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Redeployment and Localization in Wireless Sensor Networks Using Mobile Anchors

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Abstract— Redeployment of sensors is one of the most crucial aspects during localizations in wireless sensor network. Redeployment is required in case of the communication break due to dead nodes, out of the range nodes, and link breakage problem. Mobile anchor nodes are used for localizing the sensors in the network and the entire terrain is divided into square size grids and sub-grids in order to efficiently use the mobile anchors. In this paper, the concept of redeployment of sensor nodes is used to replace the dead nodes resulting in improvement of performance of localization algorithm. We have proposed a localization algorithm which handles all the above mentioned issues.

Keywords— Main grid, sub-grid, link breakage, Localization, Mobile anchor, GPS.

I. INTRODUCTION

Wireless Sensor Network provides facility to monitoring 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) [1], the time of arrival of the signal (ToA) [1], and the angle of arrival (AoA) [1] 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. Fig. 1 is showing the hierarchy of the localization algorithms [1].

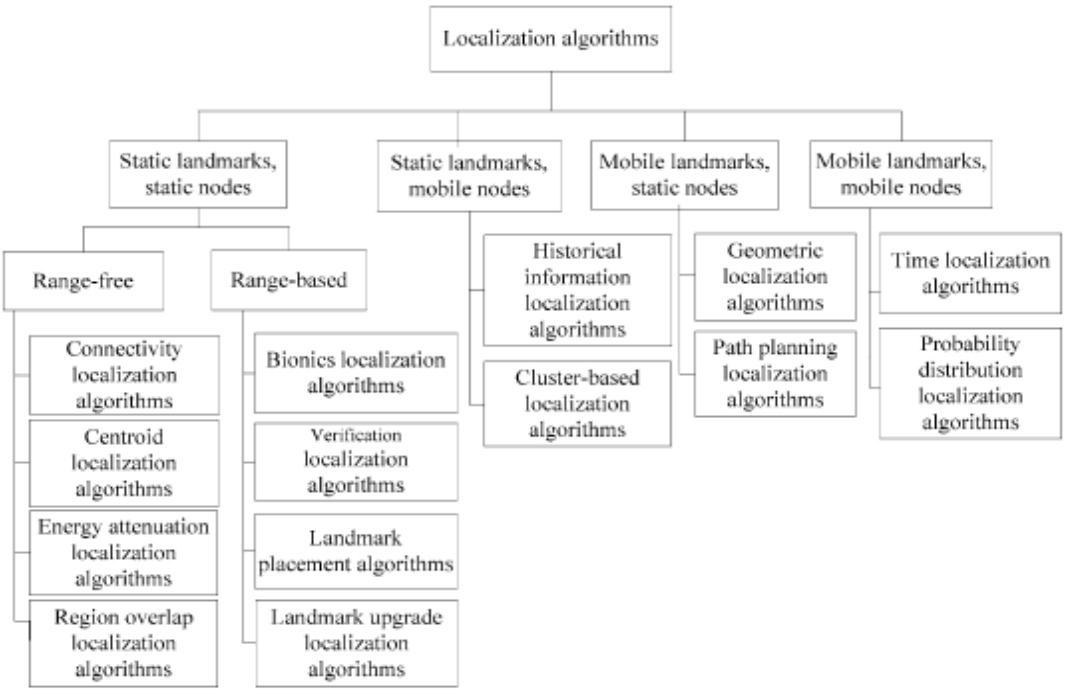

Fig. 1 Classification of Localization Algorithms

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.

Link breakage problem, out of range problem and dead node replacement in to the network are most common problems and difficult to solve, This paper is describing about how to deal with these issues and solve them very easy way. Everything is described in detail in next segment of the paper.

II. PROPOSED METHODOLOGY

System environment made up of sensor nodes and mobile sensors i.e. Mobile anchor; we have proposed a solution for the issues like link breakage energy consumption and dead nodes. This process is divided into number of sub-parts like:

- selection of area and grid construction
- deployment of sensors
- redeployment and sensors
- localization process

We have discussed every segment in detail.

