International Journal of Engineering Research and Science & Technology

IJERST

ISSN : 2319-5991
Vol. 6, No. 2
May 2017

www.ijerst.com

Email: editorijerst@gmail.com or editor@ijerst.com

International Journal of Engineering Research and Science & Technology

ISSN 2319-5991 www.ijerst.com
Vol. 6, No. 2, May 2017

Research Paper

RSSI BASED ENERGY EFFICIENT NODE FAILURE AND COVERAGE SELF HEALING SYSTEM FOR WIRELESS SENSOR NETWORK

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A node is capable of gather information and communicating with each other. As sensor nodes are typically battery operated, it is important to efficiently use the limited energy of the nodes to extend the lifetime of the sensor networks. Hence it is normal inactive nodes miss their communication in the network, hence it splits the network. Due to hardware failure in the node, it have limited lifetime span. For avoidance of split of network self healing is necessary. In this paper the coverage problem is rigorously analyzed. In this case sensor need for other active nodes to compensate for these failed nodes. In order to extend the coverage area of the neighbour node if there is any node failure in the network, it is need to calculate the distance between these nodes by using Enhanced Virtual Force algorithm with boundary forces (EVFA-B). Border coverage is crucial for optimizing sensor placement for intrusion detection and a number of other useful applications. In proposed sensor deployment strategies are evaluated in terms of surveillance coverage, monitoring density, network self-healing competence, and moving energy consumption. The coverage extension in the network is implemented in real time by using LABVIEW software.

Keywords: Coverage problem, Enhanced virtual force algorithm with boundary forces EVFA-B, Self healing competence, Energy consumption

INTRODUCTION

Wireless Sensor Networks sometimes called wireless sensor and actuator networks. They are spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, pressure etc. and to cooperatively pass their data through the network to the main location. The more modern networks are bidirectional, also enabling control of sensor activity. The development of wireless sensor networks was motivated by military applications such as battlefields surveillance; today such networks are used in many industrial and consumer applications, such as industrial

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process monitoring and control, machine health monitoring and so on.

The WSN is built of nodes from a few to several hundreds or even thousands, where each node is connected to one or sometimes several sensors. Each such sensor network node has typically several parts: a radio transceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery or an embedded form of energy harvesting. A sensor node might vary in size from that of a shoebox down to the size of a grain of dust, although functioning motes of genuine microscopic dimensions have yet to be created. The cost of sensor nodes is similarly variable, ranging from a few to hundreds of dollars, depending on the complexity of the individual sensor nodes. Size and cost constraints on sensor nodes result in corresponding constraints on resources such as energy, memory, computational speed and communications bandwidth. The topology of the WSNs can vary from a simple star network to an advanced multi-hop wireless mesh network. The propagation technique between the hops of the network can be routing or flooding.

SENSOR NODE ARCHITECTURE

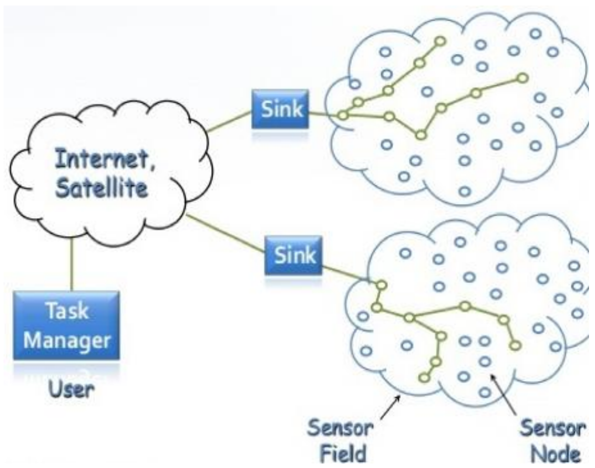
Sensor nodes have witnessed a progressive miniaturization over the past few years. However, different configurations are possible in which some of the components shown may be omitted, e.g., the Global Positioning System (GPS) may not be required on some nodes or multiple sensing elements like acoustic and seismic sensors can be used on a single node. The particular configuration usually depends on the application for which the sensor node is intended. An attempt to further reduce the physical size of sensor nodes led to the AMPS initiative carried out at Massachusetts Institute of Technology (MIT). More recently the development of the motes platform highlighted the opportunities for smaller nodes. Further size reduction may be expected.

