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A Movement of Mobile Sink in Wireless Sensor Network to Conserve Energy

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Abstract-Energy is the major constraint in wireless sensor network. In wireless sensor network with static mobile collector (SNSMC),static nodes located near to sink consume more energy, since the nodes relay the data collected by sensor nodes far away from the sink. The battery drained in short time. This problem is resolved by the MMC-WSN method. While simplifying the routing process, proposing an energy-efficient routing technique based on cluster based method for mobile sink is preferred. First part ,the selection of cluster head (CH) in cluster based method made periodically according to their residual energy and in second part the mobile sink moves across the sensing field and directly collects data from cluster heads and returns to back to initial site in a specific sequence based on spanning graphs. The spanning graph includes the shortest search path for the MS. Finally, a tour-planning algorithm is used on the basis of the spanning graph. An energy efficient routing technique (EFR) in WSNs among obstacles uses the shortest route. In this way, the mobile sink retrieves all detected knowledge among a given time and sends to base station which reduces the packet delay and energy-consumption and WSNs.

Keywords: *Wireless sensor networks, obstacles, energy efficient routing, cluster-based, mobile sink, spanning graph.*

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I. Introduction

A wireless sensor network (WSN) consists of sensor nodes capable of collecting information from the environment and communicating with each other via wireless transceivers. The collected data will be delivered to one or more sinks, generally via multihop communication. The sensor nodes are typically expected to operate with batteries and are often deployed to not-easily-accessible or hostile environment, sometimes in large quantities. It can be difficult or impossible to replace the batteries of the sensor nodes. On the other hand, the sink is typically rich in energy.

Since the sensor energy is the most precious resource in the WSN, efficient utilization of the energy to prolong the network lifetime has been the focus of much of the research on the WSN. The communications in the WSN has the many-to-one property in that data from a large number of sensor nodes tend to be concentrated into a few sinks. Since multi-hop routing is generally needed for distant sensor nodes from the sinks to save energy, the nodes near a sink can be burdened with relaying a large amount of traffic from other nodes.

Sensor nodes are resource constrained in term of energy, processor and memory and low range communication and bandwidth. Limited battery power is used to operate the sensor nodes and is very difficult to replace or recharge it, when the nodes die. This will affect the network performance. Energy conservation increases the lifetime of the network. Optimize the communication range and minimize the energy usage, we need to conserve the energy of sensor nodes .Sensor nodes are deployed to gather information and desired that all the nodes works continuously and transmit information as long as possible. This addresses the lifetime problem in wireless sensor networks. Sensor nodes spend their energy during transmitting the data, receiving and relaying packets. Hence, designing routing algorithms that maximize the life time until the first battery expires is an important consideration.

Designing energy algorithms increase the lifetime of sensor nodes. In some applications the network size is larger required scalable architectures. Energy conservation in wireless sensor networks has been the primary objective, but however, this constrain is not the only consideration for efficient working of wireless sensor networks. There are other objectives like scalable architecture, routing and latency. In most of the applications of wireless sensor networks are envisioned to handled critical scenarios where data retrieval time is critical, i.e., delivering information of each individual node as fast as possible to the base station becomes an important issue. It is important to guarantee that information can be successfully received to the base station the first time instead of being retransmitted.

In wireless sensor network data gathering and routing are challenging tasks due to their dynamic and unique properties. Many routing protocols are developed, but among those protocols cluster based routing protocols are energy efficient, scalable and prolong the network lifetime

.In the event detection environment nodes are idle most of the time and active at the time when the event occur. Sensor nodes periodically send the gather information to the base station. Routing is an important issue in data gathering sensor network, while on the other hand sleep-wake synchronization is the key issues for event detection sensor networks. A wireless sensor network (WSN) consists of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, pressure, etc. and to cooperatively pass their data through the network to a main location. The more modern networks are bi-directional, also enabling control of sensor activity. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance; today such networks are used in many industrial and consumer applications, such as industrial process monitoring and control, machine health monitoring, and so on.

