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A Survey on Minimizing Energy Consumption and Maximizing Network Life Time in Wireless Sensor Networks

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***Abstract*— A wireless sensor network (WSN) are spatially distributed autonomous sensors to monitor particular environmental conditions, like temperature, sound, pressure, precision agriculture and audio video/surveillance and to cooperatively pass the sensed information to the Base station. Basically sensors have very limited power and energy, sensor networks are used to provide accurate information about a sensing field for an extended period of time. In order to reduce energy consumption and to prolong the network lifetime in this paper we have analyzed many different techniques like Multiple Base station, Data Mules, Joint mobility and finally conclude Mobile Relays as the best technique to "Minimize energy consumption and maximize network life time". Mobile Relay is an intermediate node which is used to relay data from source to sink (Base station) by placing Relay into optimal position.**

***Index Terms*— Base Station, Data Mules, Mobile Relay nodes, Sensors, Wireless sensor networks**

I. INTRODUCTION

A wireless sensor networks (WSN) are spatially distributed autonomous sensors in order to monitor physical or environmental conditions, such as temperature, sound, pressure, it is also used in microclimate monitoring[1], precision agriculture and audio/video surveillance. An average size wireless sensor network can collect data up to 1 Gb/year from biological habitat [1][2]. Due to the limited capacity of sensor nodes all data sensed by sensor networks needs to be transmitted to the base station. Sensor nodes operate with battery power; it has very limited power and energy [3]. In order to reduce the energy consumption several different approaches were used.

In order to minimize the energy consumption and maximize the network life time we have analyzed different schemes for data gathering, and data relaying with minimal energy. In this paper we have used techniques like Mobile Base station which move around the network to collect data from sensor in order overcome the energy depletion of nodes which are near by the base station. Here we use multiple base stations to reduce energy consumption. Some of rendezvous based data collection algorithms are proposed, where the mobile base station only visits a selected set of nodes referred to as rendezvous points within a deadline and the rendezvous points buffer the data from sources. High data traffic towards the base station is always a threat to the networks life time. Data mules are a kind of robot which is used to move around the network to collect and relay it to sink.

Joint mobility uses same technique as multiple base stations where base station is made mobile to prolong the network life time. Finally we conclude paper proposing Mobile relay as the best approach to minimize the energy consumption and maximize the network life time.

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II. TECHNIQUES USED TO REDUCE ENERGY CONSUMPTION

A. Multiple Base station

Multiple Base station [4] : Sensor nodes which are one-hop away from a base station drain their energy faster than other nodes in the network because the nodes which are one hop away from base station need to forward messages originating from many other nodes, in addition to delivering their own messages. In doing so, these sensor nodes deplete their energy quicker and become in-operational. As a result, many sensor nodes will be unable to communicate with the base stations and the network becomes in operational. To increase the lifetime of sensor network therefore they have proposed to employ multiple base stations, and periodically change their locations. Employing multiple base stations instead of one they have effectively either reduced or retained the hop count of each sensor node in the network. Since the energy consumed in routing a message from any sensor node to its nearest base station is proportional to number of hops the message has to travel, employing multiple base stations effectively reduces the energy consumption per message delivered.

B. Data Mules

Data mule is like a robot which move around the network to collect data from sensor nodes.

Data Mules [5]: Data collection by data mules is done by traversing their paths, polling for data. The sensor nodes do not know which of the data mules they belong to. The nodes respond for data when they hear the poll packet. The data mule will send back an acknowledgement only if it is responsible for servicing that node. The sensor node marks the data mule from which it hears an acknowledgement, and does not respond to poll packets from the other data mule in future.

C. Joint mobility was used to prolong network life time.

Sensor nodes which are near by the base station need to relay all the data gathered to base station whose energy gets depleted very soon and network become in operational. In order to overcome these drawbacks, joint mobility uses a technique to make a mobile base station where base station move around the network to collect the data from sensors and also sensors around the base station changes, so that energy consumptions of sensors can be reduced and it increases network life time.

