International Journal of Future Generation Communication and Networking
Vol. 13, No. 3, (2020), pp. 2122–2133

Fuzzy based cluster head selection on the hierarchy TEEN in WSN

G.R. AnnushaKumar[1], V. Padmathilagam[2], K.Devarajan[3]

1.Assistant professor in Electronics and Communication Engineering, Government College of Engineering, Thanjavur, Tamil Nadu, India. Email: gr.anuskumar@gmail.com.
***2.**Assistant Professor in Electrical and Electronics Engineering,FEAT,Annamalai University, Chidambaram, Tamil Nadu, India. Email: vpt_au@yahoo.co.in.*
***3.**Assistant Professor in Electronics and Communication Engineering,FEAT,Annamalai University, Chidambaram, Tamil Nadu, India. Email: devarajan_lecturer@yahoo.com.*

Abstract

In recent years Wireless Sensor Network (WSN) is dispersed in multiple clusters with the sensor. The sensors have played an important role for the data gathered from the remote area by sensors mounted on the clustering area its named as Sensors Nodes (SN) subsequently the Base Station (BS) will received the gathered information. So the lifetime of the sensor node depends on the power battery power supply. The improvement of sensor node life time in WSN is to balance the network load and thereby exhausted out the life span of the system, by this the efficient consumption of SNs energy has achieved. Lot of clustering algorithm is there for get better the life span of the sensors Nodes in that TEEN (Threshold-sensitive energy efficient sensor network) is considered for harvesting the energy dissipation in the WSN, Further to develop the life span of the sensor nodes a suitable algorithm have to consider. In this paper, a fuzzy based algorithm is used for selecting the prompt cluster head selection among the clustering. If the cluster head is selected properly the Quality of service (QoS) is increasing like throughput, energy consuming of nodes, and alive nodes with respect to number of rounds.

Keywords: *WSN, hierarchical routing protocol TEEN andFuzzy-TEEN.*

1. INTRODUCTION

In the past decades the data communication system plays an important role for the application of Wireless network systems. An electromagnetic waves are used to broadcast and collect the data's through air medium for end to end communications. The peoples can access the information's through electronic medium by the use of budding tool which is called Wireless networking. In order to improve the performance of the system a Wireless Sensor Networks (WSNs) has been proposed a ground-breaking information congregation technique. The WSN has certain enhanced features than the wired communication networks which are greater adaptability and improved flexibility. A multiple count of minute, cost effective sensor devices are connected in the physical layer of WSN in order to enhance the performance of the system. The sensor nodes of WSN are able to connect at diversified geographical location which is one of the major benefits to the society. The WSNs are used in the hazardous locations such as dangerous flood, earth-quake and target detection in military applications etc. The researchers are

ISSN: 2233-7857 IJFGCN

admired with WSN by it's adaptability and produce cost effective results while troubleshooting the complications in the isolated places.

2. ARCHITECTURE OF WSN

A WSN is a device composed by low-performance strategy referred as sensor nodes (SN) which are spread across the region to monitor atmospheric changes. **(Sudhir B. Lande and Sushil Z. Kawale 2016)** Each SN can communicate through a network. Any or more SNs of the network can function as a sink for direct user contact. The SN has been established physically or arbitrarily. The SN will collect the data's directly and a systematic procedures are followed and forward to the base station through the supplementary sensor nodes for immediate processing. In most of the applications the SN has been utilized in the complicate and hazardous zones like tricky to access the remote environments etc. SN's functions provide data storage, collaboration, and the network synergy with other SNs. The layout of the WSN including the treatment unit, sensor unit, power unit and communication unit is illustrated in the Figure 1.

