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Connectivity of Distributed Mobile Nodes Using WSN

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Abstract:*Wireless Sensor Network has specific features and necessities that are unique in its way. The basic function of Wireless Sensor Network is to collect the information from the covered area. One of the dynamic research areas in wireless sensor network is the coverage area. The effectiveness of the sensor network is considered in the terms of the coverage area and connectivity of the nodes. There are several factors which are considered like energy efficiency, coverage area, connectivity etc., must be measured during the deployment of sensor networks. In the proposed scheme deployment area is considered to be rectangle in shape, which is divided into number of regular hexagon. To achieve the maximum coverage and better connectivity of the Mobile Sensor Nodes are set themselves at the center of the hexagon and when deploy these nodes on the deployment area they randomly takes their position and makes the connection with each other by sensing them as the neighboring node. This presented scheme also used to calculate the distance covered by the nodes by maintaining the connectivity among the nodes and it also works to enhance the distance covered by the nodes. The presented scheme is simulated and the simulation results show that the presented scheme yields better performance on some parameters as compared to some existing scheme in the literature.*

Keywords: Wireless sensor network, Ad-hoc Network, Mobile Sensor Node, Distance Coverage Area

I. INTRODUCTION

Wireless Sensor Network is the network to study and analyze the physical phenomenon. The research work in this area focuses on the efforts on the new area in the wireless technology. In this section, the author will explain the WSNs, different terminologies used in WSNs, Characteristics of the WSNs and constraints in the wireless sensor network. The concept of wireless sensor networks is based on a simple equation:

Sensing + CPU + Radio = Thousands of potential applications

As soon as people understand the capabilities of a Wireless Sensor Network, hundreds of applications spring to mind. It seems like a straightforward combination of modern technology .A wireless sensor network is a group of sensor nodes which collaboratively performs a common function in many applications, these sensor nodes are battery driven which are very difficult to recharge or change the batteries.[3] The most important requirement of the WSN is to reduce the energy consumption which also necessary for the efficient communication and routing techniques which increases the life of the network. So, as there is limited computation and storage resources the sensors can provide energy efficient resource management as they are not equipped with the operating system and therefore, these applications are responsible for the energy efficient communication and routing strategies. Sensor nodes are used for the sensing, event detection and location detection so these wireless networks have many applications like military application, Environment application, health, home and other applications which are described as follows:

1. **Military Applications:** The Sensor networks will become the important part for the future system as it provides command, control , communication, computing, intelligent, surveillance and targeting which helps the military officers to track the movement of the enemy in the battlefield. The main advantage of Wireless Sensor network is that it can be

deployed and operated remotely without putting human lives at risk. In military networks, deployment bring its own challenges of security and confidentiality.

2. **Health:** Sensor networks are used in hospitals in monitoring the patients and tracking various systems and humans. These are also used to track and monitor drug doses prescribed to the patients and also prevent the situations where the drugs are administered to the wrong patient.

3. **Home:** The various home appliances are also made with these sensor networks which are interconnected with each other and the central system of the home. These sensor enabled home appliances are safer and more energy efficient.

4. **Solar Energy:** The photovoltaic cell in the solar panel is attached in such a way that when solar radiations from the sun are absorbed, harvested and converted into the electric energy which leads to sustainable Wireless Sensor Networks.

In terms of the components SNs, WSNs are classified in two categories: homogeneous WSN and heterogeneous WSN. In homogeneous WSN architecture, the SNs have the same capabilities and functionality with respect to the different aspects of sensing, communication and resource constraints. In heterogeneous WSN architecture, each node may have different capabilities and execute different functions in terms of energy heterogeneity, link heterogeneity and computational heterogeneity.

II. Literature Review

To provide maximum coverage area with minimum energy consumption and convergence time. This section presents a review of some of schemes of WSNs considering coverage area, number of sensor nodes required and distance covered by these nodes.

In [12] author presented the virtual force algorithm as a practical approach of the sensor deployment scheme. This algorithm uses a force-directed approach which improves the coverage area provided by the initial random situation. The VFA algorithm has the several advantages which includes small computation time and a one-time relocation of the nodes. Furthermore, the preferred sensor coverage area and parameters are provided as input to the VFA algorithm, thus ensure flexibility of the nodes, These nodes shows how probabilistic localization algorithm is used in the combination of force-directed situation for the sensor nodes. It also shows that the proposed probabilistic localization algorithm extensively reduces the energy consumption for target detection and location. The VFA algorithm is more efficient if it provides the theoretical limits on the number of sensor nodes needed to attain given coverage threshold. Also, there is no route plan for moving the sensors in the VFA algorithm, where sensor nodes crashes and this happen during the repositioning. Since the current target localization algorithm considers only one target in the sensor field, it is necessary to extend this existed approach to facilitate the localization of multiple objects. Another extension lies in distributed localization and querying. Extension to non-mobile sensor nodes, and situations of sensor node failures also considered in this approach.

