An Energy Aware Multiple Sink Repositioning Algorithm for Improving Lifetime in Wireless Sensor Networks

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ABSTRACT
In Wireless Sensor Networks, potential sink selection and sink movements are costly in terms of node energy. In this paper, we propose K -Partitioned Minimum Depth Tree using the optimal search in Placing Optimal Number of Sinks in Sensor Networks for improving the Network Lifetime Maximization. Initially the optimal number of sinks is determined using the optimal sink algorithm satisfying the h-hop constraint. Then a K-Partitioned Minimum Depth Tree (k-PMDT) is constructed for positioning multiple sink nodes and setting up the routes. After determining the optimal number of sink positions and routing, best sink reposition is selected by optimum search method. Link movement is done by intelligent movement and it limits the sinks movements while maintaining their direction to the optimal positions. The main advantage of this method is to improve the lifetime of WSN's.

Keywords
Wireless Sensor Network, Energy efficiency, Sink repositioning, Lifetime, Sensor nodes

1. INTRODUCTION
The collection of nodes that are ordered into a cooperative network is called as wireless sensor network (WSN). There is a large range of sensor networks. Wireless sensor network was mainly designed for military application. Each node in wireless sensor network having the capabilities for processing, contain multiple types of memory, have a power source, have a RFC transceiver, and accommodate various sensors and actuators. The nodes communicate wirelessly and often self-organize after being deployed in an ad hoc fashion. Systems of 1000s or even 10,000 nodes are anticipated. Such systems can revolutionize the way we live and work. This new technology is moving with new technologies such as military, transportation, environmental, medical, homeland defense, entertainment, crisis management and smart spaces. In these scenarios the WSNs are usually deployed randomly in wide areas, and the network elements form a self-organizing ad-hoc multi-hop network. Once deployed, sensor nodes begin to observe the environment, communicate with their neighbors (i.e. nodes within communication range), collaboratively process raw sensory inputs, and perform a wide variety of tasks specified by the applications at hand. The ability to be deployed in very large scales without the complex pre-planning, architectural engineering, and physical barriers that wired systems have faced in the past, these factors that makes wireless sensor network so unique and promising both in terms of research and economic potentials. Many wireless sensor networks also utilize minimal capacity devices which places a further strain on the ability to use past solutions [1][2][3][4].

Sink repositioning means a moving node which has the ability to move around to collect data from sensors nodes and reposition is based on the collected data. To know the real time information on the sink position is the major challenge is that the sensor nodes. We need an estimation strategy is required at each hop to improve the effectiveness of WSN. Deployment of nodes in the network relies independent of metrics that base the state of the network or it assumes a pattern of network operations, which remains unchanged throughout the network lifetime. The nodes can be distributed adaptively based on the requirement as either controlled or random [5][6]. It is very complex to finding an efficient strategy for optimal gateway location. They are the two characteristics of gateway that are responsible for complexity. Those are one is gateway movement and second one is temporary location finder. The first responsible characteristic for complexity is the gateway can be moved to infinite possible positions. The second responsible characteristic for complexity is the temporary location finder. We will construct the new multi- hop network topology for a solution to the temporary discovery gateway location. The new multi- hop network topology is to confirm that the current temporary solution is qualifyable than previous temporary solution. The mathematical expression for this problem will require more parameters such as positions of all deployed sensors and state parameters like energy level and transmission range [6][7]. Sink repositioning can be performed in the following ways. Multiple Sink Deployment, Sink Mobility and Deploying Multiple Mobile Sinks [9][10]

2. LITERATURE REVIEW
Yu-Chen Kuo et al., [11] have proposed fast sensor relocation algorithm to arrange redundant nodes to form redundant walls without GPS. Redundant walls are constructed in the position where the average distance to each sensor node is the shortest. Redundant walls can guide sensor nodes to find redundant nodes in the minimum time. When the sensor node fails, our algorithm replaces the faulty node by the cascaded movement. The main advantage of this algorithm is it can find the proper redundant node in the minimum time and reduce the relocation time with low message complexity.

Wint Yi Poe et al., [12] have proposed local search technique for sink placement in WSNs that tries to minimize the maximum worst-case delay and extend the lifetime of a WSN, simultaneously. Since it is not feasible for a sink to use global information, which especially applies to large-scale WSNs, they introduce a self-organized sink placement (SOSP) strategy. The main goal of this research is to provide a better sink placement strategy with a lower communication overhead. Avoiding the costly design of using nodes' location information, each sink sets up its own group by communicating to its n-hop distance neighbors.

