Clustering and routing wireless sensor network based on the parameters of distance, density, energy and traffic With the help of fuzzy logic

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Abstract

Totally the wireless sensor networks consist of many multi task sensors of low ability and small size which communicated at short distance [3]. Todays this networks are proper device for attain information, extracting data & assessing environmental events and their industrial, domestic and military utility is increasing [3,4]. The application of these networks depends on the cover and age of the network. Using these networks in tough environments makes it hard or impossible to recharge or exchange sensor nodes and these causes a tight limitation on communication and the processing time. So, one of the salient of energy [2,3]. Today's paring attention to intelligent devices like fuzzy logics, genetic algorithm, neural networks for managing power dynamic which considers reducing the energy consummation of sensor network, has increase magnificently [5,7].

1. Introduction

Researches show the communicative protocols can be effective in a large amount on reducing energy consumption [1,14]. Clustering is e method in which the communication tasks place by the head branches. It is one of the appropriate protocols for reducing the number of the diffuser towers the central receiver and thus it causes the reduction of energy consumption this matter causes the longing of the network [3]. one of the most magnificent about clustering the sensor network is the leach method in the setup phase of this method in each cluster one node is chosen as a head cluster. Other members of the cluster send their data to the head cluster. The collected data of the member nodes are processed in the head cluster before being send to the base station and after collecting the data and in the steady state phase in the shape of a packet are send to the base station in a direct way [1, 9]. fig.1 shows the perfect energy consumption by leach algorithm in a specific duration. The nodes near the main station are used in a lesser extent whereas the further nodes almost miss the whole energy [18]. The non-parallelism of energy consumption and the wasting of energy is evident because of their very much distance from the central receiver. If assume that all nodes are of the same importance, none of the nodes should be used more than the others. So we should use the state which the energy consumption reaches the lowest [18]. fig.2 shows the perfect way of energy consumption in the heads cluster.

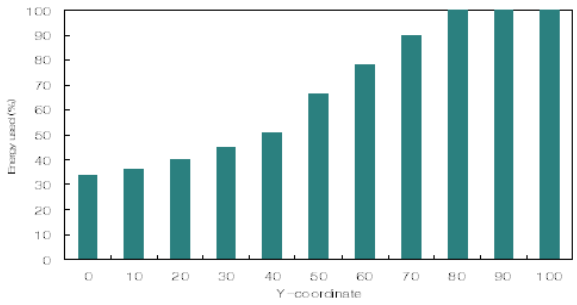

Fig.1 Energy histogram in LEACH

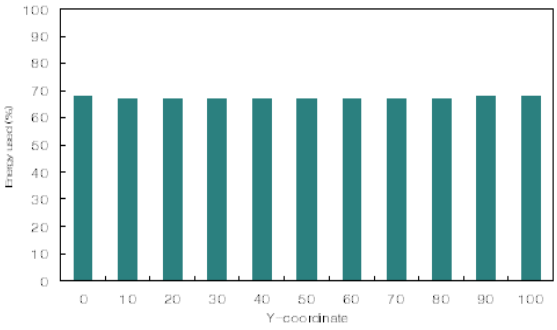

Fig. 2 Ideal energy histogram

The PRWSN [16] suggests a process which every node primarily sends it distance from the destination to the fuzzy processor as an input and receives the consuming energy extend and it sown supporter as the output.
The FUMOR [10] which uses the multi-tasks method for longing the age of the load level as the module fuzzy input.
In TRM [17] a method is used which the network is primarily divided into two zones of CH, RCH. Initially the threshold is assessed according to the energy input, the average distance of the CHs and the number of the active nodes of each cluster. Then if the CH is in a further state than the threshold, the emission happens by RCH.
In CHEF [6] the process of three parameters are assessed which are the cluster dependence, remain power of sensor battery and the network traffic by the fuzzy logic.
In this essay we have implemented a communicative method between CH, BS for reducing and balancing energy which causes the lingering of the network. The fuzzy method use in this essay uses the four parameters of distance, density, the remained energy and traffic. Because the fuzzy module is heavy process then some of the node energy is considered for the fuzzy module and its energy gets decreased.

