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Fuzzy Logic Application in Routing Management Protocol for WSN Applications

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Abstract: Traditional quality of service requirements usually coming from multimedia-type applications like bounded delay or minimum bandwidth are irrelevant when applications are tolerant to latency or the bandwidth of the transmitted data is very small in the first. In some cases, only occasional delivery of a packet WSN systems are now a day's handling a very wide range of telecommunications application types. Due to this it is hardly be possible with any single mechanism to decide data propagation of a WSN. However many common features appear in correspondence of the characteristics and the parametric mechanisms of such systems during routing and energy management scenarios. This work focus on utilizing node characteristics with fuzzy logic based intelligent decision mechanism for mitigate the major challenges of the nodes selection for establishing the multi hop routing of the wireless sensor networks. The node characteristics are considered in terms of nodes data forwarding success rate probability evaluation by simple and flexible fuzzy rules.

Keyword: Fuzzy Energy Aware Routing Protocol, MEMS, Routing, Clustering, WSN.

1. Introduction:

Wireless sensor network WSN is a hot research area with a rapidly growing set of applications. Given the benefits offered by wireless sensor networks (WSNs) with respect to that of wired networks, for example, simple deployment, low installation cost, high mobility, and lack of cabling. WSNs are appealing technology for smart infrastructure; for example, building, factory automation, and process control applications [1]. WSN is well established for low-cost systems, it brings IoT applications richer sensing and actuation capabilities. A sensor network is a number of tiny sensor nodes of low costs that cover a certain region of interest ROI to measure data using different sensing capabilities and transmit it to the base station BS as in Fig. 1. The data transmission process requires radio communication system that mainly consists of the following: (1) A processing unit contains Digital to Analog Converter (DAC), (2) memory, and (3) Digital Signal Processing (DSP) unit that helps the node to choose the suitable protocols to accomplish the data transmission task according to the system requirement. Moreover, such protocols handle the limited battery size and control the additional node capabilities that include mobility and location discovery mechanism that are essential in many applications. Therefore, sensor nodes have very high adaptability in their physical features and protocols to suit different types of application environments and requirements, as described in [2].The communication performed between nodes using multi-hop or direct transmission, as studied in [3]. In multi-hop data transmission fashion, the nodes communicate with each other using minimal transmission power. The data sent by a source node travels through the nodes in-between to reach the destination node which is typically the base station BS. To minimize power consumption in data transmission, it is preferable to use the multi-hop transmission to reach the BS instead of direct transmission, especially in large ROIs and if only one BS is used. Consequently, the computational and communication task of sensor nodes may divide them into three main types according to their role in ROI.

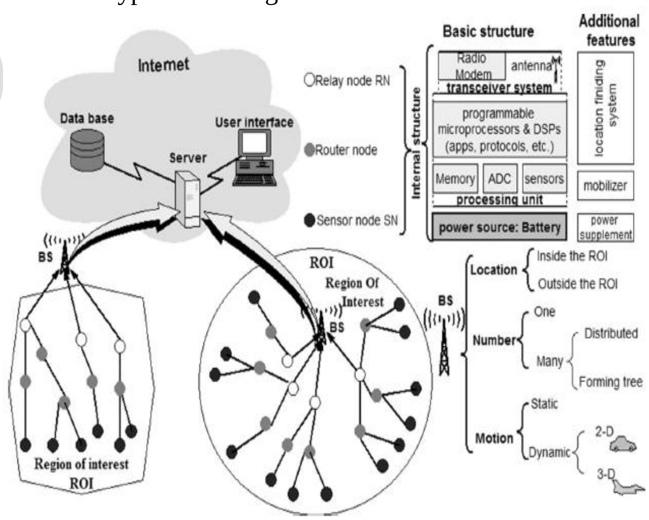

Fig. 1 Different aspects of WSN system

2. Related Work:

In [13], Naeimi et al. have led an exhaustive study of group based directing conventions for homogeneous sensor organizations. They grouped bunching conventions as per their goals and grouping process technique that incorporates bunch head CH determination, group development, information accumulation and information correspondence. Consequently, the creators gave point by point characterizations of bunching conventions for homogeneous organizations in each stage in light of the current examination beginning around 2012. The CH determination grouping incorporates selforganized plans, helped plans, and multifaceted assessment plans.

