Impact of Probabilistic Neighbor Discovery on Performance of Sensor Networks

Leeger Yu   Anthony Ephremides

Objectives

◆ Evaluate the impact of neighbor discovery on performance of sensor networks with an event detection mission

◆ Investigate the inherent tradeoff between detection accuracy and energy consumption

◆ Develop an appropriate data fusion scheme for probabilistic network topology

Model Assumptions

◆ *On neighbor discovery:*
  ◆ Sensor nodes probabilistically broadcast in each synchronized slot
  ◆ SINR criterion for successful reception
  ◆ Probabilistic outcome for discovered network topology

◆ *On event detection:*
  ◆ Binary hypothesis testing: $H = H_0$ or H_1
  ◆ Spatially-correlated measurements
  ◆ Locally collected and processed data aggregated via multi-hop fusion
  ◆ Final decision at fusion center: $\hat{H} = H_0$ or H_1

◆ *On performance evaluation:*
  ◆ Detection accuracy: probability of error
  ◆ Data fusion effectiveness: accuracy of resulted log-likelihood ratio
  ◆ Energy consumption: in neighbor discovery & detection operations

Achievements

◆ Developed an analytical approach to determine the probabilities of each link being discovered as a function of link length, and simplified the computation complexity by adopting a disk model

◆ Modeled spatially-correlated measurements by a Markov random field applied on a nearest-neighbor dependency graph

◆ Derived a close-form expression for log-likelihood ratio as a sufficient statistic of detection based on an accurate or inaccurate neighbor dependency graph

◆ Established an energy consumption model to calculate energy consumptions for neighbor discovery and detection operations

◆ Proposed heuristics for new data fusion schemes to achieve a more accurate log-likelihood ratio with a less energy consumption for the probabilistic network topology, which completely or partially replace the observed measurement of discovered nearest neighbor in the calculation of log-likelihood ratio by an estimated measurement of the real nearest neighbor
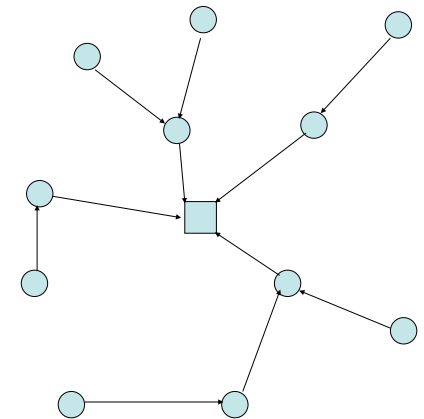
Future Work

◆ To compare the performance of proposed data fusion schemes with existing scheme designed for deterministic network topology

◆ To complete the framework to analytically and quantitatively evaluate the impact of neighbor discovery on performance of the system

◆ To demonstrate the tradeoff between detection accuracy and energy consumption for all data fusion schemes