Section: Research Paper
ISSN 2063-5346

NETWORK RECONFIGURATION SYSTEM UNDER DISASTER MANAGEMENT IN WIRELESS SENSOR NETWORKS

Kirti
Research scholar, Kalinga University, Raipur
Email id. : kirtinandal3@gmail.com

ABSTRACT
Designing a dynamic routing protocol that can handle network applications and becomes useful under different network conditions is a challenging problem. This work provides a technique for reconfiguration of network nodes in WSN with the help of controller system. All scenarios of the dynamic reconfiguration infrastructure have been evaluated. In this work, all nodes are communicating with each other. Each node is mobile in nature and controlled by a controller used. After some time, controller changes its topology and updates its location to a new location. While updating the nodes location, some nodes lost its energy and become faulty nodes. During reconfigure time, each faulty node is replaced by a new one so that network may work better. But in this, some localization error is present but its value is less than 3 m which is very efficient. The controller controls the movement of nodes and provides new area under suitable conditions. The time required for a particular network to reconfigure its components is around 15 to 20 seconds, which is very less when compared to the cost of restarting the application with the correct components. All scenarios of the dynamic reconfiguration have been evaluated by use of MATLAB software.
Keywords-Wireless Sensor Network, Routing Protocol, Reconfiguration system, Localization Error etc.

1. INTRODU CTION

Due to technological advancement, the fabrication of inexpensive sensors is now economically viable. By using sensing electronics, the environment around the sensors is measured and then converted into an electrical signal. As a result, following signal processing, certain substance attributes are provided, and further processes take place. A network needs a lot of sensors to accomplish many different processes and applications. Because of their applications in numerous disciplines, wireless networks are of great interest to research communities. A WSN network includes 100 to 1000 sensing nodes, which is a significant amount. Other applications include habitat monitoring, traffic monitoring, military reconnaissance, etc. The major applications in the military use for "tracking of adversary, battlefield observation, and classification of target" [1].

Because to their extremely low production costs, WSN nodes can be deployed in large numbers, which presents certain management issues for the network. Providing a route to the network, topology control, and protocol management are the primary duties. Energy restrictions complicate these issues, and the unreliability of WSN communication calls for action to increase network efficiency. This thesis offers network design for mobility-based networks and focuses on the use of location error control to raise the overall effectiveness of the WSN.

Modern sensors may now be fitted with small but powerful CPUs and wireless transceivers with reasonable ranges thanks to a new technology called micro electro-mechanical systems technology. This new sensor network technology uses several sensors dispersed across a vast region to monitor the atmosphere by taking measurements of important physical factors like temperature, sound, etc. A wireless sensor network is a collection of specialised sensors with communication capabilities for observing and documenting environmental variables in various places. A WSN is a network made up of a lot of tiny nodes that is used to gather local data and assess the physical environment globally. A wireless sensor network is created by the cooperation and synergy of sensing, processing, communication, and actuation [1]. A WSN typically has a weak or non-existent infrastructure. There are only sensing nodes in it. Figure 1 shows the general structure of WSN in which all sensor fields are connected with sink.