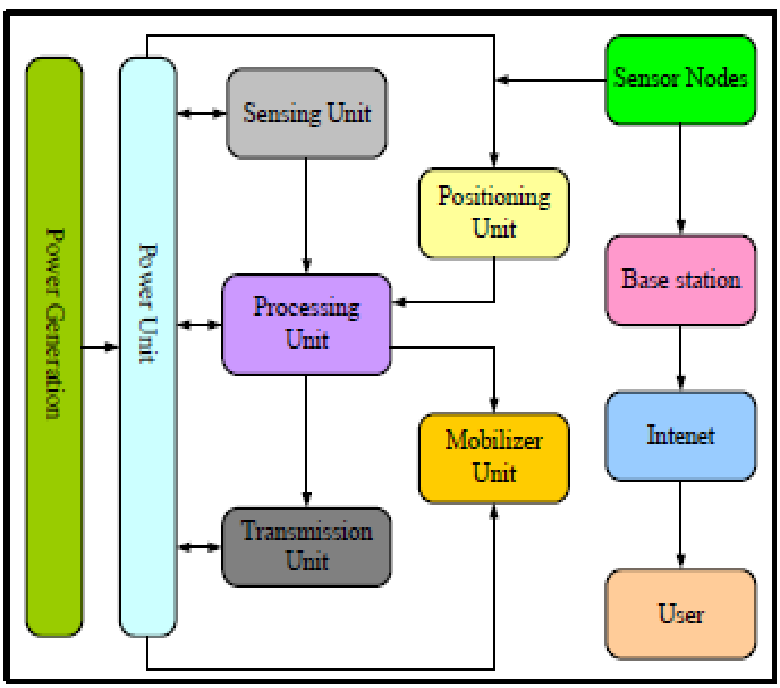


Figure 1: Architecture of WSN

This package includes different numeral sensors with hybrid analog to digital (ADC) converters. These sensors gather various information by integrating the ADC and return it to the sensed data. ADC is responsible for monitoring the data collected by SN and recommending additional steps by sensing the data. The role of the transmission device is to accept the demand or instruction from the transmitted data.

ISSN: 2233-7857 IJFGCN

The CPU is responsible for reading and controlling the control over the receipted data and measuring the ADC order or command. The power unit role is to provide electricity to all WSN systems. -SN package involves position finding (used to find a place) and movement of units (used to shift sensors).In this way SNs can be used by routers in connecting with Wireless networks that are battery limited. The WSN's low power, flexible, fault tolerance network and costs are much less, and maintenance free. The SN's even relay the data necessary via the network.

