International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Region Based Energy Efficient Clustering In Wireless Sensor Networks

Naveen Kumar Tyagi

SGI, Shamalkha, Computer Science and Engineering

Abstract: ***Computers, communication, and sensing technologies are converging to change the way we live,Interact, and conduct business. Wireless sensor networks reflect such convergence. These networks are based on collaborative efforts of a large number of sensor nodes. They should below-cost, low-power, and multifunction. I have proposed residue energy based clustering protocol which makes use of clustering in order to extend the life time of the Wireless Sensor Network. It includes two phases: Setup Phase (selection of Cluster Head (CH), and the Steady Phase (transfer of sensed data from the environment to the Base Station or Sink)***

Keywords: Sensors, Sink, node, leach, cluster, power, Cluster Head.

1. Introduction

Wireless Sensor Networks: - Wireless Sensor Network is a kind of an ad-hoc wireless network consisting of spatially distributed sensors nodes and a sink (base station) .These sensor node are deployed in a physical area and connected through wireless links.

Sensor Node: From a technical perspective, a sensor node is a device that translates parameters or events in the physical world into signals that can be measured and analyzed. Another commonly used term is Transducer which is often used to describe a device that converts energy from one form into another. A sensor node consists of mainly four units:

- sensing
- communication
- processing and
- Power supply

2. Literature Survey

Sensor nodes have constraints like limited power resources and bandwidth. Thus different innovative techniques which overcome the inefficiencies are required so that the lifetime of the network can be functional for a longer time and the life time of the network can be extended. Thus, the main aim is to evenly distribute the consumption of energy load among the sensor nodes in order to overcome the problem of overly utilized sensor nodes that will run out of energy as compared to other sensor nodes.

In order to minimize the energy consumption, some of the previous research works focused on the low energy hardware design of the digital circuits which include micro sensor, low power transceivers etc. But this only reduced the energy consumption up to certain level. However, the energyconsumption is mainly due to the communication over the network. Thus the primary focus should be more on design and architecture of the Wireless Sensor Network. For this several research works have proposed energy efficient protocols on Clustering, Routing, Data aggregation etc. These protocols work on the evenly distribution of the energy consumption among the sensor nodes of the Wireless Sensor Network. The communication protocols can be classified into three domains.

- Direct
- Multi-Hop
- Clustering

2.1 Node Clustering In Wireless Sensor Networks

Node clustering is an effective technique for improving the energy efficiency and prolonging the network lifetime of a wireless sensor network (WSN). In a clustered sensor network, a cluster member in a cluster transmits its data to its cluster head over a short distance. The cluster head collects data from its cluster members and perform data aggregation on the data before it transmits the aggregated data to the sink directly or along a multi-hop path. This can effectively reduce the amount of data transmitted in the network and thus significantly save the energy consumed for transmitting the data.

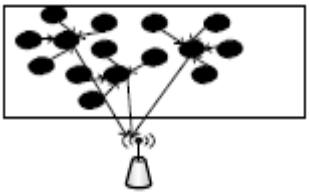


Figure 1: Cluster Base Networks

2.2 Clustering Methods

The two basic approaches for the co-ordination of entire clustering process are distributed and centralized. Distributed clustering: where each sensor node can run their own algorithm and takes the decision of becoming cluster head. Ex Low Energy Adaptive Clustering Hierarchy (LEACH) ,Hybrid Energy-Efficient Distributed clustering (HEED) Centralized clustering: a centralized authority groups the nodes to form clusters and cluster heads. Sometimes hybrid scheme can also be implemented. Ex Two-phase cluster formation algorithm (TCF) i.e local centralized adaptive, RCHR (regional clustering hierarchical routing algorithm) i.e. a regional-centralized clustering algo.

3. Low Energy Adaptive Clustering Hierarchy (LEACH)

LEACH is proposed by Heinemann. It is a clustering routing protocol in which a cluster head collects data from sensor nodes belonging to the cluster and sends the data to the sink node after data aggregation process. To make all sensor nodes in this network consume their node energy equally and extend the life time of the network, this algorithm randomly changes the cluster head, which in turn uses more energy than any other node belong to the cluster, every time period. To reduce overall communication costs, the cluster head performs data aggregation and then send the data to the sink node. The cluster head is determined by the following function (1):

$$T(n) = \begin{cases} \dfrac{P_t}{1 - P_t \cdot (r \cdot \bmod \frac{1}{P_t})}, & \text{if } n \in G \\ 0, & \text{otherwise} \end{cases} \quad (1)$$

Where Pt is the desired percentage of cluster heads, r is the current round number; G is the set of nodes that have not been cluster-heads in the last 1/Pt rounds. A round consists of two phases;
a set-up phase and
a steady state phase.

