International Journal of Research and Development in Applied Science and Engineering (IJRDASE)
ISSN: 2454-6844

A Review on Exterior Bound Allotted Advanced Node Distribution for Energy Efficient Clustering (EBAN DEEC) Protocol

Ashish Prakash
Electronics and Communication Engg,
I.E.T., DRMLAU, Ayodhya, India
ashishprakash585@gmail.com

Ramesh Mishra
Electronics and Communication Engg,
I.E.T., DRMLAU, Ayodhya, India
rameshmishra1985@gmail.com

Astha Singh Kushwaha
Electronics and Communication Engg,
I.E.T., DRMLAU, Ayodhya, India
sastha75@gmail.com

***Abstract*-** **In latest years, numerous guidance conventions have been proposed to enhance the lifetime, deployment of nodes, power performance, latency, robustness, fault tolerance, and reliability of Wireless Sensor Networks (WSN). The vitality necessities and drawing out the lifetime of the WSN is imperative a part of guidance conventions. Diverse bunch primarily based directing convention have proposed to enhance the normal conventions i.e. Direct transmission, multi-soar steering, static bunching and least transmission-power. Among all organization primarily based conventions, DEEC is the most conspicuous WSN conference. In this paper, we have got attempted to increase the DEEC by such as numerous components in DEEC for homogeneous and heterogeneous situations.**

Keywords-- Data aggregation, Dynamic cluster head rotation, Heterogeneous system, DEEC Protocol, WSN.

1. Introduction

DEEC, that is a WSN protocol for homogeneous structures, isn't always appropriate for heterogeneous systems. Putting few heterogeneous nodes in a Wireless Sensor Network is an powerful manner to increase the network's stability and lifelong. The electricity saving schemes used for homogeneous WSNs does not works effectively when used for heterogeneous WSNs. Thus, a brand new energy efficient clustering protocol need to be designed for them. Heterogeneous WSNs are very an awful lot useful in actual deployments due to the fact they may be more close to real existence situations.

We can divide heterogeneous WSN device especially in three components.
1) Computational heterogeneity
2) Link heterogeneity
3) Energy heterogeneity

1.1. Computational heterogeneity:

In this type of system, some of the nodes have more energy than the other normal nodes. The heterogeneous nodes can provide some benefits such as complex data processing and long term storage with the use powerful computational resources. We are going to use this approach in EBAN DEEC Phase 2.

1.2 Link heterogeneity:

Here, some of the heterogeneous nodes have higher bandwidth and longer distance network transceiver than the normal nodes. It can provide more reliable data transmission.

1.3 Energy heterogeneity:

This system has some of the heterogeneous nodes that are line powered or their batteries are replaceable.
For our protocol, Computational heterogeneity is the best suitable. Because in EBAN DEEC, we are trying to increase the lifetime of the network. By distributing powerful calculations to advance nodes, we can increase the network lifetime. Link heterogeneity is dealing with the quality and reliability of packets whereas; Energy heterogeneity can be implemented in practical situations. We are not considering Link and Energy heterogeneity from the algorithm point of view.

2. Related Work:

Georgios Smaragdakis et.al. (2004) [2] they study the impact of heterogeneity of nodes, in terms of their energy, in wireless sensor networks that are hierarchically clustered. In these networks some of the nodes become cluster heads, aggregate the data of their cluster members and transmit it to the sink. We assume that a percentage of the population of sensor nodes is equipped with additional energy resources—this is a source of heterogeneity which may result from the initial setting or as the operation of the network evolves. We also assume that the sensors are randomly (uniformly) distributed and are not mobile, the coordinates of the sink and the dimensions of the sensor field are known. We show that the behaviour of such sensor networks becomes very unstable once the first node dies, especially in the presence of node heterogeneity. Classical clustering protocols assume that all the nodes are equipped with the same amount of energy and as a result, they can not take full advantage of the presence of node heterogeneity. We propose SEP, a heterogeneous-aware protocol to prolong the time interval before the death of the first node (we refer to as stability period), which is crucial for many applications where the feedback from the sensor network must be reliable. SEP is based on weighted election probabilities of each node to become cluster head according to the remaining energy in each node. We show by simulation that SEP always prolongs the stability period compared to (and that the average throughput is greater than) the one obtained using current clustering protocols. We conclude by studying the sensitivity of our SEP protocol to heterogeneity parameters capturing energy imbalance in the network. We found that SEP yields longer stability region for higher values of extra energy brought by more powerful nodes.

