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Implementation of Mobility Based Multi-Sink Algorithm for Energy Balancing In A Consumer Home Network

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Abstract*— Limited energy resource is the major constraint associated with Wireless Sensor Network (WSN). As communication is the major cause of energy depletion in the network so designing of energy efficient routing algorithm is one of the key challenges that need to be address for extending lifetime of network. With the fast development of the Internet, wireless communications and semiconductor devices, home networking has received significant attention. One of the main design issues for sensor network is conservation of the energy available at each sensor node. Consumer products can collect and transmit various types of data in the home environment. Typical consumer sensors are often equipped with tiny, irreplaceable batteries and it therefore of the utmost importance to design energy efficient algorithms to prolong the home network lifetime. Sink mobility is an important technique to improve home network performance including energy consumption, lifetime and end-to-end delay. Also, it can largely mitigate the hot spots near the sink node. The influence of static sink nodes on energy consumption under different scale networks is first studied and an Energy efficient Clustering Algorithm is introduced and tested. Then, the influence of mobile sink velocity, position and number on network performance is studied and a Mobile-sink based Energy-efficient Clustering Algorithm (MECA).

Index Terms—**Wireless sensor network, hotspot phenomenon, network lifetime.**

I. INTRODUCTION

Wireless sensor network is a growing technology which is offering solution to a variety of application areas such as healthcare, military and industry. Sensors are building blocks of WSN. Sensors usually used for target tracking, environmental monitoring, system control and biological detection. Corporate sensor network is mainly used for observing the activities of employees. Many energy efficient routing algorithms and protocols have been proposed to prolong network lifetime for WSN [2]. Some representative technologies to implement a corporate network include: IEEE 802.11, IEEE 1394, Ultra Wide Band (UWB), Bluetooth and ZigBee. ZigBee is highly suitable for implementing home automation networks. Wireless Sensor Networks (WSNs) are suitable for the corporate environment due to their intrinsic nature including the attributes of self-organizing, infrastructure-less and fault-tolerance. WSNs are usually composed of many sensors and actuators which can sense, process and transmit raw data to a remote sink node (or BS).

Typical corporate sensor includes measurement of humidity and temperature, monitoring the activities of employees and healthcare [1]. The components of WSN are sensors, cluster head, base station or sink node. Sensor nodes collects data and sends to a cluster head or to a base station in a multi-hop fashion, that is it first sends data to its nearest sensor, which in turn it sends data to its nearest sensors till it reaches the destination. In the existing system there will be a single base station, the sensor nodes near to the base station will be busy is forwarding the data ,which is sent from far away sensors . these creates a high traffic load near to the base station .they will consume all their available electric power much earlier than others, which will cause degraded network performance including network partition, isolated nodes and reduced network lifetime, this is called hot spot phenomenon. Intuitively, the following disadvantages can be reduced if the mobile sink nodes are well deployed and scheduled. First, the hot spot problem can be largely mitigated when the sink nodes move around. Second, energy balancing can be achieved among sensor nodes with prolonged network lifetime. Third, transmission latency can be reduced and throughput can be improved under multiple sink nodes environment. Finally, some isolated nodes or data under sparsely deployed networks can be periodically accessed by mobile s sink nodes to improve network performance. As per sink node deployment strategy, it can be categorized into four classes, namely: single static sink, single mobile sink and multiple mobile sinks deployment strategy. In this paper, both static sinks and multiple mobile sinks deployment strategies are studied. This paper aims to jointly optimize the clustering algorithm and sink node deployment strategy under a corporate sensor network. Two sink mobility based energy-efficient clustering algorithms are first tested. These two algorithms are termed Energy-efficient Clustering Algorithm (ECA) and Mobile-sink based Energy-efficient Clustering Algorithm (MECA). Then, the influence of multiple sink number, velocity and position on network performance is presented. Since the sink node is more expensive, a mechanism to find the optimal sink number to prevent the overuse of sink nodes is further provided. Then by implementation of both static and multiple mobile sink nodes simultaneously Static and Multi-mobile-sink Clustering

