IJDACR
ISSN: 2319-4863

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary research
Website: www.ijdacr.com (Volume 3, Issue 7, February 2015)

Fuzzy Logic Based Region wise Routing Protocol for Wireless Sensor Network

Mugdhita Rege[1], P. P. Narwade[2]
[1]PG Student, MGM College of Engineering and Technology Kamothe,
[2]Professor, MGM College of Engineering and Technology Kamothe, Dept. Electronics and Telecommunication Engg.
[1]mugdhita32@gmail.com, [2]narwadepp@rediffmail.com

Abstract: ***Wireless sensor networks are collection of several small, battery operated electronic devices known as sensors in order to monitor physical phenomenon such as temperature, pressure or humidity. Furthermore these sensor nodes are usually operated by battery which is normally not easy to replace. Till now many routing protocols have been proposed for energy efficiency of both homogeneous and heterogeneous environments. Hierarchical routing protocols are considered as best in regard to energy efficiency [1]. Clustering technique using hierarchical routing protocols minimizes energy consumption in a great extent. We propose here a protocol designed for the characteristics of heterogeneous WSNs. Region-wise routing protocol (FUZZY-SEP) is used for some nodes to transmit data directly to base station. In FUZZY-SEP, Cluster Head (CH) selection is based on fuzzy level information which minimizes the time for the selection of cluster head.***

Key Words: ***WSN (Wireless sensor network), FUZZY-SEP (Region-wise routing protocol), CH (Cluster head), BS (Base station), fuzzy logic, network lifetime, routing, energy efficiency.***

I. INTRODUCTION

Wireless sensor network (WSN) has appeared as an emerging field in last few years providing a variety of useful applications such as target detection and monitoring, scientific observation, safety-related. The purpose of mapping a WSN is to collect relevant data for processing and reporting. Sensor nodes periodically sense the environment and transmit the data with respect to time [2]. The occurrence of a certain event can be recognized from a sudden drastic changes sensed by wireless sensor network. Sensor nodes are battery-operated and are expected to operate for a long time without any failure.But reality is different from our expectations as it is difficult rather impossible to replace the battery of sensor nodes .Thus energy consumption is a major key objective in wireless sensor network communication. By varying the parameters like distance, residual energy and load we can prolong the network lifetime which in turn leads to reduced energy consumption [3].

Wireless sensor network is formed by number of identical nodes. A sensor node is composed of sensor unit, analog-digital circuitry, processor, memory, transceiver, battery source and a set of protocols to support the communication. These nodes are responsible for data gathering which is carried on in order as shown in fig. 1 - sensing, processing and communication. The sensor nodes are usuallyprogrammed to monitor or collect data from surrounding environment and pass the information to the sink [4].To maintain the connectivity and coverage among all the nodes in the network, proper routing algorithm is essential.

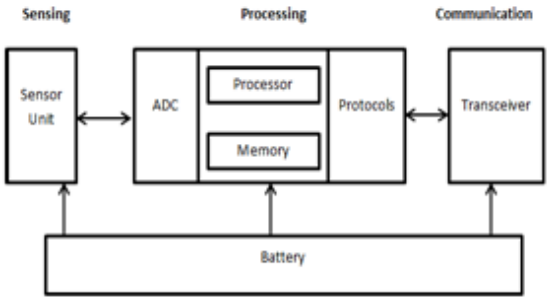

Fig. 1- Components of a sensor node

All the recent research work focuses on sensor networks that are based on clustering technique. Grouping of sensor node is called as cluster. Clustering provides WSNs large coverage area and network scalability. Clusters create hierarchical fashion which enables network to use resources efficiently. In hierarchical clustering single cluster head (CH) is elected in a single clusterwhich transmits data to the sink node. Clustering is classified as Homogeneous or Heterogeneous. Homogeneous clustering consist of identical sensors which are equally capable of sensing, computation, communication, and posses equal energy level. This type of identical

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary research
Website: www.ijdacr.com (Volume 3, Issue 7, February 2015)

sensornetworks is termed as Homogeneous. Whereas, the possibility of working with more than one type of sensors within a samenetwork is mentioned as Heterogeneous. Heterogeneous networks use nodes with different batteryand different functionalities [5]. The Low Energy Adaptive Clustering hierarchy protocol (LEACH) is first and most basic hierarchical clustering algorithm which is popular for energy efficiency and reduced power consumption. A cluster head (CH) is responsible for coordinating the transmission of data between the BS and other sensor nodes. Each node elects itself as a cluster head based on the probability scheme and realizes its availability to other sensor nodes in the cluster as shown in fig 2. In clustering technique apart from residual energy distance is another major attribute to determine the signal strength [7].