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. A sensor node might vary in size from that of a shoebox down to the size of a grain of dust, although functioning "motes" of genuine microscopic dimensions have yet to be created. The cost of sensor nodes is similarly variable, ranging from a few to hundreds of dollars, depending on the complexity of the individual sensor nodes. Size and cost constraints on sensor nodes result in corresponding constraints on resources such as energy, memory, computational speed and communications bandwidth. The topology of the WSNs can vary from a simple star network to an advanced multi-hop wireless mesh network. The propagation technique between the hops of the network can be routing or flooding.

Figure: Wireless Sensor Networks

Sink: A wireless sensor network (WSN) typically consists of a sink node sometimes referred to as a base station and a number of small wireless sensor nodes. The data collected by the sensor nodes are forwarded to a sink node.

Base station: The *base stations* act as a gateway between sensor nodes and the end user as they typically forward data from the *WSN* to a server.

II. Related Work

J. C. Cuevas-Martinez et. Al: Wireless Sensor Networks (WSNs) have been applied including health monitoring, environmental monitoring, military surveillance, and many others as internet of Thing(IOT)

G. Han et al: A cross-layer optimized geographic node-disjoint multipath routing algorithm (CGMR), uses mobile nodes to the reduce the energy expenditure of WSNs to a large extent. Static nodes (SN), it is cost effective .

M. Ma, Y. Yang, and M. Zhao et al: Tour planning for mobile data-gathering mechanisms in wireless sensor networks, the mobile data-gathering tour for different sensor networks. An M-collector similar to a mobile base station is introduced to collect sensing data from static sensors. The MDC begins its periodical movement from the base station and finally returns for transferring the data to the base station. For some applications in large-scale networks, it take a divide-and-conquer strategy and use multiple M-collectors, each of which moves through a shorter data-gathering tour. The path is not planned properly as MDC used in small networks.

M. Zhao, Y. Yang, and C. Wang et al: In the paper titled "Mobile data gathering with load balanced clustering and dual data uploading in wireless sensor networks," A three layer groundwork is proposed by author for mobile data aggregation in WSNs, which includes the sensor layer, cluster head layer, and mobile collector (called SenCar) layer. The groundwork employs load balanced clustering and dual data uploading, which is named as LBCDDU. The motive is to get good scalability, network lifetime and low latency. LBCDDU attains over 20% energy saving per node.

H.-L. Fu, H.-C. Chen, et al: APS-Distributed air pollution sensing system on Wireless Sensor and Robot Networks says the energy-efficient reporting mechanism to prevent redundant transmissions of sensed data to save energy consumption of sensors and prolong network lifetime of the WSRN.

G. Smaragdakis, I. Matta, and A. Bestavros, et al''SEP: A stable election protocol for clustered heterogeneous wireless sensor networks says the network lifetime is defined as the time interval from sensor nodes start working until the death of all static sensors. However, in physical environments, the sensing field may contain various obstacles which make the scheduling for the mobile sink

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more complex Here, the mobile sink can move to any site except the site of obstacles.

Y.-C. Wang e-al: 'Efficient dispatch of multi-capability mobile sensors in hybrid wireless sensor networks, don't consider that the sensing field may contain various obstacles. In fact, the route for mobile nodes in sensing field containing obstacles is more complex than that sensing field without obstacles.

H. A. S. Kumari and K. Shivanna, et al: ''Dispatch of mobile sensors in the presence of obstacles using modified Dijkstra's algorithm gives a modified Dijkstra's algorithm to dispatch mobile sensor from its position to the event location. It gives simple way to dispatch the mobile sensor to the event location in the presence of obstacle.

