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Research Article

An Efficient Algorithm for Sink Mobility to Extend Lifetime of Homogeneous Wireless Sensor Networks

Pratik Dekate[Á*]

[Á]Department of Computer Science and Engineering, Birla Institute of Technology, Mesra, Ranchi 835215, India

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Abstract

Wireless sensor networks consist of large number of very small nodes that are deployed in some geographical area. The purpose of the network is to sense the environment and report what happens in the area it is deployed in. Wireless sensor networks face new challenges not known in cellular and ad-hoc wireless networks. Energy constrains of Wireless sensor networks are an important challenge. Data transmission requires more energy than sense data. Distance between origin and destination has an important role in energy consumption. This work is focus on maximizing lifetime of a wireless sensor network by using a mobile sink with an optimum approach. We have considered a hierarchical network with some cluster that cluster heads are responsible for collecting data from their own clusters. Furthermore, we have used an approach to calculate optimum path, with this optimum strategy we will see network lifetime is increased extremely.

Keywords*: Mobile sink, Heterogeneous Network, Leach C, Clustering, Energy Efficient, Wireless Sensor Network.*

1. Introduction

A wireless sensor network (WSN) is a network consisting of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, humidity, motion or pollutants and to cooperatively pass their data through the network to a main location. The WSN is built of nodes from a few to several hundreds or even thousands, where each node is connected to one (or sometimes several) sensors. Each such sensor network node has typically several parts: a radio transceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery or an embedded form of energy harvesting (Howard, 2002).

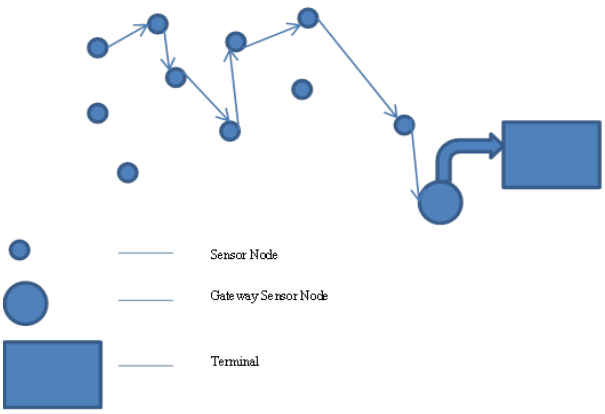

Fig. 1 Multi-hop wireless sensor network

*Correspondinag author: **Pratik Dekate**

2. Problem Statement

Wireless sensor networks (WSNs) can be seen as a large collection of small wireless devices that can organize themselves in an ad hoc network capable of sensing environmental conditions within their range and have constrained energy, processing and communication resources. After the sensing phase, a sensor node needs to transmit the data to a base station, where an application will process the data. In direct transmission of data from source node to sink node, nodes located farther away from sink node have higher energy consumption and die out first (Shown in Fig. 2). However, a wireless sensor network usually lacks infrastructure and sensor nodes must organize themselves in order to create routes that lead to a sink. Therefore, WSNs perform multi hop data propagation in order to relay data to a static base station (or data sink). In a static sensor network deployed for periodic data reporting if sensors are uniformly deployed, then the sensors near the sinks consume more energy than those deployed in other parts of the monitored area and will die first. This is because besides sending their own sensed data, they also participate in forwarding data on behalf of other sensors that are farther away from the sink and thus they will deplete their energy more quickly (Shown in Fig. 3), so the lifetime of the sensors close to the sink becomes the bottleneck for the network lifetime (George Zaki and Nora Ali, 2010).