They proposed SEP (Stable Election Protocol) so every sensor node in a heterogeneous two-level hierarchical network independently elects itself as a cluster head based on its initial energy relative to that of other nodes. Unlike [17], we do not require any global knowledge of energy at every election round. Unlike [7, 14], SEP is dynamic in that we do not assume any prior distribution of the different levels of energy in the sensor nodes. Furthermore, our analysis of SEP is not only asymptotic, i.e. the analysis applies equally well to small-sized networks. We are currently extending SEP to deal with clustered sensor networks with more than two levels of hierarchy and more than two types of nodes. They are also implementing SEP in Berkeley/ Crossbow motes and examining deployment issues including dynamic updates of weighted election probabilities based on current heterogeneity conditions. SEP code and results are publicly available at http://csr.bu.edu/sep.

The first work that questioned the behaviour of clustering protocols in the presence of heterogeneity in clustered wireless sensor networks was [17]. In this work Heinzelman analyzed a method to elect cluster heads according to the energy left in each node. The drawback of this method is that this decision was made per round and assumed that the total energy left in the network was known. The complexity and the assumption of global knowledge of the energy left for the whole network makes this method difficult to implement. Even a centralized approach of this method would be very complicated and very slow, as the feedback should be reliably delivered to each sensor in every round.

In [7], Duarte-Melo and Liu examined the performance and energy consumption of wireless sensor networks, in a field where there are two types of sensors. They consider nodes that are fewer but more powerful that belong to an overlay. All the other nodes have to report to these overlay nodes, and the overlay nodes aggregate the data and send it to the sink. The drawback of this method is that there is no dynamic election of the cluster heads among the two type of nodes, and as a result nodes that are far away from the powerful nodes will die first. The authors estimate the optimal percentage of powerful nodes in the field, but this result is very difficult to use when heterogeneity is a result of operation of the sensor network and not a choice of optimal setting.

In [14], Mhatre and Rosenberg presented a cost based comparative study of homogeneous and heterogeneous clustered wireless sensor networks. They proposed a method to estimate the optimal distribution among different types of sensors, but again this result is hard to use if the heterogeneity is due to the operation of the network. They also studied the case of multi-hop routing within each cluster (called M-LEACH). Again the drawback of the method is that only powerful nodes can become cluster heads (even though not all of the powerful nodes are used in each round), and that M-LEACH is valid under many assumptions and only when the population of the nodes is very large.

Li Qing et.al. (2006) [3], The clustering Algorithm is a kind of key technique used to reduce energy consumption. It can increase the scalability and lifetime of the network. Energy-efficient clustering protocols should be designed for the characteristic of heterogeneous wireless sensor networks. We propose and evaluate a new distributed energy-efficient clustering scheme for heterogeneous wireless sensor networks, which is called DEEC. In DEEC, the cluster-heads are elected by a probability based on the ratio between residual energy of each node and the average energy of the network. The epochs of being cluster-heads for nodes are different according to their initial and residual energy. The nodes with high initial and residual energy will have more chances to be the cluster-heads than the nodes with low energy. Finally, the simulation results show that DEEC achieves longer lifetime and more effective messages than current important clustering protocols in heterogeneous environments.

They describe DEEC, an energy-aware adaptive clustering protocol used in heterogeneous wireless sensor networks. In DEEC, every sensor node independently elects itself as a cluster-head based on its initial energy and residual energy. To control the energy expenditure of nodes by means of adaptive approach, DEEC use the average energy of the network as the reference energy. Thus, DEEC does not require any global knowledge of energy at every election round. Unlike SEP and LEACH, DEEC can perform well in multi-level heterogeneous wireless sensor networks.

There are two kinds of clustering schemes. The clustering algorithms applied in homogeneous networks are called homogeneous schemes, and the clustering algorithms applied in heterogeneous networks are referred to as heterogeneous clustering schemes. It is difficult to devise an energy-efficient heterogeneous clustering scheme due to the complicated energy configure and network operation. Thus most of the current clustering algorithms are homogeneous schemes, such as LEACH [10], PEGASIS [11], and HEED [12].

