

Commencement of Mobile Wireless Sensor Networks for Ensuring Target Coverage and Improving Network Connectivity with Minimum Movement

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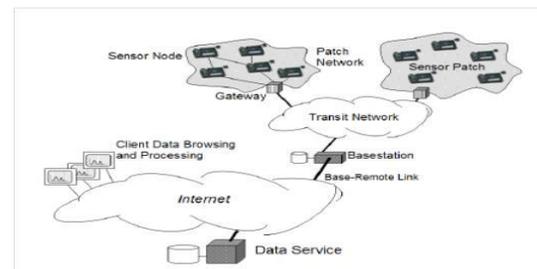
Abstract- Mobile wireless sensor networks can be described as a wireless sensor network in which the sensor nodes are mobile and it is a set of physically distributed sensor nodes. Sensor node is a small wireless device with limited battery life, radio transmission range and storage size. It performs various tasks like collecting important data, monitoring the environment and processing the data etc. The main property of sensors i.e. mobility can be very efficiently used to improve the target coverage quality and network connectivity in randomly deployed mobile sensor networks. Two main challenging issues of mobile sensor networks are Target coverage (TVOC) AND Network connectivity (NVOC). This paper focuses on the challenges of the Mobile Sensor Deployment (MSD) problem and investigates how to deploy mobile sensors with minimum movement and energy consumption to form a WSN that provides both target coverage and network connectivity.

Index Terms- Wireless Sensor Network (WSN); Target Coverage (TCOV); Network Connectivity (NCON); Mobile Sensor Networks (MSNs); Mobile Sensor Deployment (MSD).

I. INTRODUCTION

Wireless Sensor Network is an arrangement of autonomous and well disturbed which may or may not have an additional facility of mobility. The nodes are deployed and relocated on their own due to the mobility of sensors. Sensors also get their own location and get placed at the target area after initial distribution. Wireless Sensor Networks are currently used in many applications including environmental monitoring and object tracking. MWSNs are smaller, emerging field of research in contrast to their well-established predecessor. MWSNs are much more versatile than static sensor networks as they can be

deployed in any scenario and cope with rapid topology changes. Basically MWSM are the collection of small and light weight wireless nodes.



Coverage is the central evaluation metric for any wireless network. The major advantageous feature is that it has the ability to deploy a network over a larger physical area. Eventually it can improve a system's value to the end user. It is very important to keep in mind that the coverage of the network is not equal to the range of the wireless communication links being used. The technique that extends the coverage of the network well beyond the range of the radio technology alone was Multihop communication technique.

Coverage is a measure of the quality of service provided by a sensor network. Due to the attenuation of energy propagation, each sensor node has a sensing gradient, in which the accuracy and probability of sensing and detection attenuate as the distance to the node increases. The total coverage of the whole network can therefore be defined as the union which includes possible cooperative signal processing of all nodes sensing gradients. It represents how well each point in the sensing field is covered. Coverage is a fundamental issue in a WSN, which determines how well a phenomenon of interest (area or target) is monitored or tracked by sensors.

Each sensor node is able to sense the phenomenon in a finite sensing area.

Connectivity in MWSN'S

Connectivity in mobile wireless sensor networks is a vital issue in WSN's which concerns with delivering the sensed data from the source sensor to the destination via radio transmissions. Each sensor node has only limited communication range compared with the size of the monitored area, only reason for this is sensors are low-cost devices with constrained resources. Multi-hop communications are required when a sensor cannot reach the sink node directly. Any two sensors are called neighbors if they are within each other's communication range. The sensor nodes and the communication links between each pair of neighbors build the network topology, which is required to be connected by the connectivity requirement.

Connectivity represents how well the sensor nodes in the network are "connected" to each other. It is a fundamental property of a wireless sensor network, for many upper-layer protocols and applications, such as distributed signal processing, data gathering and remote control, require the network to be connected. Since the sensor nodes communicate via wireless medium, a node can only directly talk to those that are in close proximity to itself (within its communication range). If a sensor network is modeled as a graph with sensor nodes as vertices and direct communication links between any two nodes as edges, by a connected network we mean the graph is connected.

Network Lifetime in MWSNs

Network lifetime is the most dominant and challenging issues in wireless sensor networks which defines how long the deployed WSN can function well. Unattended nodes with limited battery energy are sensors. In the absence of proper planning, the network may quickly cease to work due to the network departure or absence of observation sensors deployed close to the interested phenomenon. As a sensor network is usually expected to last several months without recharging, prolonging network lifetime is one of the most important issues in wireless sensor networks.

