Method & Implementation of Optimal Routing Mechanism with Wakeup Schedule in WSN

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Abstract- **This work proposes an optimal routing mechanism under sleep scheduling in wireless sensor networks. Duty cycling is a technique that increases energy efficiency by allowing a node to turn off part or all of its systems for periods of time. These sensor networks have certain characteristics such as limited power and battery driven. In this work, an on demand routing under asynchronous sleep scheduling is proposed for each sensor. The aim of this work is to minimize the energy consumption by nodes so that lifetime will improve. The proposed mechanism is implemented with MATLAB. In this, it provides a complete path from sender to receiver without any packet loss. In this, it covers different scenarios under sleep schedule. The main objective is to provide energy efficiency in network & also reduce delay. In this, it presents a multipath routing protocol for data transmission. All these are useful for reducing the energy consumption and improve the accuracy.**

Keywords-*Sleep Awake Cycle, shortest path in Networks, wireless sensor networks, sleep scheduling.*

I. INTRODUCTION

Recent advances in micro electro-mechanical systems (MEMS) technology have made it possible to offer sensors used for sensing the surroundings with small but powerful processors and wireless transceivers with sensible ranges. This emerging Wireless Sensor Networks (WSN) technology consists of a huge number of sensors deployed across a geographic area to monitor the environment by measuring physical parameters such as temperature, motion, sound, etc. Due to recent technological advances, the manufacturing of small and low cost sensors became technically and economically feasible. The sensing electronics measure ambient conditions related to the environment surrounding the sensor and alter them into an electric signal. Processing such a signal reveals some properties about objects located or events happening in the vicinity of the sensor [1].

WSN are easily vulnerable to attacks. Providing security solutions to these networks is difficult due to its characteristics such as tiny nature and constraints in resources. A lot of research efforts in the field of embedded system, such as low-power design, dynamic power management, and energy-aware routing algorithms have been devoted to achieve lifetime maximization of WSNs. With the advances in these technologies, more and more applications based on WSN are mature and they are becoming an indispensable part of people’s life, and will have a great impact on the future.

One of the most important issues regarding the design of sensor networks is power consumption since these networks consist of a large number of nodes and are usually deployed in hazardous and remote areas where the replacement of batteries is impossible. The second is overhearing, which occurs when a node receives and decodes packets that are not destined to it. The third, over-emitting, occurs when the transmitter node transmits a packet while the receiver node is not ready to receive it.

Although sensor nodes are identical devices but their characteristics varies with the network structures. Sensor deployment, coverage, transmission power, computation, reporting, addressing and communication pattern greatly affects the routing protocol operation both at nodes and at base stations. Routing protocol used for WSN communication support unicast (one -to -one), multicast (one-to -many) and reverse-multicast (many-to -one) in the following ways [2].

To improve a sensor network's reliability and extend its longevity, sensor networks are deployed with high densities. However, if all sensor nodes in such a dense deployment scenario operate at the same time, energy will be consumed excessively. Also, packet collisions will increase as a result of the large number of packets being forwarded in the network. In addition, most of the data forwarded in the network will be redundant since when node density is high, sensing regions of the nodes will overlap and the data of adjacent sensor nodes will be highly correlated.

From literature survey, The main test in wireless sensor networks is to decrease energy consumption and to increase the throughput of sensor node for enhancing the lifetime of sensor network. In this process, the data is to be transmitted to the first node that wakes up and makes a progress in the performance for minimizing the delay policy. They demonstrated that the when nodes are densely deployed in environment, the expected energy consumption keeps close to the lower bound.

Since each node has limited energy, these nodes are usually put to sleep to preserve energy, and this helps to extend the network lifetime. Energy-efficiency is generally achieved by duty-cycling the nodes, which makes nodes, sleep most of the time and wake-up just when it is necessary. Sleep scheduling method is always used to reduce the energy consumption so that nodes will work for a long time without recharging their batteries. There are two major schemes for sleep scheduling of sensor nodes, (i) random (ii) synchronized. Any sleep scheduling scheme has to ensure that data can always be routed from source to sink

The paper is ordered as follows. In Section II, It defines sleep scheduling in WSN. In section III, it describes the proposed work related to sleep awake cycling in WSN. In section IV, it provides the proposed results of system. Finally, conclusion is explained in Section IV.

