

Dependable Routing Approach for In-Network Aggregation in Wireless Sensor Network

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Abstract: *Wireless sensor networks create a lot of information that needs to be proceeds, delivered, and evaluated as per the application goals. The way this information is controlled by the sensor nodes is a key issue. Data fusion emerges as a reaction to process information accumulated by sensor nodes and profits from their preparing capacity. Data-centric technologies are needed that perform in-network aggregation of data to yield energy-efficient dissemination. For precise monitoring, extensive scale dense Wireless Sensor Networks (WSNs) will be progressively deployed in diverse classes of uses. It is likely that redundant data will be identified by adjacent nodes when sensing an event, because of the high thickness of nodes in these systems. Since energy preservation is a key issue in WSNs, in order to save energy data fusion and aggregation ought to be abused. In this case, redundant data can be aggregated at intermediate nodes reducing the size and number of exchanged messages and, thus, decreasing communication costs and energy consumption. There is requirement of novel Routing for In-Network Aggregation which have some features like high aggregation rate, and reliable data aggregation and transmission, reduced number of messages for setting up a routing tree, maximized number of overlapping routes and best aggregation quality.*

Keywords: Wireless Sensor Network, Routing Protocol, In-network Aggregation.

1. Introduction

A Wireless Sensor Network (WSN) is a unique kind of ad hoc network made out of an expansive number of nodes outfitted with distinctive sensor gadgets. This network is upheld by innovative advances in low power wireless communications alongside silicon reconciliation of different functionalities for example, sensing, communication, and processing. WSNs are developing as a vital computer class focused around another figuring stage and network management structure that will empower novel applications that are identified with distinctive zones, for example, ecological monitoring, industrial and, human services, and military. Normally, wireless sensor networks have solid stipulations with respect to power assets furthermore computational limit.

Sensor nodes are energy compelled gadgets and the energy utilization is for the most part connected with the sum of accumulated information, since communication is frequently the most extravagant action as far as energy. Hence, algorithms and protocols intended for WSNs ought to consider the energy utilization in their origination. Also, WSNs are information driven systems that typically create a lot of data that needs to be routed, frequently in a multihop design, to a sink node, which acts as a gateway to a monitoring focus. Given this situation, routing assumes a critical part in the data gathering process.

A conceivable procedure to advance the directing undertaking is to utilize the accessible transforming limit gave by the intermediate sensor nodes along the routing ways. This is known as data-centric routing or in-network data aggregation. For more proficient and viable information gathering with a least utilization of the constrained assets, sensor nodes ought to be designed to keenly report information by making nearby choices. For this, information accumulation is a compelling strategy for saving energy in

WSNs. Because of the inherent redundancy in raw information accumulated by the sensor nodes, in-networking aggregation can frequently be utilized to diminish the communication cost by eliminating redundancy also sending just smaller aggregated data. Since insignificant communications leads specifically to energy savings, which expands the network lifetime, in-network data aggregation is a key innovation to be underpinned by WSNs. In this work, the terms data fusion and information aggregation are utilized as equivalent words. In this connection, the utilization of data combination is twofold [2]: they are to exploit data redundancy and expand information correctness, and to diminish communication load and save energy.

One of the primary difficulties in routing algorithms for WSNs is the manner by which to ensure the delivered of the sensed information indeed in the vicinity of nodes failure and interruptions in communications. These failures get to be much more basic when data aggregation is performed along the routing paths since packets with aggregated data contain data from different sources and, at whatever point one of these packets is lost a lot of data will likewise be lost. In the connection of WSN, data aggregation mindful routing protocols ought to present some alluring qualities for example, a decreased number of messages for setting up a routing tree, maximum number of overlapping routs, high collection rate, furthermore a dependable information transmission.

2. In-Network Data Aggregation

In this section we survey on different papers related to the In-network aggregation in wireless sensor network.

2.1 Tree-Based Approach

In The Impact of Data Aggregation in Wireless Sensor Networks Krishnamachari et al. (2002) [1] model data-

centric routing and contrast its performance with traditional end-to-end routing schemes and examine the impact of source-destination placement and communication network density on the energy costs and delay associated with data aggregation.

In Improved Steiner Tree Approximation in Graphs (G. Robins and A. Zelikovsky, 2000) [2] present a new polynomial-time heuristic with an approximation ratio approaching $1 + \frac{\ln 3}{2} \approx 1.55$, which improves upon the previously best-known approximation algorithm of with performance ratio ≈ 1.59 . The Steiner tree problem in weighted graphs seeks a minimum weight connected subgraph containing a given subset of the vertices (terminals).