3.1 Advantages of the LEACH algorithm

It can be seen that LEACH algorithm as a typical sub cluster routing protocol has the following advantages: The hierarchy, path selection and routing information is relatively simple, and the sensor nodes do not need to store large amounts of routing information, and do not need complex functions. The cluster head node is randomly selected, the opportunity of each node is equal, and the load of whole network is balance.

3.2 Disadvantages of LEACH algorithm

Because the cluster head in LEACH protocol are randomly generated, energy consumption can be evenly distributed in the network; however, it ignores residual energy of nodes, geographic location and other information in the election of cluster head node. So it can easily lead to exhaust the energy quickly in cluster head nodes.

LEACH assumes that all the nodes can be directly communicate with the cluster head node and the base station node, the actual network of base stations are usually far away from the sensing area, this would make the cluster head which is far from the base station is easier to fail. Therefore, expansion of the network is not strong, and is not suitable for large networks.

Because the distribution of cluster head is totally dependent on the random number, so the number of the cluster heads can be big at a regional, and the number of the cluster heads will be little at other regional. In the cluster-heads centralized regional, the number of the general node is very little, and this can have lost the meaning of hierarchical routing; in cluster-heads sparse region, cluster head node is responsible for too much data, and the distance from the cluster head is far, transmitted signal energy consumption is too large.

4. Problem Definition

Rather than use randomly generated number for the selection for Cluster head we can take intoaccount certain parameters like threshold value and residual energy.Instead of direct communication of far cluster head with the base station multihop routing can be used. In this thesis we have proposed residue energy based clustering protocol which makes use of clustering in order to extend the life time of the Wireless Sensor Network. It includes two phases: Setup Phase (selection of Cluster Head (CH), and the Steady Phase (transfer of sensed data from the environment to the Base Station or Sink).

In the past few years, a large number of energy efficient protocols have been proposed. Some of them emphasized on Centralized approach, some emphasized on the Distributed approach and some on the Hybrid approach. Clustering basically involves a set of Cluster Heads which are chosen from a pre-defined criterion. The functionality of the CH is to synchronize and gather data from the cluster members. After aggregating the data, the CHs transmit this data to the Base Station. Some of the Cluster based energy efficient protocols are LEACH [1], LEACH-C [1] PEGASIS [20].

In LEACH, every node generates a random number between 0 and 1. If the random number generated by the sensor node is less than the threshold value, then that node is nominated for the Cluster Head. The number of CHs in LEACH is not fixed or optimal. The data aggregated at CHs is transmitted to the Base Station.

In this approach the CHs are rotated after every round so that the energy dissipation is even. LEACH-C is a centralized protocol which involves the Base Station for the selection of CH. All the sensor nodes send their location and energy to the Base Station. The Base Station forms the cluster using annealing algorithm and associate members with the CHs. In PEGASIS, the cluster formation is done on the basis of location of every sensor. In HEED, the cluster formation is on the basis of probability of residual energy of each node as well as the cluster radius for intra cluster communication.

5. Radio Energy Dissipation

We assumed a simple model for the radio hardware energy dissipation where the transmitter dissipates energy to run the radio electronics and the power amplifier, and the receiver dissipates energy to run the radio electronics as shown in figure 5.1. Using this radio model, to transmit k - bit message at distance d the radio expends:

$$E_{Tx}(k,d) = E_{Tx-elec}(k) + E_{Tx-amp}(k,d)$$

$$E_{Tx}(k,d) = E_{elec} * (k) + E_{amp} * k * d^2$$

And to receive this message, the radio expends:

$$E_{Rx}(k,d) = E_{Rx-elec}(k)$$

$$E_{Rx}(k,d) = E_{elec} * k$$

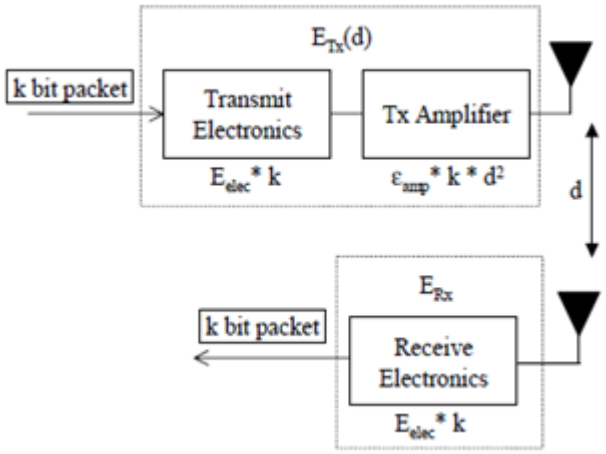


Figure 1.1: Radio Energy Dissipation Model [1]

