ISSN (Online) 2321-2004
ISSN (Print) 2321-5526

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN ELECTRICAL, ELECTRONICS, INSTRUMENTATION AND CONTROL ENGINEERING
Vol. 3, Issue 5, May 2015

Energy Efficiency Improvement of DWEHC Protocol Using Fuzzy Logic

Komal Bhoite[1], Pramodkumar Kulkarni[2]

Postgraduate Student, Department of Electronics and Telecommunication, DYPIET, Pune, India[1]

Assistant Professor, Department of Electronics and Telecommunication, DYPIET, Pune, India[2]

Abstract: The WSN is a specialized wireless network made up of a large number of sensors and at least one base station. The foremost difference between the WSN and the traditional wireless networks is that sensors are extremely sensitive to energy consumption. Energy saving is the crucial issue in designing the wireless sensor networks. Since the radio transmission and reception consumes a lot of energy, one of the important issues in wireless sensor network is the inherent limited battery power within network sense in order to maximize the lifetime of sensor nodes; it is preferable to distribute the energy dissipated throughout the wireless sensor network. In this paper we are aiming to present new energy efficient routing protocol for WSNs. We are going to propose a Extended Distributed Weight-based Energy-efficient Hierarchical Clustering protocol (EDWEHC). Each node first locates its neighbours (in its enclosure region), then calculates its weight which is based on its residual energy and distance to its neighbours. The largest weight node in a neighbourhood may become a clusterhead. Neighbouring nodes will then join the clusterhead hierarchy. The clustering process terminates in O(1) iterations, and does not depend on network topology or size. To improve the energy consumption performance fuzzy logic rules are integrated in DWEHC.

Keywords: Wireless Sensor Networks, Energy Consumption, Fuzzy logic, DWEHC

I. INTRODUCTION

A sensor network is defined as being composed of a large number of nodes with sensing, processing and communication facilities which are densely deployed either inside the phenomenon or very close to it. Each of these nodes collects data and its purpose is to route this information back to a sink. The network must possess self-organizing capabilities since the positions of individual nodes are not predetermined. Cooperation among nodes is the dominant feature of this type of network, where groups of nodes cooperate to disseminate the information gathered in their vicinity to the user. Recent advances in micro-electro-mechanical systems (MEMS) technology, wireless communications, and digital electronics have made possible to develop low-cost, low-power, multifunctional sensor nodes that are small in size and communicate freely in short distances [1]. These tiny sensor nodes, which consist of sensing, data processing, and communicating components, leverage the idea of sensor networks based on collaborative effort of a large number of nodes.

The main goal of data aggregation algorithms is to gather and aggregate data in an energy efficient manner so that network lifetime is enhanced. WSN offer an increasingly attractive method of data gathering in distributed system architectures and dynamic access via wireless connectivity [2]. Data aggregation attempts to collect the most critical data from the sensors and make it available to the sink in an energy efficient manner with minimum data latency. Data latency is important in many applications such as environment monitoring where the freshness of data is also an important factor. It is critical to develop energy efficient data aggregation algorithms so that network lifetime is enhanced. There are several factors which determine the energy efficiency of a sensor network such as network architecture, the data aggregation mechanism and the underlying routing protocol. There are different kinds of methods presented for data aggregation in WSNs with aim of archiving better minimum energy consumption. In this paper we are working on cluster based routing methods.

The rest of the paper is organised as following. Section two describes related work and section three describes proposed methodology. In section four and five, simulation environment and result analysis are described. Finally, this paper draws the conclusion in section six.

II. RELATED WORK

In the last few years, a relatively large number of clustering routing protocols have been developed for WSNs. Recent few surveys of clustering routing methods for WSNs have been presented. These surveys mainly aim at outlining some characters of clustering and summarizing some popular clustering routing algorithms with comparison based on different attributes and performances. However still this methods suffered from different limitations.

A. Review of Clustering Based Energy Efficient Methods

In the Linked Cluster Algorithm (LCA)[3] is presented in which a node becomes the clusterhead if it has the highest id among all nodes within two hops. In updated LCA[4] is presented in which those nodes with the smallest id become cluster head. All the other nodes which are 1-hop to the heads become children of the heads. In [5], those nodes with highest degree among their 1-hop neighbours become cluster heads.

 DOI 10.17148/IJIREEICE.2015.3517

In [6], the authors propose two load balancing heuristics for mobile ad hoc networks, where one is similar to LCA and the other is degree-based algorithm. The Weighted Clustering Algorithm (WCA) [7] elects clusterheads based on the number of surrounding nodes, transmission power, and battery-life and mobility rate of the node. WCA also restricts the number of nodes in a cluster so that the performance of the MAC protocol is not degraded. In [8], the authors aim at maximizing the lifetime of a sensor network by determining optimal cluster size and assignment of clusterheads. They assume that both the number and the location of the clusterheads are known, which is generally not possible in all scenarios. All the previous protocols require either knowledge of the network density or homogeneity of node dispersion in the field. Younis and Fahmy [9] propose Hybrid Energy Efficient Distributed clustering (HEED). HEED does not make any assumptions about the network, such as, density and size. Every node runs HEED individually. Further HEED suffered from limitations related to distributed WSNs.

