2007), Genetic algorithm (GA) (Davis, 1991), Cuckoo Search (CS) (Yang & Deb, 2009), Differential Evolution (DE) (Storn & Price, 1997), Firefly Algorithm (FA)(Yang, 2010), Strawberry plant algorithm (Merrikh-Bayat, 2014), are used in path planning techniques. The remaining part of the paper organized as follows. Section 2 Related Work, Section 3 Implementation, Section 4Approach for Multiple Robots, Section 5 Strawberry Algorithm Section 6 Simulation Results and Section 7 contains a concise conclusion.

2. RELATED WORK

Li Lu et al. (2008) (Lu & Gong, 2008), proposed method for path planning in the unknown environment using the particle swarm optimization, this approach transformed to minimization concept. The advanced fitness function is based on the target and also obstacles in the search space or environment. The environment is unknown because of the limited sensor range of the robot. The global best solution calculated by executing PSO iteratively. The robot updates the environment on its each move. The final path is generated using the fitness function, and also simulation is done in the dynamic environment so that final path generated do not collide with obstacles.

Amin Zarger et al. (2009) (Nasrollahy & Javadi, 2009), introduced a method assuming the goal position is moving according to the time, and also obstacles are not static. Particles swarm optimization used to find collision free path and concept used for fitness function development is minimization concept. This method is applied irrespective of shape and size of objects. Ellipsmasehian et al. (Masehian & Sedighizadeh, 2010), proposed a method which introduces a concept that is particle swarm optimization hybrid with the probabilistic roadmap. The PSO for choosing the global best and the probabilistic roadmap for avoiding the obstacles. In this method, two objective functions developed which minimizes the path length and path smoothness such that robot reaches its goal position.

Dun-wei Gong et al. (Zhang, Gong & Zhang, 2013), developed method for the path planning in danger sources. A multi-objective PSO in which the model has two parameters to optimize, the changing degree of the path and the path length. In this algorithm, a parameter called self-adaptive mutation operator based on the path which blocks by hurdles or obstacles is designed to improve the flexibility in the new path. The local bests of particles governed by the Pareto domination based on the path blocks degree are employed.

Mao Yang et al. (Yang & Li, 2011), proposed an algorithm for the robot path planning in which PSO based on cubic splines for the multi-mobile robot. The improved PSO used for getting the optimal path and PD controller for tracking the center shortest path. The method developed by Na Geng et al. (Geng, Gong & Zhang, 2013), gives path planning using, multi-objective PSO. In which the environment developed by line partition method. The danger zones in the environment detected by combining range optimal criterion, and danger degree of the path, here overall path length is optimized. Myo Thida et al. (Thida, Eng, Monekosso et al., 2013), introduced an algorithm which uses communication concept between the swarms to trace the many crowds. The method improves the PSO by effective communal communication between the swarm. This approach traces the multiple goals in the complex environment. B.B.V.L. Deepak et al. (Deepak, Parhi & Raju, 2014), introduced an algorithm using particle swarm optimization. In this algorithm, the fitness function is developed based on the distance between the each of the swarm and the goal point and between the particles of the swarm and closest obstacle. In each iteration, global best selected, and the overall path is generated using global bests.

Qianzhi Ma et al. (Ma & Lei, 2010), developed an algorithm for path planning in a dynamic environment which uses a method called time rolling window. The fitness function is designed such that it guarantees collision avoidance and algorithm works successfully in the static and vibrant environment. Rashmi Ramjan Sahoo et al. (Sahoo, Rakshit, Haidar et al., 2011), proposed path