Node Filtering and Face Routing for Sensor Network

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Main Contributions

- Efficient Algorithms for identifying **Redundant Sensor Nodes**
- New Technique for **Filtering Redundant Nodes** in Sensor Network
- Reliable Algorithm** for Message Routing - Forwarding
- User Friendly Prototype **Implementation in Java**
- Results of Experimental Investigation

What are Sensor Nodes?

Small scale electronic devices with

- Limited memory and processing power
- Wireless Communication Interface (range ≈ 70 meters)
- Low-power Battery
- Sensing component (temperature, sound, ...)

Usually assumed to be stationary

Allowed to be active/inactive

Typical Sensor Nodes:

Berkeley MICA Mote

- Cost - \$10
- Size - 40cm³
- Weight - 70g
- Battery - 15kj
- Memory - 4KB Ram
- OS - TinyOS
- Radio Range - 30m

Smart Dust

- Cost < \$1
- Size - 0.002cm³
- Weight - 0.002g
- Battery - Less
- Memory - Less
- OS - Smaller
- Radio Range - Shorter

WINS NG 2.0

- Cost - \$100
- Size - 5300cm³
- Weight - 5400g
- Battery - 300kj
- Memory - 32MB Ram
- OS - Linux
- Radio Range - 100m

Randomly Generated 500 Sensor-Nodes inside a Rectangular Region

Randomly Generated 600 clustered Sensor-Nodes inside a Rectangular Region

Sensor Network Modeled by Gabriel Net

Linking Rule: Given a set of nodes $S = p_0, p_1, p_2, \dots, p_{n-1}$, two nodes p_i and p_j are connected by an edge if the disk with diameter ending at p_i and p_j does not contain any node.

Greedy Routing in Gabriel-Net

- How to send packet from the source(S) node to destination(D) node?
- Greedy Rule:** Forward packet to the node closest to the destination node
- Thick-Segment Route ( ) Path Traced by Greedy- Rule

Occasional Trouble with Greedy Routing!

While sending packet from red node (S) to blue node (D), it get trapped in the green node (T)

How to Fix Trapping Problem?

- Follow the Face of the Network to exit from the Trap (shown by directed line-segments)

Identifying Redundant Nodes

Two nodes close to each other are called **equivalent** if their transmission range cover the same sub-set of nodes.

Redundant Nodes in Clusters

First Filtering Rule: Just keep representative node from redundant clusters (black-nodes)

Refined Network after Removing Redundant Members (un-connected!)

First Result (Our Finding): Connectivity between S and D is not compromised by removing redundant nodes .

Characterizing Floating Chains (enclosed by thick ellipse)

Second Result: Solo-Faced Floating Chains can be Filtered without compromising connectivity between S and D

Network after Removing Floating-Chains

Characterizing 2-connected components

External 2-connected components can be removed without compromising Network Connectivity between S and D

Applying All Three Filtering Rules

Network after filtering External 2-Connected Components. Filtered nodes are shown as tiny background dots.

Java Implementation

- Greedy Routing:** Successful most of the time.
- Hybrid Greedy-Face Routing:** Guaranteed to be successful if there is a path from source to target
- Node Filtering:** Used for extending battery life.

Future Work and Extensions

- We are picking a redundant member from equivalent nodes arbitrarily
- Develop Rules for picking appropriate node from equivalent cluster
- Extensive simulated experimental investigation on randomly deployed sensor nodes
- Apply Proposed Filtering Method on Real-World Sensor Network