Self-Organised Cluster based Energy Balanced Routing Protocol for Wireless Sensor Network

Shital V. Bahale
ME (CSE)
PRMIT & R, Badnera - Amravati.

M.A Pund, PhD
Prof. Department Of Comp. Engg.
PRMIT & R, Badnera - Amravati.

ABSTRACT
Wireless sensor network (WSN) is a system composed of a large number of low-cost micro-sensors. WSN provides low cost solutions to variety of real-world problems. Sensors are low cost tiny devices with limited storage, computational capability and power. The critical issue in Wireless Sensor Network is how to reduce the energy consumption of nodes. The power device of the sensor node in WSNs cannot be recharged or replaced so the energy efficiency is very important. The resource constrained nature of sensor nodes pose the unique challenges to the design of WSNs for their applications. The limited power of sensor nodes mandates the design of energy-efficient communication protocol.

To overcome this problem and to improve the performance need not only to minimize total energy consumption but also to balance WSN load. In this research, a cluster based routing protocol is proposed.

The proposed Self organized cluster based energy balanced routing protocol (SCERP) reduces energy consumption thus increasing lifetime of the network by separating network into more number of clusters.

The proposed protocol (SCERP) focus on an important parameter namely energy balance for WSN thus maximizing the network lifetime through even and uniform energy consumption. Limited power of sensor nodes mandates the design of energy-efficient communication protocol.

The critical issue in Wireless Sensor Network is how to reduce the energy consumption of nodes.

Since sensor nodes have limited power supply and cannot be easily recharged or replaced when the battery power is depleted, the operation of WSN needs to be energy efficient. If some sensor nodes have no more energy, the WSN may not allow reliable operation due to partition of the network[1,14]. Limited energy in each node affects the lifetime of the entire network, and as a result energy efficiency has been a critical design issue for the protocols of WSN[4]. Various protocols for sensor network have been developed for which energy efficiency is primary goal [5,6].

Keywords
Wireless Sensor Network, Cluster, Cluster Head, Energy Balance

1. INTRODUCTION
The fundamental goal of a WSN is to produce information from sensed data by individual sensor mode by prolonging the life time of WSN as much as possible. The resource constrained nature of sensor nodes pose the unique challenges to the design of WSNs for their applications. The proposed Self organized cluster based energy balanced routing protocol separates network into more number of clusters, then by means of distance, protocol is proposed to constructs a routing tree for each cluster. In routing tree, most number of children for cluster nodes is determined. Then the base station tells sensor nodes when to send or receive the data. The energy consumption of each sensor node in this round can be calculated by base station and used for calculating the topology for the next round.

Thus the proposed protocol minimizes the total transmission power aggregated over the nodes in the selected path, and balances the load among the nodes for prolonging the network lifetime.

This paper is organized as follow, section I is about introduction of topic, section II discusses Existing approaches in WSN, section III explores Clustering algorithms , and section IV discusses the proposed Self organized cluster based energy balanced routing protocol. Thus paper explores Energy balancing in WSN with SCERP. Conclusion summarizes our proposed work.

2. EXISTING APPROACHES IN WIRELESS SENSOR NETWORKS
Various protocols for sensor network have been developed for which energy efficiency is primary goal [5,6]. In general, routing in WSNs can be divided into flat-based routing, hierarchical-based routing, and location-based routing depending on the network structure[10].

Out of the protocols available, hierarchical protocols such as LEACH, HEED, PEGASIS, and PEDAP can achieve satisfactory solutions[9,15].

In [2,3,9] author introduced a hierarchical clustering algorithm for sensor networks, called Low Energy Adaptive Clustering Hierarchy (LEACH). LEACH is a cluster-based protocol, which includes distributed cluster formation. LEACH randomly selects a few sensor nodes as cluster heads (CHs) and rotate this role to evenly distribute the energy load among the sensors in the network. In LEACH, the cluster head (CH) nodes compress data arriving from nodes that belong to the respective cluster, and send an aggregated packet to the base station in order to reduce the amount of information that must be transmitted to the base station. LEACH uses a TDMA/CDMA MAC to reduce inter-cluster and intra-cluster collisions. However, data collection is centralized and is performed periodically. Therefore, this protocol is most appropriate when there is a need for constant monitoring by the sensor network.