In [14], Liu introduced a broad review on grouping directing conventions in WSNs. He framed the targets of grouping for WSNs and fostered an original scientific classification of WSN bunching directing techniques in view of three central matters: First, bunch qualities that incorporate fluctuation of bunch count, consistency of bunch measures, the strategies for between bunch steering, and the habits of between group steering. Second, bunch head attributes, which incorporate the CH presence, CH contrast of capacities, CH portability, and CH job. Third, grouping processes, which that incorporate the control habits, execution nature, assembly time, boundaries for CH political race, and organization proactivity.

Pantazis et al. [15] introduced a powerful extended review of the paper proposed by Al-Karaki in 2004 [16] on the energy proficiency of directing conventions for WSNs. The creators characterized the steering conventions into level, progressive, inquiry based, intelligible and non-intelligent based, exchange based, area based, versatile specialist based, multipathbased, QoS-based. They give a point by point examination among these conventions as far as organization versatility, hubs portability, power use, course choice measurements, occasional message type, and heartiness. They additionally characterized the conventions as per obligation cycling, datadriven and versatility to demonstrate that the energy utilization of the radio is a lot higher than the energy utilization because of information testing or information handling.

Rault et al. [17] introduced a comprehensive perspective on energy-saving arrangements while thinking about the particular necessities of the applications. It gives WSN creators an outline of the effective arrangements of their application-explicit WSN design. They arranged WSN applications as indicated by their particular necessities. These prerequisites incorporate versatility, inclusion, dormancy, QoS, security, portability and heartiness. Then, at that point, they introduced another characterization of energy-preservation plans to be gotten together with applications explicit necessities. These plans are extensively isolated into five principal techniques which are: radio improvement, information decrease, rest/wakeup plans, energy-productive directing, charging.

3. Methodology:

Appropriate QoS support, energy efficiency, and scalability are important design and optimizationgoals for wireless sensor networks. But these goals themselves do not provide many hints on how tostructure a network such that they are achieved. A few basic principles have emerged, which can beuseful when designing networking protocols; the description here follows partially references. Nonetheless, the general advice to always consider the needs of a concrete application holdshere as well – for each of these basic principles, there are examples where following them wouldresult in inferior solutions.

Algorithm

i. We use Fuzzy logic based enhanced A* algorithm to find the optimal path from source node to destination node.

ii. At the initial stage each node sends its parameters: residual energy, packet reception rate, node buffer state.

iii. Based on these parameters the sink node evaluates the node status by fuzzy rulesfor the current routing schedule.

iv. If the node status of the node is less than the threshold energy it do not participate in the process and network load is balanced.

v. Three input based Fuzzy logic algorithm generates the node status and this is used as cost heuristic function to determine the choice of suitable nodes to find optimal path.

vi. Our intention is to forward data packets to the next neighbour node which has high residual energy, high packet reception rate, and high free buffer.

vii. To achieve this we use above mentioned parameters in a fuzzy evaluation system of the normalised input ratios given as:

node_status(n)=fuzzy_evaluation_function_of[(Eres(n)/Eini(n),(Nr(n)/Nt(n)),(Bf(n)/Bini(n))} (3.1)

Where, Eres (n) = residual energy of node n

Eini (n) = initial energy of node n

Nr (n) = number of received packets

Nt (n) = number of transmitted packets

Bf (n) = fixed free buffer

Bini (n) = initial free buffer

viii. In the fuzzy rules higher weightage is given to parameters residual energy of node.

