Modeling of Humanoid and Multi-agent System

EE 382C.9 Embedded Software Systems Spring 2004
Final Presentation by
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May 5th, 2004
Objective
- develop a network deployment algorithm for sensor network Humanoid Multi-agent System (HMAS)
- Mobile ad hoc network (MANET)
- Sensor network (SN)

Problem
- expensive to achieve energy efficiency (NP-complete) [Li 2004]

Museum problem [LaMarca et al 2002]
- surveillance SN to cover the entire museum
Contributions

- Proposed a genetic algorithm (GA) for network deployment considering power matrices
  - artificial intelligence mapping
  - power

- Simulated and gathered statistical data of the GA algorithm

- What is GA?
  - a mimic of Darwin’s Evolution Theory
Network Hierarchy
Algorithm

- Randomization
  - direction vectors (1 for each node)
- Collect sensor vector after duration $t$
  - receiver power matrices (rpm)
  - coverage information (cov)
- Generate a fitness value
  - current rpm
  - previous cov
- Recombine direction vectors
- Mutate the direction vector
- Termination
Network Hierarchy

- **Cluster 1**
  - Node 1
  - Node 2
  - Base station

- **Cluster 2**
  - Node 3
  - Node 4
  - Node 5
Network Transform

Cluster 1

Node 1

Node 2

Node 3

Node 4

Cluster 2

Node 5

Base station
Modification to the algorithm

- Global area coverage monitored by the global base station
  - sensor vector of boundary nodes of each cluster

- Local optima is avoided by altering the assignment of the base station in each cluster, and re-clustering the nodes
  - base station set
Simulation

Network Simulator Version 2

random movement trace

GA movement trace
Simulation Result

- **Specification**
  - **Hierarchy**
    - 2 domains, 3 clusters
    - 2 base stations, 11 mobile nodes
    - $t_m = 60s$
  - **Wireless**
    - 11Mbps, 20us delay
    - packet size: 512Kb
    - Mac Layer protocol: IEEE 802.11
    - constant bit rate source

- **Result**
  - **Packet Loss**
    - 0.05% without GA
    - 0.02% with GA
  - **Energy**
    - 0.1W model
    - N/A without GA
    - ~37.2 J with GA
Simulation Result

Energy Consumption vs Number of Mobile Nodes

Energy Consumption per Node (J)

Number of Mobile Nodes

mobility: 0.5J/m
wireless: 0.1W
Conclusion

- GA improved deployment performance in energy and time
- From ultra-wide band to GA network deployment
- Potentials
Algorithm II

Deployment (MANET)

i. random direction generation for the nodes: direction_vector and base_station_set

ii. recombine direction_vector of each node

iii. after $t_m$ each end node sends a sensor vector to its router

   sensor_vector = \{id, coverage[t], power[t][ ]\}

   power[ ]: receiver power vector of neighboring nodes
   t: current time stamp

iv. the router sorts the sensor_vector by a fitness function

   fitness(coverage[t], power[t][ ], coverage[t-t_m], power[t-t_m][ ])

   that returns

   power[t+t_m][] and coverage[t+t_m]

   to decide the next direction of movement, so that:

   a. $power_i < power[t+t_m][r] < power[t][r] < power[t-t_m][r]$ where $r = id(router)$

   b. $power[t+t_m][i] < power[t][i] < power[t-t_m][i]$ for all $i \neq r$

   c. coverage[t+t_m] < coverage[t] < coverage[t-t_m]

   $power_r$: lowest receiver power defined by network

   power[t+t_m][i] and coverage[t+t_m]: expected next receiver power and next coverage

v. if $t_m = 0$, return

   if (power[t+t_m] == power, and power[t+t_m][i] ~ 0 for all $i$)
   
   mutate direction_vector and base_station_set and decrease $t_m$ by $t_{\text{delta}}$

   else repeat ii.