PATH OPTIMIZATION OF MOBILE SINK FOR ENERGY EFFICIENT DATA TRANSMISSION

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Abstract- *The sink node movement along with fixed path can minimize the energy utilization in Wireless Sensor Networks (WSN). This technique brings significant challenges for data collection and energy consumption. To overcome the issue several combinatorial optimization techniques are considered. The optimization of the path is to solve the Path Stop Point (PSP). The path of the mobile sink is determined based on various constraints to avoid data loss and more energy consumption. The path determination mainly based on flow constraint, energy constraint, and cost constraint. This paper reviews about various optimization techniques available and focuses to overcome the constraint problem.*

Key-words: Mobile Sink, Optimization, Wireless Sensor Networks (WSN), Path Stop Problem (PSP).

1. INTRODUCTION:

The constituents for path planning are environment (e.g., a network, a graph, a tree, or a geometric representation); constraints (avoiding obstacle , short length, number of turns depending on the specific application criteria); and a combination of criteria (e.g., optimizing cost or distance functions). The known Dijkstra's algorithm allowed computing a tree of shortest paths from any source node to all other destination nodes. In most cases all sensor nodes of WSNs are battery-powered and located in the unattended environment. Once node's energy exhausts, the node is disabled and it will affect the network operation by splitting the network to shorten network lifetime. Therefore, in WSNs, network lifetime is the important parameter of network performance.

The WSNs algorithms should save the energy and increase the network lifetime. Some researches on lifetime optimization algorithm with fixed nodes have got accomplishments. For example, an ant colony optimization approach for the lifetime maximization of wireless sensor networks. In this algorithm, cover constraint, collection constraint, and routing constraint are considered. The function is established, ant colony optimization is used to obtain the lifetime optimal scheme. Reference [2] constructs optimal clustering protocol and designs energy-aware cluster-head rotation and routing protocol to prolong network lifetime. The two methods to optimize the lifetime of chain based protocols using integer linear programming (ILP) formulations [1]. In those algorithms, it is inevitably to cause energy consumption by the unbalanced distribution of node and energy hole problem. This constraint can be overcome by sink nodes' movement. All nodes have its turn to transmit data near sink nodes and have the same lifetime. In the network lifetime maximization problem, the network lifetime optimization models is established with mobile sink node, use optimization algorithms to solve the models, and obtain optimal method. The path determined for movement of sink node is already known and do not consider how to select the anchors or movement path of sink node [4]. The guide agent nodes and intermediate guide nodes, analyzes the TSP (travelling salesman problem), determines path for movement with node cooperation, and proposes data gathering algorithm which provides data transmission latency optimization and energy. However, the algorithm do not consider lifetime of the network. Range constrained clustering (RCC) divides nodes into several clusters. Sink node stays at the cluster centres to gather data. The TSP solver is used to calculate the shortest path movement of sink node through some cluster centres. determine the locations of mobile sink node. However, they do not allow the data gathering when sink node is moving. Whether the algorithms can obtain optimal solution needs theoretical analysis.

The various techniques to decide the stop points of the sink node are analyzed and the disadvantages in the techniques are taken in account to establish an algorithm that overcomes the effects. The paper organized into various techniques explanation, analysis and conclusion.

2. RELATED WORKS

The optimization technique is usually carried over to minimize the energy consumption by the nodes and also to increase the network lifetime and to reduce the complexity in delivering the sensed data to the sink node. Optimization can be done for various combinatorial manner such to find the shortest path, to reduce the cost of readjustment of path due to dynamic nature, to avoid loss of data, etc.

2.1 Lifetime optimization Algorithm

The paper presents an algorithm called Lifetime optimization algorithm for mobile sink node wherein constraints like energy, flow and link are considered. The mobile sink is allowed to start and end its tour in same location. Here static data gathering technique is used wherein the mobile sink waits at a point and gathers the data from the nodes. The mobile sink is allowed to move to the centres of the grid. The grids are formed based on the population of the nodes in order to distribute the nodes all along the network. Multiple mobile sink are considered and state indicators are used in order to avoid collision in the path of node. RSSI (Received Signal Strength Indication) is used to collect the information regarding the neighbourhood nodes. Kalmann filtering is employed in order to avoid the historical informed already availed about the neighbour node in sink.

2.2 Optimal Stop Points for Data Gathering

Each sensor in the network generates a fixed amount of data between consecutive visits by the MS. Data sensed by sensor nodes are send to the rendezvous nodes of their respective stop points. When the MS reaches its stop point, it sends a beacon message to rendezvous nodes to collect data. Since the energy required to transmit data and to receive data is the dominant component of a node's energy usage, energy consumption required for data gathering is proportional to the average hop count from sensor nodes to their stop points. So the length of the path increases more stop points are used, the average number of hops to sensor nodes decreases and the energy consumption required for data gathering decreases. The algorithm used consists of various stages in the path decision. The admission configuration is based on the cost of the link. The next stage is neighbourhood investigation in which a set of nodes are selected based on criteria whose cost is low so that it is avoid for the stop points of mobile sink. Then aspiration criterion and stopping criterion are also considered based on the cost of the link.