ix. The value of distance function ,h(n) is calculated as:

h (n) = 1/Min (hcns)(3.2)

Where, Min (hcns) = minimum hop count from node n to the sink node.

x. To compute the minimum hop count we must calculate the distance from node n to sink node:

$$d(n, s) = \sqrt{(xn-xs)^2 + (yn-ys)^2} \quad (3.3)$$

xi. To calculate the minimum hop count:

hcns= d (n, s)/avg d (n, j) (3.4)

where, avg d (n, j) is the average distance between node n and its immediate neighbour node j.

xii. Performance Evaluation:

The energy consumed for transmitting and receiving k bit data can be evaluated as-

$E_{tx}(k) = k(E_{elec} + \varepsilon_{amp}.d^2)$ (3.5)

$E_{rx}(k) = k(E_{elec})$ (3.6)

Where, Eelec= per bit energy dissipated in transmitting and receiving circuitry

And, εamp= energy required per bit per meter square for the amplifier to achieve acceptable S/N Ratio.
Total energy= k (2Eelec+ εamp.d^2).

4. Result and Discussion:

We have considered a network consisting of N nodes randomly distributed in an area of length MxM meters having an initial energy E_0 and they have a destination D which is to be accessed by establishing route from various source nodes to the destination for example the algorithm considers an area length (M) in meters of 200 with number of nodes (N) = 10.

We have considered buffer size of 10 packets. Initially buffer status is assumed to be randomly filled and on each round the nodes packets are dispatched and received to vary the buffer size.

We have used the fuzzy inference system to develop the node status evalution system to select the neighbour node best fit for packet transmission as next hop.The details of fuzzy inference system are given below:

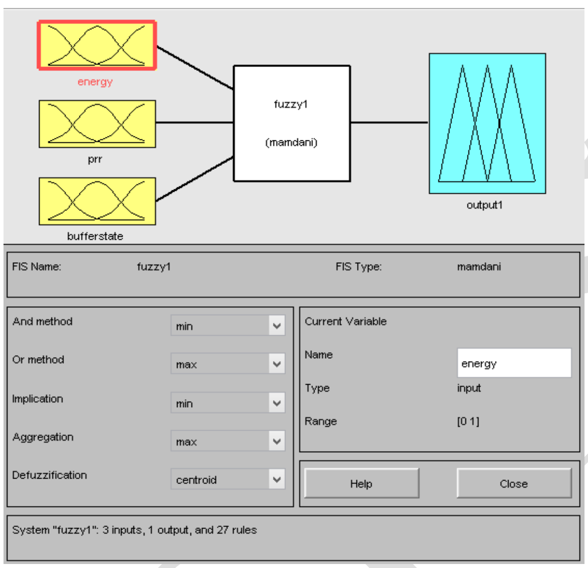

Figure 4.3: Fuzzy inference system for evaluationof node status.

Figure 4.3 shows the fuzzy inference system for evaluating the node status. It has three input known as energy ratio, packet receive rate and buffer state and the output is the node status. The inputs are partitioned using membership functions as shown in figure 4.4(a,b & c).

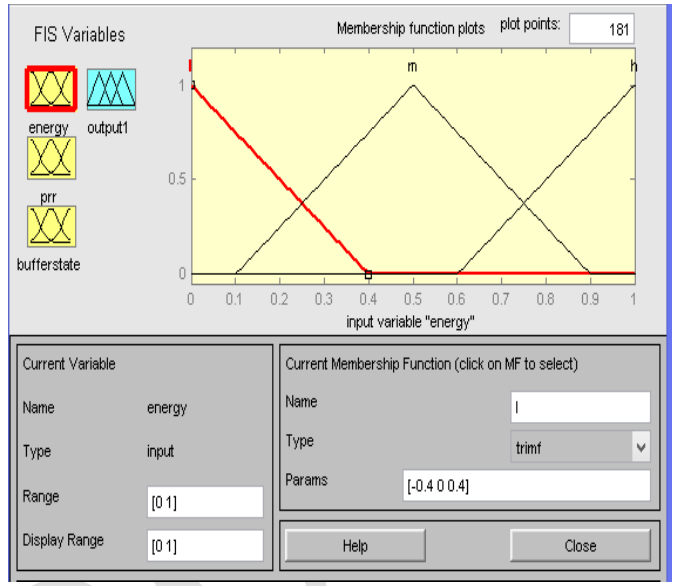

Figure 4.4a: Member ship function for input 1 energy ratio.

