International Journal of Applied Engineering Research
ISSN 0973-4562 Volume 10, Number 11 (2015) pp. 28379-28388

http://www.ripublication.com

An Approach To Make Energy Efficient Routing Protocol Based on Improved RSSI Value

Manpreet Kaur
Department of Computer Science, Lovely Professional University
Phagwara, Punjab, India, manpreetparmar42@gmail.com
Gulshan Kumar
Assistant Professor, Department of Computer Science
Lovely Professional University
Phagwara, Punjab, India,gulshan.16865@lpu.co.in

Abstract

Wireless Sensor Network is a collection of sensors or devices which are capable of data sensing, data storing and also has computational capacities. These sensor nodes collect information and then send it to sink by multihop path. These sensor nodes have limited resources like memory and battery. In wireless sensor network sensor nodes consume most of their energy in data transmission and idle listening. Therefore protocols for efficient energy consumption have been proposed that are based on sleep scheduling, communication, and aggregation and compression of data. This paper focuses on C3 protocol for coverage, connectivity and communication.

Introduction

A Wireless Sensor Network is a collection of sensor nodes which are randomly deployed in the monitoring area. These nodes are mobile nodes and can move within the network. A sensor node is composed of four parts that are a processing unit, a transceiver, a sensing unit and a power unit [1].

WSNs are used to analyse physical and environmental conditions. Sensor nodes in WSNs sense or collect the information from the field and then send this information to the sink. These sensor nodes have limited energy and memory. So the network should be energy efficient. Therefore protocols for efficient energy consumption have been proposed that are based on sleep scheduling, communication, and aggregation and compression of data. Routing protocols can be based on network structure. Network structure based protocols can be further divided into three categories that are Hierarchal Routing, Flat Routing and Direct Communication Routing. Based on State of information routing can be classified into proactive, reactive and hybrid [2].

Different types of routing protocols in WSN:-

Network Structure Based Protocols
This can be further categorized into two types:-

Direct Communication Routing
In Direct Communication Routing nodes directly send collected or sensed data to the sink therefore they consume their energy in very less time. Number of collisions is also more in this routing. Therefore Direct Communication Routing is of very little use [2].

Flat Based Routing
In Flat based routing all the nodes performs the same tasks or functions and work together to perform sensing task. Different protocols comes under flat based routing like Directed Diffusion, SPIN (Sensor Protocols for Information via Negotiation), Energy Aware Routing (EAR) [3].

Hierarchical Routing
Hierarchical routing protocols divide the network into clusters. This protocol selects the nodes which are having high energy for data processing and transmitting. Nodes which are having low energy are used for sensing. Hierarchical routing protocols include LEACH, TEEN (Threshold Sensitive Energy Efficient Sensor Network Protocol), HPAR (Hierarchical Power Effective Routing) etc.

State of Information
These can be further divided into three categories that are proactive, reactive and hybrid.

Proactive Routing
This routing technique maintains routing information of all the nodes in the tables. Calculates routing information prior and keeps consistent and accurate information to all the nodes or destinations. This protocol periodically broadcast routing information to maintain consistent and accurate routing tables.

Reactive Routing
Reactive routing is on demand routing in which routing information to destination is calculated only when path is required. It uses route discovery process and route maintenance. It reduces the communication overhead because it does not broadcast routing information where as it only calculates information when path is required. It also uses re establishment phase in case of any node failure.

Hybrid Routing
Hybrid routing is based on both proactive and reactive routing. In this routing cluster formation is done. Proactive routing is used for communication within the cluster and reactive routing is used for communication within different clusters.

Operation Based Routing

This routing classification is done on the basis of operations performed in routing. This can be further classified into different categories such as multipath routing, query based, negotiation based and QOS based.

Multipath Routing

In this routing technique multiple paths from source to destination are made instead of single path. Thus it increases network lifetime and performance. Paths are kept active by sending messages to all the paths. Several techniques have been proposed to select the route for data transmission. Path having highest remaining energy can be chosen and whenever an new path with energy more than previously used path will be discovered then path will be changed [6].

