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HETEROGENEOUS CLUSTER BASED ROUTING PROTOCOLS IN WIRELESS SENSOR NETWORK- A SURVEY

Padmavati [1] , T.C. Aseri [2]
[1 2] CSE Dept
[1 2]PEC University of Technology
[1] padmavati@pec.ac.in, trilokchand@pec.ac.in

ABSTARCT:
Wireless sensor network consists of thousands of sensor nodes which sense the environment and send the sensed data to the sink node. There exist many algorithms for routing in wireless sensor networks. In cluster based routing algorithms the clusters are formed and in each cluster one sensor node is selected as cluster head which collects data from other sensor nodes (cluster members) and further forwards data to the sink node. The energy efficiency of the protocol and network lifetime can be increased with node heterogeneity where few nodes are provided with extra capability like energy. In this paper we have surveyed various heterogeneous clustering protocols for wireless sensor networks and compared with various parameters like level of heterogeneity, criteria of CH selection, intra cluster topology, data transfer from CH to base station (sink node).

Keywords: *WSN, Homogeneous WSN. Heterogeneous WSN, sink node, cluster head*

1. INTRODUCTION

WSNs applications are wide and are ranging from military sensing, physical security, air traffic control, traffic surveillance, video surveillance, industrial and manufacturing automation, process control, inventory management, distributed robotics, weather sensing, environment monitoring, national border monitoring, building and structures monitoring etc. [1]. The routing algorithms of traditional wireless networks is not possible to adopt in WSN because building global addressing scheme is not possible because of the deployment of many sensor nodes in WSN, almost all application of WSN require many-to-one data flow from sensor nodes to sink, and sensor nodes produces redundant data as sensor nodes are densely deployed so many sensors may sense the same area [2].
Definition1: Stability period

Stability period (first node death) is the time interval where the first node in the network field depletes all of its energy and stability period is considered as a major measure of network lifetime [3].

2. RELATED WORK

2.1. *Homogeneous WSN*

In homogeneous WSN all sensor nodes are having equal capabilities

2.1.1. Low energy adaptive clustering hierarchy (LEACH) protocol

LEACH divides the whole WSN into some clusters each containing few cluster members and a cluster head which act as an intermediary between cluster members and the base station [4,5]. LEACH protocol consists of

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many rounds. Each round consists of two phases. The first phase is cluster set up phase where clusters are formed and cluster head (CH) is selected for each round and the second phase is steady phase where actual data transmission occurs from cluster members to CH and later CH aggregates data and further transmits to the base station. The time duration of cluster set up phase is small as compared to the steady phase.

2.2. *Heterogeneus WSN*

In heterogeneous WSN three types of sensor nodes heterogeneity can be provided namely, computational heterogeneity, link heterogeneity and energy heterogeneity [6]. In computational heterogeneity, at least a node or few nodes have more powerful microprocessor and larger memory than normal nodes. In link heterogeneity, at least a node or few nodes have higher bandwidth and a longer distance network than a normal node. In Energy heterogeneity, at least a node or few nodes are line powered or their battery is replaceable. Among all three types of heterogeneity, energy heterogeneity is more suitable for WSN compared to others as they require more resources and hence decreases network lifetime.

In paper [7] authors have reviewed and compared various energy-efficient clustering algorithms for heterogeneous WSN based on various parameters.

In paper [8] authors have presented a survey and compared various clustering protocols in WSN.

2.2.1. Stable Election Protocol (SEP)

SEP is developed for two levels heterogeneity, normal nodes and advanced nodes [9]. The advance nodes, where ‘m’ is the fraction of total number of ‘n’ nodes equipped with ‘α’ amount of extra energy than the normal nodes. The election probability to become CH is correlated directly to initial energy of the nodes.

2.2.2. Distributed energy efficient clustering algorithm (DEEC)

DEEC is a distributed energy efficient clustering algorithm for heterogeneous wireless sensor networks. In this algorithm cluster heads are selected based on probability using the ratio between residual energy of each node and the average energy of the network [10]. So the sensor node with higher remaining energy has more chance to become a cluster head.

DEEC algorithm is implemented with two level of heterogeneity and it has been shown that it also perform well in a multilevel heterogeneous WSN. The nodes with high initial and residual energy will have more chances to be the cluster-heads than the low-energy nodes. DEEC prolong the network lifetime especially the stability period as compared with LEACH and SEP.

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2.2.3. Developed distributed energy-efficient clustering (DDEEC) algorithm

DDEEC algorithm has modified the clustering scheme of DEEC algorithm, such that for initial number of rounds CH are selected from the advanced nodes, later when the energy of these nodes become equal to the normal nodes then the probability of selecting CH of these advanced nodes will be same as that of normal nodes. DDEEC performs better than DEEC and SEP in terms of network lifetime and first node death (FND) [11].

