World Academy of Science, Engineering and Technology
International Journal of Electronics and Communication Engineering
Vol:10, No:12, 2016

Optimized Energy Scheduling Algorithm for Energy Efficient Wireless Sensor Networks

S. Arun Rajan, S. Bhavani

***Abstract*—**Wireless sensor networks can be tiny, low cost, intelligent sensors connected with advanced communication systems. WSNs have pulled in significant consideration as a matter of fact that, industrial as well as medical solicitations employ these in monitoring targets, conservational observation, obstacle exposure, movement regulator etc. In these applications, sensor hubs are thickly sent in the unattended environment with little non-rechargeable batteries. This constraint requires energy-efficient systems to drag out the system lifetime. There are redundancies in data sent over the network. To overcome this, multiple virtual spine scheduling has been presented. Such networks problems are called Maximum Lifetime Backbone Scheduling (MLBS) problems. Though this sleep wake cycle reduces radio usage, improvement can be made in the path in which the group heads stay selected. Cluster head selection with emphasis on geometrical relation of the system will enhance the load sharing among the nodes. Also the data are analyzed to reduce redundant transmission. Multi-hop communication will facilitate lighter loads on the network.

***Keywords*—**WSN, wireless sensor networks, MLBS, maximum lifetime backbone scheduling.

I. Introduction

WIRELESS Sensor Networks (WSNs) are right now being utilized in an assortment of utilizations extending from restorative to military, and from home to industry. WSNs and its applications aim at providing a reference tool for the people who rely on reliable sensors. A WSN involves spatially appropriated self-managing devices to supportively screen physical or environment conditions, for instance, temperature, sound, vibration, weight, development or pollutions [2]. The growth of WSNs was inspired by military applications such as battleground observation and it is now applied in several engineering and civilian application areas, including manufacturing process monitoring and control, machine fitness checking, atmosphere and locale monitoring, healthcare applications, home robotics, and traffic control [5]. The individual devices in a WSN are inherently resource constrained. Furthermore, these WSNs comprise of expansive number of parts called sensor hubs. Hubs convey remotely the information they have gained utilizing their sensors to the base station. Sensor hubs are relied upon to deal with batteries for a while to a couple of years without recharging. Consequently, vitality productivity turns into a basic issue in WSNs [6]. This limitation requires vitality productive systems to draw out the system lifetime. There are repetitions in information sent over the system [3]. To overcome this, an optimized energy scheduling approach has been proposed. Previously [3], [5], [6] researches were done to improve the validity of the WSN node likely LEACH, PEAGASIS, DEEC and VBS.

S. Arun Rajan is with the Electrical and Electronics Engineering Department, Karpagam Academy of Higher Education, Karpagam University, Coimbatore, Tamilnadu 641021 India (phone: +91-8675020920; e-mail: sarunrajan.karpagamuniv@gmail.com).

Dr. S. Bhavani is with Electronics and Communication Engineering Department, Karpagam University, Coimbatore, Tamilnadu 641021 India (e-mail: bhavanisns@yahoo.com).

Existing methodologies slightly improve the life expectancy of WSN nodes, but they have some drawbacks because of non-consideration of the factors like geometrical correlation of the nodes, value of the data and Multi-level clustering. To enhance the lifetime of WSN hubs multi-level specially appointed grouping is proposed with essential and auxiliary cluster heads [6]. Data transfer will be from primary to inferior cluster head and then to the sink. Cluster head assortment will be based on spatial factors, i.e., distance of the hub from the base station and node density around the cluster head. Also multi-hop communication will facilitate lighter loads on the network [7].

II. Literature Survey

A. LEACH

Low Vitality Adaptive Clustering Hierarchy is one of the significant changes in remote sensor systems clustering technology [1]. LEACH oversees stack worry among the bunch heads by turning the cluster heads in each round. The hubs which are not a bunch head in the past round are utilized as a pool as a part of which the cluster head is chosen in light of the likelihood work [4]. The choice of whether a hub is lifted to a group head is made powerfully at every interim.

$$T(n) = \frac{P}{1-\left(r mod \frac{1}{p}\right)} \text{ if n €G} \quad (1)$$

The cluster head is nominated by (1) where n is the given hub, P is the a priori likelihood of a hub being chosen as a bunch head, r is the current round number and G is the arrangement of hubs that have not been chosen as group heads in the last rounds [3]. Although LEACH provides a way that the load can be shared with the nodes, it does not consider the vitality of the hubs and the separation they are from the base station. Henceforth, the heap fluctuation in LEACH calculation is higher because of its randomness in selection of the cluster head.