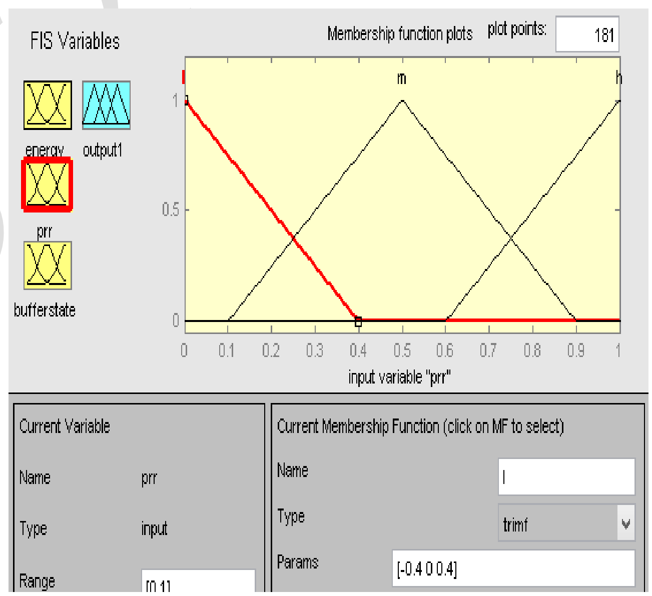

Figure 4.4 b: Membership function for input 2 packet receive ratio.

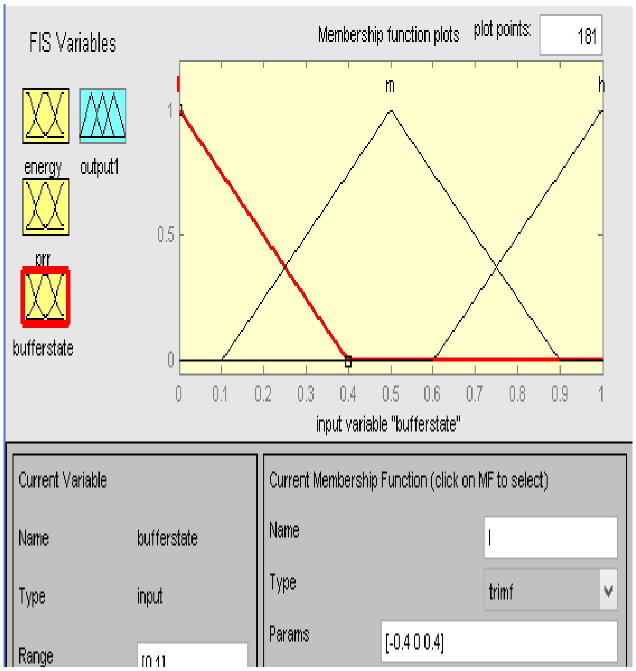

Figure 4.4 c: Membership function for input 3 buffer state ratio.

We can see in figure 4.4(a to c) that all three inputs are ratios hence the are varying from 0 to 1 and each input is divide into three equally spaced partitions allotted for LOW,MEDIUM and HIGH values of the input range.