In [7,8], the authors proposed a hybrid, energy-efficient, distributed clustering algorithm (HEED). HEED is an improvement of LEACH on the manner of CH choosing. In each round, HEED selects CHs according to the residual energy of each node and a secondary parameter such as nodes proximity to their neighbors or nodes degrees. By iterations and competition, HEED ensures only one CH within a certain range, so uniform CHs distribution is achieved across the network. Compared with LEACH, HEED effectively prolongs network lifetime and is suitable for situations such as where each node has different initial energy.

In [3,9,13], an enhancement over LEACH protocol was proposed. The protocol, called Power-Efficient Gathering in Sensor Information Systems (PEGASIS), is a near optimal chain-based protocol. The basic idea of the protocol is that in order to extend network lifetime, nodes need only communicate with their closest neighbors and they take turns in communicating with the base-station. When the round of all nodes communicating with the base-station ends, a new round will start and so on. This reduces the power required to transmit data per round as the power draining is spread uniformly over all nodes.

PEDAP [11] is a tree-based routing protocol that makes all the nodes form a minimum spanning tree, which costs minimum energy for data transmitting. It also has another version called PEDAP-PA which slightly increases energy for data transmitting but balances energy consumption per node. PEDAP has the same network assumptions as PEGASIS and uses data fusion.

In [12] the author proposed a hybrid protocol called HECTOR protocol based on two sets of virtual coordinates. One set is correspond to rooted tree coordinates, and the other one is based on hop distances on the way to some landmarks. In HECTOR, the node presently holding the packet forwards it to its neighbor that optimizes ratio of power cost in excess of distance progress with landmark coordinates, along with nodes that lessen landmark coordinates and do not increase distance in tree coordinates.

3. CLUSTERING ALGORITHM'S

3.1Cluster Head Selection Algorithm

In order for a node to become cluster head in a cluster the following assumptions were made.

- All the nodes have the same initial energy.
- There are S nodes in the sensor field.
- The number of clusters is K.

Based on the above assumptions, the average number of sensor nodes in each cluster is M where M=s/k

After M rounds, each of the nodes must have been a cluster head (CH) once.

We assigned each node a unique identifier i, Mi

for all i= 0,1, 2,3, 4, …S-1

Variable I is used to test whether it is the turn of a node to become a CH.

Originally, all nodes are the same, i.e.there is no CHs in each cluster, j= 0 where jis CHs counter.

A node q is selected among all nodes and continuously executes the following steps:

Firstly, q increments I by 1 and check if I is even, if yes that node is selected as the CH for that round and announces its new position to all member nodes in the cluster.

Else if I is odd, it cannot be a CH for that round, it will wait for the next round and be ready to receive advertisement message from the new CH.

A predetermined value is set (threshold value) for the new CH to transmit for that round.

When the value has reached, j will be incremented by 1 and the process of selection of new CH begins.

It continues until j= K. The algorithm stops when j= K. The new CHs collect sensed data from member nodes, aggregate them, and transmit the compressed data to the next cluster head or base station.

3.2Cluster Formation Algorithm

The next step in the clustering phase is cluster formation after CHs have been elected. Below gives the description

of new cluster formation.

Step 1:The new cluster heads elected above broadcast advertisements (ADV) message to all non-cluster nodes in the network using Carrier Sense Multiple Access (CSMA) MAC Protocol.

Step 2:Each sensor node determines which clusters it will join, by choosing CH that requires minimum communication energy.

Step 3: Each non-cluster node uses CSMA to send message back to the CHs informing them about the cluster it wants to belong.

Step 4: After CHs have received messages from all nodes, Time Division Multiple Access (TDMA) scheduling table will be created and send it to all nodes. This message contains time allocated to each node to transmit to the CH within each cluster.

Step 5:Each sensor node uses TDMA allocated to it to transmit data to the CH

Step 6:CHs will issue new TDMA slots to all nodes in their clusters when allocated time for G has elapsed.

4. SELF ORGANIZED CLUSTER BASED ENERGY BALANCED ROUTING PROTOCOL

The proposed Self organized cluster based energy balanced routing protocol (SCERP) reduces energy consumption thus increasing lifetime of the network by separating network into more number of clusters. Clustering is a good method in wireless sensor networks (WSNs) for effective data communication and towards energy efficiency. It involves grouping of sensor nodes together, so that nodes communicate their sensed data to the CHs. CHs collect, aggregate and transmit the aggregated data to the processing centre called base station for further analysis.