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Algorithm (SMCA) algorithm is proposed. A traditional corporate network can be modeled as graph G (N,E) where N is the set of all sensor nodes and E is the set of all links(i,j) . Here *and* j are neighbouring nodes. Node i can communicate directly with its neighbour node j if their Euclidean distance is smaller than its transmission radius. Here, the first order radio model [2], [3] is used as the Energy model. Based on the distance between transmitter and receiver, a free space (d^2 power loss) or multi-path fading (d^4 power loss) channel models are used. Each sensor node consumes E_{Tx} amount of energy to transmit a *l* bits packet over distance d and E_{Rx} for reception, where E_{elec} is the energy dissipated on circuit, and ε_{fs} and ε_{mp} are free space and multi-path fading channel parameters E_{Rx} respectively.

$$E_{Tx}(l,d)=\begin{cases} lE_{elec}+l\,\varepsilon_{fs}\,d^2, d<d_o \\ lE_{elec}+l\,\varepsilon_{mp}d^4, d>d_o \end{cases} \quad (1)$$

$$E_{Rx}(l)=lE_{elec} \quad (2)$$

II. RELATED WORKS

LEACH [3] is one of the most famous hierarchical routing protocols for WSNs, which can guarantee network scalability and prolong network lifetime up to 8-fold than other ordinary routing protocols. The energy can be well balanced among sensors since each sensor takes turn to become the cluster head at different rounds. However, 5% of cluster head nodes are randomly chosen and the cluster heads use direct transmission to send their data to the sink node. In 2003, Shah *et al* [5] first proposed the basic idea of mobile sinks for WSNs where the authors call them "Data Mules." The Mules use random walk to pick up data in their close range and then drop off the data to some access points. The energy consumption for sensors can be largely reduced since the transmission range is short. Younis *et al* [6] also investigated the potential of base station repositioning to improve network performance. The authors addressed when, where and how the base station should be moved by checking the traffic density of nodes one hop away from base station as well as their relative distance. A Scalable Energy-efficient Asynchronous Dissemination (SEAD) protocol [7] was proposed to minimize energy consumption in both building a dissemination tree and disseminating data to mobile sinks. When the sink joined the tree, the Steiner tree was built recursively and SEAD found the minimal cost entry to the tree for the sink using unicast. Gandham *et al* [8] tried to use an ILP (Integer Linear Program) to determine the locations of multiple base stations. They aimed at minimizing the energy consumption per node and prolonging the network longevity. In 2004 - 2005, the idea of multiple mobile sinks for WSNs was further investigated. Akkaya *et al* [4] stated that to find the optimal moving positions for mobile sinks was an NP-hard problem in nature. Oyman *et al* [9] focused on multiple sink location problems and they presented three problems (BSL, MSPOP and MSMNL) depending on design criteria and provided solution techniques. Luo *et al* [10] formulated life time maximization as a min-max problem and jointly studied the sink mobility and routing strategy. They claimed that the overall energy is minimized when the mobile sinks were located at the periphery of the circular network. Wang *et al* [11] studied the WSNs with one mobile sink and one mobile relay individually and they claimed that the improvement in network lifetime over the all static network was upper bounded by a factor of four. However, more recently, Shi *et al* [12] proposed theoretical results on the optimal movement of a mobile base station. They showed that when base station location is un-constrained, the network lifetime can be at least (1- ε) of the maximum network lifetime under their designed joint mobile base station and flow routing algorithm. Marta *et al* [13] proposed to change mobile sinks' location when the energy of nearby sensors became low. In that case, mobile sinks had to find new zones with richer sensor energy. The authors claimed that an improvement of 4.86 times in network lifetime was achieved compared to the static sink case. Lee *et al* [14] introduced a single local sink model to minimize total energy cost during geographic routing. The optimal sink location is determined by a global sink and this model was extended to multiple local sinks model to provide scalability. Kim *et al* [15] proposed an Intelligent Agent-based Routing (IAR) protocol to guarantee efficient data delivery to sink node. Mathematical analysis and experimental results were provided to validate the superiority of their proposed protocol in terms of delay, energy consumption and throughput.