B. PEGASIS

PEGASIS (Power Efficient Gathering Systems in Sensor Intelligence Systems) is a grid based system which suggests the node formation chain that gives lesser distance of node transmissions. At any instance of time, energy saving is achieved only when one node is transmitting towards the base station [1], [3]. PEGASIS enforces the energy saving mechanism at the node level compared to the hierarchical level [1]. Every node in the cluster experiences data aggregation. Although the energy consumption is less, an improper load variance is observed because end node handles more data than the start node [3], therefore the residual energy is not considered. So, there will be more possibility of having high rate of dead nodes at the end of the rounds.

C. DEEC

DEEC took the idea of remaining vitality and normal vitality of the system in choosing the cluster heads with existing heterogeneity of the hubs and effectively enhanced the steering in system [3]. Different types of DEEC were investigated which enhances the routing further, for example [2], [4] DDEEC and EDEEC. DDEEC utilizes same strategy for estimation of average energy in the system and CH selection algorithm in view of residual energy as utilized as a part of DEEC. DDEEC presents a residual energy threshold technique [4] that, when the advanced as well as the normal node reaches its minimum level of its residual threshold energy, then both [2] (normal and advanced) of the nodes uses the same probability to become a cluster head. EDEEC, which is the enhanced version of the DEEC; is proposed to insert another node (super node) in the network with normal as well as advanced nodes, which increases the heterogeneity and lifetime of the network. It has been observed that, DDEEC having [4] low stability period, decreased lifetime and decreased throughput as comparing [3], [5] with the EDEEC.

D. VBS

Backbone scheduling forms a dynamic system in which radios are alternatively turned ON and OFF. The communication quality will not get affected, as WSNs are having redundancy in the network. A single backbone may not be sufficient and several backbones are required for improving network lifetime [5]. In a VBS, a fine grained sleep wake scheduling algorithm is proposed that the duty cycle is varied throughout the system period.

III. Proposed Methodology

Multi-level ad-hoc clustering is proposed with primary and inferior cluster heads. Data transfer will be from primary to inferior cluster head and then to the sink. Cluster head assortment will be based on spatial factors, i.e., distance of the node from the base station and node density around the cluster head. Data value will be considered in load balanced clustering.

A. Cluster Head Assortment

$$P_{norm}=\frac{p_{opt}}{(1+a*m-m*m0*(a-\left(\frac{b+c}{2}\right))}$$

$$P_{adv}=\frac{p_{opt*(1+a)}}{(1+a*m-m*m0*(a-\left(\frac{b+c}{2}\right))}$$

$$P_{super}=\frac{p_{opt*(1+b)}}{(1+a*m-m*m0*(a-\left(\frac{b+c}{2}\right))}$$

$$P_{sadv}=\frac{p_{opt*(1+c)}}{(1+a*m-m*m0*(a-\left(\frac{b+c}{2}\right))}$$

P_{norm}, P_{adv}, P_{super}, P_{sadv} = Probabilities for normal, advanced, super and super advanced nodes.

B. Node Scheduling

1. Node scheduling is the course of facilitating nodes periodically to save resources.
2. Scheduling is useful in applications where frequent changes in data do not occur.
3. Virtual Backbone Scheduling is an effective method for turning nodes ON and OFF periodically while maintaining data integration. The nodes are turned on and off based on a switching probability.

The switching probability is calculated based on node residual energies when compared to the typical energy of the overall system

$$P_{switch}=\begin{cases}1-Er,\ if\ \overline{E_r}\geq E_T \wedge Er\leq\overline{Er}, \\ 0, \qquad if\ \overline{E_r}<E_T \vee Er>\overline{Er},\end{cases}$$

P_{switch} = Node switching probability, Er = Node average energy ET = Node energy.

