Energy curtailing with huddling practices with Fuzzy in Wireless Sensor Network

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Abstract— Wireless sensor is a mounting field and energy conservation is always being in the peak challenges. Researchers have gone all the way through architectures and topologies that permit energy proficient operation in wireless sensor network. Clustering being stretchy helps to supplely mould the network according to the needs. Cluster head election and cluster formation is previously investigated by numerous researchers. In this paper, a proposed novel scheme the Fuzzy Abiding Cluster Head Formation Protocol (FACFP) that uses Mamdani's fuzzy inference system in the process during cluster formation. We demonstrate that using multiple parameters in cluster formation can minimize the usage of energy. We will compare our proposed technique with well-known existing protocols to show that using multi parameter FIS enhances network lifetime and conserves energy utilization.

Key words: Wireless sensor networks, Fuzzy logic, cluster head election

I. INTRODUCTION

Wireless sensor network consists of plentiful sensor nodes that could intellect, compute and ensue for the final resultants [1]. When the sensor senses and collects the records all around the environment, the computational part process the data by the analog to digital conversions using ADC and promote the converted form of data to the target Base Station[2] as shown in Figure 1.1. Wireless sensor network commune with not merely the base station but as well as creates gaze links. Thereby within the huge dash of nodes it is challenging to devise sensor network to dish up the purpose to cutback energy consumption, cost and size of nodes for the purpose of our needs.

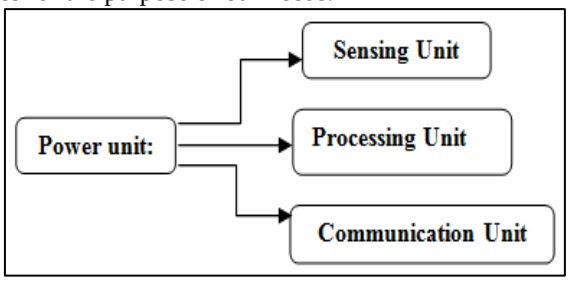


Fig. 1.1: Sensor operation

The clustering strategy stretches the limits to accomplish the goals. It is the efficient energy protocols that enhance the lifespan of nodes. It is essential to stabilize the energy utilization in the field of nodes [10].While many researchers have gone through the cluster head election [3], cluster formation [4] and the clustering algorithms [5]. We have focus on stable cluster formation. In LEACH cluster forms on the basis of probabilistic schemes where randomly no or many volunteers appear to stand for the election of cluster head [6] but it consider the distance of smallest transmissions merely distance among node and cluster head, this could impact other parameters directly or indirectly energy expenditure and network lifetime. We present fuzzy approach for abiding formation of cluster that uses energy and centrality of nodes. For the formation of cluster three descriptor of Mamdani fuzzy inference system is used. We call our novel approach as fuzzy abiding clustering formation protocol (FACFP) for wireless sensor network. To simulate our energy improvement with the proposed proposal FACFP, we compare the results of our approach with another protocol.

The paper is distinguished in various sections. as: Section II present information of related work. In section III portray our novel scheme in brief. Comparison among our approach and existing is presented under Section IV via testing of proposed scheme. Section V includes the whole conclusion of the paper.

II. Previous work

Many researchers have gone through the surveys of presented clustering strategies, techniques and algorithm in recent years [6]. Our proposed protocol, Fuzzy abiding cluster head formation protocol (FACFP) would be conservatory of fuzzy clustering algorithm. The probabilistic clustering was derived by LEACH protocol to lengthen on the whole lifetime of network and to diminish energy consumption [7]. LEACH is the institution of many other algorithms that are proposed by authors of [3, 9]. LEACH operates in two modes: set-up phase and steady phase. In set up phase; nodes are singled out at random probability prospect of 0 and 1 that decide whether to opt for node as cluster head or not. This process is made with the outline following judgment made on the threshold value; hence node becomes Cluster Head for that particular round. Computing [t (n)] in the below equation

$$t(n) = \frac{P}{1-p\left(r \bmod \frac{1}{p}\right)} \text{ if } n \in G, \text{otherwise } t(n) = 0 \ldots (1.1)$$

Hereby P represents the percentage of cluster heads to be expected, r is the number of rounds and G is set of all the nodes that are not elected as a cluster head from the last 1/P round.

Gupta[3] has introduced the fuzzy loom for selecting the cluster heads using three essentials personage that are energy levels, concentration of nodes and centrality of a node. He divides each personage in three varying levels: low, high and medium and applied it on LEACH. The only discrepancy lies in these two protocols were in their set-up phases; where base station accumulates the information of energy level and location for each node, assess it with FIS to analyze the chance for node to appear as Cluster head. Base station finalizes the node that gets maximum chance to be a cluster head.