WIRELESS SENSOR NETWORKS ARCHITECTURE

Wirelessly connected distributed sensor nodes form a unique class of networks known as Wireless Sensor Networks (WSN). Typical sensor network architecture is illustrated in Figure 1. The sensors are deployed in a field or in an environment where an event is to be detected. The user sends a query for data over a wireless medium. The choice of the distance between the base station or querying point and the network is based on many variables including accessibility and the transmitting range of the sensor network.

Since some applications of sensor networks may require a large number of nodes, the cost of each sensor node is a major determinant of the cost of the network. It is desirable to keep the

Figure 1: Wireless Sensor Network Architecture



cost of a sensor network to a minimum. The major cost component of a sensor network is the cost of manufacturing a sensor node. Recent advances in MEMS technology have resulted in the development of low-cost nodes compared with traditional systems. This will make the deployment of sensor networks feasible for most proposed applications.

Hundreds or thousands of sensor nodes may be densely deployed in a sensor field. Node densities can be as high as 20 nodes/m^3. Deployment may be carried by different means including dropping them from an airplane, through a catapult or by other suitable means. The potentially large numbers of these sensor nodes preclude a carefully planned deployment policy. In addition, since the nodes need to operate unattended, unfavorable conditions such as energy depletion, destruction of a node or malfunctioning of a node may affect the topology of the network. This requires the maintenance of network topology.

A sensor node typically consists of a sensing unit, a processing unit, a transceiver unit and a power unit. Optionally, a location finding system or a power generator may be included depending on the intended application. For many sensor network applications, a large number of sensor nodes need to be deployed for reasons discussed previously. The different hardware components affect the characteristics of the sensor node hence the sensor network. Thus, the hardware that constitutes the sensor node needs to be carefully selected. For example, it is usually impractical to replace the power unit once the sensor node is deployed. The transceiver unit is known to consume relatively high amount of energy compared with the other hardware components. Since some applications of sensor networks may require a large number of nodes, the cost of each sensor node is a major determinant of the cost of the network. The major cost component of a sensor network is the cost of manufacturing a sensor node. Recent advances in MEMS technology have resulted in the development of low-cost nodes compared with traditional systems. As an example, the Bluetooth radio system is manufactured for less than $10 while sensor nodes are expected to be less than $1.

RELATED WORK

In coverage sensor automation algorithm, the failure of the node is detected. Node failure in wireless sensor network composed by static sensor nodes is common due to the nature of the sensor devices and harsh environments in which they are deployed. Node failure can reduce the performance of the network as a whole, thus affecting its functionality in delivering the desired services. This method is used for node sensing and node failure. Crossing the limit of its coverage also considered to be node failure. Node failure in the network results in lost of information from that particular node. Hence the adjacent node can transmit the information by extending its coverage area up to the failure node. In order to extend the coverage area, it is to be need that the distance measurement between the failure node and the adjacent node. For this distance calculation Enhanced Virtual force algorithm is used. Node having the minimum distance can capable of extending its coverage. Once the node failure can be identified, it should be known to the server. It will command to the neighbour node having the minimum distance to compensate the failure node. Based on the received signal strength calculation the node having the minimum distance can capable of extending its coverage up to the failure node. The coverage problem is rigorously analyzed. Optimization to coverage algorithms which allow the coverage area to adaptively reconfigure and repair itself in order to improve the performance of the network. The Coverage Extension is done by using an algorithm called Sensor Self Organizing algorithm. The node that involves to perform the action, that current node only active at a time other to be sleeping mode using node scheduling scheme.

OVERVIEW OF THE NETWORK

The Wireless Sensor Network is build of "nodes"- from a few to several hundreds or even thousands, where each node is connected to one sensor. A node in a wireless sensor network that is capable of performing some process and gather sensor information and communicating with other connected nodes in the network. Coverage in wireless data communication to identify node failure. Dynamic route adjustment by increasing transmits power to cover the void area. Also it implements a high speed and energy efficient sensor deployment strategies in the wireless sensing areas. Node failures in Wireless Sensor Networks composed by static sensor nodes are common due to the nature of the sensor devices and the usually harsh environments in which they are deployed. Node failures can diminish the performance of the network as a whole, thus affecting its functionality in delivering the desired services. Our proposed mobile sensor nodes acting in cooperation with static ones in order to fill gaps created by faulty static nodes. The proposed fault handling mechanism presents alternative policies with pros and cons, depending on the user priorities imposed to the system and the occurrence of failures.