3. Research Methodology

A . Related Work

WSNs usually contain two types of nodes: sensor nodes

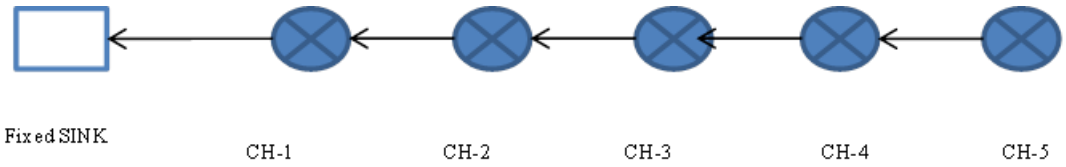

Fig. 2 Direct transmission

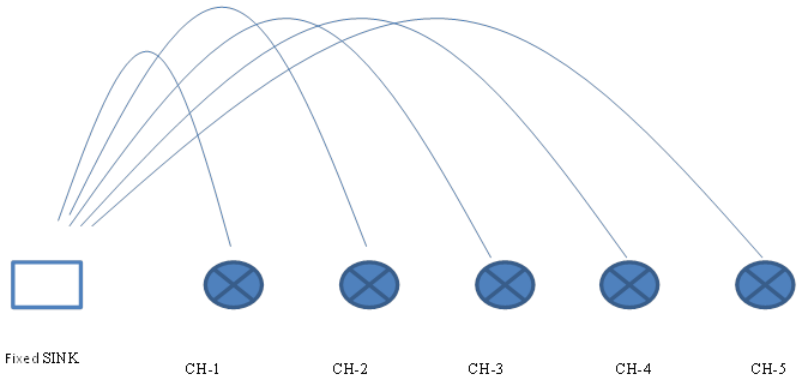

Fig. 3 Hop by hop transmission

and sink (or base station) nodes. A sensor node is a small device that has limited power, sensing and computation capabilities, while a sink node has more resources in terms of power, computation, and mobility. Sometimes sensor nodes are grouped in clusters using various mechanisms and one of the sensors is selected as cluster head based on various criteria. A cluster head manages the sensors in its cluster, gathers information from them, and forwards data to/from the sink. There are two different types of algorithm: (1) algorithms where sink is stationary and (2) algorithms where sink is moving on predetermined paths. In this section, we review the related work on mobile sink for data collection in WSNs. In (Noushin and Marjan, 2012), the authors consider only one mobile sink that moves in a pre deterministic path within a heterogeneous clustered network, where special nodes are playing role of cluster head and they remain cluster head for lifetime of network. However, this approach is not fault tolerance, failure of cluster head node will cause to failure of whole cluster. So, our approach is to use homogenous clustered network where failure of cluster or network is not dependent on single sensor node.

B. Data Routing Protocol : LEACH C

The protocol, called LEACH-C, uses a centralized clustering algorithm and the same steady-state phase as LEACH. LEACH-C protocol can produce better performance by dispersing the cluster heads throughout the network. During the set-up phase of LEACH-C, each node sends information about its current location (possibly determined using GPS) and residual energy level to the sink. In addition to determining good clusters, the sink needs to ensure that the energy load is evenly distributed among all the nodes. To do this, sink computes the average node energy, and determines which nodes have energy below this average. Once the cluster heads and associated clusters are found, the sink broadcasts a message that obtains the cluster head ID for each node. If a cluster head ID matches its own ID, the node is a cluster head; otherwise the node determines its TDMA slot for data transmission and goes sleep until it's time to transmit data (George Zaki and Nora Ali, 2010).

Three main reasons for adopting LEACH C protocol as data routing protocol are

1. In Leach C, It is sink, which knows the location of sensors, who selects Cluster Head of Cluster, In sink mobility it is beneficial.
2. Selected Cluster Head remains Cluster Head for a fixed number of cycles "C". While sink mobile in network for data gathering we won't change cluster head.
3. The CH selection is done on the following criteria :
    a. The node is Active node
    b. The node has energy greater than the average energy of all active nodes.
    c. The sum of its distance to the active nodes is least.

However, we will fix the number of cycle to 1, while sink is moving in network to collect data cluster head should not change and sink should aware of location of all sensors as well as energy level for cluster head selection purpose. In this paper it is sink who find its own optimum path to collect data from CH, and so LEACH C is suitable.