The cluster-heads have to spend extra energy for aggregating data and performing long-range transmission to the distant base station. The LEACH protocol selects clusterheads periodically and drains energy uniformly by role rotation. Each node decides itself whether or not a cluster-head distributed by a probability. Under the homogeneous network, LEACH performs well, but its performance become badly in the heterogeneous network as shown by [9]. In PEGASIS, nodes will be organized to form a chain, which can be computed by each node or by the base station. The requirement of global knowledge of the network topology makes this method difficult to implement. HEED is a distributed clustering algorithm, which selects the cluster-heads stochastically. The election probability of each node is correlative to the residual energy. But in heterogeneous environments, the low-energy nodes could own larger election probability than the high-energy nodes in HEED. The heterogeneity of nodes in terms of their energy is considered in our DEEC, which is designed for heterogeneous networks. At the same time, DEEC keeps the merits of the distributed clustering algorithms.

Estrin et al. [18] discuss a hierarchical clustering method with emphasis on localized behavior and the need for asymmetric communication and energy conservation in sensor networks. They suggest using the remaining energy level of a node for cluster-head selection. In [10], it is proposed to elect the cluster-heads according to the energy left in each node. We call this clustering protocol LEACH-E.

The drawback of LEACH-E is that it requires the assistance of routing protocol, which should allow each node to know the total energy of network. SEP [9] is developed for the two-level heterogeneous networks, which include two types of nodes according to the initial energy, i.e., the advance nodes and normal nodes. The rotating epoch and election probability is directly correlated with the initial energy of nodes. SEP performs poorly in multi-level heterogeneous networks and when heterogeneity is a result of operation of the sensor network. Our DEEC protocol assigns different epoch of being a cluster-head to each node according to the initial and residual energy. In DEEC, a particular algorithm is used to estimate the network lifetime, thus avoiding the need of assistance by routing protocol.

Many LEACH-like algorithms are proposed to improve the performance of LEACH recently. In [13], the authors have studied multi-hop clustered networks, and use a randomized clustering scheme to organize the sensors. They provide methods to compute the optimal values of the algorithm parameters. Mhatre and Rosenberg [14] study the case of multi-hop routing within each cluster, which is called M-LEACH. In M-LEACH, only powerful nodes can become the cluster-heads. EECS [15] elects the cluster-heads with more residual energy through local radio communication. In cluster formation phase, EECS considers the tradeoff of energy expenditure between nodes to the cluster-heads and the cluster-heads to the base station. But on the other hand, it increases the requirement of global knowledge about the distances between the cluster-heads and the base station. In LEACH-B [16], a new adaptive strategy is proposed to choose cluster-heads and to vary their election frequency according to the dissipated energy. The simulation results show that the improvement obtained by LEACH-B is limited.

Brahim Elbhiri et.al. (2010) [4], Typically, a wireless sensor network contains an important number of inexpensive power constrained sensors, which collect data from the environment and transmit them towards the base station in a cooperative way. Saving energy and therefore, extending the wireless sensor networks lifetime, imposes a great challenge. Clustering techniques are largely used for these purposes. In this paper, we propose and evaluate a clustering technique called a Developed Distributed Energy-Efficient Clustering scheme for heterogeneous wireless sensor networks. This technique is based on changing dynamically and with more efficiency the cluster head election probability. Simulation results show that our protocol performs better than the Stable Election Protocol (SEP) by about 30% and than the Distributed Energy-Efficient Clustering (DEEC) by about 15% in terms of network lifetime and first node dies.
They have explained DDEEC protocol which is a Developed Distributed Energy-Efficient Clustering for heterogeneous wireless sensor. It's an energy-aware adaptive clustering protocol and with an adaptive approach which employ the average energy of the network as the reference energy like in DEEC. When every sensor node independently elects itself as a cluster head based on its initial and residual energy and without any global knowledge of energy at every election round. To increase more the DEEC protocol performances, the DDEEC implemented a balanced and dynamic way to distribute the spent energy more equitably between nodes. These modifications introduced enlarges better the performances of our DDEEC protocol than the others.

