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An Energy-Aware Routing for Maximum Lifetime in Wireless Sensor Networks

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Abstract: The maximum lifetime routing problem in wireless sensor networks has received increasing attention in recent years. One way is to formulate it as a linear programming problem by maximizing the time at which the first node runs out of energy subject to the flow conservation constraints. The solutions in this problem correspond to the rates allocated to each link. In this paper, propose the use of a regularization method which can jointly maximize the network lifetime and minimize another objective (e.g., packet delay). Most of the sensor nodes are battery powered. The limited amount of energy in each node is one of the bottlenecks. One simple approach is to minimize the power consumed to deliver a packet to the destination. The typical solution is to use the shortest path with link costs equal to the energy required in each link to transmit a packet. Another approach is to maximize the lifetime of the network. There are various ways to define the lifetime of a WSN. It can be defined as the time at which the first node runs out of its energy.

***Index Terms* - WSNS, Distributed Data, Energy Efficiency,Routing model,Hotspot problem in wireless sensor networks.**

I. INTRODUCTION

A wireless sensor network (WSNs) is a network consisting of spatially autonomous devices using sensors to cooperatively monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants, at different locations. A sensor transforms the collected data into electric signals and sends it usually via a radio transmitter to a sink node. The sink node acts as a gateway between the WSN and external networks.

WSNs are expected to have significant impacts on many military and civil applications, such as combat field surveillance, security and disaster management. Each sensor node is powered by a limited energy source (e.g., a battery). As sensor nodes can be deployed in large numbers at remote locations, it is typically not feasible to recharge their batteries.

This proposed approach introduced the max-min lifetime routing algorithms. The problem of max-min lifetime routing protocols is that they do not save energy in the whole network. In a large scale sensor network, saving energy in the whole network is more important than that at individual nodes. Other notable approaches include maximizing data collection or maximizing residual energy.

Transmitting every node sensed value to some destination that is external to the WSN for storage and off-line analysis may be prohibitively expensive and sometimes not possible, given the typical data collection rates and network sizes. In this approach, apart from network longevity, scalability is an issue as it will result in increased bandwidth requirements, raising the risks of packet loss due to collisions [BGS00, Sri]. In addition, the nodes that lie closer to the sink consume energy much faster, as they have to relay more packets towards

1.1 WSNS As A Distributed Computing Environment

In the in-network approach, energy efficiency arises from cooperation and a reduction in the need to transmit large amounts of data.

One common strategy to achieve this is to perform data reduction (e.g., by computing aggregates) and filtering as early as possible in a data path. For the sake of increased network longevity, it is therefore crucial that tasks such as routing, sensing, localization, communication and others, are carried out using energy-efficient algorithms. It follows from the considerations above that a WSN may be viewed as a distributed computing platform, with each node being viewed as computational resource and not just a data collection and data transmission resource. Albeit limited, node resources such as processing power and memory can be used to execute application logic. WSN applications can therefore be considered to be fully-fledged distributed systems, since sensor nodes cooperate not only in the execution of application but in transmitting the results to the destination and in performing functions such as adapting to changing network topology, and ensuring the longevity of the network.

Moreover, each sensor node acts as a separate data source providing data by means of its sensing capabilities or pulling it out of its flash memory. Note, however, that sensor nodes constitute a distributed environment and hence, there is no central clock to regulate the activities of the network. Time synchronization is, therefore, a critical requirement for in-network processing, as is accurate time stamping of sensor events and, possibly of processing and communication events as well. This is a well studied problem, and it is beyond the scope of the dissertation to address such issues. Components that provide such functionality are assumed to exist in support of the distributed algorithms described later on. More specifically, WSNs have been the focus of research in which the network is viewed as a database against which queries can be executed [1].

This approach, with its reliance on declarative specifications of the data to be retrieved, can be seen as response to the software engineering challenges alluded to above and to the fact that too many existing deployments have tended to be application-specific. Gehrke et al. and Madden et al. propose that WSNs can be programmed with considerably less effort by the use of the database paradigm. This has given rise to Sensor Network Query Processors (SNQPs) implementing in-network declarative query processing over WSNs, examples of which include, Cougar, and SNEE. Declarative queries allow users to specify what data they want from a WSNs without needing to know such details as how to contact the relevant sensing devices on sensor nodes, how to deploy application logic, how to manage its execution and how to transmit results back to the user. However, current WSNs query processors are not capable of performing spatial analysis. At present, in-network spatial analysis in WSN is not catered for by a comprehensive, expressive, well-founded framework.