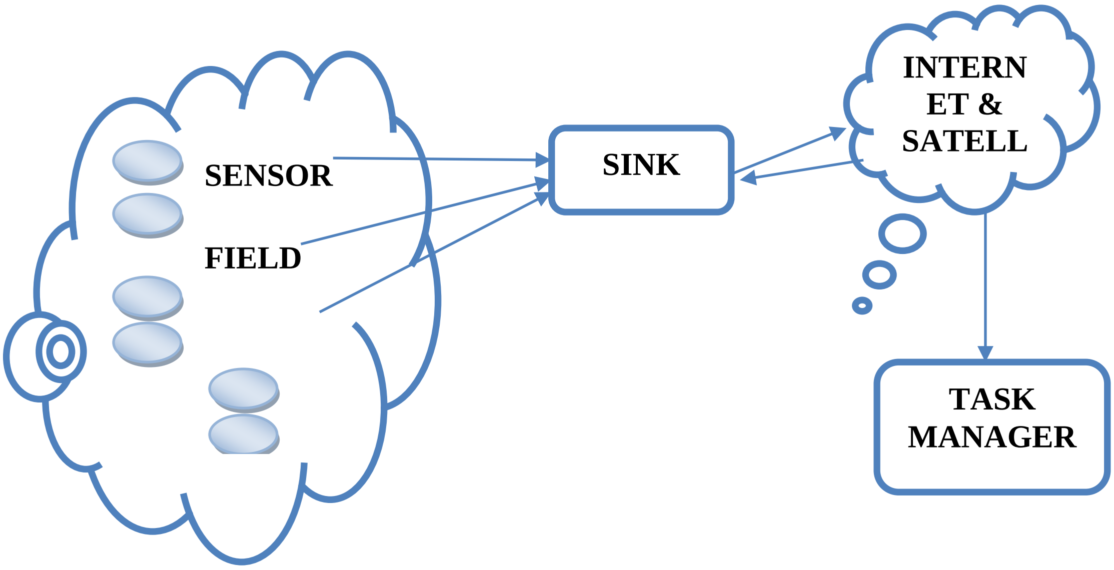

Figure 1: General model of a WSN [1]

2. FACTORS INFLUENCING SENSOR NETWORK DESIGN

A sensor network design is influenced by many factors:

1. **Fault Tolerance:** Due to physical or environmental interference, sensor nodes may become barren, die, or suffer damage. This scenario shouldn't jeopardize the network's overall presentation. We refer to this as fault tolerance. The capacity to maintain sensor network functionality in the face of sensor node failures is known as fault tolerance [2].
2. **Scalability:** When sensor nodes are first deployed, their numbers might range from a hundred to a thousand. The network may be enlarged, going from thousand to million nodes, depending on the application. Thus, the network ought to be able to handle the extra nodes. Scalability is the phrase used to describe all of these problems.
3. **Production costs:** Cost of a single node is important because a network is made up of numerous sensor nodes. Using a costly node will raise the network's overall cost. Thus, a low-cost node should be utilized to limit the network's production costs.

Section: Research Paper
ISSN 2063-5346

4. **Hardware Constraints:** The power supply, communication, computing unit, and sensors are the four fundamental components of a sensor node. Also, depending on the application, they could have extra parts like a locator, a power source, and a mobilizer. These all fit into a compact size module. Also, the node's overall energy consumption should be low, and it should be able to function autonomously and unattended.
5. **Transmission Media:** A wireless medium connects the communication nodes in a many hoping sensor network. These connections can be made using optical, radio, or infrared media. The chosen transmission medium must be reachable in order for these networks to function globally. The usage of scientific, industrial, and medical bands for radio links suggests license-free transmission in most nations [3].
6. **Power Consumption:** A microelectronic sensor node is a powered by a finite amount of energy. Because battery recharge is not always available in some applications, sensor node lifespan is dependent on battery lifetime. Each node acts as both a data router and a data inventor in a multi-hop sensing network. The network may need to be reorganised and packets may need to be rerouted as a result of some nodes being dysfunctional. Hence, power control and energy conservation become even more crucial. A sensor node's primary goals are to detect events, process the data, and then broadcast the results. Hence, the three areas of sensing, communication, and data processing can be split into.

3. RECONFIGURATION MIDDLEWARE FOR WSN

Prior research for WSN middleware has centred on a variety of objectives, from providing a comprehensive and general data collecting platform to streamlining localised data transfer across nodes. There are numerous techniques to do reconfiguration. Monitoring the WSN's quality of service at the base station and, when necessary, reprogramming the sensor nodes is one method. One alternative is to do reconfiguration on each node separately while locally monitoring the situation.

Centralized Reconfiguration

Some writers build a global model using data from running sensor nodes to determine whether a WSN needs to be reconfigured. Afterwards, in order to find a suitable new configuration, a design space search is carried out. This configuration is then transmitted to the sensor nodes. Unfortunately, this necessitates updating the entire code image after deployment because the tool chain of the leading WSN operating system, Tiny OS, converts software components to a static image. This consumes a lot of bandwidth and power. A mechanism for building virtual computers for sensor nodes that run brief script-like programmes is provided by some [2]. These scripts can be delivered to a node and run-time loaded and unloaded. The drawback of this method is that programmes must be written as a list of general procedures with minimal room for specific functionality, even though it is more effective than reprogramming.

Distributed Reconfiguration

Impala is a system that allows nodes to reconfigure themselves decentralized. An application adapter and update component are present in every node. They react to certain network events and routinely verify the system and application parameters. A finite state machine models the various software components. The application is transferred to another state if certain prerequisites are met. Granularity is a drawback of this method because even little changes require a full state, and applications can only have a certain number of states. The authors have not yet been able to perform reconfiguration on a platform for sensor nodes, and their rationale is given minimal consideration.