A sensor node is generally composed of four components: sensing unit, data processing unit, data

communication unit and power unit. The power unit supplies power to the other three units. Any activity of the other three units - sensing, data processing, data transmitting and data receiving-will consume battery energy. Experiments show that wireless communication (data transmitting and receiving) contributes a major part to energy consumption rather than sensing and data processing. Therefore, reducing the energy consumption of wireless radios is the key to energy conservation and prolonging network lifetime.

II.LITERATURE SURVEY

Zhuofan Liao, Jianxin Wang, Shigeng Zhang, Jiannong Cao and Geyong Min, "Minimizing Movement For Target Coverage and Network Connectivity in Mobile Sensor Networks" (2015).

In this paper, the Mobile Sensor Deployment problem is divided into two sub-problems,(TVOC) problem and (NCON) problem. For the TCOV problem, it is NP-hard. For a special case of TVOC, an extended Hungarian method is provided; for general cases, two heuristic algorithms are proposed based on clique partition and Voronoi diagram, respectively. For the NCON problem, first propose and edge constrained Steiner tree algorithm to find the destinations of mobile sensors, then use the extended Hungarian to dispatch rest sensors to connect the network [1].

Sonali Karegaonkar and Archana Raut, "Improving Target Coverage and Network Connectivity of Mobile Sensor Networks" (2015).

In this paper, in addition to Basic algorithm and TV-Greedy algorithm, LWZ compression algorithm is applied while sending data from sensor node to sink node, hence the computation speed of transmission is maximized. Simulation result obtained validates the performance of the proposed algorithm [2].

D.Prasad, "Enhancing Target Coverage and Network Connectivity of Mobile Sensor Networks" (2016).

In this paper the issue of Target Coverage (TCOV) and Network Connectivity (NCON) in Mobile Sensor Networks (MSNs) are taken into consideration Greedy algorithm achieves less movement than basic algorithm because it selects the sensor which is very close to target to achieve that target. Hence, the proposed scheme overcomes the issue of TCOV & NCON in MSNs & increase the network lifetime [3].

Mr. Mayur C. Akewar and Dr Nileshsingh V. Thakur, "A study of Wireless Mobile Sensor Network deployment" (2012).

In this paper, fundamental problem of deployment in mobile sensor network is discussed. The issues of mobile sensor network deployment are investigated in detail. It further discusses the types of algorithm and different ways of deployment like deterministic, random and incremental deployment along with self-deployment. Different approaches for mobile sensor network deployment are discussed in detail with their comparisons. Modeling of deployment problem with other real world problem is also discussed [4].

E. Mathews and C. Mathew, "Deployment of mobile routers ensuring coverage and connectivity," (2012). The first algorithm, agent assisted router deployment, is used in scenarios where a proactive pre-deployment is not feasible due to the limited speed of the routers compared to the speed of the agents and the second one self-spreading is used in scenarios where the proactive pre-deployment is feasible. The algorithms have a greedy deployment strategy for releasing new routers effectively into the area and a triangular deployment strategy for connecting different connected components created from different base stations [5].

III. PROPOSED SYSTEM

In this paper our main aim is to focus on the challenges of the Mobile Sensor Deployment problem and investigate how to deploy mobile sensors with minimum or movement at all to form wireless sensor network that provides both target coverage and network connectivity.

As sensor movement consumes much more energy than sensing and communication do, the movement of sensors should be minimized to increase the networks' lifetime.

Methodology

In this paper, sensor nodes should be deployed in such a way that they cover the complete area. We prefer to have static nodes. Then divide the complete area into the zones. Each zone will have a zone header. Zone headers should be at a convenient distance from each sub nodes. Then we will select a source and a destination. Information will transfer from sub nodes to headers and then from headers to

headers, finally to the destination. A lot of energy will be saved, thus increasing network's lifetime.

METHODOLOGY STEPS

1. Deploying sensor node randomly in described area.
2. Prefer to have static nodes.
3. Divide the complete area in zones.
4. Each zone will have a zone header.
5. Select a source and destination.
6. Information will transfer from sub node to header and then from headers to headers, finally to the destination.
7. Lot of energy will be saved, thus increasing network's lifetime.

IV. TEST RESULTS

This proposed technique was implemented by using MATLAB software. MATLAB stands for MATrix LABoratory and it is built up around vectors and matrices. MATLAB is used for solving algebraic and differential equations and for numerical integration. It allows plotting of functions, implementation of algorithms and interfacing with programs written in other languages including C, C++, Java and Fortran. MATLAB also has some tool boxes useful for signal processing, image processing, optimization, etc.

