Management Science Letters 3 (2013) 715–720

Contents lists available at GrowingScience

Management Science Letters

homepage: www.GrowingScience.com/msl

Cluster heads optimum choice and route discovery by using fuzzy logic in wireless sensor networks

Mohammadreza Ramzannezhad Ghaleh[a*], Mehdi sadegh zadeh[b] and Esmail saeedian[c]

[a]*Department of Computer Science, Islamic Azad University, Science & research branch, Bushehr Branch, Bushehr, Iran*
[b]*Department of Computer Science, Islamic Azad University, Mahshahr Branch, Dezful, Iran*
[c]*Department of Computer Science, Islamic Azad University, Bandargaz Branch, Bandargaz, Iran*

C H R O N I C L E

Article history:
Received July 18, 2012
Received in revised format
10 November 2012
Accepted 15 November 2012
Available online
November 19 2012

Keywords:
Network management
Cluster head
Fuzzy method

A B S T R A C T

Optimum energy consumption in wireless sensitive networks plays an important role on network management. In the proposed model of this paper, first all the nods send the energy, station distance and density parameters to their fuzzy modules. According to each nod's fuzzy module outputs, a timer is activated for all nodes, which start reverse-counting from obtained value from fuzzy module. Timer of better nod comes to zero sooner and two best nods are selected in each zone (with the distance of r). One of them is introduced as superior cluster head and the other nods are connected to the closest cluster head. In addition, the cluster head not introduced as superior cluster head first collects data from neighbor's nods and then sends it to the superior cluster head after classifying data as package. The performance of the proposed model of this paper is compared with other methods and the preliminary results indicate that the proposed algorithm has increased first nod death time compared with other methods in the literature.

1. Introduction

Sensitive wireless networks normally include enormous multipurpose sensitive nods with low power and small size, which could communicate in short distances. These networks are considered as a convenient tool for data extracting from environment and monitoring environmental events and their usage in domestic, industrial and military contexts grows, increasingly (Heinzelman et al., 2002). There are some challenges associated with design of sensitive wireless networks and one of them is that energy resources are substantially more restricted than wire networks and sensors' (sensitive nods) charging or battery replacement in a network might be hard or impossible and this may create relatively high limitation in setting communication and sensor's process time among all networks.

*Corresponding author.
E-mail addresses: ramzannezhad@hotmail.com (M. Ramzannezhad Ghaleh)

doi: 10.5267/j.msl.2012.11.024

Sensor's regular failure may not damage wireless sensitive networks performance and neighbor sensors, in case of high density, can be replaced to handle such problem (Akyildiz et al., 2002).

The other important challenge in designing wireless sensitive networks is associated with connection protocol. The most popular protocol of this kind is cluster architect in which connection is made only through cluster heads (Younis et al., 2006; Chen et al., 2006). LEACH protocol is one of the most popular protocols in clustering sensory networks, which incorporates two setup fuzzy and steady state fuzzy. In steady state fuzzy data, transferring is used through single hop to base station, a nod is chosen as cluster head in each cluster, and cluster member is another type, which can be used. Data gathered from member nods, before transferring to base station, are controlled in cluster head and then all data are sent to base station as a package (Heinzelman et al., 2002).

Ghorbannia Delavar et al. (2011) introduced a new hybrid routing algorithm with special parameters in wireless sensor network for network with significant number of sensors. The algorithm selects the cluster heads (CH) based on the scale of average local energy and the density surrounding each node. The method also chooses a kind of mechanism to perform cluster formation in specific conditions based on the neighborhood rule and local information of a node and its neighbors. In addition, in PRWSN, the data of each cluster is transferred to BS based on a hybrid method. In networks with high density, which implement multi-hop frameworks, the energy of nodes near to BS are discharged with a higher speed while in single-hop methods the energy of nodes which are far from BS are dismissed earlier. To overcome these problems, they implement a combination of the single and multi-hop techniques to increase the lifetime of the network.

PRWSN recommends a method where each node implements a fuzzy processor for energy consumption. In this technique, first, each node sends its distance to the destination as the input fuzzy processor, and then it gets much of its power and reinforcing type as output (Ghorbannia Delavar et al., 2011). In FUMOR technique, there are other factors used such as distance, energy and node level as a fuzzy model for increasing of network lifetime (Tajari et al., 2011).

