ENERGY EFFICIENT PATHWAY SCHEME FOR REDUCING DELAY IN WIRELESS SENSOR NETWORK

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Abstract: *The improvement of the level of innovation of forest fires supervising using information and communication technologies has planned importance for many countries where forest fires occur repeatedly. In recent years, considerable progress has been made in the area of Wireless Sensor Networks (WSNs). A dynamic improvement in sensors and wireless skill are the main subscriber to the awareness of uninterrupted forest fire supervising system. One application is to use Mobile Sink (MS) to harvest data from a network. MS is extensively employed for data collection, which is reduce the energy utilization because of avoid multi hop data communication. However, the MS create additional delay in the network. To overcome this problem we introduce An Energy Efficient Path Scheme (EEPS) for reducing delay in WSN. This scheme focuses on how to shorten the length of traveling path to reduce the delay time of data gathering. This scheme main aim is to reduce the data communication path thus diminish the data collecting time in the network.*

Key words: *Mobile Sink, Path Strategy, Advanced Node, Energy, Forest Fire Detection.*

1. Introduction

Forest fires are among the disasters that have multidimensional negative effects in social, economic and ecological matters. The probability of ignition of forests is in solid increase due to climate changes and human activities. Forest fires reduce the cover of tree and lead to an increase in the gas emissions of our planet, and approximately 20% of CO2 emissions in the atmosphere are due to forest fires. Current environmental conditions have recently been producing more frequent and severe wildfires, causing the destruction of sizeable forested areas every year. WSNs have been less used in the emergency operations and more used in static and conventional monitoring areas. After the evolution of wireless ad hoc sensor networks, the applications of these networks have increased far beyond the expectation. The world of automation demands all the more the use of wireless processes for safety and most comfortable work.

Forest fire detection requires continuous monitoring with both periodic updates as well as emergency messages flowing through intermediate multiple hop. This multiple hop communication is to make energy consumption; congestion and BS near node tend to die earlier. Consequently, the network causing unnecessary delays and hazardous effects the BS becomes disconnected from network.

Delay may appear to be a very simple issue among the networks because the delayed packets ultimately try to deliver within the allocated time period. However, forest fire detection requires timely responses from the site under test to avoid the entire breakdown of the network. Figure.1 indicates the illustration of Forest Fire Detection in WSN.

To overcome this above problem, we introduce the MS as is collects the data from the sensor nodes. In WSN, the sensors can be scheduled to transmit information bits to a MS when it gets closer to them, resulting in a smaller communication cost. Along this line, various approaches have been proposed for addressing different aspects of this problem, such as path planning and speed control of the MS, and routing design of the network. However, using MS not only causes long latency for data collection, due to the limited speed of the MS, but also consumes motion energy Advanced node is used to reduce the multi hop sensor communication thus reduce the energy consumption in WSNs.

