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SCERP: A Lifespan Improvement Protocol for WSN using a Clustering Approach

Shital V. Bahale , Dr.M.A.Pund

P.G. Student ME CSE, PRMIT&R , Badnera -Amravati

Associate Professor, Department of Computer Science & Engg. , PRMIT&R , Badnera –Amravati.

ABSTRACT: In recent years real time implementation of Wireless Sensor Network has raised with great potential. A large number of low-power, low-cost, multifunctional wireless sensor nodes are consists in WSN, with sensing and communications capabilities. Key challenge in WSN are to utilize the energy of nodes efficiently, balance overall energy consumption of the network and thus extending network lifetime for this several energy efficient routing algorithms have been proposed till date.

To address these issues, a new technique of cluster head selection by considering ratio of nodes current energy and average network energy is taken into consideration. If a node satisfies certain threshold condition it remains as cluster head which minimizes energy required for election of new cluster heads and for re-clustering. Simulation result shows that there is an efficient increase in minimizing the node energy dissipation and will lead to maximize the network lifetime.

KEYWORDS: Network lifetime; Energy retention; Base station; Clustering in WSN

I. INTRODUCTION

Twenty-first centuries most important technology is wireless sensor network (WSN) [1]. From all over the world , industry and academia wireless sensor network in the past decades has received tremendous attention. A large variety of inexpensive, low-power , sensing element nodes, with wireless communications, sensing and computation capabilities is one amongst the component of WSN [2,3]. For communication over short distance sensor node uses a wireless medium. Sensor nodes collaborate to accomplish a common task, such as military surveillance, environment monitoring, and industrial process control [4]. The philosophy behind WSNs operation is that, even though each individual sensor node is limited in capability, the aggregate power of the entire network is sufficient for the required mission.

In hostile environments where it is impossible to access the sensors and recharge their batteries, energy poses a big challenge for network designers[24]. Furthermore, there will be a major impact on the network performance when the energy of a sensor reaches a certain threshold, the sensor will become faulty and will not be able to function properly.

Thus, routing protocols designed for wireless sensors network should be as energy efficient as possible to extend sensors lifetime, and hence prolong the network lifetime while guarantying overall good performance[5,22,23].

It is shown by the current researches that the clustering routing technology is the most influential technology for WSNs because of effective data communication and energy efficiency [6]. Clustering involves grouping of sensor nodes together, so that nodes communicate their sensed data to the cluster heads (CHs), cluster heads collect, aggregate and transmit the aggregated sensed data to the processing centre called base station for further analysis [7,25]. By reducing the amount of sensing element nodes that participate in long distance transmission cluster minimizes energy consumption and provides re-source utilization in WSNs [8,9].

In this paper for efficiently exploiting the power of each individual sensor node a self-organised cluster based energy balanced routing protocol for WSN is introduced. The ratio of current energy of a node and average network energy for selecting cluster heads from normal nodes by this considered by this improvement.

This paper is organized as follows into various sections. Section II presents some related work about various clustering protocols, Section III describes the proposed method, the simulation results and discussion are given in Section IV. Lastly, Section V describes conclusion.

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II. RELATED WORK

In[11,19] **Heinzelman, Chandrakasan** & **Balakrishnan** discuss and proposed Low Energy Adaptive Clustering Hierarchy (LEACH) a communication protocol for wireless sensor network. All nodes are self-organized, and protocol uses randomization for distribution of energy load evenly among the sensor nodes in the network. Then high energy cluster head position randomly rotated such that it rotates among the various sensors in order to not drain the battery of a single sensor. Then protocol runs for several rounds where each round consists of two phases: first Setup Phase and after that Steady-state phase.

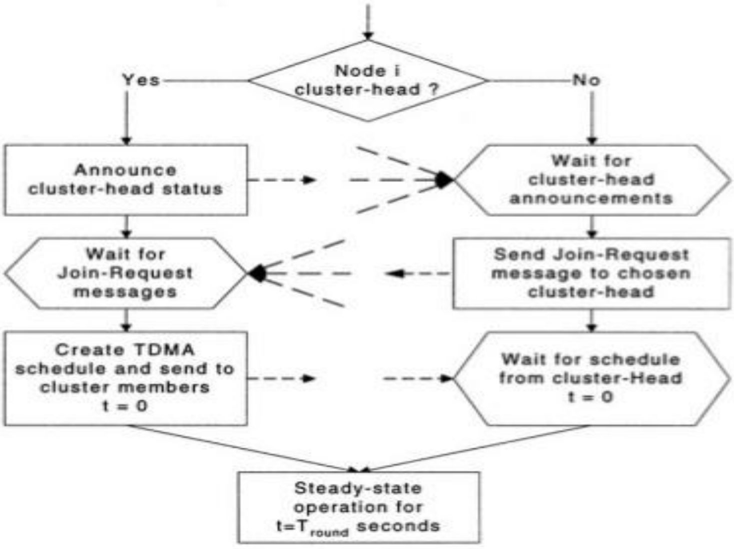

Fig. 1 Flow Chart of the Setup Phase of Leach Protocol

Clusters head selection and cluster are organized is done in set-up phase, followed by the steady state phase in which schedule for communication with the cluster head was created and data transmission to the base station will takes place. Steady-state phase is longer than setup phase to reduce the routing overhead of broadcasting request messages. Setup phase consist of advertisement phase and cluster setup phase.

