Routing for Sink Nodes with Obstacles in Cluster Based WSN

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***Abstract* - In Wireless Sensor Networks (WSNs), the benefits of exploiting the sink mobility to prolong network lifetime have been well recognized. In physical environments, all kinds of obstacles could exist in the sensing field. Therefore, a research challenge is the determination of efficient dispatch of the mobile sink to find an obstacle avoiding shortest route. This research article presents an energy-efficient routing mechanism based on the cluster-based method for the mobile sink in WSNs with obstacles. According to the cluster-based method, the nodes selected as cluster heads collect data from their cluster members and transfer the data collected to the mobile sink. In this work, the mobile sink starts the data-gathering route periodically from the starting site, then directly collects data from these cluster heads in a single-hop range and finally returns to the starting site. However, due to the complexity of the scheduling problem in WSNs with obstacles, the conventional algorithms are difficult to resolve. Simulation results verify the effectiveness of the method.**

***Index Terms* - Wireless Sensor Networks, Network lifetime, Security, Trust, Attacks.**

1.INTRODUCTION

Wireless Sensor Networks (WSNs) have been applied in many areas, including health monitoring, environmental monitoring, and military surveillance and also as Internet of Thing (IoT). Energy efficiency has become the most key issue for WSNs. However, power supplies for sensor nodes are limited and hard to replace. In addition, compared with other nodes, nodes near the base station (also called the sink) consume more energy, since the nodes relay the data collected by sensor nodes far away from the sink. Hence, once these sensors near the sink fail, the data collected by other sensors cannot be transferred to the sink. Wireless sensor networks (WSNs) have been broadly studied in ubiquitous computing environment because of its widespread utilization. The application area of WSNs includes environmental management, health-care services, and military monitoring [1–3]. WSNs are composed of many sensor nodes equipped with processors, memory, and short-range wireless communication. In real applications, the sensor nodes are distributed in the areas of interest, and they sense data from surrounding environments. The sensor nodes co-operate with each other to transmit the sensed data to the central base station called sink node. A routing protocol determines the path between a source node and destination (i.e., sink node) for sensed data transmission. The efficiency of WSNs is highly dependent on routing protocol that directly affect the network lifetime. The main objective of routing protocol is to enhance both reliability and lifetime of WSNs by considering the capability of a sensor node with resource constraints such as limited power, slow processor, and low communication bandwidth. Hence, the challenging issue of routing protocol is to reduce the communication overhead for data transmission by determining an optimal path. Clustering is one of the most popular techniques for routing protocols. The cluster-based routing is an efficient way to reduce energy consumption within a cluster by decreasing the number of transmitting messages to the sink node. Hence, there have been many researches on cluster-based routing protocols. A popular cluster-based protocol called LEACH proposes a two-phase operation based on a single-tier network using clusters. LEACH randomly selects a portion of nodes as cluster headers, and they gather the neighbouring nodes to construct clusters. Each node forwards the sensed data to a cluster header which collects and delivers data to the sink node. There are several extensions of the LEACH protocol to increase energy efficiency, but the existing protocols have some limitations. First, it is assumed that all sensor nodes can transmit data to the sink node with enough power and network capability. However, the entire network becomes disconnected although most of the nodes still have a lot of energy. Therefore, to extend the network lifetime, minimizing the energy consumption of sensor node is the key challenge for WSNs. Different approaches are proposed to prolong the lifetime of WSNs. Recent work shows that one can use mobile node to reduce the energy expenditure of WSNs to a large extent. Consequently, the lifetime of WSNs is prolonged. When compared with static nodes, mobile nodes possess more energy and powerful capabilities. Mobile nodes are usually mounted on a mobile vehicle equipped with enough energy and can collect data from all static nodes by moving across the sensing field. The mobile nodes are used as the mobile sink which moves across the sensing field to collect data. On one hand, the mobile sink reduces the communication overhead for sensor nodes close to the base station or the sink leading to the uniform energy consumption. On the other hand, with the movement of the sink, one can handle better the disconnected and sparse network. Therefore, the network lifetime can be significantly extended by the optimum