STEP 1:

Initially create a deployment area with a certain range of length and breadth. Based on the requirements the length and breadth are taken. Length on x-axis is 10 and breadth on y-axis is 10.

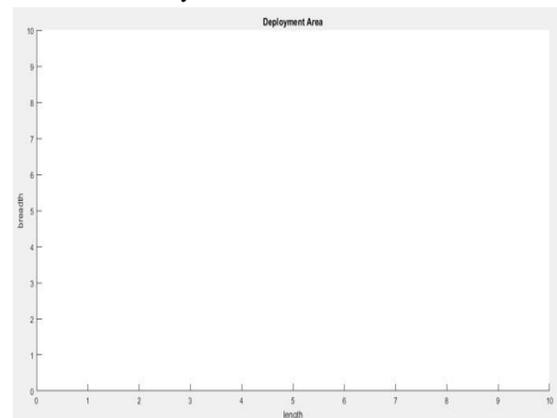


Fig 2: Deployment of area

STEP 2:

After plotting the desired area, divide the deployed area into equal zones. The number of zones should be

selected as per the requirement to divide the deployment area into zones. The deployment area is divided into five zones with equal spacing.

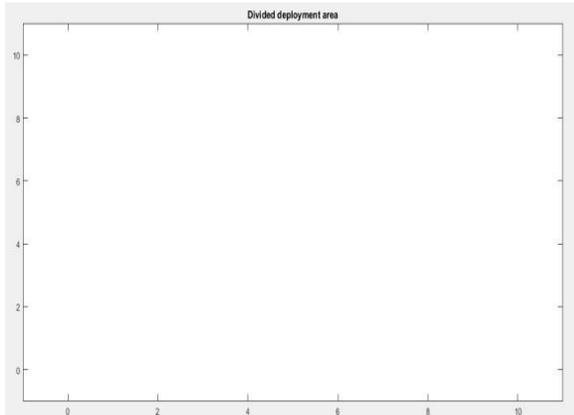


Fig 3: Divided deployment area

STEP 3:

In this step deploy the sensor nodes in each of the zone. Here each zone will have a zone header and the remaining are sub-nodes. Sensors are deployed in uniform manner and the number of sensor nodes in one zone is selected based on their requirements. Each sensor node has a sensor id number which is further saved in Excel file. As shown in the figure4, each zone has a header which is in red color and the remaining nodes are sub-nodes. As shown in the figure4, each zone has a header. It is in red color and remaining nodes are sub-nodes.

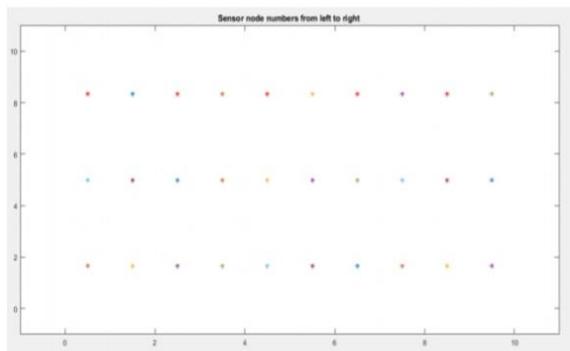


Fig 4: Deployment of nodes in each zone

STEP 4:

In this step we need to select a sender and a receiver from different zones. The sender will first communicate with the zone header. Sender zone's header will then search for receiver zone's header. When once it is found the receiver's zone header will transmit to the receiver node. The sender and receiver can be of any zone. Sensor id numbers are used for selecting the sender.

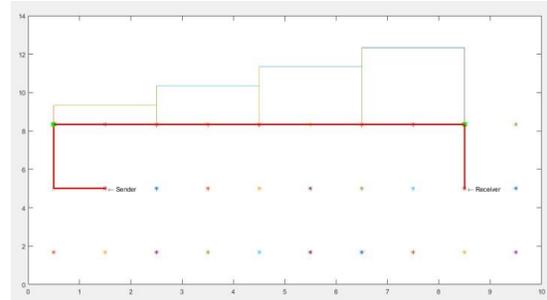


Fig 5: Comm. between sender and receiver

STEP 5:

When once the communication is completed, the next step is to calculate the energy. This is the energy depletion across the nodes that were involved in the communication process. In this step, we get the information about energy consumed in the transfer process. The graph denotes the nodes involved and energy values in figure 6. This is the energy depletion across the nodes that were involved in the communication process. From this step we get the information about the energy consumed in the transfer process.