M. J. Handy, M. Haase, and D. Timmermann, et al: The author proposed Low energy adaptive clustering hierarchy with deterministic cluster-head selection for reducing the power consumption of wireless sensor network. The operation of LEACH is divided into rounds. Each of these rounds consists of a set-up and a steady-state phase. During the set-up phase cluster-heads are determined and the clusters are organized. During the steady-state phase data transfers to the base station. LEACH collects data from distributed micro sensors and transmits it to a base station. LEACH uses the following clustering-model: Some of the nodes elect themselves as cluster-heads. These cluster-heads collect sensor data from other nodes in the vicinity and transfer the aggregated data to the base station.

H. Zhou, N. Shenoy, and W. Nicholls, et al: ''Efficient minimum spanning tree construction without Delaunay triangulation,' a spanning graph is an undirected graph which contains all minimum spanning trees. The obstacle-avoiding spanning graph is the set of edges that can be formed by making connections between terminals and obstacle corners. Once a spanning graph is constructed, the infinite possible sites for the mobile sink movement will be reduced to afinite set of sites. Therefore, the algorithm based on the spanning graph makes it more efficient to schedule for the mobile sink.

III. Problem Statement

In existing system Sensor network, with the routing process, a major limitation with static sensor nodes and data collection by the sink from various sources will be difficult and time consuming process. The Cluster Heads (CH) is elected in terms of "probabilities" without the energy consideration. Data transmission is largely limited by the physical speed of the nodes and the length of their trajectory. This leads to more energy and large delay. So, energy efficient routing of mobile sink came into existence to overcome all this problems.

IV. Implementation Methodology

The network firstly, divided into cells of radius d. Each cell is considered as a mobile node and n uniformly deployed nodes are arranged into network of cluster head. Each cluster is managed by a cluster head (CH), to which all the cluster members report their data. The cluster head gathers the data from mobile nodes and The Mobile node is used as the mobile sink which moves across the sensing field to collect data based on spanning graph in a shortest route. After receiving the data of the sensors, the MS delivers it to a Base Station (BS). On the one hand, the mobile sink reduces the communication overhead for sensor nodes close to the base station or the sink, which leads to the uniform energy consumption. One the other hand, with the movement of the sink, we can better handle the disconnected and sparse network. Therefore, the network life time can be significantly extended by the optimum control of the route of the mobile sink.

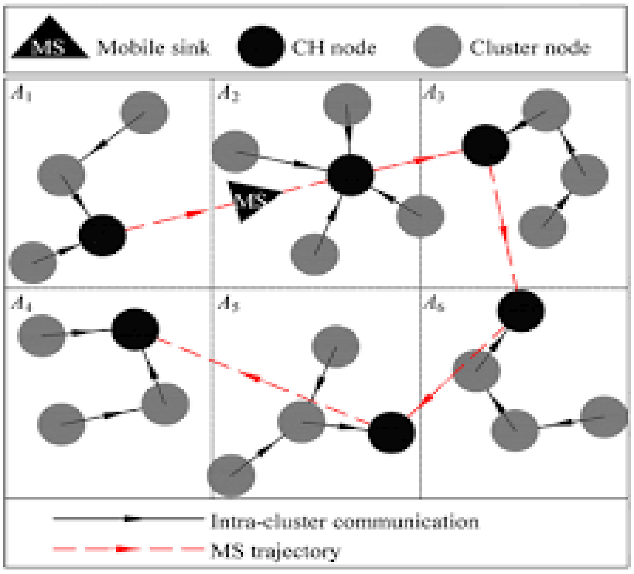

Figure: The network model

The following figure is 100 nodes with MDC-WSN topology frame work which has been introduced now. Yellow color indicates the MS (Mobile Access) oval shape indicates the nodes. That green color circles indicate the coverage ranges of that particular CH (cluster heads).The passing of messages is indicated by that dotted line, that is done by ADHOC process i.e., by temporary dynamically forming of networks (Technically by AODV) in NS2. Here the message passing is done in this following manner.