Dynamic Reconfiguration In WSN

Dynamic reconfiguration methods have recently drawn more and more interest from the scientific community. By enabling hardware reconfiguration of the sensor network at runtime to accommodate environmental dynamics, these strategies offer a novel method for creating an energy-efficient WSN in a highly dynamic environment. On the sensor node level, a number of reconfiguration strategies have been developed as a result of hardware technological advancements. They include adaptive sampling rate (used to adjust the sampling rate of sensors), dynamic voltage scaling (DVS), dynamic modulation scaling (DMS) (used to modify communication modulation schemes), and intelligent node activation (used to modify processor voltages and operating frequencies) (used to change sensor node status). These dynamic reconfiguration approaches produce energy efficiency that can be divided into two categories. The DVS, DMS, and adaptive sampling rate are utilized to reduce the energy consumption of sensor nodes during node-level reconfiguration. Intelligent node activation identifies node activity during network-level reconfiguration to reduce redundant energy use. Using any reconfiguration technique requires taking into account dynamic elements including shifting user needs, varying communication channel quality, shifting application, adding additional nodes, and node failure. This makes implementing dynamic reconfiguration in WSNs more difficult.

Node Level Reconfiguration

By dynamically altering the hardware platforms of sensor nodes, dynamic reconfiguration at the node level aimed to reduce energy consumption. We focused on the DVS and DMS hardware reconfiguration techniques since they have been utilised separately to reduce energy usage in computing and communication systems. To fully use the energy-aware potential of sensor nodes, a dynamic time allocation was created that took both DVS and DMS into account at the same time. The two energy-aware strategies are initially discussed in the following sub-sections, after which the dynamic time allocation is examined in a single-node situation and expanded to a multi-node scenario [4].

4. LITERATURE REVIEW

The performance of the geographic routing algorithm in duty cycled WSN was presented by **Wang, K. et al. in [2010] [5].** They offered a multi-routing metric system for this algorithm. It includes the geographical distance and the period of time known as the sleeping delay. This involved the forwarding node waiting to send packets to its neighbors after waking up. They understood that in random duty cycled WSN, routing should take into account not only node distance but also node sleep latency. In duty-cycled wireless sensor networks, routing performance was given by **Zhu, C. et al. in 2011 [6].** They concentrated on enhancing greedy forwarding's functionality while sleep scheduling was in effect. In comparison to existing linked sleep algorithms, they showed through simulations and results that they could shorten the length of the transmission line for greedy forwarding. **T. Condeixa et al. [2012] [7]** proposed and assessed various methods for allocating mobility management features. Start the decoupling of mobility from the most popular split into data and control planes and the division of mobility management's control plane into location and handover management. Comparing the distributed approaches to the most widely used fully centralized approaches, evaluate the distributed approaches based on the proposed decoupling. Dynamically reconfigurable buses were proposed by **Wankar, R., et al. [2012] [8].** The design became well-known for its use of general-purpose processors and high performance computing. It is an effective computational model in which the communication patterns between the processors can be altered while the computation is being carried out.

The localization problem was identified as a concern with wireless sensor network technology by **S. Afzal et al. [2012] [9].** The process of calculating and approximating the positions of sensor nodes is known as the localization issue. Without location information, the data gathered by the network is generally useless. The networking and application domains of a wireless sensor network both heavily rely on location information. The localization techniques and new taxonomy based on important traits are proposed in this study. Also, it introduces key elements to confirm the effectiveness of localization approaches. When designing these networks, the factors that must be taken into account include the coverage area, mobility, power consumption, communication capabilities, etc. Sharma, **S. et al. [2013] [10]** had presented wireless sensor networks, which are an interconnection of many nodes deployed for monitoring the system through measurement of its parameters. This study provided a survey on architecture design difficulties and protocol classification. A framework for adapting the WSN's power consumption, transmission reliability, and data throughput to various application needs was developed by **M. Szczodrak et al. in 2013.** The framework enables the specification of unique network, MAC, and radio protocols for each application at design time in addition to the events and policies driving WSN reconfigurations. The WSN automatically modifies itself at runtime in response to these occurrences and in accordance with these policies. The method suggested by the author can reconfigure the entire network in a matter of milliseconds with minimal memory and control cost. A mobility management method based on the session-to-mobility ratio (SMR) was presented by **Majumder, A. et al. in 2013 [12].**