II. SLEEP & WAKEUP IN WSN

The general scheme for the sleep &wakeup procedure is that each sensor node selects a starting time between 0 and Tperiod randomly and each node follows its own wakeup schedule for the succeeding periods. For ease let's assume that Tperiod is equal to 1. The duty cycle is defined as the percentage of time a node is active compared the time for one period Tperiod. The ratio between the preamble lengths P over one period of time Tperiod is denoted as p, since Tperiod is assumed equal to 1, therefore p is equal to P in this work. The preamble length in this work is expressed as "preamble p" due to the Tperiod equal to 1.

The reachability is defined as the number of the received packets by the sensor nodes *Nr* over the total number of sensor nodes *N* within the area. Thus the reachability is can be written as R =*Nr*/*N*. The number of the received packets can be attained both directly via the source node and indirectly via the retransmitting of other sensor nodes in the area.

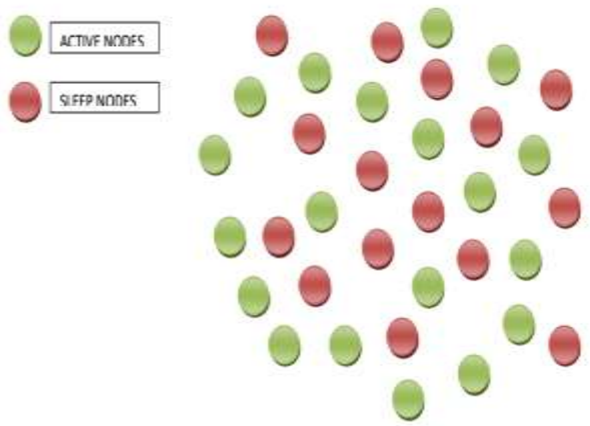

Figure 1: Sleep Scheduled Nodes in Network

1. The On-demand Protocol

The on demand protocol is one of the types of power management protocol. This protocol is based on the fact that a sensing node should be in the sleep mode or off when there is no data packet to transmit or receive. As soon as there is a data packet that needs to be transmitted or received the sensor node will become active and will be in on state. In this way sensor nodes interchange between sleep & active periods depending on network action. The outcome is that sensor do not waste energy by unnecessary transmissions and unnecessary sensing & hence the energy consumption is minimized. But the main disadvantage of this protocol is that it is hard to notify the sleeping nodes if another sensor node wants to communicate with them. The Scheduled 2.

2. Rendezvous Protocol

The second power management protocol is called scheduled rendezvous protocol. It belongs to the synchronous protocols since it requires all neighbouring sensing nodes to wake up at the same time. In Figure, the sleep scheduling of sensor nodes using a scheduled rendezvous protocol is shown. In this approach sensor nodes wake up according to a wakeup schedule and remain active for a short time interval to communicate with their neighbours. After the transmission of the data the senor nodes will go to sleep until the next time. The main advantage of this protocol is that it is definite that if a sensor node is awake that all its neighbouring sensor nodes are awake as well. It is very convenient for data aggregation and allows sending broadcast messages to all neighbours.

3. The Asynchronous Protocol

In this, each node is allowed to wake up independently of the others by providing assurance that neighbouring sensor nodes always have overlapped active periods of time within a specified number of cycles. According to this figure only sensor node 1 and sensor node 3 can receive the transmitted packet. Since the active period of the sensor nodes moderately overlap with the active period of the source node. The main advantages of this protocol are that a sensing node can wake up at anytime when it wants to speak with its adjacent sensing nodes.