1.1.1Core Challenges for Performing Distributed Spatial Analysis Over WSNs

There are major differences between carrying spatial analysis over WSN and classical spatial database systems. The design of distributed spatial analysis algorithms that run correctly and efficiently over WSNs poses several challenges, some of which are summarized in the remainder of this sub-section.

1.1.2 Support For Induced Geometries

WSN applications are usually deployed for real world monitoring, in contexts where scientists are interested in the shape and size of an event as it occurs in the sensing scope of the nodes. The accurate characterization of the geometry of transient, physical phenomena as they take place in the sensing scope of a deployed WSN is referred to in this dissertation as induced geometries. Therefore, in the case of WSNs, spatial analysis needs to be carried on three types of geometries, viz., asserted, induced, and derived geometries. Note, furthermore, that derived geometries may be computed based on any combination of existing induced, asserted or derived geometries.

1.1.3 Supporting Continuous Queries

Classical spatial DBMSs mostly operate on non-streamed data and only support one-off queries. In contrast, WSNs must support continuous queries, which are posted once and evaluated many times, result tuples being generated continuously for possibly long periods of time [SN05]. WSNs are, by definition, connected to the physical world and sensed data streams represent properties of dynamic, evolving real world events (as opposed to stored data in the case of classical DBMSs).

Traditional spatial DBMSs only support queries that are posted once and produce a complete result set in one single return event. Continuous monitoring of an induced geometry makes it possible to track the spatial evolution of the underlying spatial phenomenon. An event of interest can be characterized by an event-defining predicate (e.g., humidity>98 and temperature<10). If so, then the notion of an event geometry is definable in terms of the location in space of those sensor nodes that satisfy the event predicate. More specifically, changes in the measurements of physical quantities obtained by a group of sensor nodes can be used to characterize the life cycle of an event of interest by the way its geometry changes. This is so because, over time, the measurements obtained by each sensor node will vary depending on the distance at which that node lies from the physical

1.1.4 Distributed Data

In the case of the classical approach, the assumption is that a computer is used to store the geometries. WSNs are distributed platform, therefore, each node is only aware of that part of induced geometries lying in their sensing range. Because of this kind of resource constraint, complete information regarding induced, asserted and derived geometries is distributed throughout the WSN. No node can assume to have complete information about the geometries it is part of. The ensuing challenges are highly nontrivial, particularly so in the case of induced geometries. In such scenarios, a task related to the detection of an induced geometry is re-evaluated with some periodicity and each node independently updates the local information that defines the induced geometries it is a member of.

Thus, unless it cooperates with other nodes, each node is, in principle, only aware of its own membership status. The inherent scarcity of resources and the nature of underlying platform, where execution is distributed and carried out periodically over sensed data streams, give rise to non-trivial challenges. Furthermore, the resolution or scale of the spatial data may vary, geometries may have different spatial dimensions, and spatial types (e.g., points, lines, or regions). These several forms of diversity give rise to challenges on how to integrate and to keep them consistent in order to provide correct answers for spatial analysis tasks.

1.1.5 Energy Efficiency

In the case of WSNs, for reasons of energy efficiency and network longevity, the algorithms should run in a distributed manner inside the network. This requirement for in-network processing arises because the cost of communication dominates energy consumption and nodes are energy-bound. The need to reduce communication often precludes sending all sensed values back from the nodes to the base station as well as any scheme that often requires the exchange of messages in a non-localized manner, i.e., beyond the one-hop neighborhood of a node. Concrete algorithms implementing spatial operations as well as algorithms for task dissemination, routing, aggregation, etc., must be localized.

1.1.6Contributions and Organization

Our primary contributions of this research are as follows. I have propose MAC-aware routing scheme in WSNs with multiple sinks to maximize the network lifetime. One of the three sufficient conditions proposed in, (referred to as rate-based) is used as a base for ensuring feasibility of the obtained routing solutions in regard to the medium access contention constraints. Since rate-based condition is linear, we formulate our routing problem using linear programming, where the objective function is to maximize the network lifetime for a provided data rate[2][3].

2. EXISTING SYSTEM

Power consumption is one of the major drawbacks in the existing system. When a node traverse from one network to another network located within topology, the average end delay time is increased because of more number of coordinator nodes present in the topology. By traversing more number of coordinator from the centralized node, battery life is decreased. So network connectivity doesn't maintain while the sensor node traversing. The sensors collect all the information for which it has been for. The information collected by the sensors will be sent to the nearest sensor[4]

A. Existing works focused on minimizing the total energy consumption of the network.

B. Nodes in the network being drained out of energy very quickly.

C. Energy consumption is high

D. It is not robust.

E. The sensors have a limited power so they are not capable to transform the information to all the other sensors.

F.Because of this power consumption network life time is low.