2. System and Energy Model

The apparent network has the below characteristics:

- ✓ Nodes are diffused in the zone randomly and are home generous.
- ✓ The base station in at center of the zone
- ✓ The nodes are able to adjust their ability of emission according to their distance from the specify receiver whys is essential for the network sequence [15].
- ✓ The nodes have the same energy & ability.
- ✓ The condition & identity of the nodes are evident for the base station.
- ✓ The covered area is divides in to smaller areas likes web in which every head cluster gets chosen.

The method of the emission of the gathered data in every head cluster towards the adjacent head cluster send data to the heads cluster that are closer to the base station, have lesser density and more energy (fig.3). In case of path traffic we can choose better path among the other path.

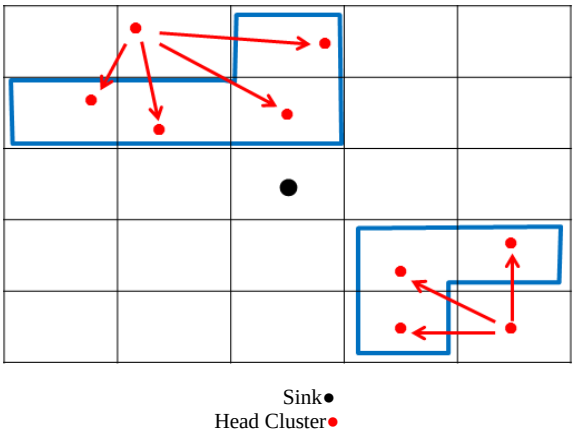

Fig..3 Data emission to adjacent heads cluster

In the recommended method, the fuzzy logic controller is used (fig.4) which is one of its main principles [8].

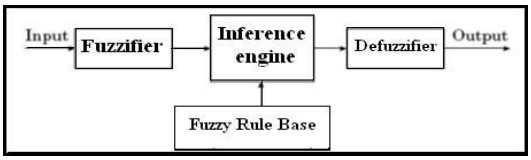

Fig.4 Fuzzy system members

These is uses Gaussian membership functions which has a higher sensitivity than trapezium and triangular functions [11]. The used energy model. Energy model is that Leach energy model [3].
Every node for emitting l bit of data consumers E_s energy tike the distance d and formula 1 is concluded.

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

Eelect is requirement energy for electronic circuits activation. d_{co} is Threshold measure, E_{mp}, $E_{fs}$are requirement energy for multi-path & campus power amplifier activation. If the distance was larger than $d_{co,}$ we can amplify transmitter power and following multi-path model else followed on campus model [4].
Also consumed energy for receiving 1 bit of data concluded formula2 [3].

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

3. Presented algorithm

In this essay every phase sends to its fuzzy module all the energy node parameters, distance from station and the density diffused (density means the number of the adjacent nodes which are to avail).
The network traffic at the time which the system has high pressure of tasks defines the ideal way by the conditional orders. According to the fuzzy module of each group in every defined zone the node is specified and chosen as the heads cluster. Then the other existing nodes in the area are linked to the specified heads cluster. The heads cluster after collecting the data, send them to the adjacent heads cluster. The below figure shows the sample radar for sending data to the adjacent zones.

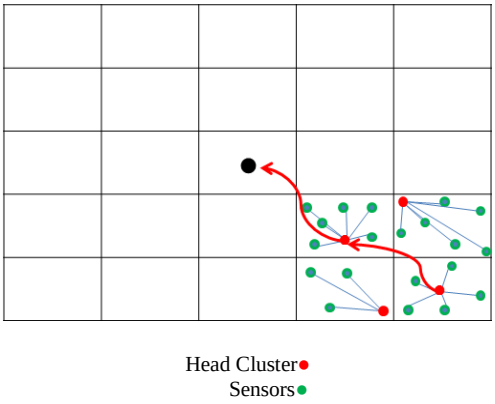

Fig.5 The plan of collecting data in a cluster

In the suggested method, because the distance of a region node is less than the distance of every node used in the leach method (figure 6) the amount of energy according to the relation one get lower and the pressure would be diffused equally.