III. PROPOSED WORK

A sensor node consumes battery power in the following four operations: sensing data, receiving data, sending data, and processing data. Generally, the most energy consuming component is the RF module that provides wireless communications. Consequently, out of all the sensor node operations, sending/receiving data consumes more energy than any other operations. Sensor nodes in a WSN have a limited amount of energy and if all the sensor nodes would be active all the time the whole network may collapse in a short time. This is due to the high energy consumption of the sensor nodes. However it is not necessary for all the sensor nodes to be active all the time, they only need to become active when there is a need to transmit and /or receive data. Therefore, sleep scheduling can prolong the lifetime of a WSN significantly. Sleep scheduling works by activation sensor nodes when there is a need to transmit/receive data the remainder of the time the sensor node sleeps. Sleep scheduling belongs to the category of power management protocols which is one of the main energy conservation techniques used for WSNs.

Firstly, the nodes' wake interval is increased as the distance of the node from the Base station decreases as such nodes send their own data as well as act as relay nodes for those away from the Base Station. Secondly, the wake interval of nodes may also be increased due to their topological significance. Sleep wake scheduling has been used to save the energy and enlarge the network lifetime. Energy efficiency has intrinsic trade-off with delay, thus, normally in such sleep wake scheduling strategies, maximization in network lifetime is achieved at the cost of increase in delay. To achieve this, delay minimization at three levels is observed and addressed: the delay occurred because of traffic load at the nodes near the Base Station, the delay occurred due to transfer load at the connectivity dangerous node, and delay occurred while dealing with traffic burst when an event occurs. To diminish the delay, a heuristic which maximizes the wakeup-up time in a scheduling period at three levels is used.

First of the power management protocol that is introduced is the on-demand protocol. This protocol is based on the idea that a sensor node should be in the sleep mode or off when there is no data packet to transmit and/or receive. As soon as there is a data packet that needs to be transmitted and/or received the sensor node shall become active. In this way sensor nodes alternate between active and sleep periods depending on network activity. The consequence is that the energy consumption is minimized since sensor do not waste energy by unnecessary transmissions and unnecessary sensing. But the main disadvantage of this protocol is that it is difficult to inform the sleeping sensor nodes if another sensor node wants to communicate with them.

The second power management protocol is called scheduled protocol which belongs to the synchronous protocols since it requires all neighbouring sensor nodes to wake up at the same time. In Figure, the sleep scheduling of sensor nodes using a scheduled rendezvous protocol is shown. In this approach sensor nodes wake up according to a wakeup schedule and remain active for a short time interval to communicate with their neighbours. After the transmission of the data the senor nodes will go to sleep until the next rendezvous time.

The next algorithm that can be used is the asynchronous protocol. The basic idea is that each node is allowed to wake up independently of the others by guaranteeing that neighbouring sensor nodes always have overlapped active periods of time within a specified number of cycles. One of the advantages of this protocol is that a sensor node can wake up at anytime when it wants to communicate with its neighbouring sensor nodes. Therefore, in asynchronous protocols there is no need to exchange extra synchronization information unlike in the synchronous protocols so that the energy efficiency is improved. In contrast with the scheduled rendezvous protocol, it is not possible to broadcast a message to all neighbouring sensor nodes in one period of time.

