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Neural Network Based Prolong Structural Building Monitoring Management System Using Hybrid Wireless Sensor Network

[1]Dr. C. Jenifa Latha, [2]Ramanarayan Sankriti, [3]Dr.Sudha Arvind, [4]Ali Baig Mohammad,

[5] Dr.MS.Mariam Jenabhar

[1]Professor, Department of Civil Engineering , Saveetha Engineering College (SEC),Saveetha Nagar, Thandalam, Chennai - 602 105, Tamil Nadu, India
[2]Assistant Professor/Dept. of Civil, Chaitanya Bharathi institute of Technology, Hyderabad, India
[3]Professor, ECE Department, CMR Technical Campus, Hyderabad
[4]Assistant Professor, ECE Dept., Koneru Lakshmaiah Education Foundation, Vaddeswaram, Andhra Pradesh, India
[5]Assistant Professor, Department of Commerce, Sree Sevugan Annamalai College, Devakottai, Tamil Nadu

Abstract

The wireless sensor network is well suited for smart building monitoring system as it is cost effective compared with wired network. A hybrid protocol that uses concept of LEACH to increase the life time of sensor network and HRP protocol for effective communication to base station is use in building monitoring system. The sensors such as humidity sensor, strain sensor, temperature sensor, and electrical current monitoring sensor are deployed in huge amount around the building infrastructure and these sensor are organized as different clusters. At initial stage cluster head sensor activates few member sensors for gathering information and rest of sensors are inactive state. This increases the life time of sensor network. If anything happens abnormal then few more sensors are activated to gather more information by cluster head. A neural network is implemented to isolate information from the cluster member nodes and communicate effectively to sink node. In order to reduce the work load of cluster head node, Information Collection Node (ICN) and Energy Monitoring Node (EMN) are added in each cluster to isolate information and monitor energy level of cluster member nodes. Thus hybrid protocol for structural building monitoring system is implemented that increases life time and effectively convey sensory information to sink node in wireless sensor network.

Keywords: - Structural building monitoring system, Hierarchical clustering, LEACH, HRP.

1. Introduction

Now a day's wireless sensor networks play a major role in collecting information from sensors and sending to the sink node. Sensor networks are deployed in various areas such as healthcare monitoring, civil building application, and military defenses. Wireless sensor networks can sense information humidity, pressure, temperature etc .These sensors collects information about the surroundings then process the information and send to base station (BS) [1].

Internet of Things (IoT) is the emerging technology that are used in various application such as health care smart cites, vehicular networks, machine to machine communication and other areas . In IOT uses RFID to uniquely identify things and controlling them with various mechanisms. IOT is used in pervasive computing i.e. present everywhere that gather information for all IOT device component and processes these information. Networking Scientists, Research & Development industries, and many

other business organization are developing an achievable and robust architecture to make it commercial and it is used by normal people [2, 3].

Wireless sensor Networks comprises of three main parts such as communicating unit sensing unit and processing unit. The sensing unit has analogue to digital converter that converts analog signal to digital signal and sensors for sensing information they are powered by battery and replacement of these battery is difficult as most sensors are deployed in typical areas where human cannot enter such as volcanic environment, military area surveillance, etc. As energy drains sensors fails since replacement of battery is not possible then we need to deploy new sensory to make it WSN active. Next the communication unit is responsible for sending data over a sensory channel. At last, the processing unit has some microcontroller and a microprocessor, which controls the sensor nodes by sending control signals to microcontroller and a microprocessor.

Recent advances in materials and sensor technologies have brought significant new tools for upgrading building systems. Many of the structures date back to the decades in their fundamental form, the intelligence added approaches tackles the issues that hinder efficient implementation. active structural damage control SHM has become a main stay for evaluating entire behaviour, especially from manufacture through its usefulness

Buildings are subject to dynamic loading, hence dynamic analysis is required.

Using SHM techniques, the perpetually berated transfer function has been used to predict seismic wave effects on buildings . Analyze the buildings' state A neural network (NN) can analyse both damaged and undamaged data. Artificial free vibration is used to inspect places and forecast vibration range and level. Dynamic loading causes harm. Most SHM buildings are static loaded. The main parameters for static loading are displacement, strain, temperature, and time. Warm and cold seasons Buildings under static load typically use a 1D or 2D scheme. Modern technologies and a global positioning system can trace the structure in 3D.