B. Review of Energy Efficient Methods(Fuzzy Logic)

FML-MP (a fuzzy multi-path maximum lifespan routing scheme), an online multi-path routing scheme that strives to achieve a good distribution of the traffic load is developed in [10]. It uses an edge-weight function in the path search process. In [11] the authors presented Optimal Forwarding by Fuzzy Inference Systems (OFFIS) for flat sensor networks. The OFFIS protocol selected the best node from candidate nodes in the forwarding paths by favouring the minimum number of hops, shortest path and maximum remaining battery power, etc. The authors in [12] presented a novel algorithm for routing analysis in WSNs utilizing a fuzzy logic at each node to determine its capability to transfer data based on its relative energy levels, distance and traffic load to maximize the lifetime of the sensor networks. Rana et al. in [13] used A-star algorithm to search optimal route from the source to destination in such a way that, there is a pre-defined minimum energy level for sensor nodes so that sensor node doesn't participate in routing if its residual energy level is below that level.

WSN network is having main limitation is related to power consumption. Therefore there are many research methods presented to save excessive power consumption and extend the lifetime of WSNs. Most of research is done on routing protocols of WSNs. In the literature protocols presented for energy efficiency required either knowledge of the network density or homogeneity of node dispersion in the field.

III. PROPOSED METHODOLOGY

In this proposed work, we have presented the new energy efficient algorithm which is based on DWEHC algorithm called as EDWEHC. Each node first locates its neighbours (in its enclosure region), then calculates its weight which is based on its residual energy and distance to its neighbours. The largest weight node in a neighbourhood may become a clusterhead. Neighbouring nodes will then join the clusterhead hierarchy. The clustering process terminates in O(1) iterations, and does not depend on network topology or size. To improve the energy consumption performance we are integrating the fuzzy logic rules in DWEHC. The performance evaluation is done between existing DWEHC algorithm and proposed EDWEHC algorithm.

A. Fuzzy Logic and Proposed System Architecture

Fuzzy logic was first introduced in the mid-1960s by Lotfi-Zadeh in [14]. Since then, its applications have rapidly expanded in adaptive control systems and system identification. It has the advantages of easy implementation, robustness, and ability to approximate to any nonlinear mapping. Fuzzy logic analyzes information using fuzzy sets, each of which is represented by a linguistic term such as "small," "medium," or "large."

The goal of the fuzzy part of the proposed protocol[15] is to determine the optimal value of the node cost NC(n) of node n that depends on the remaining energy RE(n) and the traffic load TL(n) of node n. Fig.1 shows the fuzzy approach with two input variables RE(n) and TL(n), and an output NC(n), with universal of discourse [0…5], [0…10], and [0…1],respectively. Our new method uses five membership functions for each input and an output variable, as shown in Fig. 2.

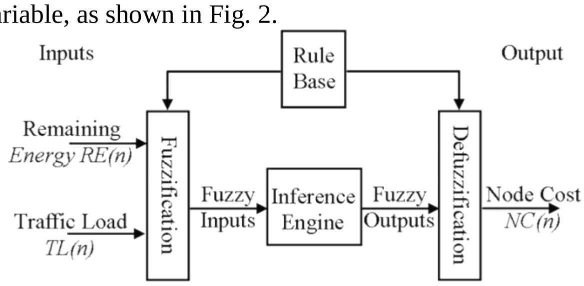

Fig 1. Fuzzy structure with two inputs (remaining energy and traffic load) and one output (node cost).

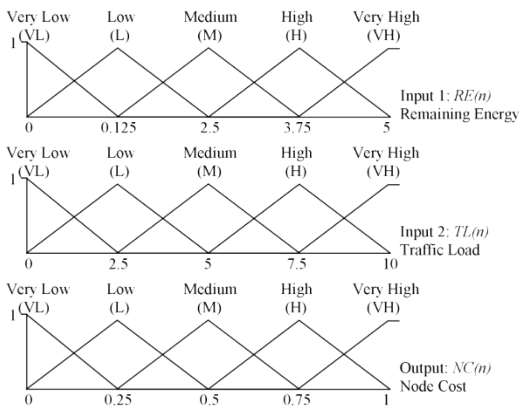

Fig.2 Membership graph for the inputs (remaining energy and traffic load) and the output (node cost)