The algorithm in [6] in which each sensor node finds the location of the nodes to which it needs to communicate for providing the maximum coverage of the nodes. The author performs numerous experiments for deciding about the coverage area of the network and the deployment time of the algorithm. The key weakness of these algorithms is that every node exist within the line of sight of the other node in which it have to decide the optimal location of the node it needs to move to, if any node is beyond the coverage area of the other nodes then that node is unable to decide its relative location.

In [8] authors presented a possible area which is based on mobile sensor network deployment strategy. Two key ideas which were deal with [8] (i) forming a hexagonal structure with artificial forces generated from a potential field and (ii) its hierarchical application for wider area coverage. Hexagonal formation shows the best situation for the same sensor model in terms of coverage area. Potential field based artificial force algorithm provides simple and efficient method to deploy large

number of sensors because the strength which is used for this purpose is used as a control input for each node without any complicated control algorithm. This approach enables to construct hierarchical structure without any further complexity. This scheme is effectively implemented as the manifest through the simulations. The main weakness of this scheme is that it cannot achieve global optimization. This is a basic feature of the potential field based method. In some cases, they have unwanted formation, where a coverage hole exists in the middle of the hexagonal structure.

In [3] the authors presented a GPS-based localization scheme with energy efficiency. Since this location finding problem is very critical for the sensor nodes, to solve this problem author works on it by using the clustering based approach. In this approach, there is a cluster head and several other neighbor nodes, cluster head nodes broadcasts the message to the network and the nodes which are in range receive that message and sends to cluster head node and other neighboring node to make the connection with the nodes and utilizes the energy and the time. In this the author also calculates the distance covered by the network of the sensor nodes using the triangulation technique. This approach is very useful the less energy consumption networks which works on the maximization of coverage area with energy efficient and less time. In this the cluster head node is the node which communicates with the nodes those exists in the same cluster and then the cluster head node has the responsibility to communicate with the node which exists in the other cluster. In this way, the nodes are communicating with each other and make the network of the nodes with the efficient use of the energy.

In [2] authors offered a new scheme that is not governed by these assumptions, therefore they adjusted with the wider range of applications. These schemes have been considered in the direction of maximizing the sensing coverage area which also gives the guarantee of the connectivity of the various mobile nodes of the network by moving small distances. For the implementation of these schemes, there is no need to have the knowledge of the layout of the field in which the nodes exists as they may be irregular and also may have holes of the different shapes. This scheme is the improved form of the traditional virtual-force-based method therefore the author gives it the name as Connectivity-Preserved Virtual Force (CPVF) scheme. In this scheme, they show the restricted communication, to show the simplicity of this method, which results reduced coverage in some cases. For the advancement of the performance of this scheme the author further describe the Floor based scheme which reduces the problems of CPVF scheme and, as a result, considerably this scheme performs better than the previous scheme.

In [11] the author explained a new scheme which works on the protocol named PEAS which is robust energy saving protocol and in this author uses sensors with small battery lifetime. This protocol works by maintaining the nodes of the network which is working and the nodes which are redundant keeps turned off. In this protocol, operations are based in which each node will communicate with its neighbor nodes which are working through this all the nodes maintain the connectivity with each other and all other nodes which are not connected to these are turn off and goes to the sleep mode. In this way, Peas protocol is able to save the energy by turn off the unused nodes and it also divides its network in the grid which works with the GPS or other location service to know the location of the node that in which grid the node exists. By using this PEAS protocol author describes the energy saving method for the network in which maximum nodes are connected.

In [10] author study about the coverage area of the sensor nodes that the nodes covered by the particular network. They use the K-Cover algorithm to calculate the coverage area of the sensor node and maximum set cover nodes is proved to be NP complete. In K-Cover algorithm, the nodes are divided into K different set of coverage node and every set can cover the whole area. These coverage set works alternately and implement area monitoring. As the lifetime of one coverage set is same as the lifetime of the original network. K coverage set network lifetime increases for the k times. In this the author concerned about how to divide the coverage set based on the maximum coverage set number and realize the node set division by distributed algorithm based on localized information. So for this purpose they put the concept of node minimum layer Overlapping subfield (MLOF). Then it calculates network area minimum coverage layer number by MLOF as the maximum number of coverage set. Then, the distributed maximum coverage set number calculated algorithm MCNCA is proposed. In this way the author

calculates the maximum coverage area of the sensor nodes and large distance covered by the nodes in sensing the nodes of the network.