Parul Saini et. al. (2010), [5] Many routing protocols on clustering structure have been proposed in recent years. In recent advances, achieving the energy efficiency, lifetime, deployment of nodes, fault tolerance, latency, in short high reliability and robustness have become the main research goals of wireless sensor network. Many routing protocols on clustering structure have been proposed in recent years based on heterogeneity. We propose EDEEC for three types of nodes in prolonging the lifetime and stability of the network. Hence, it increases the heterogeneity and energy

level of the network. Simulation results show that EDEEC performs better than SEP with more stability and effective messages.
Wireless sensor network is a combination of wireless communication and sensor nodes. The network should be energy efficient with stability and longer lifetime. In this paper, proposed E-DEEC adds heterogeneity in the network by introducing the super nodes having energy more than normal and advanced nodes and respective probabilities. Simulation results shows that E-DEEC has better performance as compared to SEP in terms of parameters used. It extends the lifetime and stability of the network.

For homogeneous wireless sensor networks **Heinzelman, et. al.** [17] 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 rotates this role to evenly distribute the energy load among the sensors in the network [1]. PEGASIS [11] is a chain based protocol which avoids cluster formation and uses only one node in a chain to transmit to the BS instead of using multiple nodes.

Manjeshwar et. al. proposed Threshold sensitive Energy Efficient sensor Network protocol (TEEN) [20]. TEEN pursues a hierarchical approach along with the use of a data-centric mechanism. the cluster head broadcasts two thresholds to the nodes. These thresholds are hard and soft thresholds for sensed attributes. TEEN is not good for applications where periodic reports are needed since the user may not get any data at all if the thresholds are not reached.

Manjeshwar et. al. The Adaptive Threshold sensitive Energy Efficient sensor Network protocol (APTEEN) [21] aims at both capturing periodic data collections and reacting to time-critical events. The architecture is same as in TEEN. The main drawbacks of TEEN and APTEEN are the overhead and complexity of forming clusters in multiple levels implementing threshold based functions and dealing with attribute-based naming of queries.

Heinzelman, et. al. [10] proposed LEACH centralized (LEACH-C), a protocol that uses a centralized clustering algorithm and the same steady state protocol as LEACH. SEP (Stable Election Protocol) [9] is proposed in which every sensor node in a heterogeneous two-level hierarchical network independently elects itself as a cluster head based on its initial energy relative to that of other nodes.

Li Qing et. al. proposed DEEC [19] (Distributed energy efficient Clustering) algorithm in which cluster head is selected on the basis of probability of ratio of residual energy and average energy of the network. Simulations show that its performance is better than other protocols.

B. Elbhiri et al, proposed SBDEEC (Stochastic and Balanced Developed Distributed Energy-Efficient Clustering (SBDEEC) [22] SBDEEC introduces a balanced and dynamic method where the cluster head election probability is more efficient. Moreover, it uses a stochastic scheme detection to extend the network lifetime. Simulation results show that this protocol performs better than the Stable Election Protocol (SEP) and the Distributed Energy-Efficient Clustering (DEEC) in terms of network lifetime. Our E-DEEC (Enhanced Distributed Energy Efficient Clustering) scheme is based on DEEC with addition of super nodes. We have extended the DEEC to three-level heterogeneity. Simulation results show that E-DEEC performs better than SEP which is too extended to three-level scheme.

T. N. Qureshi et. al. (2012), [6] Wireless Sensor Networks (WSNs) contain numerous sensor nodes having limited power resource, which report sensed data to the Base Station (BS) that requires high energy usage. Many routing protocols have been proposed in this regard achieving energy efficiency in heterogeneous scenarios. However, every protocol is not suitable for heterogeneous WSNs. Efficiency of protocol degrades while changing the heterogeneity parameters. In this paper, we first test Distributed Energy- Efficient Clustering (DEEC), Developed DEEC (DDEEC), Enhanced DEEC (EDEEC) and Threshold DEEC (TDEEC) under several different scenarios containing high level heterogeneity to low level heterogeneity. We observe thoroughly regarding the performance based on stability period, network life time and throughput. EDEEC and TDEEC perform better in all heterogeneous scenarios containing variable heterogeneity in terms of life time, however TDEEC is best of all for the stability period of the network. However, the performance of DEEC and DDEEC is highly effected by changing the heterogeneity parameters of the network.
They have examined DEEC, E-DEEC, T-DEEC and DDEEC for heterogeneous WSNs containing different level of heterogeneity. Simulations prove that DEEC and DDEEC perform well in the networks containing high energy difference between normal, advanced and super nodes. Whereas, we find out that EDEEC and TDEEC perform well in all scenarios. TDEEC has best performance in terms of stability period and life time but instability period of EDEEC and TDEEC is very large. So, EDEEC and TDEEC is improved in terms of stability period while compromising on lifetime. Further research can be done on the above mentioned issue.

