Advanced Energy Efficient Routing Strategy Based on Election for Wireless Sensor Network

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ABSTRACT
In WSN Sensor node near to the sink will exhaust their limited energy more rapidly than other sensor nodes, since they will have to forward huge data during multi hop transfer to the base station. Therefore network lifetime will be reduced because of hotspot problem. Important research issue is how to cope up with network lifetime. In this paper, a modified Election based Protocol is proposed, the decision of selecting cluster heads by the sink is based on the additional energy and residual energy and geographical location at each node. Besides, the cluster head also selects the shortest path to reach the sink with the use of the congested link. Simulation results show that our approach enhanced the performance than traditional routing algorithms, such as LEACH.

Keywords
Wireless Sensor Networks, Multipath Routing, Packet Loss, Life time, Clustering..

1. INTRODUCTION
A. Detail Problem Definition

Many wireless sensor networks (WSNs) are deployed at the environment where the energy deployement is very difficult but it is not impossible. In WSN there are limited resources still which are useful to increase system lifetime with minimum energy consumption. So our aim is to solve the problem of energy consumption vs. QoS requirement to provide reliability gain with the goal to maximize the WSN system lifetime. Clustering is one of the best solutions to achieve the energy conservation and scalability in wireless sensor network. If the homogeneous network is consider then the cluster head (CH) is selected among all nodes which rotate in the network. Some of the protocol like HEED[2] is used to elect cluster head among all available nodes in the network. Recent studies [3][4] suggest that use of heterogeneous nodes can also improve the performance in better way and prolong the system lifetime in WSN. The nodes with highest resources like highest residual energy will perform the role of CH and they are useful to perform the task.

A routing protocol is used when a source node is not able to send its packets directly to its destination node and has to rely on the intermediate nodes to forward these packets on its behalf. Since a network is characterized by its limited wireless channel bandwidth, it would be beneficial if the amount of data transmitted to the sink can be reduced. To achieve this, a localize collaboration between the sensors in a cluster is required in order to reduce bandwidth. As the need for efficient use of WSNs, advanced clustering protocols were developed to meet the additional requirements like network lifetime, reduced and evenly distributed energy consumption etc. The most widely used WSN clustering protocols are (LEACH, EEHC, and HEED) [5][6].They are all probabilistic in nature and their main objective was to reduce the energy consumption and prolong the network lifetime.

Clustering has characteristics such as, energy-efficient, lower latency, *etc.* The idea of clustering is to select a cluster heads from the set of nodes in the network, and then remaining node become members of the cluster heads [7][8]. The data gathered are transmitted through cluster heads to sink . However, sink nodes are always fixed, which could result in the neighboring nodes to die faster. A typically clustered sensor network is illustrated in Fig 1. Clustering structure

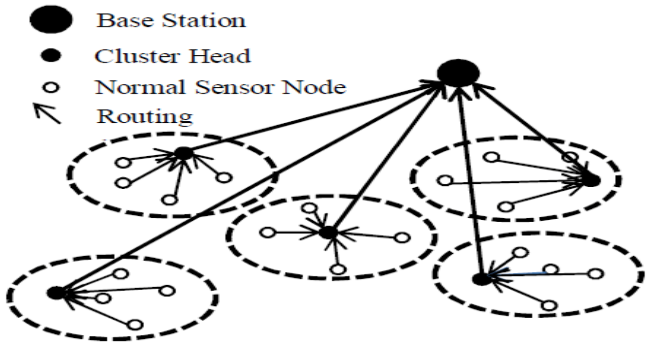

Fig 1. Clustering structure

In this paper, we propose a modified Election based Protocol (MEP), which employs the decision of selecting cluster heads by the sink is based on the associated additional energy and residual energy at each node In this In modified algorithm, the cluster head selects the shortest path to reach the sink between the direct approach and the indirect approach with the use of the congested link.

The part of the paper is organized as follows: Section 2 describes some related work, and our system model is provided in Section 3. In Section 4, our proposed MEP algorithm is explained. Section 5 presents simulation results and analysis. Section 6 gives a discussion of our work and finally Section 7 conclusion this paper.

B. Need of Proposed System

The problem in existing algorithm is to manage energy effectively of a clustered WSN to maximize system lifetime in the presence of unreliable nodes which are responsible for packet loss. We are addressing the tradeoff issue between energy consumption and Quality of service to acquire reliability and timeliness so that we can maximize the lifetime of a clustered WSN. We are analyzing the optimal amount of redundancy in WSN where data are routed to a remote sink in the presence of unreliable nodes, so that the probability to answer users query must be maximized while maximizing the system lifetime through multipath routing, there are two major problems exist, first is how many paths to use and second is which paths to use. We are concentrating on to address the how many paths to use to reach to the sink problem we are employing a algorithm for congested node so that there must be less energy conservation by the nodes in the network. The path is ignore through congested node in WSN. In this paper we decide how many paths to use in order to tolerate residual compromised node so as to increase system lifetime of the WSN.