III. System Model

The area, which is extremely hazardous for human being to work continuously with the network for a long time, like remote harsh field, disaster area, battle, volcanoes, etc. In these type of areas human being cannot reach for any type of work, so MSNs are deployed randomly with the help of the flying objects like helicopter, airplane etc. In this type of deployment, in some areas these MSNs are collected in one portion of the area also connected with each other but in some areas they are very few and unable to connect with each other and sometimes also to the nodes which are present in some other portion of the deployment area. Due to this, The MSNs where the large number of nodes are connected becomes the high concentration area and is able to sense almost the all the data that will be transmitted to this portion of the deployment area and sometimes in this portion unnecessarily congestion in the network and bandwidth wastage is also occurs whereas the area with only few MSNs either causes network partitioning or communication holes.

By this scheme, we are able to check the connection of the nodes and in the same network we come to know that how many nodes are connected to each other and how much distance they covered. So that, if according to the network or our data there is a requirement of more nodes and distance to be covered by the nodes. The proposed scheme which helps to increase the coverage area and the distance covered by the nodes while maintaining the connection among the nodes.

This scheme also focuses on overlapping of sensing range of multiple sensors lead to generation of packets with duplicate data, which leads to congestion in the network, hence to avoid this congestion utilizes more power resources like batteries. So, the random deployment requires large number of sensor nodes to achieve required level of coverage which increases the system cost and has the efficient utilization of resources and for better control and management, this deployment scheme is preferred.

Algorithm 1

oval[]: the locations of the mobile nodes which are initially broadcasted on the network.

cand: This parameter of MSN is set to true if it is the most suitable (nearest) MSN to occupy its nearest_Loc.

broadcast (nearest_Loc, distance): This function is used by MSNs to broadcast the nodes with its nearest location and also with distance between the nodes.

rs-it represents the sensing range of the individual mobile node which is deployed in the area.

rad-it represents the range of the nodes within the same sensing range is double.

Step1: nearest_Loc=oval[0];

Step2: rad=2*r_s

Step3: cand=true;

Step4: broadcast(nearest_Loc, Distance);

Algorithm 2

After broadcasted the nodes with their nearest location and the distance covered by them.

Step 1: If(nearest_Loc== rad)

Then

If(distance<rad)

Then

is_Cand=false

End-If

End-If

Step2: If(nearest_Loc>rad)

Then

is_Candidate=false

End-If

Working of Algorithm 1 and Algorithm 2:

When we broadcast the nodes on the deployment area each node has a parameter of the nearest location and the distance covered by them. So, the deployment area stores this nearest location information in some variable for further use. Then, the nodes which exist in the same cluster starts connected to each other by comparing the range and nearest location with the other nodes. If the nearest location is same as the double of the sensing range of individual node then it means the node is of the same group and already connected and it is nearest location is more than it means node exist in the different cluster then also candidate is false. The node which has the less distance then the double of the range of the other node is connected with the node and makes the candidate true.

Distance_covered[]: It represents the distance covered by the neighboring nodes of the hexagon with the nearest locations to the nodes of other hexagon.

Algorithm 3:

Step1: nearestDist=(2 * r_s * cos 20 + r_s * cos 40)

Step2: For i= 0 to sizeOf(oval[]) Repeat Step3 to step 11

Step3: If sizeOf(distance_covered[])==0

Then

loc=oval[0];

tempadd(loc);

distance_covered.add(temp_List[]);

Else

Go To Step4.

Step4: loc=oval[0];

Step5: For j=0 to sizeOf(distance_covered[]) Repeat Step6 to Step10

Step6: temp_Loc_List[]=distance_ccovered[j];

Step7: Flag=True;

Step8: For k=0 to sizeOf(temp_Loc_List[]) Repeat Step9.

Step9: If(dist(loc,temp_Loc_List[k])< nearestDist)

Then

Flag=False;

Terminate the Loop;

Step10: If(Flag=True)

Then

Temp_Loc_List.add(loc);

Step11: If(Flag=False)

Thennew_List.add(loc);

distance_covered.add(new_List[]);

Step12: End

Working of Algorithm 3:

This algorithm collects the information of nearest locations from the above algorithm which is stored in the variable nearest location. The distance_covered variable is used to store the value of the distance covered by the node with the help of the nearest location. If the distance of any node is in the range of any node then that node is added into the temporary lists made for making the connection of the nodes. If the distance of the node that is present in the distance table is less than the nearest distance then the flag value is set to false and the loop will be terminated as the node is already connected with the other nodes. If flag value is true then the node is added into the new list as it newly added node in the connection, in this way, the distance of the nodes is improved and the coverage area is maximized by adding the new nodes in the list.

