MOBILE ANCHOR ASSISTED LOCALIZATION ALGORITHM TO IMPROVE NETWORK LIFE TIME IN WIRELESS SENSOR NETWORK

A Dissertation submitted

By

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In partial fulfilment of the Requirement for the

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Under the guidance of

Mr. Ravi Kant Sahu

(Assistant professor)

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This is to certify that **Maid Amol Prabhakar** has completed M.Tech (computer science and technology) dissertation proposal titled **Mobile Anchor Assisted Localization Algorithm to Improve Network Life Time in Wireless Sensor Network,** under my guidance and supervision to the best of my knowledge, the present work is the result of her original investigation and study and no part of the dissertation proposal has ever been submitted for any other degree or diploma.

The dissertation proposal is fit for the submission and the partial fulfilment of the conditions for the award of M.Tech Computer Science & Engineering.

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DECLARATION

I, **Maid Amol Prabhakar** hereby declare that the dissertation proposal entitled, **Mobile Anchor Assisted Localization Algorithm to Improve Network Life Time in Wireless Sensor Network.** Submitted for the M.Tech Degree is entirely my original work and all ideas and references have been duly acknowledged. It does not contain any work for the award of any other degree or diploma.

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ABSTRACT

Wireless Sensor Network which is consisting of the sensor nodes, it is very important to know about the location of the sensor nodes, so we can reach the area to take necessary action. The research work describes about the solution of the problems like link failure problem, dead nodes into the network, battery management for the better performance, focused on reducing the hardware we used into the network.

Designed algorithm is divided into mainly three phases, first deployment of the sensors which process again use for the purpose of redeployment of the nodes, second is localization of the sensor nodes involved into the network with help of anchor node, and third and important phase is apply the triangulation method to localize those nodes which are yet to localize even if anchor nodes have sent their locations to them. mobile anchor is roam around the area i.e. sensor area and at the particular quantum of time broadcast the beacon messages which tells them then information about mobile anchors, information includes the current location of the anchor node, so other anchor use that information for the localization. Once mobile anchor enters within the range of the static nodes it receives the beacon messages it records the entering and location i.e. first location within the area and exit location i.e. last location while passing through the range of the stationary node. We are using the concept of redeployment to solve the problem of dead nodes and link failure problem using grids. Simulation we are using for the implementation is NS-2. And result of the implementation is shows that the performance of the improved, graphs and performance is shown in following chapters.

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CHAPTER 1

INTRODUCTION

1.1 Wireless Sensor Networks:

A Wireless Sensor Network is defined as a group of tiny disposal low power sensor nodes that usually derive their energy from attached batteries. Wireless Sensor Network is a network consisting of self-powered small sensor nodes which sense the physical or environmental parameters like temperature, motion, moisture, pressure, sound vibration etc. at different reasons. A sensor node consists of a sensing unit, a processor, a transceiver station and a power source.

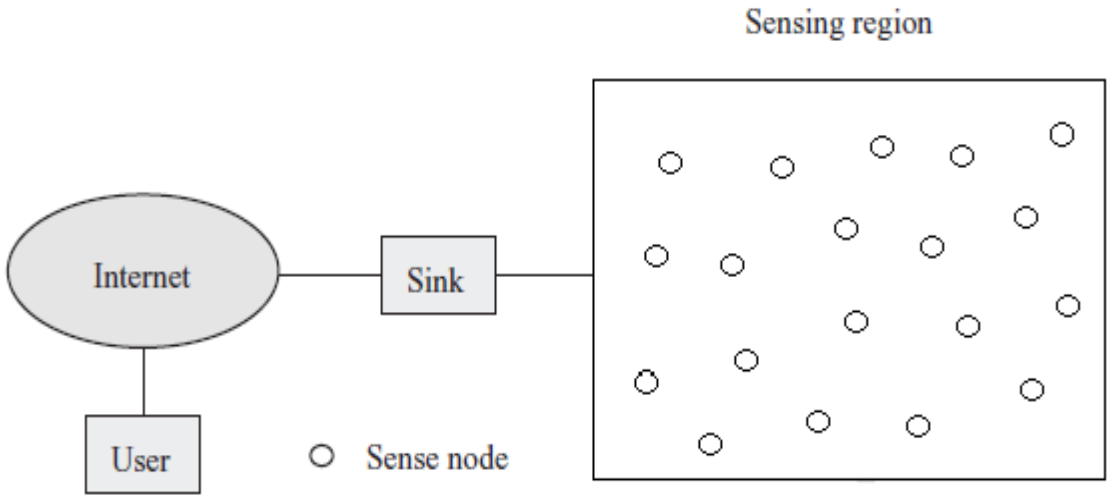


Fig. 1.1 Sensor network architecture

Micro processing unit with a micro controller controls all of the functions of the sensor node and manages the communication protocols to carry out specific tasks. A sensor node includes these major components plus application depended components such as power generator, location tracker and mobilizer. Power generator like solar cells, may be utilized to support the power unit for prolonging the sensor node lifetime. Mainly in transmitting and receiver packet and control messages the energy consumed.

The sensor nodes are limited in hardware support in networking and support for software deployment. Wireless Sensor Network is a collection of tiny sensor nodes connected

wirelessly to each other and to the sink or base station. Wireless Sensor Network is very useful in those areas for data gathering where existing approaches fails. For example under water military areas, irrigation control, environmental monitoring, etc.

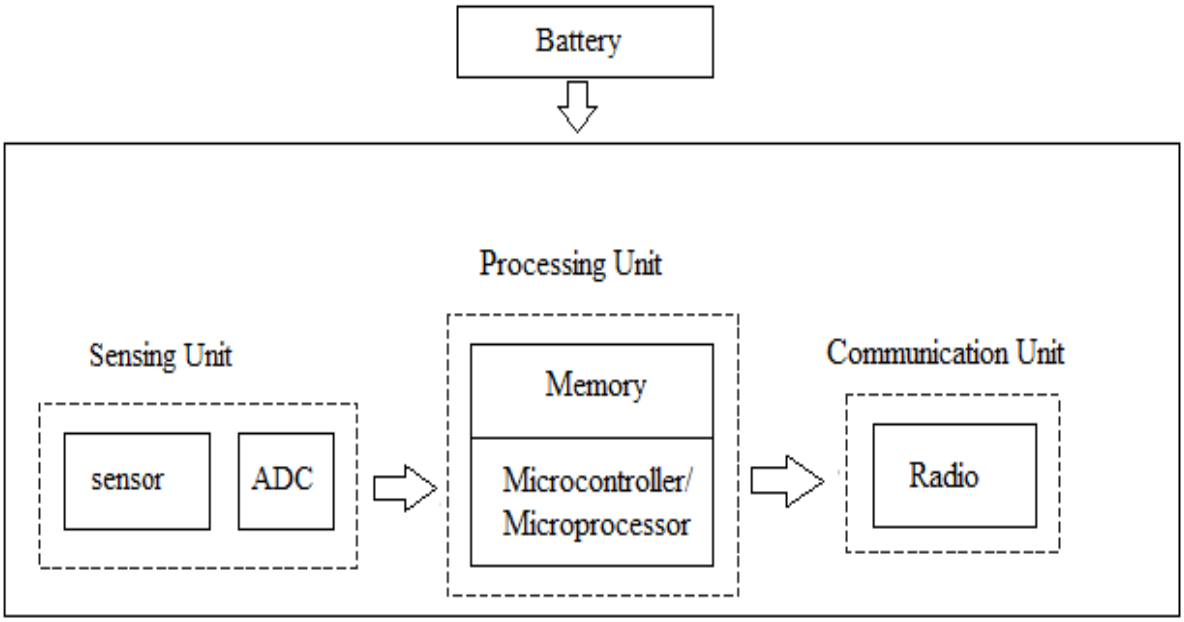


Fig.1.2 Architecure of sensor network

Wireless Sensor Network provides facility to monitor physical environment with better result, can say accuracy. It uses two types of algorithms- ranged based algorithms and range free algorithms. Range based algorithms are depends on measuring physical attributes of the wireless signals that are transmitted between the antennas uses techniques like received signal strength indicator (RSSI), the time of arrival of the signal (ToA), and the angle of arrival (AoA) but these kind of devices requires more power and it increases the cost of the network, And range free algorithms can be centralized or decentralized.in case of centralized algorithm each sensor is totally depend on information about itself. This information may be used to measurement to neighbour node or one-hop connections. Using this information base station creates the map of the network and estimates the location of each node. But this centralized range free algorithm suffers from the communication overhead between the station and the sensors. In case of Distributed range free algorithm sensors and base station are exchanges the massages. Sensor nodes are distributed randomly without predetermining their positions over a particular area or field and they don't need any installation. These sensor nodes are inexpensive and have the low energy and different memory capabilities. The

technology behind the wireless sensor network allows it to develop a single network instead of various large networks.

1.2 Terms Related to the Sensor Networks

1) **Energy per packet:** Energy spent to send packet from source to destination.
2) **Energy and reliability:** Energy of nodes and reliability of the data transmission between nodes.
3) **Network Lifetime:** The time until the certain network dies. This depends upon the battery power.
4) **Average energy dissipated:** It is metric to calculate average energy consumption at per node.
5) **Total number if nodes alive:** Total number of nodes which are alive at the end of simulation.
6) **Distance:** Distance between the transmitter and receiver
7) **Packet delivery ratio:** It the ratio of the successful delivery of the packets from sender to receiver. It should be high.
8) **Range of the sensor:** It is the range of the sensor which covers the area around the sensor node.
9) **Time**: Time until first node dies
10) **Idle listening:** The node in the idle mode does not take part in the communication also consume energy.

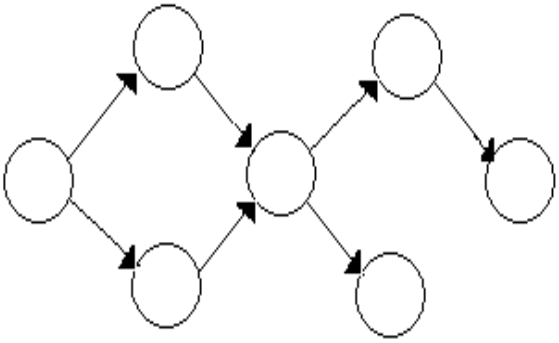
1.3 Communication between Nodes in WSN

WSNs mostly have the asymmetric traffic pattern for the communication. Pattern for the communication are as follows.

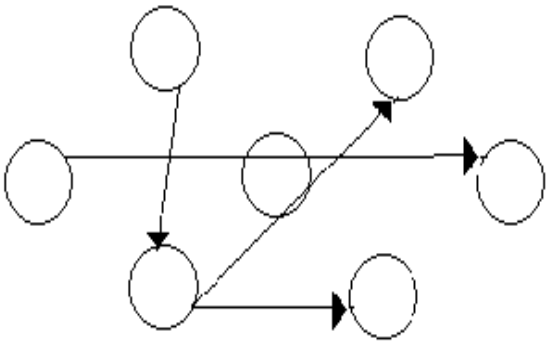
1) **Local:** This is used to communication between neighbouring nodes.
2) **Point to Point:** This is used to direct communication between two end points. For example communication between cluster head and a node of between two cluster heads or between cluster head and sink node.
3) **Convergence:** Many node data to one and converged data are sent further. It is the data collection mechanism. Example is nodes send data to cluster head and cluster head send

converged data to sink node.

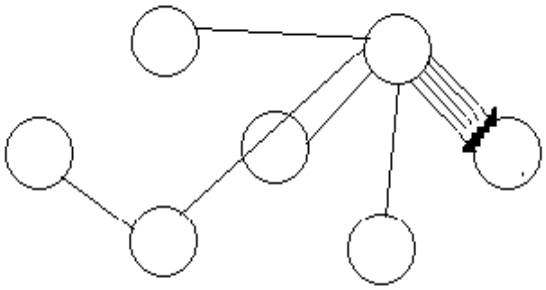
4) **Aggregation:** Many nodes send data to one and aggregated data is sent further. For example the node sends data to cluster heads it aggregates the data and send it to sink node.
5) **Divergence:** Sink node sends commands to node and cluster heads.



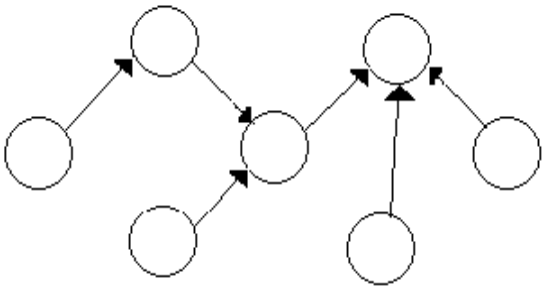
1. Local



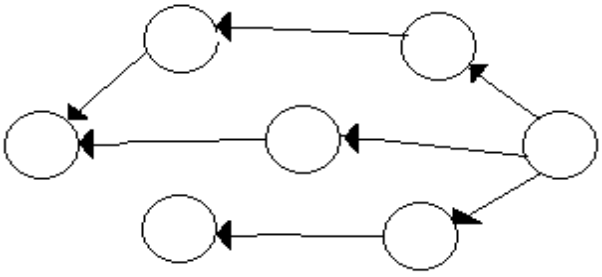
2. Point to point



3. Convergence



4. Aggregation



5. Divergence

Fig.1.3 Communication pattern of nodes

1.4 Features of Wireless Sensor Network

- Wireless Sensor Network is easy to configure as sensor nodes can be deploys without any installation or predetermined locations.
- Wireless Sensor Network replaces the physical presence of the human.
- It supports mobility of nodes.
- It is robust as large number of sensor nodes is deployed.
- Wireless Sensor Network can be easily extended by deploying more sensor nodes.