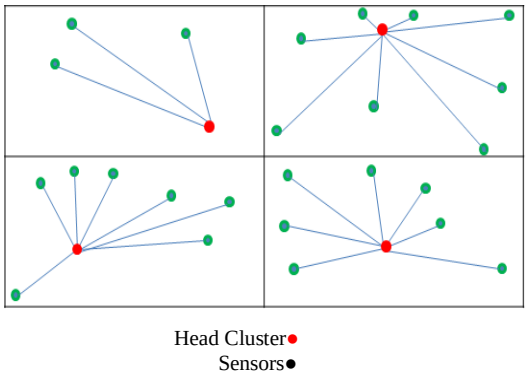

Fig.6 The plan of data collection in a cluster according to leach method

Pseudo-code fuzzy clustering with density parameters, distance and energy, which is used in the essay are presented below.

Pseudo-code for fuzzy clustering

1) Send energy, distance and density parameters of each node to its fuzzy module.
2) Performs commands at inference engine, according to input of each nodes and fuzzy rule base, then determine output of the fuzzy module.
3) Selecting best node according to output of the fuzzy module in the region
4) Send a broadcast message to other nodes by head cluster to introduction to other nodes in region (by broadcasting at within a region)
5) Connect each node to head cluster at the self-region
6) Collect data by head cluster from the other nodes.
7) Aggregate and compress data received from the other attached node to head cluster (Produce Single Packet)
8) Reduce energy from node for run fuzzy module program
9) Sending data collected from head cluster to neighbor head cluster in other region which is the best(Given the parameter of neighboring heads cluster)

After defining the head cluster in the steady phase, the multi-task communication is used for emission and the head cluster send controlled messages to the adjacent heads cluster and the perfect path would be chosen. The perfect path is a way which the head cluster has more energy and less density and closer distance to the base station and has no traffic.
Then the data after being collected by the head cluster are send to the same path and these would go on in the next head cluster until it is sent to the central receiver (figure.7).

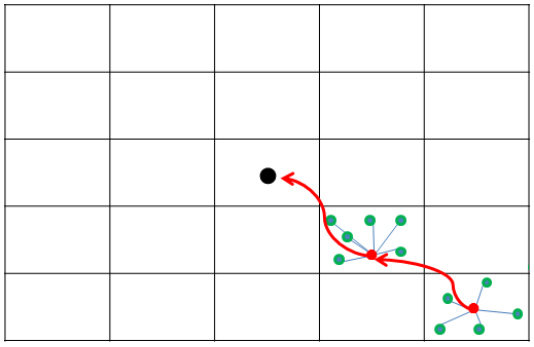

Fig.7 The quality of making an ideal path for transferring data to the central receiver

Pseudo-code for fuzzy Routing

1) Send a control message by head cluster to their surrounding heads cluster according to figure 6
2) The fuzzy module is performed in each head cluster which has received the control message.
3) Choosing the best head cluster among surrounding heads cluster which has best output from fuzzy logic
4) Check selected head cluster for traffic status. Select other head cluster if traffic has happened.
5) Send data to Specified head cluster at step 3.
6) Execution steps 1 to 5 until the sink receive pockets

The input parameter in the fuzzy module consists of the distance of the node from the base station, the energy and density of every node. The language variables for every input consist of:

$$\boldsymbol{Energy} = \{\boldsymbol{vlow}, \boldsymbol{low}, \boldsymbol{med}, \boldsymbol{high}, \boldsymbol{vhigh}\}$$
$$\boldsymbol{Density} = \{\boldsymbol{low}, \boldsymbol{med}, \boldsymbol{high}\}$$
$$\boldsymbol{Distance} = \{\boldsymbol{near}, \boldsymbol{med}, \boldsymbol{far}\}$$

The output of membership function by language quantity consist of:

$$\boldsymbol{Output} = \{\boldsymbol{vsmall}, \boldsymbol{small}, \boldsymbol{med}, \boldsymbol{long}, \boldsymbol{vlong}\}$$

The figure8 to figure10 shows the mapping of fuzzy inputs and membership function of the output [7].