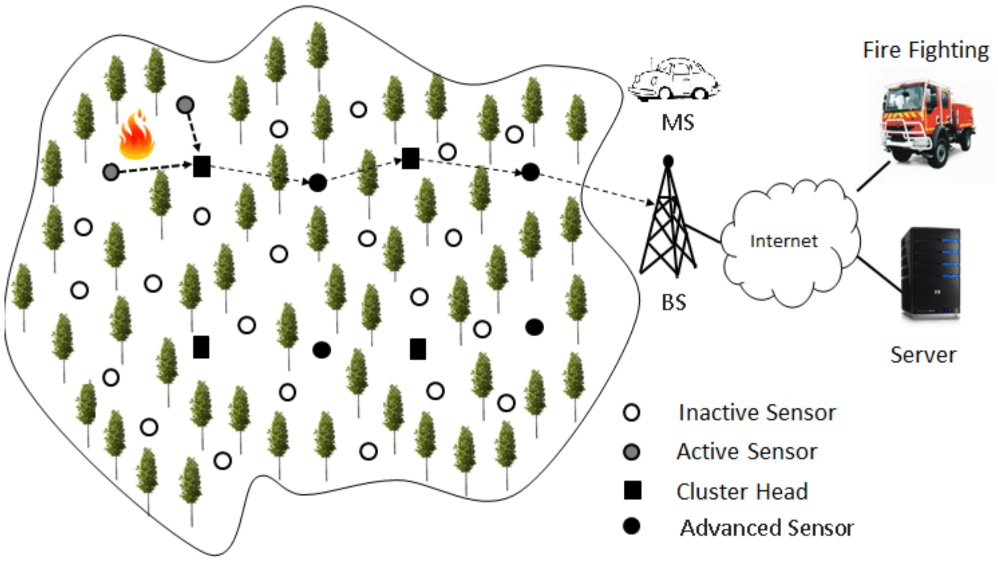

Fig.1 illustration of Forest Fire Detection

2. Related Work

In [1] explained MS based data collecting in mobile WSNs. This scheme built a path based on tree. CHs gather the data of all sensor nodes and perform data aggregation then it sent to sink reversely by tree. In [2] introduced to Maximizing the Data Collection Throughput (MDCT) based on a pre-specified path using a MS. In this scheme, data collection depends on time slot is allocated to a sensor node for data transmission. However, this scheme creates data delivery delay. In [3], travelling salesman problem is used to visit every point in the network. This method reduces the computational effort required for traveling path-planning algorithm. Fault-tolerant Router Algorithm [4] utilized Hamiltonian Cycle for tolerating the single-node failure. In [5] MS travels in variable trajectory and collect data from SN within the range. To minimize the overall network overhead, balanced energy consumption, and improve network lifetime. CH performs filtering and forwards the data to near MS. This scheme select the path of MS is balancing traffic load in the network. In [6] explored path-planning and path optimization algorithms in WSNs. Efficient Mobile Data Collector [7] dynamically changes its Data Gathering Tour in between by utilizing information from Neighbor Table. Each CH learns about its neighbors and sends the data. Ant colony algorithm [8] performs a series of routes used in Swarm Intelligence. Ant colony algorithm used to find most favorable path through shortest distance and number of interactions accurately and quickly to get improved efficient energy. In [9] described the movement direction based path selection strategy that adopts the grid structure and provides an efficient mobile sink's location updates. This scheme provides an energy-efficient location update strategy and makes a minimal delay path for data dissemination. Clustering and Path Planning [10] described to solve the joint path planning and clustering problem based on space-filling curves.

In [11] Path Planning Strategy using space-filling curves handles realistic communication environments by utilizing probabilistic channel predictors. In [12] explained Weighted Rendezvous Planning (WRP). In WRP, every sensor node is assigned a weight corresponding to its hop distance from the tour and the number of data packets that it forwards to the closest RP. An Energy Harvesting Device (EHD) scheme [13] used to maximizing the long-term average transmission rate. This method is simple and Low-Complexity. However, it increases the number of packets that can be sent in a time slot in order to create additional delay. Reliability Guaranteed Efficient Data Gathering scheme [14] that guarantees the QoS and optimizes the following network performance metrics as well as the end-to-end reliability in WSNs. This reduces the energy consumption of the nodes in the hotspot area. Distributed Energy Efficient Clustering (EDDEEC) [15] Algorithm employs an energy aware three level heterogeneous clustering protocol in WSN. The probabilities of CH selection are based on the initial energy of the node, average energy, remaining energy of the node, and average distance of the network. It provides scalability. Energy Aware routing scheme [16] select the next hop depend on the residual energy and throughput of the target nodes. This scheme provide better network lifetime in WSNs.

A tree-cluster-based data-gathering algorithm (TCBDGA) [17] is a weight-based tree-construction method. This weight is calculated by computed by number of neighbors, distance to the BS and remaining energy. TCBDGA reduce the energy utilization thus improve both the hotspot problem and network lifetime in WSNs. An Energy-Balanced Heuristic [18] network region is divided into grid cells and these grid cells are assigned to clusters based on k-dimensional tree algorithm. Therefore, the energy consumption is reduced in data gathering and sink movement. It generates an optimal grid cell division within a limited time of iterations, and prolongs the network lifetime. Energy Aware Optimal Clustering and Reliable Routing [19] present an efficient reduction of energy consumption plus reliable packet delivery in WSN. The markov model for packet routing, which is reduces the node dropped rates as well as re transmissions of information.

3. Energy Efficient Pathway Scheme

In this scheme the forest fire detection based on the sensor nodes and the five factors affect the fire danger such as season, fuel moisture, wind, visibility range, and activity of fire-starting agencies.

Season: The temperature, humidity, wind, and fuel moisture same in June , July, or August, the green vegetation such as grass, weeds, and brush is maturing, curing, and becoming less a fire retardant and more a fire accelerator as the season progresses. Even more consistent with calendar date is the number of hours of dangerous burning weather, according to hours of sunshine each day.