When an event occurs, the sensor nodes deployed in that sensor field work to sense environmental or physical conditions such as temperature, sound, pressure, etc. The data gathered after monitoring the particular area by the sensor nodes is processed based on certain phenomena and the information is broadcasted to the base station (which is the central node) through network i.e. through various neighbour nodes. Each node before forwarding the information to the next node checks that whether the node itself is not the destination node. For forwarding the message to base station, the sensor nodes are supposed to be known about the direction of the base station. If the source node is able to directly announce the message to the base station then message is not forwarded to the intermediated nodes. The data can be transferred to more than one base stations or sinks. Base station then uses sensed information according to the application requirement. This whole process of sensing the field, gathering the information and forwarding the gathered information requires a lot of energy. In Wireless Sensor Network, the message is mainly broadcasted to the nearby nodes. The sensed information received by the base station is used according to the requirement of the application. Distance Vector is an example of distributed range free algorithm. Localization had a major issues and challenges in such networks. The such as

- Cost
- Power consumption
- Flexibility and Reliability
- Complexity
- Short Range
- Installation

- Mobility

We consider some issues in implementation of the Wireless Sensor Network localization and try to improve the performance of the sensor network, and in all given issues power are important issues in localization in Wireless Sensor Network because sometimes we place the sensors in such areas like forest, under the sea where we can't recharge or replace the battery of the sensors we can use it single time, so less power consumption is one of the main considerable issue in Wireless Sensor Networks. Power Consumption, short range, security and cost is most important issues that researcher considers. And in this research paper we are considering the low power consumption and low cost. And after that check the variation or can say impact of increasing or decreasing range of the factor on another one.

1. Cost: When installer seeks to install the devices in the region where he installs the devices he considers the cost of the network. Let's consider example of GPS is the main component that Need to identify the exact location of the node. But it's costly to place the GPS at each node, because hardware increasing the cost and it indirectly affects on the quality of the network and cost is the main issue in localization in Wireless Sensor Network. L1, L2 and L3 are three nodes with GPS device but it's costly to place GPS at all nodes as shown. Right here we are not considering any kind of distance.

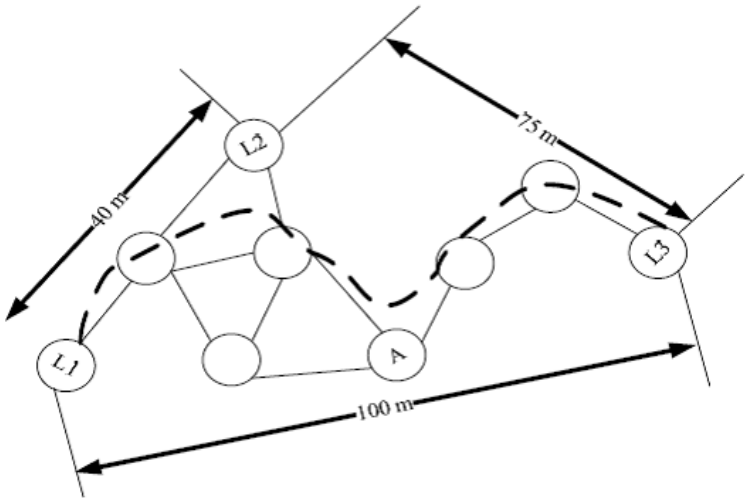


Fig. 1.4 An example of WSN using three anchors L1, L2 and L3

2. Power consumption: For the long time use of the hardware user need to consider the power consumption of the sensors When we are not considering the cost then there many condition may occurs, like one hardware may increase and power consumption may increase,

or second condition may occurs that due to many hardware options and system will not consider particular path so more power may use by hardware. User need to consider power consumption for long time use of the sensors.

3. Reliability and Flexibility: Whatever sensor node we are using in Wireless Sensor Network that should be very flexible and robust to the environment for which environment its build for. Like there are some nodes we are using on the country borders and we are using rechargeable battery, so in that case we are not able to charge the battery every day.so we can say reliable or flexible for such conditions.

4. Complexity: A main thing to location estimation is to gather Time-of- Arrival (TOA) measurements from a number of nodes and to estimate a target location. The two major sources of range measurement errors in location techniques are measurement error and Non-Line-of-Sight (NLOS) error. NLOS errors caused by blocking of direct paths have been considered as one of serious issues in the location estimation. Therefore, Iterative Minimum Residual (IMR) method, which identifies NLOS nodes and removes them from the data set used for localization, has been proposed. IMR improves location estimation precision in comparison with the technique that does not identify and remove NLOS nodes. However, IMR needs a lot of calculation to identify NLOS nodes. So we need to consider a low complexity localization algorithm based on NLOS node identification using minimum subset for NLOS environments. We evaluate our proposed algorithm by computer simulation. We show that the proposed method achieves almost the same root mean square error (RMSE) as the conventional method with lower complexity.

4. Short range: For the low power consumption administrator set the path of the sending and receiving the data from the node, and tries to gain the data through short range. Short range is in terms of the distance and other factors like power consumption etc. are directly proportional to the short range. Means as range is gets short power consumption gets less.

5. Installation: User usually installs the sensors in that places where he can't reach easily and it's hard to find the situation that what is going on. Let's take example of installed sensors under the water, or sensor placed on the country border for sensing the required data. User may have lack of experience of individual for troubleshooting those devices.

6. Mobility: In Wireless Sensor Network mobility is mainly consider in MANET (Mobile ad-hoc Network). It is easy to find the static location of the network by using different working neighbour nodes. But in case devices are moveable it's easy to sense the data but find the location of the particular node is little more difficult.so mobility is a big issue in localization in Wireless Sensor Network.

1.5 Applications of Wireless Sensor Network

Wireless sensor networks have applications in various fields which are:

- **Medical Diagnosis system:** It includes monitoring the blood pressure, pulse rate etc. of the patient and then send the generated reports to the doctor which is being concerned.
- **Forest Fire:** It includes monitoring of temperature of forest so that whenever a fire starts, it should be detectable.
- **Military applications:** Military applications include military and battlefield surveillance. Movement of the enemy troop is monitored at border areas.
- **Transportation:** In transportation, sensor nodes can be deployed in high traffic areas so that the traffic can pass reliably and easily.
- **Agriculture:** In agriculture field, crop is monitored and protected from the cattle.
- **Smart Buildings:** It includes sensor doors, elevators, accelerators etc.

1.6 Sensing in Wireless Sensor Network

- Periodic Sensing: It is the process of sensing the events and queries periodically i.e. after a certain period of time.
- Query Sensing: It is the process of sensing only the queries and not the events.
- Event Sensing: It is the process of sensing only the events and not the queries.

Sensor Nodes are very important and the crucial part of a Wireless Sensor Network as sensor nodes sense the events collects the information, processes the information, stores the message and then transmits that message through the neighbour sensor nodes to the base station. Base Station or Sink also sends queries to the source node through these sensor nodes. After gathering the information, sensor node generates the report and only that report is forwarded instead of transmitting all the raw data to the base station. So communication between source

and the sink takes place through these sensor nodes. In a sensor network, each sensor node consists of three subsystems.

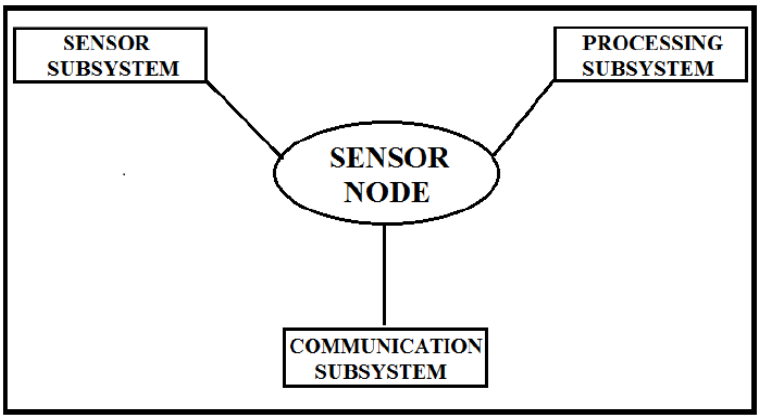


Fig. 1.5 Sensor node

- Sensor Subsystem
- Processing Subsystem
- Communication Subsystem

- **Sensor Subsystem:** This subsystem of the sensor node senses the field on the basis of various factors. Its task is to be active and to sense every event which takes place in an area.
- **Processing Subsystem:** This subsystem of the sensor node is responsible for processing i.e. computations of the gathered information sensed by the sensor subsystem.
- **Communication Subsystem:** Communication subsystem of the sensor node is responsible for announcements regarding the event occurred, the exchange of messages between the neighbour sensor nodes and between the sink and the source. It also includes a system which finds the location of the various neighbour nodes and base station using the routing protocols.

  Besides a power management system is also there in the sensor node which is responsible for managing the power i.e. how much power has consumed and how much power has left.
- **Source:** Source is the sensor node which actually generates the data when an event occurs.

- **Event:** The information which is to be reported is actually the event.
- **Sink/ Base station:** The node which is interested in the information about event is known as sink or base station.

1.7 Issues of Wireless Sensor Network

- **Efficiency of Energy**: Consumption of energy is a very vital factor for the lifetime of the network. As the traffic i.e. the transmissions of messages and queries between the source and the sink increases, more power is consumed. If power consumption is increases the lifetime of the Wireless Sensor Network decreases. So high power consumption is an obstacle for the lifetime of the sensor node and the Wireless Sensor Network.
- **Failure of nodes:** Sensor nodes are prone to failure as the energy of the nodes continuously decreases. At the certain level the node run out of the energy and it fails.
- **Unparalleled power sources:** When the sensor node is not left with energy, it dies and it cannot be replaced with another power source.
- **Failure of the whole network:** When the nodes between the source and the sink fail, then the sink or the base station is completely separated from the whole network. So as the base station is isolated, it cannot receive or send messages and queries and the whole network fails.
- **Limited Storage:** Sensor nodes are built with low memory. So limited data can be stored.
- **Redundancy of data:** Sometimes an event is sensed by more than one node. So all the nodes which sensed that event broadcasts the message to other nodes. In this way the duplicate messages are sent to one node and hence redundancy of data takes place.
- **Distance and cost trade-off:** When the source is very far from the sink or base station then it becomes expensive to manage the communications.

1.8 Clustering and Agglomerative Clustering

Clustering prologue the life time of WSN in case of data dissemination, because the node are densely deployed , the data gathered by them may be redundant in this case cluster heads are used to aggregate data, remove the redundancy and send data sink nodes. The most important

factors to select the cluster head are the distance between cluster heads. Size of the cluster and inter and intra cluster communication.

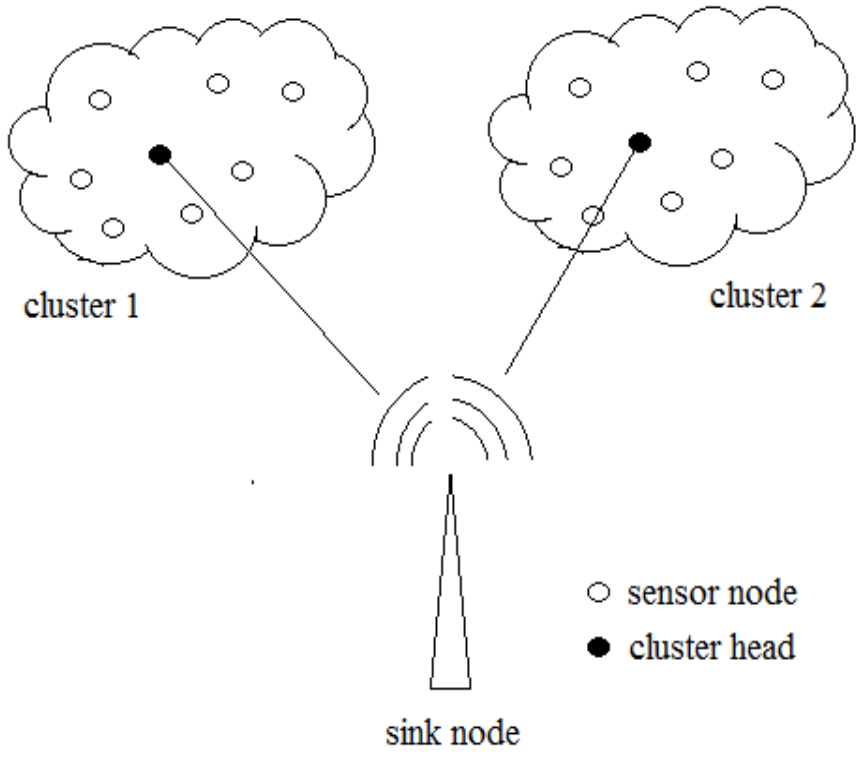


Fig. 1.6 Clusters in WSN

Multi-hop communication is used where the distance between the nodes and cluster head is more than node's transmission range; this is an example of intra-cluster communication. When the distance between cluster head and based station is more than cluster head communication range then the inter-cluster communication is used.