After implementation of these algorithms the distance is calculated by the nodes within some sensing range with help of the simulator. To calculate we take input as sensing range and the Number of nodes in the deployment area, to show how much distance it covered. According to this number of nodes which are deployed on the area, it calculates the distance and by using the above algorithm it makes connection among the nodes, so that by maintaining the connection among the nodes the distance can be enhanced without changing the value of sensing range, so that all the nodes come in the connection of all other node.

This following table shows the distance covered by nodes with the sensing range and the number of nodes in the deployment area.

Table I

Shows the Distance Covered By Nodes with Particular Range

Candidate nodes	**Distance**
(400,70)	452
(400,80)	778
(400, 90)	927
(500,70)	971
(500,80)	1492
(500,90)	2285

IV. Simulation Parameters

The following values of various parameters are considered during the simulation of the presented scheme:

1. Sensing range is 400m
2. Number of nodes deployed is 70

The following results are obtained after simulation of the presented scheme. Figure 5.2 represents the logical partitioning of the deployment area. The small circles within the deployment area are locations of the centers of the regular hexagons.

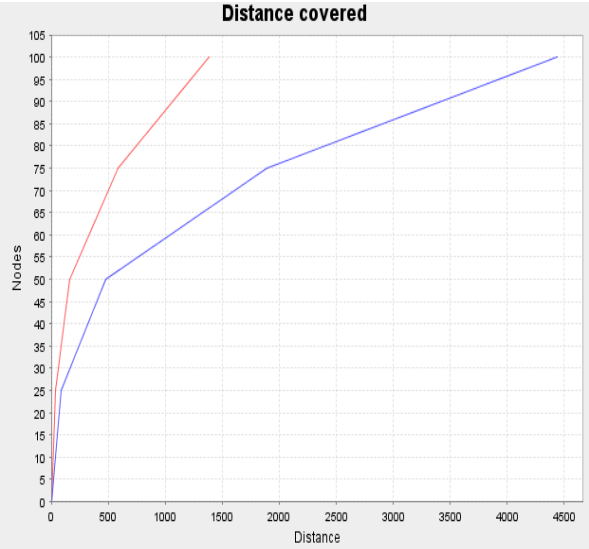

Fig 1: The graph between Number of Nodes or MSNs and distance covered by them.

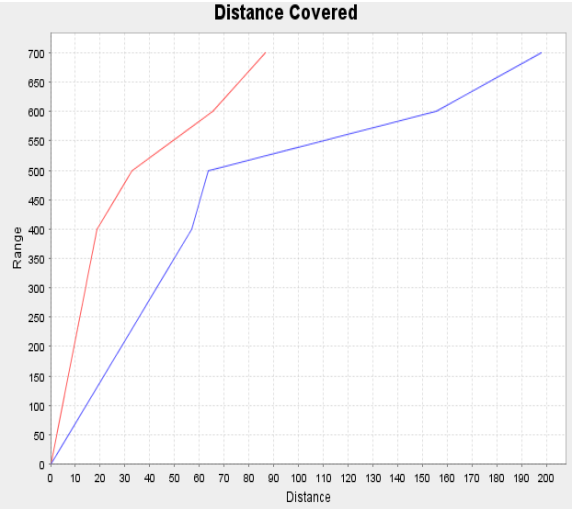

Fig 2: The graph between Sensing Range and Distance covered by them.

V. Conclusion And Future Scope

WSNs are ad hoc network whose aim to send data and information to the destination by sensing and some processing done by the intermediate nodes. The deployment schemes and resources used in WSNs helps the researchers to think about the deployment schemes which are energy efficient and increase the coverage area of the network.

This presented scheme achieves the maximum coverage area of the MSNs or the mobile nodes within the limited sensing range while maintaining the connectivity among the MSNs. This work also calculates the distance covered by the MSNs and also increases the distance covered by connected the nodes which remain out of the range by moving the nodes near to the other nodes. In the simulation result we can observe that the presented work gives the better result than the earlier results.

Future Scope

As a future work the presented scheme will be simulated and the presented work will be analyzed and compared with the earlier work. The parameters that would be analyzed in this scheme are distance covered by the MSNs and the sensing range of the MSNs.

In the future the researcher can think about this work by considering that if any type of failure occurs in MSNs or any other problems in the route, which may affect the deployment scheme and gives the better results. So, as a future work we may also considers the problems and these constraints in the deployment area.

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