Energy Aware Deforestation Monitoring System All rights reserved Energy Aware Deforestation Monitoring System

Article *in* Australian Journal of Basic and Applied Sciences · March 2016

K. Latha
Anna University of Technology, Tiruchirappalli

Australian Journal of Basic and Applied Sciences, 10(2) Special 2016, Pages: 283-289

AUSTRALIAN JOURNAL OF BASIC AND APPLIED SCIENCES

ISSN:1991-8178 EISSN: 2309-8414
Journal home page: www.ajbasweb.com

Energy Aware Deforestation Monitoring System

[1]K.Latha and [2]S.Sathish Kumar

[1]*Assistant Professor,Department of Computer Science and Engineering, University College of Engineering Trichy (BIT campus), Trichy-620024, India.*
[2]*PG Scholar, Department of Software Engineering,University College of Engineering Trichy (BIT campus), Trichy-620024, India.*

Address For Correspondence:
K.Latha, Assistant Professor,Department of Computer Science and Engineering, University College of Engineering Trichy (BIT campus), Trichy-620024, India.

ARTICLE INFO

Article history:
Received 04 December 2015
Accepted 22 January 2016
Available online 14 February 2016

Keywords:
WSN, Deforestation, Closeness factor, Energy efficient, Network life time, Coverage.

ABSTRACT

Forest degradation and deforestation leads to a fraction of the annual worldwide human-induced emission of greenhouse gases, which causes biodiversity losses and the destruction of millions of people's homes.Despite local/regional causes, its consequences are global. Designing, deploying, and evaluating a novel wireless system which detects the occurrence of deforestation factors such as Forest Fire, Illegal Logging of Trees as earlier as possible, requires substantial effort. Because it is still a great challenge to design a WSN system for rare event detection where network lifetime and robustness is a major concern. In this approach, as soon as the deployment of the sensor nodes is made, the base station will be grouping the set of nodes deployed into two disjoint sets based on the closeness factor of the nodes and keep one set of nodes inactive till the other node's energy gets depleted.

INTRODUCTION

Forests being an imperative resource play a crucial role in maintaining the earth's Ecological balance. The key factors of deforestation are clear cutting of trees, tree theft, forest fire etc. Massive scale deforestation has negative impact on the atmosphere leading to global warming, flash floods, landslides, drought etc. Because of these adverse effects, forest management department have taken steps for watching the forest to forestall deforestation.

WSN has several potential applications that haven't yet been explored. Wireless sensor Networks (WSNs) technology is being employed widely for monitoring and controlling applications. In this paper, the application for WSN most targeted on is for purpose of detecting Deforestation Factors. A sensor module is deployed within the forest manually or through a flying object. The sensor module consists of multiple sensors like temperature sensor, humidity sensor, etc. They collect the target surroundings data and incessantly transfer it to the control center where the necessary process is meted out.

Sensor nodes are less expensive and though it gets broken in fire it won't be a great loss. WSN has the property of self configuration and thus needn't be organized manually. Using GPS the exact location of the fireplace is simply obtained and also the nearest fire service will be easily informed using GSM.

Life time is the critical issue for many of the applications, and energy could be a major constraint in WSN's,since a significant amount of the energy is consumed by the operations like transmission, sensing, processing and even the hardware operation in standby mode consumes a big quantity of power also. When the nodes are deployed in a geographical area, the node density could also be varied from application to application, as an example, the density may be as high as twenty nodes/m3 or more.The redundancy of the nodes may increase the dependability level of the whole network and increase the energy consumption also. This

To Cite This Article: K.Latha and S.Sathish Kumar, Energy Aware Deforestation Monitoring System. ***Aust. J. Basic & Appl. Sci.,*** *10(2): 283-289, 2016*

disadvantage of higher density of node seen in the deployment stage may be exploited for achieving energy potency. To attain the energy potency, it's necessary to form one set of redundant nodes to stay in energy conservation mode whereas the other set is in active or full power mode. In this approach, base station is chargeable for separating the deployed node in to 2 or additional disjoints sets. As soon as the deployment is finished the base station will determine, which are all the nodes, that are closed to each other and it'll attempt to separate them into two disjoint sets. Later it keeps one set of node in energy saving mode. These set of nodes stay passive till the energy of the other set nodes go down below some threshold value. Hence,the entire field is efficiently depicted by a subset of active nodes that perform the task well. I.e. The Task of sensing the informatiom and sending the perceived information from the part of the region is done by this subset of nodes one by one in a sequential manner. The experiment is conducted to review the effectiveness of the projected mechanism.