C. Two Level Structure

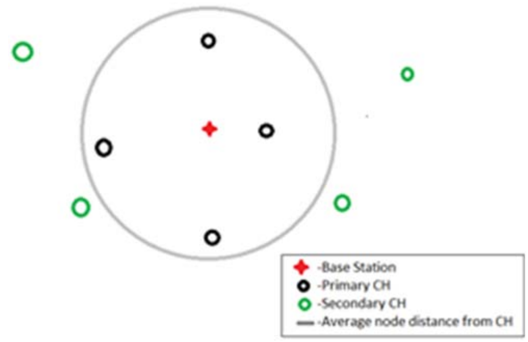

Fig. 1 Two Level Architecture

D. Algorithm for Data Linking

STEP 1: *The nodes' energy levels are measured and the typical energy is calculated.*
STEP 2: *The possibilities of nodes of becoming a cluster head are calculated using the heterogeneous DEEC probability equations.*
STEP 3: *The cluster heads are chosen by means of the probability.*
STEP 4: *The cluster heads can be split into two zones based on distance to the base station*
STEP 5: *The non-CH nodes propel information to the nearest CH. Therefore, the outer nodes send to the outer secondary CH and inner nodes direct the data to inner primary CH*
STEP 6: *The secondary CH aggregate information and lead to primary CH called multi-hop communication*
STEP 7: *The primary CH aggregate data from secondary Cluster Heads and hubs and transfer them to the base station.*

E. Data Link Structure

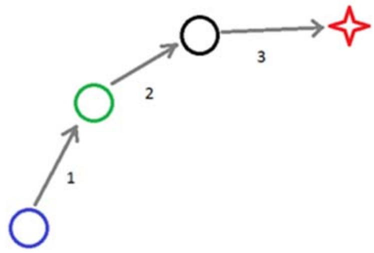

Fig. 2 Link Representation

Communication Strategy:

1. Transfer from node to nearest secondary cluster head
2. Multi-hop communication from secondary to primary CH
3. Data aggregation from primary CH to base

IV. Experimental Results

As a declaration observed from the results in Figs. 3-7, the random distribution of WSNs over an area of 100 m^2 is obvious. Also it is clear that, dynamicity of system lifetime is achieved among LEACH, PEGASIS and DEEC [1], [3], [4]. The reproduction was completed in MATLAB R2013b.

TABLE I
Network Simulation Parameters and Values

Parameter	Value
No. of Nodes	100
Sensing region	100 *100 m
E_{elec}	50 nJ/bit
E_{DA}	5 nJ/bit
ε_{fs}	10 pJ/(bit.m^2)
ε_{mp}	0.0013 pJ/(bit . m^4)

The parameters given in Table I were considered for simulation of the network. Initially, the sensor nodes are deployed randomly in the sensing region. The presented clustering method is used for CH selection. The method is compared [2], [4], [5] with PSO, LEACH and DEEC. The parameters are responsible for the network lifetime are considered for comparison.

In Fig. 3, we compare the number of alive nodes against the number of rounds for different algorithms. As a result of comparison with other existing algorithms [5], [6], the number of alive nodes increases with respect to the rounds by using our proposed method. Therefore, the performance of DEEC is less compared to our system.

Fig. 4 reveals the comparison of total energy consumption throughout the simulation of 1000 rounds. It is clear from Fig. 4 that the energy consumption of all the nodes deployed in the network is least when using the presented algorithm.

Fig. 5 depicts the total number of packets received by the BS. The presented method sends the largest number of packets and it provides better packet delivery than LEACH [3].

Fig. 6 shows the Packet Delivery Ratio of different algorithms. It is evident that the presented method has better PDR throughout the rounds [7].

