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Data retrieval process to Improve Energy Efficiency in Wireless Sensor Networks

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ABSTRACT

Wireless Sensor Networks are technically self-organized wireless ad-hoc networks which incorporate a vast number of existing sensor nodes which are resource constraint within location. In Wireless sensor networks, is one of the most necessary tasks to gather or collect the data from various resources and transmits the gathered necessary data to a required distant base station. The effectiveness of various factors WSNs can be calculated in different terms of network lifespan. Data collection is a continues operation but analytical and critical operation in many WSN's application using our daily wage operations. To prolong network lifetime or span of years innovative technique item set that can improve performance energy efficiency are highly required.

This paper presents complete overview of designing Energy Efficient Data Collection Methods used for prolonging network lifetime in Wireless Sensor Network (WSN). The study highlights the importance of various data conditions for multiple purposes like emergency care response, medical monitoring surveillance, defense applications, surveillance in volcanic or remote regions operations etc. using different data collection methods such as data aggregation clusters, data aggregation trees, network coding, correlation dominating set, etc. are considered in detailed in this review. Furthermore a comparison of different Data Collection Method based on the network lifetime or span, energy efficiency, complexity of the algorithm, transmission cost and fusion cost is done on existing resources.

Keywords: Wireless Sensor Networks, Energy Efficiency, Data Collection, Clustering, Aggregation Tree Network Coding

I. INTRODUCTION

A WSN is a set of distributed independent sensors which are capable of monitoring the environmental and physical conditions and it collectively transmit the data to a BS. The development of WSN was motivated by the military applications and presently WSN are used in weather monitoring and forecasting, forest fire monitoring, industrial applications, health monitoring, agriculture, physical environment monitoring, and so on.

In addition to the unreliable wireless communication, WSN have to work with limited resources such as limited energy, limited processing capacity, limited storage, limited memory, limited communication capacity, etc. So, WSN suffers from lot of problems such as lost messages, delay in data delivery, data redundancy, loss of data, etc, which results in low quality of service (QoS). Energy availability is the most important challenge in WSN. The data collected by the sensor node have to reach the sensor gateway at the earliest. Different energy efficient methods in WSN have to ensure anon going and continuous network and reduced power consumption. Changing the limited power sensors is inefficient in almost all applications. Due to which, the battery lifetime determines the network lifetime. So in WSN energy conservation and energy controlling have so much importance that it manage and control the energy efficient techniques and protocols.

The data collection methods can be categories into various types such as aggregation trees, cluster formation, network coding, correlation dominating set, etc. [3]. To increase network lifetime and scalability, clustering can be done which is an effective topology control approach. In cluster formation technique, cluster heads are responsible to transmit data to the BS and the remaining nodes are attached to the cluster head. The aim of Data aggregation protocols is eliminating redundant data transmission and thus improving the network lifetime WSN. To combine the data in network aggregation trees are formed and the correlated data which is collected by the sensor nodes are combined and transmitted. Many aggregation methods are there and two methods are discussed in this paper.

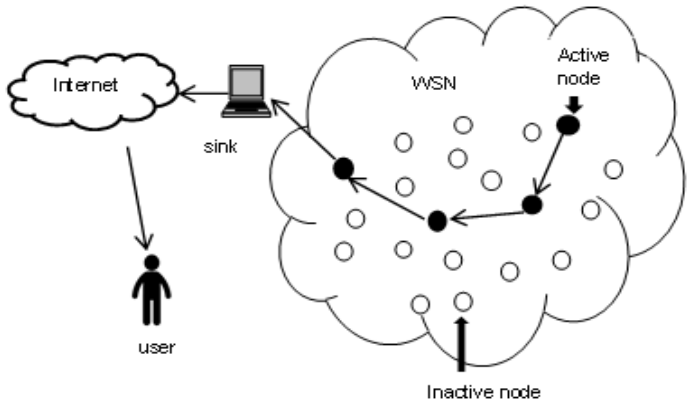

Figure.1: Active Nodes in a Wireless Sensor Network merging data from Different resource.

II BACKGROUND

2.1. Data retrieval: Data retrieval means obtaining data from a database management system such as ODBMS. In this case, it is considered that data is represented in a structured way, and there is no ambiguity in data. In order to retrieve the desired data the user present a set of criteria by a query.[1]

2.2. Wireless sensor network: A wireless sensor network (WSN) is a wireless network consisting of spatially distributed autonomous devices using sensors to monitor physical or environmental conditions. A

WSN system incorporates a gateway that provides wireless connectivity back to the wired world and distributed nodes.