Agglomerative clustering is the bottom up clustering technique in which similar objects are combined and last a cluster head is selected and the node must be grouped carefully for example nodes are grouped based on their distance from a node and so on. The three main approaches for this are UPGMA, BIRCH and DBSCAN.

UPGMA is a clustering method which clusters the nodes based on similarities. The most similar nodes are grouped first and then these nodes are treated as a node and grouped to most similar node. Here the similarity is based on the distance and after grouping the distance is calculated based on generated tree. The similarity between two clusters is defined by averaging the resemblance coefficient of all in both clusters.

In BIRCH the dense region is treated collectively as a single cluster and the sparse region is treated as optional. This is the clustering mechanism which does not require the whole data in advance it scans the nodes when it wants.

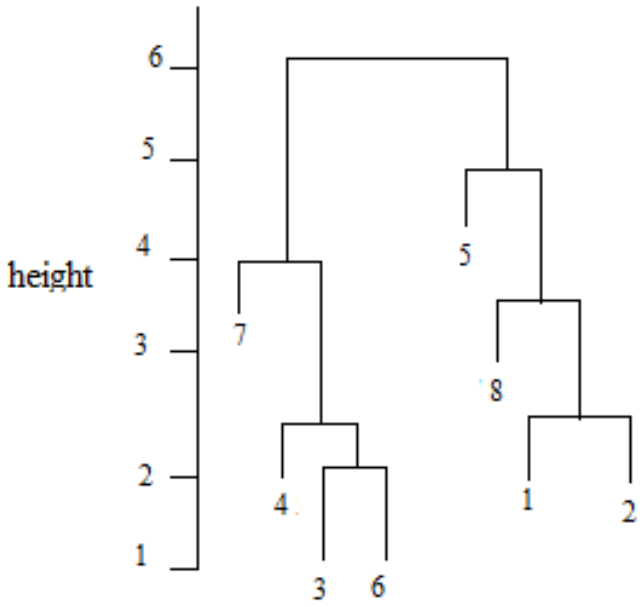


Fig. 1.7 Agglomerative clustering

Based on Euclidean distance and Manhattan distance the nodes area clustered and clustering features (CF) tree is generated. DBSCAN is clustered technique which uses Euclidian distance for clustering and clusters are generated considering monpt (the minimum number of nodes in a cluster). If number of nodes in a cluster is less minpt then that cluster is merged with nearby cluster.

1.9 Terminologies

1. **Localization**: Localization in Wireless Sensor Network is defined as the process of finding the position of the node into the network, the node may be static or moving .localization process helps to determine the geographical position of the node, localization process may be use different concepts like lateration, angulation, trilateration, multilateration, and triangulation.

- **Lateration:** Lateration is used to measure distance between nodes to find estimated location. It helps to find the location of the node.

- **Angulation:** Angulation is the used when angle between nodes need to be calculated to calculate estimated location.
- **Triangulation:** In this method we need at least two angle of un-localized node to calculate the position of the node.
- **Multilateration:** We need to have more than three points to localize the node.
- **Trilateration:** In this method we uses three node location and draw three circuits to calculate the intersection of the three circles while is the single point which is a position of the node which is un-localized.

2. **Anchor based localization:** Anchor node are the node which is GPS equipped and these type of node are aware of their own location which is used to localized other nodes in to the network, and this total process called anchor based localization.
3. **Anchor free localization:** Anchor free localization algorithms calculated only relative positions, it does not consider anchor node.
4. **GPS based scheme:** This type of schemes are very costly because it uses the hardware like GPS receiver on every node, but advantage of GPS based schemes is, it has very high accuracy. Most of the systems try to use GPS in less quantity so they can reduce the cost of the network and achieve high accuracy.
5. **GPS free Schemes:** GPS free schemes do not use GPS devices in to the network while implementing it. These kinds of systems use the parameters line distance and angle. GPS free schemes have less accuracy.
6. **Stationary nodes:** In Wireless Sensor Network nodes have nature that they are static and fixed at the one place. In maximum applications uses stationary nodes, and that is one main reason many algorithm for localization are designed for static node.
7. **Mobile Node:** Mobile anchor nodes are movable in nature and in network for the particular purpose. In vehicle ad-hoc network the node used i.e. mobile node. In many applications, mobile nodes are equipped with GPS and these types if nodes we called mobile anchor nodes.
8. **Grid:** In graphics, design, lines are used to sub-divide the page using vertical and horizontal lines. Page can be divided vertically and horizontally into margins, inter column space of columns.

9. **Sub grids:** Grids are again subdivided into sub-divisions known as sub grids. Sub grids can be of any shape like square, circle, pentagon, etc.
10. **Network Manager**: In Wireless Sensor Network, network is managed by network manager. The manager tries to solve the problems that arises in the network, for example replacement of the dead node, link failure problem and if any node having battery issues.
11. **Grid Manager:** Grid manager is responsible for managing nodes that comes under the grid. It receives the signals from the other nodes present in the network and allocates them the sensing task. If there is any dead node in the grid then the grid manager sends the message to the network manager to replace that particular node.
12. **Sensor Nodes:** It is made up of hardware and software component which is used to sense the environment sensor nodes are used in environmental, military industrial and many more applications. Sensor node may be the static.

CHAPTER 2

REVIEW OF LITERATURE

In Wireless Sensor Networks, Localization very large and important problems and challenges, while working on the sensor network it is very important to know the location of the sensor, without the exact information of about the location makes that data of no sense. Localization performs very important role in Wireless Sensor Network, like target tracking. The main idea in localization method is they firstly deploy some nodes with such coordinates that are knows using GPS and transmit beacons with their coordinates to help other nodes to find their position. In this paper, we survey some of existing localization issues on which we are focusing on, like cost of the network, power consumption, flexibility, complexity, mobility, short range etc. and localization algorithms. Localization algorithms are classified into two categories: range-based and range-free. We have discussed about the Range based algorithms in this paper. Range based algorithms are depends on measuring physical attributes of the wireless signals that are transmitted between the antennas using techniques like received signal strength indicator (RSSI), the time of arrival of the signal (ToA), and the angle of arrival (AoA).

In this paper author explains about the accuracy of the localization result while there is noisy environment and other interference. And he has described about the omnidirectional and single directional antenna.

Baoli Zhang, and Fengqi Yu *et.al* (2010), "LSWD: Localization Scheme for Wireless Sensor Networks using Directional Antenna" have explain the about the how to get accurate location of the nodes with help of directional antenna.

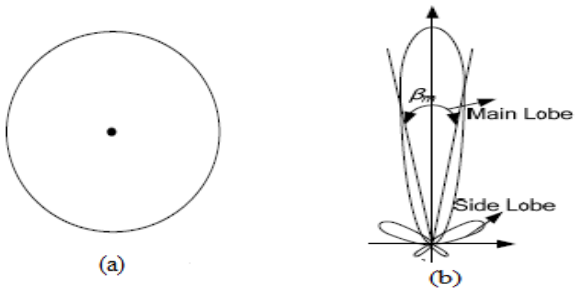


Fig. 2.1 Antenna model (a) Omni directional, (b) Single beam directional antenna

On the basis of geometry techniques using the directional Antenna of mobile anchor nodes author proposed a localization scheme called LSW Localization scheme Wireless Sensor Network using directional antenna. And it concentrate the energy in a one particular direction with high gain and narrow area covered, it uses minimum number of beacon information without increasing hardware and complexity.

The reviewed literature describes the data dissemination in different cases i.e. in case when the sinks are stationary and in case when the sinks are mobile. The shortest paths which are considered to disseminate the data so as to utilize the energy are also described.

Sung Hwi Kim *et.al* (2012), "Data Dissemination Protocol with Hole Masking Algorithm in Grid-based Wireless Sensor Networks" has explained the issues of whole problem which is faced by the data dissemination protocol in Wireless Sensor Network. They described that whenever sensor nodes are failed due to energy consumption or any physical destruction then holes are generated. Hole masking algorithm is proposed in this paper to deal with various holes in WSN and to reduce the energy consumption and to increase the lifetime of wireless $sensor network by avoiding complicated computation and selecting the dynamic node in the grid cell. Hole masking algorithm explains that in each grid, residual energy i.e. node with larger energy level is selected as the head node. In Wireless Sensor Network, this head node is responsible for dissemination of data. Whenever any event takes place, the data is sent to head node for generation of data report and then that data report is forwarded to the sink. The queries of the sink are also handled and managed by the head node. So the energy of the head node is consumed at high rate. When this node dies or fails, the nearest node with largest residual energy is selected as the new head node.

Ahad Jahangiry, Ramin Ahmadi, Shahram Babaie *et.al* (2011), "Localization in Wireless Sensor Network by Mobile Stations Based on Random Distribution" in this paper author is focusing on the localization of methods in Wireless Sensor Network like trilateration method, three angles and multilateral method to find the location of the node. It is very easy to find the location of the other nodes using this techniques, it uses the mathematical parameters like angle, radios, distance, so it can be calculate using the formulas that are already mentioned in the method description. This paper author is identifying the location of the node by a technique in which four nodes are deploying on such place that it

forms a square. Sensor node identifies their location after receiving data from the particular station.

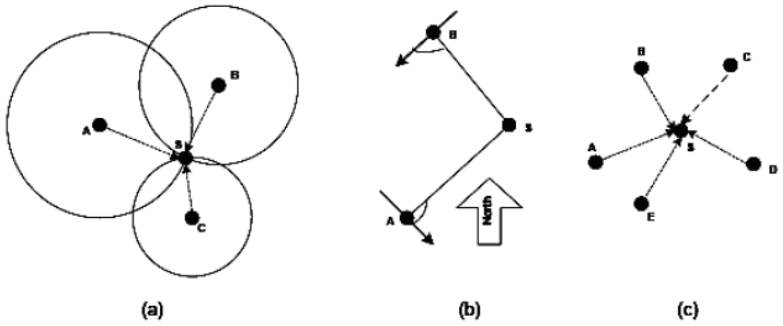


Fig. 2.2 Domain composition methods (a) Trilateration (b) Three angles, (c) Multilateral

Once t it gets the data from the station as a centre of the field which are coordinated edge of the area and according to the author simulation is shown that it takes short time to locate the unknown station and have small average error rate and high success rate.

Vasileios Mekikis, G. Athanasiou, Carlo Fischione *et.al.2013* "A Wireless Sensor Network Testbed for Event Detection in Smart Homes" in described case paper author is focusing on the detection event including water leakages and shutting the water pipes depend on the event detection, Testbed is used for the accurate distributed event detection by Wireless Sensor Network for applications used in smart homes. Author combines the detection theory and estimation theory to provide more accurate result. And he is using indoor localization to identify the detect event. According to the detection of event the user is alerted through a notification of twitter alarm, and probability of the false alarm is become well than before by 30% and enhanced performance related to error by 1.7%.

B.T. Lee, S. Kim *et.al* (2008) "Scalable DV-Hop Localization for Wireless Sensor Networks" as the author described in the paper, author is emphasis on to reduce the cost of the communication. As we know localization has two types of the algorithms. Range based and range free algorithm. The sensor nodes based on range based schemes uses special devices and that are not suitable for the measurement in Wireless Sensor Network. So, author is proposing algorithm named SDV-Hop algorithm for the communication to reduction of the cost and improve its performance.it has less complexity than DV-Hop localization algorithm.

This algorithm is dividing networks in to multiple cells and flooding is also limited so communication cost is reduced.so SDV-Hop algorithm is well suited for the network with large number of nodes.

A. Baggio, K. Langendoen *et.al* (2008) "Monte Carlo localization for mobile Wireless Sensor Network**s"** as authors is described in the paper they are using range-free localization algorithm which is based on the anchor nodes. Author called it Monte Carlo localization boxed author claimed that has improved the localization accuracy and efficiency for the gathering of the information in a better way using filtering and selection of particular area algorithm bound the area with particular limit which samples the area of deployment in a localization area and simulation showing the result that accuracy is improved by minimum of 3% and maximum of 73% and it has reduced the cost for the future work there is trade of s of the energy and accuracy of Monte Carlo localization boxed algorithm.

Guangije. H. huixu, T. Q. dunge, J. jiange, t. hara *et.al.* (2011) "localization algorithm of wireless sensor network: survey, in this paper authors are described about the different localization algorithm they described uses of the techniques in localization of nodes and sensor network practical use like in military area on the border, In many huge application like smart homes. They have given the classification of the algorithms.