2. System and Energy Model

The proposed network model of this paper considers the following assumptions,

Nods are distributed randomly in environment and all nods are assumed as equal.
Base station is located in environment center.
Nods have the ability to justify their transfer power based on their distance to consider receiver, which is important to assure about network cohesion (Hou et al., 2006).
All nods have the same energy and capability.
Position and identity of all nods is clear for base station.
Energy consumption model in this paper is the same as energy consumption model used in LEACH paper. Each nod for transferring I bit data to its d distance would consume E_s energy which is calculated as follows,

$$E_s = \begin{cases} lE_{elect} + l\varepsilon_{fs}d^2 & d < d_{co} \\ lE_{elect} + l\varepsilon_{mp}d^4 & d \geq d_{co} \end{cases} \quad (1)$$

where E_{elect} represents required energy for activating electronic circuits, d_{CD} is threshold limit, E_{mp} and E_{fs} are power reinforcing, activating energy for two states of open area and multi-way states, respectively. If distance becomes more than a specified threshold d_{CD}, then receiver would use multi-way state; otherwise open area model can be implemented for channel. In addition, the amount of energy consumed in receiver nod for receiving I bit energy is calculated as follows,

$$E_r = lE_{elect} . \quad (2)$$

3. Algorithm

In this paper, first all the nods send the energy, station distance and density parameters to their fuzzy modules. By node density, we mean the number of neighboring nodes around a node, which are located in its effect range. According to each nod's fuzzy module outputs, a timer is activated for nodes, which start reverse-counting from obtained value from fuzzy module. Timer of better nod would come to zero sooner and two best nods are selected in each zone (with the distance of r). One of them is introduced as superior cluster head and the other nods are connected to the closest cluster head. In addition, the cluster head not introduced as superior cluster head first collects data from neighbor's nods and then sends it to the superior cluster head after classifying data as package. Fig. 1 shows details of collecting the data in the proposed method.

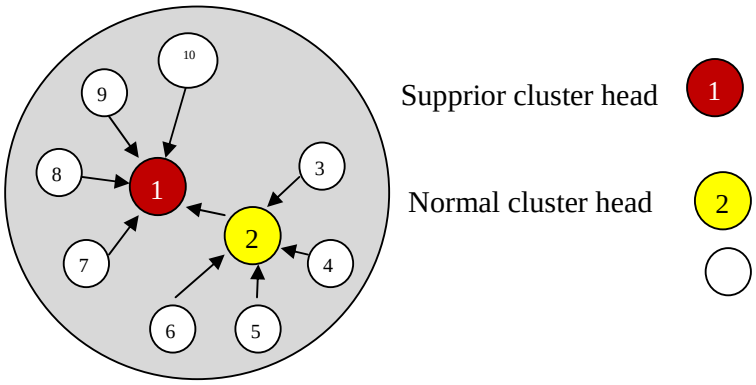

Fig. 1. The procedure for collecting data in the proposed model

In proposed method, as the distance of continual nods is generally less than the distance of each nod to cluster head used in LEACH method (Fig. 2), the amount of energy decreased based on Eq. (1). In addition, cluster head receives n/2 packages instead of n-1 packages, so it consumes less energy for receiving packages in cluster head according to Eq. (2).

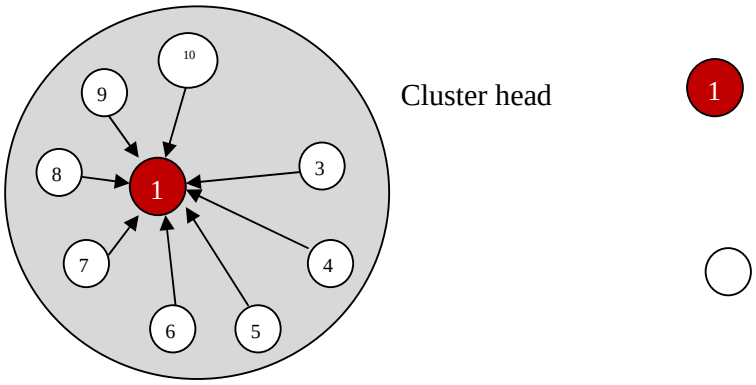

Fig. 2. Design of data collection in a cluster according to LEACH method

After specifying cluster head and superior cluster head in setup fuzzy, multi-hop inter cluster method are implemented in steady state fuzzy for data transfer. Then, superior cluster head sends a control message to other superior cluster head in distance of 2r, which are closer to base station and the superior cluster head with optimum way would answer the message. Optimum way is a method through which superior cluster head maintains more energy, less density and closer distance to base station. After accumulation, data are sent through that way by superior cluster head and the same

processes are continued in next superior cluster head until data reaches sink. Fig. 3 shows details of the proposed model.
Input parameters in fuzzy module include following issues:

1. Distance of each nod from base station
2. Node energy
3. Density of each nod

Variable indices for each input include:
ENERGY ={vlow, low, med, vhigh} DENSITY={low, med,high} DISTANCE={near, med, far}