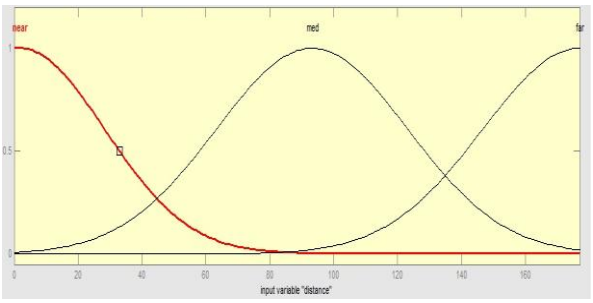

Fig. 8 The fuzzy set for distance variability

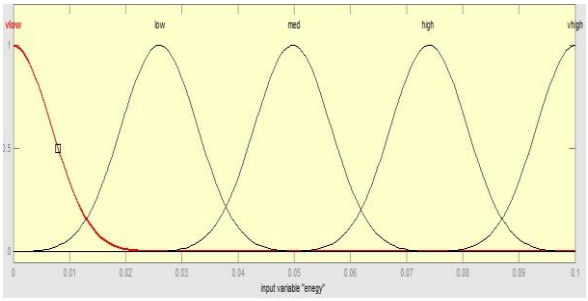

Fig.9 The fuzzy set for density variability

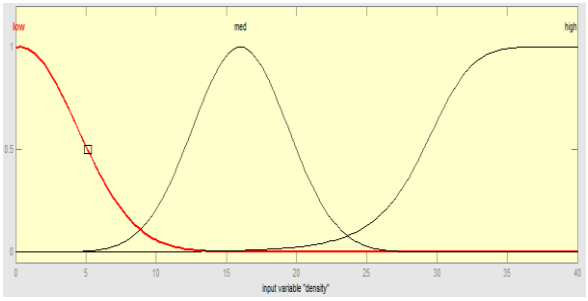

Fig.10 The fuzzy set for energy variability

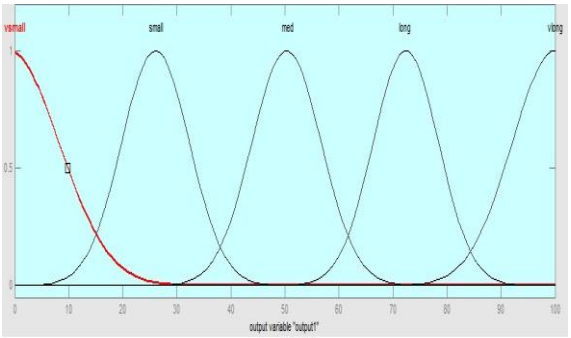

Fig.11 The fuzzy set for output variability

Some of the fuzzy laws presented below (table 1):

Table 1: fuzzy rules

No	*Distance*	*Density*	*Energy*	*Output*
1	med	high	vlow	vlong
2	med	high	low	long
3	med	high	med	med
4	med	high	high	small
5	med	high	vhigh	Vsmall
6	far	low	vlow	vlong
7	far	low	low	vlong
8	far	low	med	long
9	far	low	high	med
10	far	low	vhigh	med
11	near	small	vlow	vlong
12	near	small	low	vlong
13	near	small	med	med
14	near	small	high	med
15	near	small	vhigh	small

4. Simulation and result

The presented algorithm and at her protocols are simulated by MATLAB ® software. The assessed quantity are brought in these simulation in the table 2.