2. RELATED WORK

A. Study of Existing techniques

Low-Energy Adaptive Clustering Hierarchy (LEACH) is clustering-based protocol that used randomized rotation of local cluster heads and evenly distribute the energy load among the sensor node in the network. LEACH reduces communication energy by as much as 8 times compared with direct transmission and minimum-transmission-energy routing [9]. Advantages can be summarized as follows: first, it can postponed the network lifetime compared to the original routing protocol and static clustering algorithms. Other advantage is , the cluster heads fuse the data collected from the other areas, and transfer it to the sink node, which could effectively raise the energy use ratio. Finally, LEACH distributes the task among every sensor node, reducing the overload of individual nodes .It uses a central control algorithm to form clusters, which distributes cluster heads more evenly throughout the network. Nodes with energy below the average cannot be used as cluster heads for the current round [10].

However, LEACH type algorithms have some disadvantages. First, the algorithm offers no guarantee about the placement of cluster head nodes. Second, if the cluster head dies in round *n*, the whole cluster is unable to transfer its data to the base station till the next round. This intermittent failure of clusters could be a problem when observing a region in real-time. Third, the individual sensor nodes transfer their data to the cluster head through single-hops, which is not suitable for large networks. Therefore, further research has been undertaken into some of these issues.

In Power-Efficient Gathering in Sensor Information System (PEGASIS) sensor node is distributed evenly for WSNs. Each node will receive from and transmit to close neighbors and be a leader for transmissions to the base station [11]. It assumes that all nodes have global information of the network; the base station is fixed at a far distance from the sensor nodes; the sensor nodes are homogeneous and the energy cost for transmitting a packet depends on the distance of transmission.

The Hybrid Energy-Efficient Distributed (HEED) [12] algorithm selects cluster heads according to energy node degree. There is a tradeoff between extending the time until the first node dies (FND) and the time until the last node dies (LND). In [13], protocol has been proposed to obtain a better compromise between stability and network lifetime. As the tradeoff that exists between network lifetimes and coverage is the major problem in fixed sink networks, the authors in [13] proposed an energy-aware coverage-preserving hierarchical (ECHR) algorithm which accommodates energy-balance and coverage-preservation.

In [15], an Energy-Efficient Unequal Clustering (EEUC) mechanism for continually data gathering in WSNs is proposed to address the hot spots problem. It partitions the nodes into clusters of unequal size, and clusters closer to the base station have smaller sizes than those far away from the sink.

Recently, several applications which introduce sink mobility into the wireless sensor networks have appeared. In some applications, mobile elements have been taken forward to attach network node for data collection. This is because the role of hot spot node will rotate among most sensors, which will basically balance the traffic load throughout the whole sensor network.

A network infrastructure based on the use of controllably mobile elements was discussed in [18], consumption of energy reduces for the communication at the energy constrained nodes and, thus, increasing useful network lifetime. In particular, the infrastructure focuses on network protocols and motion control strategies. In the reliability domain, various reliability requirements are supported by probabilistic multipath forwarding.

B. Analysis of Existing System

In Existing systems:-

- In existing works no consideration was given to redundancy management.
- In existing works no consideration was given to Energy Consumption & detection of hot spot.
- In existing works no consideration was given to Packet dropping & Energy Consumption & Maximization of WSN lifetime.

C. Comparison of existing systems with proposed system

In Existing System, effective redundancy management of a clustered WSN is used to prolong its lifetime operation in the presence of unreliable nodes. We address the tradeoff between energy consumption vs. Quality of Service to acquire in reliability, with the goal to maximize the lifetime of a clustered HWSN. More specifically, we analyze the optimal amount of redundancy through which data are routed to a remote sink in the presence of unreliable nodes.

3. SYSTEM MODEL

A. BasicAssumption

We make the following basic assumptions

1. Sensor nodes are deployed statically
2. Each nodes has unique id
3. Power adjustment of node base on distance

As per above consideration network is not to be homogeneous. It can be heterogeneous with various types of sensor and sink nodes.