3. PROPOSED SYSTEM

In the proposed system the base station can dynamically move from one location to the other for reducing the power consumption. The problems faced in the existing systems are overcome through the proposed system. Each mobile estimate its life-time based on the traffic volume and battery state. The extension field in route-request RREQ and route reply RREP packets are utilized to carry the life-time (LT) information. LT field is also included into the routing tables. When a RREQ packet is send, LT is set to maximum value (all ones). When an intermediate node receives the RREQ, it compares the LT field of the packet to its own LT. Smallest of the two is set to forwarded RREQ packet. When a node having a path to the destination hears the RREQ packet, it will compare the LT field of the RREQ with the LT field in its routing table and put the smaller of the two into RREP. In case destination hears the RREQ, it will simply send RREP with the lifetime field equal to the LT in the RREQ. All intermediate nodes that hear RREP store the path along with the life time information. In case the source receives several RREPs, it selects the path having the largest LT.

- Unattended operation
- Robustness under dynamic operating conditions
- Scalability to thousands of sensors
- Energy consumption is low
- Efficiency is high

4. SYSTEM MODELS AND PROBLEM FORMULATION

In this section, first introduce the routing model, the data correlation and aggregation model and the power consumption model. Based on these models, we define the network lifetime and formulate the optimization problem.

4.1 Routing model

Consider a wireless sensor network with a set of sensor nodes N that generate data constantly, and a single sink node s that is responsible for collecting data from sensor nodes. Each node has multiple routing paths to the sink node. The routing algorithm suitable for use belongs to the class of geometric routing algorithms. Every sensor node is assumed to know its own position as well as that of its neighbors, which can be obtained with some positioning schemes. Each node can forward packets to its neighbor nodes within its transmission range that are closer to the sink node than itself. Since nodes can make routing decisions based on the position information of its neighbors and the sink node, this routing algorithm is localized and particularly suitable for large-scale sensor networks. Let Ni denote the set of neighbors of node i and Ni = {jjdij 6 R, j 2 N}, where dij is the Euclidean distance of node i and j, and R is the radius of the transmission range. According to the geometric routing, only those neighbors that are closer to the sink node s can serve as the downstream nodes.

Let us denote this set of downstream neighbors as Si = {kjdks< dis, k 2 Ni}. Similarly, the set of upstream neighbors is denoted as Ai = {kjdks P dis, k 2 Ni}. Note that in case a node has no neighbors that are closer to the sink node than itself, we encounter a problem known as ‘‘local maximum’’ where the node fails to find routing path to the sink node according to geometric routing. A few solutions have been proposed for this problem. However, the consideration of these solutions is beyond the scope of this paper. In the following, we assume that the downstream neighbor set Si is non-empty for all i 2 N.

4.2Data correlation and aggregation model

In sensor networks, data collected by neighboring nodes is normally correlated due to the spatio-temporal characteristics of the physical medium being sensed, such as the temperature and humidity sensors in a similar geographic region, or magneto metric sensors tracking a moving vehicle. As a result, the data collected by sensor nodes often carries redundant information. Data aggregation (combining the data at the intermediate nodes) is an effective way to remove the redundant information and reduce the traffic.

To incorporate data aggregation into the geometric routing model, we adopt the foreign-coding model scheme. Specifically, we assume a node i is able to compress the data originating at its upstream neighbor j using its local data. The compression ratio depends on the data correlation between node i and j, which is denoted by the correlation coefficient qji = 1 H(XjjXi)/H(Xj), where H(Xj) is the entropy coded data rate of the information Xj at node j, and H(XjjXi) is the conditional entropy coded data rate of the same information Xj at node i given the side information Xi.

The basic function of a routing algorithm is to select the path from a set of available paths that is most efficient based on a specific criteria. Intuitively, to maximize the WSN’s network lifetime, the path that achieves minimum power consumption while ensuring fair power consumption among individual nodes should be used. Much effort has been focused on WSN multi-hop routing algorithms, and many algorithms have been proposed. These may be widely categorized as flat multi-hop routing algorithms and hierarchical multi-hop routing algorithms [9].