Related Work:

Surveillance plays a crucial role in forest management. It had been employed in the past and is still being employed for observation and information assortment. Many surveillance techniques are utilized for monitoring and prevention of deforestation. They're generally classified as Ground-based sensing techniques and Remote sensing techniques.

Ground-based techniques typically include surveillance by on-the-spot security staff and mobile patrols watching the property by water, land and air (Magrath *et al*., 2007). Some complementary systems like mounted Earth System are used with observation towers placed at strategic points with specialised personnel for observing and detecting the presence of fire. All these systems are costly and time consuming, requiring plenty of resources.

Nowadays, remote sensing technologies are used like, aerial images, automatic video surveillance, wireless surveillance systems and satellite imagery. Satellite imagery is incredibly pricey for use in monitoring any illegal activity like trespassers, tree thievery and deforestation (if they're ready to detect at all). On the other hand, with the technological advancements in wireless communication, numerous low power, and low cost, small-sized sensors nodes are out there which may be promptly deployed to watch surroundings over immense areas.

Environmentally, WSNs finds vast application in land management, agriculture management, lake water quality management, fire detection, tree thievery prevention and also in the prevention of deforestation. Additionally, WSN system has also been used for strain observation in railway bridges. (Bischoff *et al*., 2009), developed an occurrence based strain observation wireless sensor network system for railway bridge. They used low power MEMS acceleration sensors for detecting an approaching train. Whensoever this incident was detected, strain gauges were operated and measured information was used for cycle numeration based fatigable assessment of steel bridges. This event based detection was developed to manage the power consumption and build the system more energy economical. Moreover, solar battery-powered base station was used to increase the system lifespan.

(Al-Turjman *et al*., 2009), focused the numerous design factors necessary for WSN system deployment particularly in harsh surroundings like coverage, connectivity and lifelong. They explored the problem of placement of the relay nodes in 3D forest area. They developed an optimisation problem that focuses on maximising the network connectivity with a limit on the quantity of relay nodes used. They came up with a threshold on a minimum range of relay nodes used for desired connectivity in harsh surroundings.

(Luming *et al*., 2008), studied and came up with a brand new technology that combined the benefits of video monitor and GIS systems for forest fire monitoring. This combination of two techniques complemented one another well and helped in increasing the accuracy of fire detection and thence prevention, reducing the wrong alarm. Also, synchronous tracking of video monitored spaces in GIS of forest resources helped in obtaining a lot of correct info of the land type of the affected area.

Some of the researches deal with achieving maximum network life time and energy efficiency of the WSN. (Samira Nemati *et al*., 2012) The energy–aware immune system methodology selects the minimum range of selected nodes which will send its information to the sink and considerably cut back the energy consumption. Additionally, considering the remaining energy of the selected nodes, their energy is balanced. Hence, choosing acceptable sensors has a very important impact on reducing network energy consumption and increasing its life span. By minimizing the error function, the foremost correct sensors for transmitting data are going to be identified and redundancy in data transmission are going to be eliminated.

(Ghalib A. Shah *et al*., 2007) Since energy conservation could be a key issue for WSNs, spatial correlation has been exploited and an energy aware spatial correlation based on clustering protocol is mentioned. Cluster head divides the cluster into correlation regions and successively selects a representative node in every region. In every cycle, it chooses a representative node and solely this node is going to be active until the end of the round, other nodes therein region is going to be inactive during that time span. The only downside of this methodology is that cluster head has got to waste its energy for selecting the representative node and this happens in every round.

(Fei Yuan *et al*., 2014), proposed the data density correlation factor. The proposed correlation degree is a spatial correlation measurement that measures the correlation between a sensing element node's information and its neighboring sensing element node's information. With the DDCD clustering methodology, the sensing element nodes that have high correlation are divided into constant cluster, permitting a lot of correct collective information will be obtained in cluster-based data aggregation networks created by the DDCD clustering methodology. Also, the number of information sent to the sink node will decrease.

MATERIALS AND METHODS

Fire Detection Mechanism:

The present methodology consists of standalone boxes, with every box consisting of various sensors like humidity and temperature sensors. Those boxes are deployed around the entire forest space so that an entire coverage is obtained.