Fuel Moisture: It determines forest inflammability. The drier these fuels, the greater the danger, and in determining current danger it does not matter whether this dryness is controlled by precipitation alone, humidity alone, or any combination of precipitation, temperature, humidity, wind, and sunshine. A statistical analysis of the influence of weather factors on the moisture content of these fuels has shown that even very complete weather measurements cannot be used dependably every day for this purpose. Some of the finer fuels such as tree moss, dead grass, and weeds also contribute appreciably to fire danger when they are extremely dry.

Wind: The wind is one of the most important variables of fire danger. The crown fires occurring with on the ground, and of blow-ups during high humidity. In all such cases a high wind is usually the cause, and when the fuels are dry and the humidity low, even a small increase in wind velocity immediately accelerates the rate of spread of fire.

Visibility Range: The distance at which small smokes may be detected is a factor in fire danger. Visibility conditions may be such as to permit seeing small smokes 20 miles or more from a lookout, or the atmosphere may be so hazy that new fires can occur within 1 mile of a lookout, yet not be seen. When visibility is restricted there is greater danger of fires becoming large, more lookout stations must be manned, and in dry weather more men must be sent to every fire that escapes quick detection. In the early spring, before the average season fire control organization is warranted, the only action needed may be the placement of a few observers at their stations, their distribution depending primarily upon atmospheric visibility range.

***Fire-Starting Agencies*:** Fire danger and fire control are affected by the activity of any fire-starting agency. The fire records show that man does not produce peak loads of fires in Region One. Consequently this scheme does not rate danger higher on week-ends and holidays even though there are more people in the forests at such times. Hence it is not surprising that forest managers have in the past failed to agree when, for instance, date and duff or wood moisture have been conducive to high fire danger while humidity, wind, lightning, and visibility were favorable to easy forest protection.

The main scope of this article is to design an optimal routing path for mobile sink to reduce the delay and energy consumption in the WSNs. Here, the network is form in the circle shaped scenario. It consists of number of sensor nodes randomly placed and Base Station controls sensor nodes.

The Some number of sensor nodes is grouped into clusters based on communication range and the Advanced Nodes (ANs) are placed in the triangle shape. These nodes are used to communication purpose and it contains additional energy and transmission range. The CH is selected depend on energy. The CH role is gathering and integrates the sensor data and transmits the data to MS.

The MS has adequate capability to stock up gathering data. The MS motions at a fixed speed in the network. Initially, several ANs are determined where the MS will stop during its journey to gathering data. The advanced node is used to preserve the energy and reduce the multi-hop communication of data from the sensor to the MS. Here, the MS gathers data from the static sensors based on the buffer overflow time of the sensors. The number of MS goes around the network to collect data from the static sensor nodes. The aim is to minimize the number of stop points, while ensuring that all the sensors are covered.

In this scheme, the MS moves around at a fixed speed in a network scenario. The MS is moving on a circle and it stops some place during its journey to gathering data. This place is called Received Point (RP). This point calculation is given below.

$$RP = \frac{2\Pi r}{2} * \sqrt{3} \qquad (1)$$

Where,

$r \rightarrow$ Radius

During data collection, the MS stop at the RP and it broadcast the message to the whole network. This message is called test message, it contains Received Point, Hop Count, sequence number. The time-period among one RP to another RP is name as mov. The sensor nodes get the test message from MS, and then it collects the hop count information and updates the routing table. This table consists of neighbor node, CH, advanced node ID and hop count. The sensor node decides the minimum hop count route is selected to transmit the data to MS in a network. The sensor node wants to communicate the data to MS, it first sends the data to its CH then the CH checks near MS.

If it present, the CH directly sends the data to MS otherwise, it sends the data to MS via advanced node. The AN helps to avoid the multi hop CH data transmission in the network. Thus, it reduces the CH energy consumption in the network.