Initially all the sensor nodes are randomly deployed in the network in Advertisement Phase. Now nodes will decide whether it will become the cluster head for that particular round or not. A random number between zero to one is generated by each node. If the generated number for a particular round is less than a threshold value (Tn), the node will become a cluster head. The threshold value may be calculated in [10] as:

$$T(n) = \begin{cases} \dfrac{p}{1 - p \times \left(r \times \bmod \dfrac{1}{p} \right)} & \text{if } n \in G \\ 0 & \text{otherwise} \end{cases}$$

Where p is the desired percentage of cluster heads, r is the current round, and G is the set of nodes that have not been cluster-heads in the last 1/p rounds.

Remaining nodes receives an advertisement message from a node that has been elected as cluster-head for the current round. Leaf nodes job is to keep sensing the messages throughout the setup phase to listen to the advertisement. Immediately after advertisement phase, each non cluster head node joins the cluster head to which it belong [12].

Limitations of LEACH Protocol:

1. Criteria for cluster head selection in LEACH are random and depend upon some probability instead of minimum residual energy of node or any cost function or path function i.e. distances between the base station or sink node and the node.
2. Some of the clusters may have CH at the edge of the cluster, thus Cluster head distribution is not uniform in Leach protocol.

S. Lindsey and C.S. Raghavendra proposed PEGASIS in [13] as an extension of the LEACH protocol. Sensor nodes form chains so that each node transmits and receives from a neighbor. From the chain only one node is

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selected for transmitting data to the sink, then aggregated data is gathered and transferred from node to node, and finally sent to the base station. PEGASIS avoids cluster formation and uses just one node in a chain to transmit to the sink. In the data fusion phase a sensor instead of sending directly to CH , transmits to its local neighbors.

PEGASIS routing protocol in its construction phase assumes that all the sensors have knowledge about, the positions of the sensors, and use a greedy approach. A greedy approach is used for chain construction when a sensor fails or dies because of low battery power. A randomly chosen sensor node from the chain will transmit the aggregated data to the BS in each round. In [20,21] performance analysis of PEGASIS with different protocols is is mentioned that reduces the per round energy expenditure compared to LEACH.

Although PEGASIS avoids the clustering overhead, it still requires dynamic topology adjustment since in order to have knowledge of where to route its data a sensor node needs to know about energy status of its neighbors. Significant overhead are often introduced by such topology adjustment in extremely utilized networks.

A. Manjeshwar and D. P. Agrawal introduced in [16] a hierarchical clustering protocol, which groups sensors into clusters with each led by a CH. In [17] W. Lou introduced a multipath routing protocol named as TEEN. First sensors report their sensed data to their CH, and then the aggregated data is sent to the higher level CH until the data reaches the sink. In [18] and [14], Parminder Kaur, Mrs. Mamta Katiyar and N.M. Elshakankiri, N. M. Moustafa and Y. H. Dakroury discuss the sensor network architecture in TEEN based on a hierarchical grouping. In TEEN clusters are formed by closer nodes and the process goes on the second level until the sink is reached. Application of TEEN is where the users can control a trade-off between response time and data accuracy, energy efficiency. A data-centric method with hierarchical approach is used by TEEN. Important feature of TEEN protocol is that it is suitable for time critical sensing applications.

G. Smaragdakis, I. Matta and A. Bestavros in [15] proposed SEP is another clustering protocol. To distribute energy uniformly in WSNs SEP uses a non-homogenous sensor nodes. In SEP the cluster head selection process uses two different levels of energy. A cluster head is elected from node with the highest weight according to their different energy and then subsequent CHs are elected using this process. There is a random selection of CHs and uniform energy consumption among sensor nodes in this approach.

This survey point out quick exhaust in energy level for nodes away from the sink, and nearer nodes still have required energy left for communication. For the long-run strength and health of the sensing element network ,this imbalance of energy consumption is definitely undesirable. Hence a cluster-based approach associated an economical routing protocol that uses this structure is proposed for WSN.

