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Mobility and Intruder Prior Information Improving the Barrier Coverage of Sparse Sensor Networks

Abstract:

The barrier coverage problem in emerging mobile sensor networks has been an interesting research issue due to many related real-life applications. Existing solutions are mainly concerned with deciding one-time movement for individual sensors to construct as many barriers as possible, which may not be suitable when there are no sufficient sensors to form a single barrier. In this paper, we aim to achieve barrier coverage in the sensor scarcity scenario by dynamic sensor patrolling. Specifically, we design a periodic monitoring scheduling (PMS) algorithm in which each point along the barrier line is monitored periodically by mobile sensors. Based on the insight from PMS, we then propose a coordinated sensor patrolling (CSP) algorithm to further improve the barrier coverage, where each sensor's current movement strategy is derived from the information of intruder arrivals in the past. By jointly exploiting sensor mobility and intruder arrival information, CSP is able to significantly enhance barrier coverage. We prove that the total distance that sensors move during each time slot in CSP is the minimum. Considering the decentralized nature of mobile sensor networks, we further introduce two distributed versions of CSP: S-DCSP and G-DCSP. We study the scenario where sensors are moving on two barriers and propose two heuristic algorithms to guide the movement of sensors. Finally, we generalize our results to work for different intruder arrival models. Through extensive simulations, we demonstrate that the proposed algorithms have desired barrier coverage performances.