2.2.4. Energy efficient heterogeneous clustered scheme for WSN (EEHC)

EEHC worked on three types of sensor nodes normal nodes, advanced nodes and super nodes. There are $N \times m \times m_o$ number of super nodes used with β times more energy than the normal node. Where N represents the total number of nodes m and m_o are the fraction of the total number of nodes. The rest $N \times m \times (1-m_o)$ number of advanced nodes which are equipped with α times more energy than the normal nodes; the remaining $N \times (1-m)$ number of normal nodes [12]. EEHC is more effective in prolonging network lifetime as compared to LEACH.

2.2.5. Threshold distributed energy efficient clustering (TDEEC) algorithm

DEEC algorithm targets the sensor nodes containing high energy mainly on advanced nodes, and these nodes acts as a victim nodes as their residual energy depletes faster and become their energy same as that of the normal nodes. Hence the advanced nodes die more quickly than the normal nodes. So in order to avoid above scenario TDEEC algorithm modified the threshold value of DEEC algorithm such that the sensor node decides whether to become a CH or not based on the ratio of residual energy to average energy of that round with optimum number of cluster heads [13]. TDEEC performs better than SEP and DEEC in terms of network lifetime.

2.2.6. Enhanced distributed energy efficient clustering scheme for heterogeneous WSN (E-DEEC) algorithm

E-DEEC algorithm worked with three types of nodes, normal nodes, advanced node, and super nodes. The simulation result shows that EDEEC performs better than SEP in terms of network lifetime and energy consumption [14].

2.2.7. A Novel Multihop Energy Efficient Heterogeneous Clustered Scheme for Wireless Sensor Network (MEEHC)

In this paper authors have implemented a new clustered based energy efficient multihop routing protocol based on the three level of heterogeneity [15]. MEEHC performs better in terms of prolonging the network lifetime and stability period when compared to HEED [16] and EEHCA [17].

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2.2.8. EDDEEC: Enhanced Developed Distributed Energy-Efficient Clustering for Heterogeneous Wireless Sensor Networks

EDDEEC worked on three types of heterogeneous nodes. A novel clustering routing technique is used so that the probability of election of CH is changed dynamically [18]. EDDEEC prolongs network lifetime, longer stability period and increased number of messages sent to base station as compared to DEEC, DDEEC, and E-DEEC.

2.2.9. BEENISH: Balanced Energy Efficient Network Integrated Super Heterogeneous Protocol for Wireless Sensor Networks

BEENISH worked on four types of heterogeneous nodes as normal nodes, advanced nodes, super nodes and ultra-super nodes. In BEENISH CH are selected based on ratio of residual energy of a node and average energy in the network field [19]. BEENISH prolongs network lifetime, longer stability period and increased number of messages sent to base station as compared to DEEC, DDEEC, and E-DEEC.

3. COMPARISON OF HETEROGENEOUS CLUSTER BASED ROUTING PROTOCOLS

In this section a comparison of heterogeneous clustering algorithms of WSN is presented based on meter. Table 1. Provides the comparison of heterogeneous clustering algorithms that are discussed in section 2. The comparison is done based on parameters like heterogeneity level, criteria of CH selection, intra cluster topology, and the method of data transmission from CH to sink node.

Table 1. Comparison Of The Heterogeneous Cluster Based Routing Protocols For WSNs

Clustering Approach	Heterogeneity level	CH Selection is based on				Intra cluster topology	Data transfer from CH to sink node
		Initial energy	Average initial energy	Residual energy	Average energy		
SEP	Two	-	-	Yes	-	Single hop	Direct link
DEEC	Two/Multi	-	-	Yes	Yes	Single hop	Direct link
DDEEC	Two	Yes	-	Yes	-	Single hop	Direct link
EEHC	Three	-	-	Yes	-	Single hop	Direct link

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TDEEC	Two/Multi	-	-	Yes	Yes	Single hop	Direct link
E-DEEC	Three	-	-	Yes	-	Single hop	Direct link
MEEHC	Three	-	Yes	Yes	-	Single hop	Multi hop
EDDEEC	Three	Yes	-	Yes	Yes	Single hop	Direct link
BEENISH	Four	-	-	Yes	Yes	Single hop	Direct link

4. CONCLUSION

Clustering is a technique to reduce energy consumption and to provide stability in WSN. A survey of the current state-of-the art in energy efficiency for various types of heterogeneous clustered routing protocol has been discussed. The comparison between various heterogeneous clustered routing protocols is also presented.