III. PROPOSED APPROACH

This section proposes SCERP, which reduces average energy consumption and enhance the network lifetime by balancing load of network among sensor nodes. In this approach BS is assumed to be located at a fixed, all the network nodes which are assumed to be located within the sensor field, closest nodes form clusters. Then the clustering process goes to the second level till the base station is reached. The main characteristic of SCERP protocol is in the cluster head selection process, to elect a cluster head, the ratio of nodes current energy with average network energy and distance is taken into consideration. In next round new cluster heads will be elected only when nodes energy is below threshold value. Thus energy required for re-electing cluster heads can be greatly reduced. Here nodes having sufficient energy for operation and whose distance to sink is minimum are elected as cluster head. The respective CH gets the sensed data from cluster member nodes, aggregates the sensed information and then sends it to the base station.

Flowchart of the proposed work

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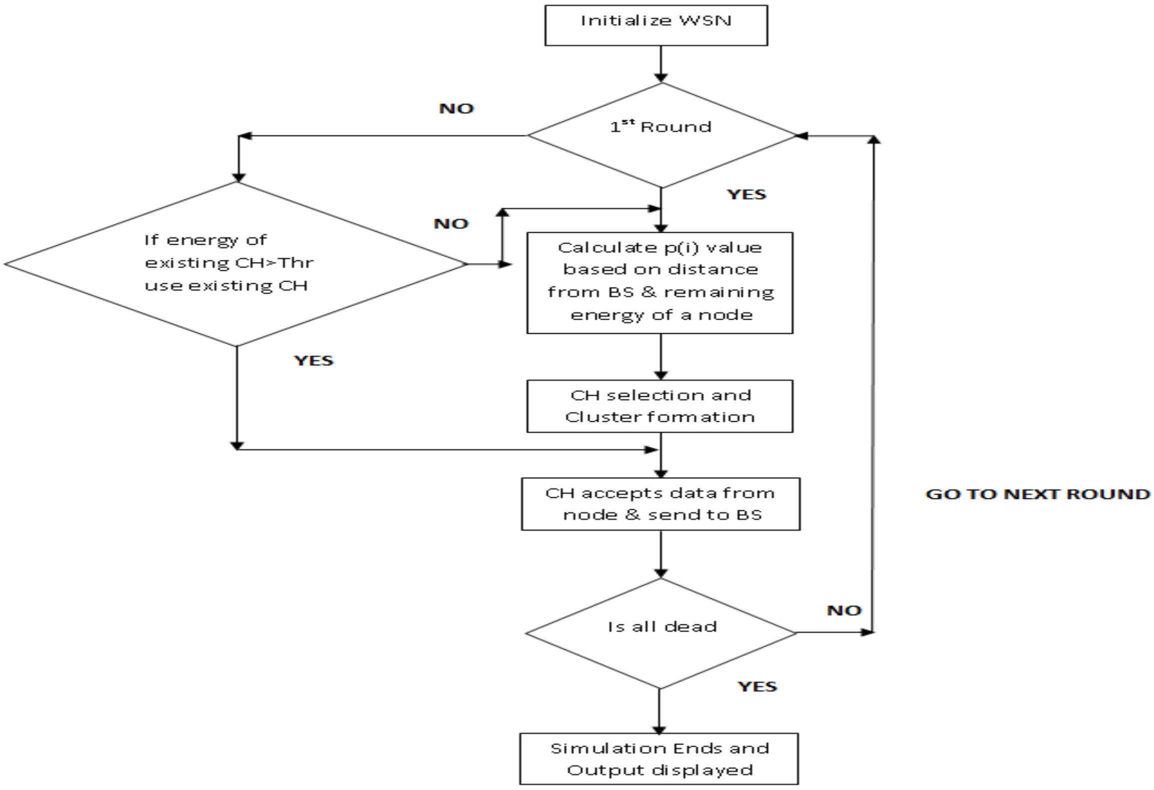

Fig.2 Flowchart Of proposed SCERP Protocol

IV. SIMULATION AND RESULTS

Here the simulation is performed in MATLAB for certain number of rounds. In order to implement the proposed algorithm same simulation parameters are used for both Leach and SCERP as listed in Table 1. Our goal is to compare the performance of these algorithms and the level of energy it attends after a certain number of rounds.

Table 1: Simulation Parameters

Parameter	Value
Area(x,y)	100,100
Base Station(x,y)	50,50
Nodes(n)	100
Initial Energy(Eo)	1.0
Maximum Lifetime	5000
Transmitter Energy	50nJ/bit
Receiver Energy	50nJ/bit

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Free space amplifier	10pJ/bit/m^2
Multipath amplifier	0.0013pJ/bit/m^4
Message size	4000 bits
Data aggregation	5nJ/bit/signal
P	0.1

Performance metrics are energy consumption per round, network lifetime when first and last node dies, data packets received by the base station per round in network.