Damage detection is critical in SHM, hence methods like ambient vibrations have been employed to foresee damage. For example, the SHM technique was used to monitor the San Pedro Apostol church both short and long term. long-term temperature and humidity monitoring [1]. SHM can be used to protect historic structures as well as modern structures. Non-destructive approaches can be employed to monitor Ottoman constructions. strategies for forecasting damage and monitoring building health

In order to minimize battery energy conception sensor nodes has limited coverage and the sensors that are not in coverage area of base station can communicate through intermediate sensor nodes. However, some case the wireless sensors nodes are organized as different clusters and the cluster head is responsible to collect information from cluster area and send to base station. It indicates the separation of data into groups of cluster head data. To maximize life time all sensors sends their gather information to cluster head and these cluster head aggregate these information and send to the base station

Only cluster head is responsible for gathering information process them and sending to the sink node this saves the energy of other sensor nodes as they are going to send information to cluster head and they are not going to do any processing. The cluster head also plays a vital role in wireless sensor network. It reduces the redundant information while aggregating data from different sensor nodes. In general if anything happens it is detected by multiple sensors deployed around the environment. As this information is Send to cluster head, it eliminates the redundant information and forward to sink Node. Thus it reduces the bandwidth requirement of wireless sensor network as sending information is reduced and it also saves the energy of Sensors node [5].

The sensor near to base station can directly transmit its information to it. If it is On hop transmission. Generally much of Sensor nodes are deployed far away from base station and they com communicate only through neighbor Sensor nodes. This is multi hop transmission and it requires dynamic topology creation in Wireless sensor network [6}

The cluster formation and grouping member Sensor nodes with the cluster head is a major problem in wireless Sensor Network. As much of work such as collecting sensory data, aggregating it, removing redundancy and sending to the base station are done by cluster head. This lead to drain in energy level of cluster head and soon it become unavailable. Then a new cluster head is detected [7].

SHM systems notify users when there are significant structural changes or deterioration. The main purpose of structural damage detection is to figure out what caused the damage, where it happened, and what kind of damage it is. the remaining life expectancy of the structure Internal and external factors like as corrosion, fatigue, and ageing, as well as earthquakes, wind, and collision, cause structural defects that cause collapses. The effects of the above mentioned causes may be gradual and not obvious until the structure is compromised. considerable, and only seldom repairable at a high cost. The ability to detect structural damage is critical to a structure's long-term safety. Infrastructure It assesses the structural system's measurable and qualitative degradation under severe loads. It is vital to keep track of things.the occurrence, location, and magnitude of safety and performance degradation

Design and Implementation of Hospital Management System

Hospitals are information-intensive organisations that require adequate information systems to handle and interpret data. Hospital information systems (HIS) and clinical information systems (CIS) are computer-based systems used in hospitals to help manage patient records, accounting, human resource management, asset management, stock management, and knowledge management. The monitoring system's sensing component contains sensors, recorders, servers, and other firmware to measure the building's response, collect data, and send it to an onsite server in real-time.

Figure 1a Represents the 3D view of Structural Health Monitoring System in Hospitals

2. Proposed System

Building is categorized into different areas and different sensors such as strain sensor, temperature Sensor, humidity sensor etc around the area are grouped into clusters. Let CL1, CL2, and CL3 ... CLN) be different clusters formed around the building.

Select the cluster head (Ch) such as Ch1 ∑ CL1, Ch2 ∑ CL2, ... ChN ∑ CLNInformation collection Node (ICN) Such as ICN1∑ CL1, ICN2∑ CL2... ICNN∑ CLN and Energy Monitoring Node EMN1∑ CL1, EMN2∑ CL2, …EMNn∑ CLn in every cluster area.

Cluster head node activates some of cluster member nodes and deactivates other robes based on their requirement. The cluster head also gather information from Information collection Node and process them and send it to sink station either directly or through other cluster head nodes. Information Collection Node effectively collects and isolates information from cluster member node and eliminating duplicate information through neural network and sends to cluster head Node. Energy Monitoring Mode gathers information about the energy level of member node and send to cluster head Node. Cluster head nodes select few sensors for gathering environment data ,based on the energy level sent by based energy monitoring node.