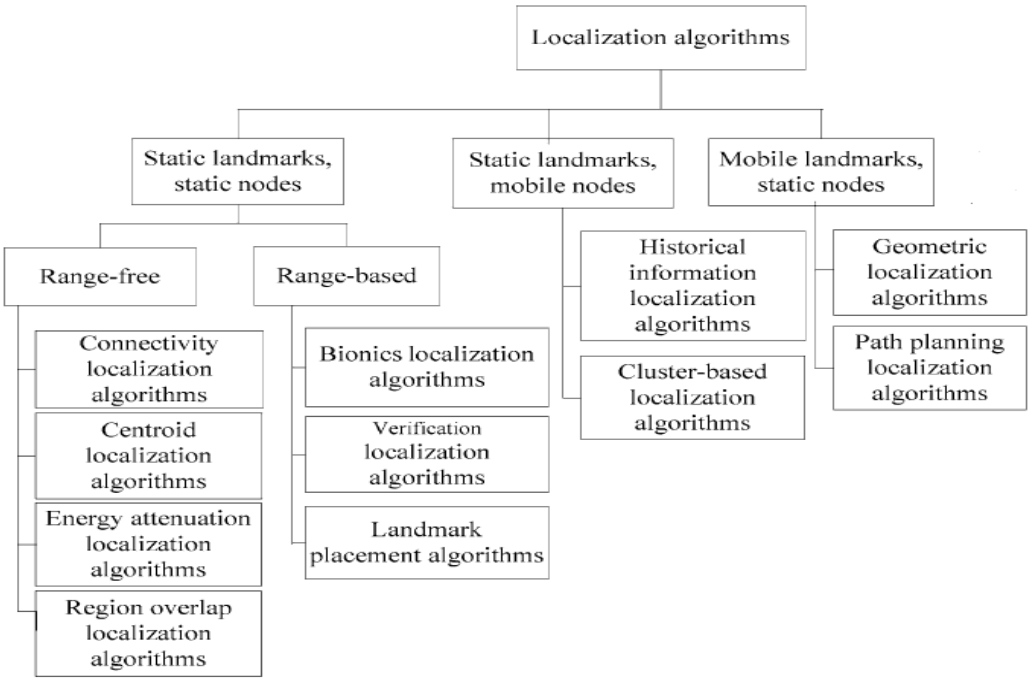


Fig. 2.3 Classification of localization algorithms

Author has explained about the techniques of the localization i.e. range free and range based that comes under the static landmark static nodes. They have explained about static landmark mobile nodes and mobile landmark static nodes as shown in classification diagram. They also have compared those algorithms as shown in table.

Table 2.1 Comparison of the algorithms

Algorithm name	Localization accuracy	Node density	Landmark density	energy consumption
DV-hop algorithm	Better	Greater	Smaller	Greater
Landmark Sparse algorithm	Average	Smaller	Smaller	Greater
Centroid algorithm	Average	Smaller	Greater	Greater
Three dimensional algorithm	Better	Smaller	Smaller	Greater
APIS algorithm	Better	Smaller	Greater	Smaller

Baoli Zhang *et. al.* (2009) "An Improved Localization Algorithm for Wireless Sensor Network Using a Mobile Anchor Node" Localization algorithm proposed by the Ssu and guo with help of mobile anchors for the localization as per the algorithm described one mobile anchor is roam around the area i.e. sensor area and at the particular quantum of time broadcast the beacon messages which tells them then information about the mobile anchors, information includes the current location of the anchor node, so other anchor use that information for the localization.

Once mobile anchor enters within the range of the static node it receives the beacon messages it records the entering and location i.e. first location within the area and exit location i.e. last location while passing through the range of the stationary node.

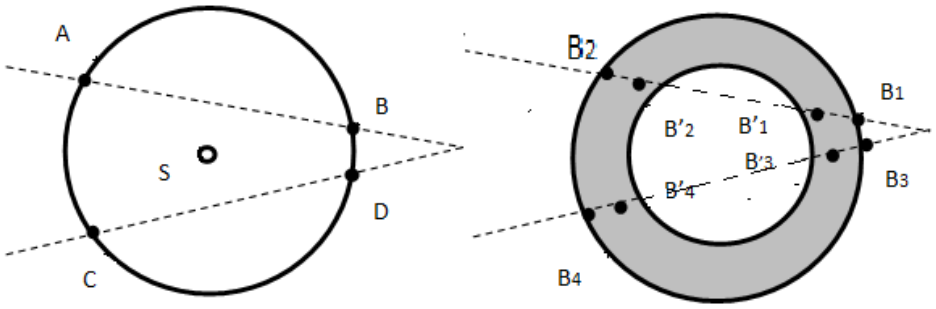


Fig. 2.4 (a) Identification of sensor node location (b) Error occurrence in localization

Like we can see in fig 3.4, It shows that it has grey area which has high probability to receives the broadcast bacons messages by the sensor node S. as per the Ssu algorithm, B1,B2,B3 and B4 are the bacon point but B'_1, B'_2, B'_3,and B'_4 are the actual bacon points so causes the localization error. So we are working on the algorithm for low cost and accurate localization algorithm.

J. Sena Esteves *et. al.* (2009)"Generalized Geometric Triangulation Algorithm for Mobile Robot Absolute Self-Localization" in this paper author has described about the triangulation method for the localization. Mobile robots send the beacon points from the three different locations which is helps to calculate the node location into the network. But there are two conditions to apply these methods. First, the beacon points must be ordered in antilock wise fashion and second, all three beacons should have less than 180°.

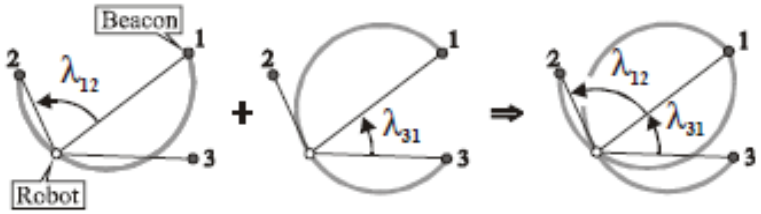


Fig. 2.5 Three object triangulation

Baoli Zhang and F. Yu (2009), "An Energy Efficient Localization Algorithm for Wireless Sensor Networks Using a Mobile Anchor Node", The node it is using into the network which is having GPS receiver will be the mobile node or we can say it is mobile anchor and it will roam over the network and it will broadcast its own location to its neighbour node. The movable node chooses the best path into the network to roam, so it will visit the maximum number of node network. The anchor node will broadcast the location after a particular quantum of time and then stationary node work they are virtually anchor points, so further they can help to calculate the distance or can say location of the neighbour node location them. If we emphasis on the localization of individual node in Wireless Sensor Network when same nodes are in mobile condition at the same time and if we are considering the cost then use of GPS are not efficient, So, with help of mobile geographic distributed localization(MGDL) algorithm by using acceleration that equipped in nodes. Each node is

monitored by the MGDL and then use detection procedure to detect the node movement if happens on network. Sometimes node may be mobile so need to detect that movement for accurate localization result, as the node moves it starts a series of procedure to mobile localization to calculate again and update localization of the moveable node locally until the node stops the movement and become static.

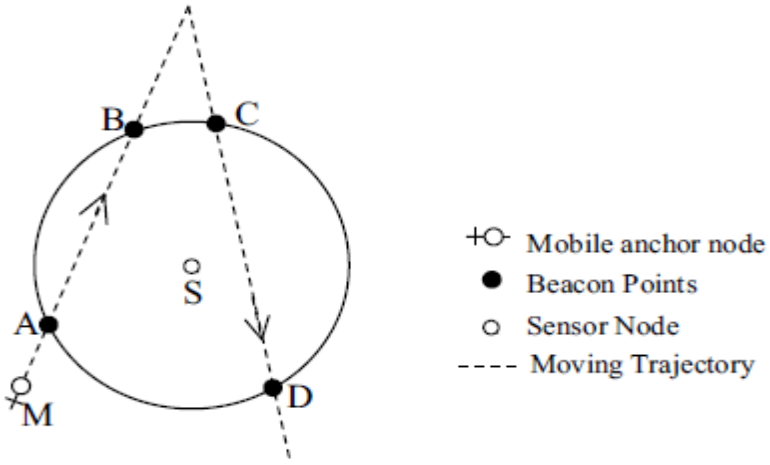


Fig. 2.6 Beacon point selection in Ssu's algorithm

it uses the parameters like distance, movement from particular point of the node i.e. acceleration, time etc. to calculate the acceleration but these are part of the accelerometer ,in this procedure it takes the advantage of the MGDL localization algorithm using robotics in which robot may have perception or may be a pre-learned map of the network environment and area.

H. Chen *et. al.* (2013), "Accurate and Efficient Node Localization for Mobile Sensor Networks" in this paper the authors are described about the technic to improve the accuracy and efficiency of the localization of the node in Mobile Sensor Network. They have proposed a range free co-operative localization algorithm. It combines the hop distance measurement steps. For decreasing the positioning error they have designed the differential-error correction scheme. Authors are also described about the back off-based broadcast mechanism for the localization algorithm. The key term behind these technics are suppress redundant broadcast and decrees the message overhead. According to author proposed method is fast and efficient. It has fast convergence and it has small localization estimation error.

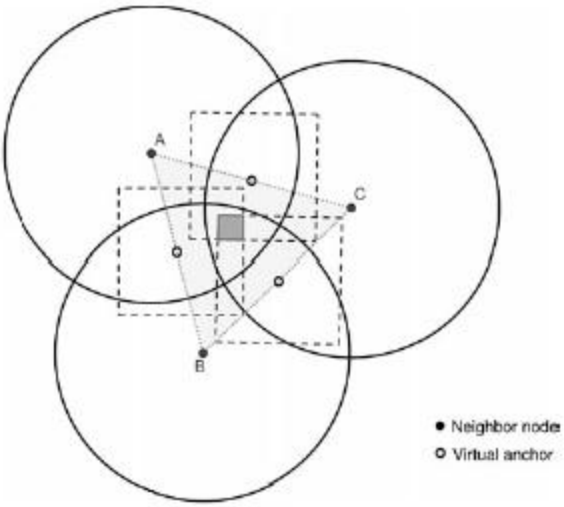


Fig. 2.7 Example of building a location prediction area using information from three one-hop neighbors

Above shown Fig. 2.7 shows the prediction area and particles. Particles represent possible locations extracted. It has three nodes A, B and C which has some acceleration.it considers velocity. Velocity may be calculated by sensor data. For example sensor nodes can estimate velocity itself, Using three dimensional accelerometer.

Conclusion

Wireless Sensor Network has sustained enormous technological advancements. Wireless Sensor Network is a network composed of sinks, sources and sensor nodes. These devices communicate to each other through wireless medium. Wireless medium may be the radio signals. Sensor nodes are distributed randomly without predetermining their positions over a particular area or field and they don't need any installation. These sensor nodes are inexpensive and have the low energy and different memory capabilities. The technology behind the Wireless Sensor Network allows it to develop a single network instead of various large networks.

When an event occurs, the sensor nodes deployed in that sensor field work to sense environmental or physical conditions such as temperature, sound, pressure, etc. The data gathered after monitoring the particular area by the sensor nodes is processed based on certain phenomena and the information is broadcasted to the base station (which is the central node) through network i.e. through various neighbour nodes. Each node before forwarding the information to the next node checks that whether the node itself is not the destination node. sensor area and at the particular quantum of time broadcast the beacon messages which

tells them then information about the mobile anchors, information includes the current location of the anchor node, so other anchor use that information for the localization.

CHAPTER 3

PRESENT WORK

3.1 Rationale

We are using mainly two methods include redeployment and mobile anchor to localize the nodes. These two methods are very beneficial to reduce the cost of the network and to achieve accuracy. In the Wireless Sensor Network we are using limited number of mobile anchors equipped with the GPS. Consider a network where we are using Global Positioning System on each node and we know that deployment of GPS on every node increases the cost of the network, so it is better to use limited number of mobile anchors which will roam all over the network and localize all nodes. Redeployment is very much important to solve the problem of the link failure and dead node.

3.2 Scope of the Study

In Wireless Sensor Network which is consist of the sensor nodes, it is very important to know about the location of the sensor nodes, so we can reach the area or field i.e. place where node is deployed to take the action if necessary. Such as at the war time it is necessary to keep the information about the border area that no one is crossing the border. if we are not able to track the location of the information would be of no use, so nodes are using the Global Positioning System (GPS) to know about its own location so it can send its own location to reachable nodes and other neighbour node can calculate their own location with help of stationary nodes using the methods like angle of arrival, time distance of arrival.

The node it is using into the network which is having GPS receiver will be the mobile node or we can say it is mobile anchor and it will roam over the network and it will broadcast its own location to its neighbour node. The movable node chooses the best path into the network to roam, so it will visit the maximum number of node network. The anchor node will broadcast the location after a particular quantum of time and then stationary node work they are virtually anchor points, so further they can help to calculate the distance or can say location of the neighbour node location them. If we emphasis on the localization of individual node in Wireless Sensor Network when same nodes are in mobile condition at the

same time and if we are considering the cost then use of GPS are not efficient, so we are using limited number of mobile anchor so it reduces the cost of the network and we don't need to use GPS on every node, with help of Ssu and Yu's algorithm we are localizing the nodes. But prier we are managing the network in a designed fashion. The necessary steps we need to consider are size of the grid, position of the sensor nodes and in which sub grid the sensor is deployed, because in this research we are using fixed grids, fixed sub grids and fixed number of the sensors in each grid, by using acceleration that equipped in nodes. Each node is monitored by the MGDL and then use detection procedure to detect the node movement if happens on network.