The wireless protocol you select depends on your application requirements. Some of the available standards include 2.4 GHz radios based on either IEEE 802.15.4 or IEEE 802.11 (Wi-Fi) standards or proprietary radios, which are usually 900 MHz.[2]

The main characteristics of a WSN include:

- Power consumption constraints for nodes using batteries or energy harvesting.
- Ability to cope with node failures
- Some mobility of nodes
- Heterogeneity of nodes
- Homogeneity of nodes
- Scalability to large scale of deployment
- Ability to withstand harsh environmental conditions
- Ease of use
- Cross-layer design

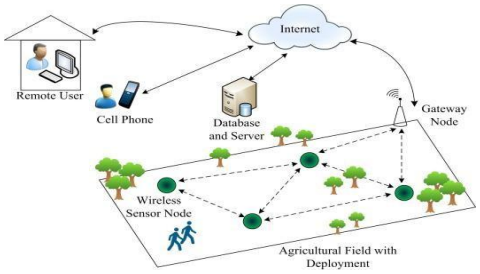

Figure.2: Wireless Sensor Network working process

2.3. Data collection: It is the process of gathering and measuring information on targeted variables in an established systematic fashion, which then enables one to answer relevant questions and evaluate outcomes.

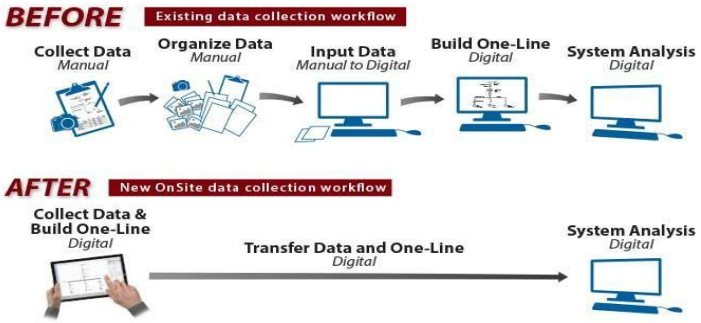

Figure.3: Data collection informational procedures

2.4. Efficient energy: It is use, sometimes simply called **energy efficiency**, is the goal to reduce the amount of **energy** required to provide products and services. For example, insulating a home allows a building

to use less heating and cooling **energy** to achieve and maintain a comfortable temperature.

III RELATED WORK

In network coding technique is the global process of collection and routing information by a multi-hop network. With the goal of minimizing energy consumption, this technique processes the data at the intermediate node and thereby increasing network lifetime. There are different coding techniques which will decrease the transmission cost. In correlation dominating set technique few sensor nodes are activated so that they can sense the data. By using the correlation of data which is gathered by the nodes, the active nodes will also collect data for the remaining inactive node. The active nodes will transmit the data to the central node by forming a tree.

The following section consists of the explanation of these techniques and comparisons based on the advantages and disadvantages of these techniques are presented.

Data Collection Techniques Based On Clustering:

- **LEACH (Low-Energy Adaptive Clustering Hierarchy):** The LEACH is a self-configuring and an adaptive cluster formation technique. LEACH is a clustering based protocol that uses data fusion to reduce the amount of data transmission. LEACH protocol was a major improvement over conventional clustering approaches in WSN. LEACH protocol is completely distributed in the sense that it does not need control information from the BS and nodes do not require global topology information.

In this technique, the nodes arrange themselves into local clusters and select one node as a cluster head. This selection of the cluster head is done on the basis of the total system energy and the nodes residual energy. The non- cluster head nodes can sent request to the selected cluster head to join. The cluster head collects data from the non- cluster head nodes to perform signal processing functions and transmit the collected data to a BS. The balancing of node energy usage is done randomly by rotation of cluster heads. Thus LEACH protocol has two phases: Setup phase and Steady phase. In the first phase the selection of cluster- head is done and non-cluster nodes are added to the cluster head. In the second phase the cluster heads collects and transmits the data to the base station [7].

The disadvantage of this technique is that it limits the scalability of the nodes in network. The non-cluster nodes have to send data in the allotted time. The cluster head may not be uniformly distributed over the network. The exact correlation is presumed which may not be corrected in some cases.

- **HEED (Hybrid and Energy-Efficient Distributed Clustering)**

For long lasting WSN, the HEED protocol lists a distributed clustering protocol. HEED protocol does not made assumptions about the infrastructure or node processing abilities, it emphasis on different energy levels in sensor nodes.

HEED [8] protocol periodically selects cluster heads on the basis of two parameters from the sensor nodes. These

parameters are the node residual energy and the node degree or node closeness to its neighbors. HEED protocol ensures the connectivity of the clustered network as it makes required boundaries on intra-cluster and inter-cluster communication ranges and on node density. This approach is hybrid: cluster heads are selected probabilistically based on the above defined two parameters and nodes join these clusters so that transmission cost is reduced.

This approach supports a scalable data aggregation and effective in increasing network lifetime. It spends, spends less energy in clustering and can provide features such as load-balancing, less overhead. It is a complex algorithm as it has multiple iterations. Due to large number of iterations there are only little chances to decreases residual energy Advantages of this method are Scalable data aggregation, Prolong network lifetime and Load balancing. The disadvantage of this method is the complexity of the algorithm.