The plan makes it possible for the MC to send location update messages to the gateway and lowers the cost of mobility management by using forward chain, tunneling, and a threshold SMR value. On cost per handoff, cost per packet delivery, and overall communication cost per time unit, the impact of threshold SMR selection has been studied. Using wireless connectivity, **Battula, R. et al. [2013] [13]** demonstrated a system of mobile nodes that can self-organize into a network. The flat routing techniques are adequate since the network topology changes frequently. Either geographic or hierarchical routing systems are needed in bigger networks. Geographical routing creates an effective route search towards the destination using location data. Several of the most significant geographic routing protocols for WSNs are discussed in this article. Wireless Sensor Networks are being used to build and implement applications in a variety of scenarios, from intelligent homes to environment monitoring, according to **Marco, A. et al. [2013] [14].** The work of creating WSN applications that adapt at run-time to changes in the context, in the resources available, as well as in the user requirements should be made easier by new programming paradigms. In order to aid in the creation of WSN applications, this article will describe PROTEUS, a platform for managing adaption and reconfiguration. Show how PROTEUS may be used to develop dynamic clustering algorithms, where clusters are built and destroyed at runtime and nodes must adjust and reconfigure as necessary, after introducing PROTEUS. DRRP, a routing algorithm having the capability of dynamic reconfiguration, was proposed by **Gaoy, S. et al. [2014] [15].** By giving users the ability to create various virtual potential fields, DRRP is able to satisfy the requirements of various applications and network setups. Set a parameter that can be altered dynamically to affect the virtual hybrid potential field in order to improve the performance of our routing protocol. The routing protocol can be continuously

Section: Research Paper
ISSN 2063-5346

optimised by adjusting the parameter in accordance with the circumstances. The antenna radiation pattern and node orientations are included in the enhanced Received Signal Strength Indicator (RSSI) distance estimation model proposed by **Mwila, et al. [2014] [16].**

5. RESEARCH METHODLOGY

WSN field is growing in research now days. Literature provides various definitions of WSN Network in terms of reliability and fault tolerance. There are many protocols developed for routing in network and addresses various issues related to communication. From the literature survey, a dynamic routing algorithm is proposed that provided the feature of dynamic reconfiguration in system. It provided the goal to meet different network requirements. It was done by use of potential fields. It performed a dynamic reconfiguration to network by setting a parameter and changed it dynamically. Currently, it is very complicated to modify a routing service in a large scale sensor network because the service is statically pre-configured into each node, which is often unattended. So, it proposes a mobility based network reconfiguration system in WSN which can be dynamically reconfigured.

In this, these nodes do not require high data rates for transmission. They have long lifetime and generally low data rates. In network mode, these nodes are dispersed over an environment. These are placed randomly in area provided and also the distance between them is also minimum so that performance of network will be useful. After placement of nodes, it requires to determine the topology of network i.e. tree or star based etc. Then provide optimum routing technique based on shortest path so that delay will be minimized. In this routing, data is routed through various nodes so that data may reach to destination. In environmental collection of data, it does not require the development of optimal routing by own but it requires the routing strategy outside network and communication is also necessary. This is probable by creating the physical topology of the net is comparatively continual.

After the deployment of the sensor nodes, there is a Head node selection by polling method. Then head check the status of each node and collects the environmental data from sensor nodes. For this, there is a direct communication between head & nodes. Head asks the nodes about environment conditions, then reply back to head about status. Now if temperature goes above threshold due to any disaster effect, the nodes sense data and tells to the head and starts moving from their locations. Then they collect to any other location and when the disaster under control then head orders the nodes to repositioning or reconfigure their locations within minimum time. The steps are described in detail below:

1. Placement of Nodes

In above figure, the first step describes the sensors are being deployed in a disaster area. Sensors are randomly spread over the area. Here we take large number of sensors with number associated with it so that proposed scheme will evaluate easily. No two nodes overlap each other.

2. Discover a Topology

In typical usage scenario, the nodes will be evenly distributed over an outdoor environment. This distance between adjacent nodes will be minimal yet the distance across the entire network will be significant. They create a random topology initially.

3. Provide Random Mobility

Then provide random mobility in nodes to show that all nodes are dynamic in nature. All nodes move here & there depends upon their speed. We can change the speed of nodes manually.

4. Environmental Data Collection

All nodes are communicating with each other on the basis of shortest path calculated. Then head check the status of each node and collects the environmental data from sensor nodes. All nodes collect data like temperature or any disaster affect from environment.

5. Communication between BS & Nodes

For this, there is a direct communication between head & nodes. Head asks the nodes about environment conditions, and then nodes reply back to head about status. For this, there is no loss of data because there is direct transfer of packets from head & all nodes.