6. Methodology / Approach

6..1 Assumptions

In our protocol architecture, we assume that N number of Sensor Nodes are scattered randomly over the network. A snapshot of the random network is shown in figure 1.2. These nodes are static and homogeneous in nature and the Base station is in center and is fixed and unlimited energy. Moreover, following assumptions are made for the underlying network model.

- The energy of the Base Station is infinite.
- Every sensor node is capable of communicating with every other sensor node and to the
- Base Station (sink) if needed.
- Each sensor node has power control for communication i.e. range of the transmission can be controlled.
- Each sensor node has a Unique Id for its identification and as well as region id.
- The network is divided into region.
- Each Node has same energy in starting of the network.
- Nodes are setup randomly with id and region id.

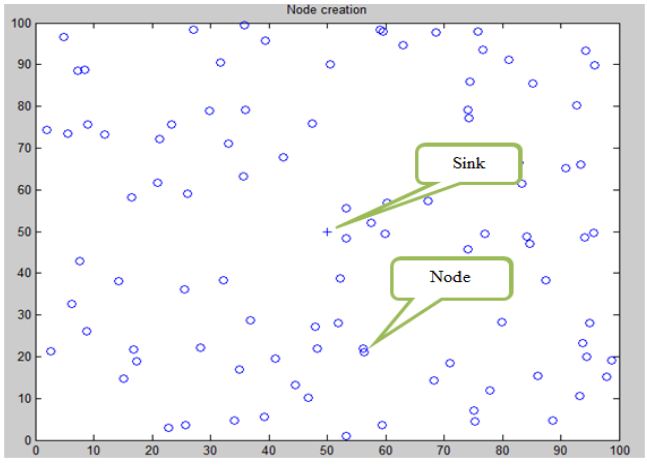


Figure 1.2: a graph view of the nodes randomlyGenerated inside of the network with a range of100 m X 100 m

6.2 Proposed Protocol

In proposed protocol there is 100mx100m network area and there are 100 nodes which are randomly created in the network area with the id, energy, region id etc. there is two phases (1) setup phase and (2) steady phase.

6.3 Setup Phase

In the setup phase, nodes are created with id, energy, and region id etc. this phase each node decides whether or not to become a cluster head for the current round according to the region. The node is elected as a cluster head for region id and maximum energy of that region. After this CH election, each cluster head prepares a TDMA schedule and transmits to all the cluster nodes in that respective cluster. A snapshot of the network is shown in figure 1.2and 1.3.

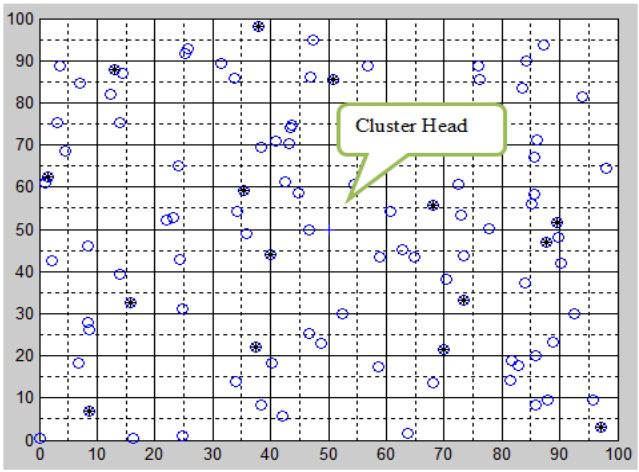


Figure 1.3: Show the cluster head

6.4 Steady Phase

In this phase nodes send their collected data to CH at once per frame allocated to them. This assumes that the node always has a data to transmit. The node goes to sleep mode after this transmission until next allocated transmission slot, to save the energy. The CH must keep its receiver on all the time to receivethe data from cluster nodes. After reception of all the data, CH aggregates that data and transmits it to the base station. A snapshot of the network is sh.

