# An Efficient Data Aggregation and Query Optimization for Energy Efficiency in Wireless Sensor Network

**S. Antony Alice Jeya Bharathi, Dr.K.Algarsamy**

*Abstract*— **Wireless Sensor Network (WSN), a dispersed independent devices used to sense the physical or environmental circumstances which comprises of collection of discrete sensors for observing and classifying the collected data. The data aggregation is a method of collecting the data from sensor nodes and monitors the information obtained from the sensors. Data aggregation minimizes the traffic in network and reduces energy utilization on the sensor nodes. The aggregated data provides energy competent to improve the network lifetime and also minimizes the redundant information. Common data aggregation methods utilized to combine the information obtained from the sensor node and combine the information using different aggregation algorithms like LEACH (low energy adaptive clustering hierarchy) and TAG (Tiny Aggregation) etc.**

**Query processing is used to extract the information from the database and at the same time optimization process provides the information in a fast and efficient manner to the user. The query is provided using the set of commands that extort the information from the database in an efficient manner. The query is based on the database structure which is known as database schema and subsequently filters are used by the query processor. Moreover, query optimizations are the most significant for the clients in order to access huge database consisting of internet or client server process. In addition, query optimization minimizes the system resources which are necessary for query processing and eventually offered to the user with accurate result. Finally, query optimizations are presented with fast results to the users in order to access the application for fast information processing to the user.**

*Index Terms*— **WSN, LEACH, TAG**

## I. INTRODUCTION

Rising fields of wireless sensor networks concentrates on sensing, estimating and communicating into a single insignificant device. The authority of wireless sensor network lies between the capabilities to organize huge amount of tiny nodes being collected and organize by itself.

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Prediction based data aggregations, decrease unnecessary data transmission and minimizes [4] energy utilization using new prediction based data collection protocol for coordinating the information sequence of the sensor node and the sink node.

Many simple application of wireless sensor network technology are used to observe the distant surrounding for low occurrence in the data development. Aggregators nodes are executed by end to end encrypted data aggregation whereas decreases the involvement of invader to collect [8] the secret data. The wireless sensor nodes are not necessary to converse straightly with their adjacent high-power base station for the confined peers. Here data aggregation is discussed and query processing in sensor networks are presented.

### A. Data Aggregation

Data aggregations are used to reduce unnecessary data communication and further to increase the duration of wireless sensor networks with energy constrains. Data aggregations are used to reduce the amount of data communication by merging sensor nodes in networks. It is used to secure [1] data using data aggregation protocol.
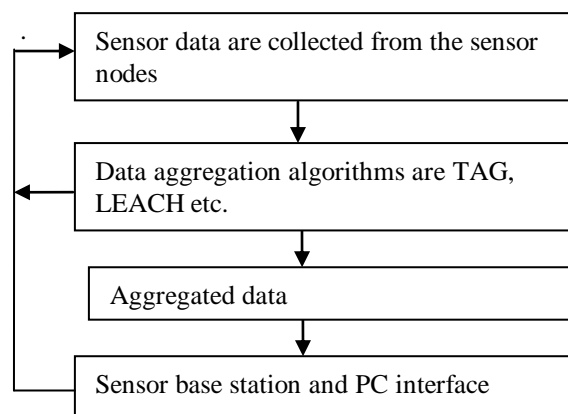


**Fig 1.1.Data Aggregation Algorithm**

**Fig 1.1.represent the data aggregation algorithm implementation steps to be derived in WSN.**

In wireless sensor network data communication are performed by the multi-hop approach in that every node are transferred by the neighbor node to the nearby sink. Data aggregation used to merge the information is always intend with various sources and also reduce the amount of broadcasting to save the energy consumptions

Data aggregations are always considered with the reduction of the data transformation and save energy consumption [5]. In data aggregation, SafeQ protocols are used to prevent the process from malicious node and [17] attackers are expanding data from both sensor collected information and sink nodes. To protect privacy and security, SafeQ utilize the new method to encode both information and queries.