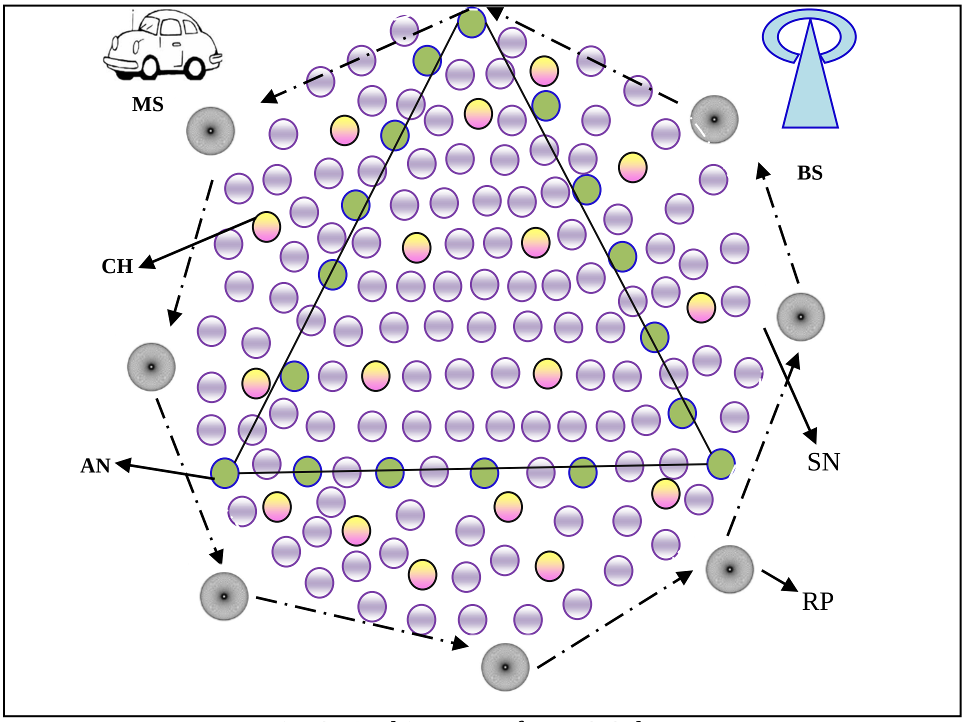

Fig. 2. Architecture of EEPS Scheme

4. Performance Evaluation

The simulation analysis is obtained using the Network Simulator (ns-2). Since WSNs are configured both as static sensor node and advanced node, IEEE 802.15.4 network scenario is considered.

Table.1 Simulation Parameters of EEPS Scheme

Parameter	Value
Channel Type	Wireless Channel
Simulation Time	50s
Number of Nodes	50
MAC type	802.15.4
Traffic model	Constant Bit Rate
Simulation Area	1000x1000
Network interface Type	WirelessPhy
Transmission Range	250

The NS2 is an open source programming language written in C++ and OTCL (Object Oriented Tool Command Language). NS2 is a discrete event time driven simulator, which is used to mainly model the network protocols. The parameters used for the simulation of the EEPS scheme are tabulated in table 1.

The simulation of the proposed scheme has 50 nodes deployed in the simulation area 1000×1000. The nodes communicate with each other by using the communication protocol User Datagram Protocol (UDP). The traffic is handled using the traffic model CBR. The radio waves are propagated by using the propagation model two-ray ground. All the nodes receive the signal from all direction by using the Omni directional antenna. The performance of the proposed scheme is evaluated by the parameters packet average delay and throughput and residual Energy.

4.1 Packet Delivery Rate

The Packet Delivery Rate is the ratio of number of packets delivered to all receivers to the number of data packets sent by the source node. The packet delivery rate of the existing method MDCT and the proposed EEPS method are plotted in figure 3.

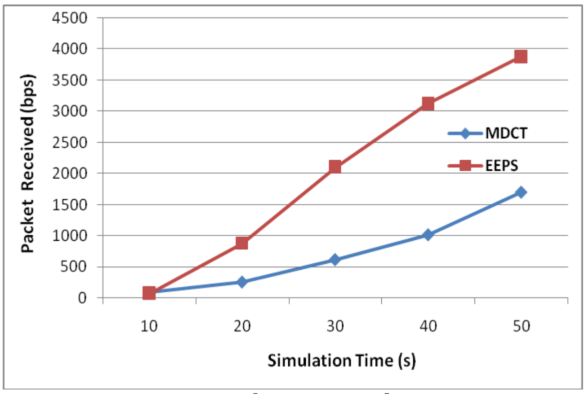

Fig. 3. Packet Received Rate

The packet delivery rate is calculated by Equation 2.

$$PDR = \sum_{0}^{n} \frac{Pkt\ Recvd}{Pkts\ Send} \qquad (2)$$

Observations from figure 3 represents that the EEPS method reaches better packet delivery rate than the existing method MDCT.