Heinzeman, et al. [17] introduced a clustering algorithm for homogeneous WSNs called as LEACH in which nodes randomly select themselves to be CHs and pass on this selection criteria over the entire network to distribute energy load.

G. Smaragdakis, et al. [9] proposed a protocol called as SEP in which every sensor node in a heterogeneous two level hierarchical network independently elects itself as a CH based on its initial energy relative to other nodes.

L .Qing, Q. Zhu and M. Wang [11] worked on heterogeneous WSN and proposed a protocol named as DEEC in which CH selection is based on the basis of probability of the ratio of residual energy and average energy of the network.

Brahim Elbhiri, et al. [22] worked on heterogeneous WSN and proposed a protocol named as DDEEC is based on residual energy for CH selection to balance it over the entire network. So, the advanced nodes are more likely to be selected as CH for the first transmission rounds, and when their energy decreases, these nodes will have the same CH election probability like the normal nodes.

P. Saini et al. [23] proposed a protocol EDEEC which is extended to three level heterogeneity by adding an extra amount of energy level known as super nodes.

Parul Saini and Ajay K Sharma [8] proposed a protocol TDEEC scheme selects the CH from the high energy nodes improving energy efficiency and lifetime of the network.

Parul Saini et. al. (2010), [8] in recent advances, many routing protocols have been proposed based on heterogeneity with main research goals such as achieving the energy efficiency, lifetime, deployment of nodes, fault tolerance, latency, in short high reliability and robustness. In this paper, we have proposed an energy efficient cluster head scheme, for heterogeneous wireless sensor networks, by modifying the threshold value of a node based on which it decides to be a cluster head or not, called TDEEC (Threshold Distributed Energy Efficient Clustering) protocol. Simulation results show that proposed algorithm performs better as compared to others.
In this paper they proposed TDEEC (Threshold Distributed Energy Efficient Clustering) protocol which improves stability and energy efficient property of the heterogeneous wireless sensor network and hence increases the lifetime. Simulation results show that TDEEC performs better as compared to SEP and DEEC in heterogeneous environment for wireless sensor networks.

Heinzelman, et. al. [17] introduced a hierarchical clustering algorithm for sensor networks, called Low Energy Adaptive Clustering Hierarchy (LEACH) for homogeneous wireless sensors networks. LEACH is a cluster-based protocol, which includes distributed cluster formation. LEACH randomly selects a few sensor nodes as cluster heads (CHs) and rotates this role to evenly distribute the energy load among the sensors in the network [1]. PEGASIS [11] is a chain based protocol which avoids cluster formation and uses only one node in a chain to transmit to the BS instead of using multiple nodes.
Manjeshwar et. al. proposed Threshold sensitive Energy Efficient sensor Network protocol (TEEN) [20]. TEEN pursues a hierarchical approach along with the use of a data-centric mechanism. In TEEN, the cluster head broadcasts two thresholds to the nodes. These are hard and soft thresholds for sensed attributes. TEEN is not good for applications where periodic
reports are needed since the user may not get any data at all if the thresholds are not reached. Manjeshwar et. al. then proposed Adaptive Threshold sensitive Energy Efficient sensor Network protocol (APTEEN) [21] which aims at both capturing periodic data collections and reacting to time-critical events. The architecture is same as in TEEN. The main drawbacks of TEEN and APTEEN are the overhead and complexity of forming clusters in multiple levels implementing threshold-based functions and dealing with attribute-based naming of queries.

Heinzelman, et.al. [10] proposed LEACH-centralized (LEACH-C), a protocol that uses a centralized clustering algorithm and the same steady-state protocol as LEACH. O. Younis, et.al [12] proposed HEED (Hybrid Energy-Efficient Distributed clustering), which periodically select cluster heads according to a hybrid of the node residual energy and a secondary parameter, such as node proximity to its neighbors or node degree. G. Smaragdakis, I. Matta, A. Bestavros proposed SEP (Stable Election Protocol) [9] in which every sensor node in a heterogeneous two-level hierarchical network independently elects itself as a cluster head based on its initial energy relative to that of other nodes. Li Qing et.al. [19] Proposed DEEC (Distributed energy efficient Clustering) algorithm in which cluster head is selected on the basis of probability of ratio of residual energy and average energy of the network. Simulations show that its performance is better than other protocols.

