STEINER TREE RECTILINEAR MODEL FOR DATA AGGREGATION AND SENSOR NODE QUERY PROCESSING IN WSN

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ABSTRACT

A huge number of sensor nodes are organized in the arbitrary position in wireless sensor network for better utilization of energy while performing the communication. Query Result optimization through various algorithms report for lesser computational complexity and energy utilization restrictions on sensor nodes. Concealed Data Aggregationfor Multiple Applications (CDAMA) scheme offers the application explicit data fromaggregated ciphertexts. The collected data carries hugeenergy cost in CDAMAscheme with intermediate nodes and the secure data aggregation is not relied on the sensor network. Real-time Data Management (RDM) in wireless sensor network process and optimize the real time queries with the real world application but the query processing with data aggregation result does not offer with minimal energy consumption. So in the upcoming work plan, Integration approach is proposed to deal with better energy utilization by combining the data aggregation and query processing work. Steiner Tree with Rectilinear Distance (STRD) method is proposed for integrating the data aggregation and query processing work with the better energy utilization. Primarily data aggregation process carried out in the STRD method using the likelihood function. The likelihood function uses the rectilinear distance formulation to aggregate the similar data with energy efficiency. The rectilinear distance based aggregated data are used in the second part of the work to perform the query processing

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with the optimal query result in sensor network. The Steiner Tree with the heuristic query processing ensures the optimal query result with approximately 5% minimal energy consumption in wireless sensor network. STRD method performs the simulation work on the parametric factors such as average energy utilization per sensor node, tree construction efficiency, query processing rate, query response time, and precision rate.

I. Introduction

Wireless Sensor Networks are measured to perform the data aggregation and query processing work. Each sensor network capture and stores the data (i.e.,) information from sensor node. Information query system develops to perform the query processing with the stored sensor network information. The query values while processing differs for each users query and it is mainly affected by the routing schemes.

Localized Power Efficient Data Aggregation Protocols (L-PEDAP) as developed in [3] are based on the LMST and RNG topologies. The definite routing tree is build over the topologies and evaluates each parent selection policy on the best among them. K-connected Deployment and Power Assignment Problem (DPAP) as illustrated in [5] monitor the sensor position and broadcast power intensity to improve the coverage level. Multi-Objective EvolutionaryAlgorithm based on Decomposition (MOEA/D) does not recover the performance ratio of different routing protocol in wireless sensor network.

Fault Tolerant TrajectoryClustering (FTTC) technique as illustrated in [10] decide the cluster heads in WSN algorithm. Thenetwork lifetime fails in achieving the robustness on FTTC technique. Quorum-based MAC protocol regulates the wake up times of sensor nodes as demonstrated in [9] decrease collision points and improves the robustness. Quorum-based MAC protocol for channel assignment has higher overhead and utilizes more channel work.

Redundant Radix Based Number (RBN)representation for encoding and transmitting data in [6] characteristically make use of low cost devices with effective coverage property and lowpower operations for commanding with the easy modulation techniques. Real-time Data

Management (RDM) in wireless sensor network as illustrated in [2] process and optimize the queries with the real world application but the query processing with data aggregation result does not offer the minimal energy consumption.

Recoverable Concealed Data Aggregation (RCDA) as shown in [8] gets better sensing information even when the data aggregation process carried out. With thisindividual information, two functionalities are provided explicitly the integrity and authenticity.Data Aggregation and optimal routing on the wireless sensor network as demonstrated in [4] maximize the network lifetime. The optimality is accomplished using the dispersed gradient algorithm with smoothingapproximation function.Concealed Data Aggregationfor Multiple Applications (CDAMA) scheme as described in [1] is not relied on the sensor network.

In this work, focus is made on integrating the data aggregation and the query processing work in the wireless sensor network. Initial work is carried out for data aggregation using the likelihood function. The Steiner Tree constructed for the easy processing of the query from the user in the sensor network. Finally the data aggregation and query processing combined through the Steiner Tree with Rectilinear Distance (STRD) method.

The structure of this paper is as follows. In Section 1,describesthe basic problems in hybrid data aggregation approach in wireless sensor network. In Section 2, present an overall view of the Steiner Tree with Rectilinear Distance (STRD) method.Section 3and 4 outline simulation results with parametric factors and present theresult graphfor research on wireless sensor network. Finally, Section 5 demonstrates the related work and Section 6 concludes the work.