4.3 Hierarchical multi-hop routing

Flat multi-hop routing algorithms are excellent in terms of their capability of using power-aware metrics to choose minimum power consuming paths. However they fail to take advantage of the highly correlated nature of the data collected from the WSN. The relatively high node density of the WSN and the application scope of the WSN (e.g., temperature readings collected from geographically close locations have a high probability of becoming similar), make data aggregation a very attractive technique in WSN. Hierarchal multi-hop routing algorithms successfully utilize the data aggregation to decrease the volume of data flowing in the network. In hierarchical multi-hop routing algorithms, sensor nodes assume different roles, which can be changed with time.

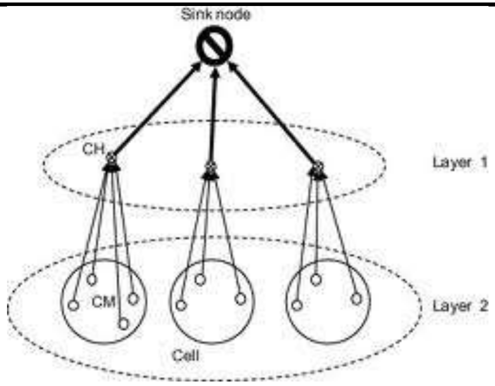

Figure 4.3Ex. HieraticalMultihop Routing

IN Figure 4.3 is a two-layered hierarchical multi-hop routing algorithm. Each node can play the role of a Cluster Head (CH) or Cluster Member (CM). In addition, each node's role can be renewed in a time interval, referred to as a round. At the beginning of each round, each node can declare itself as a CH with a certain probability; otherwise the node behaves as a CM. The network is divided into a number of clusters, referred to as cells, this division corresponds to Voronoi partitioning with each individual CH located in the center of its cell, as illustrated in Fig. 3(a). CM(s) choose the CH that are closest to it, i.e., lies within its cell, and each CH and CM(s) form a cluster, CMs transmit the data they collected to the CH that controls the cell to which they belong to, then each CH compresses the data received from the CM(s), and sends it to the sink node.

4.4 Hotspot problem in wireless sensor networks

We define the hotspot problem as the isolation of the sink node from the rest of the network as a result of the power exhaustion of nodes in the hotspot area. In this paper, the area in the interior of the maximum transmission distance of the sink node is defined as the hotspot area. Owing to the many-to-one(convergecast) traffic patterns in sink-based WSN, since the sensor nodes which are close to the sink node transmit a larger amount of data than the nodes further away from the sink, they exhaust their energy in a much more rapid manner, and die promptly. When all of nodes located in the hotspot area die, it is impossible to gather data from a large number of alive nodes, due to the lack of available routes between the sink node and the nodes outside of the hotspot area, despite the abundance of residual energy in the network, in fact argues that by the time that sensor nodes one-hop away from the sink node exhaust their energy, sensors farther away can have up to 93% of their initial energy [10].

In other words, to evaluate the network lifetime in a more meaningful manner, it is essential to take into account the influence of the hotspot problem. While most of previous works have just only investigated the time change of the surviving rate of nodes in the network or the time the first node dies. Therefore, we propose an algorithm designed with the consideration of the impact of the hotspot problem in order to achieve an extension of the functional network lifetime.

4.5Hybrid multi-hop routing algorithm

In general, since the number of sensor nodes in the hotspot area is much smaller than the nodes that are outside the hotspot area, consequently, the amount of data generated by the nodes in the hotspot area is negligible as compared to the volume of data flowing into the hotspot area from outside the hotspot area, implying that most of the power consumption in the hotspot area is due to relaying the data that came from outside the hotspot area. That is to say, that in order to decrease the power consumption in the hotspot area, the amount of data flowing into the hotspot area needs to be reduced, and/or the power consumption to relay a unit of data from outside the hotspot to the sink node needs to be minimized.

In fact, our proposed scheme aims to achieve the effect of both solutions by adopting the hybrid multi-hop routing algorithm, which employs a hierarchical multi-hop routing algorithm outside the hotspot area to decrease the inflow of data flowing to the hotspot, and uses a flat multi-hop routing algorithm inside the hotspot area to decrease the transmission distance of nodes in hotspot area.

4.6 Energy Efficient Maximum Lifetime Routing Algorithm

The proposed routing algorithm uses shortest energy cost path that maintained the energy balance for entire network. For energy efficiency algorithm uses greedy heuristic path. For energy efficient greedy heuristic optimal path algorithm calculate the energy cost of each and every link in the network. This means it finds a subset of the links that forms an optimal path that includes every node, where total cost of all the links in that path is minimized.