4.2 Packet Dropped Rate

The Packet Loss Rate (PLR) is the ratio of the number of packets dropped to the number of data packets sent. The packet loss rate is calculated by Equation.3.

$$PLR = \sum_{0}^{n} \frac{Pkt\ Dropped}{Pkts\ Send} \qquad (3)$$

Figure 4 shows the PLR plot of the two protocols named MDCT and EEPS. The packet loss rate of the proposed scheme EEPS is lower than the existing scheme MDCT.

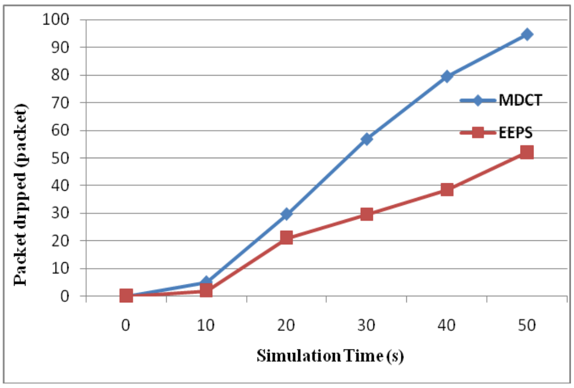

Fig. 4. Packet Dropped Rate

4.3 Delay

The average delay is defined as the time difference between the current packets received and the previous packet received. It is measured by the equation 4.

$$Average\ Delay = \frac{\sum_{0}^{n} Pkt\ Recvd\ Time - Pkt\ Sent\ Time}{n} \qquad (4)$$

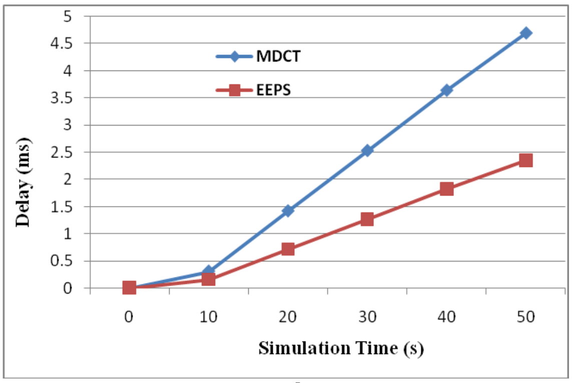

Fig. 5. Delay Rate

Figure 5 shows that the average delay value is low for the proposed scheme EEPS than the existing scheme MDCT. The minimum value of delay means that higher value of the throughput of the network.

4.5 Throughput

Throughput is the average of successful messages delivered to the destination. The average throughput is estimated using equation 5. Where, n represent the number of nodes in the network.

$$Throughput = \frac{\sum_{0}^{n} Pkts\ Received\ (n) * Pkt\ Size}{1000} \qquad (5)$$

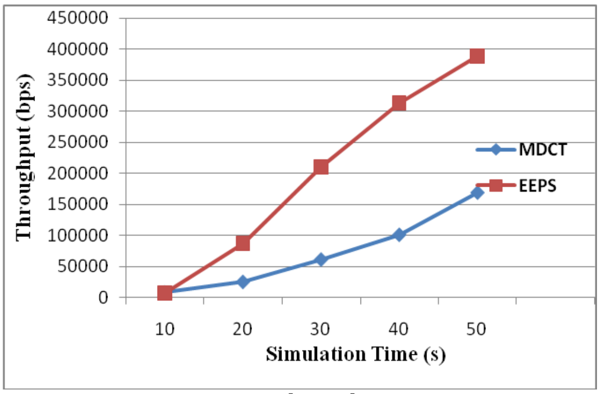

Fig. 6. Throughput

Figure 6 shows that proposed scheme EEPS has greater average throughput when compared to the existing scheme MDCT.

6. Conclusion

In this paper, An Energy Efficient Path Strategy for diminishing the delay in WSN is proposed. This main aim is to reduce the data communication path thus diminish the data collecting time in the network. This scheme focuses on how to shorten the length of traveling path to reduce the delay time of data gathering. This efficient data collection problem is concerned to improve the performance of the network. The EEPS algorithm presents better results compared to the sink trail protocol in the traditional methods. Simulation scenarios prove the efficiency of the proposed EEPS algorithm.