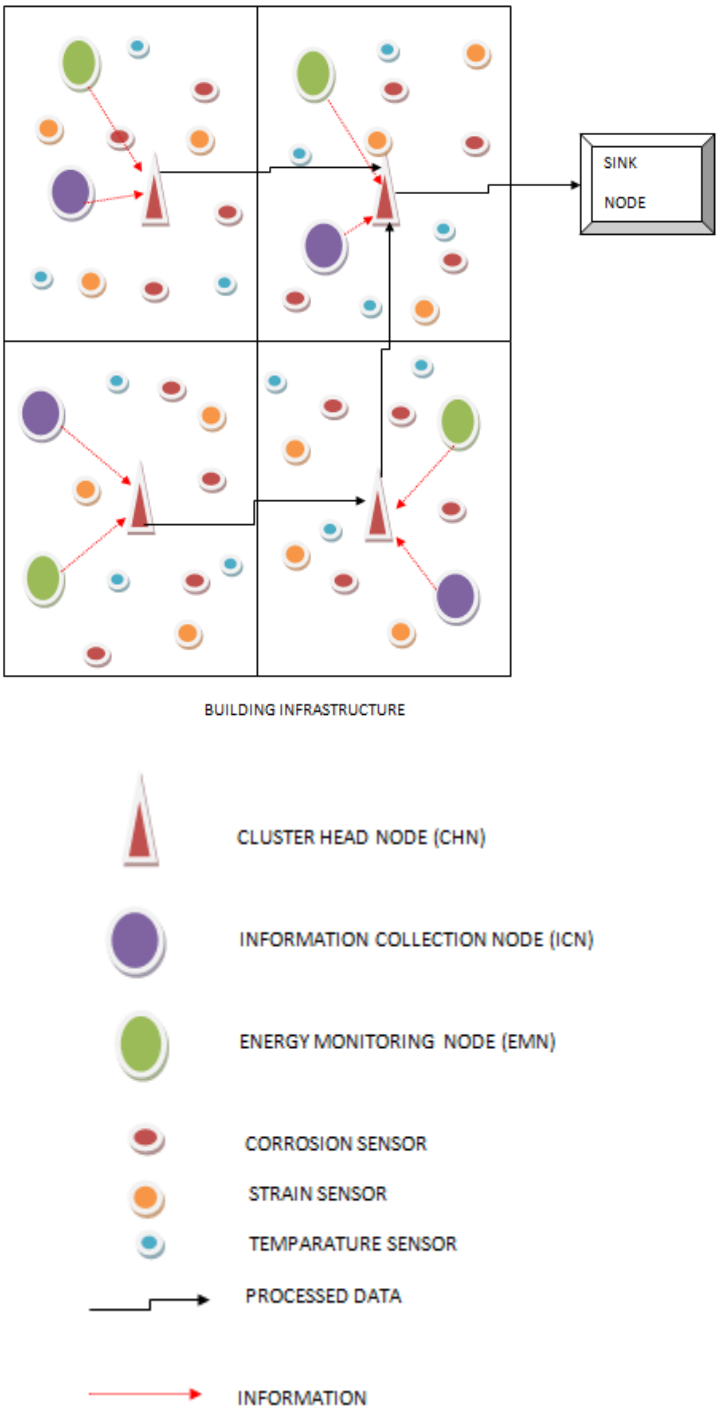

Figure 1brepresents the Building Monitoring Diagram

2 a. Information Collection Node

Information collection node in each cluster collects information from each cluster member sensor nodes through neural network and eliminates duplicate information then it sends to cluster head node in their respective TDMA time slot.

routine Information_Collection_Node (Member_Node m)

{

For Each (m)

m gathers environment data around building

m transfer sensed data to Information Collection Node (ICN) in corresponding cluster in their respective slot of TDMA.

End for

send consolidated information to cluster head

}

2. b. Energy Monitoring Node

Energy monitoring node in each cluster collects residual energy level of each cluster member nodes and send to cluster head node in their respective TDMA time slot.

routine Energy_Monitoring_Nod*e* (Member_Node m)

{

For Each (n)

m sends their residual energy level to Energy Monitoring Nodes in their respective cluster in their allocated time slot.

