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Research Article

Mobile Sensor Swapping for Network Lifetime Improvement

Soniya R. Deshmane†* and Poonam Lambhate‡

†Department of Computer Engineering, Sacitribai Phule Pune University, Pune, Maharashtra, India
‡Department of Information Technology, Sacitribai Phule Pune University, Pune, Maharashtra, India

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Abstract

Extending network lifetime is a big challenge to WSN. Energy saving is very important to improve the network lifetime. Sensor nodes closer to the sink always consume more energy than nodes away from the sink. In this paper, we consider adaptive energy threshold algorithm and energy level algorithm for Mobile Sensor Swapping. In this approach we swap the positions of sensors which consume more energy with the sensors having low energy consumption. So we can use this approach to extend network lifetime as well as to balance the energy consumption among the sensors.

Keywords: *Wireless sensor network, Mobile sensor node, Network lifetime, Duty cycling.*

1. Introduction

Wireless Sensor Networks (WSNs) are used in a variety of applications such as forest monitoring, biological, military, environmental monitoring, vehicle monitoring, healthcare, industrial applications (Akyildiz, *et al*, 2002).. The main component of WSN is battery operated tiny sensors having low-cost and low energy. We know network lifetime is the time until group of sensor nodes in the network runs out of energy or the first sensor node dies. According to applications sensors are deployed manually or randomly, so manual maintenance and replacement of sensors is difficult task. We know sensors are energy constrained devices. We should managed them carefully, to extend the lifetime of the network. Number of WSN applications have some requirements. These requirements are:

- We should cconsider the monitoring coverage area before the placement of sensors.
- Bottleneck problem.
- Requirement of few sensors having extra capabilities and the ability to perform difficult motion planning.
- Sensor nodes closer to the sink Or Sensor nodes farthest from its parents Or Sensor node having lots of descendants always consume more energy(Moukaddem, *et al*, 2013)..

Mobile Sensor Swapping approach addresses all these key requirements. We exchange the position of sensor having more energy consumption with the sensor having less energy consumption.

*Corresponding author: **Soniya R. Deshmane**

2. Literature Survey

There are several approaches have been proposed for prolonging lifetime of a network (Vijaysinh, *et al*, 2014). In general, they can be classified as Controlled mobility, Duty cycling, Topology control and Data reduction.

1)Controlled Mobility (Robotic Mobility): Controlled or Robotic mobility is the ability of a network to move without human support(Mikhaov, *et al*). Several controlled mobility approaches are Data mules, Mobile relays and Mobile base stations.

a) Data Mule: In this approach one or many moveable sensor nodes, called mules visit all the sources in the network to gather the data and then physically transmit this data to the sink.

b) Mobile Relay: In this approach the mobile relays in the network relocate to different positions to reduce the communication distances between sensors.

c) Mobile Base Station (Mobile Sink): In this approach, a powerful moveable sink travels around the WSN and through one or multiple hops transmission, it gathers data from the sensors.

2) Duty Cycling

This approach schedule the node activity between sleep and active state (Yang, *et al*).

3) Topology Control

WSN uses various types of topologies like tree, mesh, chain etc. Topology control is a technique used in a distributed computing to change the original network (modeled as a graph) (Nagpure, *et al*, 2014). To preserve the preferred properties such as connectivity, coverage, compactness of the network we must perform topology control on periodic basis. It balances burden on sensors and increases network scalability and network lifespan. Clustering is an effective topology control approach. Cluster based approaches make role rotation i.e exchanging the position of the cluster head and the cluster member.

4) Data Reduction

In this approach sensors decrease the quantity of generated data.In this way we reduce the energy consumption of a radio element.

3. Mobile Sensor Swapping

A. Background

Mobile sensors swapping concept was originated from huddling and rotation nature of emperor penguins(Zitterbart, *et al*, 2011). To preserve the energy and for the significant wind protection they swap their positions from outside huddle to inside huddle for some time and vice-versa. In mobile sensors swapping, we propose to swap the physical positions of mobile sensors to share the load of any high energy consumption position. We perform swapping throughout scheduled node sleep times, because in numerous WSN applications, maximum time sensor nodes are in a sleep state throughout their lifetime.