CHEF(cluster head election mechanism using fuzzy logic in wireless sensor networks) [6] protocol was analogous to Gupta's protocol that enhances the lifetime of nodes using fuzzy loom with localized cluster head

mechanism whereas gupta's protocol does not need BS to gather local information from all nodes

LEACH-FL (improving on LEACH protocol of wireless sensor networks using fuzzy logic) [7] exercise fuzzy logic to advance LEACH protocol on three factors: energy level, node density and distance between CH and BS. This was analogous to gupta's excluding that set-up stage pick different parameters to relate in consider FIS to attain probability for each node.

The above discussion exhibits number of deviations on LEACH protocol that employ fuzzy loom [5] [6] [7]. Conversely these protocols use fuzzy loom for CH selection, while proposed algorithm FACFP exercises fuzzy logic for cluster formation.

III. FUZZY LOOM FOR CLUSTER HEAD FORMATION WITH FIS

Our proposed aspiration is to obtain enhanced lifetime of wireless system via designed FIS system which presents the method for originating the mapping of Input to output. It drives alike as LEACH and only fluctuates in cluster formation phases. Our approach favor to be a cluster head for the non-Cluster head's among nodes. [8]

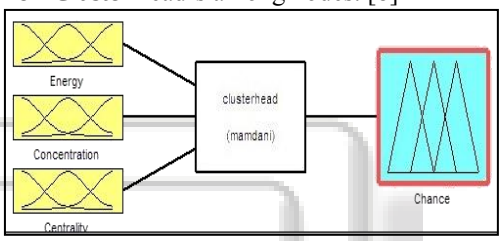


Fig. 1: FACP protocol using FIS system..

A. *FIS parameters and rules*

We use radio model to figure the energy so being devoted during transmission and reception of data between transmitter and receiver.[9]

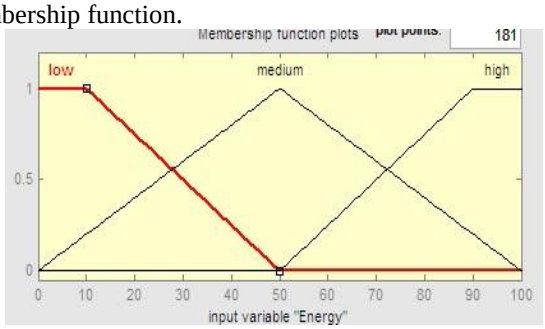
$E = E(tx) + E(rx)$ ..(1.2)

$E(tx(k,d)) = E(elec) * k + \varepsilon(amp) * K * d^{\lambda}$ .... (1.3)

$E(rx(k,d)) = E(elec) * k$ .... (1.4)

Where d is the distance between transmitter and receiver of the network, $\boldsymbol{E(tx)}$ the transmitted energy, $\boldsymbol{E(rx)}$ is the received energy, $\boldsymbol{\varepsilon(amp)}$ is the energy constant for propagation and $\boldsymbol{E(elec)}$ is the electronics energy. $\boldsymbol{\lambda}$ is path loss exponent.

To acknowledge and enlarge the network lifetime in MATLAB fuzzy logic toolbox, we split each linguistic personage; ENERGY and CONCENTRATION in three varying levels: low and high with trapezoid membership function and medium with triangular membership function and CENTRALITY of nodes as close and adequate with trapezoid membership function and far with Triangular membership function.



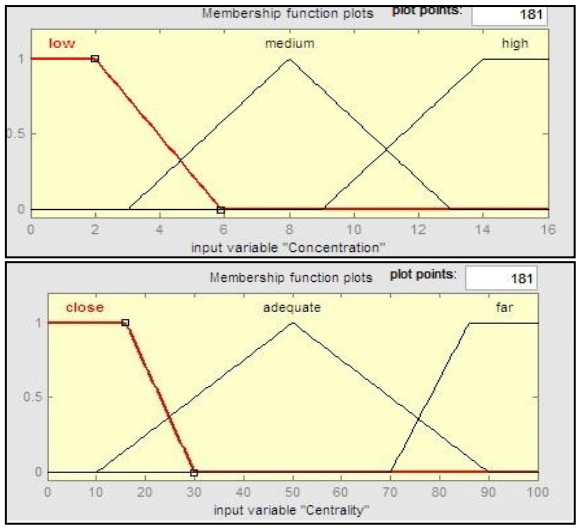


Fig. 2: Defining energy, concentration and centrality via FIS system

To bestow the proposed protocol feature flexibly, we split linguistic personage for chance value into 7 levels as: very small, small, rather small, medium, rather large, large and very large. We present very small and very large with trapezoid membership function and the rest with triangular membership function.