End for

Send Energy Level status information of all member nodes to cluster head Node

}

2. c Cluster Head Node

The cluster head node collects information from the information isolation node and sent to sink node directly if it is in its coverage area or else it may forward information through intermediate cluster head node. It also receives information from energy monitoring node and takes decision about whether the sensors around building are kept active or not based on their energy level.

routine Cluster_Head_Node (Information_Collection_Node i,Energy_Monitoring_Node e)

{

Process Information from i node

Send processed Information to base station either directly or through other cluster head.

Collects energy information from e and make necessary sensor active

}

Initialize each sensor node has some residual energy as assign the Cluster Head and record this information shared with one hop neighbour node using ADV packets. To make the decision based on their residual energy in a node receiving ADV packets. If compare advertise or new receiving ADV packets of residual energy are greater than node's own ADV packets of residual energy then new receiving node as assign the CH and update every level and also shared by all other one hop neighbour node except source node. Otherwise, no there is updating ADV packets and forwarding to the source node. After a particular time interval all nodes have a same ADV packet with same id and energy level is chosen as CH. This process is Repeat the cluster head energy level becomes low

3. Cluster Head Selection Algorithm steps

Step1: Each sensor node around the building initially consider them as cluster head and record their residual energy level in ENERGY_ADV advertise packets

Step2: ThenENERGY_ADV advertise packet is shared among their neighbour node sensors.

Step3: When other sensor nodes receive ENERGY_ADV advertise packets then the decision are taken based on their residual energy level and received advertise energy level.

Step 3.1 if advertise ENERGY_ADV packet residual energy is higher than sensor node's own residual energy then assign advertise node as Cluster Head and update energy level and broadcast to all other neighbor node except sending sensor node.

Step 3.2if advertise ENERGY_ADV packet residual energy is smaller than the sensor node's own residual energy then there is no updating and just forwards to the sending sensor node

Step4: After a particular time period, all sensor nodes have a sameENERGY_ ADV packet with same id and energy level and it is chosen as Cluster Head.

Step5: Repeat step2 cluster head energy level becomes low.