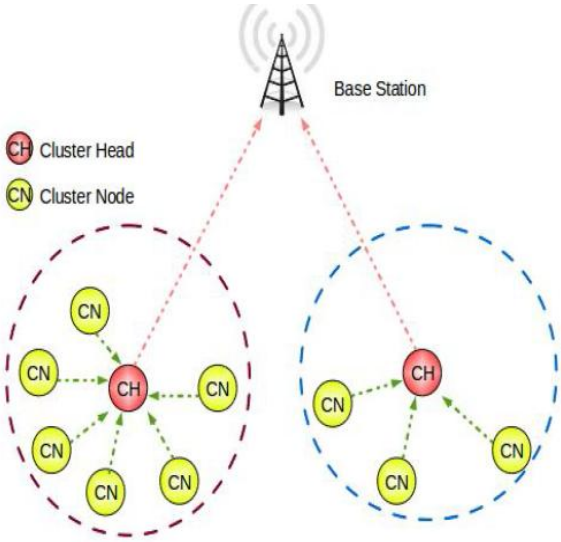

Fig. 1 Cluster Formation

The protocol operation is divided into rounds. Each round consists of three main phases: initialization phase, clustering phase and data transmission phase.

Phases of the proposed algorithm are:

A)Initial Phase

In initial phase, the network parameters are to be initialized and the nodes are formed into group of clusters.

B)Tree Constructing Phase

In a routing tree structure, for every cluster node a path to its cluster head is identified. Cluster head knows position of all nodes located in its cluster.

C) Self-Organized Data Collecting and Transmitting Phase

After the routing tree is constructed, each sensor node collects information to generate a DATA_PKT which needs to be transmitted to BS. By controlling the BS energy waste can be reduced .When BS receives all the data, the network will start the next phase.

D) Information Exchanging Phase

Since each node needs to generate and transmit a DATA_PKT in each round, it may exhaust its energy and die. This can influence the topography. So in information exchange phase the nodes that are going to die inform others.

The proposed Self organized cluster based energy balanced routing protocol (SCERP) focus on an important parameter namely energy balance for WSN thus maximizing the network lifetime through even and uniform energy consumption.

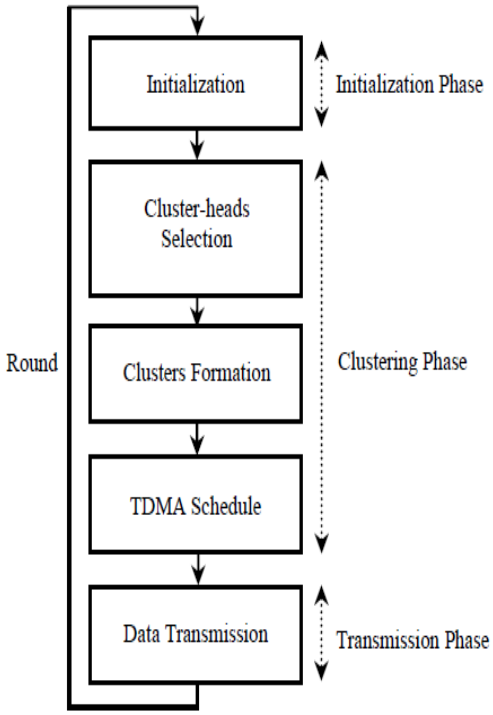

Fig.2 Proposed Protocol Operation

5. CONCLUSION

Due to the scarce energy resources of sensors, energy efficiency is one of the main challenges in the design of protocols for WSNs. The ultimate objective behind the protocol design is to keep the sensors operating for as long as possible, thus extending the network lifetime.

The proposed Self organized cluster based energy balanced routing protocol separates network into more number of clusters, then by means of distance, protocol is proposed to constructs a routing tree for each cluster. In routing tree, most number of children for cluster nodes is determined. Then the base station tells sensor nodes when to send or receive the data. The energy consumption of each sensor node in this round can be calculated by base station and used for calculating the topology for the next round.