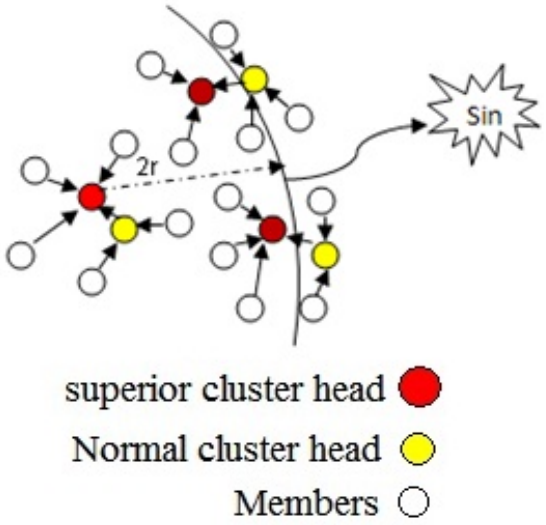

Fig. 3. The process of creating optimum way for transferring data to sink

Member function output according to variable value include OUTPUT={vsmall, small, med, long, vlong}. Figs. 4-7 indicate fuzzy inputs and outputs of member function.

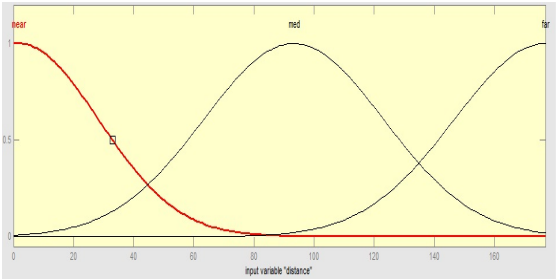

Fig. 4. Fuzzy collection for distance variable

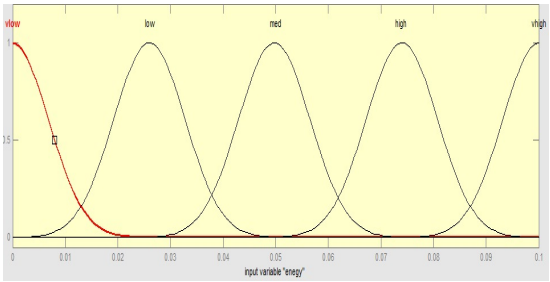

Fig. 5. Fuzzy collection for energy variable

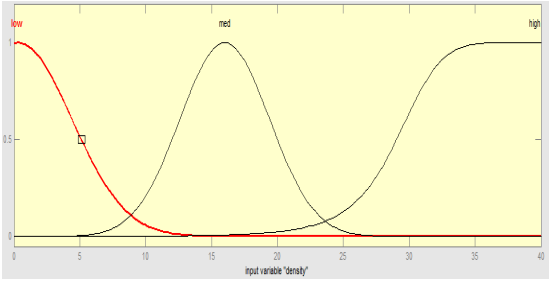

Fig. 6. fuzzy collection for density variable

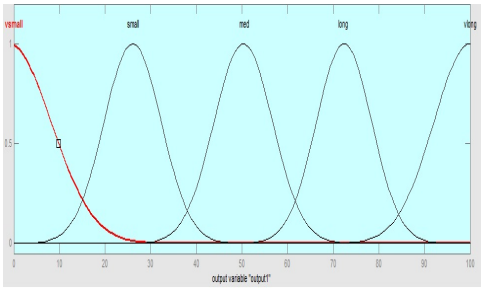

Fig. 7. fuzzy collection for member function output

Table 1 shows details of fuzzy rules used for the implementation of the proposed model.

Table 1
Fuzzy decision rules

Rule	Distance	Density	Energy	Output	Rule	Distance	Density	Energy	Output
1	Near	Low	Vlow	Vlong	14	Near	High	High	Vsmall
2	Near	Low	low	Vlong	15	Near	High	Vhigh	Vsmall
3	Near	Low	Med	Med	16	Med	Low	Vlow	Vlong
4	Near	Low	High	Med	17	Med	Low	Low	Vlong
5	Near	Low	Vhigh	Small	18	Med	Low	Med	Long
6	Near	Med	Vlow	Long	19	Med	Low	High	Med
7	Near	Med	Low	Long	20	Med	Low	Vhigh	Small
8	Near	Med	Med	Med	21	Med	Med	Vlow	Vhigh
9	Near	Med	High	Small	22	Med	Med	Low	Vhigh
10	Near	Med	Vhigh	Vsmall	23	Med	Med	Med	Med
11	Near	High	Vlow	Long	24	Med	Med	High	Small
12	Near	High	Low	Long	25	Med	Med	Vhigh	Vsmall
13	Near	High	Med	Small					

4. Simulation and results

The proposed algorithm of this paper along with other protocols have been simulated by MATLAB software using the information given in Table 2. Fig. 6 shows a typical response of the proposed algorithm when this size is 250*250.

