

# Introductory Chapter: Motion Planning for Dynamic Agents

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## 1. Introduction

Dynamic agents enclose an extensive range of ventities covering mobile robots, autonomous vehicles, drones, unmanned aerial vehicles (UAVs), unmanned ground vehicles (UGVs), unmanned underwater vehicles (UUVs), and other objects in motion. An integral aspect in the development of these agents, especially the autonomous ones, is to devise a course of action enabling them to make their plans in various situations. Motion planning is the computational process of navigating the above-mentioned entities from one to another place while avoiding collisions, optimizing for assessment criteria, and adapting to varying conditions. It generates a feasible and safe trace to follow and enables efficient interactions between dynamic agents and their environment [1, 2]. This introductory chapter conceptualizes motion planning and brings insights into the various motion planning approaches for dynamic agents along with their applications, significance, and existing challenges that require future considerations and future potential. This chapter emphasizes the integral role of motion planning in shaping the future of robotics and autonomous systems.

Motion planning is comprised of two components namely path planning and trajectory planning. The path refers to a sequence of configuration vectors considering independent attributes like position, orientation, linear or angular velocity, steering angle, acceleration, and many others. A trajectory is an order of spatio-temporal states, feasible for agent dynamics, in free space. First, the trajectory planner generates an array of feasible and collision-free trajectories then, it selects an optimal one founded on cost function optimization. These components ensure safe and efficient motion, especially in complex, unknown, and ever-changing environments. Therefore, motion planning is a crucial aspect of robotics and automation [3]. Motion planning approaches are applied according to the application and its requirements for dynamic agents. Some widely employed approaches are sampling-based, optimization-based, model predictive control (MPC), bio-inspired, and artificial intelligence (AI)-based approaches as illustrated in **Figure 1**. These methods offer opportunities, however, face some restrictions [4].

The first category is sampling-based approaches that are computationally efficient and operative in high-dimensional spaces. These methods are further categorized as random and de-randomized or deterministic sampling-based approaches [5]. Algorithms that randomly sample the configuration space for generating feasible paths are referred to as random sampling-based methods. These are successful approaches for robotic motion planning problems. These aim to conduct a probabilistic search that examines the configuration space with independently and identically distributed random samples. This assessment is enabled through a collision

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