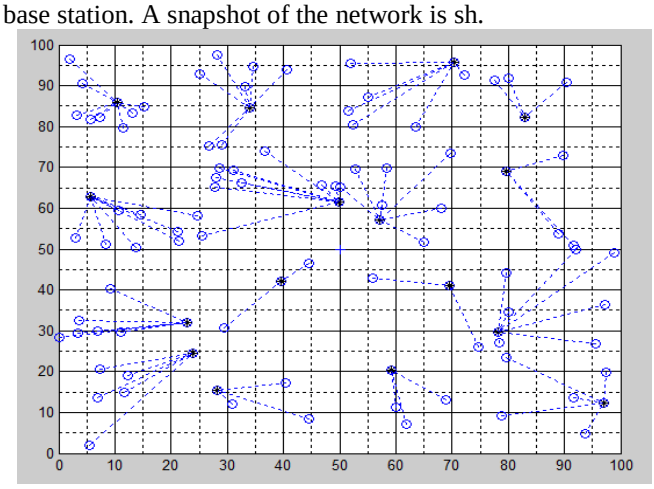


Figure 1.4: CH aggregates data and transmits it to the base station (sink)

6.5 Performance Evaluation

A wireless sensor network is densely deployed with a large number of sensor nodes, each of which operates with limited battery power, while working with the self-organizing capability in the multi-hop environment. Since each node in the network plays both terminal node and routing node roles, a node cannot participate in the network once its battery power runs out. Increases in dead nodes generate network partitions and consequently, normal communication becomes impossible as a sensor network.

Table 1.1: Simulation parameters

Parameters	Values
Network	100 x 100 m2
Number of nodes	100
Base Station (Sink) Location	50,50 (center of network)
Initial Energy for all nodes	0.5J
Energy dissipated for free space (Efs)	10 pJ/bit/m2
Energy dissipated for multipath fading (Emp)	0.0013 pJ/bit/m4
Data Aggregation Energy (EDA)	4 nJ/bit/signal
Data packet size	2000 and 4000 bits

7. Simulation Parameters

Simulation is done in matlab on Windows. Scenario conditions are stated in the table 1.1.

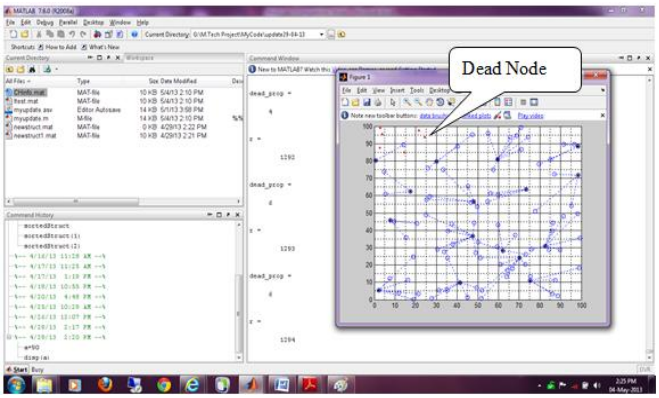


Figure 1.4: Matlab simulation result for 2000 bits running mode

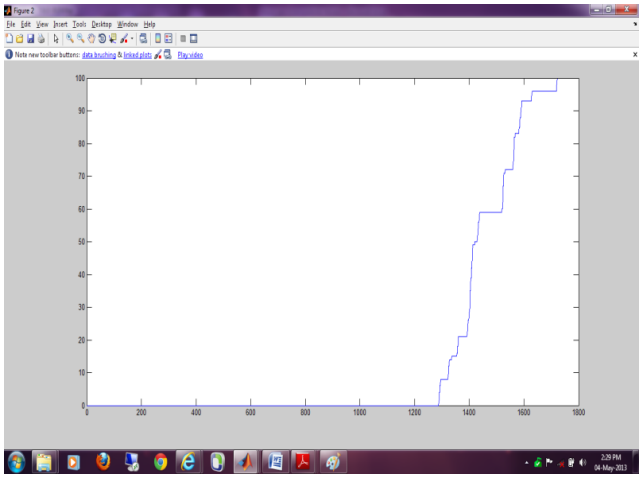


Figure 1.5: Matlab simulation result for 2000 bits

8. Results & Discussion

Simulation and results of existing energy protocol LEACH, Direct, MTE are compared with proposed approach. A new algorithm shows its performance in comparison with existing and known algorithms. Results are derived from limited energy simulations where each node begins with 0.5J/node of energy.