**B. Query processing and optimization**

In WSN efficient communication is achieved using data aggregation and [16] query processing. Query processing and optimization are essential method for the DBMS and are used for timeframe method. Query processing refers to data extraction from the database. The updating of data and recovery can be achieved using several low level processes. DBMS scheme concentrates on the low level process and reduces the problem related to the user according to the DBMS requirements. End to end data aggregations are used to sense the exact process in the WSN in order to avoid the [13] jamming in network. Three phases are involved in the DBMS processing query consisting of Parsing and Translation, Optimization and Evaluation. Parsing and translation translate the query using the query processing engine. The query optimization uses the policy for interior data structures and conversion of it accordingly. Finally, evaluations select the optimization engine and perform the optimization in an efficient manner.

## II. CLASSIFICATION OF DATA AGGREGATION AND QUERY PROCESSING

Wireless sensor networks uses sensor nodes to reduce energy while transmitting data with the controlled computational authority, limited reminiscence and battery power.

**A. Aggregated Data in the Sensor Network**

Secure data aggregations are based on protection process, data privacy and reliability. Various data aggregation algorithms [3] used under many protocols but not efficient for the exact process in the networks. To conquer this process distributed algorithm is used to minimize aggregation latency with efficient performance. This algorithm utilized O (K) time slots to process the aggregation work where K denotes the relationship between the fastest and straight connections in the network. The aggregation techniques are categorized into two phases, namely hop-by-hop and end-to-end encrypted data aggregation. The common

structure for data aggregations are obtained from end-to-end encryption and achieves higher estimation cost on the sensor nodes. Data aggregation are identify as an effective technique to minimize energy utilization in WSN. Data aggregations are typically considered into two types namely, Tree based data aggregation and Grid based or in-network based data aggregation. Fig 1.2 represents the classification types of data aggregation.
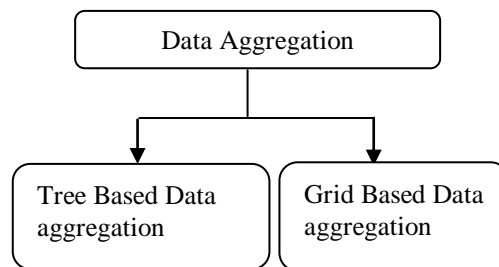


**Fig 1.2.Types Data aggregation**

In tree based data aggregation, sensor nodes are classified in the form of tree where aggregated data are executed at intermediate nodes and data are transmitted to the root node. The main features of the tree based networks are to perform effective data aggregation tree with minimum energy consumption. The grid-based data aggregations are also known as in-network data aggregations used for allocating data aggregators for sensors in secure regions. Efficient and privacy-preserving aggregation systems (EPPA) are used for the sensor node interaction and also to provide security. It is utilized [6] in the sequence increases to formatting multi dimensional information and encrypts the controlled data by the homomorphic Paillier cryptosystem techniques.

**B. Query Optimization**

Query processing is the process of transmitting high-level query into an accurate form and implemented in low-level language. processor selects suitable process for the query execution. Query optimizations are related to relational database management systems for query transmission. The advantages of query processing are,

➢ Quick processing of query
➢ Minimum cost per query
➢ Best performance of the process
➢ Effective procedures for the database engine
➢ Take less memory

Two kinds of query optimization Logical optimizations are used to create a series for relational database whereas physical optimizations are used to establish the functions for effectual query processing. Three stages are required for query processing in the DBMS.

They are:

➢ Parsing and translation
➢ Optimization
➢ Evaluation

Parsing and translation are accessed by the DBMS to create query processing engine. Query optimizations are used to transmit the query to the interior part of the data structures. The final stage involved is the evaluation which is used to create the optimization engine by the applicants and performs the query processing

### III. CURRENT APPROACHES ON DATA AGGREGATION AND QUERY OPTIMIZATION

The most of the existence protocols, applications and services for WSN provides data aggregation and query processing but do not provide security. Consequently data aggregation and query optimization should be provided in addition to security, serve as the next line of defense for enhanced system are indispensable for WSN with high security necessities.