B. Network Model:

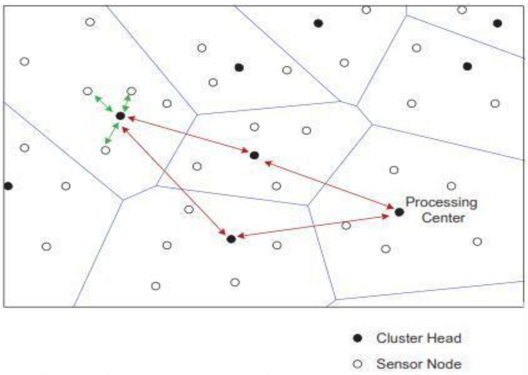

Fig.2 Network model

We are assuming that geographic routing which is a well known routing protocol for WSNs, is used to route the data from CH to the base station or sink along with multipath routing; thus, in this case there is no need to maintain path information of the network. We must familiar of the location of the destination node so that packet can be send correctly towards it. So the CH are responsible to get the location of all SN and vice versa in its cluster and it is the part of clustering. A CH are also aware with the location of neighbor CHs along with the direction towards the base station or sink.

The network is divided into group of cluster. Sensors node is selected as cluster head based on Threshold value ,which will be discussed in section 5.The sensor will transmit collected sensed data to the base station through cluster heads through single of multi hop transmission. The network model can be described as an undirected graph G(S,E) where S is the set of all sensor nodes and P(i,j) is the set of wireless link between node i and j. Let E be a energy efficient algorithm which saves the energy such that [19][20]

E={Wn,C,CH,P,N ¦ Φ s } where

Wn represent web network Wn = {wno¦ Φwn }

C represent cluster C = {co,c1,c2..cn¦ Φc }

CH represent cluster head CH = {ch0,ch2,ch2..chn¦ Φch}

P represent path P = {p0,p1,p2…pn¦ Φp}

N represent no of nodes N = {n0,n1,n2..nn¦ Φn }

C. C. Energy model :

We use radio energy model in equation to transmit an l bit length message through a distance d, the energy consumption by the radio is given by

For multi-hop communication, the calculation of energy consumption model is

$$\varepsilon(n) = c(n) \times h(n) \times e(n) \quad \text{------------ (1)}$$

Where $c(n)$ → Number of transmitted bit.

$h(n)$ →Average number of hops for the transmission.

$e(n)$ → Energy consumption to transmit single bit.

Every node sends data only to cluster node (i.e. if $h(n)=1$)

so energy consumption by individual node n_i in time t is given by,

$$\varepsilon(n_i) = c(n_i) \times 1 \times e(n_i) \times sr_i \times t \quad \text{------------ (2)}$$

Where sr_i → Sampling rate of node n_i in samples per second, ***t*** → time in seconds

Cluster head is responsible for forwarding all data in cluster. Hence energy consumption of cluster head is given by

$$\varepsilon(\mathrm{ch}) = h(ch) \times \sum_{i=0}^{n} \left(\varepsilon(\mathrm{ni})\right) \quad \text{----------- (3)}$$

Where $h(ch)$ is number of hops for transmission from cluster head to sink node and ***n*** is number of nodes in cluster. In current scenario node is selected as cluster head based on hop count values and same node is selected as cluster head throughout network life time.

Energy consumption of cluster node in time t is

$$\varepsilon_t(\mathrm{ch}) = t \times h(ch) \times \sum_{i=0}^{n} \left(\varepsilon(n_i)\right) \quad \text{------------- (4)}$$

In this proposed approach cluster head is selected periodically based on remaining energy of node, every node get chance to be cluster head for some period, i.e. in every period (t) node is cluster head for time $\frac{t}{n} or \left(t - \frac{t}{n}\right)$ time as normal node

Energy consumption by every node in time t is

$$\varepsilon(n_i) = c(n_i) \times 1 \times e(n_i) \times sr_i \times \left(t - \frac{t}{n}\right) + \frac{t}{n} \times h(ch) \times \sum_{i=0}^{n} \left(\varepsilon(n_i)\right) \quad (5)$$

Where P is a ratio of cluster heads among all sensors. 1/p is the relative number of nodes in one cluster, r is the index of current round and g is the set of nodes that have not been cluster heads in the last r mod(1/P) rounds.

In each round node generates a random number between 0 and 1. If the random number is < than the T(n), then node will be selected as a cluster head. After sensor node is selected as cluster head, threshold T(n) will be set to be 0. Hence every random number between 0 and 1 will not be smaller than the corresponding T(n. Sensor node which have not selected as cluster head will continue the selection with threshold T(n) which will increase as round increases. After the (1/P-1) round, T(n) = 1. Thus the remaining nodes which have not been cluster heads will be cluster heads in the last round.