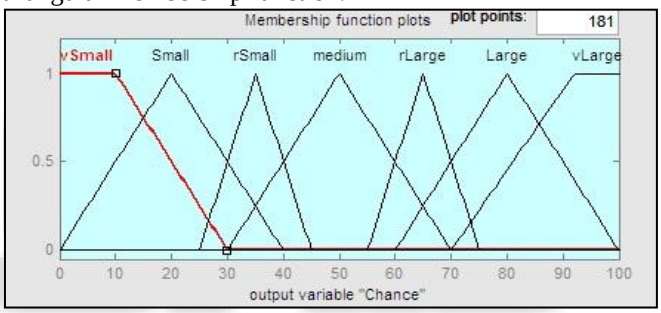


Fig. 3: Degree of membership functions vs. chance allotted.

We have three factors, each divides into three levels use to derive rules as 3^3 = 27 to analyze the chance computed via if-then rule. Two extreme cases are considered among whole rules from Table 1.

Extreme case 1: If (energy = low), (conc.= low) and (cen. = far) **then** (chance = very small)

Extreme case 2: If (energy = high), (conc.= high) and (cen. = close) **then** (chance = very large)

Energy	Conc.	Centrality	Chance	Energy	Conc.	Centrality	Chance
Low	Low	Close	Small	Medium	Medium	Far	Small
Low	Low	Adequate	Small	Medium	High	Close	Large
Low	Low	Far	vSmall	Medium	High	Adequate	Rlarge
Low	Medium	Close	Small	Medium	High	Far	Rsmall
Low	Medium	Adequate	Small	High	Low	Close	Rlarge
Low	Medium	Far	Small	High	Low	Adequate	Medium
Low	High	Close	Rsmall	High	Low	Far	Rsmall
Low	High	Adequate	Small	High	Medium	Close	Large
Low	High	Far	vSmall	High	Medium	Adequate	Rlarge
Low Medium	Low	Close	Rlarge	High	Medium	Far	Medium
Medium	Low	Adequate	Medium	High	High	Close	vLarge
Medium	Low	Far	Small	High	High	Adequate	Rlarge
Medium	Medium	Close	Large	High	High	Far	Medium
Medium	Medium	Adequate	Medium				

Table1. Fuzzy If-then rule

B. Establishing Cluster Head chance value:

The representation of fuzzy logic is based on four steps: Fuzzification, Rule evaluation, Aggregation and Defuzzification [8]. These steps are drawn in our designed FIS system of MATLAB to figure out the chance value as:

1) Fuzzification:

At very first, we forward our three inputs energy, concentration and centrality of nodes to FIS. Depending on these crisp values membership value is dogged.

2) Rule evaluation:

After Fuzzification, we furnish membership value attained for if-then rule to determine new fuzzy output sets. Our proposed fuzzy protocol have manifold inputs for if-then rules, a fuzzy operator that choose least of three membership values, is used to get single number.

3) Aggregation:

Aggregation unites all output values determined from the rules with OR fuzzy operator and applies equation 1.5. To gauge the energy of a node and. distance formula to find the concentration and centrality of nodes with 1.6.

$$Ne = \frac{E(remaining)}{E(total)} \quad \text{..... (1.5)}$$

Where **Ne**= node energy

$$Do = \sqrt{((x2 - x1) - (y2 - y1))\text{^}2} \quad \text{..... (1.5)}$$

Where, **D** is distance among X and Y nodes.

4) Defuzzification:

Preceding pace is Defuzzification where we accomplish our chance value. We exploit Mamdani method to reckon implication value and centroid Defuzzification to locate cluster head election chance value to outline a cluster formation. By utilizing the values of aggregated data in appropriate ways we can estimate the chance of node to be a Cluster head to form a cluster. If more than two cluster head acquire same chance value, the strap in amid them will be busted on the basis of centrality and distance nearer to Base station to opt the best survival.

C. Evaluation:

Using the tentative model, it permits lifetime of a network metric to measure data assortment rounds till the very first node dies i.e. the first node that run out of energy alike as revealed in prose [11][12]. The bound onto which our research has established is shown in the Table 2.

Type	Parameters	Value
Network topology	No. of nodes for both parts	100
	Area of deployment	200m*200m
Part1.	Expected clusters	5
	Base Station position	100m,160m
Part2.	Area of deployment	10m*10m
	Expected clusters	9
	Base Station position	3.5m, 12m
	Startup energy(Eo)	0.5 J
Simulation configuration	E(initial energy)	100J
	Simulation rounds	5000
	Energy deduction	0.5

Table 2: Simulation parameters

IV. SIMULATION SCENARIO

Figure 4 And 5 Demonstrates the number of alive nodes and dead nodes for both LEACH and our FACFP algorithms. FACFP outperforms the LEACH algorithm on the origin of examination of value of FND and HNA in LEACH and FACFP are evaluated in the Table 3 for each simulation. These expansions lie on the character and number of bounds that have been used in this experimentation for each protocol.