II.Integration of Data Aggregation and Query Processing In Wireless Sensor Network

The main objective of the work is to integrate the data aggregation operation and the query processing work in the wireless sensor network using the SteinerTree with Rectilinear Distance (STRD) method. STRD method designed framework is shown in Fig 1.

As illustrated in Fig 1, STRD developed in the sensor network with the sensor nodes position the information on the network. The information from the source node is sent to the sink node to reduce the over utilization of energy. Sink node act as a gateway or a router in the large wireless sensor network structure. The sink node in the sensor network structure helps to aggregate the similar data suing the likelihood function. The likelihood function is carried out using the information assigned to the sensor node, and size of the information transported to the nearby intermediate nodes. The likelihood function uses the rectilinear distance formulation to aggregate the similar data with energy efficiency.

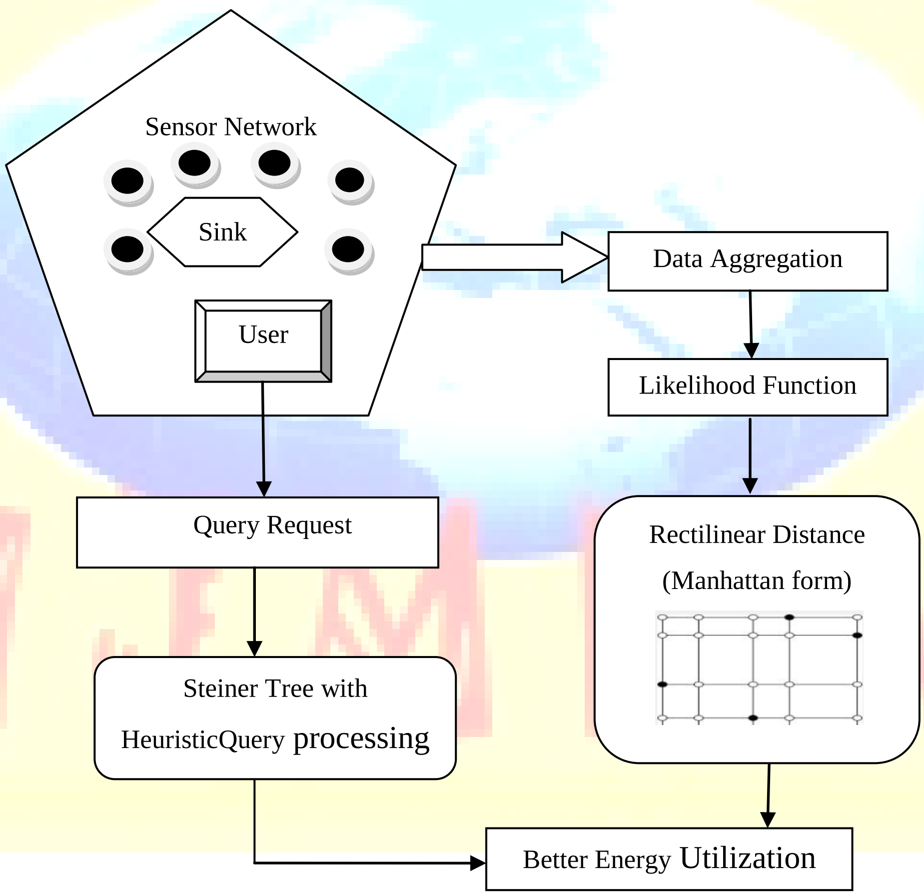

Fig 1 STRD Design Framework

SteinerTree with Rectilinear Distance is a routing scheme that optimizes the result and adaptively integrates the data aggregation work and query processing work with minimal energy utilization in sensor networks. The rectilinear distance is a Manhattan distance in STRD method in which the usual distance measured in the geometric form of the two points (i.e.,) sensor nodes. Steiner Tree is constructed with the 'n' sensor nodes and connects all the inner branches of the node (i.e.,) leaf node with the horizontal and vertical line segments. The horizontal and vertical line segments in the network structure helps to easily process the query with the linear time.