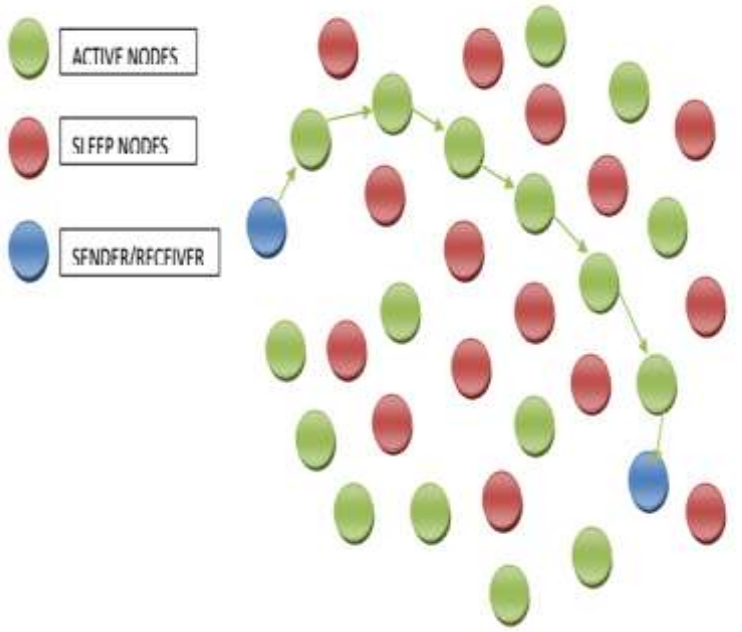

Figure 2: Proposed Scenario under Sleep Scheduled Network

Figure 3: Proposed Flow Chart of System

In most of the WSN sleep/wake protocols, energy awareness is considered as a key design issue to maximize the network lifetime at the cost of latency, delay, and throughput; thus making such design inapplicable in delay sensitive applications. In this article, the delay-minimization problem in sleep/wake scheduling is investigated for event-driven sensor networks in delay-sensitive applications. A distributed and low-complexity solution is presented. The scheme is based on developing schedules based on traffic load requirements of nodes to reduce latency and enhance energy efficiency at the same time. To reduce delay, the proposed protocol does not use a generic sleep/wake schedule for all the nodes, rather it uses a heuristic which maximizes the active duration of the nodes according to their expected traffic load at three different levels. The flow chart is presented in figure 3.

Firstly, the nodes' wake interval is increased as the distance of the node from the BS decreases as such nodes send their own data as well as act as relay nodes for those away from the BS. Secondly, the wake interval of nodes may also be increased due to their topological importance. Sleep wake scheduling has been used to save the energy and extend the network lifetime. Energy efficiency has inherent trade-off with delay, thus, generally in such sleep wake scheduling strategies, maximization in network lifetime is achieved at the expense of increase in delay.

Proposed Algorithm
Input N: No. of Nodes
Begin
Step 1: Provide N
Step 2: Activate all N.
Step 3: Communication with all N
Step 4: Set wake up time (t)
Step 5:
Case 1: If N is idle then
Put N in sleep state
Case 2: Put half N in sleep and half N active
Provide routing in On state.
Case 3: Initially all N in sleep
Provide On demand Routing in them for energy efficiency.
End

IV. SIMULATION RESULTS

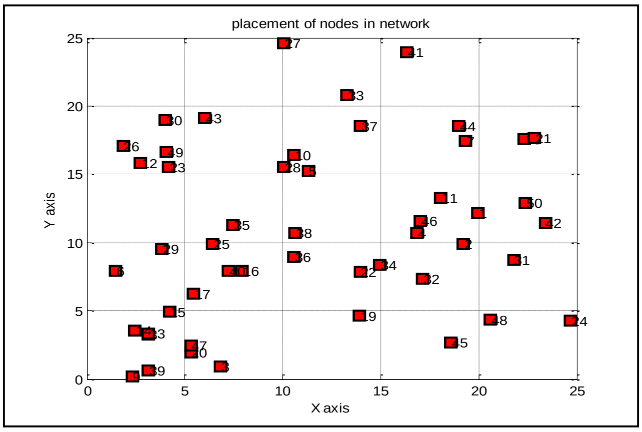

Figure 4: Placement of 50 Nodes in Network

Sleep wake scheduling has been used to save the energy and extend the network lifetime. Energy efficiency has inherent trade-off with delay, thus, generally in such sleep wake scheduling strategies, maximization in network lifetime is achieved at the expense of increase in delay. To achieve this, delay minimization at three levels is analyzed and addressed: the delay occurred because of traffic load at the nodes near the BS, the delay occurred due to traffic load at the connectivity critical node, and delay occurred while dealing with traffic burst when an event occurs.