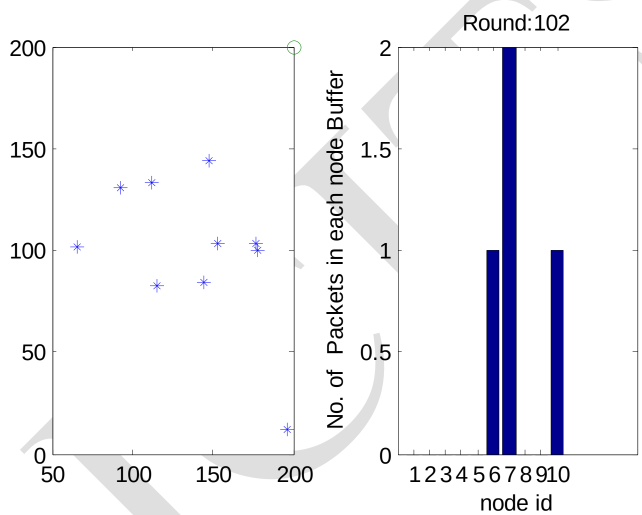

Figure 4.6: Node Distribution and buffer state at round 102.

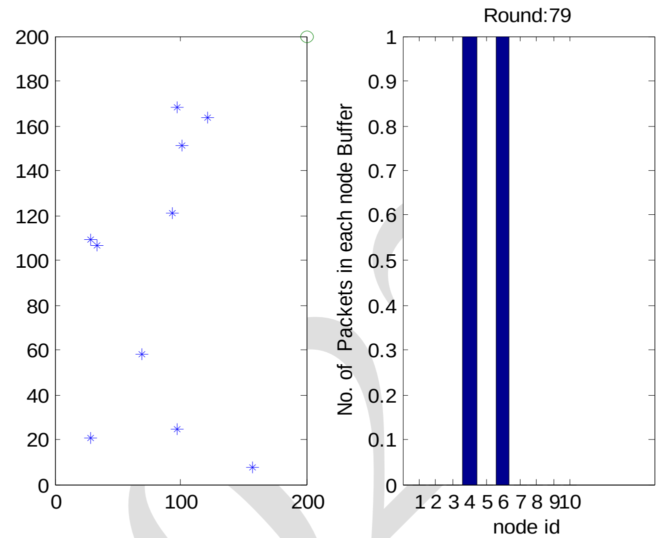

Figure 4.6: Node Distribution and buffer state at round 79.

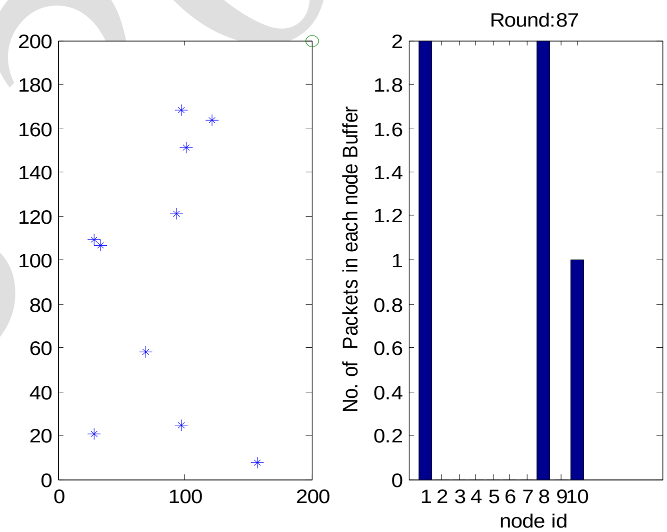

Figure 4.6: Node Distribution and buffer state at round 87.

5. Conclusion:

In this work sensor nodes network in the large-scale packet data transmission networks is considered and implemented on MATLAB programming environment. The nodes are considered with initially powered by limited and inexpensive energy source batteries with considerations of existence for a suitable time period. A schematic algorithm of components of a sensor node is simulated that consist of sensing, processing, transmission using limited power units. It also shows the communication architecture of a WSN. Each sensor node makes its decisions based on its mission, the information it currently has, knowledge of its computing, communication, and energy resources.

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