Title
Sensor Network Tomography: Monitoring Wireless Sensor Networks

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Sensor Network Tomography: Monitoring Wireless Sensor Networks

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**Goal**

SNT scans provide continuous updates of overall sensor network state after deployed in unpredictable environment for …

**Challenges**

Compared to instrumentation of other distributed systems such as the Internet, continuously monitoring a wireless sensor network poses different challenges …

- **Low User-to-Device Ratio**
  The sheer number of sensors makes it infeasible to centrally collect detailed state from individual sensor nodes.

- **Highly Distributed Data Processing**
  Knowledge of overall state over a region is more useful than of the individual node states.

- **Limited Energy Resource**
  High cost of communication requires carefully design to collect monitoring data.

**Our Approach**

- **Sensor Network Tomography:** Monitoring Wireless Sensor Networks

- **UNIVERSITY OF SOUTHERN CALIFORNIA INFORMATION SCIENCES INSTITUTE**

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- **Early Warning of System Failure**
  Discover those regions that may fail because of resource depletion.

- **Incremental Deployment**
  Provide guidance to selectively place additional sensors to “weakest regions” or “hot spots” to improve performance.

- **Functionality Validation**
  Evaluate overall response of the sensors to known stimulus or fine-tune detection algorithms.

**Abstracted Representation**

Instead of extracting individual node state, SNT scans represent abstracted view of particular network characteristics.

**In-network Aggregation**

Scans are constructed by aggregating small ones when being delivered within the network. Details are discarded to compensate local processing cost by saving communication cost.

**Link Scan**

Display connectivity between sensor network tested nodes.

- Very helpful to set up preferred network topology to debug/demonstrate different wireless routing protocols.

**Residual Energy Scan**

Depict overall distribution of the remaining energy levels of sensor nodes.

- Compared to extracting energy levels from individual nodes,

Constructing residual energy scans by aggregation and incremental update shows better scalability and energy-efficiency characteristics.

**Complementary Tools**

Detailed network states of a particular region can also be extracted once the user identify suspicious problems.

**Preliminary Results and Future Work**

- **Link Scan**
  Display connectivity between sensor network tested nodes.
  
  Very helpful to set up preferred network topology to debug/demonstrate different wireless routing protocols.

- **Residual Energy Scan**
  Depict overall distribution of the remaining energy levels of sensor nodes.
  
  Compared to extracting energy levels from individual nodes,

  Constructing residual energy scans by aggregation and incremental update shows better scalability and energy-efficiency characteristics.

**Implementation on Testbed**

- **PC/104 based wireless nodes with Radiometrix transceiver (On-going)**
  Linux 2.2 + DirectedDiffusion-3

- **UCB mote hardware with RFM radio transceiver (Future)**
  Tiny-OS + Tiny-diffusion

**Future Work**

- Continue to explore design space
  - Alternative Representation and Aggregation Schemes
  - Study the robustness of our design to network dynamics
  - Another type of scan: Outlier Scans
  - To Depict Abnormal Behaviors within the Network
  - Challenge: Compute the cut-off values to identify outliers

- **Implementation**
  - Provide tools for other researchers

- **Scans**
  - An analog to weather maps or radar images, a scan depicts resource availability or sensing activity within a sensor field.

  Example: A Residual Energy Scan consists of value range and a polygon with geographic locations of outline nodes.

  Value = 35~37% Coverage = 37% 35% 36% 38%