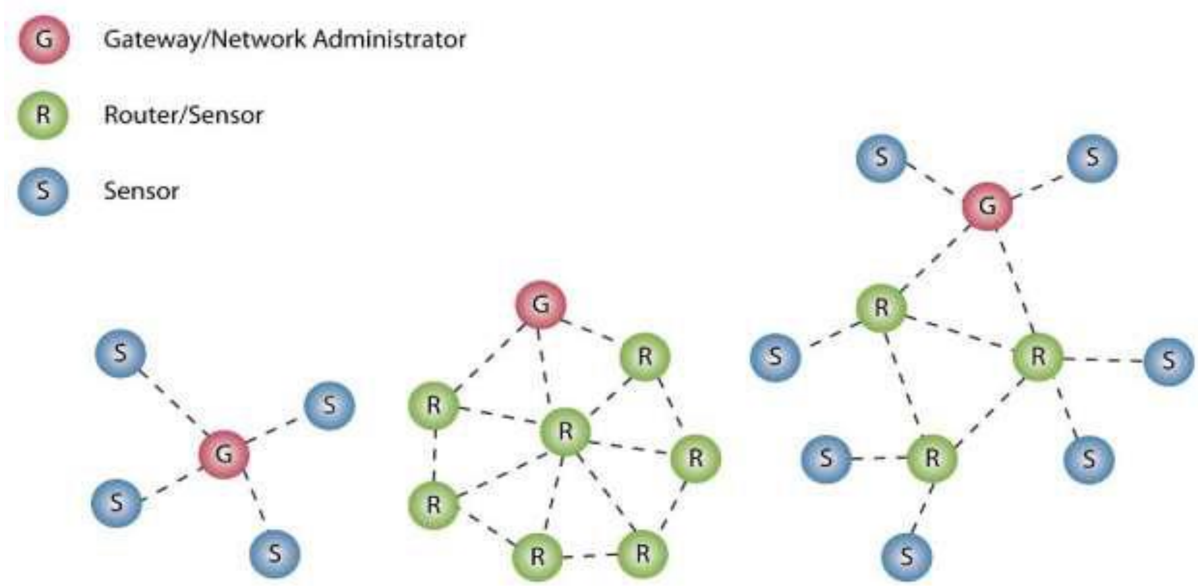


Figure 1: Topologies of WSN

The topologies that are generated by WSN are present in figure 2. Three topology types are connected in the sensor networks, namely Stern, Mesh and Tree Topology.The suggested algorithm of routing that could merge hierarchical and spatial routing could be efficient in greedy environments **(Li *et al.* 2006)**.The packet transmission cycle for the target area from source nodes to base stations involves the cross-cluster routing and intra-cluster routing in two steps. A greedy algorithm is modified for intercluster routing to transfer packets in the target regions. A quick flooding is used for intracluster routing to inundate the packet inside the cluster, if the intrinsic nodes number is less than a default threshold. If the packet is disseminated within the target cluster, the cluster head breaks the target cluster into a certain segment, generates the similar question packet, and transmit certain portions into a inner node in every subzone, the recursive geographic forwarding method is used.The nodes are normally operated by a single battery, so that the sensor network has a serious problem of energy constraints. The main design goal of protocol routing is to use the resources of sensor nodes effectively and increase the network's survival time **(Keerti Naregal and Anand Gudnavar, 2012).** To make the stability on load with consistent energy has been developed by SN. The projected effort is developed with superior numeral packet delivery to BS. (**Sahaaya Arul Mary and Gnanadurai, 2017**) For cluster configuration a Fuzzy logic algorithm has been developed with FZSEP-E. In (**Tamandani et al., 2017**) Authors studied the problems and suggested WSN security and routing protocol ideas and strategies. They have then introduced a system to ensure all wireless nodes are interconnected. In the first trial, they have applied an envelope model using a symmetrical hybrid RSA algorithm to conserve energy and maximize WSN's existence. In

ISSN: 2233-7857 IJFGCN

the second experiment they explored how MA is used to enhance the sensing node authentication protocol. The proposed envelope architecture will be implemented with two protection layers, one for authentication and the other for the generic trust which authenticates the delivery agents, to enhance middleware environment tools. The analysis showed that the new envelope protocol significantly increases the lifespan and usage of the entire network, with over 70 percent of the nodes depending on energy and CHs. **(S.Ganesh and R.Amutha, 2013)**. This proposed work the ad hoc on-demand vector routing (AODV) was updated by integrating the hierarchical clustering Signal to Noise Ratio (SNR). The well-organized and protected Routing Protocol suggested specification for wireless sensor networks using a SMS-based hierarchical clustering system (ESRPSDC) allows for the nodes to be separated into clusters, and the Cluster Head (CH) can be chosen from energy-based nodes. Failure recovery during Inter Cluster itself was introduced in order to prevent the retrieval of the end-to-end failure. The safety of the malicious nodes was achieved by analyzing plinth-based routing patterns. Extensive approach by means of a worldwide mobile simulator have found, in comparison to SNR unsuspecting routing algorithms such as Low Energetic (Leach) capture in sensor information systems (PEgasis), this ESRP significantly improves energy effectiveness and the PRR rate.The main challenges impacting wireless sensor network (WSNs) are drastically reducing use and network life. Clustering of a elevated class is one of the most effective technique to reduce energy use in WSNs. Different metrics may be utilized for determining the consistency of the clusters, which could lead to high-quality clusters given all of these parameters **(Amir Abbas Baradaran and Keivan Navi 2019).** In this thesis authors suggest a framework for the generation of high quality clustering algorithms (HQCA). A cluster consistency assessment criteria has been implemented in the HQCA system to increase cross-and intra-cluster distances and to the error rates during clustering. Depends on the fuzzy logic and based on different stages like the resident energy etc the optimum cluster head (CH) is chosen. High efficiency, small fault rates during the clustering process, independence of main CHs and improved size, and strong performance in large-scale networks with high numbers of nodes are key advantages of this approach. The efficiency of the cluster is also assessed on the basis of international and domestic parameters. Experiments showed that HQCA-WSN would increase energy consumption significantly.

