Enabling Tactical Autonomy for Unmanned Surface Vehicles in Defensive Swarm Engagements

by

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Submitted to the Department of Mechanical Engineering
on May 11, 2018, in partial fulfillment of the
requirements for the degrees of
Naval Engineer
and
Master of Science in Mechanical Engineering

Abstract

This research incorporates practical applications of marine vehicles with robotics control theory to reduce the vulnerability of allied assets to asymmetric warfare. This work utilizes distributed decentralized multi-objective optimization in the Mission Oriented Operating Suite with Interval Programming (MOOS-IvP) to enable a number of simulated unmanned surface vehicles (USV) to provide defense for a high value unit (HVU) against fast attack craft (FAC) aggressors. The primary objective is to enable a swarm of defending vehicles to protect the HVU and successfully counter a swarm of aggressors with the ability to adapt to changing situations. This research makes it possible for autonomous defenders to react according to variables such as number of defenders, number of aggressors, known kinematic capabilities of defenders, perceived kinematic capabilities of aggressors, and positional distribution of aggressors. A theoretical framework is first described for analyzing the engagements based on game theory by constructing the defense scenario as a three-party differential game. MATLAB is then utilized to demonstrate optimal solutions to this scenario as an application of game theoretical guidance, which was developed for use in missile guidance systems. Algorithms and behaviors are then presented to demonstrate that the multi-objective optimization in MOOS-IvP approaches the optimal solutions in the vehicles' autonomous response during engagements consistent with the three-party differential game. Finally this work presents MOOS-IvP simulation data to demonstrate autonomous tactical decision-making in more realistic engagement scenarios.

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