SPIN is an example of multipath routing protocol [3].

Query Based Routing

In query based routing destination node which requires data, sends the query message to other nodes. Nodes receiving this query maintain a table of all the queries. Node which is having data related to the query sends data to the destination node. Example of query based routing is directed diffusion and SPIN.

Negotiation based Routing Protocol

SPIN and SAR (Sequential Assignment Routing) are the protocols under negotiation based routing. This type of routing uses high level data descriptors to reduce transmission of same data. By use of flooding or broadcast of data results in sending redundant data by different nodes which causes more energy consumption. So the negotiation based routing works to reduce the transmission of redundant data. This routing technique uses information like how much resources left for communication decisions [3] [6].

QOS Based

In this technique routing decisions are made such that data delivered to base station fulfil QOS metrics like data quality, energy, bandwidth etc. SAR is a protocol which comes under the QOS based routing technique.

Routing decisions in SAR are based on three metrics that are Quality of Service on each path, energy consumption and priority level of data. Multipath routing technique is used to avoid failure [6].

Related Work

In this paper [7] they discussed about a protocol named as LEACH. TDMA scheme is used by LEACH which is used to divide time into different rounds of fixed length for each node. LEACH includes two phases that are setup and steady state phase. In first phase that is setup phase nodes divide network into clusters. In each cluster one node is assigned as cluster head. Setup phase is a advertisement phase, the CHs which are selected randomly send their status as clusterheads to its neighbourhood sensor nodes.

Cluster head provides fixed time slot for transmission to node in cluster using TDMA scheme. During second phase communication between cluster heads and other nodes takes place. Non cluster heads transmit their data to cluster heads. LEACH protocol does not follow hop-by-hop routing whereas other protocols use hop-by-hop routing.

In this paper authors described that PEGASIS is a chain based algorithm and uses greedy algorithm to form a chain of data. By using greedy approach distance between pair of sensors became too long and therefore sensors consume more energy. They proposed an enhanced algorithm that is EB-PEGASIS. In chaining process, a node will consider average distance of formed chain. If the threshold is smaller than distance from the closest node then the closest node is a far node. If that node joins the chain, it will make a long chain. In this condition, the far node will search a nearer node on formed chain. This method reduces the energy consumption.[8]

In this paper authors explained about C3 protocol for coverage, connectivity and communication. The C3 protocol uses the idea of virtual rings formation in the network, triangular-tessellation based deployment and RSSI based distance estimation. C3 protocol does not assume nodes to be location aware and it uses RSSI for distance estimation in order to define rings in network. The network is divided in clusters also. In triangular tessellation redundant nodes are identified and allowed to sleep. Nodes at optimal positions like corners are kept active and others are allowed to sleep. The RSSI measures the power of received signal. The RSSI value can be used to estimate the difference between two nodes. [5]

In this paper authors discussed about different energy efficient protocols such as LEACH, Directed Diffusion and EESR. EESR stands for Energy Efficient Sensor Routing protocol. This is a flat routing protocol designed to reduce energy consumption and to provide scalability. It mainly consists of gateway, base station, manager nodes and sensor nodes. Gateways deliver messages from sensor nodes to base station. Base stations have special capabilities as compared to other nodes they send and receive messages to/from gateways. It divides the area in to sectors and reduces the energy consumption and provides scalability. It saves energy because it does not flood the data and manager nodes also select the shortest path to send the data.[9]

In this paper described about the localization of nodes. They described that same nodes with Global Positioning System (GPS) are present in the network which are known as seeds. Other nodes which are not having GPS calculate their location by exchanging messages with the seed nodes. Authors proposed an algorithm which can work with static as well as moving nodes. It uses Received Signal Strength Indicator measurements that are available from the sensor hardware. Proposed algorithm is range based algorithm. Range based algorithms are based on different techniques that are time of arrival of signals and time difference of arrival.[12]