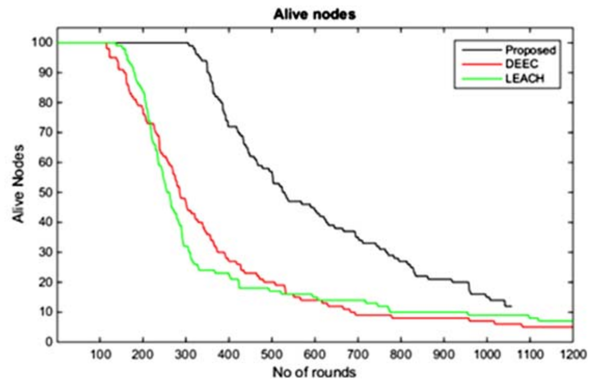

Fig. 3 Number of alive nodes Vs. Number of Rounds

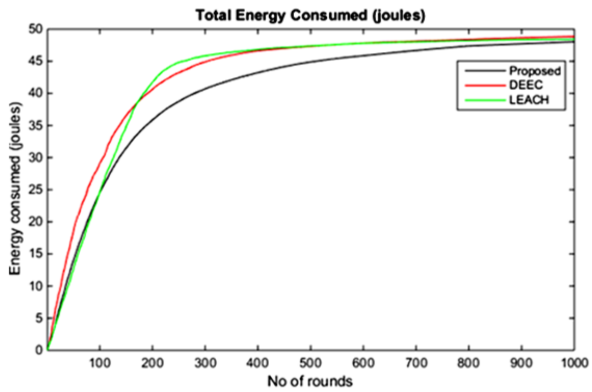

Fig. 4 Energy Consumed Vs. Number of Rounds

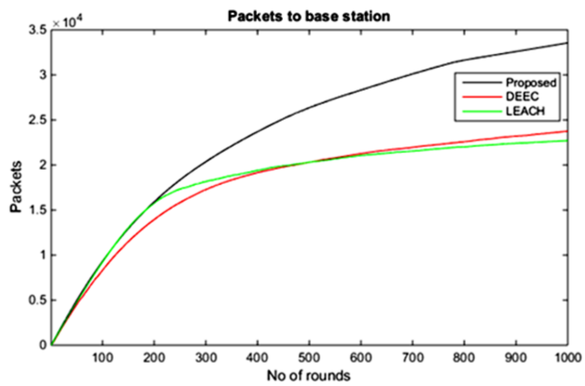

Fig. 5 Total Packets received by BS

Fig. 6 Comparison of Packet Delivery Ratio

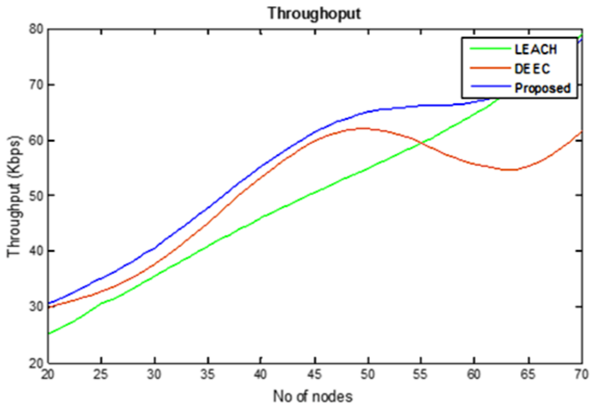

Fig. 7 Comparison of Throughput

Fig. 7 shows the throughput of the network for different methods [5], [7]. It is clear from the Fig. 7 that the presented method maintains a clear lead among the other two methods throughout the rounds.

V. CONCLUSION

This article contributes to the maximization of system lifetime by recommending an algorithm for cluster head allocation [2]. Hereby, we are allocating the cluster heads in every cluster by acquiring data, such as transmitted data and number of nodes [5]. A significant improvement in network lifetime and efficient load balancing is observed from the results. Thus, the simplicity and practical usability of the suggested concept is proved by the obtaining of information by each node without congestion or any multiple computations, with the lifetime improvement of the network. Therefore it is obvious that, WSNs data accumulation can be effectively managed by the presented system.

REFERENCES

[1] C.-T. Cheng, C. K. Tse, and F. C. Lau, "A clustering algorithm for wireless sensor networks based on social insect colonies," Sensors Journal, IEEE, vol. 11, pp. 711-721, 2011.

[2] Y. Liao, H. Qi, and W. Li, "Load-balanced clustering algorithm with distributed self-organization for wireless sensor networks," Sensors Journal, IEEE, vol. 13, pp. 1498-1506, 2013.

[3] T. Ankit and K. Ketan, "Cluster Head Election for Energy and Delay Constraint Applications of Wireless Sensor Network," IEEE Sensors Journal, vol. 14, pp. 2658 - 2664, Aug. 2014

[4] P. Yaxiong Zhao, "On Maximizing the Lifetime of Wireless Sensor Network Using Virtual Backbone Scheduling," IEEE Trans . Parallel Distributed Systems, vol. 23, no. 8, pp.567-650, Aug 2012.

[5] R. Cohen and B. Kapchits, "An Optimal Wake-Up Scheduling Algorithm for Minimizing Energy Consumption while Limiting Maximum Delay in a Mesh Sensor Network," IEEE/ACM Trans. Networking, vol. 17,no.2,pp. 570-581,Apr. 2009.

[6] Vuran, Mehmet C.; Akyildiz, I.F. "XLP: A Cross-Layer Protocol for Efficient Communication in Wireless Sensor Networks", Mobile Computing, IEEE Transactions on, on page(s): 1578 - 1591 Volume: 9, Issue: 11, Nov. 2010.

[7] Ozgovde, A.; Ersoy, C. "WCOT: A Realistic Lifetime Metric for the Performance Evaluation of Wireless Sensor Networks", Personal, Indoor and Mobile Radio Communications, 2007. PIMRC 2007. IEEE 18th International Symposium on, on page(s): 1 – 5.