Sometimes node may be mobile so need to detect that movement for accurate localization result, as the node moves it starts a series of procedure to mobile localization to calculate again and update localization of the moveable node locally until the node stops the movement and become static. it uses the parameters like distance, movement from particular point of the node i.e. acceleration, time etc. to calculate the acceleration but these are part of the accelerometer ,in this procedure it takes the advantage of the MGDL localization algorithm using robotics in which robot may have perception or may be a pre-learned map of the network environment and area.

3.3 Problem Formulation

From the literature review it is inferred that the consumption of energy, cost of sensor nodes etc. are big issues to be concerned for enhancing the life period of a Wireless Sensor Network and solve the problems most probably occurs while transmission of signals like, link failure problem, dead nodes problem, better management of the battery, Less energy consumption. Less cost of the hardware. Sensor node is operated by the non-rechargeable battery, so utilization of hardware to decrease the cost of the network by use of the mobile anchor and by using other methods for localization Wireless Sensor Network.

3.4 Objectives

- To redeployment of the node to solve the problem of link failure between the nodes into the network and replace the dead nodes.

- To use the mobile anchor in the Wireless Sensor Network for the localization of the sensor nodes, mobile anchor will roam all over the network and broadcast its own location to the neighbour nodes to localize them.
- To reduce the cost requiring for the communication, it may be the hardware cost, we are using mobile anchor node for the localization so no need to use of the Global Positioning System at every node.
- To minimize the energy consumed in whole process and energy management, as we are using mobile anchor it reduces the use hardware at every node like Global Positioning System so it will consume less energy.

3.5 Research Methodology

Localization algorithm proposed by the Ssu and guo with help of mobile anchors for the localization as per the algorithm described one mobile anchor is roam around the area i.e. sensor area and at the particular quantum of time broadcast the beacon messages which tells them then information about the mobile anchors, information includes the current location of the anchor node, so other anchor use that information for the localization.

Once mobile anchor enters within the range of the static node it receives the beacon messages it records the entering and location i.e. first location within the area and exit location i.e. last location while passing through the range of the stationary node.
Like we can see in fig 3.2, It shows that it has grey area which has high probability to receives the broadcast bacons messages by the sensor node S. as per the Ssu algorithm, A, B, C and D are the bacon point are the actual bacon points so causes the localization error.
So we are working on the algorithm for low cost and accuracy while use of localization algorithm.

As shown in fig. 3.2, Dark portion of the figure showing the range of the sensor node which covers the sub grid, and only that much portion we are going to consider, and the portion with light grey colour shows the actual range of the sensor. The purpose of considering the range only with the dark shaded colour is to cover the maximum portion of the grid even if the considered node is placed on the unplanned place.

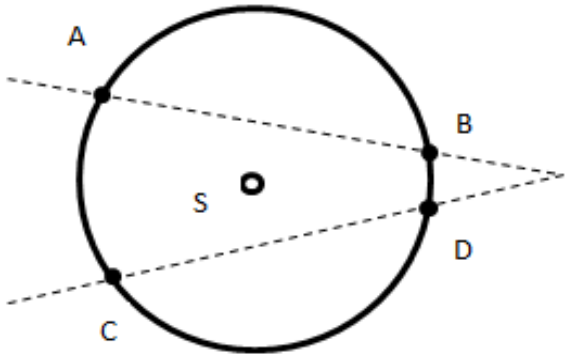


Fig. 3.1 Identification of sensor node location

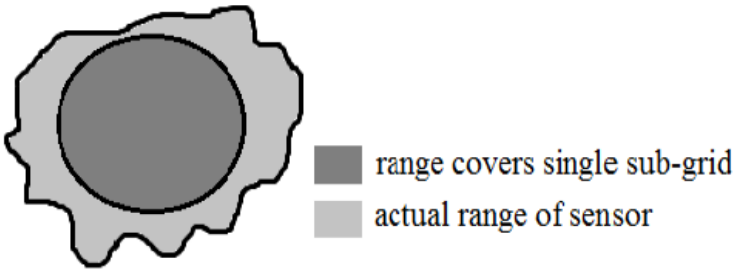


Fig. 3.2 Actual range of the sensor node

In this algorithm of the localization we have used the method of redeployment to solve the problem of link failure and dead node problem and increase the life time of the network by proper management of the battery consumption.

3.6 Steps of Algorithm

There are mainly nine steps to implement the algorithm, and every step introduces new terminologies that we have prior defined in chapter no. 2 terminologies.

Step 1: Select the area: The first step of selecting the area is mainly decides the area, where the network we want to deploy and which area we have to cover to sense the environmental factors.

Step 2: Define the area of the grid: After the selection of the area we need to subdivide the area of the grid from vertically and horizontally. So we can easily identify the area of the sensor node, i.e. in which grid it is exactly placed. And area of the grid is fixed so that it can

easily be dived in equal parts and that also help for the mobile node movement. We called it main grid.

Step 3: Define the sub grid of each grid: It is very necessary to divide the main grid in to sub grid. So it can be exactly identify the in which main grid it has deployed and in particular main grid and in which sub grid it has deployed so if any problem occurs in to the network like node got dead or any link is failed so, with help of the location of the node we can easily replace the node.

Step 4: Deploy the sensor nodes into the each sub grid: Once we selected the area and divide it into the form of grids we are ready to deploy the sensor nodes in to the particular grid. According to the grid sensor will get deployed, in each sub grid there is only single node we need to place and each main grid contains only four grids.

Consideration:

- Area of main grid
- Area of sub grid
- Range of the sensor
- Number of sensors in each grid
- Number of sensor in each grid

Step 5: Define the manager of each grid: This is very important aspect of the algorithm because half of the solution of the problems is depends upon the grid manager. Like, identify the dead sensor node, sending the message to the network manager. Selection of the network manager is depends upon the energy of the node i.e. the node with the maximum energy level is the manager of the main grid. And network manager manages the nodes of its area and all other sensors will send the signals to the network manager that they are alive and allocate the task to them.

Maximum energy node = manger of main grid

Step 6: Find the dead node: In this step we need to apply condition if signal received from each node in the sensor of the main grid then it considers that all nodes are alive and allocates the task of sensing to the sensor nodes, And if battery of the node is less than 10% then it sends the message to the grid manger that “low battery, please do not allocate any task or

change the sensor node" else Find out the dead node and its id, Send the message to the network manager, Change of sensor node by the network manager, Inform to the grid manager that sensor has changed.

IF signal received from each node in the sensor of the main grid

{

i) All nodes are alive

ii) Allocated the task of sensing

IF (battery of the node <10%)

{

Message to grid manager "low battery, please do not allocate any task or change the sensor node"

}

}

ELSE

{

i) Find out the dead node and its id

ii) Send the message to the network manager

iii) Change of sensor node by the network manager

iv) Inform to the grid manager that sensor has changed

}

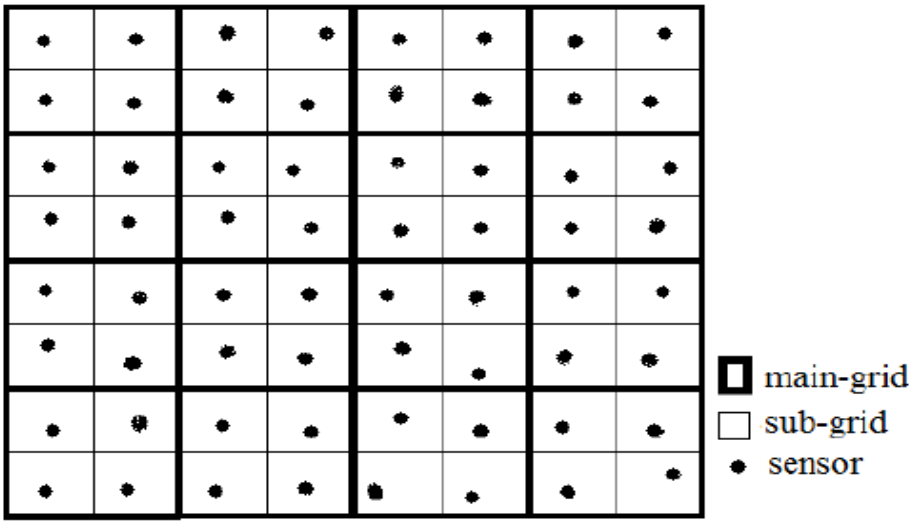


Fig. 3.3 Map of area after deployment

Step 7: Send the beacons to the sensor node: Beacon sending process to each sensor node massage will contain sensor location, node_id, timestamp, and with help of these parameters mobile anchor localizes the all nodes, but due all this process sometimes it may happen that some nodes may be remain un-localized. This kind of nodes we called UL (Un-Localized node) nodes.

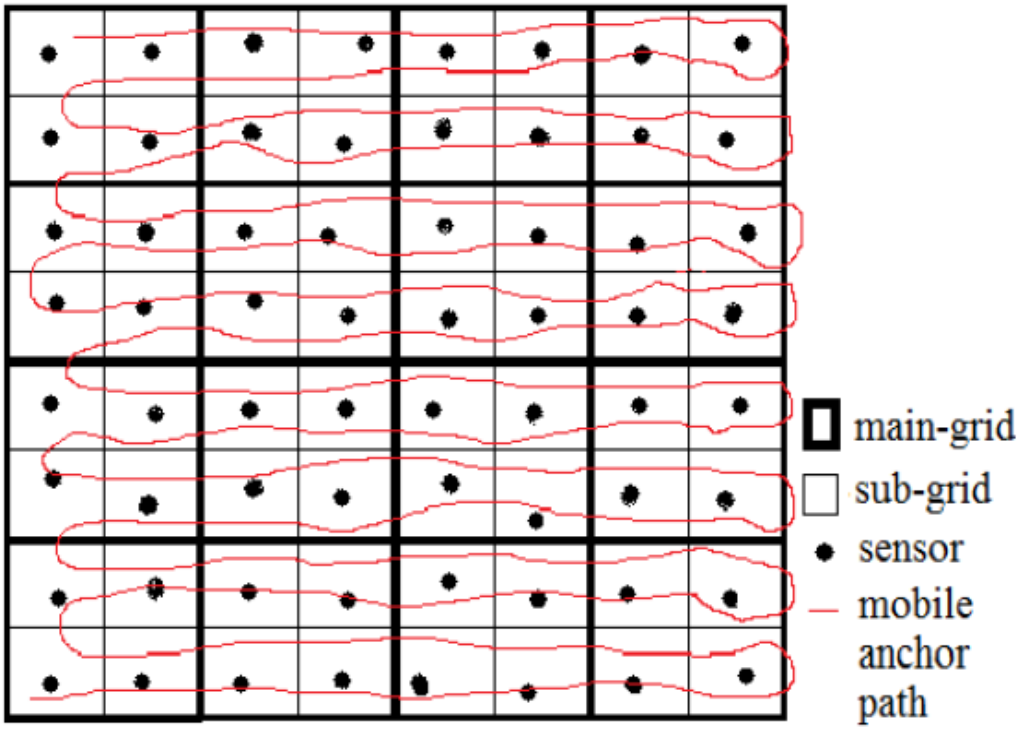


Fig. 3.4 Mobile anchor roaming for sending beacons

Step 8: Selection of the beacon points: For the purpose of the localization it is very necessary to make the chords and we use at least three beacon points from the mobile anchor and that beacon point with the strongest frequency preferred first.

Mathematically,
Selected beacon points $\{B_i,B_j,B_k\}= (x_i,y_i)$, (x_j,y_j), and (x_k,y_k)

- Calculate the difference three to sort signal strength

  For ($k=1$; $k \leq m-2$; $k++$)

  $d_k = s'_{k+2} - s'_k$
- Sort the signals strength in ascending order(B'_{min} , B'_{min+1} , B'_{min+2})

  first_min=min

Select Chords $B_i B_j$ and $B_j B_k$

After selection of the points and selections of the chords $B_i B_j$ and $B_j B_k$ we need to put the value into the equation given below.