References

[1] K. Sohraby, D. Minoli and T. Znati, “Wireless Sensor Networks Technology, Protocols, and Applications”, John Wiley & Sons, Inc.,Hoboken, 2007.
[2] K. Akkaya, M. Younis, A survey on routing protocols for wireless sensor networks, Ad Hoc Networks, Vol. (3), No.(3), pp. 325–349, 2005.
[3] X. Cao, J. Chen, Y. Zhang, Y. Sun , Development of an integrated wireless sensor network micro-environmental monitoring system, ISA transactions, Vol.(47), pp: 247-255, 2008.
[4] W. Heinzelman, A. Chandrakasan, H. Balakrishnan, Energy-Efficient Communication Protocol for Wireless Microsensor Networks, Proceedings of the 33rd Hawaii International Conference on System Sciences, 2000.
[5] W. Heinzelman, A. Chandrakasan, H. Balakrishnan, An Application-specific protocol architecture for wireless microsensor networks, IEEE Transactions on Wireless Communications, Vol. (1), No. (04), pp: 660-670,2002.
[6] M. Yarvis, N.Kushalnagar, H. Singh,A. Rangrajan,Y. Liu, S. Singh, Exploiting heterogeneity in Sensor networks,IEEE INFOCOM, 2005.
[7] N. Tuah, M. Ismail, K. Jumari, “An Energy-Efficient Node-clustering Algorithm in Heterogeneous Wireless Sensor Networks: A Survey,” Journal of Applied Science, 2012.
[8] S. K. Gupta, N. Jain, P. Sinha, “Clustering Protocols in Wireless Sensor Networks: A survey”, International Journal of Applied Information System, Vol. (5), No.(2), 2013.
[9] G. Smaragdakis, I. Matta, A. Bestavros, SEP: A Stable Election Protocol for clustered heterogeneous wireless sensor networks, 2nd International Workshop on Sensor and Actor Network Protocols and Applications (SANPA 2004), 2004.
[10] Qing, Li, Qingxin Zhu, Mingwen Wang, Design of a distributed energy-efficient clustering algorithm for heterogeneous wireless sensor networks, Computer communications, pp: 2230-2237, 2006.
[11] B. Elbhiri, R. Saadane, S. El Fkihi, D. Aboutajdine, Developed Distributed Energy-Efficient Clustering (DDEEC) for heterogeneous wireless sensor networks, 5th International Symposium on I/V Communications and Mobile Network (ISVC), 2010.
[12] Dilip Kumar, Trilok C. Aseri, R.B. Patel, EEHC: Energy efficient heterogeneous clustered scheme for WSNs, ELSEVIER, Computer Communications, pp: 662–667, 2009.
[13] Parul Saini, Ajay.K.Sharma, Energy Efficient Scheme for Clustering Protocol Prolonging the Lifetime of Heterogeneous Wireless Sensor Networks, International Journal of Computer Applications (0975- 8887),Vol(06), No.(2), 2010.
[14] Parul Saini, Ajay.K.Sharma, ”E-DEEC-Enhanced Distributed Energy Efficient Clustering Scheme for Heterogeneous WSN”,1st International Conference on Parallel, Distributed and Grid Computing, pp: 205-210, 2010.

E-ISSN: 2321–9637
Volume 1, Issue 4, November 2013
International Journal of Research in Advent Technology
Available Online at: http://www.ijrat.org

[15] Dilip Kumar, Trilok C. Aseri, R.B. Patel, "A Novel Multihop Energy Efficient Heterogeneous Clustered Scheme for Wireless Sensor Networks", Journal of Science and Engineering , Vol (14), No. (4), pp: 359-368, 2011.
[16] O. Younis, , S. Fahmy, " HEED: A Hybrid Energy Efficient Distributed Clustering Approach for Ad Hoc Sensor Networks," in Proceeding of International Conference on Sensor Technologies and Applications, pp: 260-264, 2007.
[17] G. Xin, W.H. Yang, D.De. Gang, "EEHCA: An Energy Efficient Clustering Algorithm for Wireless Sensor Networks", Information Technology Journal, Vol. (7), pp: 660-669, 2004.
[18] N. Javaid, T.N. Qureshi, A.H. Khand, A. Iqbal, E.Akthar, M. Ishfaq, "EDDEEC: Enhanced Developed Distributed Energy Efficient Clustering for Heterogeneous Wireless Sensor Networks," International workshop on Body Area Sensor Networks, pp: 914-919, 2013.
[19] T.N. Quereshi, N.Javaid, A.H. Khan,A. Iqbal, E.Akthar, M.Ishfaq, "BEENISH: Balanced Energy Efficient Network Integrated Super Heterogeneous Protocol for Wireless Sensor Networks," International workshop on Body Area Sensor Networks, pp: 914-919, 2013.