A routing protocol is a protocol that specifies how sensor nodes communicate with each other [6]. To send data between sensor nodes and the base stations routing is essential. It builds the path between source and destination and maintains it during network utilization.

Routing protocols can be classified as based on their functionality and applications as proactive, reactive and hybrid. In a proactive protocol data is transmitted or routed via a predefined route when the sensor nodes sense the environment and thereafter data is transmitted to a BS. Whereas in a reactive protocol when some sudden changes are the sensed i.e. when the sensed data cross pre-determined threshold value, the nodes immediately react. And hybrid protocol inhere the characteristics of both proactive and reactive protocols. The Low Energy Adaptive Clustering hierarchy protocol (LEACH) utilizes this type of protocol. The Threshold sensitive Energy Efficient sensor Network (TEEN) is an example of a reactive protocol. The best example of hybrid protocol is Adaptive periodic Threshold sensitive Energy Efficient sensor Network (APTEEN) that incorporates both proactive and reactive concepts [6].

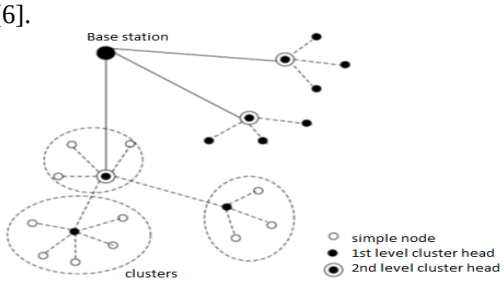

Fig.2- Clustering process in WSN

Wireless sensor network is composed of number of sensor nodes which are uniformly distributed all over the network and a single sink node. The position of the sink node can be arbitrary. Transmission between adjacent cells are carried out at same power level. Routing is done among the nodes i.e. each cell forwards its packets to the cell that is closest to the sink node; upon reaching the closest node the packet is routed to the sink node [8].

II. DESIGN ISSUES

A network should be designed by keeping in mind network characteristics and challenging parameters that appear while designing a network. Thus we can evaluate a performance of a network on following basis:

(i.) ***Power source****:* Sensor nodes are powered by battery-source whichhave limited energy. If the energy of sensor nodes crosses certain threshold level the sensor becomes faulty. In such cases they are difficult to replace as the nodes are employed in some hostile or adverse areas.

(ii.) ***Stability Period:*** The period in which the network starts its operation till the death of the first node is stability period. It is also referred to as "stable region or steady state".

(iii.) ***Instability Period:*** The period of time from the death of the first node until the death of the last node is instability period. It is referred as unstable region.

(iv.) ***Network life time:*** It is the time interval between stability and instability period:

Network lifetime = Stability Period + Instability Period

(v.) ***Alive Nodes:*** It is the total number of normal nodes having energy greater than zero i.e. alive.

(vi.) ***Throughput:*** It is the total rate of data sent over the network from nodes to their respective CHs and from CHs to base station [3], [7].

In remote sensor system, it is important to foresee the energy level of the framework. In this

IJDACR
ISSN: 2319-4863

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary research
Website: www.ijdacr.com (Volume 3, Issue 7, February 2015)

manner an energy model is characterized for energy examination of a sensor system. We accept that all nodes are consistently circulated everywhere throughout the system in progressive hierarchical groups. What's more a small amount of the aggregate nodes are furnished with more energy. Let m be division of the aggregate nodes n, which are furnished with α time more energy than alternate nodes. We mention these nodes as super nodes, (1-m)×n are ordinary nodes. Presently the election of cluster head (CH) is done in each round so the load is decently adjusted among all nodes. The cluster head then needs to report the sink node [3], [9]. The energy model is illustrated in fig. An essential outline issue in sensor systems is energy productivity.