In Wireless sensor networks, the node can continuously communicating with each other. In order to extend the coverage area of the neighbour node, the distance can be calculated by using MATLAB software. In my proposed method, the distance can be measured between the nodes having the minimum distance can be used for coverage area extension scheme. Even though there is node failure, we can get information via coverage extension method.

Figure 2: Conceptual Diagram

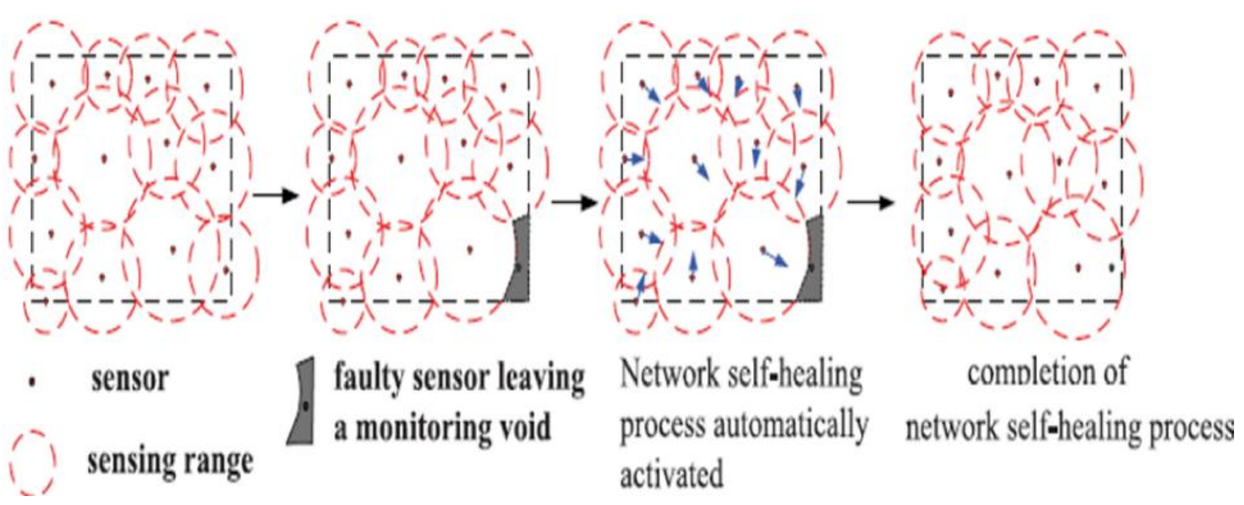


Figure 3: PC Monitoring

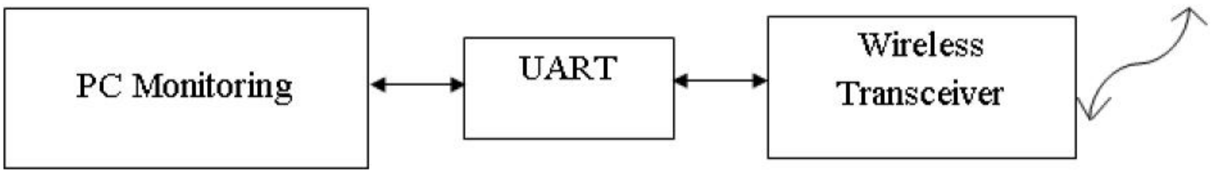


Figure 4: Block Diagram of Node 2

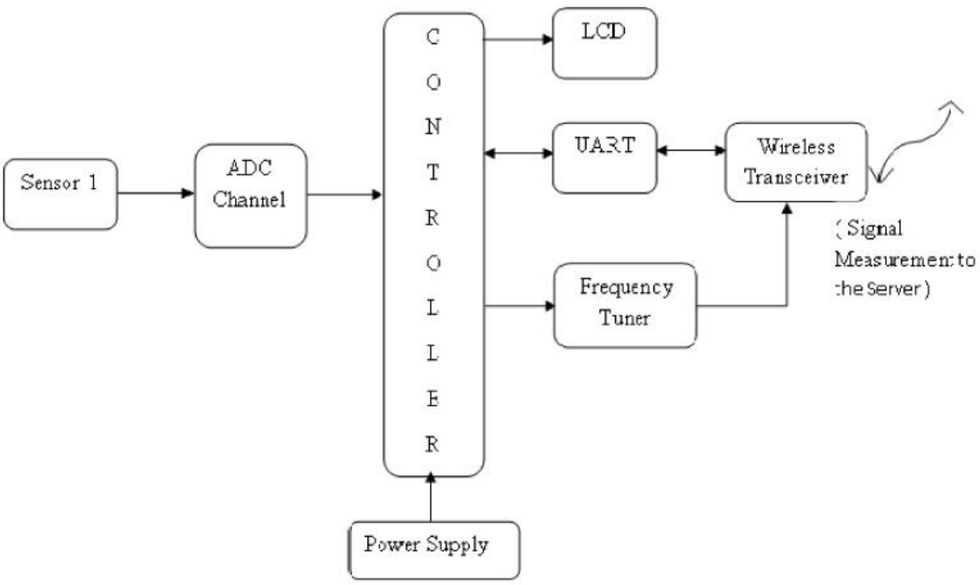
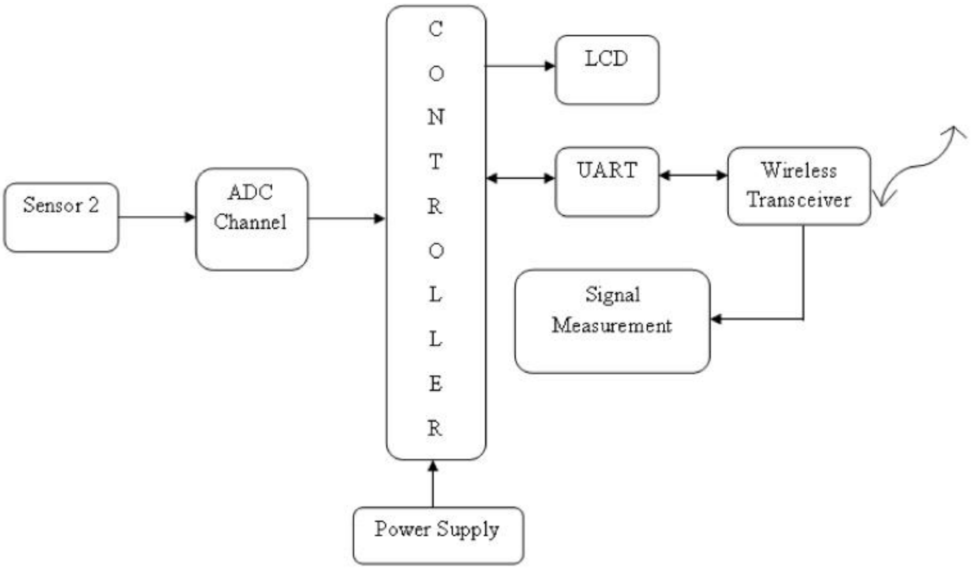


Figure 5: Block Diagram of Node 1 to Be Void



Working Principle

Node 1

Node 1 contains components such as sensor, PIC Microcontroller, LCD, UART, Wireless Transceiver and Power Supply. This node acts as a fixed node.

Temperature sensor is used in Node 1. Due to some hardware failure the node may get randomly fail. Hence the corresponding signal wouldn't be received from this node by the server. Data is not received is considered as a node failure in the network. Based on the received signal strength the minimum distance node can extends its coverage up to the failure node.

Node 2

Node 2 contains components such as sensor, PIC Microcontroller, LCD, UART, Wireless Transceiver and Power Supply. This node acts as a dynamic node. Sensor can monitor the values based on the location where it placed continuously transmit the data to the server. Humidity Sensor is used in Node 2. The output of the sensor is in analog form, but controller gets input in the form of digital. ADC is used for this conversion. PIC microcontroller has inbuilt ADC channel. UART acts as a communication protocol. Wireless Transceiver such as RSSI Zigbee works based on the UART protocol. The function of UART is to convert the values from the controller into single bit and transmit it to the server. Based on the Received signal strength the signal measurement is being done. Power Supply consists of step down transformer, bridge rectifier, capacitor, voltage regulator and resistance.