control of the route of the mobile sink. In physical environments, the sensing field could contain various obstacles. Hence, to prolong the network lifetime, a research challenge is to determine an obstacle-avoiding shortest route for the mobile sink. Low-energy adaptive clustering hierarchy ("LEACH") is a TDMA-based MAC protocol which is integrated with clustering and a simple routing protocol in wireless sensor networks (WSNs). The goal of LEACH is to lower the energy consumption required to create and maintain clusters in order to improve the lifetime of a wireless sensor network. LEACH is a hierarchical protocol in where most nodes transmit to cluster heads and the cluster heads aggregate and compress the data and forward it to the base station (sink). Each node uses a stochastic algorithm at each round to determine whether it will become a cluster head in that round. LEACH assumes that each node has a powerful radio to directly reach the base station or the nearest cluster head but using this radio at full power all the time would waste energy. Nodes that have been cluster heads cannot become cluster heads again for P rounds, where P is the desired percentage of cluster heads. Thereafter, each node has a 1/P probability of becoming a cluster head again. At the end of each round, each node that is not a cluster head selects the closest cluster head and joins that cluster. The cluster head, then creates a schedule for each node in its cluster to transmit its data. All nodes that are not cluster heads only communicate with the cluster head in a TDMA fashion, adhering to the schedule created by the cluster head. This is accomplished using the minimum energy required to reach the cluster head and needs only to keep their radios on during their time slot. LEACH also uses CDMA so that each cluster uses a different set of CDMA codes to minimize interference between clusters. In the past, one could only utilize static sensor nodes to collect the environment information. With technical progress, one can introduce mobility to WSNs. For example, one can use mobile sensor nodes to collect information. Compared with static nodes, mobile nodes have more energy and are more convenient for usage. However, in physical environments, the sensing field may be uneven and contain various obstacles. In the existing methods, a hybrid WSN, static sensors monitor and collect environmental information. Once events happen, each static sensor can sense only one attribute of events. Compared with static sensors, a mobile sensor can evaluate multiple attributes of events. According to the sensing data from static sensors, mobile sensors move to corresponding hot locations for more in-depth analysis. To minimize the energy consumption, the authors present a two-phase heuristic algorithm to dispatch mobile sensor for hot locations. In the first phase, the authors dispatch MAM sensors to hot locations in a one-to-one approach. In the second phase, according to unassigned hot locations, the authors present a spanning-tree construction algorithm for the displacement of MAM sensors. Due to similar capabilities of sensors, a research challenge is how to dispatch mobile sensors to these hot locations. However, in [8-14], the authors do not consider that the sensing field may contain various obstacles. In fact, the route for mobile nodes in sensing field containing obstacles is more complex than sensing field without obstacles. In the proposed cluster-based routing mechanism, it is assumed that the mobile sink could be a vehicle or a mobile robot with enough energy. When compared with other operations, communication is the most critical energy consumption of sensor nodes which includes transmission and reception. A radio energy dissipation model for the sensor node includes the transmitter energy dissipation model and the receiver energy dissipation model as shown in Figure.1. In the transmitter energy dissipation model, the operations for radio electronics and power amplifier consume energy. In addition, in the receiver energy dissipation model, the operation for radio electronics consumes energy. Obviously, the transmitter consumes more energy than the receiver. According to the cluster-based algorithm, all sensor nodes in the network are divided into two categories: cluster heads and cluster members. Cluster heads collect data from their cluster members which collect environment information and then forward the data to the sink either directly or via relaying across other cluster heads [6]. Due to movement of the sink, the mobile sink can move nearest to the cluster heads and consume less energy. One can balance energy consumption of sensor nodes by using the cluster-based algorithm. Therefore, the network lifetime will be prolonged significantly. To solve the scheduling for the mobile sink, one uses the Low-Energy Adaptive Clustering Hierarchy (LEACH). Once cluster heads are determined by the LEACH, the mobile sink can move closest to the cluster heads for gathering data. Hence, sensor nodes consume less communication energy which is the most critical energy consumption of sensor nodes. Here, the mobile sink mounted on a mobile vehicle is equipped with enough energy.