A. Deployment of Sensors

Deploying the sensors is most significant issue because it determines the potency of the whole system

1. The sensor ought to cover the entire forest with minimum range of nodes
2. The gap between the sensors should be equal so that it's simple to calculate the rate of spread of fire
3. The sensors should be positioned such that false alarms are avoided

These sensors aggregates the information wirelessly and transmit the information to a base station. These sensors are clustered and are active always.

They sense the parameters each quarter-hour and if there's a chance of fire detected then the parameters are going to be measured every 2 minutes. This is often to cut back the usage of battery power.

Algorithm for Fire Detection

1. Initialize all nodes and synchronize it to sameclock
2. Nodes in the cluster are virtually connected to a base station and all the base station are connected to the control center
3. When the humidity of air is high, LM 35-a kind of sensor senses the temperature and transmits it to the base station every 30 minutes
4. The rate of measurement is increased to every 15 minuteswhenever the humidity of the air reduces.
5. The no deentersthesleep state whenever the temperature is less than the threshold value,otherwisethe sensor continuously senses the temperature and transmits theresult to the base station
6. A node sends a danger packet to its neighboring nodes when it senses a fire and the timer is started and the timer is run till it gets a fire alert. This is to calculate the rate of spread of fire and the direction of spread
7. The base station collects all the values and calculates the rate and direction of spread of fire

$$\text{Rate of spread of fire} = \frac{\text{Distance between two nodes}}{\begin{array}{c}\text{Time interval between reception of}\\ \text{alert and fire detection}\end{array}}$$

8.By using the GSM, alert messages is sent to nearby villages to relocate the people to a safe locality

Topology Design for Fire Detection:

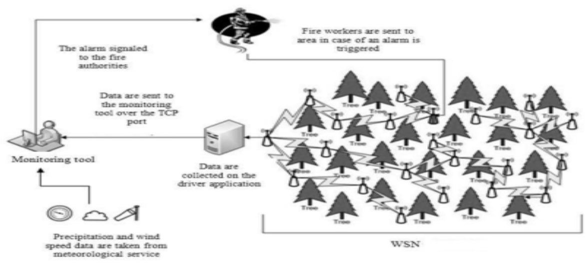

Fig. 1: Deployment of sensor

Figure 1 depicts the topology of the sensor nodes.It should be pre planned based on the density of trees within the forest area. When the density of trees is more then there are more possibilities of fire as the trees more often rub one another producing heat due to friction. In such cases the amount of sensors deployed should be higher. While considering the energy restriction the detection of fire as early as possible should not be compromised.

Mechanism for Tree Theft Detection:

The typical setup of the deforestation observance application is shown in Figure 2. Few wireless nodes (say N1 to N10) that are accountable for sensing the specified physical entities and communicating this information are deployed in the forest. The data gathered by the nodes is transferred to their upstream routers. One Base Station (BS) is employed that gathers the data from the routers. This BS is successively connected to host system through wireless connection which finally processes the data received from the BS and takes appropriate decision.

In our application, the wireless sensor nodes are mounted on every tree so as to shield the tree from essential events like thievery, fire etc. Wireless T-mote is the name given to every node. Few T-motes were hooked up to the tree models. It shaped an easy dynamic tree constellation to route packets to the host system. The Tree thievery detection approach adopted by United States can be explained with the assistance of Figure 2. From the figure 2, it is shown that fall event is detected on N10 which can be generated in case of tree thievery. Once the tree is falling, the tilt sensor generates the event and activates the node which is previously in sleep mode. This node transmits a beacon signal for a predefined amount of time to awaken the sensor nodes inside its range. A dynamic routing path created in the routing section is employed to send this message to the base station that is connected to the host system. In this example, routing path created via Node 8, 6, 4, 2, 1 is employed for alert sending.

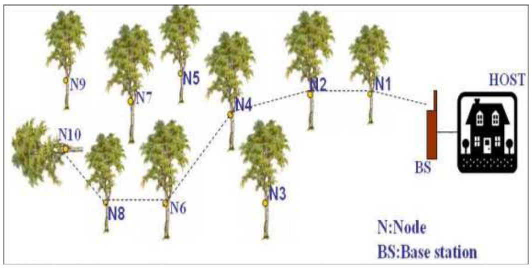

Fig. 2: Demonstration Scenario of detecting a Tree Theft using WSN

Network Design & Constraints:

One of the vital aspects of the network design is that the communication of data among the sensor nodes. Therefore, it's extremely necessary to design economical routing algorithm considering multiple constraints like low power consumption, scalability, fault tolerance and reliability that are inevitable in wireless environment. There are 2 kinds of routing possible based on the functionality of the nodes within the network namely, flat routing and hierarchical routing. In hierarchical routing, the entire network is split into multiple hierarchies. With relation to the level of hierarchy, every node has completely different functionality. Zigbee, one of the commonly used hierarchical routing protocols where the nodes are organized in a hierarchical manner. In flat routing protocol (mesh routing protocol), all the nodes within the network are organized in the same hierarchy i.e. all nodes within the network have a similar hardware and functional properties. Eg. Directed diffusion. In this study, we tend to propose a mesh routing protocol system appropriate for monitoring the forest environment, wherein the nodes within the network are in the same hierarchy. The proposed protocol for this study is an incident based protocol, where the nodes generate data corresponding to the incident occurred and transmits it to the sink.

The protocol has 2 phases: Configuration phase and Routing phase.

Configuration Phase: During this phase, the entire network is in wake up state. The sink node sends the configuration packet that traverses through the network in multiple hops. All the Nodes receive the configuration packet and construct the routing table. Routing table is employed to route the info packets towards the sink node. Once the network is configured, the sink advertises the sleep pack*et al*l over the network and all the nodes move to sleep mode.

Routing Phase: During this phase, an incident detected within the locality of the sensor, wakes up the sensor node and records the perceived information at the node. This node then transmits a beacon signal for a pre-defined amount of time to wake up the sensor nodes inside its range (neighbours).The node selects the upstream node (towards the sink) using routing table toforward the data packet. A similar procedure is carried out on the selected upstream nodesto route the data packets to the sink node. The nodes enter back into sleep mode after aspecified period of time.

Proposed Method For Energy Efficient Routing:

Network lifetime can be defined as the time span from the deployment to the instant when the network is considered no longer working. The decision of considering a network as nonfunctional is however, application-specific. It can be, for example, the instant when a certain fraction of sensors die,loss of coverage occurs (i.e., a certain portion of the desired area can no longer be monitored by any sensor), loss of connectivity occurs (i.e., sensors can no longer communicate with APs), or the detection probability drops below a certain threshold. For a highly sensitive or a critical application, the network is considered as nonfunctional soon after any one node depletes its energy. For a less sensitive application, the network is considered as functional till major set of nodes or all the nodes depletes their battery energy. Since channel states are independent of residual energies (the sensor with the better channel may have less residual energy), a lifetime-maximizing protocol needs to strike a balance between these two often conflicting objectives.

In the proposed technique, as soon as the nodes are deployed; the base station will initially gather the geographical position of every individual node. Based on the closeness factor, the nodes which are deployed are grouped in to two separate disjoint sets. The first set of nodes will be active initially during which the second set of nodes will be in the energy saving mode or in sleep mode. The reason for separating the nodes in to two disjoint sets is, when the nodes are randomly deployed, they can be anywhere in the chosen geographical area. When two or more nodes are lying nearby (very close to each other), they sense almost same information. In such cases the information will be redundant. To exploit this for energy benefit, we will find out the closeness factor between the nodes (calculate the distance between the nodes). Based on this closeness factor, divide the deployed nodes into disjoint sets. If this closeness factor is less than the threshold value, separate such nodes and maintain them in a different set. The selection of threshold value for the closeness factor is application specific and should be carefully chosen. For a highly sensitive application, for example, seismic environment, closeness factor threshold chosen must be low. But in our application,the main focus is on for temperature monitoring, so that the closeness factor threshold may be high. In other words, these nodes are more tolerant to the farthest node reporting. The closeness factor will be varying from application to application.

We have considered choosing the closeness factor threshold as 10 m. For a higher sensitive application the threshold chosen will be less than 10m.

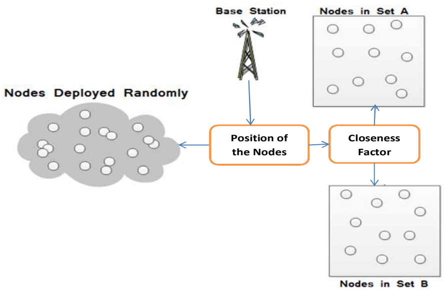

Fig. 3: Proposed Enery Efficient Routing Architecture

Figure 3 depicts the proposed energy efficient routing architecture.When the nodes of first set (List A) are active, the base station will monitor all the events of the sensors. The rate of data sensing of the nodes and data transmission are monitored by the Base station to track the energy level of active set of nodes. The instant at which the second set of nodes (List B) are to be activated is determined by the Base Station and in turn generates an appropriate control signal to “Turn on” the nodes of List B.