#### A. Data Aggregation in Wireless Sensor Network

In the network the sensors are energy controlled but it is not suitable for the sensors as it transmits data straightly to the network base station. Whenever data are collected from large [2] sensor networks normally had a huge process in the base station. To avoid this process data aggregation is performed which merge the data collected from various sensor nodes. By utilizing the data aggregation they extract the exact information for the complete network.

It is also used to reduce the increased error. The gathered information is processed by sensor to decrease communication load before they are transferred to the BS or sink.

Data Aggregations in [7] merge information from various sources which minimizes the occurrence of during communication. So, security is the important and necessary aspect in the networks. Protected data aggregation protocols provide proper security with the end to end encrypted data aggregation methods which are based on the privacy homomorphism.

Aggregator nodes combine the information, established from its child node for essential aggregation utility. This collected information's are resulted in huge level of collected nodes or sink nodes. The detection algorithm utilized outlier method for detection whereas the filtration algorithm utilized the outlier sensor nodes for filtering.

The hierarchical data aggregation provides security from attacks with high isolation in the network. Generally the networks [9] are divided into the amount of clusters and every cluster is organized by the aggregators which are straightly associated with the links. They detect the set of nodes continuously and communicate with the unique values using verification keys. The aggregator combines and encrypts the information with common secret key for the sink nodes and these nodes are transferred to the secured sink nodes. Furthermore, data aggregation approaches are investigated using dispensation [10] technique. The energy utilization of nodes and network effectiveness decreases the amount of communication or packet transmission.

The major reason for data collection in WSN are to achieve the data efficiency from the operating [11] environment which results in minimizing the utilization of data aggregation approaches. A data aggregation tree is created to utilize the packet transmission which are related with invalidate multicast construction. The major functions of the data aggregation are [12] to decrease the energy consumption by reducing the amount of data communication. All the combined nodes gather the information from their child nodes and estimate the aggregation value, followed by the values promoted towards the data sink node.

Security managements are highly required for the privacy management where arises ambiguities and information integrity is highly required to conserve the networks. DyDAP are denoted as dynamic secure end-to-end data aggregation for the security process in the network are considered in the initial form of UML replica which includes significant construction process for privacy preservation in WSNs.

In WSNs, the sensor nodes introduce fake data during combining data and promoting data [14]. The fake data detection approaches inserts fake data during data promotion and does not permit any modification on the data aggregation. However, data aggregations provide authentication protocol DAA, to incorporate fake data recognition with combined data and privacy.

To focus on the reliability of the combined information are the significance process in the WSN. It includes various methods [15] for securing the data integrity which are resolved using hop by hop approach. The data aggregation uses the hop by hop and end to end approaches for obtaining information from sensor nodes. In that, hop by hop protocols are used for reliable authentication for the sensor nodes facilitated using the sink nodes.

#### B. Query Processing

Distributed Quad-Tree (DQT), used for distance responsive for querying with the query cost for the occurrence denoted by the distance "d" in the network. DQT construction is local and does not require any communication. Numerical formulations for the query optimization [18] for the fake data recovery in the isolation reduce the risk in the transparency processing. The isolation risks are calculated as a data theoretic deviation among the various client query allocation which are incorporated with the entropy for the client sharing as a particular process. In wireless sensor networks, many of the routing protocols are used for energy consumptions and the information traffics are unrestrained liberation constraints for the given data [19]. They are dependent on the traditional ant-based algorithm and an ant-based multi-QoS routing metric (AntSensNet) for the effective information transmission. The controlled optimization framework are used to [20] develop the level of information centric storage and uncertainty in WSNs. They required both unstructured networks and structured networks for sequential query exploration and hash query efficient.

