ABSTRACT

Network lifetime maximization and quality of coverage are of paramount interest in wireless sensor networks. This is because sensor nodes are battery powered and it is essential to use the available energy optimally. Minimizing energy consumption will lead to maximization of the network lifetime. Depending on the application, energy can be efficiently used through good energy utilization methods. Sensor node deployment and sensor scheduling are two main problems which concern optimal energy use. We address sensor scheduling and sensor node deployment for target coverage problem in wireless sensor networks. Each application will have a different coverage requirement. Keeping this coverage requirement as the main objective, we identify methods to reduce energy consumption for enhancing the network lifetime and improving the quality of coverage.

This thesis first looks at random deployment of sensor nodes. Random deployments are usually dense. This may be the only way of deployment for some harsh environments such as a battle field or a disaster region. A scheduling mechanism which activates only a subset of sensor nodes at a time that is just enough to satisfy the required coverage level and the remaining nodes are set to sleep for conserving energy is initially proposed. This, in turn, prolongs the lifetime of the sensor network. The proposed heuristic performs better than the existing heuristics Greedy-Maximum Set Covers (Greedy-MSC) and High Energy and Small Lifetime (HESL). Then a scheduling scheme for $M$-connected coverage problem is proposed which requires the subset of sensor nodes to be $M$-connected and to satisfy the required coverage. This leads to a higher network lifetime and reliable data delivery. The proposed heuristic performs better than Communication Weighted Greedy Cover (CWGC). These scheduling mechanisms will be useful only for random dense sensor node deployments where each sensor node has a fixed sensing range. If the application permits deterministic deployment of nodes and if the sensor nodes
are limited, quality of sensing and energy conservation can be enhanced by restricting the sensing range requirement. Sensing models can be categorized as binary sensing model or probabilistic sensing model. In a binary sensing model, the target is either fully monitored or not monitored. A probabilistic coverage model considers the effect of distance and medium on the sensing ability of a node. A method for optimal deployment of sensor nodes such that the required sensing range is minimum for both binary and probabilistic sensing models is also presented in this thesis. Artificial Bee Colony (ABC) algorithm is used to compute the optimal deployment locations. A comparison with Particle Swarm Optimization (PSO) shows that ABC algorithm performs better than PSO for the given problem.

Finally the thesis gives a more general approach where a single round deterministic deployment of sensor nodes with fixed sensing range is permitted. A heuristic is initially proposed to solve this problem. The heuristic performs better than the random sensor node deployment. Computing optimal deployment locations using ABC algorithm outperforms the heuristic. The upper bound of network lifetime for a given region with sensor nodes monitoring targets can be theoretically computed. This helps in identifying the optimal positions wherein the network lifetime would be maximum. A scheduling mechanism is then used to schedule these nodes so that this theoretical upper bound of network lifetime can be achieved.