C. Network Models and Assumptions

We consider a hierarchical architecture with a number of clusters that each cluster has one cluster head (CH) and a number of sensor nodes. Our network has one mobile base station (sink). The following are the assumptions in our work:

1. We are deploying homogenous cluster network.
2. All sensor nodes are static except sink node.

3. Clusters created in network are static and created in such way that each node is reachable to all other nodes.
4. Every node in network has some finite amount of energy where sink node is not energy constrained.
5. For data transmission energy consumption is constant unit of energy.

4. Proposed Algorithm

We tried to explain our approach in following steps. However, energy consumption for sensing data is considered to be constant and rest of energy model is taken from (Noushin and Marjan, 2012).

Step 1: Deploy uniform sensors in interested region randomly.

Step 2: Make fixed number of uniform clusters in whole region. (Uniform clusters are where number of sensors is almost equal.)

Step 3: Sink will transmit its location to all active sensors.

Step 5: All active sensors will transmit their Energy threshold E_{TH} to sink.

Step 6: Sink will Repeat following for all sensors,

1. Check if it is active node or not.
2. If active, check Its energy is greater than average of all active nodes or not.
3. Check Sum of its distance to the active nodes is minimum or not.

Step 7: On the basis of above step Cluster Header will be selected by sink.

(Up to this point we have a cluster network and each cluster has a cluster head which is collecting sensed data from other nodes of that particular cluster.)

Step 8: By using Euclidian distance formula sink will calculate distance between all CHs and distance between sink and all CHs. Euclidean distance between two points (X1,Y1) & (X2,Y2) is given by :

$$dist = \sqrt{((X_2 - X_1)^2 + (Y_2 - Y_1)^2)}$$

Step 9: By applying Heuristic method approach like Travelling Sales man Problem[1], Sink will calculate optimum Hamiltonian path and insert each cluster head id into queue in calculated order.

Step 10: Sink will Repeat following while queue is not empty

1. Go to CH which is in the Front position of queue.
2. Collect data from that CH and remove from Front.

Step 11: Repeat from **Step 3**.

In our proposed algorithm we have adopted working of LEACH C (George Zaki and Nora Ali, 2010) and travelling salesman problem (Noushin and Marjan, 2012) to reduce energy consumption also we have implemented proposed algorithm for simulation purpose and found perfectly stable.

5. Result and Discussion

To see performance of proposed algorithm we simulate implemented algorithm for different number of rounds and analyse energy detail of each cluster (shown in fig 4).

In Fig 4 graph show energy consumption of all clusters is nearly equal after different number of rounds. Energy imbalance problem, as we discussed in problem scenario section, occurring in hop by hop and direct transmission approach is completely removed in proposed algorithm.

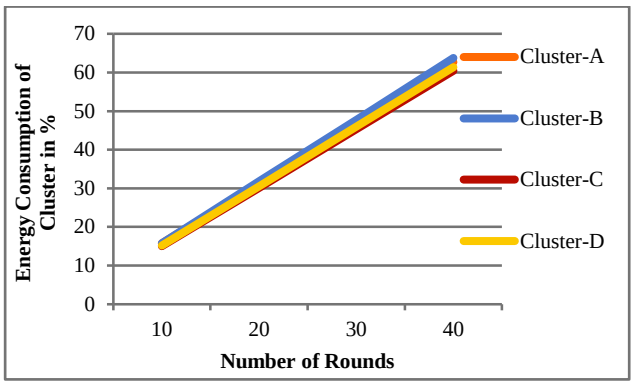

Fig. 4 Performance of proposed algorithm

Conclusion

Moreover lesser energy consumption leads to a longer lifetime which is eventually the main aim of coverage. However, we have seen data transmission from cluster head to base station by both approach direct transmission and hop by hop is not efficient. It is observed that by using a mobile sink for data gathering one can reduce the energy consumption and extend overall lifetime of network, in this paper we have shown an efficient algorithm to mobile sink.

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