In wireless sensor network a new process called region-based query processing (REQUEST) are used to maximize the set of nodes in the network. The region-based queries are processed in the hierarchical aggregation techniques which are organized by every region. The sensor structures are investigated and focused on node hardware requirements with limited energy constraints. Various

methods [22] are analyzed for data requirements in the WSNs for real time storing data and query processing.

Top-k monitoring queries are valuable in various WSN applications. A query is the kind of constant arrival [23] which had a list of controlled nodes with maximum sensor readings. To develop these queries, familiar approaches are used to filter the entire sensor nodes to prevent from the redundant communication of sensor readings. The novel top-k monitoring techniques are known as Distributed Adaptive Filter-based Monitoring which are used on the distributed network.

In cooperative communications, the clustered WSNs [24] are used to collect the relay data packets which are based on dispersed space time block coding which accomplish efficient analysis on the power utilization. In heterogeneous wireless networks the energy utilization are used by combined [25] packet size optimization. The body sensor network (BSN) and a WiFi network techniques are used by the data communication system. The BSN and the WiFi network uses the packets for payload which are based on the packet delivery ratios (PDR).

In WSN applications, executed only by the information collection and [26] aggregation. The novel creations for the data processing techniques are used in the WSN like data storage, querying and difficult liberate applications. The multi-objective optimization methods are used for self categorizing, energy management, [27] deliberation of application constraints, communication requirements and energy preservation process.

The primary query optimization difficulties in WSNs [28] are based on the BS location so that the information is transferred to sensor node in effective energy process. The information's are sent straightly to the base station or through relay nodes. Transmission protocols are used to obtain the energy consumption for increasing the lifetime of the network.

Energy consumptions are the major function in the WSN which poses the transmit route along with the data communications which are based upon the link layer, MAC layer and routing layer [29] for the transmissions. They shorten these layers by combining various processes using the optimization techniques to reduce the network lifetime.

The positions of base station are the important issues to be solved to increase the network lifetime for WSN. They had some challenging [30] method in the multihop sensor network to prevent certain troubles in the routing for the coupled data. The approximation algorithm provides mechanism for increasing the duration of the network. This algorithm is also used to identify the finite element in the base station position and used to decrease the cost parameter with the efficient performance.

**C. Data Aggregation and Query Optimization Performance**

Energy-efficient Trust dependent [31] data aggregation is a wireless sensor network routing protocol that depends on the ant colony optimization (ACO) algorithm.This technique attain dependable and energy competent data aggregation beside energy prediction. Energy-efficient Trust dependent data aggregation utilizes model of practical reputation and expectation to achieve dependability. The ACO added the

issue of energy with the ants having been penetrating the most favorable path.

The rising accessibility of location aware movable devices specified rise to a flood of location dependent services [32]. The illuminating accurate user locality to LBS may isolate their individuality and violate their privacy.

The main framework is designed for unidentified query dispensation in road networks. The location obfuscation techniques that offered unidentified LBS way in to the users and to facilitate competent query dispensation at the LBS side. The wireless sensor network, data aggregation method that decreases a huge amount of broadcast is the nearly all sensible [33] technique. This system contains three main drawbacks such as, it is intended for a multi appliance surroundings.

The base station extorts application precise data from aggregated cipher texts. Next, it moderates the collision of cooperation attacks in particular application environments.

The Wireless sensor networks are networks of [34] self-sufficient nodes used for observing an environment. The Particle swarm optimization technique is an uncomplicated, resourceful and computationally capable optimization algorithm.

WSN is used for making possible a variety of monitoring applications greater than an extensive environmental region. One such query is the K Nearest Neighbor (KNN) query that ease group of sensor data illustration dependent on specified query locality and the number of illustration specified. The Parallel Concentric-circle Itinerary based KNN [35] query processing technique obtains dissimilar itineraries by optimizing both query latency and energy expenditure.

