Node Mobility for Mission-oriented Sensor Networks

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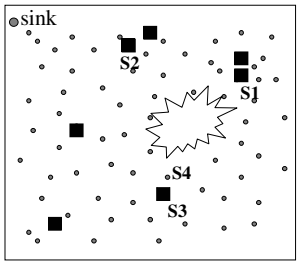
Background & Motivations

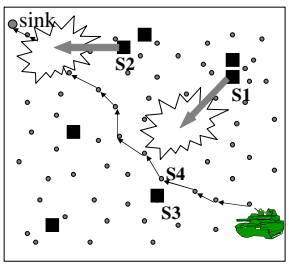
Mobility can significantly increase the capability of the sensor network by making it ***resilient to failures***, ***reactive to events***, and able to ***support disparate missions*** with a common set of sensors.

Multiple missions, each with different requirements, may share common sensors to achieve their goals.

Perimeter defense



Target tracking



Other reasons: sensor failure or new event such as chemical spill, target approaching, sensing obstacle (blocking video sensor or acoustic sensor).

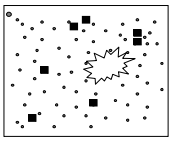
{ Mobility in sensor network is *controllable*, different from ad hoc networks }

Sensor network monitoring

Purpose : continuously monitor sensors' status (i.e., aliveness, battery state, etc.) and quickly detect coverage hole

Coverage hole detection:

- Use theoretical geographical techniques, e.g., Voronoi diagram, K-coverage
- Require information about both sensor status and mission requirement



{ *Mission oriented:* satisfy the coverage requirement of perimeter defense, but present a coverage hole for target tracking }

- Design protocols considering logical structure sharing
- Reduce false positives

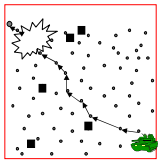
Sensor status monitoring

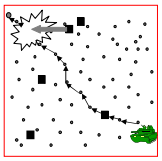
- **Centralized approach:** sensor status is aggregated and sent to a base station
- **Distributed method:** each node is monitored by its one-hop neighbors. It only detects the isolated failure pattern

Distributed poller-pollee structure.

Mobility assisted routing

Motivations





{ Move to heal the broken path
Move to increase the capacity
Move to save the power }

Objective

- Design algorithms based on our previous bidding protocol (or simulated annealing) , considering new parameters such as moving cost, and saved bandwidth, power.
- find the node positions to minimize the total required transmission power for all the active flows in the network

Research Issues

- Mobility assisted sensing: relocate sensors as the network condition changes (sensor failure or new event such as chemical spill, target approaching).
- Network monitoring: detect node failures and estimate the loss of coverage.
- Mobility assisted data dissemination (routing): moving sensors to improve network communication; increasing network lifetime, dealing with network partition.
- Integrated mobility management for sensing and routing: define utility functions that can capture the benefits of the movement from the perspective of all missions (e.g., routing or sensing).

Mobility Assisted Sensing

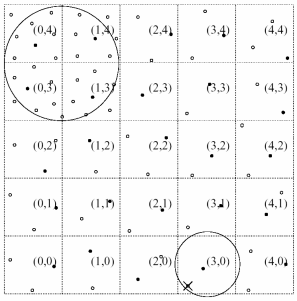
Sensor relocation relocates mobile sensors from one place to another place due to sensor failure or react to event.

Challenges of sensor relocation:

- It has strict time, power constraint
- Relocation should not affect other missions

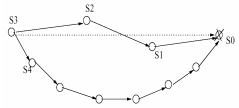
Part I: finding the redundant sensors:

- Similar to the publisher/subscriber problem
- Flooding has too much overhead
- Using a grid concept combined with quorums to reduce the search overhead
  - How to construct the quorum?
  - When to stop search?



Part II: relocating redundant sensors:

- Directly moving the sensor to the destination suffers from long delay and unbalanced power consumption
- use cascaded movement



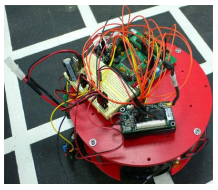
S3->S2, S2->S1, S1->S0. All movements occur at the same time

Dynamic programming techniques:

- Tradeoffs among: computation complexity, moving distance, relocation time, communication overhead
- Maximize the minimum remaining power, minimize the total energy

Prototyping

- Mobility, built from remote-controlled robots.
- Runs TinyOS, based on Berkeley Mica Motes, has processor and wireless communication.



The PIs are with the Pennsylvania State University. More information is available:
http://mcn.cse.psu.edu/
http://www.cse.psu.edu/~teng/relocation

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