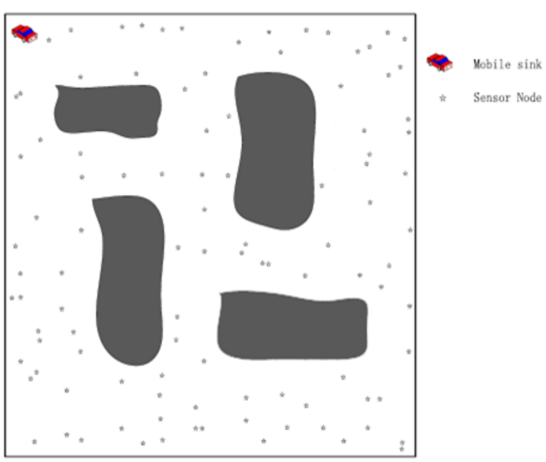


Figure 1: System Architecture

Figure 1 shows the structural diagram of sensor node components. Generally, sensor node consists of sensing, processing, transportation, mobilizer, position detecting system, and power units. The same diagram represents the communication structure of a WSN. Sensor nodes are basically dispersed in a sensor field, which is the region where the sensor nodes are placed. Sensor nodes cooperate between themselves to generate good-quality information about the physical surroundings. Every sensor node takes its decisions on its goal, the data it presently has, and it is in essence, the obstacle-avoiding the shortest route problem is similar to the Traveling Salesman Problem (TSP) which is a classical problem. One can utilize the minimum spanning tree to solve the TSP. Hence, according to the minimum spanning tree, one can also find an obstacle-avoiding shortest route for the mobile sink. The obstacle-avoiding spanning graph is the set of edges that can be formed by making connections between terminals and obstacle corners. Once a spanning graph is constructed, the infinite possible sites for the mobile sink movement will be reduced to a finite set of sites. Therefore, the algorithm based on the spanning graph makes it more efficient to schedule for the mobile sink.

2.RELATED WORK

In the paper titled “Energy consumption monitoring for sensor nodes in snap” the authors communicate that as vitality is one of most urgent viewpoints for ordering calculations' execution, it is vital to get an apparatus to compute the rest of the vitality utilization. There was not any fantastic answer for check vitality utilization of each individual sensor hub in remote sensor organize. In this paper, the creators prescribe another continuous vitality observing game plan as a practical nuts and bolts for WSN test bed (sensor arrange right hand stage, SNAP). The creators describe an observing outline which has taking after points of interest: ongoing exact vitality estimation, the ability to adapt to vast scale WSN, checked hubs with free reactions, exceedingly versatile to different sorts of sensor hubs and backings facilitate examination on hubs as for vitality productivity. In the paper titled “Wireless Sensor Network Platform for Intrinsic Optical Fiber pH Sensors” the authors investigate the capability of making a half breed WSN through the development of a nonexclusive remote sensor arrange stage, which gifts for the able coordination of a no. of novel7optical fiber (wired) sensors. The7intention is to support7the capability of a7sensor display. A fundamental design comprises of a LED light source, a photodiode, a channel, and an enhancing circuit. In this way, singular bit can proof and process the signs set up from the optical fiber sensors and send that information caught remotely to a base station. To affirm both the mixture discernment and the adequacy of a nonspecific stage, the model is confirmed utilizing a characteristic pH optical fiber sensor. At the point when the sensor is directed to a scope of arrangements, the information created from the framework are procured at the base station. The viable outcomes accomplished affirm the execution of the plan, and its capacity to give constant optical fiber sensor information observing, handling, and transmission. Recent work depicts that the advantage of utilizing the mobility of nodes. By using the mobility of nodes in WSNs, one can ease the traffic burden and enhance energy efficiency. Hence, the network lifetime is extended significantly. Many articles have proposed several different approaches. In [8], the authors present a VGDRA scheme for the mobile sink to minimize the communication cost. The sensor field is divided into a virtual grid containing the same sized cells and the nodes near the center are chosen as the cell-header nodes. In addition, a virtual backbone structure consisting of the cell header nodes is constructed the mobile sink moves across the sensor field and collects the sensing data by communicating with the border cell header nodes. To reduce the overall communication cost, the routes reconstruction process includes only a subset of cell-header nodes. In [9], the authors propose a mixed integer programming framework for base station to mitigate the suboptimal energy dissipation. To reverse the suboptimal energy dissipation trends, the base station mobility is introduced to WSNs [7]. The network lifetime is finally extended by using mobility patterns for base station. The research article [10] utilizes the support vector regression technique to construct a convex optimization model where the optimal trajectory of the mobile sink can be determined. The network lifetime is affected by the trajectory called COT. To maximize the network lifetime, the mobile sink in the event-driven is used to collect the captured data of events. In [11], the authors propose a mobile data-gathering tour for different