## IV. REVIEW OF LITERATURE

Different types of data aggregation and query optimization methods are analyzed and compared with the efficient data communication in wireless sensor network. **A. Analysis of various techniques in Data aggregation**

WSN had many transmission protocols to reduce the redundant data but some of them are not efficient. To rectify these troubles in the sensor network they used prediction based data aggregation to minimize redundant data communications and save the energy of the sensor nodes. A new prediction based data collection protocols are utilized with the double-queue method to coordinate with the information sequences and also are processed with sensor node and sink node to reduce the collective errors in the networks. Data aggregation techniques are utilized to reduce the energy consumption and increase the lifetime of the network by decreasing the amount of packets transmission in the network. The secure data aggregation increases the entire energy utilization in the network. It utilized the detection algorithm to identify the process and sends data to sensor nodes. They offered huge outlier detection rate for the distribution approach. MAC protocols are used for the data validation and data reliability. The Dynamic Data Aggregation Scheme is an end-to-end data aggregation with isolation function and intended starting from a UML representation that includes the most significant structure blocks of a privacy aware WSN. The Possibility is the one of using emerging nano technologies or mixture architectures to concentrates the power limits.

## 4.2. Query processing and Energy Efficiency in WSN

Efficient and privacy-preserving aggregation methods are used for the efficient process in the data communications. It is a growing series of the structure multi-dimensional information and certain encryption techniques used in the homomorphic Paillier cryptosystem approach. The main drawbacks of the system of heuristic methodologies for optimal steering of animatedly elected cluster head sensors, through some multi-hop communication protocol. The main framework is designed for unidentified query dispensation in road networks. They are determined using locality obfuscation method that make available unidentified LBS way in to the users and allocate resourceful query processing at the LBS elevation. The main drawback was that the unidentified client could substantiate that the locality attendant did not interfere with the innovative owner data.

The ant based routing protocol constructs a hierarchical constitution on the system prior to decide appropriate passageway to assemble various QoS necessities from different kinds of traffic, thus maximizing system exploitation, as improving its recital. The major problems of this technique are mix of numerous sink nodes in addition to node mobility.

CDAMA are the new data aggregation system which encryption scheme. The base station extracts the data from collective cipher texts. The client stores the record on an un-trusted service provider Therefore; the user has to protect their record through PH schemes because PH schemes remain exploitable possessions than usual ciphers. Energy-efficient cooperative communication are used for the appropriate decipher established packets contribute in the supportive broadcast.

Two-tiered sensor networks are utilized for the nodes which provide the tier among the sink and sensor node for the query processing but in the same way the attackers also identify the sensor nodes. To overcome this problem they use the SafeQ protocol to detect the attackers from the sink nodes. In that the SafeQ protocols identify the bad storage node in the network. SafeQ techniques are used to encode the information and the sink node from the network

| Techniques | Stretch Factor | Query Success Rate | Query cost | Power Consumption | Query Latency | Entropy maximization | Packet delivery ratio | End to End Delay | Reliability | Energy-Efficiency | Network Lifetime | Communication Energy | Average Hop Count | Query Processing |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Distributed Quad-Tree (DQT) Protocol | Y | Y | Y | | | | | | | | | | | |
| SafeQ Protocol | | | | Y | | | | | | Y | | | | |
| Optimization Technique using Bloom Filters | | | | Y | | | | | | | | | | |
| Private Information Retrieval (PIR) | | | | | Y | | | | | Y | | | | |
| AntSensNet protocol | | | | | | | Y | Y | | Y | | | | |
| Region-Based Query( REQUEST) | | | | | | | | | Y | Y | | | | |
| Distributed Adaptive Filter-based Monitoring | | | | | | | | | | Y | Y | | | |
| Cooperative communication scheme | | | | | | | | | | Y | | | | |
| Multi-Objective Optimization Methodology | | | | | Y | | | | | | Y | | | |
| Optimization of Transmission Schemes | | | | | | | | | | | Y | | | |
| Fundamental Optimization Techniques | | | | | | | | | | | Y | | Y | |
| Concealed Data Aggregation Scheme | | | | | | | | | | Y | | | | Y |
| Anonymous Query Processing | | | | | | | | | | | | | | Y |
| Parallel Concentric circle Itinerary based KNN (PCIKNN) Technique | | | | | Y | | | | | Y | | | | |
| Note: Y-yes | | | | | | | | | | | | | | |