Thus the proposed protocol minimizes the total transmission power aggregated over the nodes in the selected path, and balances the load among the nodes for prolonging the network lifetime.

6. REFERENCES

[1] Shio Kumar Singh, M P Singh,D K Singh "A Survey of Energy-Efficient Hierarchical Cluster-Based Routing in Wireless Sensor Networks" Int. J. of Advanced Networking and Applications Volume: 02, Issue: 02Pages: 570-580 (2010).

[2] Kyung Tae Kim and Hee Yong Youn "A Stochastic and Optimized Energy Efficient Clustering Protocol for Wireless Sensor Networks" International Journal of Distributed Sensor Networks Volume 2014.

[3] Laiali Almazaydeh, Eman Abdelfattah, Manal Al- Bzoor, and Amer Al- Rahayfeh "PERFORMANCE EVALUATION OF ROUTING PROTOCOLS IN WIRELESS SENSOR NETWORKS" International

Journal of Computer Science and Information Technology, Volume 2, Number 2, April 2010.

[4] Li-yong Yuan, Lin Xu,Yi-hua Zhu,and Cong Sun "An Energy-Efficient and Relay Hop Bounded Mobile Data Gathering Algorithm in Wireless Sensor Networks" International Journal of Distributed Sensor Networks.

[5] Jamal N. Al-Karaki Ahmed E. Kamal" Routing Techniques in Wireless Sensor Networks: A Survey"

[6] A. K. M. Muzahidul Islam_, Koichi Wada, Jiro Uchida and Wei Chen "A BETTER DYNAMIC CLUSTER-BASED STRUCTURE OF WIRELESS SENSOR NETWORK FOR EFFICIENT ROUTING" *International Journal of Innovative Computing, Information and Control* ICIC International Volume 8, Number 10(A), October 2012.

[7] Srigitha S. Nath,M. Deepa Lakshmi,Dr. K. Helen Prabha "*Multi Objective Energy Aware Clustering with Stato Dynamic Routing Protocol for Wireless Sensor Networks*" International Journal of Advance Research in Computer Science and Management Studies VOL 2,Issue 7, Dec 2013.

[8] Younis O. and Fahmy S., "HEED: A Hybrid, Energy-Efficient, Distributed Clustering Approach for Ad Hoc Sensor Networks", IEEE Transactions on Mobile Computing, vol. 3, no. 4, 2004 , pp. 660-669.

[9] V.Chandrasekaran, Dr.A.Shanmugam " An Energy Efficient Multihop Hierarchical Routing in Wireless sensor Networks" *IOSR Journal of Electronics and Communication Engineering (IOSR-JECE) Volume 5, Issue 4 (Mar. - Apr. 2013), PP 61-65.*

[10] Anil Kumar , Preeti gulia , Shikha Sharma "A Study on Power Saving and Secure WSN" *International Journal of Engineering Trends and Technology (IJETT) – Volume 11 Number 4 - May 2014.*

[11] M.Sengaliappan, Dr.A.Marimuthu "IMPROVED GENERAL SELF-ORGANIZED TREE-BASED ROUTING PROTOCOL FOR WIRELESS SENSOR NETWORK" Journal of Theoretical and Applied Information Technology 10th October 2014. Vol. 68 No.1

[12] Nathalie Mitton , Tahiry Razafindralambo, David Simplot-Ryl and Ivan Stojmenovic "Towards a Hybrid Energy Efficient Multi-Tree-Based Optimized Routing Protocol for Wireless Networks" www.mdpi.com/journal/sensors Sensors 2012, 12, 17295-17319.

[13] Quazi Mamun "A Qualitative Comparison of Different Logical Topologies for Wireless Sensor Networks"

[14] I.F. Akyildiz, W.Su, Y. Sankarasubramaniam and E.Cayirci, "Wireless Sensor Networks: a Survey", Computer Networks, Volume 38, N.4, March 2002.

[15] Zhao Han, Jie Wu, *Member, IEEE*, Jie Zhang, Liefeng Liu, and Kaiyun Tia" A General Self-Organized Tree-Based Energy-Balance Routing Protocol for Wireless Sensor Network" IEEE TRANSACTIONS ON NUCLEAR SCIENCE, VOL. 61, NO. 2, APRIL 2014.