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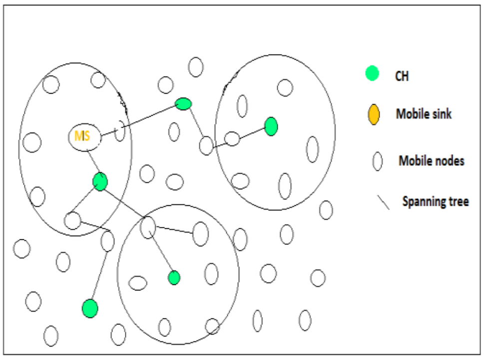

Figure: The proposed network model with 50 nodes

Cluster Partition

All the nodes in a network organize themselves into local cluster, with one node acting as the cluster head. All non-cluster head node transmit their data to the cluster head, while the CH node receive data from all the cluster members or leaf nodes, perform signal processing functions on the data aggregation and transmit data to the remote base station. Therefore, being a cluster head node is much more energy intensive than being a non-cluster head node.

Cluster Head Selection Process

All member of the cluster are asked to generate a energy value of it. And if the energy level is less than a pre determined assumed threshold value that particular node becomes a cluster head for the current round. Thus energy levels of the sensors are compared then the node with highest energy can act as a CH. In this process if more than one node have same energy (highest value), then they have to generate a random number in both the numbers. Once a node is acted as a cluster head, it cannot become the cluster head next time onwards.

Sensing and Data Collection

Energy efficient and delay sensitive data gathering using a mobile sink in a shortest distance transmission scheduling model to perform fast data gathering at the mobile sink node. In the first case, as generic clustering based data gathering, the MNs transmits its data to the cluster head (CH) from which it belongs, which is then followed by the transmission of the data from CH to the mobile sink. On the contrary, the second approach of data transmission (i.e., gathering at the mobile sink) exploits the relative distance between the MNs and the associated CH, and the nearest mobile sink. In case a node finds mobile sink nearer than the CH, the CN transmits its data directly to the mobile sink that not only reduces the computational overheads but also significant reduces delay, energy exhaustion and relaying cost etc. the second case of implementation is stated to be the proposed system. Thus, applying this technique the delay sensitive and energy efficient routing model has been derived to achieve optimal data gathering in WSNs.

Setting less Hop Count Transmission

Multi-hop routing, packets have to experience multiple relays before reaching the data sink. Minimizing energy consumption on the forwarding path does not necessarily prolong network lifetime as some popular sensors on the path. So to avoid the problem in multi-hop routing we are setting the less hop count transmission.

Energy efficiency

Clustering technique in WSNs that selects the CHs to create a connected backbone network. In this technique, where sensors make local decisions on whether to join a backbone network as a CH or to a member of a cluster. The decision of each sensor is based on their residual energy and an estimate of how many of its neighboring CHs will benefit from it being a CH. The sensor which has the highest value of the residual energy becomes the CH. During the reformation of clusters, the cluster head is changed along with the members affiliated to it. Clustering provides resource utilization and minimizes energy consumption in WSNs by reducing the number of sensor nodes that take part in long distance transmission. In WSN the primary concern is the energy efficiency in order to extend the utility of the network.

Transmission Schedule:

Once mobile has registered all the CH in its current neighborhood. It's the responsibility of mobile sink to assign the time slots to all the registered CH i.e. slots when the registered CH nodes can send the sensed data to the mobile sink. Consequently in this phase sink send the TDMA schedule to the registered CH's using the following steps

1. Check the CH registered in previous phase and accordingly arranges time slot for the registered CH.
2. Mobile sink send TDMA schedule to registered CHs.
3. Mobile sink waits for the sensed data from the registered CHs and receives the sensed data from CH.
4. Broadcast time slot information for next round.

Shortest route with Spanning graphs

Spanning graph is constructed; the infinite possible sites for the mobile sink movement will be reduced to a finite set of sites. Therefore, and the algorithm based on the spanning graph makes it more efficient to schedule for the mobile sink.