A. Selection of the area and grid construction

Area would the location where we want to analyse the environment in terms of temperature, sound or movement etc. Once area is selected we need to start with defining the grid in selected area virtually, each grid will contain equal number of sensors, which will be deployed in defined fashion.

For the proper arrangement of the sensors grid plays very important role, once grid is constructed we named it main grid, main grid is of fixed size of the area and all main grids are of same size. Each grid is divided into the sub grid, we will get figure as shown in Fig 2, Above figure shows grid construction before the deployment of the sensor, each grid is of fixed size, each single sub-grid is also of fixed size and each main- grid is contain equal number of sub grid, here we have considered four sub grids per main-grid. The purpose of this type of grid fashion is discussed in next segment of this section.

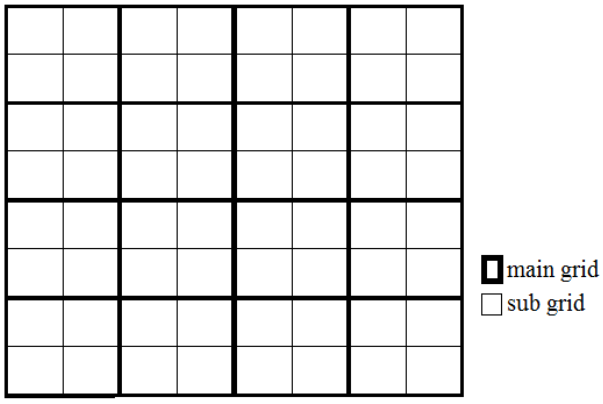

Fig. 2 Map of the area before deployment of the sensors

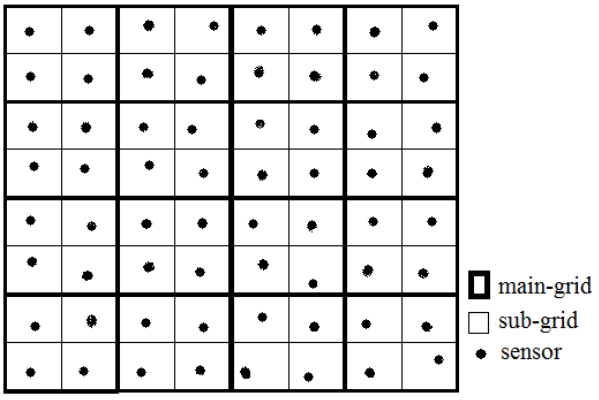

Fig. 3 Map of the area after deployment of the sensors

B. Deployment of the sensor and related issues

Grid construction is key point for the deployment and localization because it helps to find the dead node easily and replace them in very less time, roaming the mobile anchor node in localization. Sensor is deployed in the fashion where each sub grid is contain only one sensor and collection of the sub-grid is main-gird, once we are in deployment phase we need to deploy node [6][7], fashion shown in Fig 3.location of the sensor is fixed, if the sensor node is moved or deployed at the location where we are not planed it is an issue [8], but the solution if this problem is described below using diagram, see the Fig 4.range of the sensor is in zigzag fashion and if we use only range in specified area then there are very much probability that it covers maximum part of the grid and we are using same mechanism for deployment if the sensors.

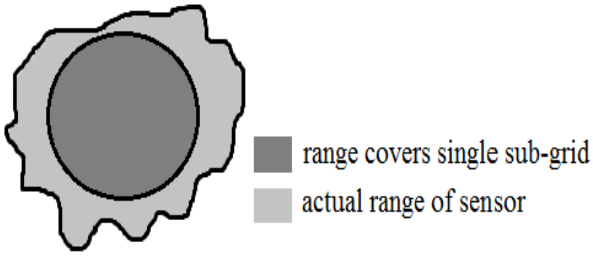

Fig. 4 Range of the sensor to cover area of sub-grid

The dark grey portion shown in the circle we are using virtually for the localization and cover the maximum area of the grid, and light grey area show the actual frequency of the sensor node. So, if sensor node is moved or deployed on unplanned location then it works correctly and covers maximum part of the grid.