| Techniques | Data Confidentiality | Data Integrity | Lifetime | Accuracy | Throughput | Delay | Energy Efficiency | Growth Rate | Communication Overhead | Energy Consumption | Authentication | Data Secrecy | Packet Delivery | Query Processing |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Secure data aggregation protocols | Y | Y | | Y | | | | | Y | | Y | | | |
| Efficient and Secure Pattern based Data Aggregation (ESPDA) protocol | Y | Y | Y | | | | | | | | Y | | | |
| Secure Reference-Based Data Aggregation (SRDA) protocol | | | | | | | | | | | Y | | | |
| Fuzzy Logic Based Approach | | Y | | Y | | | | | | | | | | |
| Data-Aware Any cast (DAA) | | | | | Y | Y | | | Y | | | | | |
| Real-time Data Aggregation protocol | | | | Y | | | Y | | | | | | | |
| Grey-Model-based Data Aggregation protocol | | | | | | | | Y | Y | | | | | |
| Efficient and Privacy-Preserving aggregation | | | | Y | | | | | | | Y | | | |
| Hop-by-Hop Data Encryption | | Y | | | | Y | | | | | Y | | | |
| End-to-End Data encryption | | | | | | | | | | | Y | | | |
| Securing Node Capture Attacks for Hierarchical Data Aggregation protocol | | | | | Y | | | | | | | | | Y |
| Note: Y-yes | | | | | | | | | | | | | | |

## V. CONCLUSION

Several data aggregation and query processing techniques are discussed in detail, where data aggregations are used as a mechanism to solve storage related issues in wireless sensor network. In order to find the efficient path for data transmission many routing protocols are used in sensor network. The information is processed between the sensor and the sink node to optimize the utilization of resources available in the network. At the same time to increase the lifetime of the network, significant process involved in data aggregations are focused to minimize the redundant node in addition to the security aspect

being covered. As a result, secured data aggregations provide security for the entire network.

Sensor networks became ubiquitous and the databases also face with certain amount of difficulty to organize the data in the network. The query processing in the sensor network is provided with the in-network aggregation for every routing layer. Many prototype used in the routing protocol are designed for query processing to extract the data from the database. The query processing is mainly focused on the adaptive approach for specific framework designed for the adaptive model. In order to provide query optimization certain key aspects has to be recognized

## VI. FUTURE WORK

Data aggregations are the major issues to be resolved to increase the lifetime of the sensor network. In future work data aggregations should be mainly concentrated to save the power consumption for increasing the lifetime of the network and provide reliable data transmit technique between source and destination. We can execute the data aggregation with minimum energy and security algorithm designed for data aggregation in order to provide more secure and more energy efficient mechanism.

Query processing techniques are analyzed and also manage the sensor data during the failures. In future work query processing can be applied within a Stochastic Well-formed Petri Nets (SWN) to analyze various query optimization process in the Sensor Network. SWN techniques are used for the accurate results using modeling process for the concurrency, organization and cooperation.

Query optimizations of cooperative communication scheme have to be improved by optimizing multiple network parameters for efficient arithmetical process. Also cooperative communication method enlarges the multi hop clustered network for optimal routing by separately selecting the cluster heads in the network intended with the upper layer routing techniques for cooperative communication using multi-hop network.

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