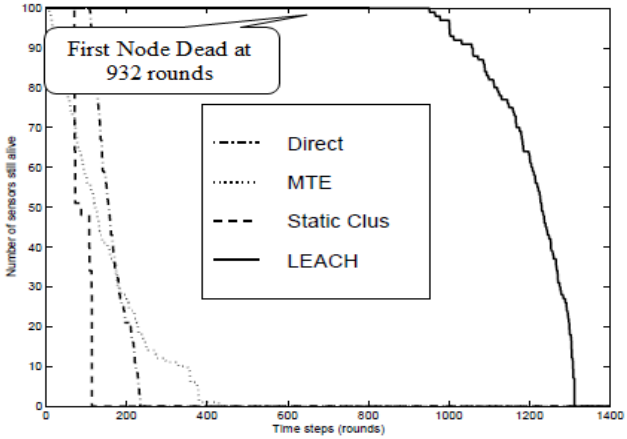


Figure 1.6: System lifetime using direct transmission,

MTE routing, static clustering, and LEACH with 0.5 J/node and data packet 2000 bits. [1]
In the LEACH, first node is dead at 932 rounds when data size is 2000 bits with 0.5 J/node. [1]

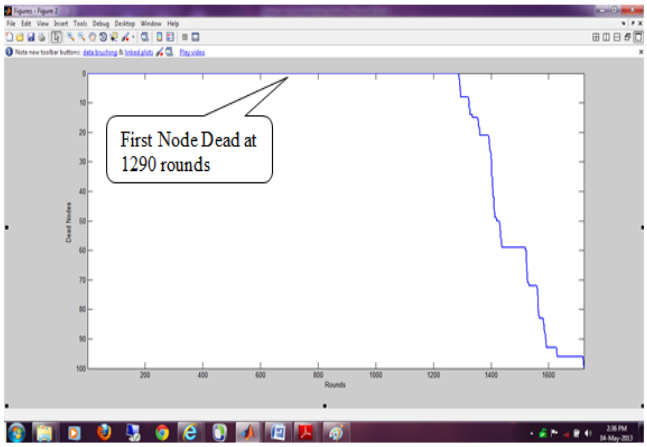


Figure 1.7: Network life in our protocol for 2000 bits With 0.5 J/nodes

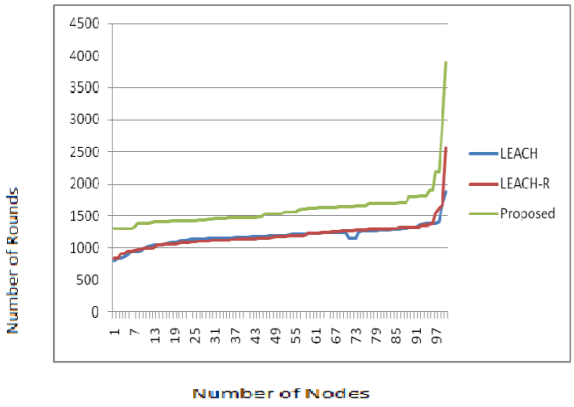
In LEACH protocol, first node dead at 932 rounds and proposed approach first node dead at 1290 rounds and life of the network is 1700 rounds in the proposed approach. The proposed approach show the good result on the simulation tool.

Simulation Result Analysis

Simulation and results of existing energy protocol LEACH and LEACH-R are compared withproposed approach. A new algorithm shows its performance in comparison with existing andknown algorithms. Results are derived from limited energy simulations where each node beginswith 0.5J/node of energy.

Comparative analysis of Leach, Leach-R and proposed protocol

The above result has been obtained by simulating the protocols on 2000 bit mode. Comparative analysis is as follows:



Comparative analysis of Leach, Leach-R and proposed protocol

The above result has been obtained by simulating the protocols on 2000 bit mode. Comparative analysis is as follows:

Comparative Analysis

Table 1.2: Comparative result

Property	Leach	Leach-R	Proposed
First Dead	795	832	1309
Half Dead	1199	1182	1535
All Dead	1882	2576	3896

In LEACH protocol, first node dead at 795 rounds, in LEACH-R first node dead at 832 and inproposed approach first node dead at 1309 round and life of the network is 3896 rounds in theproposed approach. The proposed approach show the good result on the simulation tool.