In our proposed algorithm we consider network to be heterogeneous, where there are m number of percentage of advanced nodes which have the additional energy factor (alfa) in itslf compared with normal nodes. We assume the initial energy to be E0. The energy of advanced node in our proposed sensor network is E0*(1+ α).

The total energy of new heterogeneous network is calculated as follows.

$$N.(1-m)E0+n.m.E0(1+\alpha)=N.E0.(1+\alpha\,.\,m) \qquad (6)$$

Hence total energy increses by (1+alfa.m) times. Based on quation of probabilities for advanced and normal node we improved selection method with the residual energy of certain sensor nodes. As shown in equation probability of normal node is:

$$P_{nrm}=Popt/1+\alpha\,.m\ *\ E_{resiu}/E0 \qquad (7)$$

Popt is optimal percentage of cluster head, α is factor of additional energy,m is the percentage of advanced node,Eresi is energy left after certain rounds,and E0 is the initial energy of any nodes. Similarly probability of advanced node is

$$P_{adv}=Popt/1+\alpha\,.m * (1+\alpha)*\ E_{resi}/E0 \qquad (8)$$

Define threshold for normal and advanced node.

$$T(P_{nrm})=\ P_{nrm}/1-P_{nrm}\,[r \bmod (1/P_{nrm})] \qquad (9)$$

$$T(P_{adv})=\ P_{adv}/1-P_{adv}\,[r \bmod (1/P_{adv})] \qquad (10)$$

Where Where P is a ratio of cluster heads among all sensors. 1/p is the relative number of nodes in one cluster, r is the index of current round and g is the set of nodes that have not been cluster heads in the last r mod(1/P) rounds.

4. PROPOSED MEBR ALGORITHM

In our work, we consider redundancy management in multipath routes, system lifetime can be enhanced based on energy values of a HWSN in the presence of unreliable nodes. Also we considered congested node for maximizing throughput.

We are analyzing the optimal amount of redundancy in WSN through which data are routed to a remote sink. It is in in the presence of unreliable and congested nodes, therefore the probability to answer users query must be maximized and the system lifetime can be enhanced.

To congestion through multipath routing, there are two major problems to solve first is how many paths to use and second is what paths to use. We are focusing on to address the how many paths to use to reach to the sink problem. Our approach is different from existing for the, what paths to use problem, in that we consider specific routing protocols to solve the problem. . The congested nodes are detected and the path through that node is ignored from the heterogeneous WSN. In this paper we decide how many paths to use in order to tolerate residual congested nodes so as to increase system useful lifetime of the HWSN.Also We used multiple mobile sink in order to reduced burden on single sink node.

4.1 Cluster head selection

Cluster head S selected by sink node using election approach based on residual energy and future energy required. Equation for cluster head selection is as follows.

$$T(n)=\begin{cases}\frac{P}{1-P*(r \bmod \frac{1}{P})} & \text{if } n\in G\\ 0 & \text{otherwise}\end{cases} \quad \bullet \quad Eo/E_{resu} \qquad (11)$$

Where P is a ratio of cluster heads among all sensors. 1/p is the expected number of nodes in one cluster, r is the index of current round and g is the set of nodes that have not been cluster heads in the last r mod(1/P) rounds.

In each round sensor node generates a random number between 0 and 1. If the random number is < than the T(n), it will be selected as a cluster head. After sensor node is selected as cluster head, its corresponding T(n) will be set to be 0. Hence every random number between 0 and 1 will not be smaller than the corresponding T(n), which ensure that the cluster head will not be selected twice within 1/P round. Sensor node which have not selected as cluster head will continue the selection with threshold T(n) which will increase as round increases. After the (1/P-1) round, T(n) = 1. Thus the remaining nodes which have not been cluster heads will be cluster heads in the last round.