Proposed Methodology

A sensor node in a wireless sensor network has a lot of limitations such as power, memory and limited processing capacity and sensor nodes consumes most of their energy in data transmission and idle listening so different protocols have been

proposed to increase the energy efficiency. Efficient usage of energy can be achieved by sleep scheduling, compression and aggregation of data. C3 protocol is energy efficient for coverage, connectivity and communication in WSNs. It uses received signal strength indicator to divide the network into virtual rings, defines clusters, define dings that are rings inside a cluster and uses triangular tessellation to identify redundant nodes. In triangular tessellation nodes which are not having data to transmit are kept sleep while others are kept active. In this protocol improved RSSI value is used to minimize the error in distance.

The objectives here are to make energy efficient protocol by adding improved RSSI approach in C3 Protocol for coverage, connectivity and communication. Minimize the distance error using Received Signal Strength Indicator logarithmic path loss model. RSSI is used to estimate distance of receiver from a sender. In this paper standard deviation of the RSSI value and logarithmic path loss model is used to minimize the distance error. And maximize overall coverage of the network such that obsolete nodes can also contribute in the network.

For making energy efficient WSN, a lot of protocols are described. Energy can be saved by keeping nodes in sleep mode when they are not having data to transmit. Instead of using multiple paths data can be send via single path and it reduces the number of transmissions and saves energy. C3 is an energy efficient protocol for coverage, communication and connectivity. It uses the RSSI (received signal strength indicator) for distance estimation. RSSI value is used to make virtual rings in the network. Firstly RSSI value will be calculated by the logarithmic path loss function. This function is used to minimize the error in the estimated distance. Then this RSSI value will be compared with the threshold value. Nodes which receive signal strength greater than threshold1 will make 1st ring and nodes which receive signal strength greater than threshold2 will make 2nd ring. Threshold1 is the 40% of communication range and threshold is equal to 80% of communication range (R_c).

$$RSSI = -10\, n\log_{10}(d) + C$$

Where n is path loss exponent, C is a constant, d is the distance from sender.

After formation of rings, cluster formation is done such that nodes at alternating rings have higher probability of selected as clusterhead. Then rings inside clusters are made. Then it performs triangular tessellation to identify redundant nodes and they are kept in sleeping modes. Then connection is established between nodes and transmission of data takes place.

Algorithms

Formation of Rings

This algorithm divides the network into virtual rings. Firstly the distance between two source and destination is calculated. Then the value of RSSI (Received Signal Strength Indicator) is calculated which is used for ring formation. Then value of RSSI is compared with threshold value and rings are formed.

Algorithm 1: For Ring Formation

1. Start
2. For i=1:11
3. Calculate distance between nodes
   Dist=sqrt ((x2-x (i)) ^2 + (y2-y (i)) ^2)
4. Calculate RSSI
   RSSI= -10nlog (dist) +C
5. If RSSI>th1 && dist>0
   Make 1st ring;
6. Elseif RSSI>th2 && dist>0
   Make 2nd ring;
7. End
8. End if

Cluster Formation

Cluster formation is done after dividing the network into rings. This algorithm divides the network into clusters. Firstly nodes wait for timer W1. Clusters are made such that nodes in alternate rings have higher probability to be selected as clusterhead.

Algorithm 2: For Cluster Formation

1. Calculate W1
   w1=w(i)=i+(1/energy(i))+((i+rno(i))*2/100);
   Wait (w1);
2. If node is clusterhead
   Broadcast join me message;
3. Else
   Wait for join me message;
4. End if

Formation of Dings

Dings are rings inside clusters. Dings are made to facilitate the triangular tessellation process. Firstly ding number is set to 0. The node which is clusterhead is set to fully active mode and the nodes which are not having data to send are kept in sleeping mode and some nodes are set to active mode.

