Decentralized and Nondeterministic Multi-Robot Area Patrolling in Adversarial Environments

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Abstract

Multi-robot patrolling is the problem of repeatedly visiting a group of regions of interest in an environment with a group of robots to prevent intrusion. Early works have proposed deterministic patrolling algorithms which could be learned by an adversary observing them over time. More recent works provide non-deterministic patrolling schemes which only work for perimeter patrolling and require coordination and synchronization. In this paper, we investigate the problem of finding robust and scalable strategies for multi-robot patrolling under an adversarial environment. So, we present algorithms to find different decentralized strategies for a patroller in the form of Markov chains which use convex optimization to minimize the average commute time for an environment, a subset of the environment, or a specific region of an environment when we use uniform distribution over all regions for both patroller and adversary. Additionally, we use these strategies in a game theoretical setup to form a payoff matrix to obtain an optimal mixed strategy for patroller. We also propose an algorithm to find a decentralized strategy for patroller in the form of Markov chain which converges very fast as it is the optimal response from patroller against the adversary when we use non-uniform distribution...
over all the regions for both patroller and adversary. Our results show the scalability and applicability of our approach in different types of environments. Despite the lack of synchronization and coordination among patrollers, our approach performs competitively compared to existing methods.

References

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Index Terms

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Keywords

Patroller, Adversary, Markov chain, Game theory, Convex optimization