Algorithm used:

The algorithm for grouping the deployed nodes (LTN) in to set of two disjoint sets (List A and List B) based on the closeness factor ‘theta’ is given below.

1. Deploy the ‘n’ nodes in the specified geographic area (List of total nodes LTN), the nodes are deployed in random fashion.

2. Each node is represented by its X and Y coordinate e.g. ith node is represented as $N_i(X_i, Y_i)$ and all the nodes are initially active.

3. Get the geographical position of each individual node in to the Base Station and copy the list of the total nodes LTN in to List A.

4. For i= 1 to n-1
For j= 2 to n
If i≠j then
D_{ij} = sqrt $((X_i-X_j)^2 + (Y_i-Y_j)^2)$
If D_{ij}< t*heta* thenList B = {N_j}
/* Copy the node N_j (X_j, Y_j) in to ListB.*/
End if
End if
End for

End for

5. All the nodes of list B are set to power saving mode or turned off, keeping the nodes of list A in the active state.

Results:

Performance Evaluation:

The performance of the above proposed model is evaluated by using ns-2 simulator. The performance result of the proposed mechanism is compared with the normal flat routing protocol. In the simulation, area was considered as an area of 100 m X 100 m. Initial energy of every node is assumed as 10 Joules. The closeness factor threshold theta is assumed as 10 m. The simulation parameters assumed are given in the Table 1.

Table 1: Simulation Parameters

Variables	Values
RXPower	0.00175W
TXPower	0.00175W
Initialenergyofevery node	10J
SleepPower	0.0005W
TransitionPower	0.002W

We have considered two issues namely Coverage and Network lifetime. Initially, all nodes were set in normal mode ‘on’, and performance is evaluated. Even though, it is felt that, the proposed method is going to utilize the resources efficiently, if the set of some nodes did not cover the entire network area then it is of no use if the resources are saved. So, the area coverage by the nodes of the normal flat routing protocol is compared with the proposed method. The deployment of the node is in random fashion. After applying the present method the LTN is grouped into two sets.

One of the parameter chosen to find out the effectiveness of the proposed mechanism is the coverage of the area by the nodes deployed. The coverage of the area by the nodes in normal flat routing protocol is considered as100%. In the proposed mechanism, the total deployed nodes are grouped in to two separate lists. The coverage of the area by the distribution pattern of the nodes of List A and List Bare determined and normalized to the area coverage of normal flat routing protocol.

By this approach, a conclusion can be made, even though a set of nodes are turned off, the coverage is almost equal to the normal flat routing protocol. Another parameter chosen to prove the effectiveness of the proposed mechanism is the network life time. The network life time was measured and is compared with the normal flat routing protocol. In this experiment, we have considered network lifetime as time span from the start till any node losses its battery power completely. By using the present approach ,the network lifetime expected to be doubled than the existing method.

Conclusion and Future Work:

Wireless detector Networks (WSNs) are still a rising technology and far literature out there remains theoretical, thus practical deployment guides using actual experience are few if any. In this paper, we mentioned the aspects of using wireless sensor networks for deforestation monitoring and alerting using rare event detection with immoderate low power consumption. In this paradigm, 3 sensors (mercury sensor, humidity sensor& temperature sensor) that work well for the detection of fire and tree thievery were chosen and event based routing protocol was used for alert routing and event detection. For achieving maximum network life, event based routing is combined with energy efficient routing protocol that is based on closeness factor of sensor nodes. Among the deployed nodes, the nodes are divided into 2 totally different sets based on the closeness factor. The primary set nodes are turned on at the start, and once the energy of the anyone node within the initial set is nearing to zero, its a perfect time to activate the second set of nodes, which were earlier in the sleeping mode.The projected methodology assures the maximized network life than existing approaches. As a future work,a similar technique will be extended to hierarchical routing protocols also.

Table 2: Accronyms Used

WSN	Wireless Sensor Network
GPS	Global Positioning System
GSM	Global System for Mobile Communication
MEMS	Micro-Electromechanical Systems
GIS	Geographical Information System
DDCD	Data Density Correlation Degree
TCP	Transmission Control Protocol
CONFIG	Configuration Data of Nodes
LTN	List of Total nodes

Australian Journal of Basic and Applied Sciences, 10(2) Special 2016, Pages: 283-289

REFERENCES

Magrath, W.B., R.L. Grandalski, G.L. Stuckey, G.B. Vikanes, G.R. Wilkinson, 2007. Timber Theft Prevention: Introduction to Security for Forest Managers. Sustainable Development-East Asia and Pacific Region, Discussion Papers, The World Bank Publication.