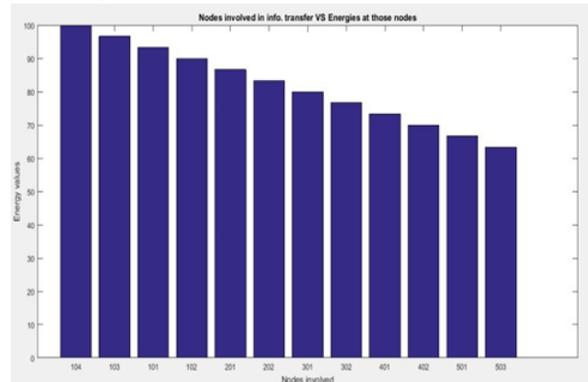


Fig 6: Graph of nodes involved info. Transfer versus energy at those nodes

Table: Energy distribution at sensor nodes involved in communication.

Serial No.	ID no. of sensor node	Energy at sensor node (in percentage)
1.	104	100
2.	103	96.66
3.	101	93.33
4.	102	90.00
5.	201	86.66
6.	202	83.33
7.	301	80.00
8.	302	76.66
9.	401	73.33
10.	402	70.00
11.	501	66.66
12.	503	63.33

The table depicts the details of percentages of energy at each sensor node which are involved in the communication between sender and the receiver.

Overall energy distribution shows the energy across all the sensor nodes which are deployed. This is the broader view of node wise energy across all the nodes deployed. Now same energy distribution values can be seen on all the nodes put together.

Here, conclusion is that the energy is consumed only of those sensor nodes only which are involved in the communication or transfer path between source node and destination node. The rest of the sensor nodes which are not involved in communication or transfer path have their full energy. No energy wastage of other sensor nodes is there. Hence, this will lead the increasing their lifetime of whole network as no energy wastage is there.

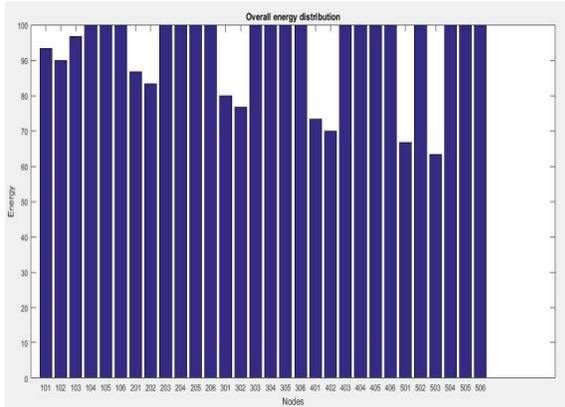


Fig 7: Graph of overall energy distribution

Next to the energy graphs, graph of impact of number of sensor and impact of number of targets is shown. We then investigate the impact of the number of mobile sensors on the movement distance of the algorithms used and our proposed algorithm. The comparison shows that proposed systems shows better results than previous methods.

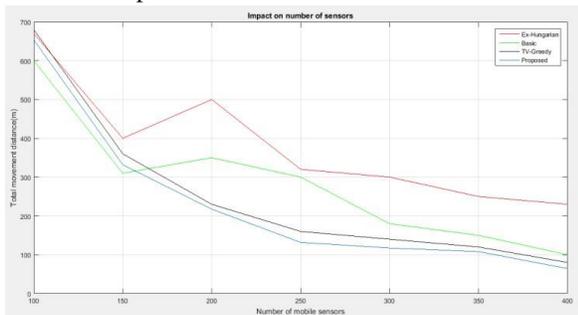
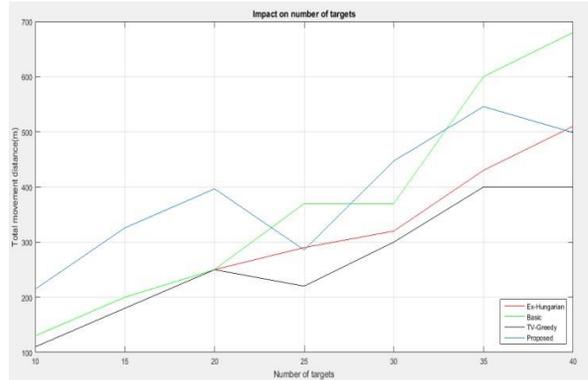


Fig 8: Impact on number of sensors

In figure 8, comparison of impact on number of sensor by Ex-Hungarian algorithm, Basic algorithm,

TV-Greedy algorithm and proposed algorithm is shown. It is clear from the graph that the movement by proposed algorithm which is shown by blue line has minimum impact on number of sensors as compared to all the other algorithms. So, by proposed algorithm there is minimum impact on number of sensors.



targets by Ex-Hungarian algorithm. Basic algorithm, TV-Greedy algorithm and proposed algorithm is shown. It is clear from the graph that the movement by proposed algorithm which is shown by blue line has less impact on number of target as compared to all the other algorithms.