In minimum-energy routing protocol, nodes in a network act as a router for other nodes. Transmission to the base station from one node occurs through intermediate nodes. The energy dissipation of the receiver is neglected in some of the protocol [7] and only transmitter energy is taken. The selection of midway nodes is completed in such a manner that transmission energy is minimized. It has been discussed whether this routing protocol perhaps consumes more energy than direct routing algorithm. That is, the energy consumed by each neighbour in order to receive and then transmit data could result in the total energy consumption to be higher.

In this work, take the scenario for 50 nodes and following result will show the information about the placement of sensor nodes in an area. The simulation environment is to randomly distribute 50 sensor nodes to an 25m*25m square. The initial energy of each node is provided. In each round, the sensor node will deliver a packet. All sensor nodes are stationary and homogenous. All sensor nodes can adjust their power levels based on distance.

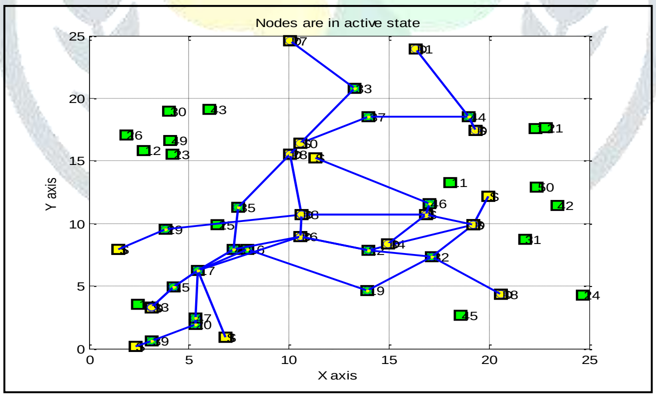

Figure 5: Communication with Other Nodes

Initially all nodes are in OFF State. If nodes want to communicate with each other, all nodes have a wakeup time and they woke up all at a time i.e. they are synchronous in nature. All nodes are ON & OFF synchronously. They provide communication by multi-hop routing technique. When the distance between a sensor node and the base station is large the data transmission from sensor node to base stations consumes more energy than in the case when the distance is small. Hence the distance between sensor nodes among another and the distance from sensor nodes to the base station impacts the lifetime of the WSNs.

In a direct data transmission, each sensor node collects and transmits the data to the base station directly, there do not exist any intermediate nodes for transmission, the path which from sensor node to the BS can also be called single-hop path. The advantage of direct transmissions is that the data rate is higher and the implementation is easier. Indirect transmission means that sensor nodes send their collected data to intermediate nodes also called relay nodes that are in the proximity of themselves. This relay node will then forward the aggregated data to the BS, the path from the sensor node to the BS is also called multi-hop path.