Exciting methods

In the past decades the TEEN (Threshold sensitive Energy Efficient sensor Network) protocol is an efficient and robust network which is appropriate for reactive .The working principle of this technique is similar to the previously existing protocols apart from the two threshold levels. The cluster head transmit hard and soft threshold levels to the respective members after along cluster periods. The actual expected value is the hard threshold value. During the execution process any node has detected the value is greater than the actual value the appropriate node should be updated by the new value. The disparity stuck between the consecutive values is referred as Soft threshold .

III. RADIO MODEL

Most of the investigate has been proposed on optimum energy consumption of radio waves nexus with various phenomena's which are having different characteristics that will pressure the benefit of diverse protocols. A straightforward work is proposed on a radio model where the radio waves spares $Eelec$=50$nJbit$ in order to operate the transmitter and receiver circuit and $eamp$=100$pJbit/m2$ is the best amplifier in the transmission circuit. The maximum loss of energy exhibits because of broadcast in the channel is measured as $r2$and for distribution a $k-bit$ memorandum in excess of remoteness d.The calculation of consumption of energy for a radio model is elaborated bellow;

$$ETxk, = ETx-eleck + ETx-ampk,d \qquad \text{Eq. 1}$$

$ETxk, =Elec*k+ eamp*k*d2$

In order to achieve the similar $k-bit$message

$ERxk = ERx-eleck$

$ERxk = Eelec*k$ Eq. 2

This model is exposed that consumption of energy will decide the symmetric property of the radio channel. So the signal to noise ratio is similar for the transmission of signals from A to B and B to A.

We have assumed the dimension of the system S = a⁄b square meter with n number of SN which are sprinkled more the specified region S. The BS is located at far-away leave from system S. For every attempt, the energy bushed by every CH can be calculated through

$$E_{CH} = nm(E_{elec} + \varepsilon_{fs} d_{BS} + E_{DA}) \qquad \text{Eq. (3)}$$

Here d is the remoteness from CH to BS. Similarly the energy bushed by cluster member is calculated through

$$E_{CM} = m(E_{elec} + \varepsilon_{fs} d_{CH}) \qquad \text{Eq. (4)}$$

The Eq. (5) is used to compute the mean distance from a CH to its members i.e. dCH. This mean distance is utilized for calculate the broadcast radius of every SN.

$$d_{CH} = \frac{1}{(n \setminus k)} \sum_{1}^{n/k} di \qquad \text{Eq. (5)}$$

Here n is the whole SN, k referred as the cluster count and di indicates the remoteness between a cluster member i and CH.

Proposed Method

In the proposed method, the first modification is done by making use of fuzzy rules for choose the best cluster head for TEEN routing protocol. The residual energy of the various nodes, remoteness to the base station and amount of cluster members are selected as the fuzzy input parameters. The fuzzy policy made are illustrated in the below table