III.TESTED ECA AND MECA ALGORITHMS

In this section, the influence of static and mobile sink nodes on network performance is studied under different scale Hierarchical networks. Two sink mobility based energy efficient clustering algorithms for WSNs are tested, namely an Energy-efficient Clustering Algorithm (ECA) as well as a Mobile-sink based Energy-efficient Clustering Algorithm (MECA) and Static and Multi-mobile-sink Clustering Algorithm (SMCA) algorithm is proposed.

A. *Energy-efficient Clustering Algorithm (ECA)*

Energy-efficient clustering algorithm comprises of three steps. Two of them are the same as used in LEACH e.g. Setup phase and steady state phase. Before set up phase, set building phase is used at the time of deployment and after every ***"x"*** rounds by BS.

1 .Set building phase

Deployed nodes are divided in to Sub Groups (***G1….Gk***) depending upon their locations.

2. Set-up Phase

Step 1: Each node from the group of deployed nodes ***G*** chooses a random number between ***0*** &1

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Step 2: If the number is greater than a set threshold ***T (i),*** the sensor node becomes a cluster-head for the existing round.

Where ***T (i)*** is calculated using

$$T(n)=\begin{cases}\dfrac{P}{1-P*(r \bmod \frac{1}{P})} & \text{if } n\in G\\ 0 & \text{otherwise}\end{cases}$$

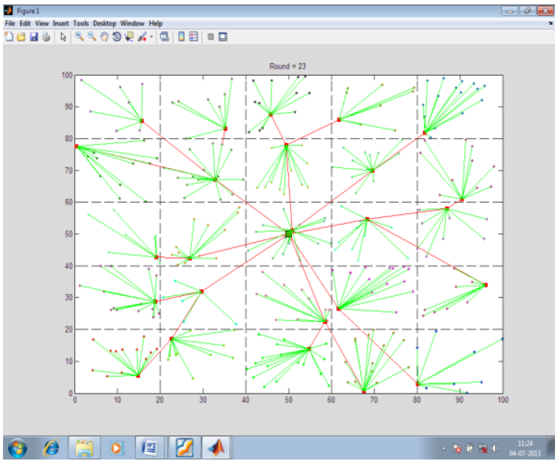
Where,

G = Group of nodes not selected as CHs in preceding 1/p rounds.
P = Recommended percentage of CH.
r = Current round.
Cluster Head Non- Cluster head node Base Station.

Step 4: Once the percentage of nodes has elected themselves to be Cluster-heads they broadcast an advertisement message (ADV).
Step 5: Each non cluster-head node decides its cluster for current round by choosing the Cluster-head that requires minimum communication energy. After choose cluster, it informs the Cluster-head by transmitting a join request message (***Join-REQ***) back to the Cluster-head.
Step 6: After choose cluster, it informs the Cluster-head by transmitting join request message (***Join-REQ***) back to the Cluster-head. The Cluster-head node sets up and broadcast a ***TDMA***
Schedule to all member nodes. It completes the setup phase.

3. Steady State Phase
Step 1: nodes send their data to the Cluster-head at most once per frame during their allocated slot
Step 2: send aggregated data to nearest cluster head.
Step 3: nearest Cluster-Head sends the aggregated data to Base-Station (BS).

This is based on rounds and system repeats the clustering and Transmission for each round.