System Description

Node 1 and Node 2 transmit the data continuously to the server via wireless transceiver. Before node is placed in the location, the entire details about the node such as IP, MAC address should be known to the server. Temperature and Humidity sensors monitor the data to the server. The output of the sensors is analog form but controller can get the input in the form of digital. For that ADC channel is used, advantage of PIC microcontroller is it has inbuilt ADC channel. Universal Asynchronous Receiver Transmitter (UART) acts as a communication protocol. Wireless Transceiver works based on the UART protocol. The function of UART is to convert the values from the controller into single bit values and transmit it to the server. Based on the received signal strength calculation the distance is measured between the nodes that is monitor in the server. Due to hardware or software failure in the network the node may get randomly fail. The node failure is identified by the coverage sensor automation algorithm. In order to compensate the failure the network needs other active nodes. The distance calculation between the nodes is being done. It is calculated based on signal strength using an algorithm called Enhanced virtual Force algorithm with boundary forces. The server command to the nearest node to extends its coverage. Depending on the received signal strength, the node having the minimum distance capable of extending its coverage. Coverage extension is being done by an algorithm called Sensor Self Organization algorithm. Up to that range from the failure node, the coverage of the nearest node is being extended in order to compensate the failure data. Instead of the failure node, nearest active node transmits the data to the server. At the time of extension only the particular node will be active and other nodes are in sleeping mode so that the congestion between the nodes is being avoided.

SOFTWARE ANALYSIS

Labview

Laboratory Virtual Instrument Engineering Workbench (LABVIEW) is a system-design platform and development environment for a visual programming language from National Instruments. The graphical language is named "G"; not to be confused with G-code. Originally released for the Apple Macintosh in 1986, LABVIEW is commonly used for data acquisition, instrument control, and industrial automation on a variety of operating systems , including Microsoft Windows, various versions of UNIX, Linux, and Mac OS.

Data Flow Programming

The programming language used in LABVIEW, named G, is a dataflow programming language. Execution is determined by the structure of a graphical block diagram on which the programmer connects different function-nodes by drawing wires. These wires propagate variables and any node can execute as soon as all its input data become available. Since this might be the case for multiple nodes simultaneously, G can execute inherently in parallel. Multi-processing and multithreading hardware is exploited automatically by the built-in scheduler, which multiplexes multiple OS threads over the nodes ready for execution.

Graphical Programming

LABVIEW integrates the creation of user interfaces into the development cycle. LABVIEW programs-subroutines are termed virtual instruments (VIs). Each VI has three components: a block diagram, a front panel, and a connector panel. The last is used to represent the VI in the block diagrams of other, calling VIs. The graphical approach also allows nonprogrammers to build programs by dragging and dropping virtual representations of lab equipment with which they are already familiar. The LABVIEW programming environment, with the included examples and documentation, makes it simple to create small applications.

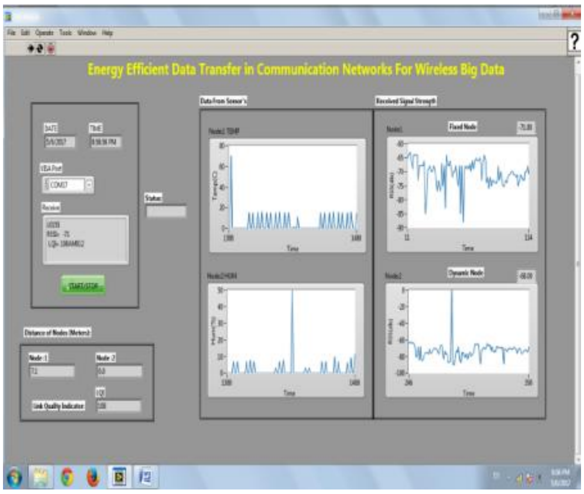
IMPLEMENTATION

Node failure in Wireless sensor networks composed by static sensor nodes is common due to the nature of the sensor devices and usually harsh environments in which they are deployed. Node failure can diminish the performance of the network as a whole, thus affecting its functionality in delivering the desired service. Our proposed sensor nodes acting in cooperation with static ones in order to fill gaps created by faulty static nodes. The proposed fault handling mechanism presents alternative policies with pros and cons, depending on the user priorities imposed to the system and the occurrence of the failures. The nodes in wireless sensor networks have a limited lifetime span due to the fact Nodes may fail due to hardware failure.