6. Disaster Management

Now if temperature goes above threshold or any other attack occurs due to any disaster effect, the nodes sense data and tells to the head and starts moving from their locations. Then they collect to any other location with the help of controller used and when the disaster under control then head orders the nodes to repositioning or reconfigure their locations within minimum time. This reconfiguration is done by reconfigurable protocol used. The nodes are moving to same locations after control of disaster. The controller controls the movement of nodes in network and provides the new location for safety.

After getting the actual distance, we should calculate estimated distance calling d_{ij} between two anchor nodes; the main calculation process is shown in the following equation:

$$d_{ij}= H_{ij} * h_{ij} \qquad \text{(i)}$$

Where, $H1_{ij}$ is estimated distance of average hop, h_{ij} is the hop between two anchor nodes. It is able to get the general error of distance calling E_{ij} between the anchor nodes i and the anchor node j, we get the equation (3.3) which is shown in the following equation from the above formula (3.1) and (3.2).

$$E_{ij} = \sum_{i \neq j}(D_{ij} - d_{ij}) \qquad \text{(ii)}$$

Thus we get an error between the actual distance and the estimated distance, so we can use the value of this error to calculate the error of average jump distance.

6. RESULTS & DISCUSSION

It shows the placement of 150 nodes in an area of 250*250 m^2. A large number of sensors are taken so that proposed scheme will evaluate easily. No two nodes overlap each other. The nodes provide a topology initially which is random in nature. Reconfiguration means the process of transition of network nodes from one point to another transition in space. Fig 2 shows the data communication by nodes in which all are communicating in efficient way.

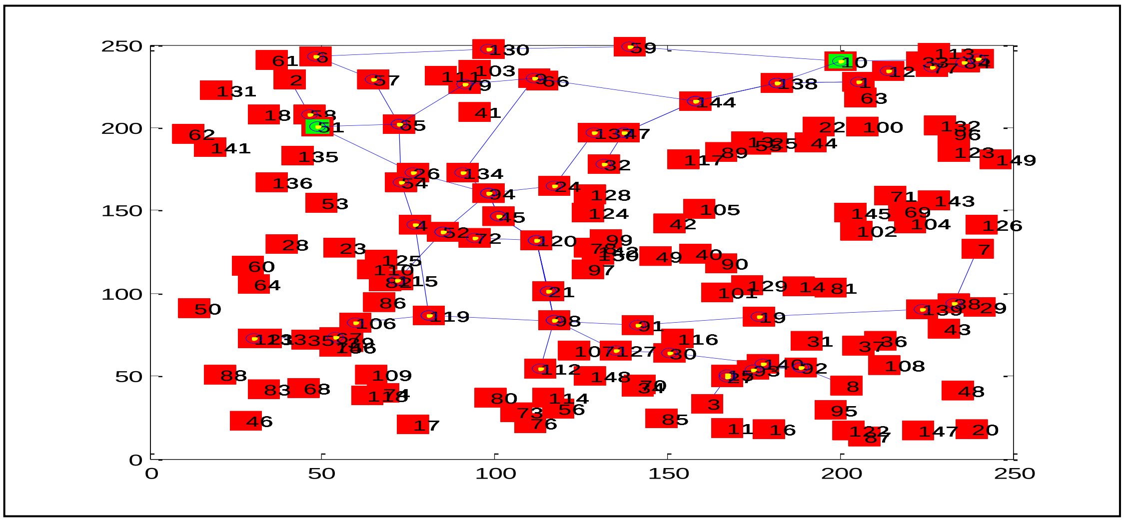

Figure 2: Data Communication by Nodes

After the deployment of the sensor nodes, there is a Head node selection by polling method. In this, a polling scheme is used in heterogeneous sensor networks for such applications to reduce power consumption. The purpose of polling is to avoid interference from multiple nodes transmitting to the cluster head simultaneously. All nodes are randomly placed and they are ready to perform the given task. In addition, they must permit the user to control when communication starts plus when the broadcast is switched on or off for reception.

It proposed a dynamic routing algorithm that provided the feature of dynamic reconfiguration in system. It provided the goal to meet different network requirements. In this process, a node management layer or controller provides as a trigger that can reconfigure heterogeneous nodes wirelessly. This trigger provided field-programmability in the system. In this, it affected only a few parameters of system. In this, it had a manageable processor that was used to handle traffic.