B. Mobile-sink based Energy-efficient Clustering Algorithm (MECA)

Relocation of sink nodes

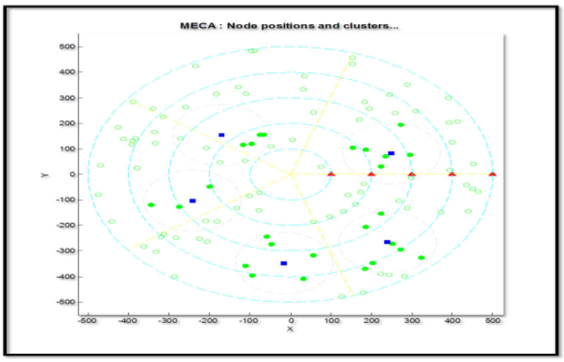
In MECA, the moving velocity V of the sink is predetermined. A sink node only needs to broadcast across the network to inform all sensor nodes of its current location P0 at the very beginning for just one time. Later on, as sensor nodes keep record of the original location of the sink, they can reduce the changed angle θ after a time interval Δt .

$$v=\frac{\theta * R}{\Delta t}\Rightarrow \theta=\frac{v*\Delta t}{R}$$

As $P0$ is known, the new location $P_{\Delta t}$ can be determined, as is shown in Fig. 3.After the broadcasting finishes, the mobile sink is ready to collect data. Here, the mobile sink is assumed to stay at a site for a period long enough to complete a round of data collection, and then moves to the next position.

2) Cluster formation and cluster head selection

As depicted in Fig. 4, the whole sensor network is divided into several clusters. When the CH selection begins, the sensor node that is located in the center of each cluster is motivated, like *S i and* is regarded as the CH candidate. It broadcasts one message within a neighbourhood of radius *R* .This message aims to motivate other nodes for the competition of the cluster head. It contains the node's id and its residual energy. Only the nodes within the transmission range can receive the message and become active, whereas the outside nodes remain idle. If any node *S* j has larger residual energy than *S i* , it becomes the new cluster head candidate and broadcasts new message with its own information to the others. If *S* j has equal residual energy with *S i* , compare the ID. The node with a smaller ID wins. If S j has smaller residual energy than *S i* , it still broadcasts the message of *Si* As soon as the comparison is done, the unselected node becomes idle again. All nodes in the cluster should be compared only once. In this way, the node with the largest residual energy is chosen as the cluster head.



Cluster Head
Sink node
Sensor node
Sensor nodes motivated for cluster head selection

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3) Hierarchical routing phase

For node S_i in one cluster, the energy consumption cost to

send data to its cluster head CH_{S_i} is given in Equ. (4). In the mean time, S_i tries to find another S_j to relay data which may consume less energy than that through directly communication with CH_{S_i}. Since the direction of data transmission can be randomly chosen, various nodes can be chosen, which turn out to cause various energy consumption. Suppose S_i chooses S_j as its relay node and let S_j have direct communication with the CH_{S_i}. To deliver a l –length packet to the CH, the energy consumed by S_i and S_j is shown in (5). Each S_i chooses S_j with the smallest $E_2(S_i, S_j, CH_{S_i})$ as the relay node if necessary:

$$E_2(S_i, CH_{S_i}) = Min(E_2(S_i, S_j, CH_{S_i})) \qquad (7)$$

Compare (4) and (7), and the smaller one is chosen:

$$E(S_i, CH_{S_i}) = Min(E_1(S_i, CH_{S_i}), E_2(S_i, CH_{S_i}))$$

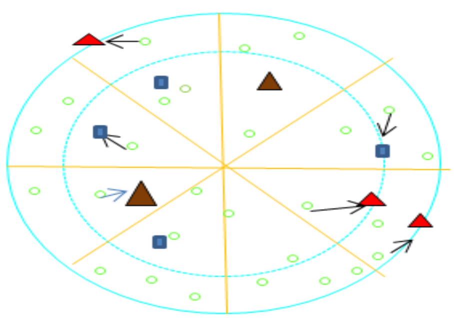
In MECA, the sink node changes its location overtime. Therefore, some nodes may consume less energy through sending data directly to the sink rather than to its cluster head. So it is necessary to compare $E(S_i, CH_{S_i})$ and $E(S_i, BS)$ and decide the final route. In summary, the clustering algorithms in this paper can be viewed as to find The $Min(E(S_i, CH), E(S_i, BS))$

