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# A Self-Organized Location Aware Energy Efficient Protocol for Wireless Sensor Networks Using Multi – Hop Method

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***Abstract: Wireless Sensor Networks (WSNs) consist of a collection of nodes. WSNs have attracted considerable attention because of their extensive applications in many areas, such as object tracking, intrusion detection, and so on. In WSNs, the energy of network node is often limited. So the efficient use of energy is a must in topology control. To solve these issues separately, more transmission power is required. To overcome this problem, we use An Energy-efficient Multi-sink Clustering Algorithm (EMCA) for WSNs. We divide the sensing field into several equal clusters. Therefore, it not only saves energy through clustering, but ensures that workload is dispersed so that the phenomenon of unbalanced energy consumption around one single sink can be alleviated. The network lifetime can also be prolonged.***

***Index Terms— Localization, Wireless Sensor Networks, Error Correcting Codes, EMCA***

## I. INTRODUCTION

Wireless sensor networks (WSNs) have been extensively employed to monitor a region of interest (ROI) for reliable de- tection/estimation/tracking of events [1]–[4]. In this work, we focus on target localization in WSNs. Localization techniques proposed in the literature for sensor networks include direction of arrival (DOA), time of arrival (TOA) and time-difference of arrival (TDOA) based methods [5] [6]. Recent research has focused on developing techniques which do not suffer from imperfect time synchronization. Received signal strength based methods, which do not suffer from imperfect synchronization and/or extensive processing, have been proposed which em- ploy least-squares or maximum-likelihood (ML) based source localization techniques [7] [8]. In WSNs, due to power and bandwidth constraints, each sensor, instead of sending its raw data, sends quantized data to a central observer or Fusion Centre (FC). The FC combines these local sensors' data to estimate the target location.

Although the size of clusters should be adjusted properly, in order to maximize energy efficiency, the usual cluster-based routing protocols do not guarantee proper clustering size, since they only use localized neighbor information. Since the CMs send data packets to a distant CH when the size of a cluster is too large, high energy consumption can occur. In addition, the CH may experience transmission delays and cause bottlenecks. In contrast, when the size of clusters is too small, the number of clusters is increased, engendering an increase in the number of CHs, which consume much more energy when compared with CMs.

## II. RELATED WORK

This work deals with the four fundamental issues in WSN; the e literature review is also performed in these four areas. Firstly, localized and topology models in sensor networks are studied and energy analysis works are analysed in the context of self-organization.

Self-organization is an important component for a successful ability to establish networking whenever needed. Such mechanisms are also referred to as Self-organizing networks. These are known as small-world networks, or scale-free networks. These emerge from bottom-up interactions, and appear to be limitless in size. In contrast, there are top-down hierarchical networks, which are not self-organizing. These are typical of organizations, and have severe size limits

### 2.1. Proposed work

LEACH is a classical clustering algorithm. In a periodical way, it randomly chooses the cluster heads. It's a chain-based protocol. Each node communicates only with a close neighbor and takes turns transmitting to the sink. Cluster heads are decided based on the average minimum reach ability power. It provides scalable and efficient data delivery.

We use similar energy model based on the distance between transmitter and receiver, a free space (power loss) or multi-path fading (power loss) channel models are used. Each cluster has only one cluster head. The other nodes in the same cluster send data to the cluster head. Then cluster head send aggregated data to its relevant sink. In our algorithm, however, the sink nodes are randomly located. Therefore, some nodes may consume less energy through sending data directly to the sink rather than to its cluster head.

 

***A. Leach***

In Energy efficient communication protocol for wireless micro sensor networks the authors used LEACH (Low-Energy Adaptive Clustering Hierarchy). The advantages of the methods are Energy dissipation, Ease of configuration, System lifetime/quality of the network. But this method has Low-energy, Distributed protocol. The Low-Energy Adaptive Clustering Hierarchy (LEACH) protocol is a well-known self-organized cluster-based protocol. The LEACH decides CHs by a randomized rotation, in order to distribute the energy consumption of sensor nodes. Each sensor node compares the threshold T(n) that has a random number, in order to elect a CH. The CHs are changed periodically, in order to balance the energy of sensor nodes. Sensor nodes of LEACH organize the clusters on their own, by using both local decision and local communication

***B. Leach-ED***

In LEACH-Energy Distance (LEACH-ED) is another self-organized cluster-based protocol. The LEACH- ED decides CHs based on two thresholds. First, the threshold is the ratio between the residual energy of a sensor node, and the total current energy of all of the sensor nodes in the network. Second, the threshold is the distance between some nodes that is less than the distance threshold; only one node becomes a CH. The LEACH-ED improves the load balance and the network lifetime better than does the LEACH.