Algorithm used

1. Initialize minimum paths between the source node and all other nodes
2. Find MST of the graph.
3. Find paths between the source-node and all other nodes using the MST.

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4. Update minimum paths based on the newly generated paths. (ie. If there exists a shorter path between one of the network node and the source-node, save this path as the minimum path)
5. Find all the bridges in the graph.
6. Remove the lowest cost edge, which is not a bridge.
7. Repeat steps 2 to 6 until Number of edges < Number of vertices.

The minimum cost paths from source to all other nodes of network, obtained using the above algorithm can be validated by comparing them with the paths obtained using any of the established single-source shortest path algorithms.

Mobile Sink Advertisement

Mobile sink when reaches any new place during its mobility, it need to inform the nodes in its neighborhood about its presence. Thus, nodes in its neighborhood can send the sensed data to the sink. For the purpose, during this phase, mobile sink broadcast beacon message to the sensor nodes in its vicinity. Beacon message contains the location of the mobile sink, information of its moving velocity V.

Algorithm used

1. Mobile sink advertisement
2. Ti time period based on communication delay
3. CHregister Cluster Head Announcement
4. CHack Cluster Head Acknowledgment.
5. Mobile sink sends the beacon message and set the time interval 'Ti' based on the communication delay
6. IF mobile sink receives message from any other sensor node within the time period 'Ti'. IF message received is CHregister
7. Send CHack message to that node
8. Include the node in registered CH list.
9. END IF ELSE. Take the sink next movement decision
10. END IF

V. Results and Discussions

Tested the simulation output with NS2 simulator and got a two type of results, one is NAM, and graph. Compared the results by using SNSMC method AND MMC-WSN method. In order to evaluate the IEEE 802.11 SNSMC and MMC-WSN methods the network setup was executed by 100 nodes. IEEE 802.11 SNSMC and MMC-WSN the performance of each protocol was executed with respect to the following parameters.

Packet delivery ratio: It is the performance measure used to know the ratio between number of packets received and number packets sent.

Energy Consumption: The total energy consumption is the summation of the transmitting (including both transmit amplifier and circuitry) and receiving energy cost at the source, destination and relay.

Network life: It shows the increase of network life time from existing to proposed system.

Delay: It show the delay has decreased from the last static sink to Movement of mobile sink.

Table: PDR (Packet delivery ratio)

TIME(sec)	SNSMC	MMC-WSN
0.0	0	0
2.0	15	15
4.0	20	20
6.0	25	30
8.0	31	33
10.0	36	40

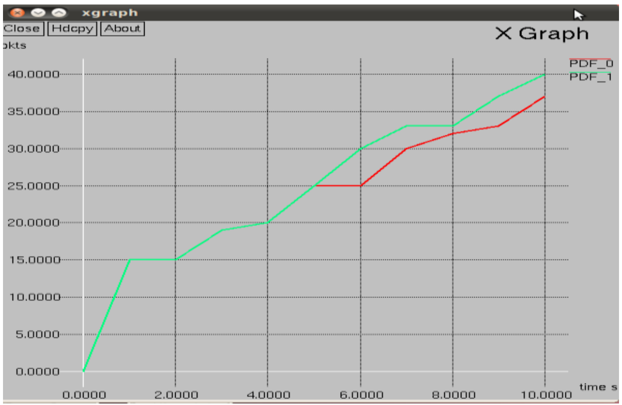

Figure: PDR (Packet delivery rate)

The number of packets delivered at constant rate. The graph represents the time on X-axis and number of packets on Y-axis Red line indicates the existing system (static mobile sink) and the green line indicates the proposed system (Mobility of mobile sink).