$L_{ij} : a_{ij}x + b_{ij}y = c_{ij}$ --------- eq. 1

$L_{jk} : a_{jk}x + b_{jk}y = c_{jk}$ ---------- eq. 2

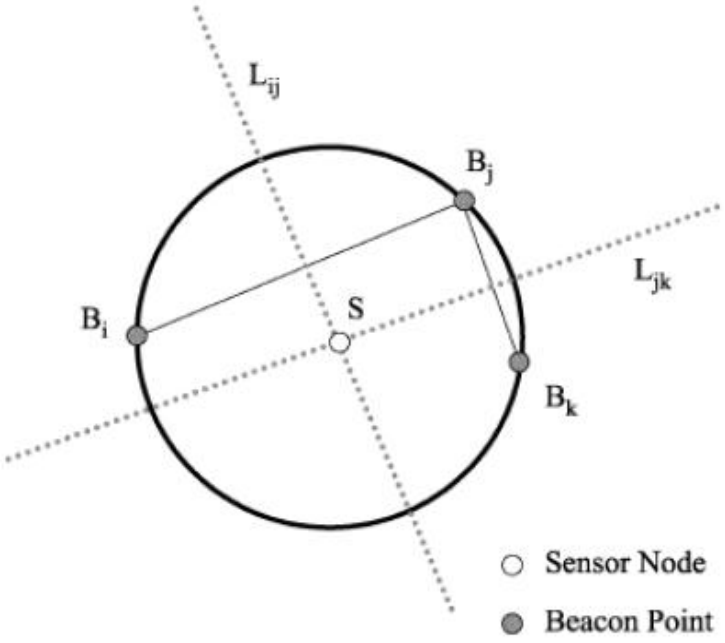


Fig. 3.5 Chord selection

Then we Use crammer rule to calculate the location of the sensor based on above parameters

$X= (c_{ij}*b_{jk}-c_{jk}*b_{ij})/(a_{ij}*b_{jk}-a_{jk}*b_{ij})$,

$Y= (a_{ij}*c_{jk}-a_{jk}*c_{ij})/(a_{ij}*b_{jk}-a_{jk}*b_{ij})$

Where, $a_{ij}=x_j-x_i$, $B_{ij}=y_j-y_i$,$c_{ij}=(x_j-x_i)((x_i+x_j)/2)+(y_j-y_i)((y_i+y_j)/2$,
$A_{jk}=x_k-x_j$,$b_{jk}=y_k-y_j$, and $c_{jk}=(x_k-x_j)((x_j+x_k)/2)+(y_k-y_j)((y_j+y_k)/2)$.

The sensor location is the point where L_{ij} and L_{jk} will meet each other.

Step 9: Apply triangulation method: Sometimes it may happens that some sensor node into the network remain un-localized and if we are using mobile anchor for this problem then

possibility is that mobile anchor need to roam all over the network again and again until node gets localized. But solution for this problem is there. If any node is still localized then we use Geometric Triangulation algorithm. This method localized the node with help of the other nodes into the network.

If (node = UL)

{

1. Properly order beacons.

2. Let λ_{31} =360^{o}+(λ_1 - λ_3)

3. Let λ12= λ2- λ1

4. Let ϕ be the angle between the positive x-axis & the line formed by the points of beacons 1 and 2.

5. let σ be the angle between the positive x-axis and beacon 1 and 3, plus φ.

6. Let γ = σ- λ31

7. Let p = $\frac{L31.sin\,\lambda12}{L31.sin\,\lambda31}$

8. Let τ =tan^{-1} $\left(\frac{sin\,\lambda31-\text{p.sin}\gamma}{p.\cos\gamma-\cos\lambda12}\right)$

9. Let L1= $\frac{L12.\sin(\tau+\lambda12)}{sin\lambda12}$

10. $X_R = X_1 - L1.\cos(\varphi + \tau)$

11. $Y_R = Y_1 - L1.\sin(\varphi + \tau)$

12. $\theta_R = \varphi + \tau - \lambda_{12}$

}

Else

{

Null

}

Cartesian plane, labeled 1, 2 and 3, known positions (x_1, y_1), (x_2, y_2) and (x_3, y_3).

L_{12} = distances between beacons 1 and 2

L_{31} = distances between beacons 3 and 1

L_1 is the distance between the robot and beacon 1

(x_R, y_R) = position

θ_R = orientation

λ_1, λ_2 and λ_3 = Angle between robot and beacon points (relative beacon orientations from the robot).

UL = un-localized

L = localized

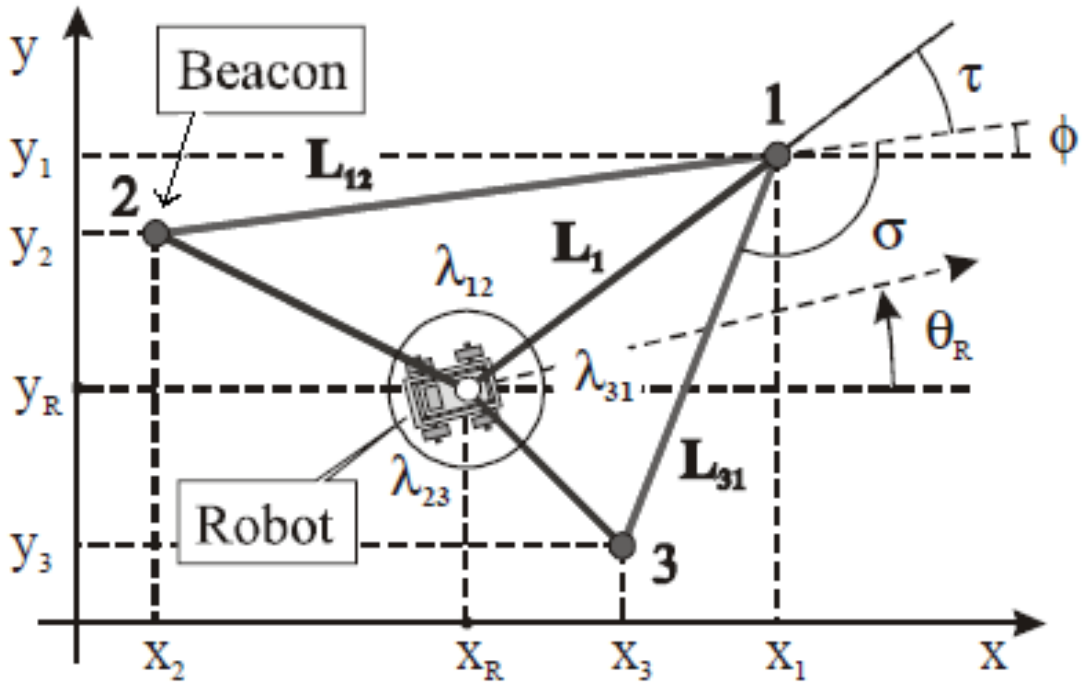


Fig. 3.6 Parameters used triangulation method

While applying this algorithm we need to consider some conditions. Conditions are related to labeling of the nodes we are using into the network and the angles between the beacons we have selected.

Specific Restrictions of the Geometric Triangulation Algorithm

1. The beacons must be labeled consecutively (1, 2, and 3) in anticlockwise fashion;
2. Both the angle between beacons 1 and 2 (λ_{12}) and the angle between beacons 1 and 3 (λ_{31}) must be less Than 180º.

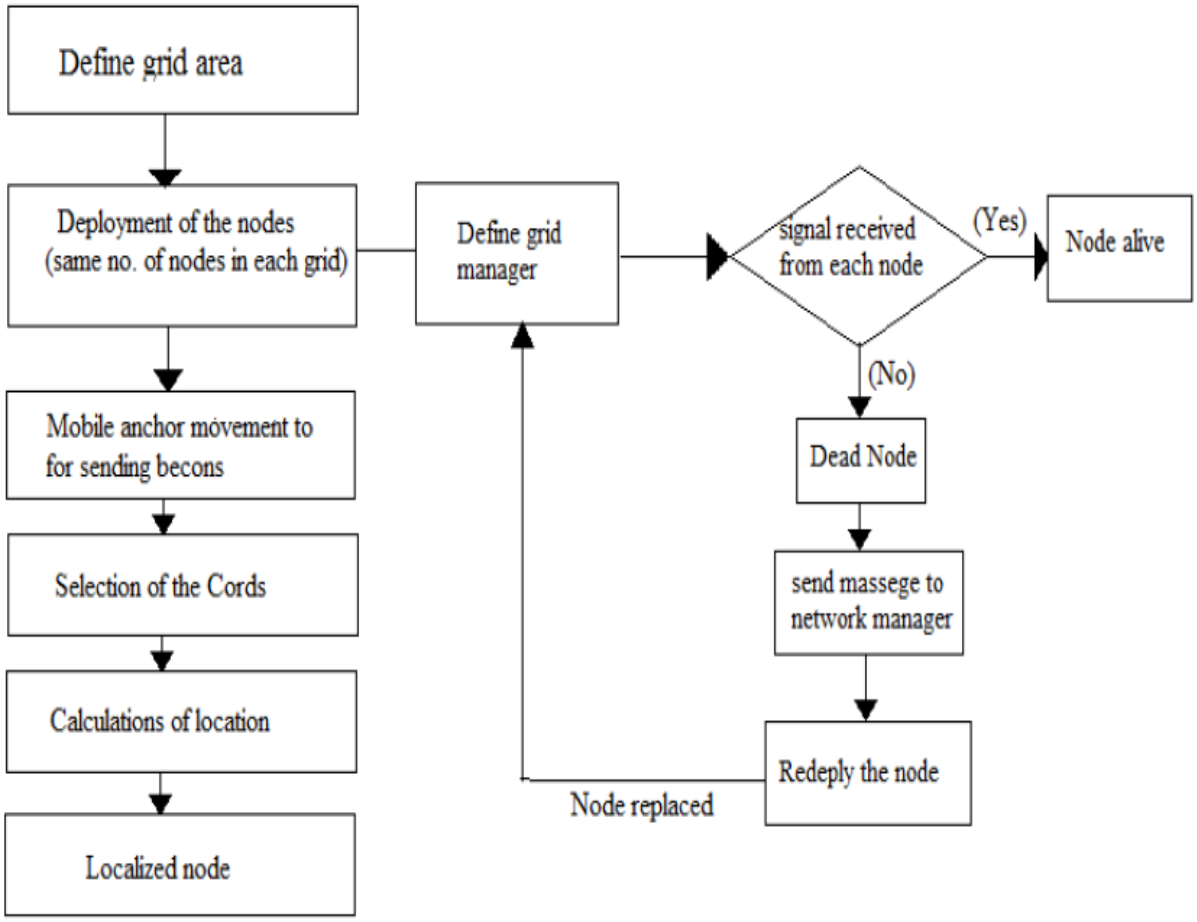


Fig. 3.7 Flow chart for proposed methodology

Flow chart 3.7 indicates the flow of the process we are following while executing the algorithm. Process is stated form selection of the area and ends at the localized node. We have discussed in detailed in section.3.6.

CHAPTER 4

RESULT AND DISCUSSIONS

4.1 Assumptions

- Nodes are spread over a certain area in which nodes can meet requirement of network range and connectivity.
- The sink node is fixed and has enough transmission power.
- Some nodes can fail when their energy is fully consumed.
- Area of the grid is fixed.
- Each main grid has equal number of nodes.

4.2 Simulation Parameters:

Parameters	**Values**
Size of Sensing area	600x600
Beacons interval	0.1, 0.3, 0.5, 0.7, 0.9 sec
Max moving speed if mobile anchor	10m/sec
Range of the Sensor Node	150x150
Area of the Main-Grid	300x300
Area of the Sub- Grid	150x150
Distance between two nodes	150
Exchanged Message Size	
Cluster Head Report	12 bytes
Beacon Messages	6 bytes
Acknowledgement	6 bytes
Data Packet	512 bytes

4.3 Results

This section is describing about the result observed during the execution of the research work on the simulator.