Table 2: The simulation parameters

Primary Energy	$0.1j$
Eelect	$50\ nJ/bit$
Efs	$10\ pJ/bit/m\text{^}2$
Dco	$87\ m$
Eda	$5\ nJ/bit/signal$
Packet Size	$4000\ bits$
Calculation Energy	$50\ nJ/bit$
Send_near Energy	$Packet\_Size * (Elect + Eda) + Packet\_Size * Efs * dis\text{^}2$
Send_far Energy	$Packet\_Size * (Elect + Eda) + Packet\_Size * Emp * dis\text{^}4$
Receive Energy	$(Packet\_Size * (Elect + Eda) * 0.05)$
Combination & Compacting	$(Packet\_Size * (Elect + Eda) * 0.05) * 0.05$

Figure12 shows a sample of algorithmic output in the zone of a measure of 250*250.

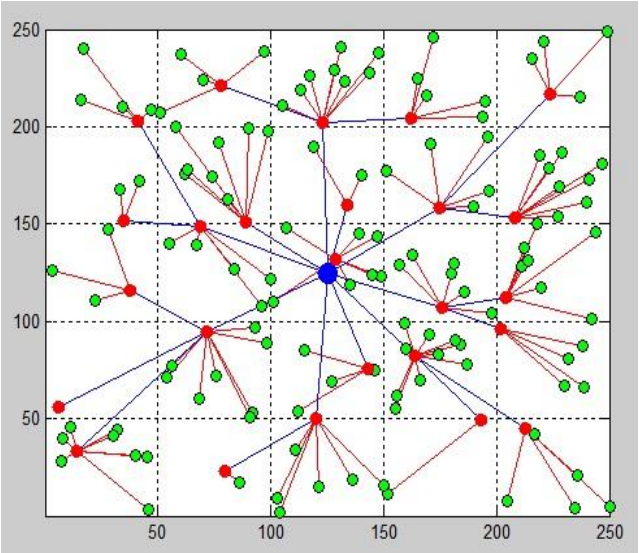

Fig.12 Sample response suggested algorithm

Table 3 shows the shortest life time of the nodes in the presented algorithm (SHR) in contrast with leach [3], FSCA [12], GSAGA [4, 13] and CFGA [5]. The ideal use of algorithm according to the life accretion is shown in table 3 in comparison with the other method. As u see the presented algorithm shows the shortest life of a node in a comparison with the other method.

Table 3: in comparison shortest life of the nodes for different algorithm

Network parameters	*Type algorithm*				
	Leach	*FSCA*	*GSAGA*	*CFGA*	*DDET*
150 node with network size 250*250	117	92	118	150	947
175 node with network size 300*300	62	59	90	120	733
200 node with network size 400*400	27	17	42	95	242

Also, the average life of every node and its maximum life according to DDET method is according to tables 4 and 5.

Table 4: The maximum life of a node

Area & Nodes	*Leach*	*DDET*
250 × 250 : 150 Nodes	888	2177
300 × 300 : 175 Nodes	913	2064
400 × 400 : 200 Nodes	1051	1379

Table 5: The average life of a node

Area & Nodes	*DDET*
250 × 250 : 150 Nodes	451
250 × 250 : 150 Nodes	1194
250 × 250 : 150 Nodes	754

Figure 13 Shows the condition of the shortest life of the first node as graphical.

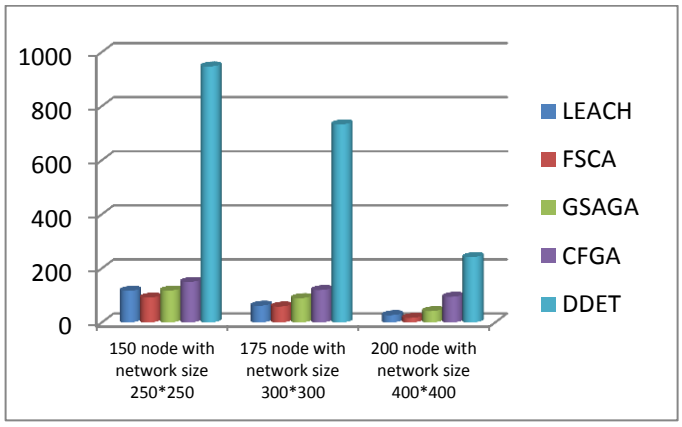

Fig.13 A comparative chart of the shortest life of the first node

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.

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