Data Aggregation with Rectilinear Distance

Data aggregation in STRD method assumes the source node as 'S" and sink node as 'SN' to design a system for the data aggregation in sensor network. The aggregated sensor network with rectilinear distance formulation reduces the energy consumption. The rectilinear distance between the two sensor nodes is defined as,

$$RD\ (Sensor\ node\ 1, Sensor\ node\ 2) = |x_1 - x_2| + |y_1 - y_2| \qquad \text{……….. Eqn (1)}$$

Where, RD is the rectilinear distance and (x_i, y_i) are the Cartesian coordinates of the sensor node points. The rectilinear distance is measured in Eqn (1) to easily reduce the energy consumption while aggregating the similar data in the sensor network structure. The data aggregation is performed based on the similar information assigned on the sensor node and similar size of the information transmitted in sensor network.

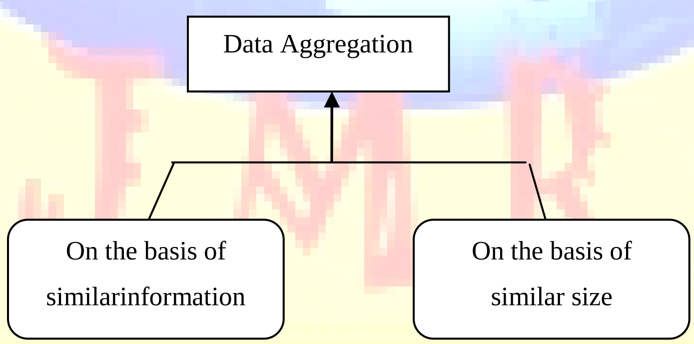

Fig 2 Data Aggregation Form

In STRD method, the data aggregation work computes the likelihood function with information and size. The likelihood function is computed as,

$$Likelihood\ Function\ (Sensor\ node_{1,2,\dots,n}) = \{f(Node\ 1_{info}, Size1) * f(Node\ 2_{info}, Size2) * \cdots .. f(Node\ n_{info}, Size\ n)\} \qquad \text{Eqn (2)}$$

Eqn (2) describes the likelihood function on the each sensor node. $Node\,1_{info}$, $Node\,2_{info}$, $Node\,n_{info}$, are the information in the sensor node and size '1', size '2'…size 'n' are the information in the each sensor node. The overall likelihood function result is used to perform the data aggregation process,

$$LF = \{f(\llbracket Node \rrbracket_{(1,2..n)} \mid Size) = \prod_{(i=1)}^{n} \llbracket f(\llbracket Node \rrbracket_i \mid size) \rrbracket\}$$ ……….. Eqn (3)

The node with similar information and with the similar size is aggregated together with the observed outcome. The outcome gives the factor value for the likelihood information. The likelihood information with the rectilinear distance forms the data aggregation with the minimal linear time.

Query processing through Steiner Tree

Steiner tree for query processing in the STRD method minimizes the energy cost in wireless sensor network. Steiner tree for query processing follows the heuristic form with the approximation factor. The approximation factor guarantees the optimal query processing result. The extension of the rectilinear distance follows the Steiner tree construction in proposed STRD method with the vertex and edges.