Table 1: Fuzzy policy used for Optimal Cluster Head for TEEN Routing

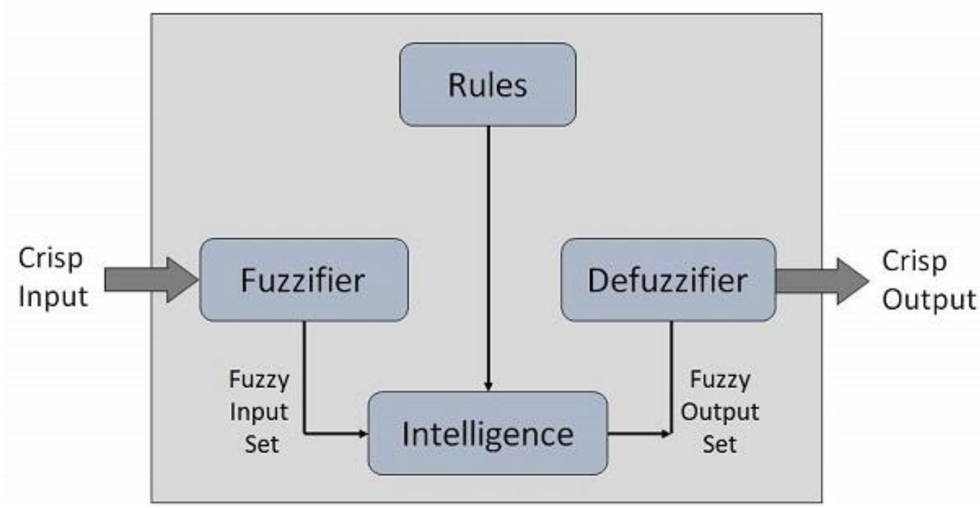
Rule	Residual Energy	Distance to BS	Number of cluster members/Cluster density	Priority to become cluster head
1.	L	C	D	G

2.	M	C	D	B+
3.	H	C	D	Far +
4.	L	C	S	Far +
5.	M	M	M	G
6.	H	C	M	B+
7.	L	C	M	B+
8.	M	C	M	F+
9.	H	C	S	F+
10.	L	M	D	B
11.	M	C	S	B+
12.	H	M	D	G
13.	L	M	S	G
14.	M	M	D	F
15.	H	M	M	B+
16.	L	M	M	F
17.	M	M	S	B+
18.	H	M	S	F+
19.	L	F	D	W
20.	M	F	D	W
21.	H	F	D	B
22.	L	F	M	W
23.	M	F	M	B
24.	H	F	M	B
25.	L	F	S	B
26.	M	F	S	F+
27.	H	F	S	G

LOW=L HIGH= H MEDUM =M FAR=F CLOSE=C DENSE=D SPARSE=S
GOOD=G BAD=B BETTER=B+ FAIR=F FAR BETTER=F+ WORST=W

The data transmission phase in F-TEEN is single hop communication as defined in the existing TEEN protocol.

ISSN: 2233-7857 IJFGCN



Fuzzifier: In Fuzzy first frame a fuzzy sets, from the inputs / crisp sets. Depending upon the degree of its membership in the set is assigned in fuzzy. With the help of the above crisp set its convert into philological value, it's named fuzzifier.

Fuzzy Rule Base: With the help of Knowledge base the rule is made. It consists of energeticactivitiesrule and its decide condition is IF-THEN by the user.

Inference Engine: It is a major role by inferring and drawing conclusion of the rule base. In that inference engine has an inputs and the simulated rules by the inference condition IF-THEN of human being.

Defuzzification: It carries out the crisp output by mapping of acquired from the inference engine from the fuzzy which can be used for sketch a number of termination. Defuzzifier is designed by the centroid by probabilityof computing.

The various fuzzy rules used to optimize the cluster head selection process has been described. The fuzzy input parameters were remaining energy of the nodes, distance to the base station and number of cluster members. The node having higher remaining energy, least distance to base station and medium density will be the best candidate for cluster head selection. The data transmission is done using single hop communication between cluster head and the base station

Results and Discussion

In these sections we compared the fuzzy-TEEN with exciting TEEN. In these methods used analysis the parameter metric such as Network-lifetime, Throughput, Network Stability is measured..

