Energy Efficient Routing in Wireless Sensor Networks

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Outline

1. Introduction
2. Motivation and Problem Specification
3. Objective Function and Constraints
4. Methodology
5. Simulation
6. Results and Discussions
7. References

System Definition

- No wired infrastructure
- Random or regular deployment
- Flexible topology
- Large number of nodes
- Small radio range

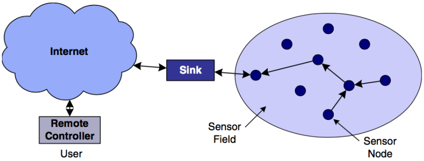


Figure: System architecture [Anastasi et al., 2009]

Design Parameters

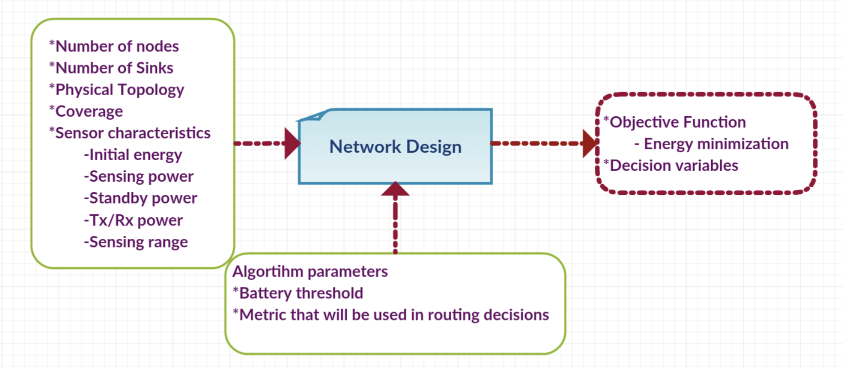


Figure: Network Design Parameters

Objective Function and Constraints

Main Objective:

Maximizing network lifetime by minimizing energy

Power Consumption Model Total power consumption of node i

$$P_{ij} = E_{standby} + E_{sensing} + E_{transmitting}.f_{ij} + E_{receiving}.f_{ji} \tag{1}$$

where f_{ij} is the flow from node i to node j [Hua and Yum, 2008].

Problem Statement

$$Minimize \sum_{i,j \in N} EdgeW_{ij}.f_{ij} \tag{2}$$

Under the following constraints:

$$G_i = \sum_{i,j \in N} f_{ij} - \sum_{i,j \in N} f_{ji}, where \forall i \in N \tag{3}$$

$$0 \leq f_{ij} \leq c_{ij} \tag{4}$$

$$f_{ij} \in Z^+ \tag{5}$$

$$\sum_{i \in S, j \in N} f_{ij} = 0 \tag{6}$$

$$\sum_{i \in N} E_{tx}.f_{ij} + \sum_{i \in N} E_{rx}.f_{ji} \leq E_{init} \tag{7}$$

Assumptions about the network

- Each node generates equal amount of data per time.
- Energy spent in transmitting a bit over a distance d is proportional to d^2.
- We do not consider the sleep states of nodes. It is outside the scope.
- Delay and packet loss will not be considered in the evaluation phase because of the same reason.
- We assumed that number of sink is placed at the center of the field.

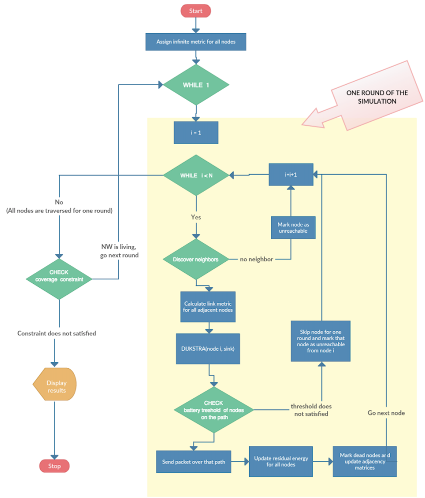
Description of the solving technique

Metric for the edge between i and j

$$\frac{F_{residual}}{d^n a} \tag{8}$$

where
$F_{residual}$ is the sum of residual energies of node i and node j,
d is the distance between node i and node j,
n is the radio transmission exponent,
a is the number of neighbor nodes.

Flowchart of the Algorithm



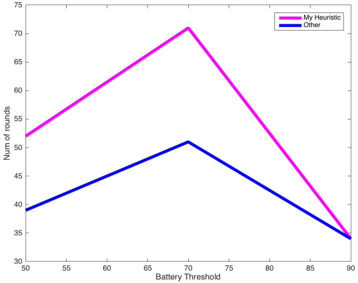
About simulation

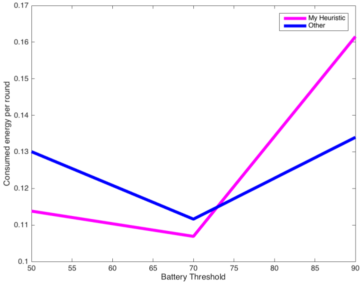
- MATLAB R2015b as a simulation environment
- Mac OSX 2,9 GHz Intel Core i5, 16 GB 1867 MHz DDR3

Table: Simulation parameters

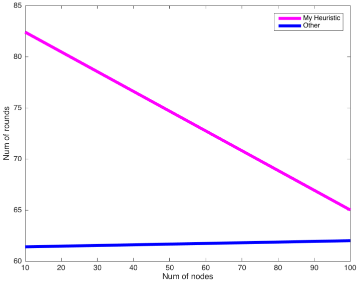
Einit	0.5 joule
Etx	100 njoule/bit
Erx	50 njoule/bit
Packet size	200 bits

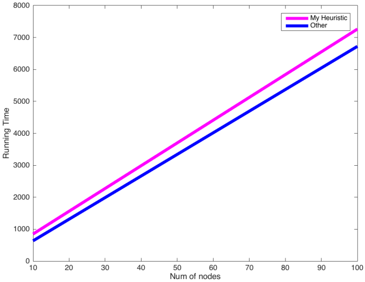
Effect of Battery Threshold: 50-70-90





Effect of num of nodes





Effect of coverage threshold

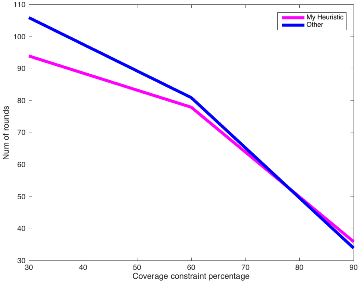


Figure: Coverage threshold:30-60-90

Effect of different size of fields

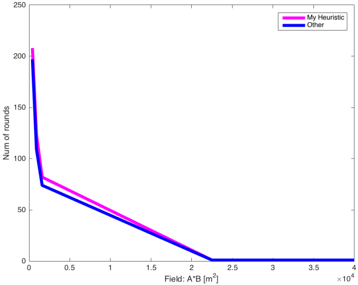


Figure: Different sizes:20*20, 30*30, 40*40, 150*150, 200*200

Effect of sensing range

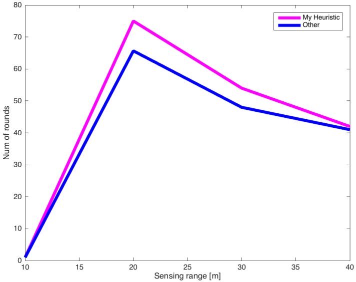


Figure: Range:10-20-30-40

References I

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Real time DEMO !

Thank you for Listening !