The rule base is simply a series of IF-THEN rules that relate the input fuzzy variables and the output variable using linguistic variables each of which is described by fuzzy set and fuzzy implication operator AND.Table I shows the IF-THEN rules used in the proposed method

ISSN (Online) 2321-2004
ISSN (Print) 2321-5526

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN ELECTRICAL, ELECTRONICS, INSTRUMENTATION AND CONTROL ENGINEERING
Vol. 3, Issue 5, May 2015

TABLE I: FUZZY LOGIC RULES

no	Antecedent		Consequent
RE(n)	TL(n)		NC(n)
1	VL	VL	L
2	VL	L	VL
3	VL	M	VL
4	VL	H	VL
5	VL	VH	VL
6	L	VL	M
7	L	L	M
8	L	M	L
9	L	H	L
10	L	VH	VL
11	M	VL	H
12	M	L	M
13	M	M	M
14	M	H	L
15	M	VH	L
16	H	VL	VH
17	H	L	H
18	H	M	H
19	H	H	M
20	H	VH	M
21	VH	VL	VH
22	VH	L	VH
23	VH	M	VH
24	VH	H	H
25	VH	VH	H

IV. SIMULATION ENVIRONMENT

NS 2 network simulator is used to evaluate the performance difference between DWEHC and EDWEHC.The simulation of this work has been done with Cygwin and Ns-allinone-2.32. Table 2 describes simulation parameters in detail. Energy Consumption is measured as the percent of energy consumed by a node with respect to its initial energy. The initial energy and the final energy left in the node, at the end of the simulation run are measured. The percent energy consumed by a node is calculated as the energy consumed to the initial energy. And finally the percent energy consumed by all the nodes in a scenario is calculated as the average of their individual energy consumption of the nodes.

TABLE II: SIMULATION PARAMETERS

Number of Nodes	20/40/60/80/100
Traffic Patterns	CBR (Constant Bit Rate)
Network Size	1000 X 1000 (X xY)
Max Speed	2.0 m/s
Simulation Time	100 s
Transmission Packet Rate	10 m/s
Pause Time	1.0 s
Routing Protocol	DWEHC/EDWEHC
MAC Protocol	IEEE 802.11

$$E_{cons} = \frac{(E_i - E_f)}{E_i} * 100$$

$$E_{Avg\ Cons} = \sum_{n=20}^{100} E_{cons}$$

V. PERFORMANCE EVALUATION

The output animation of simulation is show in fig. 3 for 40 nodes. The average energy consumption of nodes is examined. The results are shown in fig.4 and data is tabulated in table III.

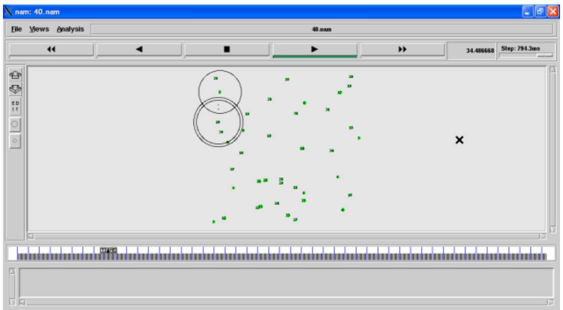

Fig.3 Network Animator of output simulation

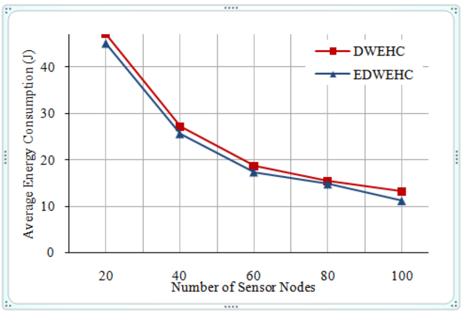

TABLE III: ENERGY CONSUMPTION FOR EACH NETWORK SCENARIOS

Network Scenarios	DWEHC	EDW EHC	Energy Consumption Reduction (%)
20	47.09	45.12	5.7%
40	27.09	25.63	13.1%
60	18.60	17.36	1.7%
80	15.33	14.78	1.4%
100	13.12	11.17	9.4%

Energy consumption of each node in DWEHC is more efficient than EDWEHC according to simulation results. Average energy consumption is reduced by 6.07 % in EDWEHC compared to DWEHC.

VI. CONCLUSION

The proposed new fuzzy logic and clustering based distributed routing protocol for WSNs with aim of improving energy efficiency. Current results analysis and simulation is done on DWEHC, EDWEHC and its outputs are depicted. The proposed routing protocol called EDWEHC is improved under each network scenario. The energy consumption in EDWEHC is decreased 6.07% as

ISSN (Online) 2321-2004
ISSN (Print) 2321-5526

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN ELECTRICAL, ELECTRONICS, INSTRUMENTATION AND CONTROL ENGINEERING
Vol. 3, Issue 5, May 2015

compare to DWEHC. The possible future direction is to validate this approach under the real time environment as well as present new method for MAC with aim of improving the performance of EDWEHC with efficient MAC protocol. Also evaluate other performance parameters.