Bischoff, R., J. Meyer, O. Enochsson, G. Feltrin and L. Elfgren, 2009. Event-based strain monitoring on a railway bridge with a wireless sensor network. Proceedings of 4th International Conference on Structural Health Monitoring of Intelligent Infrastructure (SHMII-4), ISBN 978-3-905594-52-2, Zurich, Switzerland.

Al-Turjman, F.M., H.S. Hassanein and M.A. Ibnkahla, 2009. Connectivity Optimization for Wireless Sensor Networks Applied to Forest Monitoring. Proceedings of IEEE International Conference on Communications (ICC), ISBN: 978-1-4244-3435-0, pp: 1-6.

Luming, F., X. Aijun and T. Lihua, 2008. A Study of the Key Technology of Forest Fire Prevention Based on a Cooperation of Video Monitor and GIS. Proceedings of 4th IEEE International Conference on Natural Computation, ISBN: 978-0-7695-3304-9, pp: 391-396.

Samira Nemati, Reza Azmi and M.A.S monfared, 2012. An Energy aware Spatial Correlation Method in Event driven Wireless Sensor Networks, IJCSI International Journal of Computer Science Issues, 9(5)3: 1694-0814.

Ghalib, A. Shah and Muslim Bozyigit, 2007. Exploiting Energy-aware Spatial Correlation in Wireless Sensor Networks, in Proc. Communication System Software and Middleware, COMSWARE, IEEE.

Fei Yuan, Sch. Of Inf. Sci. & Technol., Sun-Yat Sen Univ., Guangzo, China; Yiju Zhan, 2014. Yonghua Wang Data Density Correlation Degree Clustering Method for Data Aggregation in WSN, Sensors Journal, 14(4), IEEE Sensor Council.

Daniele Puccinelli and Martin Haenggi, 2005. “Wireless sensor networks: applications and challenges of ubiquitous sensing” IEEE Circuits and Systems Magazine, 5(3): 19-31.

Intanagonwiwat, C., R. Govindan and D. Estrin, 2000. “Directed Diffusion: a Scalable and Robust Communication Paradigm for Sensor Networks,” in Proc ACM MobiCOM 2000, Boston, MA, pp: 56-67.

Chih-Yu-Lin, Yu-Chee Tseng, Ten H. Lai, 2012. Exploiting Spatial Correlation at the Link Layer for Event-driven Sensor Networks, International Journal of Sensor Networks, 12(1): 1-15.

Torres, M.G.C., 2006. “Energy consumption in wireless sensor networks using GSP,” M.S. dissertation, Universiy of Pittsburgh.

Min Yao, Chuang Lin, Peng Zhang, Yuan Tian, Shibo Xu, 2013. “TDMA scheduling with maximum throughput and Fair Rate Allocation in Wireless Sensor Networks” in Proc IEEE, ICC, Adhoc and Sensor Networking symposium.

Heinzelman, W.R., A. Chandrakasan and H. Balakrishnan, 2000. “Energy Efficient Communication Protocol for Wireless Microsensor Networks,” In Proceedings of the 33rd Hawaii International Conference on System Sciences, pp: 3005-3014.

Vuran, M.C., O.B. Akan and I.F. Akyildiz, 2004. “Spatio-temporal correlation: theory and applications for wireless sensor networks,” Computer Network. J. (Elsevier), 45: 245-259.

Shakya, R.K., N. Singh, N.K.A. Verma, 2012. novel spatial correlation model for wireless sensor network applications Wireless and Optical Communications Networks (WOCN), Ninth International Conference.

Heinzelman, W., A. Chandrakasan and H. Balakrishnan, 2000. “Energy Efficient Routing Protocols for Wireless Microsensor Networks,” in Proc. 33rd Hawaii International Conference on System Sciences (HICSS ‟00).

Singh, S.K., M.P. Singh and D.K. Singh, 2010. Routing Protocols in Wireless Sensor Networks – A Survey. International Journal of Computer Science & Engineering Survey (IJCSES), 1(2).

Kompis, C. and S. Aliwell, 2008. Energy Harvesting Technologies to Enable Remote and Wireless Sensing. Sensors and Instrumentation Knowledge Transfer Network Report.