C. Redeployment and Grid Manager

Each main-grid has one grid manager which manages all the nodes into the main grid it checks whether the node involved within the grid is alive or dead. Sensors in the grid sends the a message to the grid manager periodically.it is like acknowledgment to manager that node is still alive and when battery of the node is less than 10% then node sends message to the grid manager and give information related to its battery " n_id do not have enough battery please do not assign large task or change the node", if manager gets the such message and node belongs to the same grid, then manger takes following steps, first, find out the id of the node, manger come to know that change the node with that particular id. second, grid manager sends the message to the network manager," node with n_id is discharged please redeploy the node". Network manager manages the network and solves the query of the network, like network manager gets the message to change the node, it will take appropriate action and when it is replaced it reply to the grid manager that new node is deployed successfully.

The process of the redeployment solves the problem of dead node. Sometimes node is unable to send the message to grid manager, but grid manager does not take instant action, it waits for some specified time and still node does reply grid manager then it announces that node is dead.

D. Localization Process

1) *Movement of the Mobile anchor*: Mobile anchor performing the lead role of this part of the sensor localization, mobile anchor is roaming all over the area and broadcast [3] its own location into the network, broadcasted massage will contain anchor node id, location of anchor node and time stamp. Message indicates mobile anchor with n_id is on n_loc position on this time. The main aspect of the anchor is movement of the anchor, observe the Fig 5.

Fig 5.red line is showing the path taken by the mobile anchor and while roaming, mobile anchor broadcast the beacon message in to the network but it is very necessary to capture at least three points and in this diagram we can observe that each grid is able to at least four beacon points. Once it captured points it selects point for the calculation.

1) Selection of the Point and Calculations: After capturing the beacon points it we need to select the points and every point select by considering the condition, Which is showing the range of the threshold [5] as shown

$$0<\lambda\leq 2R$$

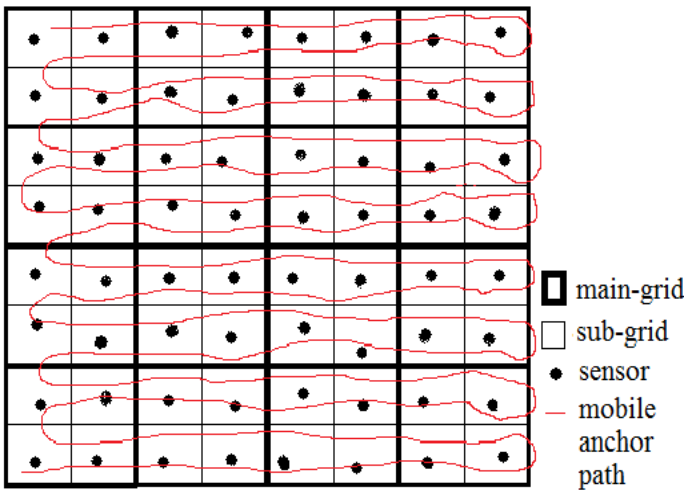

Fig. 5 Movement of the mobile anchor node

Threshold is used to avoid the incorrect selection of the point.it shows that the selected point should be within 0 to twice length of the radius. The point with the maximum strength gets first priority for the selection and the point with the weakest signal strength does not considered and only three point get selected Using these three points we are able to create two cords by joining them as shown in Fig. 6. So we get two individual chords like here its B_iB_j and B_jB_k .