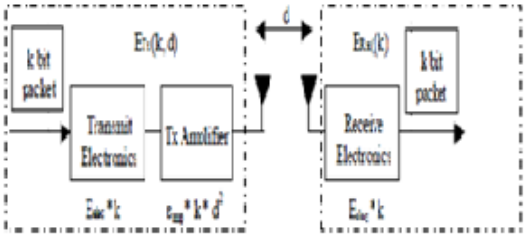

Fig.3 – Radio energy model [9]

Energy utilization for accumulation of information is substantially less when contrasted with energy utilized as a part of information transmission.Thus, to transmit a k-bit message, a separation d, the radio uses:

$$ETx(k,d) = ETx - elec(k) + ETx - amp(k,d)$$
$$= Eelec*k + eamp*k*d_2$$

and to receive this message, the radio uses:

$$ERx(k) = ERx - elec(k)$$
$$= Eelec*k$$

III. PROBLEM DESCRIPTION

For an energy proficient operation, ideal cluster arrangement is important to guarantee that energy is devoured at an adjusted rate. The operation of group based WSNs is broken into rounds. Each round is comprised of cluster head choice, cluster development and information transmission. The system lifetime is the quantity of rounds in which all nodes have non-zero energy. The majority of the grouping calculation depends on an irregular number created by every sensor node in every round for the procedure of cluster head selection. Late studies demonstrates that if parameters like residual energy, distance to base station and centrality are considered at the time of cluster head election, system execution can further be progressed. In this reference this exploration work is dedicated towards execution advancement of region-wise routing protocol and fuzzy logic.

IV. PROPOSED METHOD

We propose a Region-wise routing protocol (FUZZY-SEP) with joint consideration of cluster head selection and routing discovery. In SEP protocol ordinary nodes and super nodes are sent randomly; If greater part of typical nodes are conveyed far from base station it expends more energy while transmitting information which brings about the shortening of strength period and abatement in throughput. Consequently proficiency of SEP declines. To evacuate these defects we partition system field in small regions. Since corners are most far off regions in the field, where nodes require more energy to transmit information to base station. So in fuzzy-SEP, ordinary nodes are put close to the base station and they transmit their information straightforwardly to base station. However super nodes are put far from base station as they have more energy. On the off chance that super nodes transmit information specifically to base station more energy expends, so to spare energy of super nodes grouping procedure is utilized for super nodes only. The most important part of the proposed method is Fuzzy Inference System (FIS). The FIS has four parts and the architecture of the model is shown in fig. 4

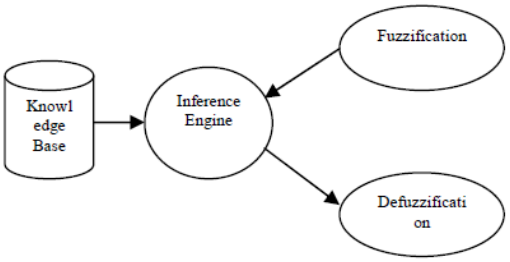

Fig.4 – Fuzzy Inference System Architecture

(i.) ***Fuzzification module:*** System inputs, which are fresh numbers, are changed into fuzzy sets by applying a fuzzification capacity.

(ii.) ***Knowledge base:*** It stores IF-THEN standards.

(iii.)***Inference Engine:*** By making fuzzy guessing on the inputs and IF-THEN

IJDACR
ISSN: 2319-4863

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary research
Website: www.ijdacr.com (Volume 3, Issue 7, February 2015)

principles it mimics the human thinking methodology.

(iv.) ***Defuzzification module:*** The fuzzy set acquired by the inference tool is changed into a crisp values.

A. Region-wise routing protocol

Region-wise routing protocols join features of both proactive and reactive ones. Ordinarily, the topology is separated into specified regions or zones. FUZZY-SEP is a mixture protocol that divides the system into a few zones, which makes a various leveled protocol as the ZRP protocol (zone-routing protocol). FUZZY-SEP is in light of GPS (Global positioning system), which permits every node to recognize its physical position before mapping a location with table to distinguish it to which it belongs [5].