III. MOBILE RELAYS TO REDUCE ENERGY COMSUMPTION AND MAXIMIZE NETWORK LIFE TIME

Mobile relay[1] is an intermediate node placed between source and sink node. Mobile relays are used to reduce energy consumptions in wireless sensor networks. It does not transport data; instead they take optimal position between sources and sink node which remain stationary to forward data. Therefore communication delay is reduced compared to data mules and multiple base stations. Optimal position is midpoint [6][7] of its neighbors. Initially sensors are deployed into distributed environment to collect data. Sensors node sends the collected information to the source node. Distance between all the source nodes and sink node is calculated using shortest path algorithm like Dijkstra's and mobile relay placed between the midpoint of source and sink node.

Mobile relay Configuration in data intensive wireless network is done using low cost disposal mobile relay using optimal mobile relay configuration technique (OMRC). Here we consider energy consumed by both wireless sensing communication and mobility of relays.

We start with initial tree construction where no nodes can move. We use Dijkstra's shortest path algorithm to compute distance between sink to all source nodes. Mobile relay is placed in midpoint of its neighbors.

Most previous work ignored the energy consumed by moving mobile relays. When we model both sources of energy consumption, the optimal position of a node that receives data from one or multiple neighbors and transmits it to a single parent is not to the midpoint of its neighbors; instead, it converges to this position as the amount of data transmitted goes to infinity. Ideally, we start with the optimal initial routing tree in a static environment where no nodes can move. However, our approach can work with less optimal initial configurations including one generated using only local information such as greedy geographic routing. Our approach improves the initial configuration using two iterative schemes. The first inserts new nodes into the tree. The second computes the optimal positions of relay nodes in the tree given a fixed topology. This algorithm is appropriate for a variety of data-intensive wireless sensor networks. It allows some nodes to move while others do not because any local improvement for a given mobile relay is a global improvement.

A. Mobile Relays:

The network consists of mobile relay nodes along with static base station and data sources. Relay nodes do not transport data; instead, they move to different locations and then remain stationary to forward data along the paths from the sources to base station.

Mobile relay nodes decide to move only when moving is beneficial, but the only position considered is the midpoint of neighbors since it converges to be the optimal solution for a single routing path.

B. Sink:

The sink is the point of contact for users of the sensor network. Each time the sink receives a question from a user, it first translates the question into multiple queries and then disseminates the queries to the corresponding mobile relay, which process the queries based on their data and return the query results to the sink. The sink unifies the query results from multiple storage nodes into the final answer and sends it back to the user.

C. Source Nodes:

The source nodes in our problem formulation serve as *storage points* which cache the data gathered by other nodes and periodically transmit to the sink, in response to user queries. Such a network architecture is consistent with the design of storage centric sensor networks. The initial position of nodes and the amount of data that needs to be transmitted from each storage node to the sink has also been considered.

Given a network containing one or more static source nodes that store data gathered by other nodes, a number of mobile relay nodes and a static sink, we want to find a directed routing tree from the sources to the sink as well as the optimal positions of the mobile nodes in the tree in order to minimize the total energy consumed by transmitting data from the source(s) to the sink and the energy consumed by relocating the mobile relays.

The source nodes in our problem formulation serve as *storage points* which cache the data gathered[9] by other nodes and periodically transmit to the sink, in response to user queries. Our problem formulation also considers the initial positions of nodes and the amount of data that needs to be transmitted from each storage node to the sink. Sensor nodes use large amount of energy for data transmission and communication in order to reduce energy consumption "redundant data transmission" should be minimized. Data aggregation [12][13][14] is done at source nodes collected from all sensor node and then transmitted to sink using mobile relays. Deployment of sensor node is very import because, some time sensor node made overlap. So that all overlapped node senses same data all sensor nodes consume energy to sense same data which is transmitted to sink node. Distance between each node during initial configuration must be done efficiently. Sensor nodes data must be processed in order to reduce redundancy which reduces energy consumption and increases network Life time.

Data Aggregation: A data aggregation [10][11] reduces energy consumption and maximizes the life time of network avoiding redundant data transmission to sink node. A technique for data aggregation protocol depends on the architecture of wireless sensor networks. There is two types of architecture in wireless sensor networks. They are:

1) Flat Network
2) Hierarchical Network.

