OPTIMIZING MULTI-AGENT NETWORK FOR TARGET LOCALIZATION THROUGH MUTUAL INFORMATION MAXIMIZATION

By Bibek Adhikari
Thesis Advisor: Kamesh Subbarao

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Abstract

A multi-agent network is a system comprising multiple interacting agents that coexist collaboratively within a networked, autonomous environment. The advancement of these networks has expanded to the realm of autonomous vehicles, facilitating applications in source localization, environmental monitoring, and search and rescue operations due to their efficiency, robustness, and scalability. These networks are optimized by strategically deploying and maneuvering the agents to maximize the information collection and objective functions while adhering to mobility constraints.

The thesis addresses the target localization problem using a multi-rover network, described as autonomous agents, using an information-theoretic distributed control framework. The objective of the mission, through the integration of the particle filter representation of the posterior probability distribution of the target state and the observable, is to compute control input to arrange agents' locations, maximizing the mutual information between the target's position and sensor measurements. Consequently, the method leads to future observation which minimizes the future uncertainty of the target state. The study applies this framework to a mission setup involving a network of multi-rover and a lunar base station deployed on the lunar surface, tasked with localizing the lunar landmarks. The study presents the localization and navigation of the rover in the lunar environment through the implementation of visual SLAM (Simultaneous Localization and Mapping). The thesis incorporates the real system dynamics of the differential drive rover, considering the irregular terrain of the lunar surface. The practical testing of the algorithm was conducted in a virtual simulated lunar environment in Gazebo within the ROS (Robot Operating System) framework demonstrating the algorithm's viability and effectiveness under realistic conditions. The simulation encompasses two different case studies and demonstrates the successful localization of the target in different scenarios. Through these simulations, the paper highlights the efficacy of the proposed framework in addressing the target localization problem, showcasing its potential for real-world applications in challenging environments like the lunar surface.