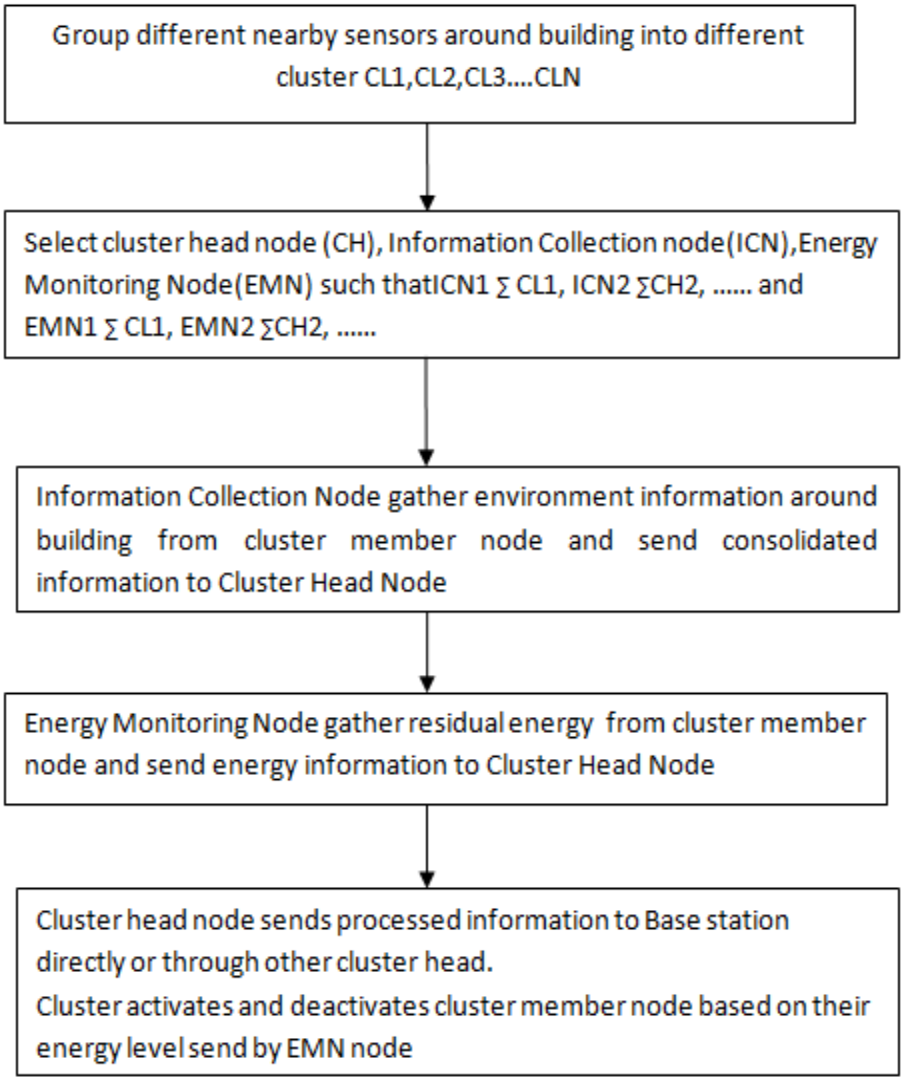

Figure 2: Represents the Flow Diagram of Cluster Head Selection Algorithm

3. a. Cluster Maintenance

If energy level of cluster head node or Information collection node or Energy monitoring node is drained then alternate node with sufficient energy level is selected and all responsibilities is delegated to the selected node.

routine Cluster_Maintenance ( )

{

If (Energy_level_Cluster_Head_ Node <Threshold_ Value)

Initiate election to find another member node with sufficientenergy level in cluster as Cluster Head Node

If (Energy _level_Information _collection_ Node <Threshold_Value)

Initiate election to find another member node with sufficient energy in cluster as Information collection Node

If (Energy _level_energy _monitoring_ Node <Threshold_Value)

Initiate election to find another member node with sufficient energy in cluster as energy monitoring Node

}

4. Simulation Result and Analysis:

A. Power Consumption

At initial stage cluster head makes only few sensor in active state and rest are inactive .When there is a need i.e. when something went wrong,based on our requirement more sensors on particular area or time are activated to gather more amount of information .This will drastically increase efficiency and reduces the power consumption. The combination of LEACH and hierarchical cluster formation will produces better result in structural building monitoring sensor. Now we compare the result of normal LEACH and our proposed system based on power consumption.

Table 1. Represents the Comparison between the Existing leach Algorithm and Proposed Method

No of nodes	Power consumption	
	LEACH	Proposed
40	22	20
45	26	23
50	29	25
55	33	29
60	36	32
65	39	36
70	43	38
75	44	40
80	46	41
85	49	43