***C. Clustering Based Data Collection algorithm***

The clustering-based data collection algorithm focuses on the energy efficiency problem of clustering and prediction. In clustering, this algorithm uses dynamic splitting and merging clusters, in order to reduce the communication cost. However, these clustering, splitting, and merging methods are operated not for energy-efficient routing, but for using AR model-based similarity of features of CH and CMs.

**Network Model**

A sensor node consumes energy, when transmitting and receiving data packets in a WSN. In wireless data transmission, energy consumption is correlated to the data packet size and the distance between the two sensor nodes. Extensive research has been conducted in the area of low-energy radios. Different assumptions about the radio characteristics, including energy dissipation in the transmission and receive modes, will change the advantages of different protocols. We also assume that a sensor node can identify its own energy.(i)Transmitting the data packet: a sensor node consumes at the transmitter circuitry and at the amplifier.(ii)Receiving the data packet: a sensor node consumes at the receiver circuitry.(iii)A -bit data packet is transmitted from sensor node to sensor node, and is the distance between the two sensor nodes and : the energy consumption of the sensor node is given by .(iv)The sensor node receives the data packet.

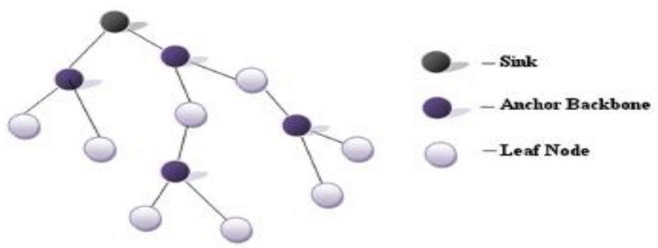


Fig. 1 Location-aware structure formation.

## III. ENERGY EFFICIENCY MECHANISM FOR EMCA

In this work, two methods were developed for localization and energy efficiency:
(1) Energy efficient dominating set construction
(2) Load balancing with dynamic node selection. Initially, the network was modeled based on the localized

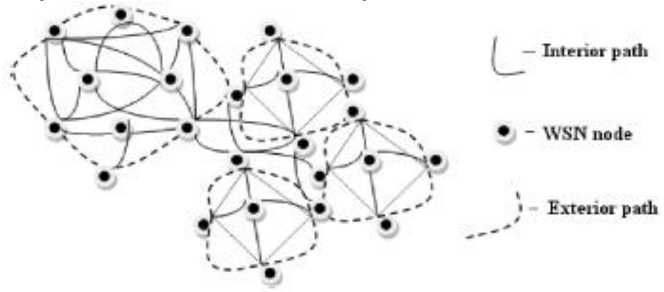


Fig2. Energy efficiency in localized model.

**3.1 Energy efficiency with load balancing**

Fig. 2 also illustrates the necessity of load balancing in a mesh-based energy efficient structure. The nodes are positioned close to each other; generally, a 20 m transmission range is assigned in WSN. The intermediate node in each localized structure acts as a sink or relay node. All paths use relay nodes to send the information to a gateway. During the information exchange process, the energy of relay nodes is drained and the network is no longer available until it resumes. This happens in many WSN applications. To avoid this scenario, an alternate path is generated between every node to the sink node. This process proceeds as follows:

(1) all nodes allow only one packet from nearby neighbours;

(2) consecutive packets are processed by other one hop connected nodes within the mesh structure;

(3) if a node is the neighbour of the sink node, a new routing scheme, known as bypass routing, occurs. In this method, an intermediate node does not open the packet but simply forwards it in another direction.

**Algorithm for load balancing**

1: Input: an undirected disk graph G = (V,E) // V, E-set of vertices and edges
2: Output: let a connected mesh structure L, be the sub graph of G
3: Construct localized mesh structure ln {V,E} // with at least two unconnected neighbors within its coverage area
4: Construct a l mesh set from ln L
5: L (v) {G}, where LP2, 3, 4, . . .// v – one vertex
6: Find a subset A for alternate routing from L such that l1, l2, . . . , ln V
7: if l1, l2 are alternate route virtual nodes then// node degree l1, l2P1or 2
8: Connect leaf node n to L or l
9: Add nodes to localized network Ln L U l U n
10: while L (v) changes the position // v, u- vertices in L (localized structure)
11: l (u) L(v). //connection of 'L' is maintained via 'l'. // l subset of L
12: Add u, v only if l connects v and u in one hop
13: similarly, other nodes of L added with one hop l1, l2, . . . , ln
14: (l, n) update i // i-state information
15: if l1 not available in one hop or not in the transmission range // this is only applicable for low transmission range
16: n l // leaf node (n) becomes virtual node