REFERENCES

[1]. Wendi Rabiner Heinzelman, Anantha Chandrakasan, and Hari Balakrishnan, "Energy-Efficient Communication Protocol for Wireless Microsensor Networks", Proceedings of the 33rd Hawaii International Conference on System Sciences,2000.
[2]. Ping Ding, JoAnne Holliday, Aslihan Celik, "Distributed Energy-Efficient Hierarchical Clustering for Wireless Sensor Networks", Distributed Computing in Sensor Systems Lecture Notes in Computer Science Volume 3560, 2005, pp 322-339.
[3]. D. J. Baker and A. Ephremides, "The Architectural Organization of a Mobile Radio Netwrok via a Distributed Algorithm", IEEE Transactions on Communications, Vol. 29, No. 11, pp. 1694-1701, Nov. 1981.
[4]. A. Ephremides, J. E. Wieselthier and D. J. Baker, "A Design concept for Reliable Mobile Radio Networks with Frequency Hopping Signaling", Proceedings of IEEE, vol. 75, No. 1, pp. 56-73, 1987.
[5]. A. K. Parekh, "Selecting Routers in Ad-Hoc Wireless Networks", in Proceedings of ITS, 1994.
[6]. A. D. Amis, and R. Prakash, "Load-Balancing Clusters in Wireless Ad Hoc Networks", in Proceedings of ASSET 2000, Richardson, Texas, Mar. 2000.
[7]. M. Chatterjee, S. K. Das, and D. Turgut, "WCA: A Weighted Clustering Algorithm for Mobile Ad Hoc Networks", Cluster Computering, pp. 193-204, 2002.
[8]. C. F. Chiasserini, I. Chlamtac, P. Monti and A. Nucci, "Energy Efficient design of Wireless Ad Hoc Networks", in Proceedings of European Wireless, Feb. 2002.
[9]. S. Younis, S. Fahmy, "Distributed Clustering in Ad-hoc Sensor Networks: A Hybrid, Energy-Efficient Approach", in Proceedings of IEEE INFOCOM, March, Hong Kong, China, 2004.
[10]. M. R. Minhas, S. Gopalakrishnan, and V. C. M. Leung, "An online multipath routing algorithm for maximizing lifetime in wireless sensor networks," in Proc. IEEE Inform. Technol. New Generat. 6th Int. Conf., Apr. 2009, pp. 581–586.
[11]. M. A. Azim and A. Jamalipour, "Performance evaluation of optimized forwarding strategy for flat sensor networks," in Proc. IEEE Global Telecommun. Conf., Nov. 2007, pp. 710–714.
[12]. S. Y. Chiang and J. L. Wang, "Routing analysis using fuzzy logic systems in wireless sensor networks," Lecture Notes Comput. Sci., vol. 5178, pp. 966–973, 2008.
[13]. K. M. Rana and M. A. Zaveri, "ASEER: A routing method to extend life of two-tiered wireless sensor network," Int. J. Adv. Smart Sensor Netw. Syst., vol. 11, no. 2, pp. 1–16, Oct. 2011.
[14]. L. A. Zadeh, "Soft computing and fuzzy logic," IEEE Software, vol. 11,no. 6, pp. 48–56, Nov. 1994.
[15]. Imad S. AlShawi, Lianshan Yan, Wei Pan, Bin Luo, "Lifetime Enhancement in wireless sensor networks using fuzzy approach and A-start algorithm", IEEE Sensors Journal , Vol. 12, No. 10, Oct. 2012.
[16]. Qi-Ye Zhang,Ze-Ming Sun,Feng Zhang, "A Clustering routing protocol for wireless sensor networks based on type-2 fuzzy logic and ACO",2014 IEEE international conference on fuzzy systems (FUZZ-IEEE),july 6-11,2014,Beijing,China.
[17]. Ashfag Ahmad,Nadeem Javaid,Zahoor Ali Khan,Umar Qasim,Turki Ali Alghamdi, "(ACH)2:Routing scheme to maximize lifetime and throughput of wireless sensor networks",IEEE sensor journal,Vol.14,No 10,Oct.2014.
[18]. HodaTaherim,Peyman Neamatollahi, Mahmoud Naghibzadeh, Mohammad-Hossein Yaghmaee, "Improving on HEED protocol of wireless sensor networks using non probabilistic approach and fuzzy logic(HEED-NPF)",2010 5th International symposium on telecommunication(IST 2010).
[19]. Hnin Yu Swe,Soe Soe Khaing, "Modified energy constraint AODV for wireless sensor network", International conference on advances in engineering and technology (ICAET 2014),March29-30,Singapore.