Table 2
Simulation parameters

Primary energy	Eelect	Efs	dco	Eda	Pocket size
0.1j	50 nJ/bit	10 pJ/bit/m^2	87 m	5 nJ/bit/signal	4000 bits

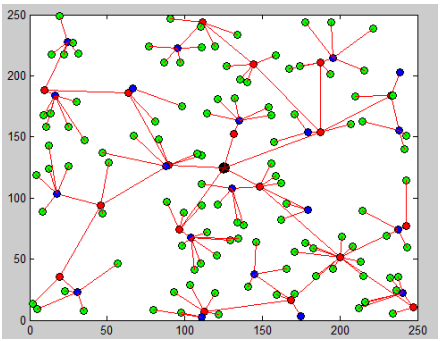

Fig. 6. A typical response of the proposed algorithm

Table 3 shows comparison between death time of first nod in represented algorithm with LEACH (Heinzelman et al., 2002) FSCA (Tashtoush et al., 2008), GSAGA (Zhang et al., 2008) and CFGA. The performance of the proposed algorithm in terms of network life enhancement is compared in Table 3 and the results indicate that the proposed algorithm has increased first nod death time compared with other methods.

Table 3
Comparison of the performance of the proposed model

	Methods				
Network Parameters	LEACH	FSCA	GSAGA	CFGA	SHCIRF
150 nodes with network size: 250×250	78	92	118	150	232
175 nodes with network size: 300×300	53	59	90	120	205
200 nodes with network size: 400×400	15	17	42	95	190

5. Results and Conclusion

Optimum energy consumption in wireless sensitive networks has got much importance, so that optimum energy consumption may lead to network life durance enhancement. In this study, using a fuzzy module which is implemented in all nods with distribution, the best nod in each zone introduces itself as the cluster head to neighbor nods and then cluster heads, communicating with neighbor cluster heads using fuzzy logic, select best cluster head for transferring data to base station. Creating equilibrium and uniformity and increasing network life time is the outcome of using fuzzy logic. The preliminary results of this paper indicates that the proposed algorithm has increased first nod death time compared with other methods.

References

Akyildiz, I., Su, W., & Sankarasubramaniam, Y., & Cayirci, E. (2002). A survey on sensor networks. *IEEE Communications Magazine*, 40(8), 102-114.

Chen, H., Mineno, H., Mizuno, S.T. (2006). A meta-data-based data aggregation scheme in clustering wireless sensor networks. *Proceedings of the 7th International Conference on Mobile Data Management*, 154-154.

Delavar, A.G., Artin, J., & Tajari, M.M. (2011). RCSDN : a distributed balanced routing algorithm with optimized cluster istribution. *In 3rd International Conference on Signal Acquisition and Processing*.

Ghorbannia Delavar, A., Artin, J., & Tajari, M.M. (2011). PRWSN: A hybrid routing algorithm with special parameters in wireless sensor network. *Recent Trends in Wireless and Mobile Networks Communications in Computer and Information Science*, 162, 145-158.

Heinzelman, W., Chandrakasan, A., & Balakrishnan, H. (2002). An application-specific protocol architecture for wireless microsensor networks. *IEEE Transactions on Wireless Communications*, 1(4), 660-670.

Hou, Y.T., Shi, Y., & Sherali, H.D. (2006). Optimal base station selection for anycast routing in wireless sensor networks. *IEEE Transactions on Vehicular Technology*, 55(3), 813–821.

Younis, O., Krunz, M., & Ramasubramanian, S. (2006). Node clustering in wireless sensor networks: recent developments and deployment challenges. *Network, IEEE*, 20(3), 20 – 25.

Saeedian, E., Niazi, M., Jalali, M., & Tadayon, G.H. (2011). CFGA: Clustering wireless sensor network using fuzzy logic and genetic algorithm. IEEE International Conference, 1-4.

Tashtoush, Y.M., & Okour, M.A. (2008). Fuzzy Self-clustering for wireless sensor networks. IEEE/IFIP International Conference on Embedded and Ubiquitous Computing.

Tajari, M.M., Mpghaddam, Y., Torshiz, M.N., Artin, J. (2011). RUMOR: fuzzy multihop routing for WSN. *IEEE Cnference Publication*.

Zhang, J., Lin, Y., Zhou, C., Ouyang, J. (2008). Optimal model for energy-efficient clustering in wireless sensor networks using global simulated annealing genetic algorithm. *International Symposium on Intelligent Information Technology Application Workshops*.