IV. PROPOSED SMCA ALGORITHM

A) *Static and Multi-mobile-sink Clustering Algorithm (SMCA)*

Here both multiple mobile and static sink nodes are deployed. Suppose whenever sink node appears near to it then cluster head it can directly forward packet to sink node. IN this case sink node is both static and mobile. Thus, energy is saved. Sensor nodes will calculate least distance which is required to forward the packets. Sensor nodes calculates the minimum energy required with the help of this formula

$$Min(E(S_i, CH), E(S_i, BS))$$



Cluster Head
Mobile Sink node
Sensor node
Static sink node

V. PERFORMANCE EVALUATION

A. Test Environment

Consider the following parameters, there are 100 Sensor nodes Deployed in a [500,500] network with multiple sink nodes placed either inside or along periphery of the area. The maximum transmission radius is assumed to be 120 meters. Each sensor node transmits the collected data to a sink either directly or in a multi-hop fashion.

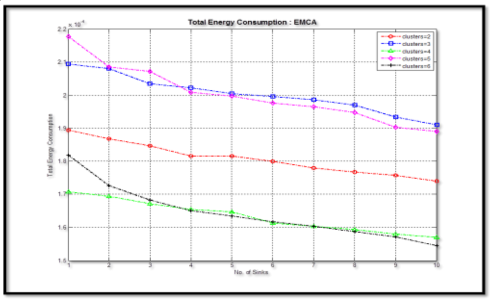
TABLE I. The following network parameters are initially assumed

Parameter name	Value
Network size	[300,300] to [500,500]
Num of nodes(N)	100
Radius(R)	120m
Packet length(l)	6 bits
Initial energy(E_0)	0.5 Joule
Energy consumption on circuit	50nJ/bit
Free space channel parameter	10pJ/bit/m^2
Multi-path channel parameter	0.0013pJ/bit/m^4

B) ECA performance analysis

i) Performance analysis total energy consumption

100 sensor nodes are randomly deployed. As illustrated in the fig. 3 .Here whole network is divided into several clusters By, changing the number of sink node and the number of cluster total energy consumption can be evaluated .It can be seen that total energy consumption units decreases as the number of sink node increases .when 3 or 4 sinks are deployed The decreasing rate of energy consumption becomes relatively small even if more sink nodes are added later.



C) MECA performance analysis

i) performance analysis of single sink mobile node by varying its velocity

The influence of single mobile sink node moving under different stratergy is studied. Fig. 4 illustrates, changing the velocity of sink node influences the energy consumption of the sensor network.

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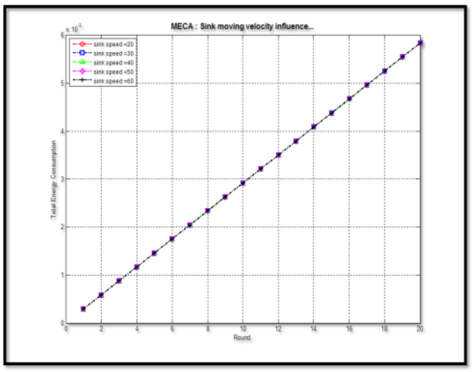
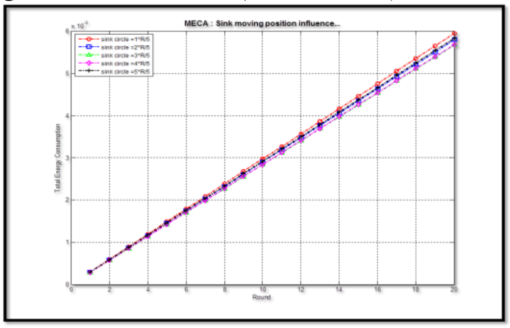