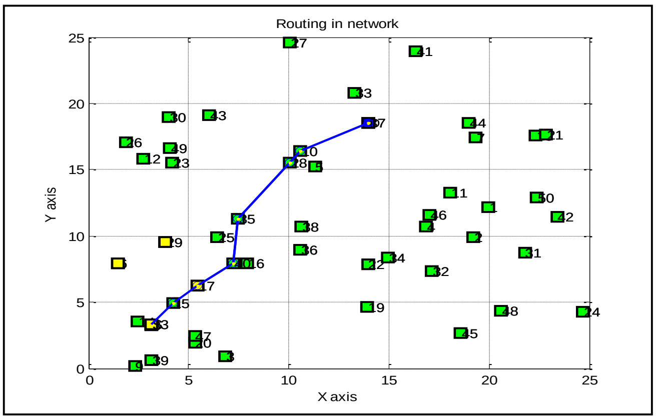

Figure 6: Shortest Path Routing in Synchronous Mode

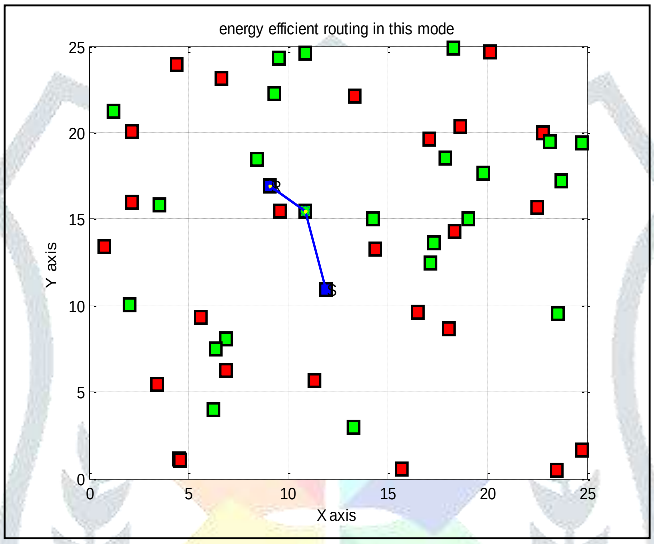

Figure 7: Energy Efficient Routing in Asynchronous Mode

In the proposed on demand case, all nodes are initially in OFF State. As Sender node is chosen and he wants to send data to a particular node. Then he finds initially all present nodes location in the path and stores it. So, only those nodes which are coming in the path gets wakeup call and they may help the sender to communicate with destination.

