

A Fuzzy Logic Based Hierarchical Routing Protocol for Wireless Sensor Networks



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PROBLEM STATEMENT

The paper identifies the existing challenges and limitations in routing protocols for WSNs. These challenges may include issues like high energy consumption, limited network lifetime, scalability problems, and the inability to adapt to dynamic network conditions. The problem statement establishes the need for a routing protocol that can overcome these challenges and improve the overall performance of WSNs.



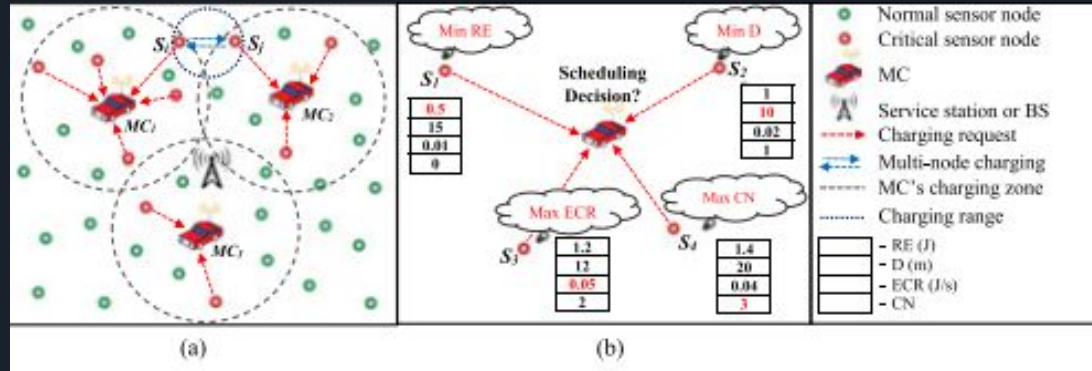
Abstract

Evaluates an energy efficient cluster-based routing protocol that uses a fuzzy logic module during the cluster-head election process in order to increase the network lifetime. The objective of this work is not to minimize the whole network consumption, but to balance the consumption over nodes to increase the network lifetime.

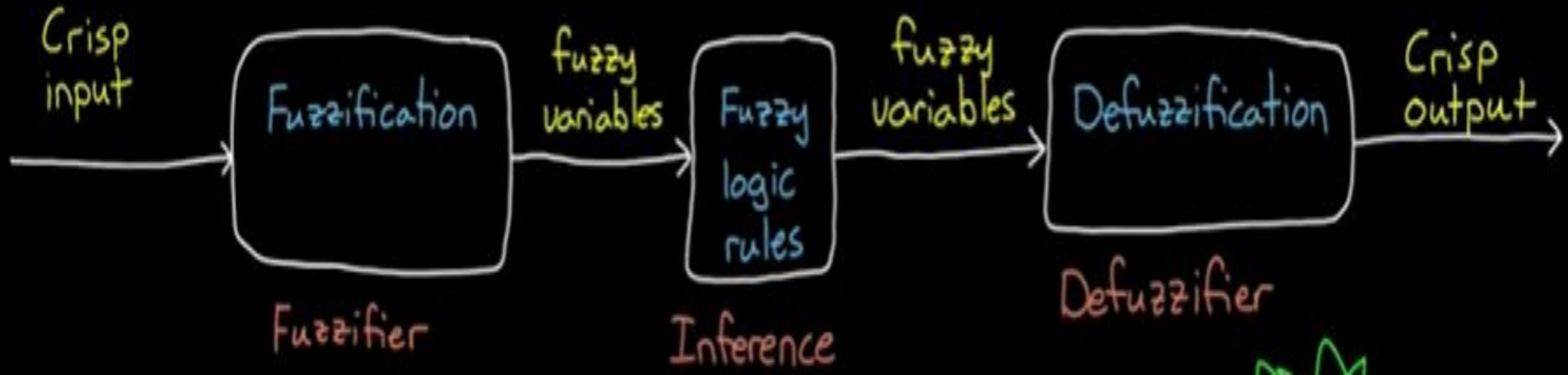
INTRODUCTION

We deal with clustering process in routing protocol using a fuzzy logic module and the proposed algorithm is implemented on LEACH protocol.

Energy Harvesting in Wireless Sensor Networks



Fuzzy Logic and it's need



- Handling Uncertainty and Imprecision
- Adaptive decision-making
- Optimizing Energy Allocation
- Balancing Trade-Offs



LITERATURE SURVEY

A. Routing protocols in WSNs

B. A cluster-based routing protocol: LEACH

C. Fuzzy logic and routing protocols



A. Routing protocols in WSNs

Routing protocols in WSNs have a central role in the energy optimization and the network lifetime. Routing protocols in WSNs can be classified, in terms of network structure, into three main categories: data-centric flat routing, hierarchical routing and location based routing.

J. Kulik, W. R. Heinzelman, and H. Balakrishnan, "Negotiation-based protocols for disseminating information in wireless sensor networks", *Wireless Networks*, Volume: 8, pp. 169-185, 2002.

C. Intanagonwiwat, R. Govindan, and D. Estrin, "Directed diffusion: a scalable and robust communication paradigm for sensor networks", *Proceedings of ACM MobiCom 00*, Boston, MA, pp. 56-67, 2000.

M. Boushaba, A. Hafifid, A. Belbekkouche and M. Gendreau, "Reinforcement learning based routing in wireless mesh networks", *Wireless Network*, vol. 19, no. 8, pp. 2079-2091, 2013.



B. A cluster-based routing protocol: LEACH

LEACH is a well-known hierarchical routing protocol.

Research Paper:

Balakrishnan, H., Heinzelman, W., Chandrakasan, A. "Energy-efficient communication protocol for wireless micro sensor networks". The Hawaii International Conference on Systems Science. Jan. 2000.