Table 2. Simulation Features Parameters

broadcast and receiving energy	50 nJ/bit
primary energy in node	2 J
Energy essential to aggregate data	5 nJ/bit/message

ISSN: 2233-7857 IJFGCN

volume of packet	2000 bits
% of Cluster Head	5%
# of nodes	200
Network area	100m x 100m
Location of BS	50m x -100m

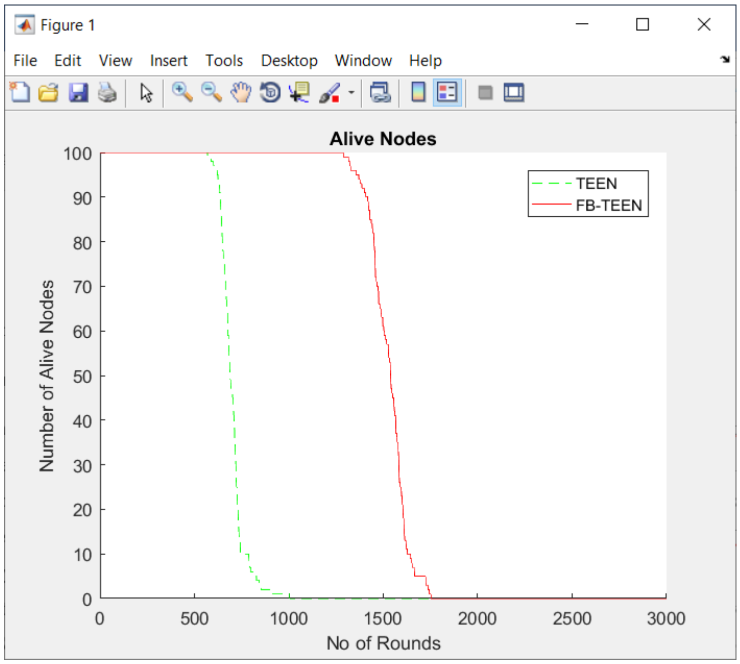


Figure 3: Quantity of Alive Nodes depend upon the Rounds

The Figure 3 shows the network lifetime of the sensor nodes. When the rounds increase the fuzzy based Cluster head selection methods increase the life span of the sensors as compared with normal TEEN, Which has the life span extend normally 1000 rounds only, but in the proposed method the life span increase more than 500 times approximately that is 1650 rounds the sensor nodes life increased.

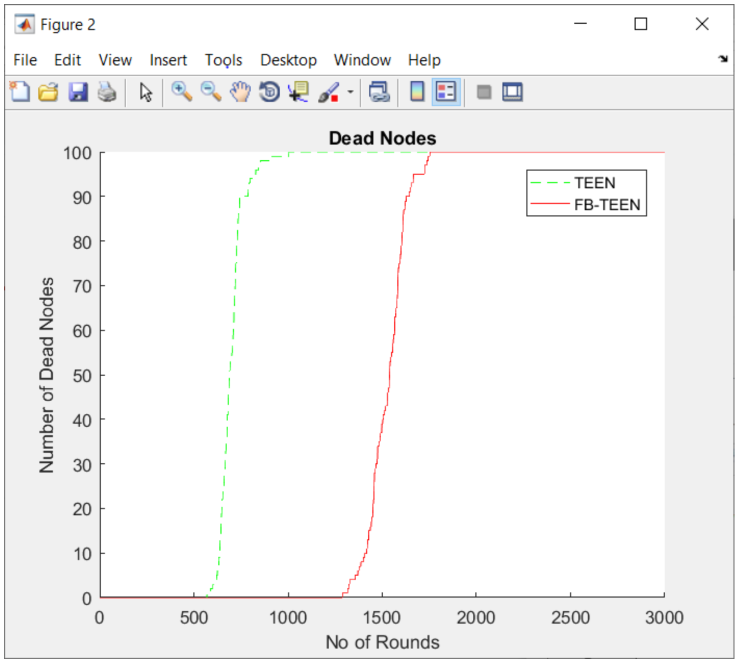
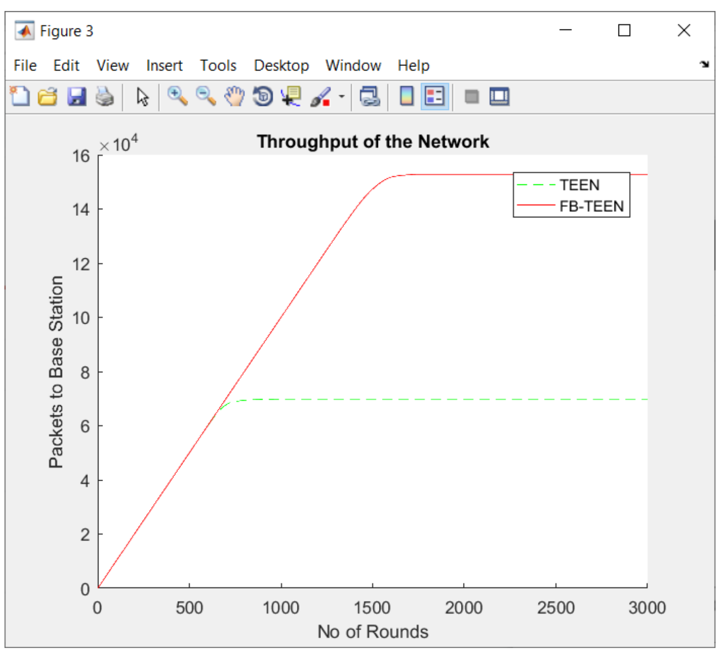