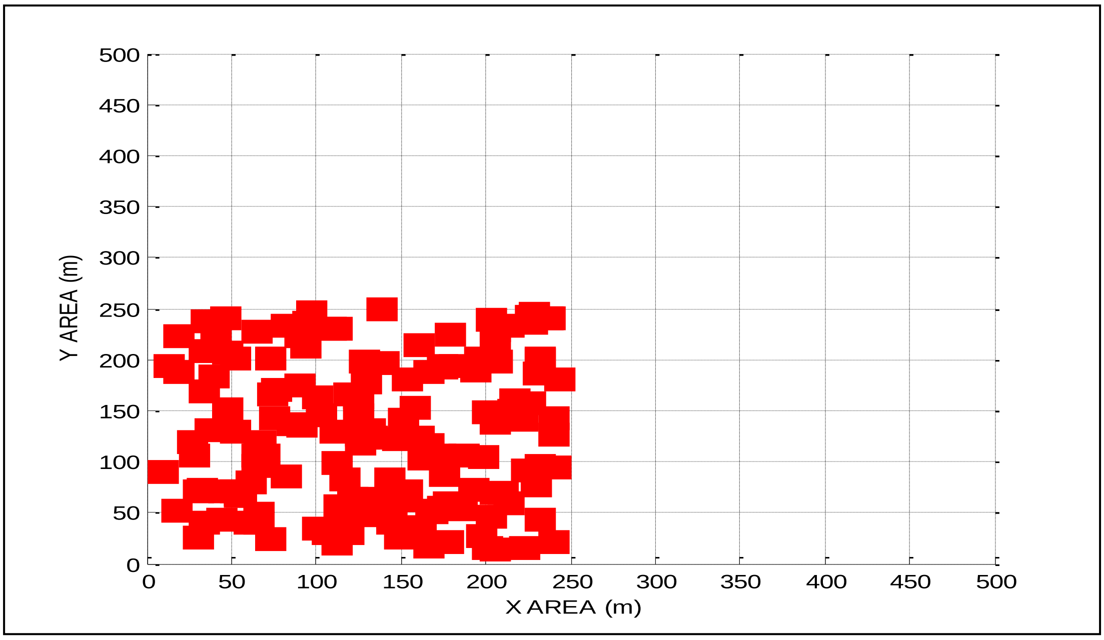

Figure 3: Initial Placement of All nodes

Fig 3 shows the initial placement of nodes and fig 4 shows the final placement after disaster management. When any incident happened, it changed their location and configure all nodes to new location successfully.