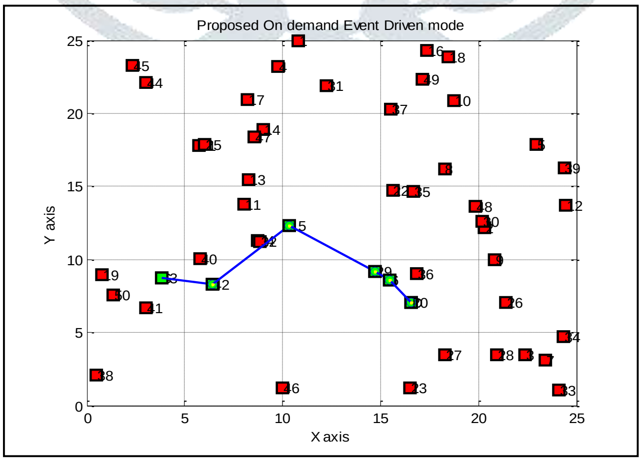

Figure 8: Proposed On Demand Routing

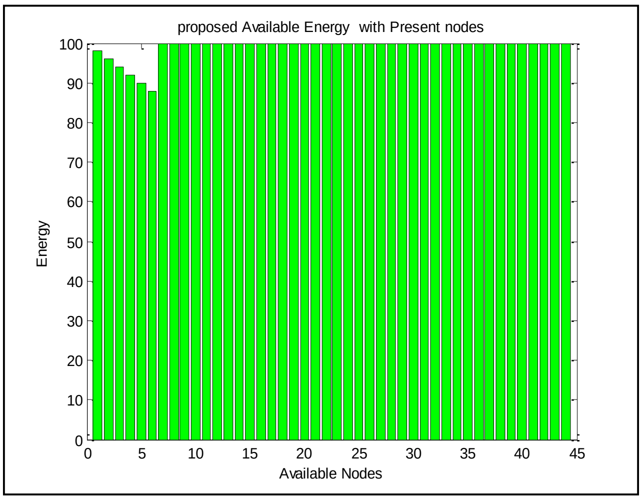

Figure 9: Proposed Available Energy in Nodes

Table 1: Performance Comparison of System

PARAMETER	PROPOSED	ACTUAL
CONSUMED ENERGY (MAX.)	12%	20%
DELAY (MAX)	5 sec	16 sec
PACKET TRANSFER	>98%	~98%

V. CONCLUSIONS

In this work, In WSN, all nodes consume energy while data transmission. So, due to this mostly nodes gets dead after some time and it causes less throughput and increase energy wastage. So, there is a scope of energy efficiency under sleep awake cycle in WSN. Also in synchronous sleep protocol, all nodes gets awake at a time so it causes amount of energy is wasted. So, there is a need to develop improved on demand sleep scheduling routing algorithm for energy conservation in WSN using MATLAB. Energy conservation makes sure that the lifetime of the network is maximized. In this work, it presents the sleep scheduling of nodes in WSN. Also ir presents optimal chaining mechanism in network. It takes the scenario of 50 & 100 nodes in network with 25*25 area. In this, optimal path selection is based on shortest distance between nodes which is to be calculated. In this, it provides different scenarios under sleep awake. It presents synchronous and asynchronous way of communication between nodes. The main objective is to provide energy efficiency in network & also reduce delay. So, to overcome this, we show the on demand scheduled routing. In this, only useful nodes are wake up by providing wakeup signal to those nodes and only those awake nodes participate in communication in network. There is a improvement in performance parameters like energy of 8 % & delay of 9 sec as compared to actual performance.

REFERENCES

[1] A. Swami, Qing Zhao, Yao-Win Hong and Lang Tong, *Wireless Sensor Networks: Signal Processing and Communications*, Wiley-Blackwell Publication, 2007.

[2] K. Sohraby Daniel Minoli TaiebZnati, *Wireless Sensor Networks*, John Wiley & Sons, Inc., 2007.

[3] W.H Liao, H-H Wang, "An asynchronous MAC protocol for wireless sensor networks", 28 July 2008.

[4] L. Almazaydeh, E. Abdelfattah, M. Al- Bzoor, and A. Al- Rahayfeh, "Performance Evaluation Of Routing Protocols In Wireless Sensor Networks", International Journal of Computer Science and Information Technology, Volume 2, Number 2, 2010.

[5] L.D.P. Mendes, J. Rodrigues, "A survey on cross-layer solutions for wireless sensor networks", 2011.

[6] Y. Chen," The Insights of DV-based Localization Algorithms in the Wireless Sensor Networks with Duty-cycled and Radio Irregular Sensors", IEEE International Conference on Communications (ICC) , June 2011.

[7] L. Oliveira and Joel J. P. C. Rodrigues ,"Wireless Sensor Networks: a Survey on Environmental Monitoring", IEEE *Journal Of Communications*, Vol. 6, No. 2, pp.143-151, April 2011.

[8] Ms. P. Tyagi, Ms. S. Jain, "Comparative Study of Routing Protocols in Wireless Sensor Network", Volume 2, Issue 9, 2012.

[9] K. P. Naveen, Anurag Kumar, "Relay Selection for Geographical Forwarding in Sleep-Wake Cycling Wireless Sensor Networks", IEEE, 2012.

[10] C. Hsueh,"Two-Tier Receiver-Initiated Secure Scheme for Hierarchical Wireless Sensor Networks", *12th International Conference on ITS Telecommunications*, pp.254-258, 2012.

[11] H. Shih, "Fault Node Recovery Algorithm for aWireless Sensor Network",*IEEE Sensors Journal*, Vol. 13, No. 7, pp.2683-2689, July 2013.

[12] M. Doudou,"Survey on Latency Issues of Asynchronous MAC Protocols in Delay-Sensitive Wireless Sensor Networks", *IEEE Communications Surveys & Tutorials*, Vol. 15, No. 2, pp.528-550,2013.

[13] P. Shi and Yun Wang, "Delay Aware Broadcast Forwarding Protocol for Asynchronous Duty-cycled WSNs", *11th IEEE International Conference on Dependable, Autonomic and Secure Computing*, pp.256-263, 2013.

[14] C. Zhu, Laurence T. Yang, Lei Shu, Victor C. M. Leung, Joel J. P. C. Rodrigues, and Lei Wang, "Sleep Scheduling for Geographic Routing in Duty-Cycled Mobile Sensor Networks," IEEE Transactions On Industrial Electronics, Vol 61, Issue 11, pp.6346-6356 ,2014.