**3.2 Location-aware structure formation algorithm**

Input: unconnected graph G with vertices V and edge E // V v1, v2, . . . , vn
Output: fully connected Tree structure with anchors
1. Select root vertex VR in G, i.e., VR G // VR is the sink node
2. Add Edge ei of VR to vi and vi to vj // i, j = 1, 2, 3,
3. If vi and vj are the two hop away nodes of VR then
4. check that C (connectivity) // vi and vj are connected with two unconnected neighbors in G
5. Select vabi and vabj to be the first level backbone anchors, named Vab1 and Vab2// vab – Backbone anchors
6. Continue step three to five until all the nodes are connected in G
7. Position information shared via vabi and vabj to VR
8. Otherwise
9. Go to step two
10. End

To prove the correctness of the proposed algorithm, the following arguments were analysed with proof: (i) in line 2: add Edge ei of VR to vi and vi to vj; (ii) in line 4, check C (connectivity) // connected with two unconnected neighbors in G; (iii) in line 7, position information shared via vabi and vabj to VR.

For (i), tree structure formation was based on vertices and their edges added to one hop neighbor and was proved as follows:
if graph G is connected, the tree is build first, before finding a localized connected structure based on the selection of nodes being in the same coverage area; connect all nodes and a tree is formed.

**3.3 Topology control for structure maintenance**

Stage-I: Topology control for phase-reduced topology (connectivity and coverage)
1: While power of v (leaf node) of V is reduced or change position
// node energy drained or the node in movement
2: vai vi. change state indication to anchor backbone
3: vi vabi VR // Connectivity maintains the hierarchy VR, vbi and v, where v is attached with
new anchor vbi.
4: Add vabi to vi only if vab contains a one hop unconnected path between the one hop neighbors
5: Update all vi to vabi in G
6: Tree (T) structure maintained
Stage-II: Topology maintenance phase
7: Let G contain vi, vab and VR.
8: if P (vi – vab – VR) then // powers are different
9: Remove vi from G and resume when it is required
10: Tree structure maintained with VR in G.

### 3.4 Self-organization in EMCA

Self-organization is mainly used to build a scalable network with a large number of subsystems. WSN are bandwidth and energy constrained. Self-organization minimizes the number of message transmissions, receptions and facilitates energy conservation. It also supports a network from node failure. In the current work, we will show how low message complexity is used for energy saving in the node, as well as in the network. Additionally, it provides a solution for avoiding collision, contention and link failure issues.

## IV. RESULT ANALYSIS

Two sets of analyses were performed in the simulation, one in a mobile and one in a stable scenario. During the simulation, received power was assigned with 0.1 watt and 0.2814 watt was set for transmission power. All the simulations were conducted using ns-2 with 200 nodes with a 1000 _ 1000 m2 deployment area, 0.90 s hello interval and random waypoint model. The ideal power levels used in ns-2 were initially assigned to each node. The initial energy of all the nodes was 0.25 J with a transmission range that varied from 10 to 50 m. Duration of the simulation time (S) was 120 s. In the first scenario, all the nodes were stationary and 10 UDP sessions were sequentially generated. Each session transmitted 50 Constant Bit Rate (CBR) packets.

### 4.1 Performance metrics

Network size vs. relay nodes: Number of nodes vs. relay nodes as a function of 200 nodes was considered. Transmission range vs. relay nodes: Transmission range varied from 10 m to 50 m and different localized structures were plotted. Node degree vs. LS (localized structure): Initially, the network was formed with three or five degree virtual nodes; node degree was increased in the order of seven per node during movement; a total of 35 was added to localized structure and the percentage of the mesh structure requirements were plotted in the result analysis. The size of the localized structure was less than or equal to n/6, with n being the number of nodes (n = 200 nodes analysed in the simulation) and six being the maximum node degree (which included the forward link) added to the network. Packet delivery ratio: Calculated as the ratio between the number of data packets that were sent by the source and the number of data packets that were received by the intermediate or destination node.

### 4.2 Simulation results for localized structures

The transmission range analysis was based on the number of intermediate nodes required within the different transmission ranges. Here, the ranges were increased from 10 to 50 m and the sizes of dominating nodes were measured. In Fig. 5, x-axis is the transmission range and y-axis is the LS size. It was observed that for the 10 m range, only 30 dominating nodes were required for connectivity and this value was reduced with an increase in transmission range, reaching 11 for 50 m. Another observation was that, as the transmission range increased from 40 m to 50 m, the size of both approaches decreased. In addition, the difference between their sizes became smaller as the transmission range increased.