B. Introduction

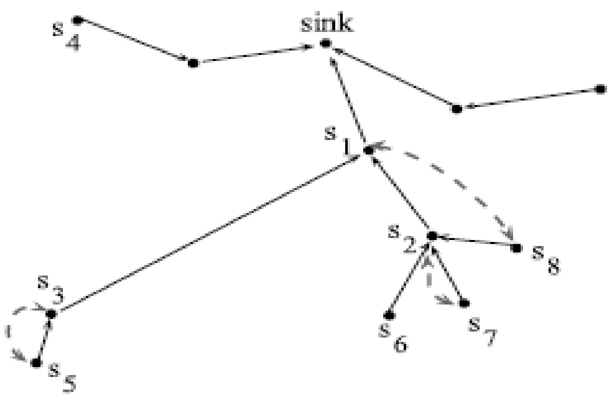

Fig.1 Mobile Sensor Rotation

Fig. 1, shows the directed routing tree consists of single stationary sink and number of moveable sensors namely s1 to s8. Here sensors s1, s2 and s3 require more energy than other sensors. We swap positions of and s5 consume less energy as compaired to s1, s2 and s3. So by swapping their positions, we share the amount of energy required at a high consumption location among the two sensors.In this way we increase network lifetime.

Mobile sensor swapping, uses several low-cost moveable sensors which swap their positions and roles. All the movements of the sensors are to known positions only and the topology does not change. Topology changes only throughout the transient periods of sensor swapping(Moukaddem, *et al*, 2013)..

4. Problem Definition

Network, Energy, and Duty Cycle Models

We consider WSNs having many moveable sensor nodes and a single stationary sink node. Sink is active all the time and has more energy back up. Sensors collect data from their environments and transfer it to the sink through single or multihops forming a directed routing tree. We use adaptive energy threshold algorithm for calculating required threshold. If sensor nodes energy drop level reaches upto the threshold value, we swap that node with other having more energy.

A. Formal Definition

Sensor nodes may swap their positons once(single time) or multiple times, according to number of swaps, we categorize swapping into single round swapinng and multiple round swapping.

B. Mathematical Model

Let W be a system such that W={I,O,Pr}

Where

Input Instance, I={S,U,P,E, V}
S = (s1,...,sn), a list of sensor nodes
U= network sink, and pu, its location
P = (p1,...,pn), a list of positions such that node si starts at location pi
E = (e1,...,en), a list of initial energies of nodes in S
V = (λ1,...,λn), amount of data gathered at each location per time interval
Output Instance, O={r1,r2}
r1 = original position of node
r2 =new position of node
Pr=Swapping of nodes using swap level algorithm.

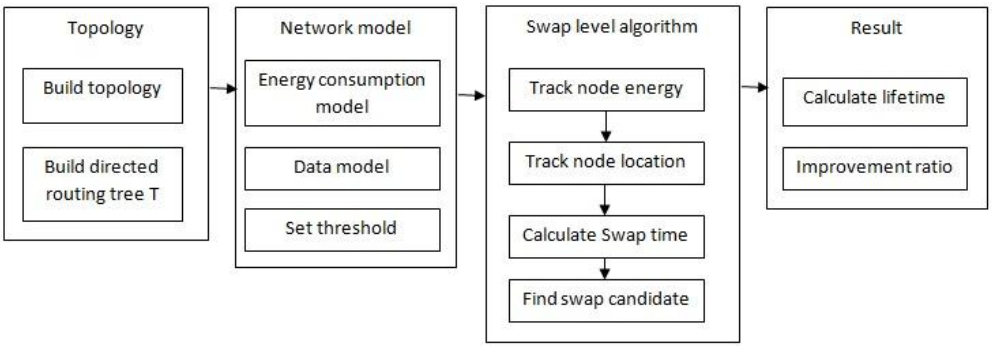

Fig.2 System Architecture

Table 1 Modules with attributes an functions

Sr. No.	Modules	Attributes	Functions
1	Topology Creation	Number of nodes	Create Topology
		Energy	Create Energy Module
		Protocol	Run Topology
2	Build Directed Tree	Nodes	Find Neighbours
		Location	Create graph and Directed tree
3	Energy Consumption Model	Node Energy	Calculate remaining Energy
4	Data Model	Node	Calculate packet sent and receive
		Packet sent	
		Packet receive	
5	Adaptive Energy Threshold	Number of packets to be send	Calculate require energy
6	Calculate swap time	No. of packets Sent and received	Calculate swap time
		Energy	
		Location	
7	Swap candidate	candidate	Swap candidate
		Swap time	

5. Implementation Strategy

A. System Architecture

Fig. 2, shows Block diagram of Sensor Rotation. Architecture is divided into mainly four blocks.

Table 1 shows attributes and functions of each module.

1)Topology

Here we build topology of network and according to that we can build directed routing tree.

2) Network model

It contains

i)Energy consumption model
ii)Data model
iii) Set threshold
Use adaptive energy threshold algorithm for setting the threshold value.

Adaptive energy threshold algorithm

We first track how many data should be transferred? Then according to that data we calculate energy and set that as required threshold. For this we use Adaptive energy threshold algorithm as follows:

a) Get source node data in bytes (B)

b) Calculate number of packets (P) required for sending B
c) Get energy (E) required for single packets
d) Total energy = P * E
e) Set this total energy as threshold energy(ρ).
f) Forward energy information to nodes which are in a path
g) They accept new request if there is enough energy to satisfy that request.

