Rapidly Estimating Swarm Resource Needs Through Autonomous Simulation

by

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Abstract

The maritime industry spends significant time and resources accomplishing long lasting collaborative tasks such as search and rescue or ocean surveying. Autonomous swarm ships' ability to scale rapidly and operate with limited resources allows them to outperform conventional crewed ships at these collaborative operations. Despite their incredible potential, perpetually operating productive autonomous swarms creates significant logistic challenges. This thesis aims to solve these problems. Specifically, this thesis aims to maximize collaborative swarm productivity, by predicting and managing robot resource needs, using operations theory, simulation, and machine learning.

Maximizing swarm productivity first requires developing a common scenario to measure productivity. Drawing from multi-robot patrol research, this thesis implements two resource-aware multi-robot patrol missions in MOOS-IvP. In each mission, vehicles perpetually patrol a grid and must periodically break patrol formation to refuel at a depot. Missions measure their performance based on how frequently robots visit each portion of the mission operating area (grid idle time) and how much area each robot controls (average Voronoi polygon area). With a common patrol scenario developed, this thesis then simulates patrol missions using different vehicle and depot parameters to generate a broad performance dataset.

Finally, this thesis develops a method to predict future mission performance from the simulated productivity dataset. Simulated mission data is post processed and used to train XGBoost models. Compared to mission simulations, these models take far less time to produce while still showing planners what performance and vehicle output they can expect from a given mission.

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