Quality of Network

It has been noticed that network with last nodes left does not provide quality of data to basestation. So we have considered the quality of network with 95 nodes. The results obtained by Comparing LEACH, LEACH-R and proposed protocol by taking initial node energy as 0.5J/node is as:

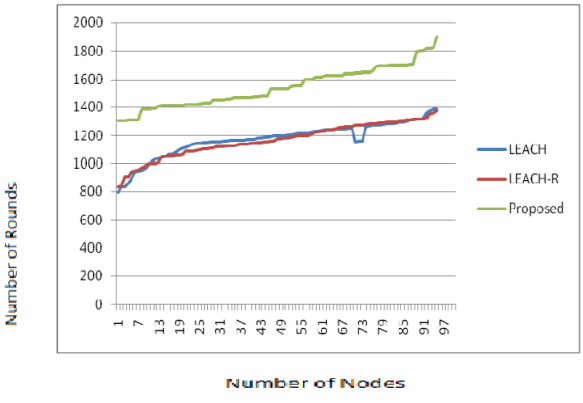


Figure 1.8: Comparative analysis of Leach, Leach-R and proposed protocol consideringquality of network.

The results is as LEACH goes upto 1383 rounds, LEACH-R goes tll 1393 and proposed protocolgoes upto 1900 rounds. Which shows proposed protocol increases network lifetime upto 517rounds more than LEACH.

9. Conclusion

The main problem is in the power consumption in the sensor node. In the LEACH, LEACH-R etc.algorithm manages the unbalanced energy consumption of the sensor nodes. We present a regionbase, energy efficient and load balanced clustering scheme applied for periodical data gathering.Proposed approach produces a uniform distribution of cluster heads across the network throughlocalized communication with little overhead. What's more, a novel approach has been introducedto distribute the energy consumption among the sensors in the cluster formation phase. Simulationresults show that new approach prolongs the network lifetime as much as the LEACH and the totalenergy is efficiently consumed. So the region base clustering shows the good results.

10. Limitations

In this research, we assume that:

- The sink should be in centre
- Region size is medium
- Diagonal region nodes should be minimum so network life is increase.
- If we work on multi hop then this limitation will overcome.

11. Future Scope

All of our contributions here are focused on the cluster setup stage with the region based. There isstill much space to improve the performance of data transmission. In the large scale sensornetworks, multi-hop communication is a mainstream technique for energy saving. We will removethe assumption of single-hop and design an energy efficient protocol for both intra-cluster and intercluster data transmission in the future work. We can also consider the property of TEEN protocoland use threshold value for monitoring in some applications under which device will be in idle stateand saves power. States can be changed by considering the threshold values which will increasethe lifetime of node in the future work.

References

[1] Chi-Chou Kao; Jun Wu; Shih-ChiehChen;"Energy Efficient Clustering Communication Protocol for Wireless Sensor Network", ICAT,2010, Vol.1,pp.830-833, Feb 2010.

[2] Meenakshi Sharma, Kalpana Sharma, Energy Efficient Extended LEACH (EEE LEACH)" in International Conference on Communication Systems and Network Technologies, 2012.

[3] Manjeshwar and D. Agrawal, "TEEN: a Routing Protocol for Enhanced Efficient in Wireless Sensor Networks," in Proceedings of the 15th International Parallel and Distributed Processing Symposium, San Francisco, April 2001, pp. 2009-2015.

[4] http://delicious.com/url/f52ae394e853898a9f34206349b1850e#shimmerresearch.
[5] Routing techniques in wireless sensor networks: a surveyhttp://www.engpaper.com/wireless-sensors-research-papers-102.htm
[6] Research on Wireless Sensor Network Security
[7] http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=5696329&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D5696329.
[8] http://ceng.usc.edu/~bkrishna/research/papers/YuPrasannaKrishnamachari_IEEETWC.pdf NOVEMBER 20.
[9] The FTRA 9th International Symposium on Wireless sensor network Technologies and Applications for Smart Space (WTA 2013)
[10] http://www.inderscience.com/jhome.php?jcode=ijsnet

Author Profile

Naveen Kumar Tyagi is an innovative thinker and researcher in the field of computer science and engineering, who has strong conceptual and problem solving skill equipped with effective Analytical skill, Naveen has completed his B.Tech with distinctions from NCCE ISRANA PANIPAT under Kurukshetra University Kurukshetra(KUK) in 2009 and currently Student of M.Tech in the department of Computer Science and engineering at Samalkha Group of Institutions (SGI), SamalkhaPanipat Haryana under KurukshetraUniversity Kurukshetra(KUK);He is good mentor and trainer who provides process enhancement sessions to IT Companies.