4.3.1 Scenario 1

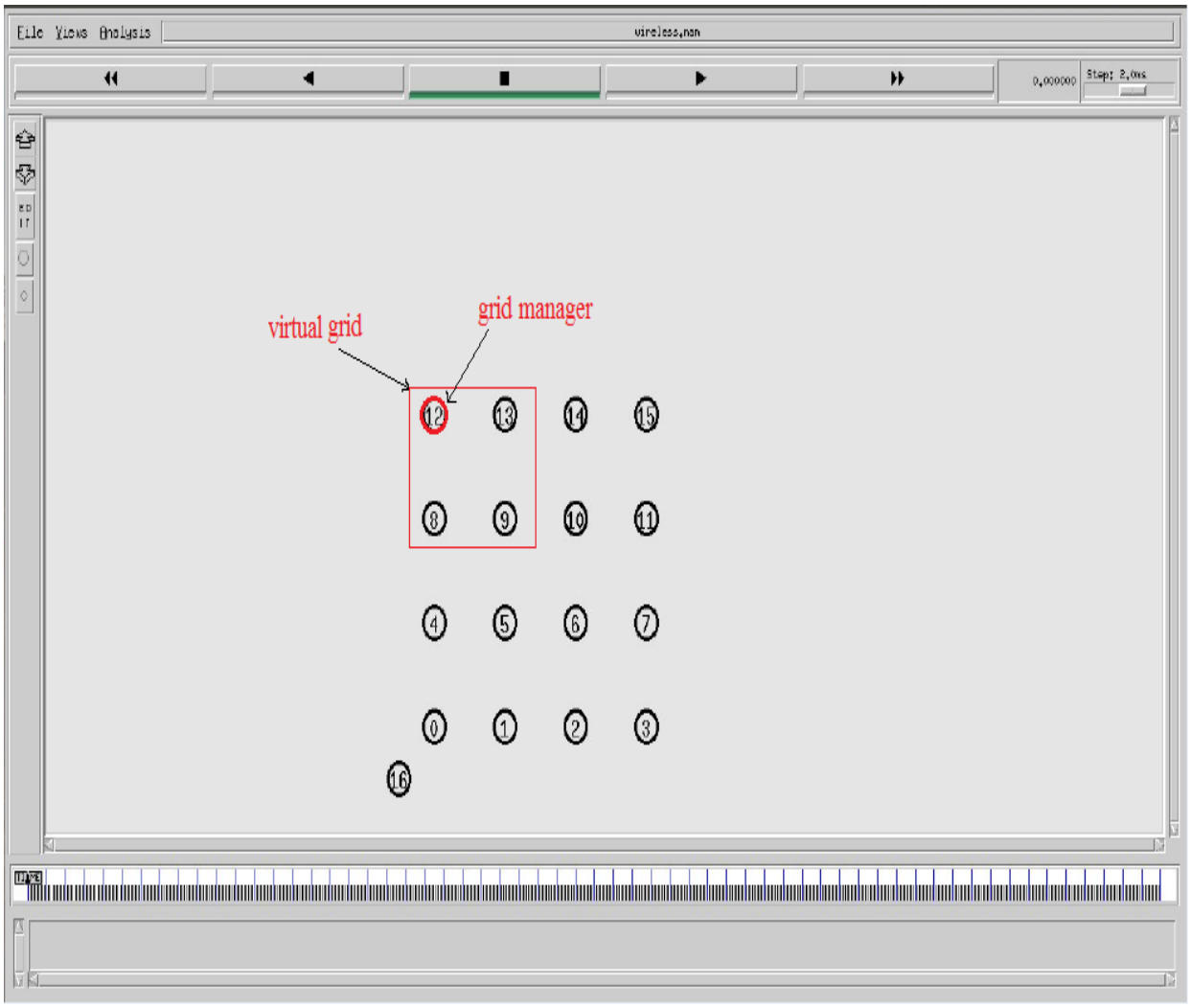


Fig. 4.1 Virtual grid and grid manager

Scenario 1 showing the deployment fashion of the sensor nodes and structure of the grid we need to deploy while creating the network. As shown in scenario, Wireless Sensor Network having total 17 nodes including mobile anchor node. Each node is deployed at the fixed location. And these nodes are deployed into a grid called sub grid. Collection of the four sensor nodes making the one cluster, considered as a one main grid. The grids we are

creating would be virtual grid. Each grid has one grid manager which manages the sensor nodes involve into the grid. Grid Manager sends the message to the network manager if there is any problem with the sensor nodes in to the cluster.

4.3.2 Scenario 2

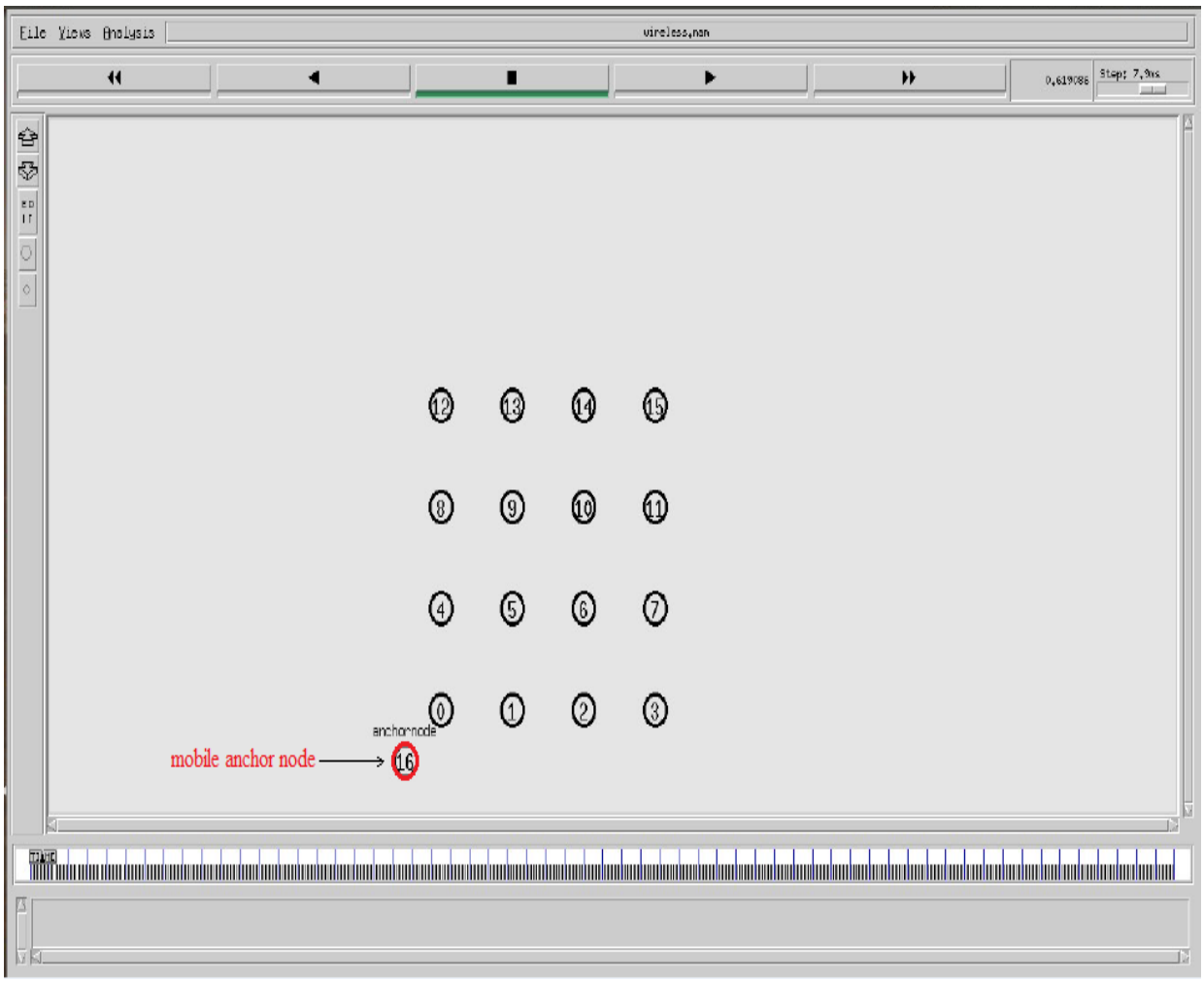


Fig. 4.2 Mobile anchor node in WSN

As shown in scenario 2, the node with the red colour indicates the mobile anchor node which roams all over the network and sends the beacons to localize the nodes in to the network.it start form the one side of the network and it sends at least three and maximum four beacon messages to the sensor nodes.

4.3.3 Scenario 3

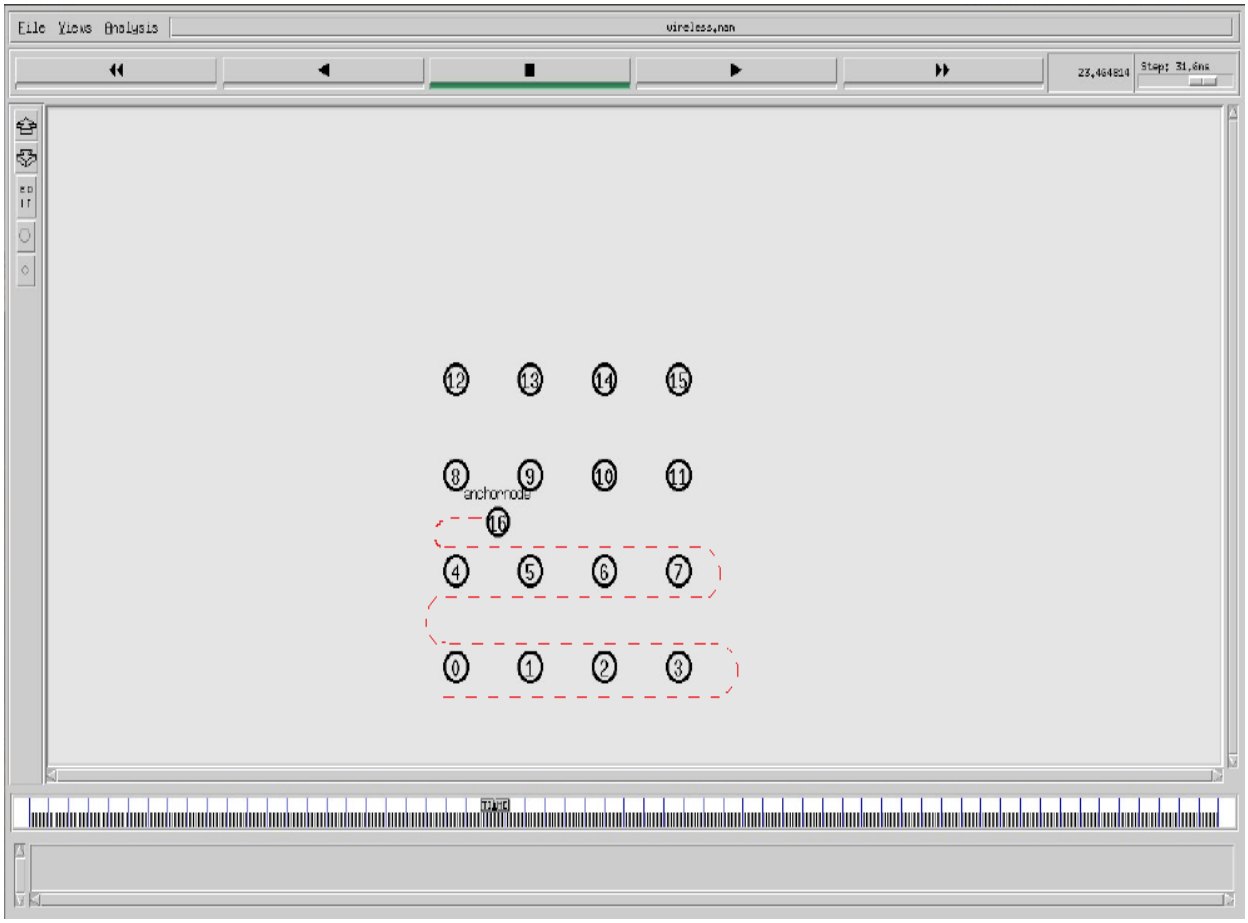


Fig. 4.3 Movement of mobile anchor node in WSN

Scenario 3 depicts the movement of the mobile sensor node. It is starting from the node 0 then 1, 2, 3, and again 3, 2, 1, 0 sequentially to sends the beacon to the sensor nodes as shown in above screen shot. If we talk about particular sensor node let's say 1, then mobile sensor node crossing its reason two times, and during that it receives at least three to four which we use for the purpose of the localization.

4.3.4 Scenario 4

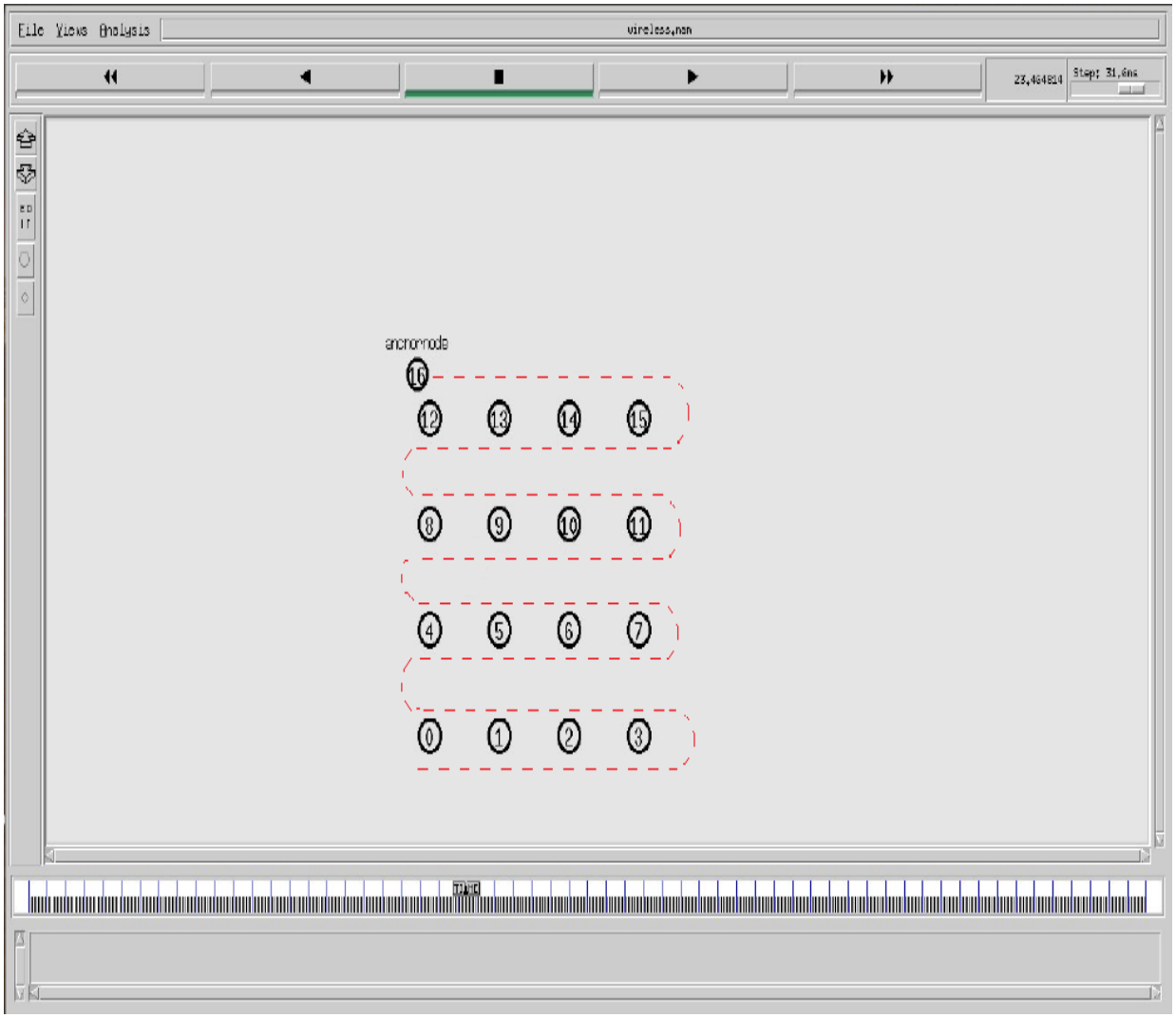


Fig. 4.4 Starting and ending point of mobile anchor node in WSN

Scenario four depicts the starting and end point of mobile anchor node, which starts from the node 0 and ends roaming at the 12. Roaming fashion is very important to receive beacons sent by the mobile anchor node.