sensor networks. An Mcollector similar to a mobile base station is introduced to collect sensing data from static sensors. The MDC begins its periodical movement from the base station and finally returns for transferring the data to the base station. For some applications in large-scale networks, the authors take a divide-and-conquer strategy and use multiple M-collectors, each of which moves through a shorter data-gathering tour. In [12], the authors adopt a wireless energy transfer technology for charging sensor nodes. The Wireless Charging Vehicle (WCV) starts a periodical tour from the service station, moves across the network for charging some sensor nodes wirelessly and finally returns. According to the novel Reformulation-Linearization Technique (RLT), the authors design a near-optimal solution for the optimization problem. In [13] and [14], the authors consider the dispatch of mobile sensors as a multi-round and multi-attribute sensor dispatch problem. In a hybrid WSN, static sensors monitor and collect environment information. Once events happen, each static sensor can only sense one attribute of events. Compared with static sensors, a mobile sensor can evaluate multiple attributes of events. According to the sensing data from static sensors, mobile sensors move to corresponding hot locations for more in-depth analysis. Many researchers have proposed different protocols for energy-efficient routing in WSNs. In general, the routing protocols for WSNs can be divided into flat-based routing, cluster-based (hierarchical-based) routing, and location-based routing [9–12], based on the network structure. In flat-based routing, all nodes are typically assigned equal roles or functionality. In cluster-based routing, however, nodes play different roles in the network. In location-based routing, sensor nodes' positions are exploited to route data in the network. Among the existing protocols, the cluster-based routing protocol is particularly more suitable for continuous data transmission in WSNs. In this section, an abbreviated overview of the well- known cluster-based routing protocols for WSNs, along with their limitations is presented. Heinzelman et al. [4] introduced a hierarchical clustering algorithm for sensor networks called Low Energy Adaptive Clustering Hierarchy (LEACH). The idea is to randomly select a few sensor nodes as cluster headers and rotate this role to evenly distribute the energy load among the sensors in the network. The LEACH protocol includes two stages of operation: node clustering and information transmission. A node that produces the random number being smaller than threshold is selected as cluster header. The other nodes are allocated to the cluster header closest to them. Second, in the information transmission stage the cluster headers aggregate the data received from their cluster members and send the aggregated data to the base station by single hop communication. LEACH outperforms traditional clustering algorithms by using adaptive clusters and rotating cluster header, that can distribute energy consumption among all the sensor nodes. In addition, LEACH can perform local computation so the amount of transmitted data can be reduced. However, LEACH assumes direct communication between a node and a base station. This is a high-power operation and shortens the lifetime of the network. Moreover, the random selection of headers does not guarantee optimal cluster construction and may cause rounds of communication when cluster headers are not available. Heinzelman et al. [4] presented Low Energy Adaptive Clustering Hierarchy-Centralized (LEACH-C) in order to distribute cluster headers evenly over the network and reduce energy dissipation. During the initial stage, each node sends to the sink node information about its current location and energy level. Therefore, sensor nodes whose remaining energy is below the average energy are excluded from becoming a cluster header. For each round, the sink node runs an optimization algorithm to determine cluster headers and the network is divided into clusters. Since LEACH-C requires the position of each node at the beginning of each round, an expensive global positioning system (GPS) is required for sending the position information. In addition, the number of nodes for each cluster is not guaranteed during formation of clusters. Farooq et al. [15] proposed a Multi hop Routing with Low Energy Adaptive Clustering Hierarchy (MRLEACH). MRLEACH partitions the network into different layers of clusters based on the distance between a sensor node and a sink node. Cluster headers are chosen by the LEACH protocol and transmit the aggregated data to a sink node by using multi hop routing. Therefore, significant improvement is achieved on energy consumption compared with the LEACH protocol. The problem of MR-LEACH is the selection of a cluster header in a layer, solely depends on the energy residue of a sensor node without considering distances among cluster headers.