Figure 4: Number of Dead Nodes versus number of Rounds

The Figure 4 shows the Dead nodes in the cluster network. The dead nodes in the cluster area are decreased When the rounds increase the fuzzy based Cluster head selection methods. The nodes life span is extended due to that the dead life span extended as compared with normal TEEN, Which has normally 500 rounds only, in the proposed method the life span increase twice approximately that is 1650 rounds the sensor nodes life increased.



ISSN: 2233-7857 IJFGCN

Figure 5: Throughput versus number of Rounds

The Throughput of the sensor nodes are exposed in the Figure 5. The nodes in the cluster area launch the data from the sensing area to the base station is efficient and rate of transmitting packets is also high, when compared with exciting TEEN methods to the projected Fuzzy based cluster head selection methods. The exciting system transmit the data rate as average of 6 x10 ^{4} bits means, the Proposed methods deliver 15 x10 ^{4} bits.

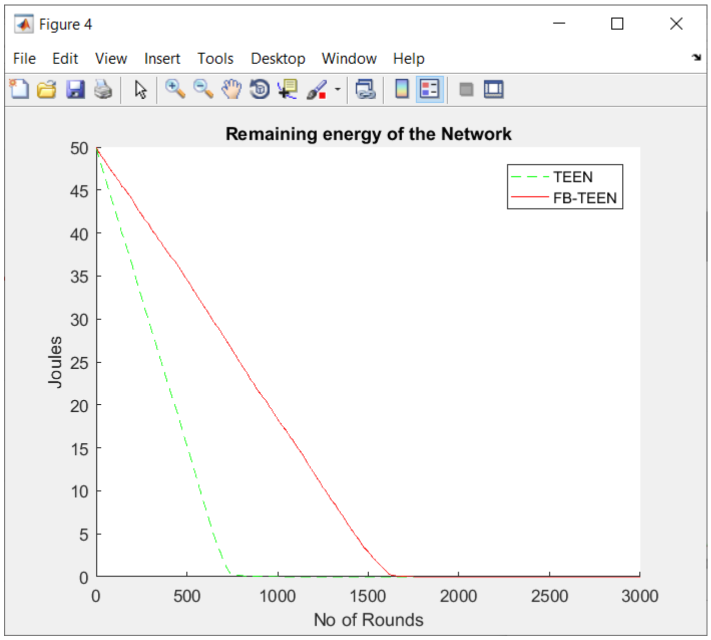


Figure 6: Number of Rounds versus Energy

The Figure 6 shows the Energy level remaining in the sensor nodes. Sensor nodes consume less energy due to proper cluster head selection in the proposed fuzzy based cluster head selection. If the packet delivery ratio in increases than the energy consume of the node is also increasing, but in the transmitting time and distance is decreased the energy level of the sensor nodes is increasing. In that the graph is shown the remaining energy of the network is huge compared to the normal TEEN.