Xu Xu et al., [13] have proposed an optimization framework for Placing Optimal Number of Sinks in Sensor Networks for Network Lifetime Maximization and it improves network performance from several aspects, including the network lifetime prolongation, network scalability improvement, and the average data delivery delay reduction. Furthermore, it also enhances the network robustness substantially, since the sensing data generated by all sensors will be collected by multiple deployed sinks regardless of the network connectivity.

Hui Zhou et al., [14] have proposed a multiple dimensional tree routing protocol for multisink WSNs based on listening and ant colony optimization. The proposed protocol is as follows: (1) listening mechanism is used to establish and maintain multidimensional tree routing topology; (2) taking into consideration hops, packet losses, retransmission, and delay account, a distributed ant colony algorithm is proposed. When nodes select routes in the data transmission, the algorithm is utilized to realize the real-time optimization by coordination between nodes.

L. Friedmann et al., [15] have proposed a new dynamic approach to extend the lifetime of a sensor network based on both mobility and multiplicity of sinks. According to the evolution of the network, in terms of energy dissipation and distribution, this approach aims to find the optimal position for all the sinks in order to optimize the lifetime of the network and move accordingly these sinks in an intelligent manner.

3. K-PARTITIONED MINIMUM DEPTH TREE

We propose K -Partitioned Minimum Depth Tree using the optimal search in Placing Optimal Number of Sinks in Sensor Networks for improving the Network Lifetime Maximization. Initially the optimal number of sinks is determined using the optimal sink algorithm satisfying the h-hop constraint. Then a K-Partitioned Minimum Depth Tree (k-PMDT) is constructed for positioning multiple sink nodes and setting up the routes. After determining the optimal number of sink positions and routing, we will select the best sink reposition by optimum search method. In optimum search, we use the local search approach and the local search approach has obtained the optimal solution, it forgot about the current sinks positions. It will solve the optimal multi-sinks position problem in a network. After finding the optimum solution, we will move the sinks using the intelligent movement.

K-Partitioned Minimum Depth Tree (k-PMDT) is designed for a sensor network which has multiple sink nodes and a Minimum Depth Tree (MDT) is a tree constructed, that MDT minimizes the cost from each vertex. In k-PMDT, k means the number of sink nodes and it divide the sensor network into k disjoint partitions.

The k-PMDT algorithm is applied on k sink nodes and for every possible combination of k sink node. The set of sink nodes which maximize V_{min} is chosen. V_{min} is the minimum volume produced at a sensor node. The k-PMDT algorithm is given below.

1. Start
2. Define
3. For ($\sum_{i=1}^{k} C_i \neq 0$)
4. {
5. For each sensor node in the list
6. {
7. For each sink node
8. {
9. Shortest path is calculated for each sensor node to sink node.
10. }
11. Choose the sink node as a root of the MDT which has shortest path among the all paths to several links
12. }
13. Calculate the V_{min} for each partitioned MDT using the equation (2)
14. Select the minimal V_{min} as a K-PMDT V_{min}
15. }
16. Choose the best set of sink nodes which maximizes K-PMDT V_{min}
17. End

Algorithm 2: k-PMDT algorithm

In k-PMDT algorithm, shortest path is calculated for each sensor node to sink node in list. For example, if there are n sensor nodes and k sink nodes. The k-PMDT algorithm runs approximately n_{C_k} times to get the best set of sink nodes.

First calculate the number of children for each sensor node in MDT and then calculate the link cost to parent. The total data volume produced at each sensor node can be calculated from the following [16]

$$V_{node} = \frac{E_i}{NC * PR + (NC+1) * PT_{child}} \qquad (2)$$

In equation (2),

E_I = Initial energy of sensor node

NC = the number of children

PR = Receiving power consumption per bit

PT = Transmitting power consumption per bit

V_{node} = the total data volume produced at sensor node

The k-PMDT algorithm solves the shortest path problem from each sensor node to a sink node. There are multiple sink nodes in the sensor network, so a sensor node calculates the shortest path to each sink node. Then, the sensor node selects one sink node as a root of the MDT which has the shortest path among the paths to several sink nodes. This process is repeated for every sensor node in the sensor network.

In the given example, MDT is formed using the potential sink nodes. The potential sink nodes are selected using the Optimal Sink Algorithm.

In optimum search, we use the local search approach and the local search approach has obtained the optimal solution, it forgot about the current sinks positions. It will solve the optimal multi-sinks position problem in a network. After finding the optimum solution, we will move the sinks using the intelligent movement.