Because of these algorithm we can minimize delay and increase throughput.

3) Swap level algorithm

This algorithm requires information about location and energy of each sensor node. Here we calculate swap time and find swap candidate for performing swapping.

Before performing sensor swapping we should make following decisions:

1)Wheather to move sensor node or not to move
2)For which locations perform swaps
3)How long to stay at each position.

To take all these decisions we use Distributed swap level algorithm.

Distributed Energy Level Algorithm (Swap-Level-d)
1.Require local information and less computation.
2.Does not require any co-ordination between the sensor nodes.

Step 1.The controller starts by gathering energy and location information from all the sensor nodes.
Step 2. Each node calculates its own energy drop level.
Step 3.Check every node energy drop level with threshold value called as ρ.(calculated from AETA)
For Si node, energy drop level is ei.

```
 if(ei== p)
          do
           {
               find candidate C that can perform acceptable swaps with Si
                 swap(Si,C)

              computes it's swap time t.
               Set ei=ei(1- p)
           }while(ei<=elow)
else
Si remains at its current position.
```

4) Result and analysis

Finally we calculate network lifetime and improvement ratio.

5. Simulation

A. Simulation Tool

We use here NS3 simulator. NS3 is a discrete-event open source network simulator(Bandyopadhyay, *et al*, 2011). NS3 is written in C++, with optional python bindings. NetAnim is used as a visualization tool in ns-3. It is separate program that uses XML trace files to show the simulation graphically. It is based on Qt4 GUI toolkit. Ns-3 uses ".pcap" and ".tr" trace files as the main trace files (Mohta, *et al*, 2009).

6. Simulation Result

A. Sensor Deployment

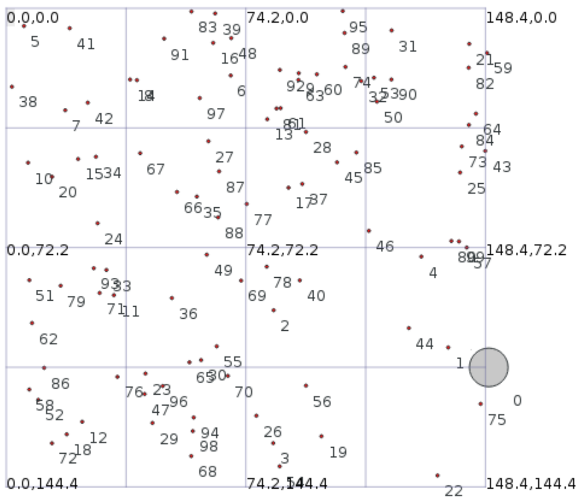

Fig.3 *Sensor Deployment*

Fig. 3, shows network with AODV protocol is simulating on the GUI based network simulator named NetAnim. It shows deployment of 100 sensor nodes. Network consists of 100 sensor nodes placed uniformly at random in a 150m by 150m area. Out of these 100 nodes we randomly choose one node as a sink node with different colour. We set the maximum communication distance (distance from one node to other) is 35m.

B. Network Topology

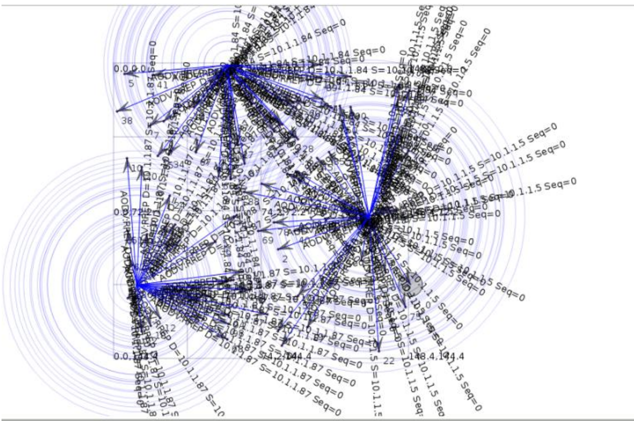

Fig.4 Network Topology

Fig. 4. shows network topology and directed routing tree.

We use netanim 3.105 to display topology. It shows information about packet transmission, Name of protocol, sequence number, Source and Destination.