Conclusion:

In the proposed method, the cluster head is chosen by a Fuzzy based rule because of that the QoS is increased. Throughput, dead node ratio, remaining energy of the sensor nodes are increased due to this the lifetime of the sensor nodes is increased. From that if choose the proper cluster head than the life time of the nodes in the cluster is extended and the QoS is efficiently increasing. Exciting TEEN is also good by selecting threshold based cluster head, but compare with Fuzzy based method is increases one half of the TEEN.

Refrences:

1) **Sudhir B. Lande, Sushil Z. Kawale** (2016), Energy Efficient Routing Protocol for Wireless Sensor Network, 8th International Conference on Computational Intelligence and Communication Networks.

2) **Prashant Tiwari, Varun Prakash Saxena, Raj Gaurav Mishra and Devendra Bhasvar** (2015), Wireless sensor networks: introduction, advantages, Applications and research challenges, International Journal of Technology Innovations and research (IJTIR), vol 14, April

3) **Q. Mamun** (2012), "A qualitative comparison of different logical topologies for wireless sensor networks," Sensors, vol. 12, no. 11, pp. 14887–14913.

4) **Sangeeta Vhatkar, Mohammad Atique** (2013), Design Issues, Characteristics and Challenges in Routing Protocols for Wireless Sensor Networks, International Journal of Computer Applications.

5) **Tai-hoon Kim and Subhajit Pal** (2010), A Comparative Study of Wireless Sensor Networks and their Routing Protocols, SENSORS.

6) **Li, S. Dong and X. Wen(**2006), An Energy Efficient Clustering Routing Algorithm for Wireless Sensor Networks, Journal of China Universities of Posts and Telecommunications, Vol.3, No.13, pp.71-75, June.

7) **Keerti Naregal, and Anand Gudnavar** (2012), Improved Cluster Routing Protocol for Wireless Sensor Network through Simplification, 18th Annual International Conference on Advanced Computing and Communications (ADCOM).

8) **Heshem A. El Zouka** (2013), Challenges in Securing Wireless Sensor Networks, SENSORCOMM 2013: The Seventh International Conference on Sensor Technologies and Applications, pp. 145-150.

9) **S.Ganesh and R.Amutha (**2013), "Efficient and Secure Routing Protocol for Wireless Sensor Networks through SNR based Dynamic Clustering Mechanisms, Journal of Communications and networks , issue 4, Aug, pp. 422-429.

ISSN: 2233-7857 IJFGCN

10) **Akyildiz, I.F., Su, W., Sankarasubramaniam, Y., Cayirci, E., 2002.** Wireless sensor networks: a survey. Comput. Networks 38, 393–422. https://doi.org/10.1016/ S1389-1286(01)00302-4.
11) **Alami, H El, Najid, A., 2016.** Energy-efficient fuzzy logic cluster head selection in wireless sensor networks, in: 2016 International Conference on Information Technology for Organizations Development (IT4OD). IEEE. https://doi.org/ 10.1109/IT4OD.2016.7479300.
12) **Anastasi, G., Conti, M., Di Francesco,** M., Passarella, A., 2009. Energy conservation in wireless sensor networks: a survey. Ad. Hoc. Networks 7, 537–568. https://doi. org/10.1016/J.ADHOC.2008.06.003.
13) **Chan, H., Perrig, A., 2004. ACE:** an emergent algorithm for highly uniform cluster formation. In: Lecture Notes on Computer Science. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-540-24606-0_11**.**
14) **Chand, S., Singh, S., Kumar, B., 2014.** Heterogeneous HEED protocol for wireless sensor networks. Wirel. Pers. Commun. 77, 2117–2139. https://doi.org/ 10.1007/s11277-014-1629-y.
15) **El Alami, H., Najid, A., 2017.** Fuzzy logic based clustering algorithm for wireless sensor networks. Int. J. Fuzzy Syst. Appl. 6, 63–82. https://doi.org/10.4018/ IJFSA.2017100105.

ISSN: 2233-7857 IJFGCN