# Chapter 10
# A Hybrid Fireworks Algorithm to Navigation and Mapping

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## ABSTRACT

*In recent years, computer technology and artificial intelligence have developed rapidly, and research in the field of mobile robots has continued to deepen with development of artificial intelligence. Path planning is an essential content of mobile robot navigation of computing a collision-free path between a starting point and a goal. It is necessary for mobile robots to move and maneuver in different kinds of environment with objects and obstacles. The main goal of path planning is to find the optimal path between the starting point and the target position in the minimal possible time. A new firework algorithm (FWA) integrated with a graph theory, Dijkstra's algorithm developed for autonomous robot navigation, is proposed in this chapter. The firework algorithm is improved by a local search procedure that a LIDAR-based local navigator algorithm is implemented for local navigation and obstacle avoidance. The grid map is utilized for real-time intelligent robot mapping and navigation. In this chapter, both simulation and comparison studies of an autonomous robot navigation demonstrate that the proposed model is capable of planning more reasonable and shorter, collision-free paths in non-stationary and unstructured environments compared with other approaches.*

## INTRODUCTION

Nowadays, robot technology is one of the most promising technologies. Robots can be deployed in fields like medical, agricultural, and explore hostile, dangerous and unreachable environments (Luo, Yang, Li, & Meng, 2017). Real-time map construction and collision-free navigation of an intelligent mobile robot is one of the most crucial issues in robotics. In an environment populated with a variety of obstacles, the task of navigation and map construction is to search a feasible collision-free trajectory for the robot to move from the starting point to the final target and simultaneously build a map.

Nature-inspired algorithms are among the most used for resolving optimization problems. The common aspect of nature-inspired algorithms is given by the fact that they are inspired by the behavior of different species. For instance, ant colony optimization algorithm (ACO) is inspired by observing the way of ants finding food. Particle swarm optimization algorithm (PSO) mimics the pattern of birds flying to find food; Artificial bee colony algorithm (ABC), fish school search algorithm (FFS), and bacteria foraging optimization algorithm (BFO) are also inspired by the bee, fish and E-coli, respectively. In addition, by nature, social phenomena inspired algorithms are inspired by brainstorming process, music harmony and fireworks explosion.

Many natural-inspired models for intelligent mobile robot navigation and mapping have been proposed. Roy, Maitra, & Bhattacharya (2017) used a hybrid particle swarm optimization (PSO) and bacterial foraging optimization (BFO) algorithm to develop a robot path planner model with obstacle avoidance. Dolicanin, Fetahovic, Tuba, Capor-Hrosik, and Tuba (2018) applied brain storm optimization (BSO) for seeking the unmanned aerial vehicle optimal trajectory by considering fuel consumption and safety degree. The BSO algorithm reduces the computational time by moving the new candidate solutions to the local best position through the local search process (Cheng, Shi, Qin, Ting, & Bai, 2014). Mo & Xu (2015) proposed another method for path planning based on particle swarm optimization. In the environment with static obstacles, biogeography-based optimization hybridized by the particle swarm optimization was used to navigate a mobile robot. A new meta-heuristic grey wolf optimizer (GWO) was developed (Zhang, Zhou, Li, & Pan, 2016) to resolve the 2D robot path planning problem. The robot can seek a safe trajectory by connecting the chosen nodes of the 2D coordinates while avoiding the threats areas and costing minimum fuel. Artificial bee colony algorithm (ABC) was developed to search the mobile robot optimal trajectory based on path length and smoothness (Contreras-Cruz, Ayala-Ramirez, & Hernandez-Belmonte, 2015). ABC algorithm was designed as a global search procedure that combined with an evolutionary strategy, which was used to refine the search for feasible paths. Compared with other methods such as the probabilistic roadmap method, the ABC algorithm has a higher chance to find a suitable collision-free trajectory and takes less time.

Besides the nature-inspired methods, various other algorithms were proposed and adjusted for solving the path planning problem as well. Luo, Jan, Zhang, and Shen (2017) used a graph-based method to develop a two-level model, which is an enhanced Voronoi Diagram associated with Vector Field Histogram algorithm based on the LIDAR sensor information for real-time robot path planning. Ullah, Xu, Zhang, Zhang, and Ullah (2018) utilized two different independent modules, namely as Artificial Neural Networks and Reinforcement Learning model to obtain their best control policies and then combine the two trained modules for realizing collision avoidance and global path planning. Neural network was used to resolve path planning problem. Yang and Luo (2004) developed a biologically inspired neural network method of intelligent robot coverage navigation model in a non-stationary environment, which is extended to unknown workspace by concurrent mapping and navigation (Luo et al., 2017).

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