Md. Solaiman Ali, et.al [24] proposed ALEACH (Advanced LEACH) a new technique to select the cluster heads in every round which depends both on current state probability and general probability. Sajjanhar et al. [25] proposed a Distributive Energy Efficient Adaptive Clustering (DEEAC) Protocol, which is having spatio-temporal variations in data reporting rates across different regions. DEEAC selects a node to be a cluster head depending upon its hotness value and residual energy.

B. Elbhiri et al [26], proposed SDEEC (Stochastic Distributed Energy-Efficient Clustering (SDEEC) SDEEC introduces a balanced and dynamic method where the cluster head election

probability is more efficient. Moreover, it uses a stochastic scheme detection to extend the network lifetime. Simulation results show that this protocol performs better than the Stable
Election Protocol (SEP) and the Distributed Energy-Efficient Clustering (DEEC) in terms of network lifetime. Inbo Sim, et.al [27] proposed ECS (Energy efficient Cluster header Selection) algorithm which selects CH by utilizing only its information to extend network lifetime and minimize additional overheads in energy limited sensor networks. Ma Chaw Mon Thein, et.al [28] proposed a modification of the LEACH's stochastic cluster-head selection algorithm by considering the additional parameters, the residual energy of a node relative to the residual energy of the network for adapting clusters and rotating cluster head positions to evenly distribute the energy load among all the nodes. We have proposed an approach called threshold distributed energy efficient clustering (TDEEC) algorithm whose main aim is to increase the energy efficiency and stability of the heterogeneous wireless sensor networks.

3. Conclusion:

In our work we have briefly describe how cluster based routing protocol DEEC can be utilized in better way for homogeneous and heterogeneous environment. Our simulation shows EBAN DEEC gives better throughput of the system compare to DEEC. We can get better efficiency by including new CH replacement scheme and different transmission energy.

References:

[1] Jamal N. Al-Karaki, Ahmed E. Kamal," Routing Techniques In Wireless Sensor Networks: A Survey", IEEE Wireless Communications, Volume: 11, Issue: 6, 26- 28, December 2004.

[2]. Georgios Smaragdakis, Ibrahim Matta , Azer Bestavros, "SEP: A Stable Election Protocol for clustered wireless sensor networks", Computer Science Department, Boston University, Boston, MA 02215, USA

[3]. Li Qing *, Qingxin Zhu, Mingwen Wang, "Design of a distributed energy-efficient clustering algorithm for heterogeneous wireless sensor networks", School of Computer Science and Engineering, University of Electronic Science and Technology of China, Chengdu 610054, PR China

[4]. Brahim Elbhiri, Saadane Rachid , Sanaa El fkihi, "Developed Distributed Energy-Efficient Clustering (DDEEC) for heterogeneous wireless sensor networks"

[5]. Ajay.K.Sharma,Department of Computer Science & Engineering, Parul Saini, Department of Computer Science & Engineering, "E-DEEC- Enhanced Distributed Energy Efficient Clustering Scheme for Heterogeneous WSN"

[6]. T. N. Qureshi, N. Javaid, M. Malik, U. Qasim, Z. A. Khan, "On Performance Evaluation of Variants of DEEC in WSNs".

[7] E. J. Duarte-Melo and M. Liu. Analysis of energy consumption and lifetime of heterogeneous wireless sensor networks. In Proceedings of Global Telecommunications Conference (GLOBECOM 2002), pages 21–25. IEEE, November 2002.

[8]. Parul Saini, Ajay K Sharma, "Energy Efficient Scheme for Clustering Protocol Prolonging the Lifetime of Heterogeneous Wireless Sensor Networks"

[9] G. Smaragdakis, I. Matta, A. Bestavros, SEP: A Stable Election Protocol for clustered heterogeneous wireless sensor networks, in: Second International Workshop on Sensor and Actor Network Protocols and Applications (SANPA 2004), 2004.

[10] W.R. Heinzelman, A.P. Chandrakasan, H. Balakrishnan, An application- specific protocol architecture for wireless microsensor networks, IEEE Transactions on Wireless Communications 1 (4) (2002) 660–670.