- **CAG (Clustered Aggregation Technique):** CAG technique forms node clusters by sensing similar values within a defined threshold based on the spatial correlation. The clusters remain same or unchanged until the sensor reading stay within a threshold over time based on temporal correlation. Since in CAG technique, every cluster transmits only a single reading, it is efficient in terms of energy. The result provided by CAG is an approximation aggregation with negligible and bounded error.

By using the correlation of sensed data, CAG minimizes the number of transmissions and aggregate queries to provide approximate results. This result is assured to be within an error-tolerance threshold provided by the user. Whenever a query is circulated in the network, the clusters are formed based on the correlation. Thus CAG technique has 2 phases: Query phase and Response Phase. In Query phase the data is transmitted by a tree formed. In the Response phase, the clusters head transmits data to the next level of the tree after aggregation [6].

CAG has various advantages such as it is energy- efficient in-network aggregation. It has leveraging both spatial and temporal correlations and is resilient to the packet loss .It ensures a confined approximation. CAG has certain disadvantages as thus technique uses simple correlation in which the selection of the cluster-head is done by the edges of the forwarding tree and connecting sensor nodes and no hybrid clustering protocol.

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Data Collection Techniques Based On Network

- **On Network Correlated Data Collection**: In on network data collection uses two coding strategies for minimizing the transmission cost of data from source to BS. There two coding strategies are Slepian-Wolf model and joint entropy coding model. These models differ from one another in optimization of transmission and complexity of optimal coding. These methods are used when there is a correlation between the data sensed by different nodes.

The nodes near the sink have high data load whereas the nodes away from the sink have mower data rate. In case of joint entropy coding the optimal coding is simple but the transmission optimization complexity is high. Here the nodes far from the have data rate whereas nodes closer to the sink have lower data rate [9]. A combination of both these methods is more beneficial and effective.

- **Single Input Coding:** The single Input Coding increases energy efficiency by correlating between the data. With the objective of minimizing resource consumption the data can be processed at the intermediate nodes. This is a global process of data collection and increase network lifetime. Single input coding is applied to the asynchronous network with no time consideration [10].

This technique determines the interrelationship in data sensed by various sensors to combine data from different sources. Two types of coding can be used: foreign coding uses MEGA and self- coding which uses LEGA. Conditional coding, In-network data processing, self-coding and foreign coding are also used to aggregate data.

Data Collection Scheme Based on Correlation Dominating Set:

- **IAND (Iterative Active Sensor Node Determination):** In this technique a small subset of sensor nodes is selected which should be enough to reconstruct data for the whole sensor network. During the gathering of data these selected active sensor nodes have to involve in the communication [1]. Since there is a need to relay data to the data gathering node, the selected nodes should be connected. In order to determine the nodes which will take part in the transmission of data to the data collecting node are the residual energy of the sensor node and the correlation between the data sensed by the nodes.

Comparison of Different Data Collection Techniques

This section lists and discusses the merits and de-merits of different data collection methods in the table. The comparison of these techniques is shown in table I. The comparison is done based on energy efficiency, network lifetime, complexity of the algorithm, transmission cost and fusion cost.

METHODS	ADVANTAGES	DISADVANTAGES
LEACH (Low-Energy Adaptive Clustering Hierarchy)	It is Completely distributed, Requiring no control information from the base station, Nodes do not Need global topology information.	Nodes must have data to send in the allotted time, Assumed perfect correlation might not be true
HEED (Hybrid and Energy-Efficient Distributed Clustering)	It ensures Prolong network lifetime, Scalable data aggregation, Load balancing	It is a Complex algorithm
CAG (Clustered Aggregation Technique)	It provides Energy-efficient in-network aggregation, Leveraging both spatial and temporal correlations resilient to the packet loss, Ensure bounded approximation	No hybrid clustering protocol
Scale free aggregation	It ensures Prolonged network lifetime, Efficient data aggregation, Decreases amount of data transmitted	Multi-commodity version of the problem, Aggregation depends not just on the number of sources, but also on the identity of the sources
MFST (Minimum Fusion Steiner Tree)	It has Varying network topology, fusion cost, correlation	It is Less robust.
On network correlated data collection	It reduces Total transmission cost	It has a Complex structure
Single input coding	It ensures Efficient collection of data	It assumes Star topology, Only single input coding
Active node determination	It has High performance, Increased network lifetime, High runtime	It can be used only for Static sensor network

	efficiency	

IV CONCLUSION AND FUTURE RESULTS

In this paper we are analyze of different types of data collection techniques that can be used to increase the energy efficiency in a Wireless Sensor Networks. To rapidly improve energy efficiency different sets using data collecting Techniques can be used and these techniques can be reduces the energy utilization with low consumption and increases the network lifetime span of using different modules. Various data collecting techniques are used to improve energy efficiency are no. of data collection Techniques based on clustering, network coding, aggregation trees and correlation dominating set. This energy consumption can be reduced and network lifetime span can be increased to aggregate extended possibilities using these existing methods.

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