Intelligent Trajectory Planning for Unmanned Surface Vehicles

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***Abstract*—This paper discusses the intelligent algorithm for trajectory planning of unmanned surface vehicle (USV) in harsh marine environments. There are several tasks discussed in this paper including docking and docking of undocking.**

***Index Terms*—Intelligent systems, Trajectory planning, Unmanned surface vehicles**

I. Introduction

THIS introduction provides a literature review of trajectory/path- planning method for unmanned surface vehicles. An effective path-planning for autonomous surface vehicles involves two steps: global path-planning and local path-planning. In the global path-planning, the goal is to avoid static obstacles such as islands, shallow-water, beacons and connect the starting and target point. However, in local path-planning, an on-line algorithm is implemented to perform rapid response to changes in the environment and dynamic obstacles. In early years, the work of Hart et al. [1] focused on the global-path planning (GPP), and heuristic methods such as A^* are used to find a path in static environments. In the

Several improvements has been applied to A^* method for dynamical environments without obstacle [2] and with obstacle [3]. Even in the presence of obstacles, the former method is still global approach. Effective obstacle avoidance path-planning methods would use local-path planning. In the literature, the local path-planning approaches for the dynamic environment includes genetic algorithm [4], [5], ant colony [6], [7], particle-swarm optimization [8], [9]. Artificial potential field is another method used for obstacle avoidance [10]–[15]. In this method, obstacles are represented by repulsive forces and targets as attractive forces, and the algorithm tries to find the local minima of the field. The main drawback with this algorithm is that it can trap in local minimas. Another method that has recently gained attraction is the fast marching method (FMM) [14], [16]. In [17], an FMM-based path planning scheme has been proposed where additional minimization step is also considered. In [18], solved the reach-avoid game problem by using FMM. In [19], a multi-layer path planner is proposed under harsh marine environment modeled by stochastic dynamic coastal environment.

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