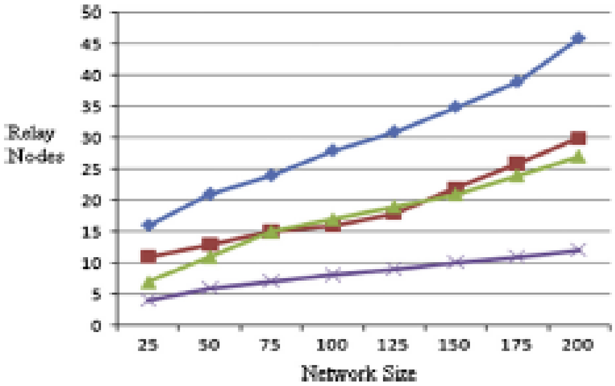


Fig. 4. Network size vs. number of relay nodes.

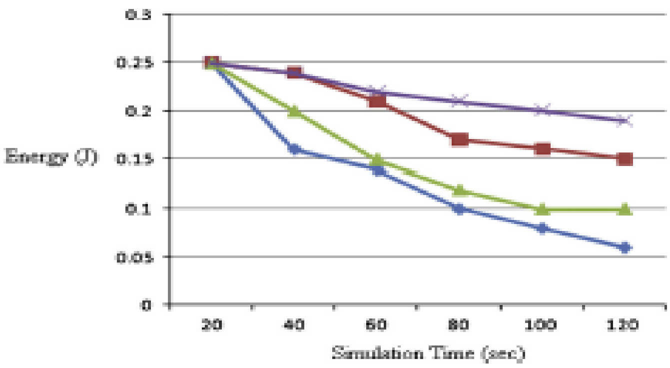


Fig. 4. Energy analysis during the simulation.

 

Fig. 7 shows the packet delivery ratio, which was defined as the ratio between the number of data packets that were sent by the source and the number of data packets that were received by the intermediate or sink node. A packet size varied from 16 bytes to 128 bytes transmitted with the proposed model and different PDR values were analysed. Three cases of PDR analysis were possible in an infrastructure less network: (1) effect of transmitting power at a node on PDR for a varying number of nodes in a certain group size; (2) effect of multicast group size on PDR for a varying number of nodes and (3) effect of group size over PDR for the varying speed of nodes in a fixed group size.

## V. CLUSTERING PHASE

The clustering phase commences when the sensor nodes are first scattered in the sensor field or after the completion of the “data transmission phase.” This phase decides new CHs to form new clusters for the WSN. To achieve energy efficiency, the criterion in the selection of CH is the remaining energy of CMs. To reduce the load (or overhead) of CHs, the EECSM regulates the size of the clusters. The clustering phase is comprised of four steps: broadcasting step, splitting step, CH selection step, and clustering step, as follows