Table 4.1 Estimated error calculation

Sensor no.	**Actual Location**		**Estimated Location**		**Estimated Error**
	X-axis	**Y-axis**	**X-axis**	**Y-axis**	
S0	50.0	50.0	50.03	50.0	0.03
S1	150.0	50.0	150.28	50.0	0.28
S2	250.0	50.0	249.71	50.0	0.29
S3	350.0	50.0	350.03	50.0	0.03
S4	50.0	150.0	50.34	150.0	0.34
S5	150.0	150.0	150.61	150.0	0.61
S6	250.0	150.0	249.51	150.0	0.51
S7	350.0	150.0	350.41	150.0	0.41
S8	50.0	250.0	50.12	250.0	0.12
S9	150.0	250.0	149.59	250.0	0.41
S10	250.0	250.0	250.51	250.0	0.51
S11	350.0	250.0	350.45	250.0	0.45
S12	50.0	350.0	50.67	350.0	0.67
S13	150.0	350.0	150.13	150.0	0.13
S14	250.0	350.0	250.43	250.0	0.43
S15	350.0	350.0	350.35	350.0	0.35

4.3.5 Output comparison

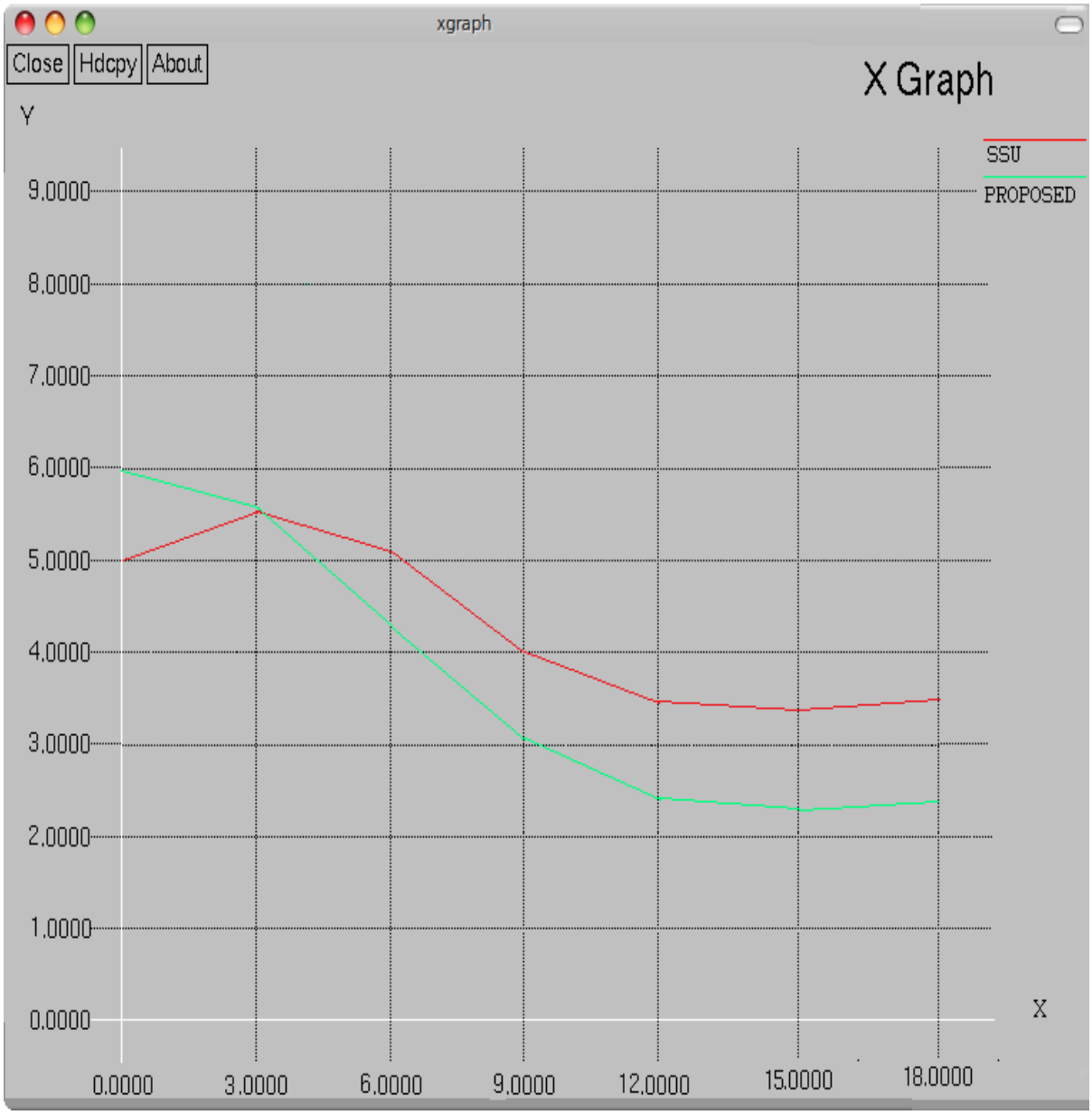


Fig 4.5 Output comparison for number of reference node

The graph shows the comparison between the error occurrences in the network. As shown in graph error is decreasing with respect to the reference node increases and as reference node is getting less error gets increase. When sensor node is having only three nodes it has more percentage of the error, but when we increased it to 6, error gets less.

4.3.6 Output comparison for range and error

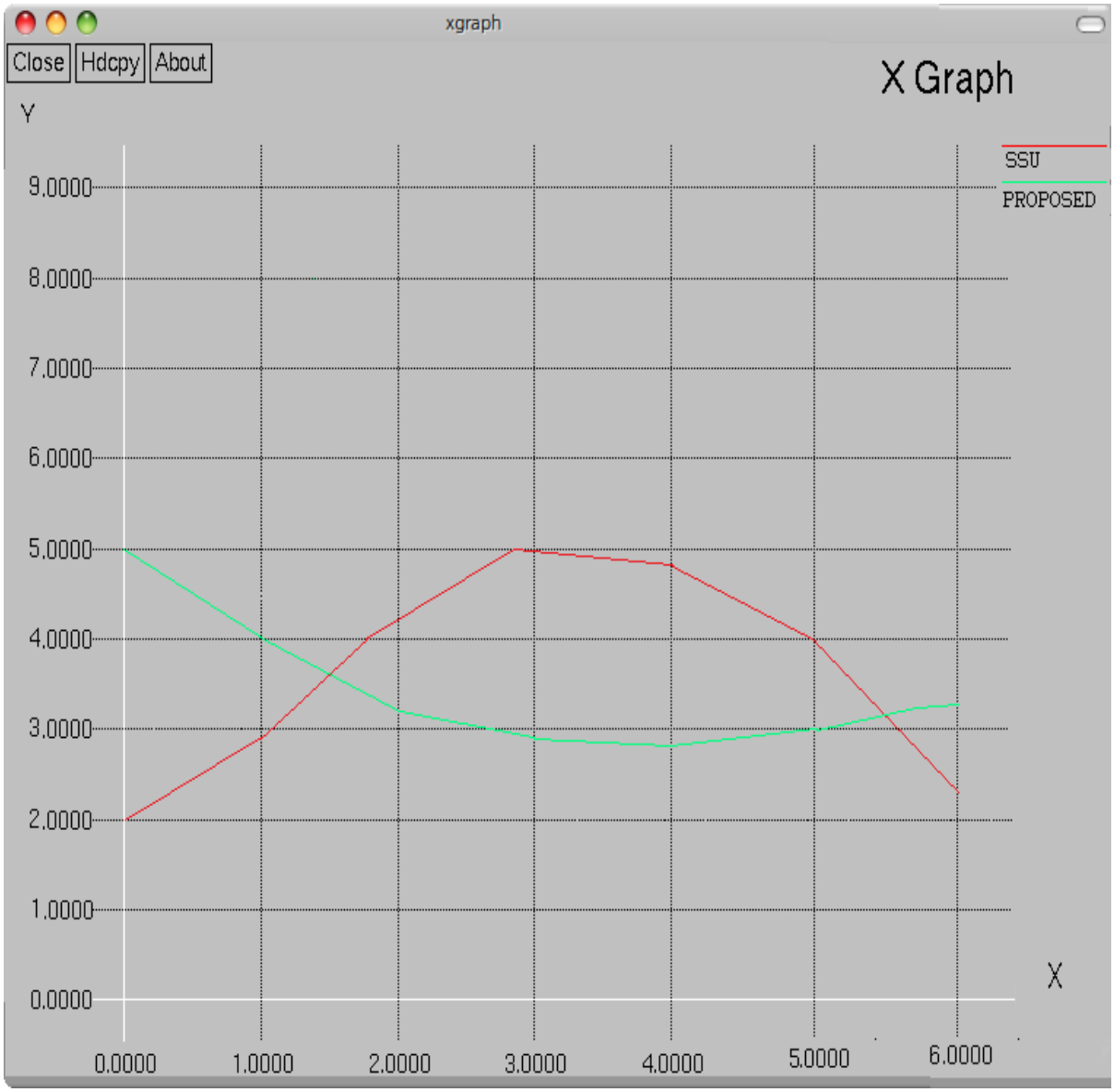


Fig. 4.6 Graph for range of sensor node over error

As shown in Fig. 4.6 graph depict the trade-off of the range over the error. As depicted in graph X–axis showing the scale of the range of the sensor node and the error variation due the range of the sensor node and y axis indicating scale of the error occurrence. The line with the green colour shows that, it does not so much variation even if it has different range of the frequency.

CHAPTER 5

CONCLUSION AND FUTURE SCOPE

5.1 Conclusion:

The proposed algorithm is novel approach for Wireless Sensor Networks, which is focussing on the problems which frequently occurs while transmission of signals like, e.g. link failure problem, dead nodes problem, better management of the battery, Less energy consumption and Less cost of the hardware. Algorithm has main three phases include deployment of the sensor nodes which is described the fashion to deployment of the sensors node, localization of the sensor nodes and use of the triangulation method. Research includes the use of the grids and grid manager for the better management of the sensors and the movement of the mobile anchor node. Mobile anchor we are using to localize the nodes and because it is movable it reduces the cost of the network. There are some restrictions we need to follow while using this kind of infrastructure like node should be placed in grid fashion to make the cluster, each cluster should have node manager to lead and manage other nodes in to the cluster.

5.2 Future Scope:

We are using mainly two methods include redeployment and mobile anchor for localization of the nodes. These two methods are very beneficial to reduce the cost of the network and to achieve accuracy, but it can be used where we can place the number of nodes in to the given fashion. In the Wireless Sensor Network we are using limited number of mobile anchors equipped with the GPS. Consider a network where we are using Global Positioning System on each node and we know that deployment of GPS on every node increases the cost of the network, so it is better to use limited number of mobile anchors which will roam all over the network and localize all nodes. Redeployment is very much important to solve the problem of the link failure and dead node.

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APPENDIX

LIST OF ABBREVIATIONS

WSN	Wireless Sensor Network
AoA	Angle of Arrival
GPS	Global Positioning Sensor
RSSI	Received Signal Strength Indicator
ToA	Time of Arrival
MGDL	Mobile Geographic Distributed Localization
LEACH	Low Energy Adaptation Clustering Hierarchy