Maintaining Worst case Guarantee in Trading-Off Quality of Tracking and Network Lifetime

Abstract

Existing literature on tracking, typically assume Full Coverage requiring every point of the target region to be covered. Though Full coverage provides fine grained detection, achieving Full Coverage in large target region may not be practical in terms of cost and network life-time. In surveillance applications though intensive coverage, for example full coverage, is needed, to track an event partial coverage of the target field may be enough to detect the occurrence of the event with possible some delay. Although attempt to formalize and analyze the trade-off between power conservation and quality of tracking or surveillance has been addresses, the question of how to systematically make this tradeoff still remains an open question.

To facilitate trading off quality of tracking with Network lifetime, firstly, we need a metric for the quality of detection of the event with a worst case bound on the delay of detection. In this paper, we consider Trap Coverage as a potential coverage model which guarantees that any object can only move within a bounded displacement (Trap diameter) before it is detected, no matter how complex the trajectory is. Then we address the problems of (1) finding minimum set of sensors to achieve trap coverage and, (2) scheduling the sensors in order to increase network lifetime. Firstly, we show that when the ratio of trap diameter to sensing radius is large, deployment of sensors in a hexagonal lattice comes within 15% of the optimal deployment density. Using this result we then present a deterministic algorithm to select minimum number of sensors to achieve a desired bound on the diameter. In case of full coverage of target region this algorithm provides a constant approximation bound and; in case of random deployment the performance of the algorithm is asymptotically optimal compared to the hexagonal lattice deployment pattern. And we also make use of the algorithm to provide the sleep-wakeup scheduling scheme.