Algorithm	FND(first node die)	HNA(half node alive)
LEACH	993	1748
FACFP	1583	2207

Table 3: Simulation result

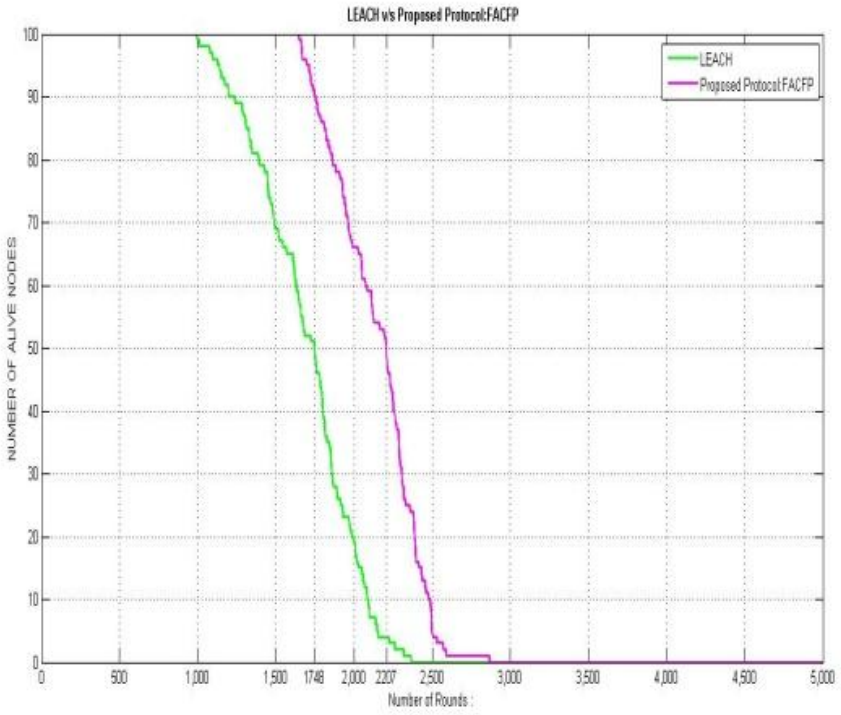


Fig. 4: Number of Alive nodes per round

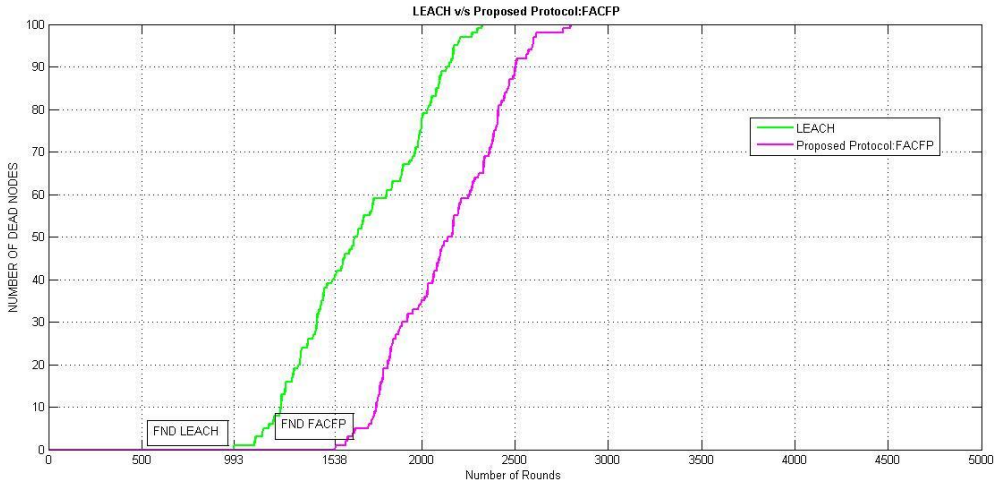


Fig. 5: Number of dead nodes per round

From the preceding upshots and investigations we wrap up that FACFP perk up time for FND as it consider three bounds for cluster formation rather than one bound in LEACH. Our proposed protocol reflects on three bounds: energy, centrality and concentration alike in [3] to evaluate chance value for being a cluster head.

V. CONCLUSION

In this paper, we present a novel approach for cluster formation in wireless sensor networks that brings fuzzy logic into play to augment network lifetime as the energy being the scarcest source for designing WSN. We have explored the recital of our protocol through simulations and weigh against LEACH, to possess energy efficiency, minimizes energy usage and consequently lengthening the lifetime of WSN. For this we have considered stationary sensor nodes. Further flow of my work is based on fuzzy sets and comparing the proposed advanced work with other clustering algorithm.

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