B. Fuzzy logic algorithm

Fuzzy Logic is a numerical control method to express human thinking in thorough scientific documentation. Not at all like traditional thinking in which, a recommendation is either true or false, fuzzy logic creates truth estimation of a suggestion taking into account phonetic variables and derivation rules. It has the beneficial points of simple usage, robustness, and capacity to be estimated to any nonlinear mapping. In fuzzy frameworks, the dynamic conduct of a framework is described by a set of semantic fuzzy principles in view of a human expert. These rules are the main center of attraction of a fuzzy framework and may be given by specialists or can be separated from numerical information [2], [4]. In either case, the standards that we are keen on can be communicated as an accumulation of IF-THEN articulations (IF predecessors THEN consequents). Predecessors and consequents of a fuzzy rule structure create the fuzzy input space and fuzzy yield space separately is characterized by blends of fuzzy sets. We suggest here the IF-THEN rule set designed for fuzzy-SEP protocol. This is the set of 27 rules designed from the combination of distance, residual energy and distance.

IF	DISTANCE	RESIDUAL ENERGY	LOAD	THEN	OUTPUT
IF	Reachable	Low	Less	THEN	18
IF	Reachable	Low	Medium	THEN	9
IF	Reachable	Low	Heavy	THEN	19
IF	Reachable	Adequate	Less	THEN	3
IF	Reachable	Adequate	Medium	THEN	6
IF	Reachable	Adequate	Heavy	THEN	17
IF	Reachable	High	Less	THEN	1
IF	Reachable	High	Medium	THEN	2
IF	Reachable	High	Heavy	THEN	11
IF	Considerable	Low	Less	THEN	16
IF	Considerable	Low	Medium	THEN	20
IF	Considerable	Low	Heavy	THEN	24
IF	Considerable	Adequate	Less	THEN	7
IF	Considerable	Adequate	Medium	THEN	8
IF	Considerable	Adequate	Heavy	THEN	21
IF	Considerable	High	Less	THEN	4
IF	Considerable	High	Medium	THEN	5
IF	Considerable	High	Heavy	THEN	10
IF	Far	Low	Less	THEN	25
IF	Far	Low	Medium	THEN	26
IF	Far	Low	Heavy	THEN	27
IF	Far	Adequate	Less	THEN	13
IF	Far	Adequate	Medium	THEN	15
IF	Far	Adequate	Heavy	THEN	23
IF	Far	High	Less	THEN	12
IF	Far	High	Medium	THEN	14
IF	Far	High	Heavy	THEN	22

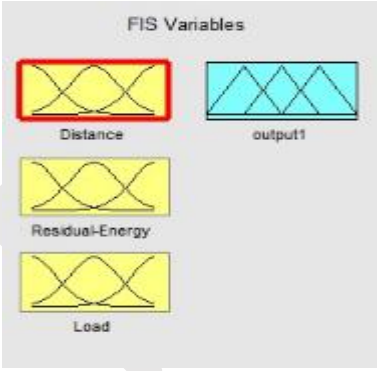

Fig.5–Output function depending upon three inputs

The process of Cluster Head selection consists of distance, residual energy and load of a super node. Following table uses three membership functions to show the various degrees of input variables.

Input	**Membership**		
Distance to the BS	Reachable	Considerable	Far
Residual Energy	Low	Adequate	High
Load	Less	Medium	Heavy

V. SIMULATION

Simulation by using MATLAB software will give brief idea about this energy efficient technique. Here consider the Matlab simulation results. Consider field dimensions in x and y directions to be 100 meters. The total numbers of nodes are assumed to be 100 with 10% probability to become a cluster head. Initial energy of the energy model is 0.5 joules. The performance is evaluated for 5000 number of rounds and the result of FUZZY-SEP is shown as follows.