Routing Techniques in Wireless Sensor Networks (J. Al-Karaki and A. Kamal, 2004) [3] present a survey of the state-of-the-art routing methods in WSNs. They first outline the design confronts for routing protocols in WSNs followed by a complete survey of different routing methods. Overall, the routing techniques are classified in to three categories based on the underlying network structure: location-based routing, hierarchical and flat. Also, these protocols can be classified in to query-based, multipath-based, QoS-based, negotiation-based, and coherent-based depending on the protocol operation. They also highlight the pros and performance issues of each routing technique. They study the design tradeoffs between energy and communication overhead savings in every routing paradigm.

In Directed Diffusion for Wireless Sensor Networking by Intanagonwiwat et al. (2003) [4] explore the directed diffusion paradigm for such coordination. Directed diffusion is data-centric in that all communication is for named data. All nodes in a directed diffusion-based network are application-aware. This allows diffusion to attain energy savings by choosing empirically good paths and by caching and processing data in-network for example data aggregation.

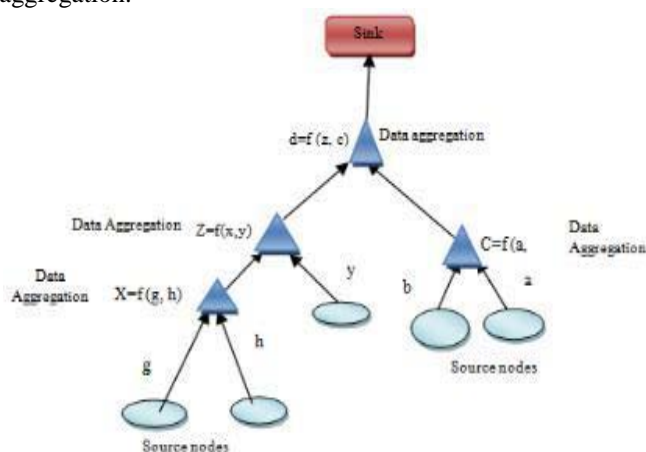


Figure: Tree-Based Approach [14]

In Directed Diffusion: A Scalable and Robust Communication Paradigm for Sensor Networks by Govindan et al. (2000) [5] explore the directed diffusion paradigm for such coordination. Directed diffusion is data-centric in that all communication is for named data. All nodes in a directed diffusion-based network are application-

aware. This allows diffusion to attain energy savings by choosing empirically good paths and by caching and processing data in-network.

2.2 Cluster-Based Approach

In An Application-Specific Protocol Architecture for Wireless Microsensor Networks by Chandrakasan et al. (2002) [6]. It introduces LEACH. It is a self-organizing, adaptive clustering protocol, which includes dynamic and distributed cluster formation. In LEACH, a good property is to save energy by using aperiodic communication. After suitable time, a randomized rotation of the role of the CH is conducted so that uniform energy dissipation in the sensor network is obtained.

In A Reliable and Data Aggregation Aware Routing Protocol for Wireless Sensor Networks by Villas et al. (2009) [7] proposes a game theoretic model of dependable data aggregation structural planning in wireless sensor networks, characterizes a multi-tier data aggregation structural planning in which semantic based aggregation and average computation aggregation is performed in sensor-level and node level aggregation separately. All nodes that catch the same target join the same logic group.

In Node Clustering in Wireless Sensor Networks: Recent Developments and Deployment Challenges by Younis et al. (2006) [8] classified the distinctive clustering methodologies as indicated by the clustering criteria and the substance in charge of doing the clustering procedure and also concentrated on distributed clustering methodologies, which are more suitable for substantial scale sensor networks. They also highlighted some of the essential difficulties that have frustrated the utilization of clustering in present applications.

In A Spatial Correlation Aware Algorithm to Perform Efficient Data Collection in Wireless Sensor Networks Oliveira et al. (2011) [9] consider the issue of building a spatial correlation mindful dynamic and scalable routing structure for information gathering and aggregation in WSNs. In spite of the fact that there are a few answers for data aggregation in WSNs, the greater part of them fabricate their structures focused around the request of occasion event. This can prompt both low quality routing trees and an absence of load balancing support, since the same tree is utilized all through the network lifetime. To handle these difficulties they propose a novel algorithm called dYnamic and scalable tree Aware of Spatial correlaTion (YEAST).