The information of energy available in the nodes is used to compute greedy heuristic path, and to balance the energy consumption across all nodes. Node that has minimum battery power will drain out their battery power quickly and would be the first one to die. So node with less energy can be added later in greedy heuristic optimal path because energy cost for a transmission from this node will be the maximum.

When network is setup each node can broadcast their residual energy information. All the nodes in network know the residual energy of neighboring nodes. Initially we assume that base station is in greedy heuristic optimal path. Algorithm can calculate greedy heuristic path using the energy cost function defined in equation (1). The node of the network added to the optimal path at each point is that node adjacent to a node of the optimal path by the link of minimum energy cost. The link of the minimum cost becomes in a path are connecting the new node to the path. When all the nodes of the network have been added to the optimal path, a greedy heuristic route is constructed for a network. All the nodes of this greedy heuristic network can transmit their data on energy efficient path. After transmitting the 'θ' amount of data flow on that path new routing path is computed.

After every transmission, residual energy Ẽm of node m changes, so after 'θ' amount of transmission energy cost of each node is recalculated. With the updated energy costs the greedy heuristic path is recalculated and procedure is repeated until any node drain out its residual energy power.

4.7. Energy Cost Function

The objective is to find out best energy efficient algorithm that will lead to the maximization of system lifetime. The energy cost for a transmission from node m to node n is calculated by

$$\mathbf{EC(m, n) = (emn)\tilde{E}m -1 + (enm)\tilde{E}n-1 ;}$$

Where, EC(m, n) is the energy cost for transmitting a packet from node m to node n.

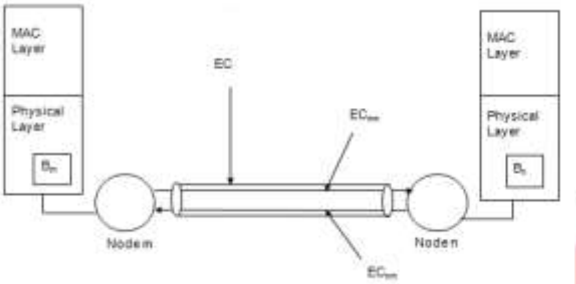

Figure 4.7.1Steps for creating energy efficient optimal path

The routing path is computed variant of prim's MST algorithm [13]. The idea behind the algorithm is that every new node added to the greedy heuristic optimal path has the minimum cost to reach the base station. The algorithm works as follows:

Step (1): Initially we assume that base station is in optimal path. Base station can add any node if energy cost for a transmission from base station to one of its neighbor node is minimum, and suppose this neighbor node is i then create a link between base station and node i. Then node i is also included in optimal path.

Step (2): The next link (i, j) to be added is such that i is a node already included in a optimal path, j is a node not yet included, and the energy cost of (i, j) is minimum among all links (p, q) such that node p is in the optimal path and node q is not in the optimal path.

Step (3): If any link (i, l) has minimum energy cost and energy cost of this link is also minimum among all links (p, q) where node p is in the optimal path and node q is not in optimal path then link (i, l) is added in path but after adding this link if create a cycle in optimal path then this link is not included in a path.

Step (4): Select another link (BS, k) where BS is a node already included in a optimal path, and k is a node not yet included and energy cost is greater than link (i, l) but minimum among all links (p, q) such that node p is in path and node q is not in path.

Step (5): Repeat this procedure until all nodes of the graph have been added to the optimal path, a greedy heuristic path is constructed for the network.

Step (6): After transmitting θ amount of data in greedy heuristic path, the new optimal path is computed. Because after transmitting the data, residual energy of all the nodes are decreases and energy cost increase.

Step (7): Suppose in network 1(b) all the nodes can transmits the data packets and let energy cost of all the links will increases by 0.5. So after θ amount of transmission minimum energy cost path will be recalculated. All the traffic flow should follow this new minimum energy cost path.

Step (8): Repeat these steps until the first node in the network dies.