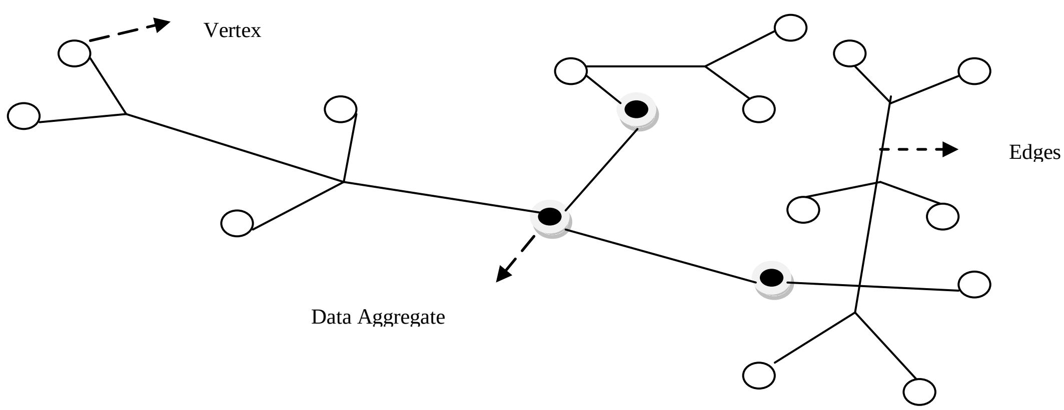

Fig 3 Steiner Tree Representation

The multiple edges carry the different data aggregation the leaf in the tree is induced as $Vertex' \in Vertex$ and clique is a complete tree in STRD method with edges between the two sensor nodes. The random vector of measurementsin STRD 'Vertex' set satisfies qualified independence properties and it is plotted as

$$QP = ST \perp [ST(i)]_{vertex} \mid [ST(i)]_{edges}$$ ……..Eqn (4)

Where, QP is the Query processing in sensor network, ST is the Steiner Tree, $\perp$ denotes the qualified independence properties for query processing , $ST(i)_{vertex}$ is the Steiner tree with the vertex ‘i’ and $ST(i)_{edges}$ is the edges with the edge ‘i’.

In STRD method, the above equation defines the value of the every senor node while performing query processing operation by using the independence properties. From Eqn (2) likelihood function, data aggregation work carried out and reduce the energy consumption sparsely. The likelihood function based aggregated data are plotted in the Steiner tree for the effective processing of the user query.

Algorithmic Step of Integration approach using STRD method

STRD address the fundamental problem by integrating the data aggregation and query processing operation analytically by exploiting the false positive rate result. The integration approach avoids collisions among the sensor nodes and provides the higher precision rate. In STRD method, all the sensor nodes act as a sink node and router. The reduction in the routing energy of STRD method comes from the utilization of the network relationship structure with Steiner tree. The STRD method through algorithmic step is described as

Step 1: Sensor network with the <Vertex, Edges> set

Step 2: Vertex with maximal clique is taken in sensor network

// Data Aggregation

Step 3: Likelihood function computed

    Step 3.1: Based on the similar Information

    Step 3.2: Based on the size of sensor nodes in wireless structure

STRD method delivers the effective integrated system for the better energy utilization.

III. EXPERIMENTAL EVALUATION OF STRD METHOD

Integration of Data Aggregation and query processing using the Steiner Tree with Rectilinear Distance (STRD) method in wireless sensor network. STRD method is evaluated through ns2 simulator. The simulation work in sensor network holds the 'n' nodes on the network size of 1000*1000. The network structure contains the 100 sensor nodes and simulation carried out with 30 milliseconds (ms). At the time of processing the query, Random Way Point (RWM) model is chosen to easily shift in an erratically selected location. The RWM uses standard number of sensor nodes for data aggregation and query processing. The minimum moving speed of STRD method is about 2.5 m/s of each node. The energy utilization in wireless sensor network with '100' sensor node is defined in terms of Joules 'J'.

$$Energy\ utilization = Simulation\ Time * No.of\ users$$

$$Precision\ Rate = \left[\frac{User\ Query\ Request\ Value \cap Retrieved\ Information\ Size}{Information\ Size} * 100\right]$$

The user query request is to perform the effective query processing in sensor network and it is measured in terms of percentage (success %).

IV.RESULT ANALYSIS

In section 4, Steiner Tree with Rectilinear Distance (STRD) method is used to analyze the result after integrating the data aggregation and query processing work in sensor network.

No. of users	Energy Utilization (J)		
	CDAMA scheme	RDM	STRD
10	380	325	295.5
20	710	602	584.5
30	999	920.5	878
40	1345.5	1250.5	1185.5
50	1650	1525	1460
60	1970	1850.5	1780.5
70	2295	2165	2075