Both Leach and SCERP protocol start with same initial energy and total 100 nodes in a network. The number of dead nodes per round for both Leach and SCERP is shown in figure 3. It shows that the network lifetime of SCERP is longer than that of Leach. Figure 4 shows the energy retention after each round for both Leach and SCERP protocol. For 100 nodes, the energy retention of SCERP is longer than that of Leach protocol. The Figure 5 depicts the number of packets routed to BS using Leach and SCERP protocol in 5000 rounds. Here graphs show packets routed to BS using SCERP is maximum.

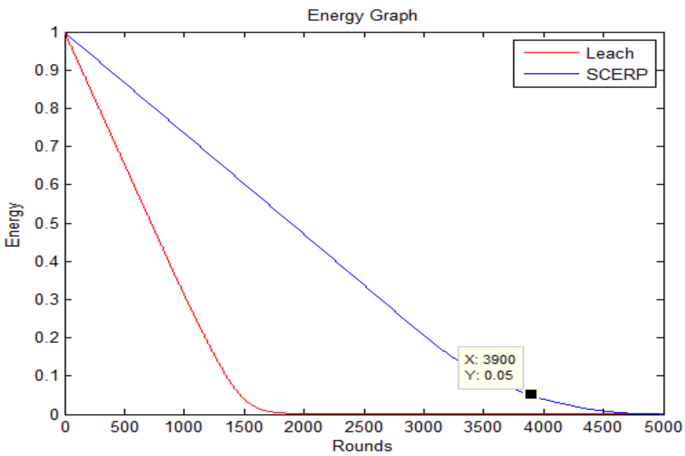

Fig. 3 Energy Retention graph of Leach verses SCERP protocol

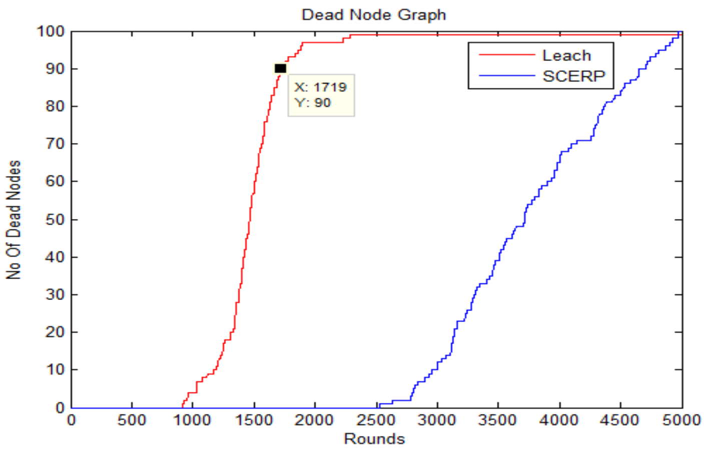

Fig. 4 Network Lifetime comparison of Leach and SCERP protocol

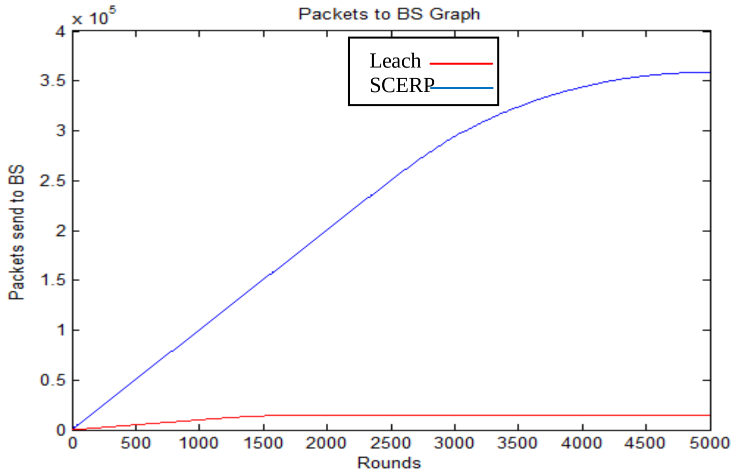

Fig. 5 Packets to Base Station graph of Leach and SCERP protocol

V. CONCLUSION

This paper for prolonging the sensor network lifetime presents a cluster-based routing protocol. To reduce the energy consumption of the WSN and to improve network lifetime, SCERP protocol is designed. From the results obtained it indicates that in proposed SCERP protocol total network lifetime is increased by 58% , where as energy retention is increased by 49% . It is proved by the simulation results that the proposed SCERP protocol outperforms Leach protocol in terms of energy consumption, network lifetime and packets send to BS.

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