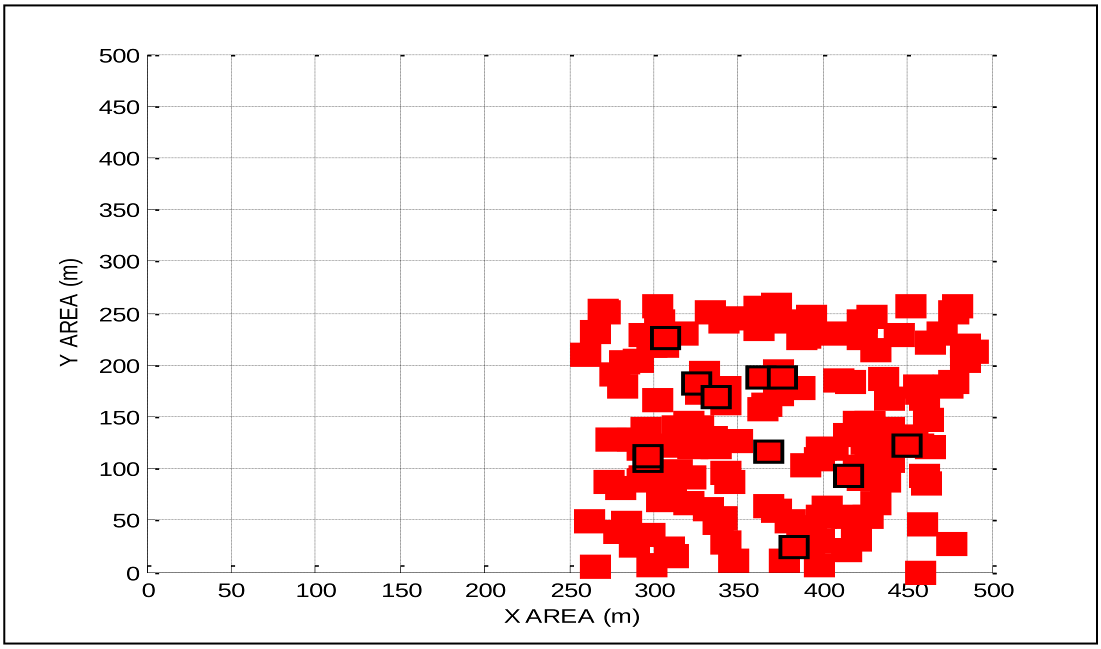

Figure 4: Nodes Placement After Reconfiguration

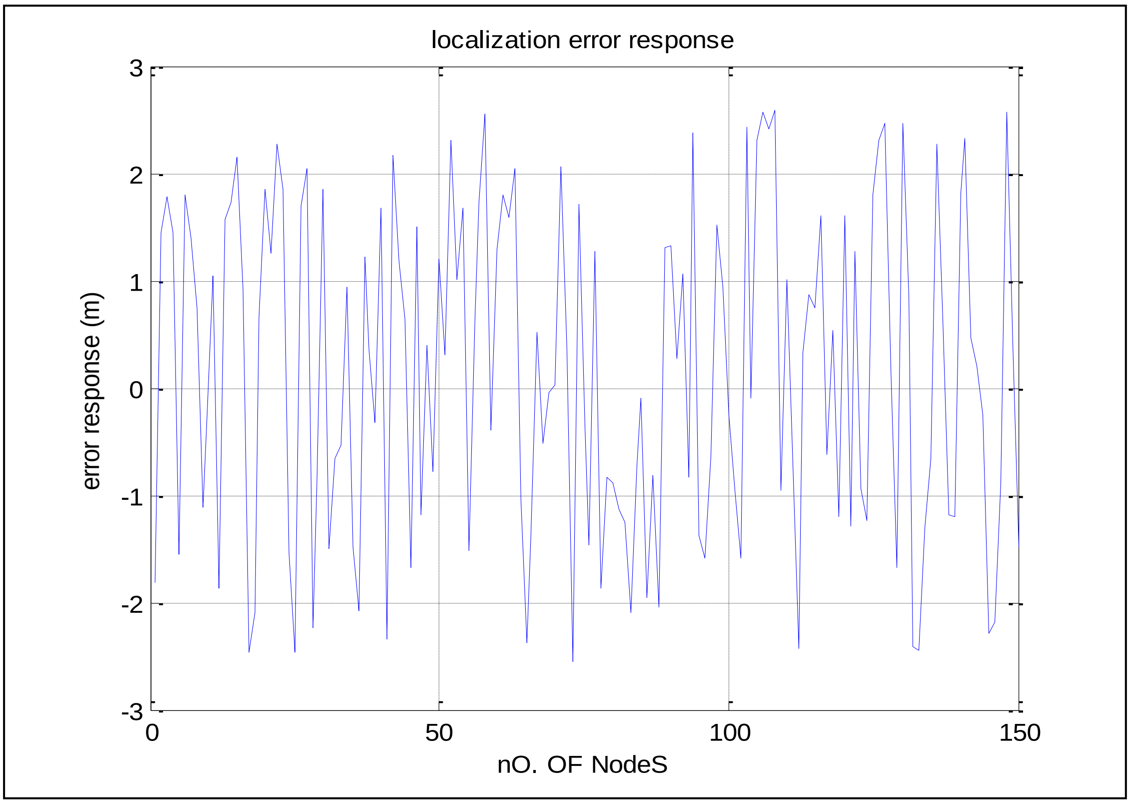

Figure 5: Localization Error when Nodes Move Right

Each node is mobile in nature and controlled by a controller used. After some time, controller changes its topology and updates its location to a new location. While updating the nodes location, some nodes lost its energy and become faulty nodes. During reconfigure time, each faulty node is replaced by a new one so that network may work better. It is hard to find out or checking the operating conditions of sensor network. During hardware reconfigure system, it requires the proper hardware requirement with suitable environment so that it works better. Due to this, there is a need of software reconfigure system for sensing network. Fig 5 shows the location error when all nodes move to new location and return back after reconfiguration. This shows that location error is low if network gets reconfigured successfully.

CONCLUSION

This work provides a technique for reconfiguration of network nodes in WSN with the help of controller system. All scenarios of the dynamic reconfiguration infrastructure have been evaluated. In this work, all nodes are communicating with each other. A head is provided for giving the instructions to all nodes. In this, it takes the scenario of disaster in forests. Before disaster occurred, all nodes changed their location for security. As disaster under control, there may get back to their locations. Each node is mobile in nature and controlled by a controller used. After some time, controller changes its topology and updates its location to a new location. During reconfigure time, each faulty node is replaced by a new one so that network may work better. But in this, some localization error is present but its value is less than 3 m which is very efficient. The controller controls the movement of nodes and provides new area under suitable conditions. The time required for a particular network to reconfigure its components is around 15 to 20 seconds, which is very less when compared to the cost of restarting the application with the correct components. All scenarios of the dynamic reconfiguration have been evaluated by use of MATLAB software.
In Future, Dynamic Routing protocol need to be evaluated with specific performance parameter with respect to application demands.