ii) performance analysis of single sink mobile node by varying its position

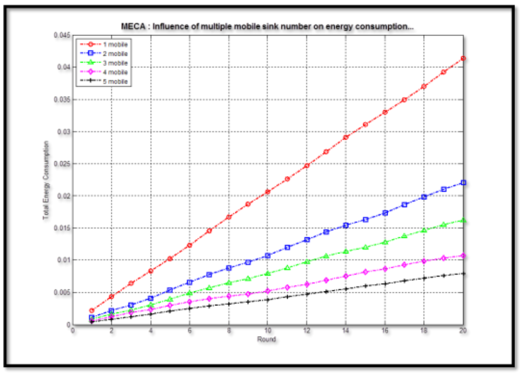
Fig.5 illustrates the influence of position of a sink node Moving in a different radius (1/5R,2/5R….)



It can be seen that single mobile sink velocity and position have little influence on energy comsumption of sensor node due to the avarege distance square being similar to the single moving sink regarding the random sensor network topology

iii) influence of multiple mobile sink number on energy consumption by varying number of sink nodes

It can be seen from fig.6 that as the number of sink nodes increases total energy consumption decreases.but,it is necessary to find the optimal sink number for improving sensor network lifetime.



VI. CONCLUSION

The main focus of this project is balancing energy among Sensor nodes and to improve the network lifetime of sensor Network. Therefore two algorithms Energy-efficient clustering algorithm and MECA is Proposed and tested .the another algorithm SMCA has been proposed.

REFERENCES

[1] I. Akyildiz, W. Su, Y. Sankara Subramanian, E. Cayirci, “Wireless sensor networks: a survey,” Journal of Computer Networks, vol. 38, no. 4, pp. 393-422, March 2002.

[2] K. Akkaya, M. Younis, “A survey on routing protocols in wireless sensor networks,” Elsevier Ad Hoc Network Journal, vol. 3, no. 3, pp. 325-349, May 2005.

[3] W. R. Heinzelman, A. Chandrakasan, H. Balakrishnan, “Energy efficient communication protocol for wireless micro sensor networks,”Proc. of the 33rd Annual Hawaii International Conference on System Sciences (HICSS), pp. 1-10, Jan. 2000.

[4] K. Akkaya, M. Younis, M. Bangad, “Sink repositioning for enhanced performance in wireless sensor networks,” Elsevier Computer Networks, vol. 49, no. 4, pp. 512-534, Nov. 2005.

[5] R. C. Shah, S. Roy, S. Jain, W. Brunette, “Data MULEs: modeling a three-tier architecture for sparse sensor networks,” Proc. of the 1st IEEE International Workshop on Sensor Network Protocols and Applications, pp. 30-41, May 2003.

[6] M. Younis, M. Bangad, K. Akkaya, “Base-station repositioning for optimized performance of sensor networks,” Proc. of the Vehicular Technology Conference, vol. 5, pp. 2956-2960, Oct. 2003.

[7] H. S. Kim, T. F. Abdelzaher, W. H. Kwon, “Minimum-energy asynchronous dissemination to mobile sinks in wireless sensor networks,” Proc. of the 1st International Conference on Embedded Networked Sensor Systems, pp. 193-204, Nov. 2003.

[8] S. R. Gandham, M. Dawande, R. Prakash, S. Venkatesan, “Energy efficient schemes for wireless sensor networks with multiple mobile base stations,” Proc. of the Global Telecommunications Conference, vol.1, pp. 377-381, Dec. 2003.

[9] E. I. Oyman, C. Ersoy, “Multiple sink network design problem in large scale wireless networks,” Proc. of IEEE International Conference on Communications, vol.6, pp. 3663-3667, June 2004.

[10] J. Luo, P. Hubaux, “Joint mobility and routing for lifetime elongation in wireless sensor networks,” Proc. of the 24th Annual Joint Conference of the IEEE Computer and Communications Societies, vol. 3, pp. 1735-1746, Mar. 2005.

[11] W. Wang, V. Srinivasan, K. Chua, “Using mobile relays to prolong the lifetime of wireless sensor networks”, Proc. of the 11th annual international conference on Mobile Computing and Networking, pp.270-283, Aug. 2005