Algorithm 3: Ding Formation

1. Set ding=0
2. If node i is CH
   Status = 1 //active;
3. Else
   Nodes wait for message;
   W2= (1/energy (i) + (ding+ (i)) ;
4. Wait(W2)
5. End

Sleep Scheduling

In this algorithm nodes which do not have data to send are kept in sleeping mode and others are set to active mode. Nodes in sleeping mode cannot send or receive data. Nodes in active mode can send as well as receive data. The nodes which are in sleeping mode consume very less energy as compare to nodes in active mode. If two or more nodes in the same ding with status active then the other nodes can go to sleeping mode.

Algorithm 4: Sleep Scheduling

1. If two or more nodes in the same ding have status= active then
   Set mode=1; //sleeping mode
2. Else
   Set mode= 2; // active;
3. End

Make Link and Routing

Communication links are established between clusterheads. Sensor nodes can send and receive data through these clusterheads. Data can be sent through gateways if no direct link is available.

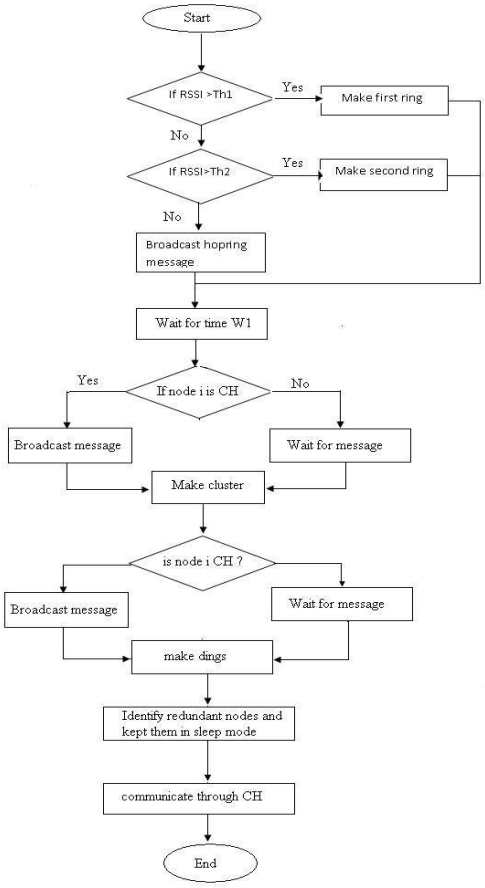
Algorithm 5:

1. Make connections between clusterheads.
2. Make gateways if there is no direct link between clusterhead.
3. Set clusterhead and gateways to active mode.

Algorithm 6: Routing

1. If node is in first or second ring
   Send data directly to sink.
2. Elseif node is not CH
   Send data to clusterhead.
3. If node is CH
   Send data to the CH in the upper ring near to sink.
4. End if

Flow Diagram



Experimental Results

In proposed work a technique based on Improved RSSI is introduced which is implemented in MATLAB and increases coverage area an efficiency of network.

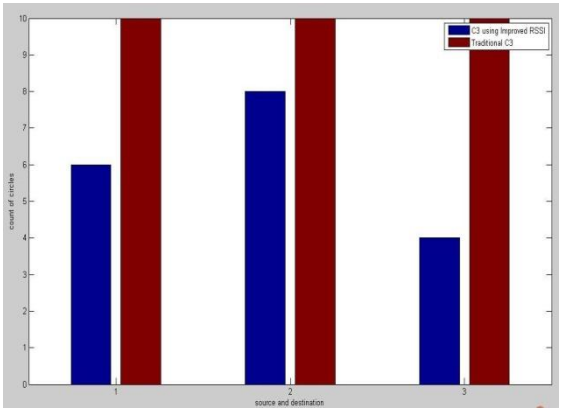


Figure 4.1: Coverage Area

In Figure 4.1 a comparison between the coverage area of technique used in C3 and improved RSSI is shown. This chart shows that improved RSSI covers large area than the existing one.