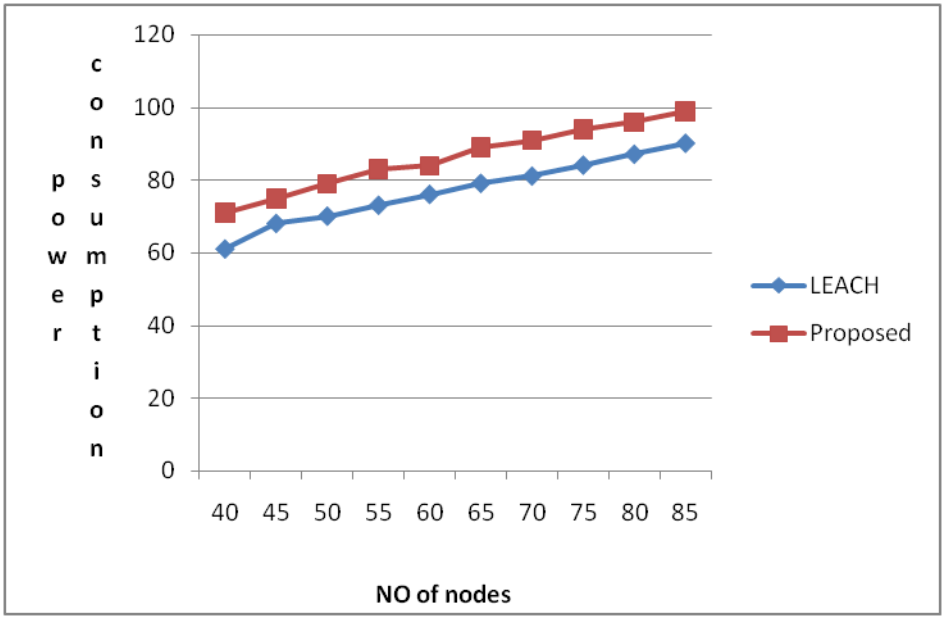

Figure3 Represents the Plot between Number of Nodes & Power Consumption

B. Information Gathering

The amount of information collection is also increased since we are isolating all information collected by different sensors by information collection node and send to cluster head node in turn it forward to sink node either directly are through intermediate cluster head sensor nodes. The neural network is used to gather environment information effectively from cluster member nodes and duplicate information are avoided before sending to cluster head nodes.

Table2. Represents the Comparison between the Existing Leach Algorithm and Proposed Method

No of nodes	Information Gathering (in %)	
	LEACH	Proposed
40	61	71
45	68	75
50	70	79
55	73	83
60	76	84
65	79	89
70	81	91

75	84	94
80	87	96
85	90	99

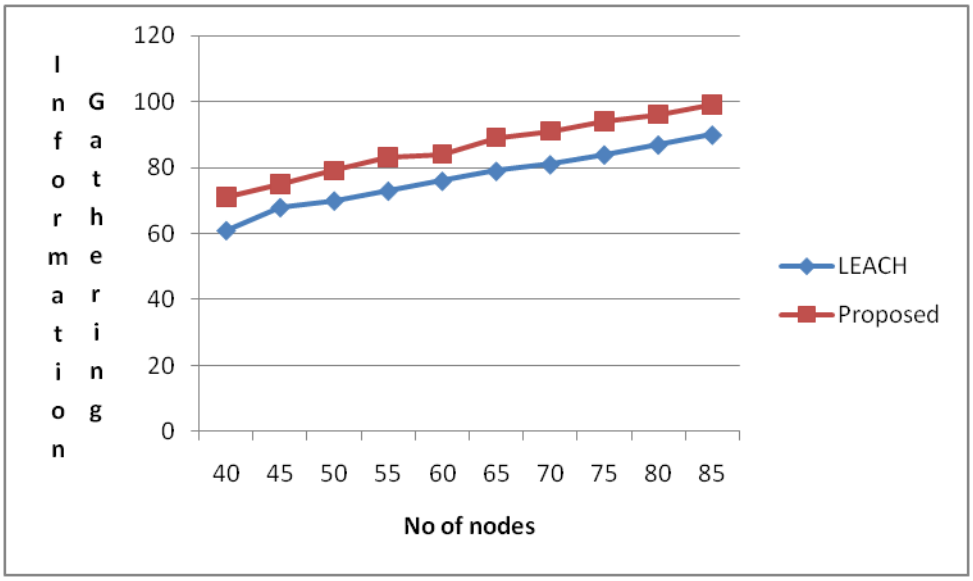

Figure-4 Represents the Plot between Number of Nodes & Information Gathering

Simulation parameters

Parameter	Default value
Simulation area	130 m × 130 m
Number of nodes	60–120
Packet length (from cluster head to BS)	6500
ctrPacket length (default packet length from normal node to cluster head)	195
Initial energy	0.45
Base station coordinates	(50, 50)
Probability to the node to become a CH	0.15
Energy for transferring of each bit	49*0.000000001
Energy for receiving	49*0.000000001

Energy for free space model	11*0.000000000001
Energy for multipath model	11*0.000000000001
Energy for data aggregation	5*0.000000001

In this cluster Head node is select based on the energy level analysis by cluster selection algorithm. All Sensor nodes collect the environmental data and do some initial processing and send the Information Isolation Node in cluster. Based on the processed data collected from each Sensor node, the cluster Head node takes decision and forward to Base Station using time division multiplexing or code division multiplexing.