V. CONCLUSION

In this work, we have studied the Mobile Sensor Deployment (MSD) problem in Mobile Sensor Networks (MSNs), aiming at deploying mobile sensors to provide target coverage and network connectivity with requirements of moving sensors. As sensors are usually powered by energy limited batteries and thus severely power-constrained, energy consumption should be the top consideration in mobile sensor networks. Specially, movement of sensors should be minimized to prolong the network lifetime because sensor movement consumes much more energy than sensing and communication do. However, most of the existing studies aimed at improving the quality of target coverage, e.g., detecting targets with high detection probability, lowering false alarm rate and detection delay. Little attention has been paid to minimizing sensor movement. To fill in this gap, this work focuses on moving sensors to cover discrete targets and form a connected network with minimum movement and energy consumption.

REFERENCES

- [1] Zhuofan Liao, Jianxin Wang, Shigeng Zhang, Jiannong Cao and Geyong Min, “Minimizing Movement For Target Coverage And Network Connectivity In Mobile Sensor Networks”, IEEE Transactions on Parallel and Distributed Systems, Vol. 26, No. 7, July 2015.
- [2] Sonali Karegaonkar and Archana Raut, “Improving Target Coverage and Network Connectivity of Mobile Sensor Networks”, International Journal of Science and Research (IJSR), Vol.4, Issue No. 4, April 2015.
- [3] D. Prasad, “Enhancing Target Coverage and Network Connectivity of Mobile Sensor Networks”, International Journal of Innovative Research in Computer and Communication Engineering (IJRCCE), Vol.4, Issue 1, January 2016.
- [4] Mr. Mayur C. Akewar and Dr. Nileshsingh V. Thakur, “A study of Wireless Mobile Sensor Network deployment”, International Journal of Computer Networks & Wireless Communication (IJCNWC), Vol.2, No. 4, August 2012.
- [5] E.Mathews and C.Mathew, “Deployment of mobile routers ensuring coverage and connectivity,” Int. J. Comput. Netw. Commun. vol. 4, no. 1, pp. 175–191, 2012.
- [6] Gao Jun Fan and ShiYao Jin, “Coverage Problem in Wireless Sensor Network: A Survey”, Journal of Networks, Vol. 5, No. 9, September 2010.
- [7] I.E.Korbi and S. Zeadally, “Energy-aware sensor node relocation in mobile sensor networks,” Ad Hoc Netw., vol. 16, no. 1, pp. 247– 265, 2014.
- [8] I.F.Akyildiz, W.Su, Y.Sankarasubramaniam and E.Cayirci, “Wireless Sensor Networks: A Survey,” in Elsevier Computer Networks, Volume: 38, Issue:2, Page(s):393-422, 2002.
- [9] Raymond Mulligan and Habib M. Ammari, “Coverage in Wireless Sensor Networks: A Survey”, Macrothink Institute, ISSN 1943-3581, Vol.2, No.2, 2010.
- [10] V. Blessy Johanal Selvarasi and A. Aruna Devi, “Sensor Deployment and Scheduling using Optimization”, International Journal of Science Technology & Engineering (IJSTE), Volume 2, Issue 10, April 2016.
- [11] WeiShen and Qishi Wu, “Exploring Redundancy in Sensor Deployment to Maximize Network Lifetime and Coverage,” 8th Annual IEEE Communications Society Conference on Sensor, Mesh and Ad-hoc Communication and Networks, 2011.
- [12] X.Bai, S.Kumar, D.Xuan, Z. Yun, and T. H. Lai, “Deploying wireless sensors to achieve both coverage and connectivity,” in Proc. 7th ACM Int. Symp. Mobile Ad-hoc Netw. Comput., 2006, pp. 131– 142.
- [13] X.R. Wang, G.L. Xing, Y.F. Zhang, C.Y. Lu, R. Pless, and C. Gill, “Integrated Coverage and Connectivity Configuration in Wireless Sensor Networks,” Proc. ACM Conf. Embedded Networked Sensor Systems (SenSys '03), pp. 28-39, 2003.
- [14] Y.Yang, M.I.Fonoage, and M.Cardei, “Improving network lifetime with mobile wireless sensor networks,” Comput Commun., vol. 33, no. 4, pp. 409–419, 2010.
- [15] Y.Zou and K.Chakrabarty, “A distributed coverage and connectivity centric technique for selecting active nodes in wireless sensor networks,” IEEE Transactions on Computers, vol. 54, no. 8, pp. 978–991, August 2005.