References

1. Xu, J., Guo, J., Long, J., Zhou, X.: *Mobile sink-based data gathering protocol*. IEEE International Forum on Information Technology and Applications (IFITA), Vol. 2, 2010, pp. 427-430.
2. Mehrabi, A., Kim, K.: *Maximizing data collection throughput on a path in energy harvesting sensor networks using a mobile sink*. IEEE Transactions on Mobile Computing, VOL.*15, No.* 3, 2016. PP.690-704.
3. Cheng, C. F., Yu, C. F.: *Data Gathering in Wireless Sensor Networks*: A Combine–TSP–Reduce Approach. IEEE Transactions on Vehicular Technology, Vol.*65, No.*4,2016, PP.2309-2324.
4. Jing, W. P., Liu, Y. Q.,Wu, Q.: *A Fault-Tolerant Router Algorithm Based on Hamiltonian Cycle in Wireless Sensor Network*. In Applied Mechanics and Materials, Trans Tech Publications. Vol. 44, 2011, pp. 1641-1645.
5. Pushpavalli, S., Gandhi, K. I.: *Stochastic analysis of data collection using mobile sink with fixed and variable trajectories*. IEEE Fourth International Conference on Computing, Communications and Networking Technologies,2013, pp. 1-5.
6. Sudarshan, S. K., Becker, A. T.: *Using gradient descent to optimize paths for sustaining wireless sensor networks*. IEEE Texas Symposium on Wireless and Microwave Circuits and Systems,2015,pp. 1-6.
7. Sharma, U., Krishna, C. R., Sharma, T. P.: *An Efficient Mobile Data Collector Based Data Aggregation Scheme for Wireless Sensor Networks*. IEEE International Conference on Computational Intelligence & Communication Technology, 2015, pp. 292-298.
8. Goyal, N., Singh, P.: Performance Analysis of Travelling Salesman Problem in Ant Colony Optimization in Wireless Sensor Networks, Vol. 3, no. 7, 2014.
9. Oliveira, T., Aguiar, A. P., Encarnação, P.: *A convoy protection strategy using the moving path following method*. IEEE International Conference on Unmanned Aircraft Systems (ICUAS), 2016, pp. 521-530.
10. Yan, Y., & Mostofi, Y.: *Efficient Clustering and Path Planning Strategies for Robotic Data Collection Using Space-Filling Curves*. IEEE Transactions on Control of Network Systems, 2016.
11. Yan, Y., Mostofi, Y.: An efficient clustering and path planning strategy for data collection in sensor networks based on space-filling curves. IEEE 53rd Annual Conference on Decision and Control (CDC), 2014,pp. 6895-6901.
12. Salarian, H., Chin, K. W., Naghdy, F.: *An energy-efficient mobile-sink path selection strategy for wireless sensor networks*. IEEE Transactions on Vehicular Technology, Vol.*63, No.*5, 2014, pp.2407-2419.
13. Biason, A., Zorzi, M.: *Transmission policies for an energy harvesting device with a data queue.* IEEE International Conference on Computing, Networking and Communications, 2015,pp. 189-195.
14. Long, J. U. N., Dong, M., Ota, K., Liu, A., Hai, S.: *Reliability guaranteed efficient data gathering in wireless sensor networks.* IEEE Access, Vol.*3*, pp.430-444.
15. Shaji, M., Ajith, S.: *Distributed energy efficient heterogeneous clustering in wireless sensor network.* IEEE 2015 Fifth International Conference on Advances in Computing and Communications,2015,pp. 130-134.
16. Khan, N. A., Saghar, K., Ahmad, R., Kiani, A. K.: *RAEED-EA: A formally analysed energy efficient WSN routing protocol*. IEEE13th International Bhurban Conference on Applied Sciences and Technology, pp. 346-349.
17. Zhu, C., Wu, S., Han, G., Shu, L., Wu, H.: *A tree-cluster-based data-gathering algorithm for industrial WSNs with a mobile sink.* IEEE Access, *3*, 2015, pp.381-396.
18. Zhou, Z., Du, C., Shu, L., Hancke, G., Niu, J., Ning, H.: *An energy-balanced heuristic for mobile sink scheduling in hybrid WSNs.* IEEE Transactions on Industrial Informatics, Vol.12,No.1, 2016, pp.28-40.
19. Vinutha, C. B., Nalini, N.: *Energy aware optimal clustering and reliable routing based on Markov model in Wireless Sensor Networks*. IEEE International Conference on Wireless Communications, Signal Processing and Networking, 2016, pp. 420-425.