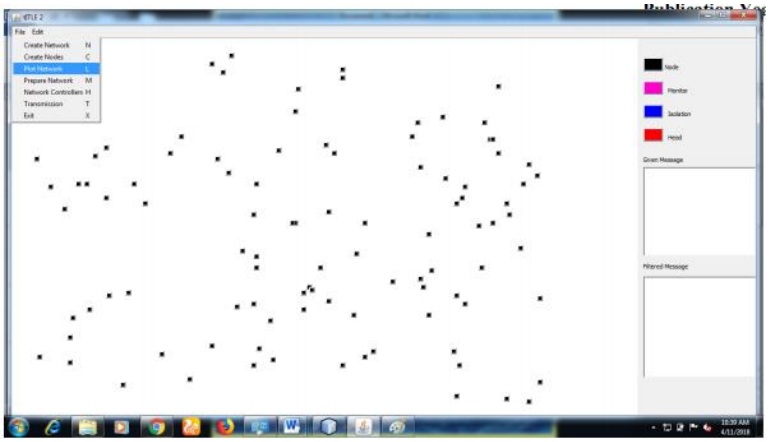

Figure-5 represents the node creation

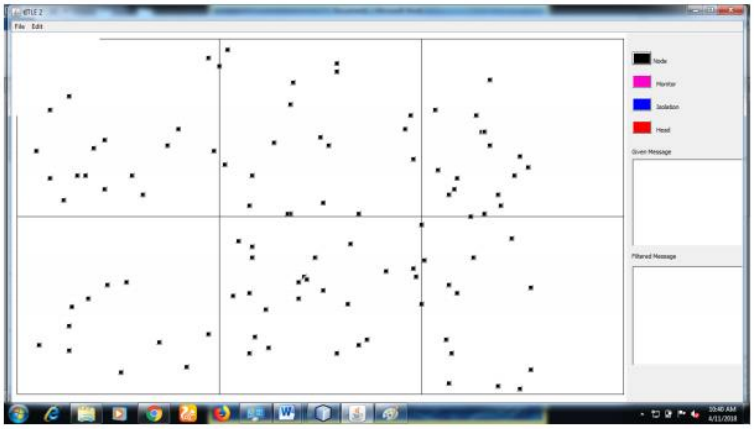

Figure 6represents the cluster node formation

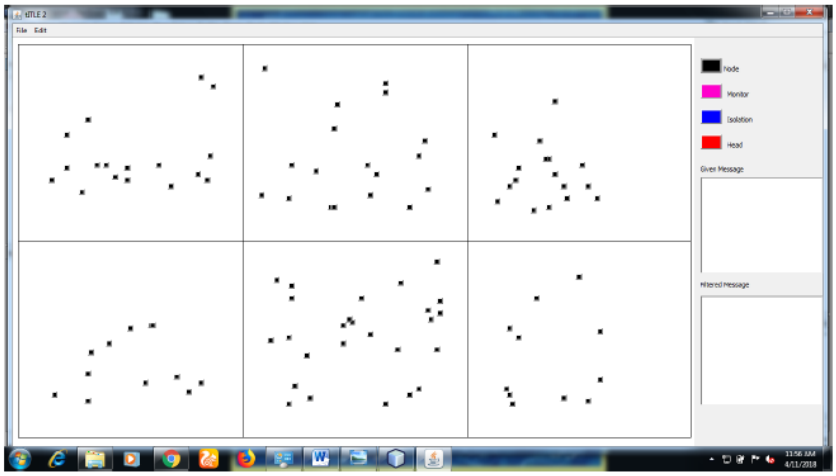

Figure7 represents partially active nodes in cluster

5. Conclusion

The combined effort of LEACH Protocol and hierarchical routing protocol increase the life time of wireless Sensor Network and effectively communicate the sensor information to the base station for building monitoring System. The LEACH protocol initially makes some of sensor node in active State and makes some sensor to be switched off. This will reduce the power consumption of wireless sensor network. When a unusual circumstance arises then it will activate some more sensors in that area to collect more information and send to Sink node for further effective measures. The hierarchical routing protocol makes some cluster information for effectively collecting and communicating to the sink node. The cluster head performs data aggregation and process them to make decision and convey to sink node. The information isolation node and energy monitoring node in cluster reduces the work load of cluster head and increases the life period of cluster head node.Thus various types of building sensors have been placed and the current situation of the building is monitored. If there are any variations in normal conditions then the information is send to remote system through cloud and corresponding activators are activated from the remote system in order to bring the situation to normal condition. This ensures a safety measures for hosipital building management system.

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