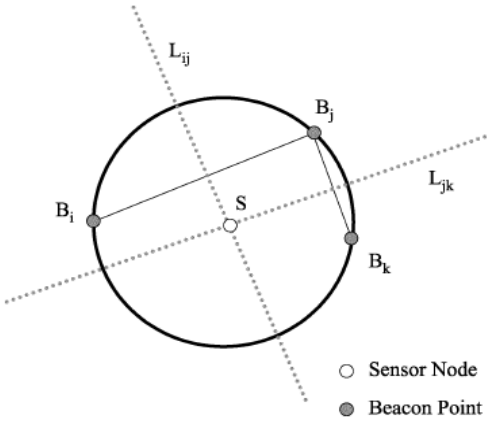

Fig. 6 selection of the beacon points

2) *Level-3 Heading:* A level-3 heading must be indented, in Italic and numbered with an Arabic numeral followed by a right parenthesis. The level-3 heading must end with a colon. The body of the level-3 section immediately follows the level-3 heading in the same paragraph. For example, this paragraph begins with a level-3 heading.

Selected beacon points $\{B_i,B_j,B_k\}=(x_i,y_i),(x_j,y_j)$,and (x_k,y_k) and this points we are going to use in crammer rule which is part of the exclamatory geometry [5][6].we use this method to calculate L_{ij} and L_{jk}

$$L_{ij} : a_{ij}x + b_{ij}y = c_{ij}$$

$$L_{jk} : a_{jk}x + b_{jk}y = c_{jk}$$

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 $c_{jk}=(x_k-x_j)((x_j+x_k)/2) + (y_k-y_j)((y_j+y_k)/2)$

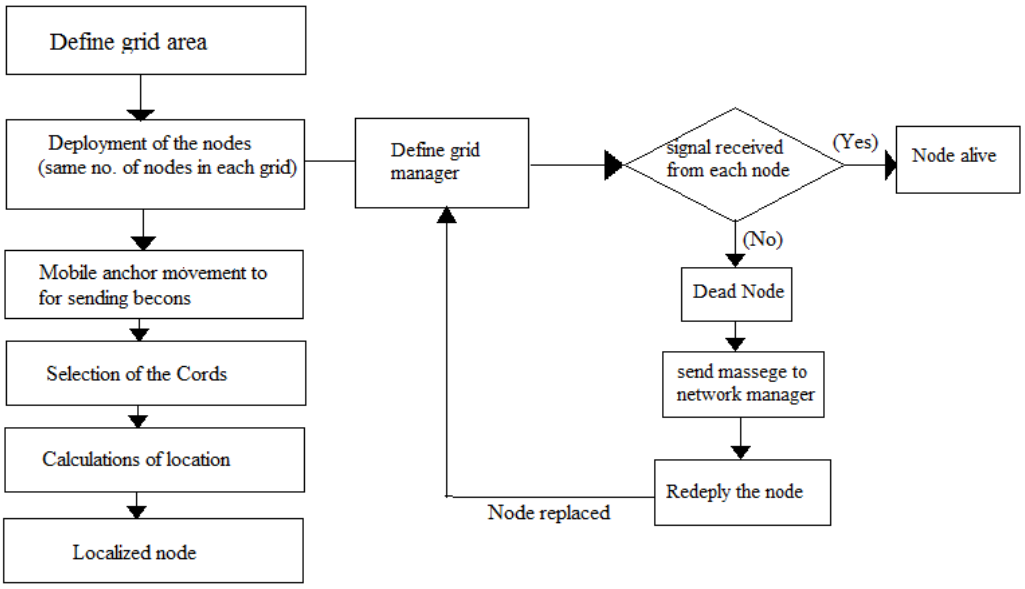

Fig. 6 Proposed Algorithm

III. CONCLUSIONS

This paper described about the localization of the sensor nodes and process of the redeployment in this paper we have proposed a method to wireless sensor network problem of breakage of links, dead nodes and situation when sensor is out of range to provide service related problems. We are using main grid and sub grid for the node deployment and elementary geometry to calculate the location of the sensor. To overcome the problem of node failure and link breakage, we have used redeployment of sensor nodes and used the mobile anchors to localize the nodes. The movement of mobile anchors is such that it moves in the grids in a zigzag pattern such that it can efficiently cover the entire sensor field.

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