Table 1 Tabulation for Energy Utilization

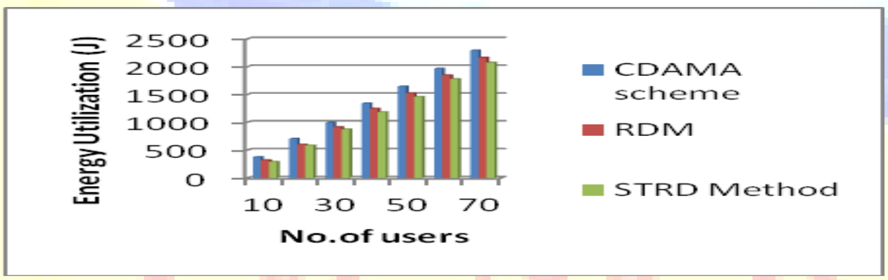

Fig 4 Energy Utilization Measure

Fig 4 describes the energy utilization based on the users count. The likelihood function uses the rectilinear distance formulation to aggregate the similar data to reduce the energy utilization by 9 – 22 % when compared with the CDAMA scheme [1]. SteinerTree with Rectilinear Distance is a routing scheme that optimizes the result and adaptively integrates the data aggregation work and query processing work with minimal energy utilization by 2 – 9 % when compared with RDM.

Information Size	Precision Rate (Success %)

(KB)	CDAMA scheme	RDM	STRD Method
50	86	91	95
100	80	87	96
150	80	89	97
200	81	90	94
250	83	92	94
300	85	91	98

Table 5 Tabulation of Precision Rate

Table 5 demonstrates the precision rate based on the information size. The information size is measured in Kilo Bytes (KB). Precision rate of CDAMA scheme [1] and RDM [2] are compared against the STRD Method.

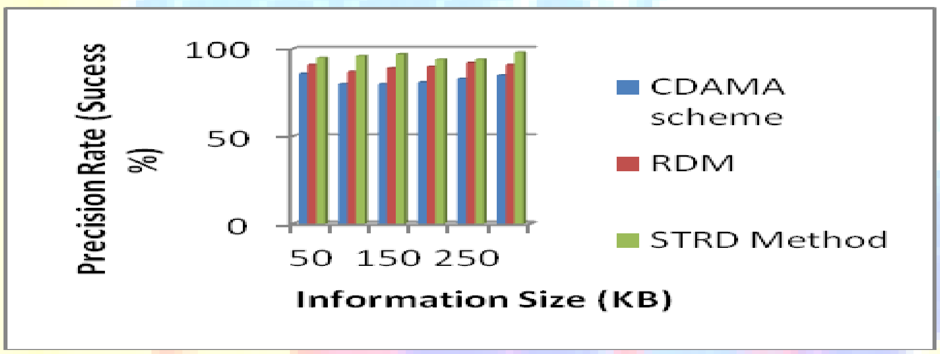

Fig 8 Performance of Precision Rate

Fig 8 demonstrates the precision rate based on the information size.The clique members in sensor network have equal weights to selectand the optimal set of the similar nodes are aggregated to attain the high precision by 2 – 10 % when compared with the RDM while performing integrated approach. Sensor node transmits the result for successful pass of information through the Steiner routing tree root to improve precision rate by 10 – 21 % when compared with the CDAMA scheme [1].

Finally, STRD method in wireless sensor network focused on integrating the data aggregation and query processing work with better energy utilization.

V.RELATED WORK

Energy-efficient routing algorithm to prolonglifetime of WSN as presented in [7] contains the Data Gathering Sequence (DGS). DGS is used to eliminate the common transmission and loop transmission among nodes in which the construction among the every node effectively forwards the traffic to its neighboring node. The neighbor sensor node does not provides the best pair of network lifetime on (α, β) features.

Link-stAbility and Energy aware Routing protocols (LAER) as illustrated in [11] report for link stability and for least amount drain rate energy consumption. Probably Approximately Correct (PAC) as demonstrated in [12] has a standardize histogram for observations with a restore rate in sensor network.

VI.CONCLUSION

Steiner Tree with Rectilinear Distance method is developed to perform the integration among the data aggregation and query processing work to attain the better energy utilization. STRD method carried out the likelihood function in the data aggregation process based on the similar information and sensor node size likelihood form. The aggregated data with rectilinear distance is computed in the Steiner Tree construction to perform the effective processing on the user query. Simulation outcome shows the considerable result on better energy utilization on the sensor network processing with 4.857 % reduced energy consumption on integration approach. The tree efficiently constructed with 17.254 % improved percentage when compared with the CDAMA scheme.

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