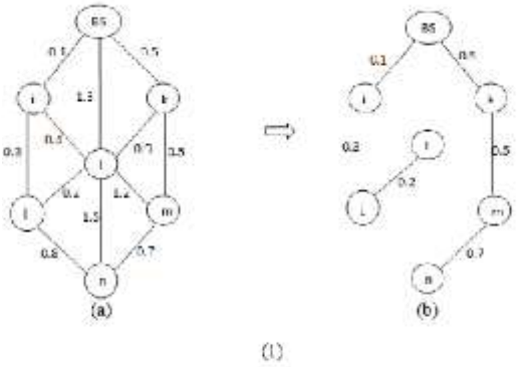

Figure 4.7.2. Minimum energy cost path

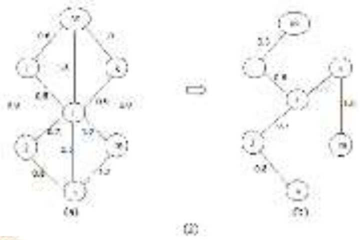

Figure 4.7.3 Minimum energy cost path after θ amount of transmission

5. CONCLUSION

The energy supplies of nodes in wireless sensor network are not replaced and therefore nodes only participate in the network for as long as they have energy, for that reason battery energy is the most important resource, so route the traffic through the minimum energy path to the destination is fatal for the network because all the nodes in that path will drain out their battery power rapidly. Therefore it's not a feasible solution and instead of this solution forwards the traffic such that energy consumption is balanced among the nodes. Most of the energy aware routing algorithm only concerned energy efficiency of the nodes but proposed EEMLR present the heuristic measure, called energy cost, to balance the energy consumption rates among the nodes in proportion to their energy reserved.

The performance of EEMLR algorithm is compared with AODV algorithm. The performance of these protocols is compared on the basis of end-to-end delay, packet delivery ratio, routing overhead, throughput and remaining node energy. From the simulation results, we have evaluated the performance of our protocol for different number of nodes and conclude that AODV algorithm has higher end to end delay as compared to EEMLR algorithm.

We also conclude that a routing protocol with more routing overhead would consume more energy than the routing protocol with less routing overhead means AODV routing algorithm has higher energy consumption than EEMLR algorithm because of higher routing overhead.

Finally we can conclude that data packet delivery in EEMLR routing is more than that using AODV routing, and energy consumption of nodes is also balanced in EEMLR algorithm.

6. REFERENCES

[1] L. Tong, Q. Zhao, and S. Adireddy, "Sensor Networks with Mobile Agents," in *Proc. IEEE MILCOM'03*, Boston, MA, USA, Oct. 2003.

[2] W. Zhang, H. Song, S. Zhu, and G. Cao, "Least Privilege and Privilege Deprivation: Towards Tolerating Mobile Sink Compromises in WirelessSensor Networks," in *Proc. of ACM MobiHoc*, Urbana-Champaign, IL, USA, May 2005.

[3] W. Heinzelman, A. Chandrakasan, and H. Balakrishnan, "An Application Specific Protocol Architecture for Wireless Microsensor Networks,"*IEEE Trans. on Wireless Networking*, Vol. 1, No. 4, Oct. 2002, pp. 660-670.

[4] S. Singh, M. Woo, and C. S. Raghavendra, "Power-aware Routing in Mobile Ad-hoc Networks," in *Proc. of MobiCom*, Dallas, Texas, USA,Oct. 1998.

[5] V. Rodoplu and T.H. Meng, "Minimum Energy Mobile Wireless Networks," *IEEE J. Selected Areas in Comm.*, Vol. 17, No. 8, Aug. 1999,pp. 1333-1344.

[6] J.H. Chang and L. Tassiulas, "Maximum Lifetime Routing in Wireless Sensor Networks," *IEEE/ACM Trans. on Networking*, Vol. 12, No. 4,
Aug. 2004, pp. 609-619.

[7] R. Madan and S. Lall, "Distributed Algorithms for Maximum Lifetime Routing in Wireless Sensor Networks," in *Proc. of IEEE GLOBECOM*,Dallas, Texas, USA, Nov/Dec. 2004.

[8] A. Sankar and Z. Liu, "Maximum Lifetime Routing in Wireless Ad-hoc Networks," in *Proc. of IEEE INFOCOM*, Hong Kong, China, Mar. 2004.

[9] Y. Xue, Y. Cui, and K. Nahrstedt, "Maximizing Lifetime for Data Aggregation in Wireless Sensor Networks," *ACM/Kluwer Mobile Networksand Applications (MONET)*, Vol. 10, No. 6, Dec. 2005, pp. 853-64.

[10] J. Park and S. Sahni, "An Online Heuristic for Maximum Lifetime Routing in Wireless Sensor Networks," *IEEE Trans. on Computers*,Vol. 55, No. 8, Aug. 2006, pp. 1048-1056.