2.3 Robust Data Collection with Mobile Sink

The sink mobility is considered as a major technique to reduce the energy consumption by the node. The various sink mobility patterns are described and their disadvantages and advantages are explained for both single and multiple mobile sink. It proved that data collection when the mobile sink path is uncontrollable is difficult and results in poor data delivery rate. The paper proposed an algorithm called Optimal Terminal Assignment based Path (OTABP) which considers the speed and path followed by the sink node. The algorithm is efficient in data delivery by the mapping between sensor nodes and sub sinks which are optimized to maximize the amount of data collected by the mobile sink.

2.4 The Constrained Shortest Path Problem

The paper focussed on the constrained shortest path (CSP) which requires minimum cost path from source to destination node with the condition that the total delay of the path should be less than or equal to specified value. The paper pointed out the various algorithms for CSP and found its equivalence, then for Minimum Cost Restricted Time Combinatorial Optimization (MCRT) problems they employed combinational parameter optimization. LARAC-BIN Binary search algorithm is proposed to search the shortest path and compared with existing LARAC algorithm for both CSP and MCRT problems.

3. PROPOSED WORK

The path optimization of the mobile sink is carried over in terms of both cost and energy consumption by the nodes. The mobile sink path and speed are fixed. The network is divided into grids and the mobile sink is allowed to move the centre of the grid. The nodes with single hop to the mobile sink are taken as agent node through which the other nodes have to communicate their data. The mobile sink location starts and ends at the same point. The proposed work is compared with existing work in terms of energy consumption by the node, route reconstruction cost and data latency.

The network lifetime is given by

$$T = \sum_{n}\sum_{p} t^{n}{}_{p} + \frac{\sum_{n}\sum_{v\in G_d}\sum_{\omega\in G_d} d_{v\omega}\, p_{v,w}}{u}$$

Where

T network lifetime

t^n_p sojourn time in which sink node at grid p in nth movement

$d_{v\omega}$ distance between grid v and ω

4. SIMULATION ANALYSIS

The following are the results simulated in the reviewed paper based on the algorithm discussed.

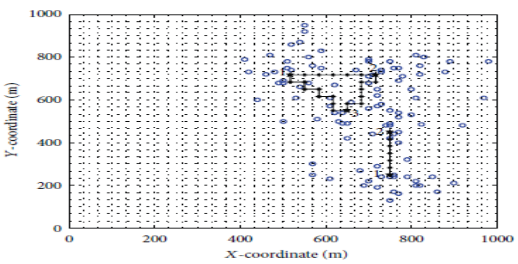

Fig.1-.Grid based path travelled by two mobile sink nodes

Figure 1 represents the multiple mobile sink system in which the fixed path travelled by the sink is simulated.

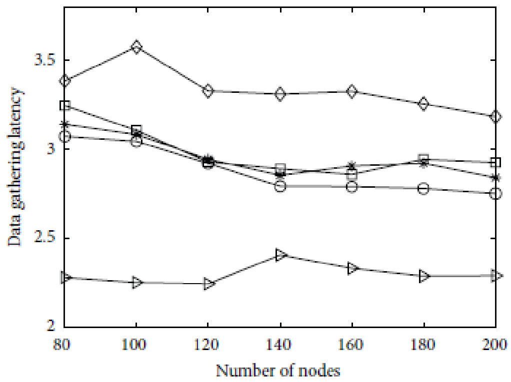

Fig.2- Comparison of Protocols

The latency parameter is taken in account and the comparison is done between the proposed lifetime optimization algorithm and others. It is found that the proposed work comparatively has less latency.

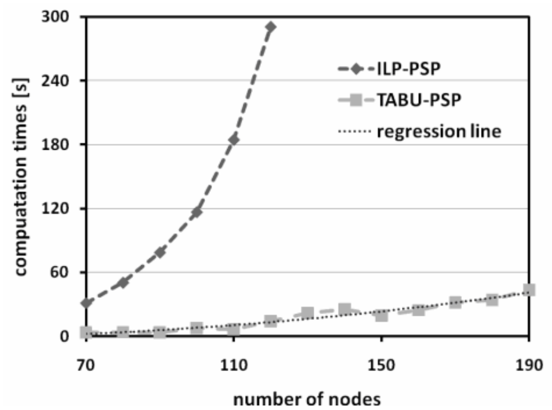

Fig.3- Computation time comparison

The above figure compares the computational time required by the algorithm to update the location and transmit the data.

5. CONCLUSION

The review of various papers is done to implement the path optimization of the mobile sink in order to reduce the energy consumption of the nodes and to reduce the reconstruction cost. The papers discussed above delivers that fixed path and speed of the mobile sink produces high data delivery rate. Also stop points of the mobile sink should be selected accurately in order to get the results efficiently.

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