REFERENCES

[1] S. Davis. Basics of Design: Battery Power Management. Supplement to Electronic Design.2004

[2] T. S. Rappaport, Wireless Communications: Principles and Practice, 2nd ed. Singapore: Pearson Education, Inc., 2002.

[3] Fabian Nack, “An Overview on Wireless Sensor Networks”, Institute of Computer Science (ICS), Freie University Berlin, pp. 1-8, 2009.

[4] Haibo Zhang and Hong Shen, “Energy-Efficient Beaconless Geographic Routing in Wireless Sensor Networks, IEEE Transactions On Parallel And Distributed Systems, Vol 21, Issue 6, pp.881-897,2010.

[5] Kun Wang, Lei Wang, Can Ma, Lei Shuy, Joel Rodriguesz, “Geographic Routing in Random Duty-cycled Wireless Multimedia Sensor Networks,” IEEE Globecom Workshop on Advanced Sensor Integration Technology, pp.230-234, 2010.

[6] Chunsheng Zhu, Laurence T. Yang_, Lei Shu, Joel J. P. C. Rodrigues, Takahiro Hara, “Sleep Scheduling Towards Geographic Routing in Duty-Cycled Sensor Networks,” IEEE Transactions On Industrial Electronics, pp.1-3, 2011.

[7] Tiago Condeixa, Susana Sargento, Andr´ea Nascimento, Rute Sofia, “Decoupling and Distribution of Mobility Management”, IEEE International Workshop on Mobility Management in the Networks of the Future World, pp. 1073-1078, 2012.

[8] Rajeev Wankar, Rajendra Akerkar, “Reconfigurable Architectures and Algorithms: A Research survey”, International Journal of Computer Science and Applications, Techno-mathematics Research Foundation, pp. 108-123, Vol. 6, No. 1, 2012**.**

[9] Samira Afzal, “A Review of Localization Techniques for Wireless Sensor Networks”, Journal of Basic and Applied Scientific Research, pp. 7795-7801, 2012.

[10] Swati Sharma and Dr. Pradeep Mittal, “Wireless Sensor Networks: Architecture, Protocols”, International Journal of Advanced Research in Computer Science and Software Engineering, pp. 304-308, Volume 3, Issue 1, January 2013.

[11] Marcin Szczodrak, Omprakash Gnawali, Luca P. Carloni, “Dynamic Reconfiguration of Wireless Sensor Networks to Support Heterogeneous Applications”, IEEE, pp. 52-61, 2013.

[12] Abhishek Majumder, Sudipta Roy, “Kishore Kumar Dhar, "Design and Analysis of an Adaptive Mobility Management Scheme for Handling Internet Traffic in Wireless Mesh Network”, International Conference on Microelectronics, Communication and Renewable Energy, 2013.

[13] Rama Sundari Battula, and O. S. Khanna, “Geographic Routing Protocols for Wireless Sensor Networks: A Review” International Journal of Engineering and Innovative Technology, pp. 39-42, Vol 2, Issue 12, 2013.

[14] A. Di Marco, F. Gallo, O. Gemikonakli, L. Mostarda, F. Raimondi, “Implementing Adaptation and Reconfiguration Strategies in Heterogeneous WSN”, IEEE International Conference on Advanced Information Networking and Applications, pp. 477-483, 2013.

[15] Shan Gaoy,Yong Piaoz, “ DRRP: A Dynamically Reconfigurable Routing Protocol for WSN”, IEEE, pp. 460-465, 2014.

[16] Martin K. Mwila, Karim Djouani, “An Efficient Approach to Node Localisation and Tracking in Wireless Sensor Networks”, IEEE Ad Hoc andSensor Networking Symposium, pp. 492-497, 2014.

[17] Yunan Gu, Miao Pan and Wei Li, “Maximizing the Lifetime of Delay-Sensitive Sensor Networks via Joint Routing and Sleep Scheduling”, International Conference on Computing, Networking and Communications, pp.540-544, 2014.

[18] Rajeev Patel, Rajendra Akerkar, “Reconfigurable Architectures and Algorithms: A Research survey”, International Journal of Computer Science and Applications, Techno-mathematics Research Foundation, pp. 108-123, Vol. 6, No. 1, 2014**.**