A. ***Flat Network:*** In flat network architecture user request to sink node. Sink node floods the query message to all the sensor nodes in the network, sensor nodes which has the matching data responds to source node where data is aggregated to check redundancy and forwarded to sink node using Mobile relay nodes.

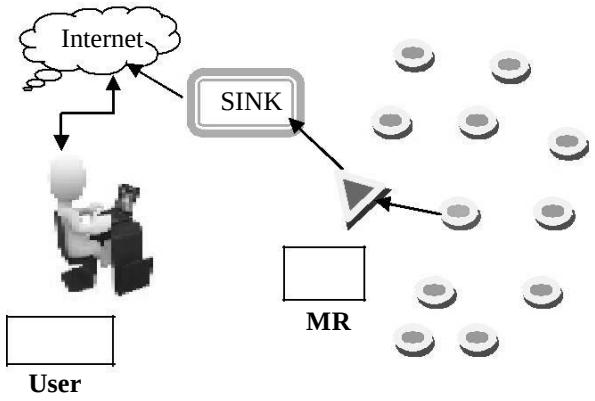

Fig 1.Flat wireless sensor network

Above diagram shows flat network architecture where sensors are spatially distributed in the environment to monitor and send the sensed information from source to sink using mobile relay.

MR-Mobile Relay

Nodes in blue indicate sensor nodes.

Node in green indicates source node.

B. Clustered Network:

In clustered network sensor are organized into clusters where each set of clusters has cluster head which acts secondary relay. Cluster head forwards data to sink node using Mobile Relay.

Data aggregation [15][16]17] in clustering network is done at cluster heads which reduces energy consumption and eliminating redundant data and also maximizes network life time.

Clustered network is used when there huge environment which need to be monitored very efficiently where data is critical. We embed multiple group of sensor to form a clustered network.

Group of nodes in blue indicates set of clustered nodes forming clustered network.

Node in green indicates cluster head which acts as secondary relay. Mobile is indicated in triangle in above diagram.

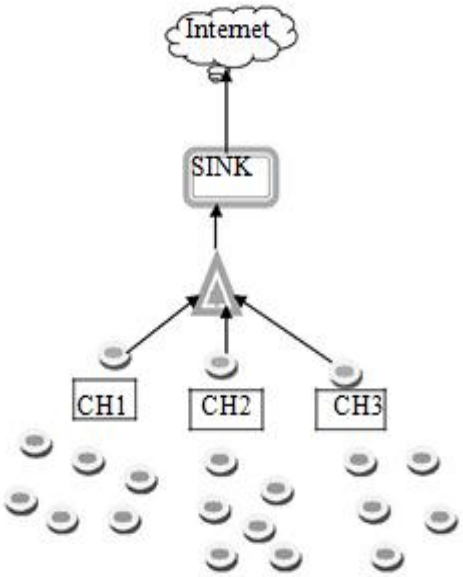

Fig 2.Clustered Wireless Sensor Network

IV. CONCLUSION

In this paper we have analyzed various schemes like multiple base stations in order to increase network life time where number of base station was increased which are moved around the network to gather information from the sensor nodes. To reduce the energy consumption of sensor nodes which are near by the base station, by making base station as mobile, nodes near by the base station will change dynamically.

So that energy of sensor nodes which are near base station was saved and network life time was increased. Second approach used data collection by data mules is done by traversing their paths, polling for data. The sensor nodes do not know which of the data mules they belong to. The nodes respond for data when they hear the poll packet.

The data mule will send back an acknowledgement only if it is responsible for servicing that node. The sensor node marks the data mule from which it hears an acknowledgement, and does not respond to poll packets from the other data mule in future. We finally conclude Mobile Relay approach to be efficient in order to reduce energy consumption and increase network life time because it considers mobility of relay and energy consumed during data transmission. It uses variety of technique like data aggregation to overcome redundant data. It uses two different network architecture like flat and clustered network. Clustered network is better when the network is very large. Flat networks are used when network is very small.

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