Highly Dynamic Routing Protocol for Data Aggregation in Sensor Networks by Boukerche et al. (2010) [10] presents the Dynamic Data-Aggregation Aware Routing Protocol (DDAARP) for wireless sensor networks. This novel protocol assembles dynamic routes, which enhance the expense and nature of last routing tree. It likewise decreases the quantity of messages important to set up a routing tree, amplify the quantity of overlapping routes, chooses routes with the highest aggregating rate, and performs reliable data aggregation transmission.

In Information Fusion for Wireless Sensor Networks: Methods, Models, and Classifications by Nakamura et al.

(2007) [11] discuss their applicability in the context of wireless sensor networks and survey the current state-of-the-art of information fusion by presenting the known architectures, methods, algorithms and models of information fusion.

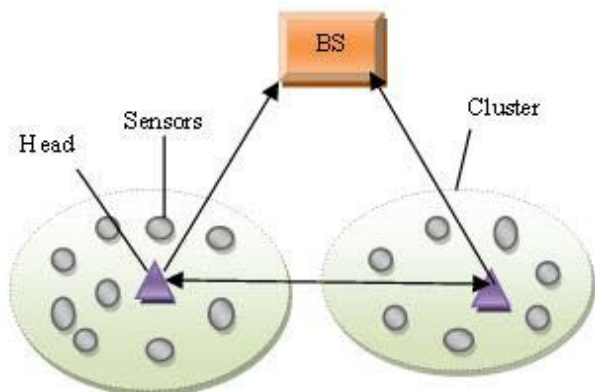


Figure: Cluster-Based Approach [14]

A. Structure-Less Approach

Author L. A. Villas et al. in [12] proposes a novel routing protocol called DST which adopts to any scenario. Different from static routing schemes, in DST, routes which are created during data transmission are not held fixed and also

not dependant on the order of events. It aims to build a routing tree with the shortest routes in Euclidean distance that connects all source nodes to the sink node, maximizing data aggregation while reducing the distance connecting each coordinator node to sink. Routes are based on straight line segments, which are computed by coordinator nodes. Drawback of this protocol is that it does not explore the spatial correlation model. DST loses its performance in situations where nodes detect the same event.

In coding theory, error-correcting codes initially developed to correct errors on noisy communication channel. Coding theory provides a mechanism, which reduces data redundancy from a message and ensures transmission of message to recipient error free. Code-based cryptosystems such as McEliece cryptosystem [13] is the first cryptosystem developed in 1979, which has implementation based on binary Goppa code and its security is based on difficulty of general decoding problem. Goppa codes forms a large family, providing a vast number of potential public keys, and there exists an efficient algorithm for decoding these codes in polynomial-time

3. Comparative Analysis

Algorithm	Routing Structure	Objective	Data Aggregation Nodes	Overhead	Scalability	Spatial Correlation
Direct Diffusion [4-5]	Tree-Based Approach	It constructs a spanning tree rooted at the Sink.	Cluster heads and Aggregator Node.	Medium	Low	No
SPT and CNS [2]	Tree-Based Approach	It constructs a spanning tree rooted at the Sink.	Cluster heads and Aggregator Node.	High	Medium	No
LEACH [6]	Cluster-Based Approach	It forms clustering of nodes and maximizes the overlapping of routes.	Cluster heads and Intermediate Nodes	Medium	Low	No
InFRa [11]	Cluster-Based Approach	It forms clustering of nodes and maximizes the overlapping of routes.	Cluster heads and Intermediate Nodes	Very High	Low	No
DDAARP [10]	Cluster-Based Approach	It forms clustering of nodes and maximizes the overlapping of routes.	Cluster heads and Intermediate Nodes	Low	Medium	No
YEAST [9]	Cluster-Based Approach	It forms clustering of nodes and maximizes the overlapping of routes.	Cluster heads and Intermediate Nodes	Very Low	Very High	Yes
DAA	Structure-Less Approach	Efficient data aggregation without explicit maintenance of structures.	Cluster heads and Intermediate Nodes	Very Low	Very High	No
DST	Structure-Less Approach	Efficient data aggregation without explicit maintenance of structures.	Cluster heads and Intermediate Nodes	Very Low	Very High	No

4. DRINA: Data Routing For In-Network Aggregation For WSN

The DRINA algorithm main goal is to build a routing tree with the shortest paths that connect all source nodes to the sink while maximizing data aggregation. in the routing infrastructure creation DRINA plays a following role.