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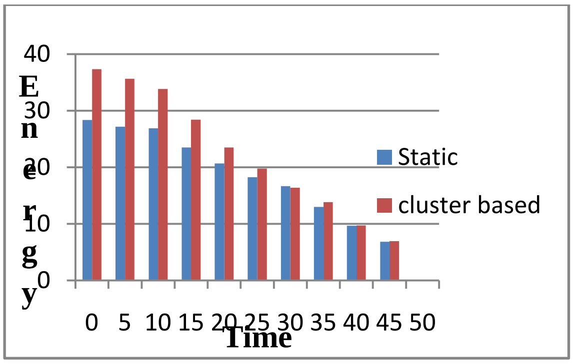

Figure: Graph represents the Energy graph

The proposed system energy point is more than the existing ones. On X-axis it indicates time and on Y-axis consuming energy. Blue line indicates the existing system and red line indicates the proposed system. Energy of red line is more that means the energy is not consumed more in this system.

Table: DELAY COMPRASION

TIME (secs)	SNSMC	MMC-WSN	Multiple sinks
0	1.4	1.2	1.1
2	1.3	1.1	0.9
4	1.5	1	0.8
6	1.6	1.5	1.3
8	2	1.7	1.5

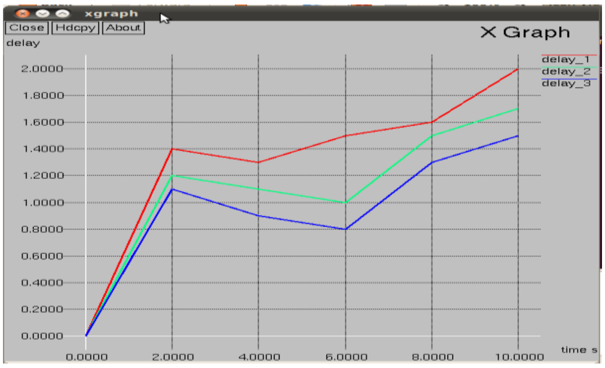

Figure: Graph represents Delay Comparison

The X-axis shows the technology and the Y-axis show time. Red line indicates the existing Static, Green line indicates the proposed method i.e., cluster based and blue line indicates enhancement method. Here in new system delay has decreased from past system.

Table: ACTIVE NODES

Rounds	SNSMC	MMC-WSN	Multiple sinks
0	100	100	100
1	100	100	100
2	98	100	100
3	93	98	100
4	85	95	99

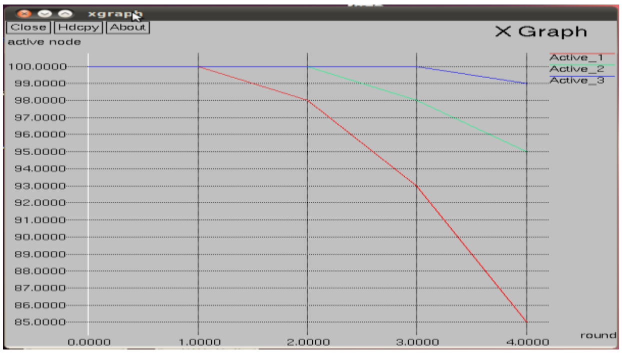

Figure: Graph represents active nodes

The above graph represents number of rounds on X-axis and active nodes on Y-axis. By comparing with SNSMC and MMC-WSN techniques, past system contains more active rounds.

VI. Conclusion and Future work

By introducing the concept of clustering we found that the life of network got increased thus the quality of service has also increased. We mainly focused on movement of mobile sink and energy-efficient clustered WSNs to prolong the lifetime of WSNs and also proposed a technique to optimize the shortest routing path among obstacles in clustered WSNs. The simulated performance proposed by MMC-WSN and the enhanced multiple mobile sink for different network scenarios and demonstrated that the energy consumption and average hop count in WSNs are reduced due to the clustering of sensors and optimization of routing path, hence the lifetime of WSNs is increased. The parameters tested for the quality of the service are packet delay, time, energy and life. In future work, we would like to focus on applying a higher energy efficient in for route optimization with mobility of multiple sinks.

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