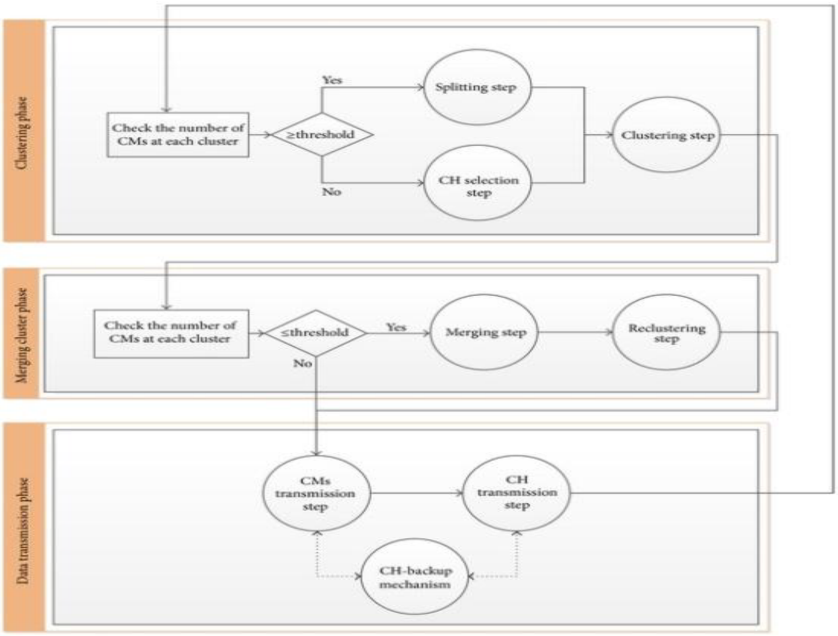


Fig.5. flow chart for EMCA

**Splitting Cluster Step**

After each cluster configuration, EECSM considers the suitable number of clusters. First, EECSM tries to split a large cluster into two small clusters. The disadvantage of a large cluster is the high energy consumption of its CH, when the data packets are transmitted from its CM to its CH via a relatively long transmission path. When receiving the data packets, the more CMs the cluster has, the more its CH consumes energy. A processing bottleneck can also occur at the CH in a large cluster. After the data transmission phase of the previous clustering round, in order to decide the number of clusters in the next clustering round, EECSM selects the next step, according to the value of the splitting threshold. If the number of CMs of a cluster is more than the splitting threshold value, the EECSM executes the splitting cluster step. Since a cluster is split into two clusters at the splitting cluster step, in the next round, two CHs for the split cluster are identified as the First CH and the Second CH, respectively.

**Merging Cluster Phase**

After the clustering phase of the current clustering round, the EECSM checks the size of the clusters. Since the EECSM checks and splits the large clusters at the previous phase, it needs to check only the small clusters at this phase. The disadvantage of a small cluster is inefficient energy consumption, particularly when the data packets are transmitted from the CH to the BS, since energy consumption from a CH to the BS is much more than the energy consumption from a CM to the BS for longer transmission. For this reason, energy consumption of a small cluster is not energy efficient, and therefore the small clusters need to be merged into large clusters. The merging cluster phase on EECSM is comprised of two steps: merging cluster step and re-clustering step, as follows.

**Data Transmission Phase**

The merging cluster phase is finished, clustering is complete. The EECSM enters into the data transmission phase, as EECSM starts to inform the situation of the sensor field to the external BS, by sending gathered data. The data transmission phase is divided into 2 steps: CM transmission step and CH transmission step. CM creates a data packet that contains neighboring environment information for each period. The data packets are transmitted to the CH. Each CH aggregates the received data packets into a data packet and transmits the data packet to the BS directly. These procedures are repeated during each clustering round.

 

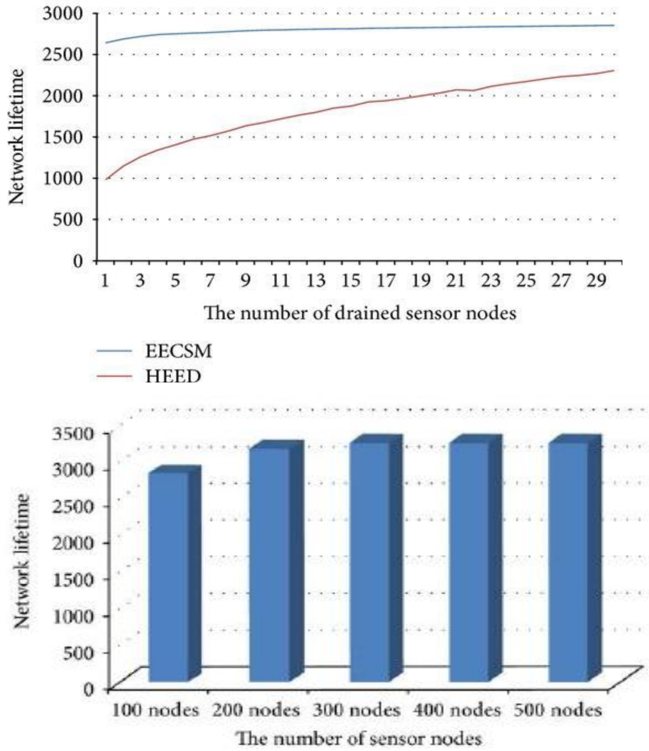


Fig.6.Performance analysis of network lifetime with scalability

## VI. CONCLUSION

The multi-sink deployment helps solve the energy hole problem. We propose an Energy-efficient Multi-sink Clustering Algorithm (EMCA) for WSNs. The inter-cluster and intra-cluster routing algorithm is explained in details. Moreover, we deduce the deployment of the sink nodes with an optimal multiple sink number through experiments. Simulations show that the energy consumption is largely reduced than SLEEP algorithm.

The four possible architectural choices for energy efficient structures were analysed with stable and mobility models in wireless sensor networks. This is a new approach for the selection of close to sink node from the dominating set with no additional cost or delay. Results proved that the proposed architecture performed well in terms of energy efficiency. The approach of adding nodes with a localized set had little application if all the nodes tended to move all over the network region.

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