4. OPTIMUM SEARCH METHOD

After determining the optimal number of sink positions and routing, the best sink reposition is done by optimum search method.

In the Local Search Approach, X_0 is the initial solution and a finite series of solutions X_i is generated with a systematic change of neighborhood. X_{i+1} is derived from xi such that for all i, f(xi) > f(xi+1). f is the evaluation function of the solution. There three levels of transformation to derive the neighborhood of a solution

One Sink Movement: In this method, only one sink relocated in respect to the initial position. This movement performs in eight directions. North(N), South(S), East(E), West(W), N-E, N-W, SE, S-W.

Two Sinks Movement: In this method, two sinks simultaneous movement to neighborhood of a solution. It avoids the deadlock situation. Using the cardinal points, the transformations are limited. Total 16 movements are possible for the couple of sinks.

Three Sinks Movement: sinks are relocated simultaneously.

Once the optimal sinks positions found, the relocation problem of each sink to it final position big problem. The linear sink movement is costly in terms of energy constraints. Local search does not consider the sink velocity, the distance to travel, and the dynamics of the network. We proposed an approach based on a local search in a constrained space to perform an intelligent movement.

Intelligent Move: In the intelligent move, the sink movements are limited by maintaining their direction to the optimal positions. ld is liberty space and it is based on the current and optimal locations of the sink. “G” is the point located at a distance d from the current position of the sink on the line formed by the current position “cp” and the optimal position of the sink.

Sink new target is defined as the constrained space and a local search is activated in the constrained space using the same principle used to find the optimal position. The constrained optimums are generated by constrained local search to help to perform efficient and power-aware movements towards the optimum position.

5. SIMULATION RESULTS

The Network Simulator (NS-2) [16], is used to simulate the proposed architecture. In the simulation, the mobile nodes move in a 500 meter x 500 meter region for 50 seconds of simulation time. All nodes have the same transmission range of 250 meters. The simulated traffic is Constant Bit Rate (CBR). The proposed Multiple Sink Positioning and Relocation (MSPR) is compared with the k-PMDT technique. The performance is evaluated mainly, according to the following metrics. Packet Delivery Ratio, Packet Drop, Residual Energy and Delay.

We vary the number of nodes as 20,40,60,80 and 100.