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary research
Website: www.ijdacr.com (Volume 3, Issue 7, February 2015)

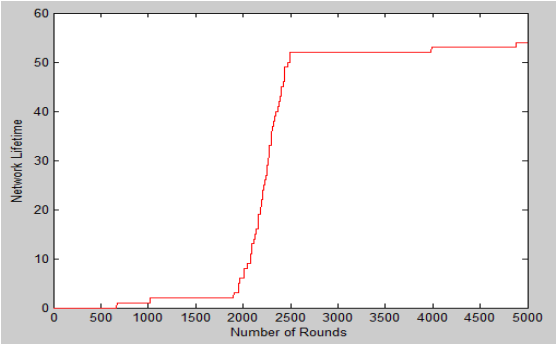

Fig.6 – Network Lifetime Vs. number of rounds for Proposed Scheme

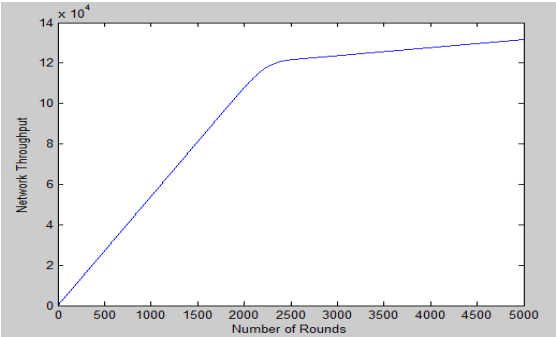

Fig.7 – Network throughput vs. number of rounds for Proposed Scheme

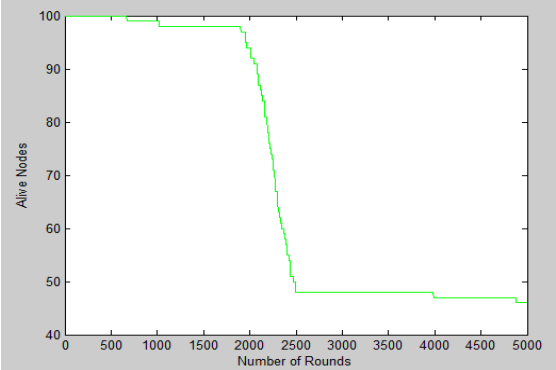

Fig.8 – Alive nodes vs. number of rounds for Proposed Scheme

VI. CONCLUSION

The proposed protocol uses the fuzzy data for the choice of cluster head to reduce the time consumed for cluster head election. To address problem of energy efficiency, we have designed FUZZY-SEP protocol implementing fuzzy logic, and presented our approach via a simulation study. This method minimizes overall utilization of energy in course while cluster head election process. So it prolongs the lifetime of system. The hierarchical clustering and organization of the nodes in diverse locations depending upon their energy level optimizes the stability period and throughput of the system.

REFERENCES

[1.] Sonam Maurya, "Hybrid Routing Approach for Heterogeneous Wireless Sensor Networks using Fuzzy Logic Technique" , Fourth International Conference on Advanced Computing & Communication Technologies, 2014

[2.] Byoung-Dai Lee and Kwang-Ho Lim, "An Energy-Efficient Hybrid Data-Gathering Protocol Based on the Dynamic Switching of Reporting Schemes in Wireless Sensor Networks", IEEE SYSTEMS JOURNAL, VOL. 6, NO. 3, SEPTEMBER 2012

[3.] Imad S. AlShawi , "Lifetime Enhancement in Wireless Sensor Networks Using Fuzzy Approach and A-Star Algorithm", IEEE SENSORS JOURNAL, VOL. 12, NO. 10, OCTOBER 2012

[4.] Imad S. AlShawi, "A Fuzzy-Gossip Routing Protocol for an Energy Efficient Wireless Sensor Networks", IEEE 2012

[5.] Badr CHAHIDI, "Hybrid Routing ProtocolFor wireless sensor networks", IJCSI International Journal of Computer Science Issues, Vol. 9, 2012

[6.] Shio Kumar Singh, "Routing Protocols in Wireless Sensor Networks – A Survey", International Journal of Computer Science & Engineering Survey (IJCSES) Vol.1, No.2, November 2010

[7.] Gaurav Sharma and Ravi R. Mazumdar ,"A Case for Hybrid Sensor Networks", IEEE/ACM TRANSACTIONS ON NETWORKING, VOL. 16, NO. 5, OCTOBER 2008

[8.] Vinay Kumar, "A Review Study of Hierarchical Clustering Algorithms forWireless SensorNetworks", IJCSI International Journal of Computer Science Issues, Vol. 11, Issue 3, No 1, May 2014.

[9.] Debnath Bhattacharyya, "A Comparative Study of Wireless Sensor Networks and Their Routing Protocols", Journal ofSensors 2010