There may be environmental condition changes, such as electromagnetic noise and physical destructions, which may cause a node to fail, or temporarily changes to participate in the current network topology. With these node failures, topology management schemes must consider the fact that some nodes may randomly fail in the network. In this case sensor need for other active nodes to compensate for these failed nodes.

Based on the location the sensors such as temperature and humidity continuously monitor the data and transmit it to the server via wireless transceiver. Zigbee is used as a wireless transceiver in the network. The distance is also

Figure 6: Data from Node 1 and Node 2



measured between the nodes. Based on the distance the received signal strength is calculated by using Enhanced Virtual Force algorithm. Thus Node 1 has -71 db as signal strength and Node 2 has -68 db as signal strength.

This figure indicates node failure in the node 1. Due to some hardware failure in the network the node may get randomly fail. This failure is identified by the server by an algorithm called coverage sensor automation algorithm. Once the

Figure 7: Failure of Node 1

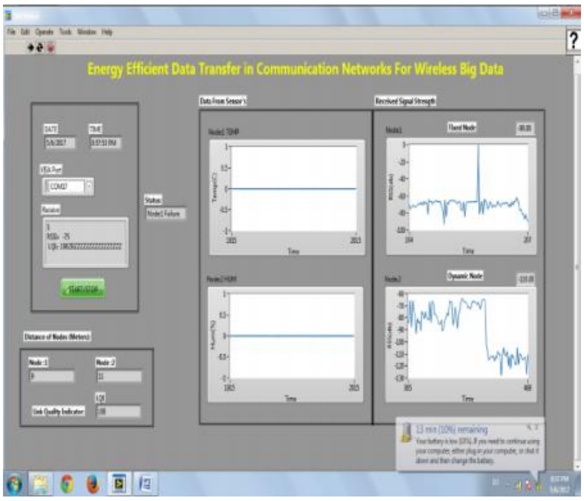
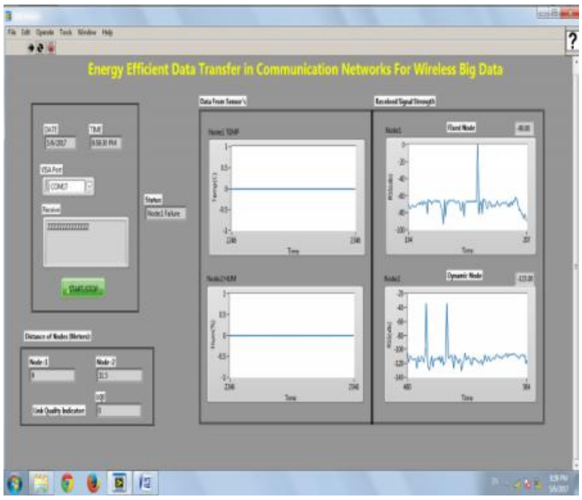


Figure 8: Coverage Extension of Node 2



failure is identified, the server will command to the nearest node to extend its coverage. In order to compensate this failure, the network needs other active nodes to send the information instead of the failure node.

It indicates the extension of coverage of Node 2. Depending on received signal strength calculation the node having minimum distance can capable of extending the coverage. Based on the command from the server, the neighbor node starts extend its coverage up to the signal declined from the failure node. The coverage extension is being done by an algorithm called Coverage Self Organization algorithm. Even though there is failure in the network , the data is being collected from the adjacent node in order to compensate the failure by coverage extension method.

RESULTS AND CONCLUSION

In this article, it is to be concluded that a node distance measurement in order to get information even though there is node failure in the network. In order to compensate the failure the other active nodes is needed in the network. Dynamic route adjustment is also possible by increasing transmit power to cover the void area of the node in the wireless sensor networks. Also it implements a high speed and energy efficient sensor deployment strategies in the wireless sensing areas. By calculating the distance measurements based omn the received signal strength between the nodes capable of extending the coverage area if there is any node failure. Thus it has the advantage of faster response time, energy efficiency, high sensitivity and dynamic movement on sensor failures. In our project, we target on smart sensing environments and deal with heterogeneous sensors equipped with actuation facilities to assist in the sensor self-deployment. Enhanced Virtual Force Algorithm with Boundary Forces protocol implements the distance measurement method between the nodes in order to extend the coverage area. Coverage self organization algorithm helps to extend the coverage in the form of frequency is done and implemented by using LABVIEW software.

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International Journal of Engineering Research and Science & Technology
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ISSN 2319-5991