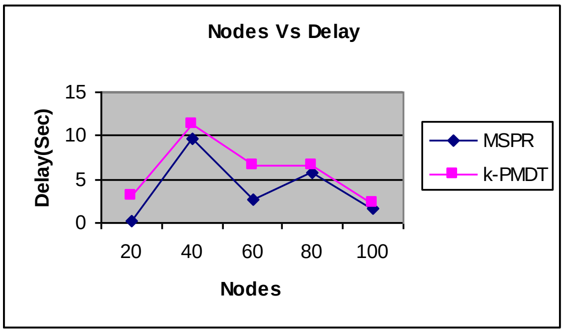

Fig 1: Nodes Vs Delay

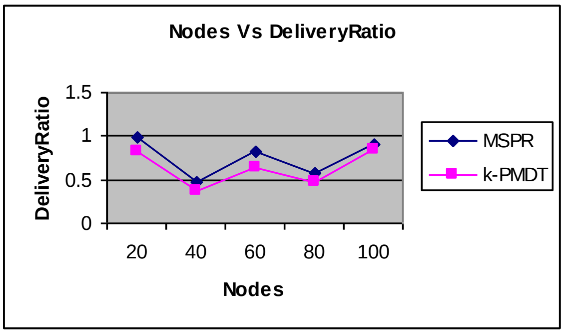

Fig 2: Nodes Vs Delivery Ratio

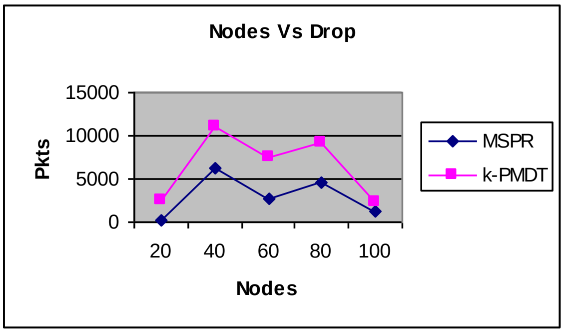

Fig 3: Nodes Vs Drop

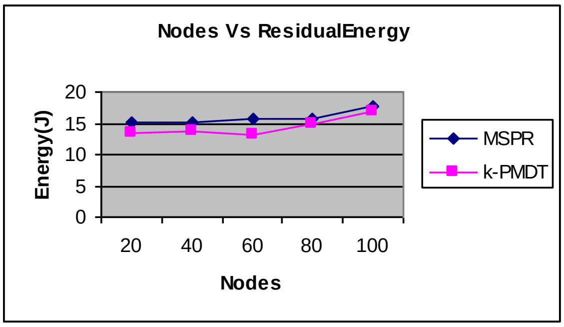

Fig 4: Nodes Vs Residual Energy

Figures 1 to 4 show the results of delay, delivery ratio, packet drop and residual energy for the number of nodes 20 to 100 in MSPR and k-PMDT algorithms. When comparing the performance of the two algorithms, we infer that MSPR outperforms k-PMDT by 42% in terms of delay, 18% in terms of delivery ratio, 59% in terms of drop and 9% in terms of residual energy.

6. CONCLUSION

In this paper, we proposed K -Partitioned Minimum Depth Tree using the optimal search in Placing Optimal Number of Sinks in Sensor Networks for improving the Network Lifetime Maximization. Initially the optimal number of sinks is determined using the optimal sink algorithm satisfying the h-hop constraint. Then a K-Partitioned Minimum Depth Tree (k-PMDT) is constructed for positioning multiple sink nodes and setting up the routes. After determining the optimal number of sink positions and routing, best sink reposition is selected by optimum search method. Sink movement is done by using the intelligent movement and it limit the sinks movements while maintaining their direction to the optimal positions. The main advantage of this method is, using of node life time in the construction of tree the tree lifetime will be improved and the optimal numbers of sinks are placed in sensor network for improving the network lifetime. The main advantage of K-PMDT is computation will be ended in a polynomial time.

7. REFERENCES

[1] I.F. Akyildiz, W. Su, Y. Sankarasubramaniam and E. Cayirci, “Wireless sensor networks: a survey”, Elsevier, 2001.

[2] John A. Stankovic, “Wireless Sensor Networks”, 2006.

[3] F. L. LEWIS, “Wireless Sensor Networks”, Smart Environments: Technologies, Protocols, and Applications, 2004.

[4] Seapahn Megerian and Miodrag Potkonjak, “Wireless Sensor Networks”.

[5] Zoltán Vincze, “ENERGY EFFICIENCY ENHANCING TECHNIQUES IN WIRELESS SENSOR NETWORKS”, 2008.

[6] Prerana Shrivastava and S. B. Pokle, “Survey on Sink Repositioning Techniques in Wireless Sensor Networks”, International Journal of Computer Applications, Volume 51– No.4, August 2012.

[7] Mohamed Younis and Kemal Akkaya, “Strategies and Techniques for Node Placement in Wireless Sensor Networks: A Survey”.

[8] Prerana Shrivastava and Dr. S. B. Pokle, “A Hybrid Sink Positioning Technique for Data Gathering in Wireless Sensor Networks”, International Journal of Engineering and Innovative Technology (IJEIT), Volume 1, Issue 3, March 2012.

[9] Mujdat Soyturk and Turgay Altilar, “A Routing Algorithm for Mobile Multiple Sinks in Large-Scale Wireless Sensor Networks”.

[10] M. Amac Guvensan and A. Gokhan Yavuz, “On coverage issues in directional sensor networks: A survey”, Elsevier, 2011.

[11] Yu-Chen Kuo and Shih-Chieh Lin, “A Fast Sensor Relocation Algorithm in Wireless Sensor Networks”, World Academy of Science, Engineering and Technology, 2009.

[12] Wint Yi Poe and Jens B. Schmitt. “Self-Organized Sink Placement in Large-Scale Wireless Sensor Networks”, 2009.

[13] Xu Xu and Weifa Liang, “Placing Optimal Number of Sinks in Sensor Networks for Network Lifetime Maximization”, IEEE, 2011.

[14] Hui Zhou, Dongliang Qing, Xiaomei Zhang, Honglin Yuan, and Chen Xu, “AMultiple-Dimensional Tree Routing Protocol for Multisink Wireless Sensor Networks Based on Ant Colony Optimization”, Hindawi Publishing Corporation International Journal of Distributed Sensor Networks, 2012.

[15] L. Friedmann and L. Boukhatem, “Efcient Multi-sink Relocation inWireless Sensor Networks”, IEEE, 2007.

[16] Network Simulator: http:///www.isi.edu/nsnam/ns