- Collaborator: - A node that senses an event and reports the met data to a coordinator node.
- Coordinator: - A node that also senses an event and is accountable for meeting all the gathered data sent by

collaborator nodes, aggregating them and sending the result toward the sink node.

- Sink: - A node involved in receiving data from a set of coordinator and collaborator nodes.
- Relay: - A node that forwards data toward the sink.

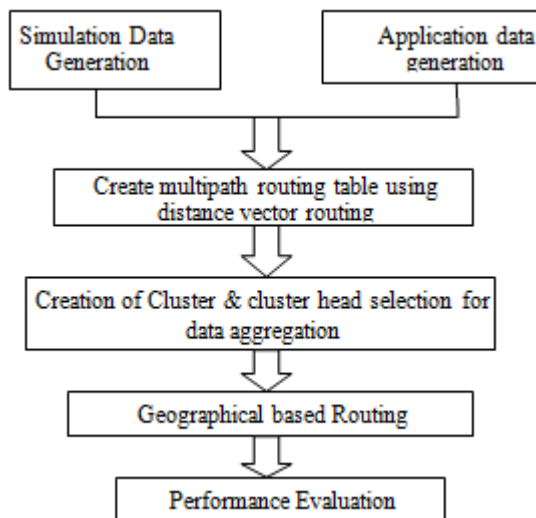
There are mainly modules of the proposed system. The introductions of these four modules are as follows:

- Build Tree: The network built in a tree structure. Were nodes are organized in a tree structure format. These nodes are dynamically loaded. The nodes are created by using the Jung libraries. These nodes are sends the data from source to destination.

- **Get Shortest Path:** Here, with the help of geographical routing, the shortest path is found which is used by a cluster head to transfer the data to the sink node.
- **Clustering:** Here, cluster formation process is done, where each node determines in which cluster it has to join and joins the cluster. Here also the node which has the highest residual energy and is closer to the sink node is elected as a cluster head. It also calculates the distance between two nodes. The remaining nodes forward their data to the cluster head and the cluster head aggregates this data with its own data.
- **Send Data:** Here, the cluster head selects the shortest path from the set of paths generated by the multipath routing table and sends the data to the sink node from the selected shortest path.

The distance between the sink and all nodes is calculated. In this phase, at first the HOP Configuration message is distributed or sent to all nodes in the network. The HCM message contains two fields which are: ID and HopToTree, ID means the identifier for each node and HopToTree means the distance of each node from which the message is passed. From the previous algorithm, the group leader which is elected starts establishing the new route for the event dissemination.

5. Propose Work



5.1 Multipath Routing Table Creation

The multipath routes are created from the source node at the time of event detection, in the context of WSN. With the help of distance vector routing, a multipath routing table is created. On the basis of geographical distances, which recover the energy efficiency as packets portable over lesser distance, the routing path is selected. This provides the all possible path from the source node. Multipath routing gives guarantee that paths are trustworthy and in case if one path is failure then other path is always obtainable.

5.2 Geographical Based Routing

The method to transport a message to a node in a network is called as geometric routing. It is also called as position based routing. Routing decision is based on multipath routing table

created by distance vector routing. Cluster head aggregates the data and forwards that data towards the sink node. It is used multiple paths which are created with the help of distance vector routing and as a Euclidean distance calculates the distance among the two nodes and also on the basis of its distance, the next nodes are selected that is the shortest distance node is selected. Every path created using multipath routing is calculated by cluster head and from this selected path, cluster head selects the path which has the shortest path to the sink. Based on the location of sensor nodes, the routing is performed. Using distance vector routing, it selects the best route according to the selection of multipath routing table for every node n .

Multipath routing which is based on geographical safeguards that paths are reliable and in case one path fails then there is always present another path and data is aggregated by the cluster head and forwarded that data to the sink.

6. Conclusion

In this paper we have surveyed the main approaches to energy conservation and data aggregation in wireless sensor networks. Wireless sensor networks are an important type of resource-constrained distributed event-based systems. We have modelled and analyzed the performance of data aggregation in such networks. Aggregation aware routing algorithms play an important role in event-based WSNs. In WSNs energy consumption is a key issue. In order to save energy data fusion and aggregation should be exploited. There is a requirement of novel Routing for In-Network Aggregation which has some features like high reliable data aggregation, and aggregation rate and transmission, reduced number of messages for setting up a routing tree, maximized number of overlapping routes and best aggregation quality.

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