C. Swapping of nodes

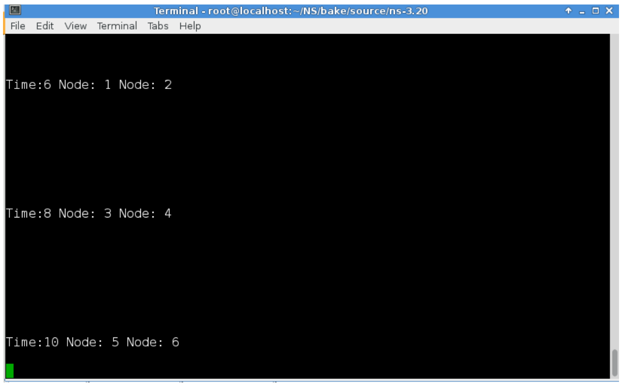

Fig.5 Swapping of nodes

Fig. 5, shows swapping of nodes and swap time, Node 1 swap with node 2, node 3 swap with node 4, node 5 swap with node 6.

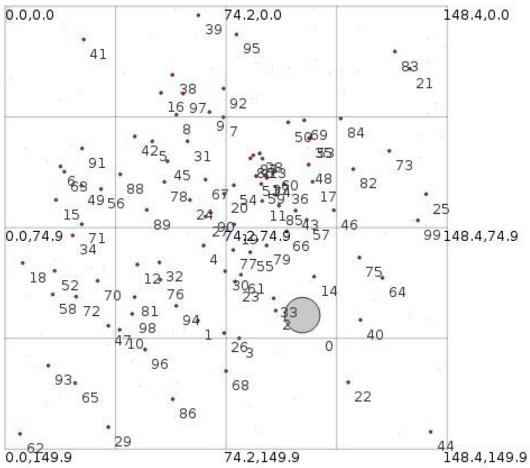

Fig.6(a) Before Swappimg

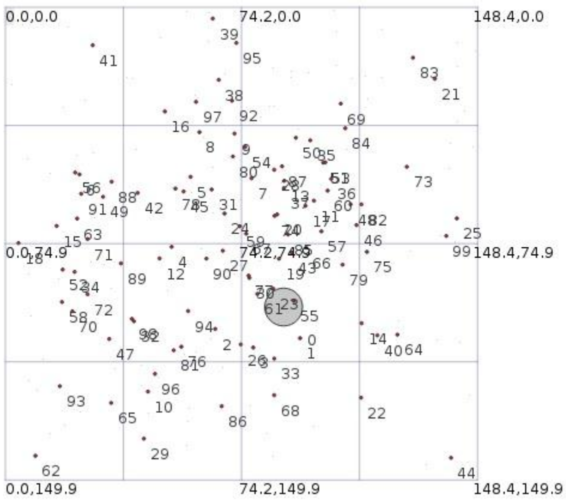

Fig.6 (b) After Swapping

Fig 6(a) shows positions of node 1 and node 2 before swapping. Fia 6(b) shows positions of node 1 and node 2 after swapping.

Conclusion

1) To save the energy of the sensors is main goal in the designing of wireless sensor networks. In this paper, we present a sensor swapping approach for extending the lifetime of mobile WSNs.
2) Sensors having high energy consumption swap their position with sensors having low energy consumption. In this way we balance the differential power consumption without modifying the existing topology.
3) Here we uses Adaptive energy threshold algorithm for calculating the threshold value. Because of this we increase network lifetime.

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References

I. F. Akyildiz, W. Su, Y. Sankarasubramaniam and E. Cayirci[2002], Wireless sensor net- works:a survey, Elsevier, Computer Networks 38, 393-422.
D. Zitterbart, B. Wienecke, J. Butler, and B. Fabry[2011], Coordinated movements prevent jamming in an emperor penguin huddle,PLoS one, Vol. 6, Issue 6, e20260.
F. El-Moukaddem, E. Torng, G. Xing[2013], Maximizing Network Topology Lifetime using Mobile Node Rotation, IEEE Transactions on Parallel and Distributed Systems.
K. Mikhaov and J. Teryonen, Energy Consumption of Mobile Wireless Sensor Network's Node with Controlled mobility.
X. Yang and N. H. Vaidya, A Wakeup Scheme for Sensor Networks: Achieving Balance between Energy Saving and End-to-end Delay.
A. V. Nagpure , S. Patil[2014], Topology Control in Wireless SensorNetwork: An Overview, International Journal of Computer Applications (0975 8887) Volume 92 No.7.
Patil Savita Vijaysinh and Dr.R.K.Prasad[2014], Survey on Network Lifetime Maximization Techniques in Wireless Sensor Network, International Journal of Emerging Trends in Electrical and Electronics (IJETEE ISSN: 2320-9569) Vol. 10.
A. Bandyopadhyay, S. Vuppala and P. Choudhury[2011], A simulation analysis of flooding attack in MANET using NS3, IEEE.
A. Mohta, S. I. Ajankar and M. M. Chandane[2009], Network Simulator-3: A Review.