3.PROPOSED SYSTEM

In this research work, Figure shows the Cluster-based routing mechanism for mobile sinks with obstacles represent the cluster-based routing for every event of nodes are sensed and data transmission between these nodes are tracked by cluster head. All the data are gathered by the cluster head and transmitted to base station. The proposed system is divided into four modules namely Nodes Partitioning, Obstacle Avoidance Clustering, Construction of Spanning Graphs and Performance Evaluation Nodes Partitioning in this module, all sensor nodes in the network are divided into two categories: cluster heads and cluster members. Cluster heads collect data from their cluster members who collect environment information, and then forward the data to the sink either directly or via relaying across other cluster heads represented in Figure.

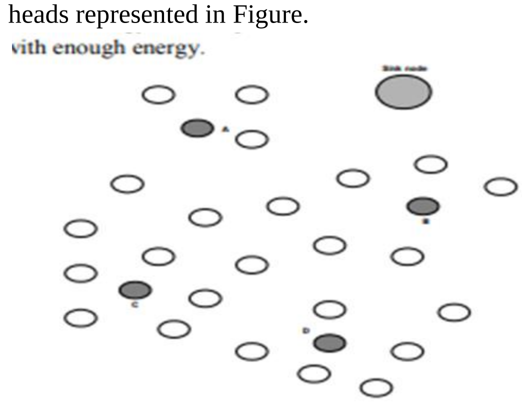


Fig 2: Nodes Partitioning

Obstacle Avoidance Clustering

In this module, a heuristic algorithm is presented to find an obstacle-avoiding shortest route for the mobile sink. In order to better solve the dispatch problem of the mobile sink, one uses the algorithm to construct the spanning graph of the network model represented in

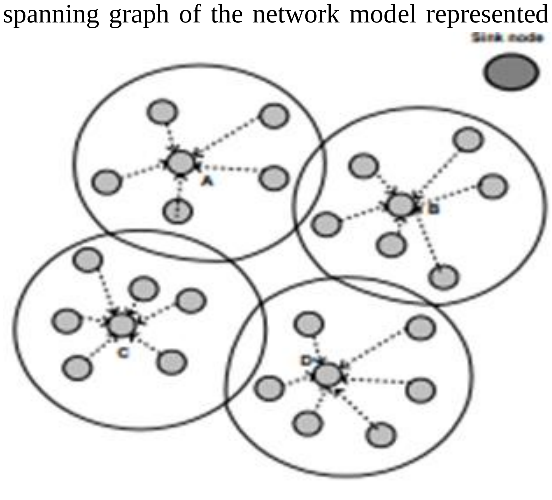


Fig 3: Formation of Clusters to avoid drops and Obstacle

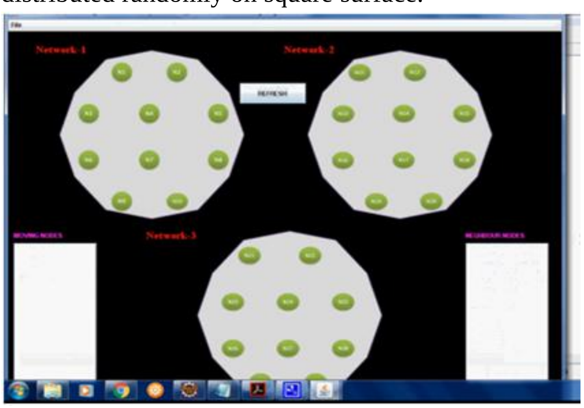
Figure. According to the spanning graph, one can obtain all obstacle-avoiding paths. Furthermore, the obstacle-avoiding shortest route for the mobile sink can be acquired from these obstacles avoiding paths.

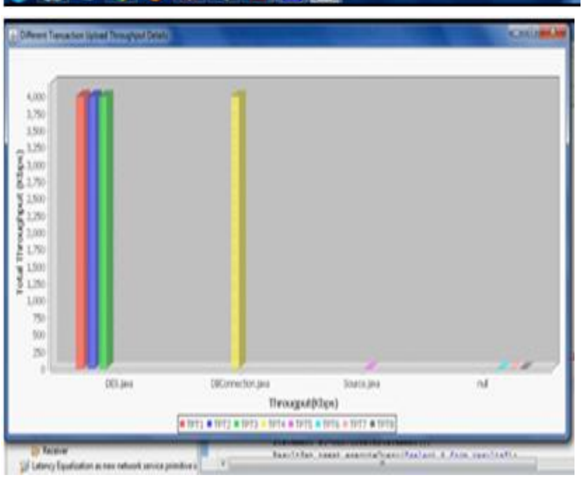
Construction of Spanning Graphs

In this module, the obstacle-avoiding the shortest route problem is similar to the Traveling Salesman Problem (TSP) which is a classical problem. One can utilize the minimum spanning tree to solve the TSP. Hence, according to the minimum spanning tree, one can also find an obstacle-avoiding shortest route for the mobile sink. The obstacle-avoiding spanning graph is the set of edges that can be formed by making connections between terminals and obstacle corners.

4.RESULTS

The performance of Cluster based routing mechanism using LEACH is analyzed using network simulator. The experimental model is built with 21 nodes distributed randomly on square surface.





5.CONCLUSION

The network is divided globally into Hierarchical Network and Non-Hierarchical Network. LEACH algorithm belongs to a category of hierarchical network. LEACH discovers the route between sources nodes to destination node with base station being involved in the communication with back-and-forth propagation for the case of inter cluster communication. LEACH algorithm is future simulated to measure the parameters which includes Average Transmission Delay, No. of Hops, Consumption of Energy, No. of Alive Nodes, No. of Dead Nodes, Lifetime Ratio and Routing Overhead. In the Obstacle Aware Approach elects the cluster head stationed on the residual energy of the node. Initially cluster head is selected based on the closeness on the center of the cluster.

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