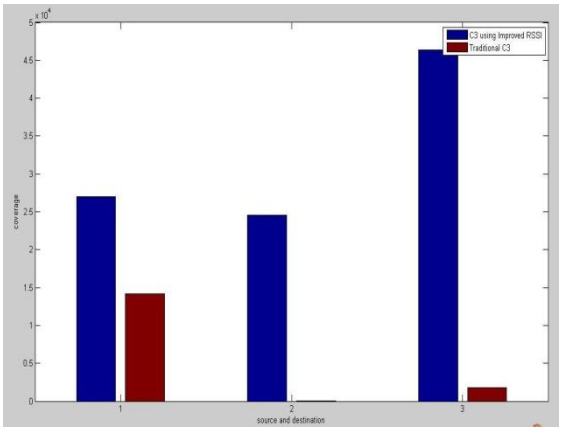


Figure 4.2: Number of Rings

In figure 4.2 a comparison between number of rings is shown. The use of improved RSSI covers more number of nodes in fewer rings than the previous technique.

Conclusion

As discussed earlier WSN is a collection of nodes with limited energy. Nodes consume most of their energy in data transmission and idle listening so different protocols have been proposed for energy efficiency. These protocols are based on sleep scheduling, compression and aggregation of data. In this work improvement is done in the existing technique to increase the efficiency in terms of coverage and energy.

Reference

[1] I.F. Akyildiz, W.Su, Y.S, E. Cayirci, "Wireless Sensor Networks: A survey" Computer Networks, Page(s): 393-422, Volume: 38, (2002).

[2] Getry.S.Sara, D.Sridharan "Routing Protocols in Mobile WSN: A survey" Telecommunication System, Page(s): 51-79, (2014).

[3] Hussain Muhammad Salman, "Survey of Routing Protocols in WSN" International Journal of Sensors and SensorNetworks,Page(s):1-6,(2014).

[4] Umesh Rawat, Mukesh Sharma, "Directed Diffusion: Features, Current Developments, issues and Analysis, International Journal of computer Applications (0975-8887), Volume: 49, (2012).

[5] Muhamad Akhlaq, Tarek R. Sheltami, Elhadi M, "C3: an energy efficient protocol for coverage, connectivity and communication in WSNs,"

Personal and Ubiquitous Computing, page(s):1117-1113 volume: 18, Issues: 5, (2013).

[6] Jamal N. Al-Karaki & Ahmed E. Kamal, "Routing Techniques in Sensor Networks: A survey", IEEE communications, Volume 11, Page(s): 6-28, (2004).

[7] Ahmed et. al "A survey on network protocols for wireless sensor network", International journal of computer applications , Page(s): 1-37, Volume:1 (2010).

[8] Ji Hong, Yuan, Liu Yueyang "An energy-efficient PEGASIS based enhanced algorithm in wireless sensor networks", Page(s): 91-96, 2006.

[9] Ali Norouzi, Abdul Halim Zaim "Energy Efficient Routing Protocols in Wireless Sensor Network", Wireless Sensor Networks, Pages: 65-75, Volume: 4 (2012).

[10] Takahiro Hara, Jinfang jiang, "Localization Algorithms of Wireless Sensor Networks: A Survey", Telecommunication System, Pages: 2419-2436, Volume: 52 (2011).

[11] Ian F.Akildiz and Memat Can Vuran "Wireless sensor networks", Communication and networking, Edition: 1st (2010).

[12] Tareq Adnan, Suprakash Datta and Stuart Mclean, "Accurate and Efficient Sensor Network Localization", Personal Ubiquitous Computing, Pages: 821-833, Volume: 18, (2014).

[13] A. Faheem, R. Virrankoski and M. Elmusrati "Improving RSSI based distance estimation for Wireless Sensor Networks", International Conference on Wireless Information Technology and Systems, (2010)

[14] Jungang ZHENG, C WU, Hao CHU, Yang XU, "An improved RSSI measurement in Wireless Sensor Networks," Procedia Engineering, Pages: 876-880, Volume: 15 (2011).