C. Fuzzy logic and routing protocols

Guo w, Zhang w. "A survey on intelligent routing protocols in wireless sensor networks". Journal of Network and computer application (2013), <http://dx.doi.org/10.1016/j.jnca.2013.04.001>

Anno, J., Barolli, L., Xhafa, F., Durresi, A. "A cluster head selection method for Wireless Sensor Networks based on Fuzzy logic". TENCON IEEE Region 10 Conference.2007.

Bagci, H., Yazici, A., "An energy aware fuzzy approach to unequal clustering in wireless Sensor Networks". The Official Journal of the World Federation on Soft Computing (WFSC).2013



PROPOSED FUZZY-LOGIC BASED TECHNIQUE

- A. The proposed fuzzy logic based algorithm
- B. Fuzzy controller design



A. The proposed fuzzy logic based algorithm

1. The proposed protocol is a LEACH.
2. 5% of the total number of nodes are elected as cluster-heads conforming to the LEACH protocol.
3. The networks incorporates two types of nodes: Clusterheads and member nodes.
4. Elimit is the Relative Energy Level , $Elimit = (E_{node} - E_{min}) / (E_{max} - E_{min})$



B. Fuzzy controller design

- The remaining energy of the node .
- The remaining energy of the current cluster-head .
- The Position (distance that separates the node to the current cluster-head).



Fuzzification of the input variables:

1. The remaining battery level of a node.
2. The remaining battery level of the current cluster-head.
3. The distance between the node and the current cluster-head.



THE PARAMETERS AND THEIR POSSIBLE VALUES

1. Node Remaining Energy Low, Medium, High
2. C-H Remaining Energy Low, Medium, High
3. Distance node-CH Far, Medium, Near
4. Probability V Weak,Weak,L Weak,Medium,L Strong,
Strong, VStrong



Rule base:

IF (Energy ==Low) AND (Energy-CH==High) AND
(Position==Medium) THEN (Probability==Very
Weak).



Fuzzy Inference Engine

Fuzzy Logic Matlab toolbox provides two different fuzzy inference systems: Mamdani and Sugeno



Defuzzification and fuzzy Control

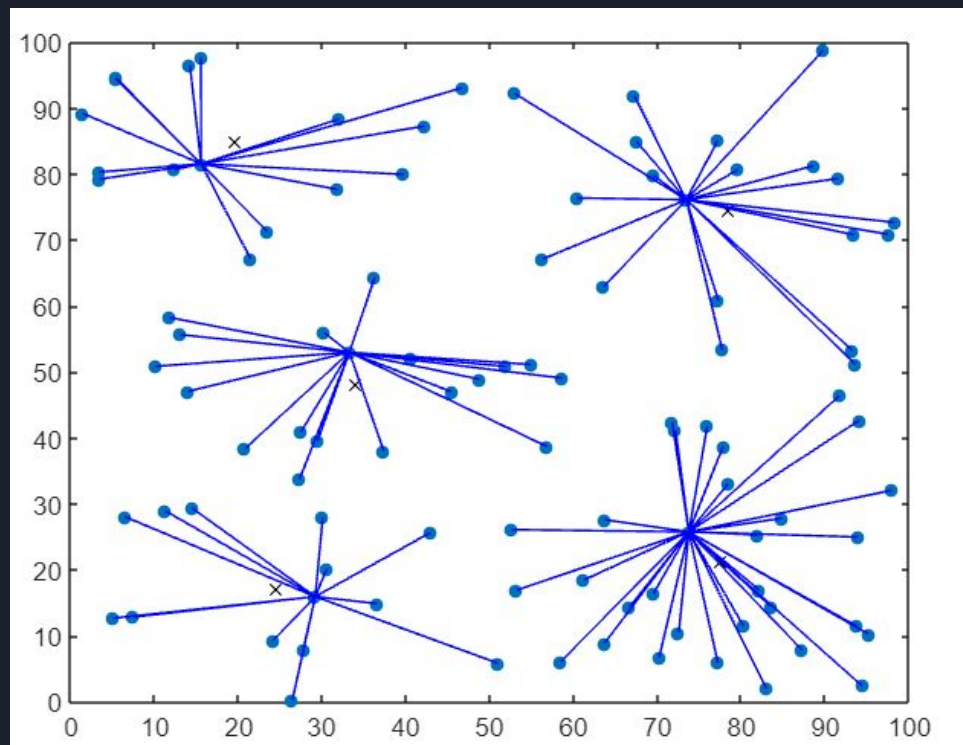
Defuzzification process transforms the fuzzy output probability to a crisp value representing the probability of a node to become a cluster-head.



Results

The probability of a node to become a cluster-head is differently affected by the three parameters: position (Distance between a member node and its corresponding C-H), the remaining energy of the node, and the remaining energy of the cluster-head. The following curves show that the improvements made to the LEACH protocol lead to best results in terms of network lifetime.

Output:





CONCLUSION

1. The system gives as output the probability of a node to become a cluster-head.
2. The fuzzy logic system has three input functions: the remaining energy for a node, the remaining energy of the current cluster-head, and the distance between a member node and the current cluster-head



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- [2] Gregory J. Pottie, Kaiser, W. J. "Wireless integrated network sensors"". Communications of the ACM.
- [3] Ran, G., Zhang, H., Gong, S. , "Improving on LEACH protocol of Wireless Sensor Networks using Fuzzy Logic"
- [4] Zheng and Abbas Jamalipour, "Wireless Sensor Networks: A Networking Perspective", a book published by A John and Sons, Inc, and IEEE, 2009.
- [5] Fuzzy logic Matlab toolbox

THANK YOU!