[11] S. Lindsey, C.S. Raghavenda, PEGASIS: power efficient gathering in sensor information systems, in: Proceeding of the IEEE Aerospace Conference, Big Sky, Montana, March 2002.

[12] O. Younis, S. Fahmy, HEED: A hybrid, energy-efficient, distributed clustering approach for ad hoc sensor networks, IEEE Transactions on Mobile Computing 3 (4) (2004) 660–669.

[13] S. Bandyopadhyay, E.J. Coyle, An energy efficient hierarchical clustering algorithm for wireless sensor networks, in: Proceeding of INFOCOM 2003, April 2003.

[14] V. Mhatre, C. Rosenberg, Design guidelines for wireless sensor networks: communication, clustering and aggregation, Ad Hoc Network Journal 2 (1) (2004) 45–63.

[15] M. Ye, C. Li, G. Chen, J. Wu, EECS: an energy efficient cluster scheme in wireless sensor networks, in: IEEE International Workshop on Strategies for Energy Efficiency in Ad Hoc and Sensor Networks (IEEE IWSEEASN2005), Phoenix, Arizona, April 7–9, 2005.

[16] A. Depedri, A. Zanella, R. Verdone, An energy efficient protocol for wireless sensor networks, in: Autonomous Intelligent Networks and Systems (AINS 2003), Menlo Park, CA, June 30–July 1, 2003.

[17] W. R. Heinzelman. Application-Specific Protocol Architectures for Wireless Networks, Ph.D. thesis, Massachusetts Institute of Technology, 2000.

[18] D. Estrin, R. Govindan, J. Heidemann, S. Kumar, Next century challenges: scalable coordination in sensor networks, in: Proceedings of the 5th Annual ACM/IEEE International Conference on Mobile Computing and Networking (MobiCom'99), August 1999, pp. 263–270.

[19] L. Qing, Q. Zhu, M. Wang, "Design of a distributed energy-efficient clustering algorithm for heterogeneous wireless sensor networks". ELSEVIER, Computer Communications 29, 2006, pp 2230- 2237.

[20] A. Manjeshwar and D. P. Agarwal, "TEEN: a routing protocol for enhanced efficiency in wireless sensor networks," In 1st International Workshop on Parallel and

Distributed Computing Issues in Wireless Networks and Mobile Computing, April 2001.
[21] A. Manjeshwar and D. P. Agarwal, "APTEEN: A hybrid protocol for efficient routing and comprehensive information retrieval in wireless sensor networks," Parallel and Distributed Processing Symposium., Proceedings International, IPDPS 2002, pp. 195-202.
[22] Elbhiri, B. , Saadane, R. , El Fkihi, S. , Aboutajdine, D. “Developed Distributed Energy-Efficient Clustering (DDEEC) for heterogeneous wireless sensor networks”, in: 5th International Symposium on I/V Communications and Mobile Network (ISVC), 2010.
[23] Parul Saini, Ajay.K.Sharma, “E-DEEC- Enhanced Distributed Energy Efficient Clustering Scheme for heterogeneous WSN”, in: 2010 1st International Conference on Parallel, Distributed and Grid Computing (PDGC - 2010).
[24] Md. Solaiman Ali, Tanay Dey, and Rahul Biswas, ―ALEACH: Advanced LEACH Routing Protocol for Wireless Microsensor Networks‖ ICECE 2008, 20-22 December 2008.
[25] U. Sajjanhar, P. Mitra, ―Distributive Energy Efficient Adaptive Clustering Protocol for Wireless Sensor Networks‖, Proceedings of the 2007 International Conference on Mobile Data Management, pp. 326 - 330, 2007.
[26] Elbhiri Brahim,Saadane Rachid,Alba-Pages Zamora, Driss Aboutajdine, ―Stochastic Distributed Energy-Efficient Clustering (SDEEC) for heterogeneous wireless sensor networks‖, ICGST-CNIR Journal, Volume 9, Issue 2, December 2009.
[27] Inbo Sim, KoungJin Choi, KoungJin Kwon and Jaiyong Lee, ―Energy Efficient Cluster header Selection Algorithm in WSN‖, International Conference on Complex, Intelligent and
Software Intensive Systems , IEEE, 2009.
[28] Ma Chaw Mon Thein, Thandar Thein ―An Energy Efficient Cluster-Head Selection for Wireless Sensor Networks‖, International Conference on Intelligent Systems, Modeling and Simulation, IEEE 2009