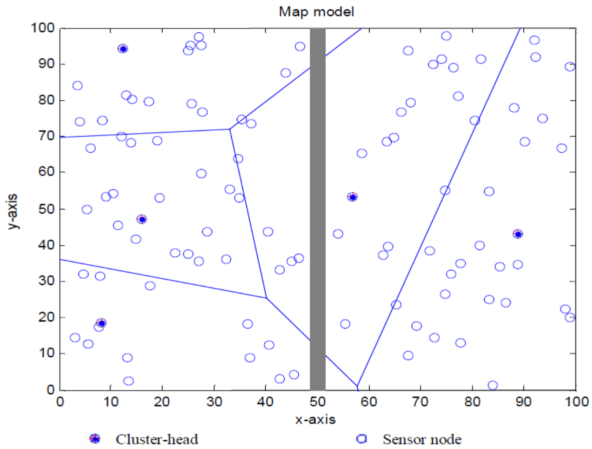

Fig.4 Llayering structure

4.2 Cluster formation flowchart

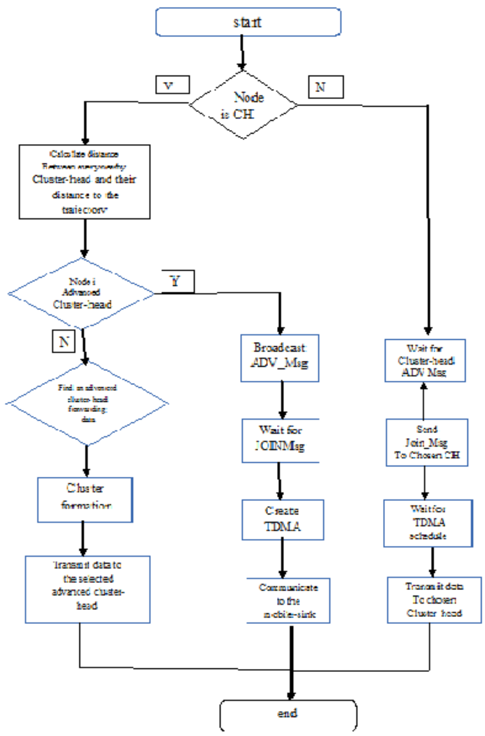

Fig. 3 Cluster formation flowchart

During the broadcasting phase each cluster head broadcasts an advertisement message and location among all members and depends on strongest signal strength members send join message to cluster head. After cluster head receives JOIN message from members ,it setup TDMA schedule and transmit this schedule among all members. By using TDMA schedule collision can be avoided. This effectively reduces energy consumptions for sensor node and prolong lifetime of the network. Assume sink nodes are moving at the center of network area. Calculate distance between advanced node to the nearest sink node depends on location. Finally cluster head wil transmit message to sink node. Then data is forwarded to main sink node.

5. PERFORMANCE EVALUATION

We used NS2 simulator to evaluate the performance of our proposed MMSE algorithm. Simulation parameters are listed as follows.

Table.1 Simulation parameters

Simulation Parameter	Representation	Unit
N	No of sensor Nodes	100
E0	Initial energy of nodes	0.2 J
E_{DA}	Data aggregation	5 nJ/bit/signal
E_{elec}	Energy dissipation to run the radia device	50 nJ/bit
L	Packet length	4000 bits

Figure 5 shows that the energy consumption increases as delay in LEACH is more as compared to MMSC algorithm

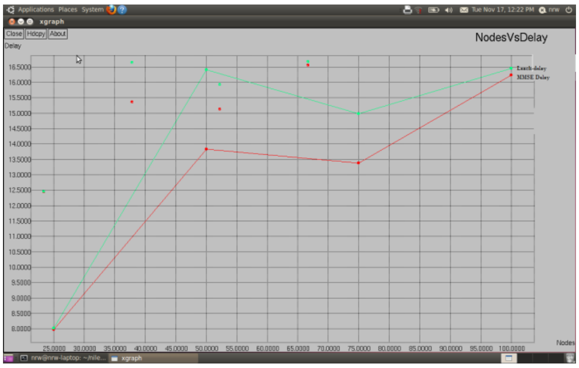

Fig. 5. Node Vs Delay

In Fig 6 shows the good delivery ratio as compared to LEACH protocol. We can find that the time when the first node dies in MSE is much longer than that in LEACH.

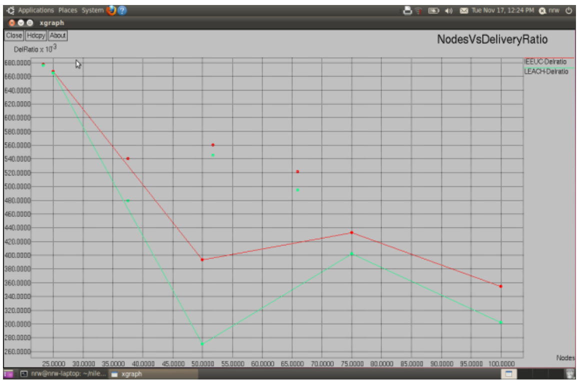

Fig.6 Node Vs Delivery Ratio

6. ACKNOWLEDGEMENT

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7. CONCLUSION

In this paper we described a election based modified MSE method for energy efficient routing in WSN. Our algorithm forms a hierarchical routing protocol by dividing the network into cluster and selecting CH base on election using remaining energy and location The modified algorithm shows good performance in balancing the energy and prolonging network lifetime.

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