REVIEW PAPER ON DRINA: A LIGHTWEIGHT AND RELIABLE ROUTING APPROACH FOR IN NETWORK AGGREGATION IN WIRELESS SENSOR NETWORKS

[1]Gagandeep Singh, [2]Dr Ashish Oberoi
[1]Student, [2] Head of Department,
[1]Computer Science and Engineering
[1]RIMT-IET,MandiGobindgarh,Punjab,India

Abstract—Large scale dense Wireless Sensor Networks (WSNs) will be increasingly deployed in different classes of applications for accurate monitoring. Since energy conservation is a key issue in WSNs, data fusion and aggregation should be exploited in order to save energy. 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. In this work, we propose a novel Data Routing for In-Network Aggregation, called DRINA.

Index Terms—Routing protocol, in-network aggregation, wireless sensor networks

1 INTRODUCTION

AWireless Sensor Network (WSN) consists of spatially distributed autonomous devices that cooperatively sense physical or environmental conditions, such as temperature, sound, vibration, [1], [2]. WSNs have been used in applications such as environmental monitoring, homeland security, critical infrastructure systemsand many other applications that can becritical to save lives and assets [3], [4], [5].

Sensor nodes are energy-constrained devices and the energy consumption is generally associated with the amount of gathered data, since communication is often the most expensive activity in terms of energy. For that reason, algorithms and protocols designed for WSNs shouldconsider the energy consumption in their conception [6], [7], [8], [9].

A possible strategy to optimize the routing task is to use the available processing capacity provided by the inter- mediate sensor nodes along the routing paths. This is known as data-centric routing or in-network data aggrega- tion. For more efficient and effective data gathering with a minimum use of the limited resources, sensor nodes should be configured to smartly report data by making local decisions For this, data aggregation is an effective technique for saving energy in WSNs. Due to the inherent redundancy in raw data gathered by the sensor nodes, in-networking aggregation can often be used to decrease the communication cost by eliminating redun- dancy and forwarding only smaller aggregated informa- tion. Since minimal communication leads directly to energy savings, which extends the network lifetime, in-network data aggregation is a key technology to be supported by WSNs. One of the main challenges in routing algorithms for WSNs is how to guarantee the delivery of the sensed data even in the presence of nodes failures and interruptions in communications. These failures become even more critical

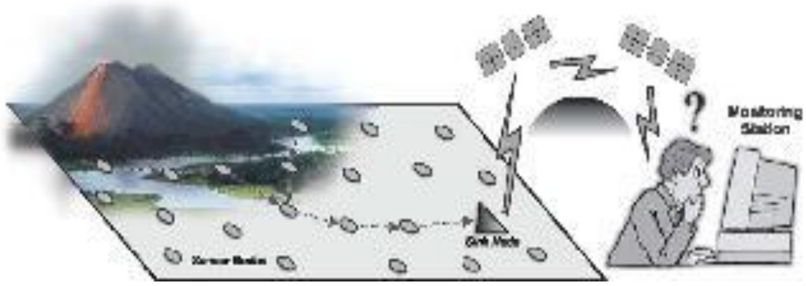

Fig. 1. Data aggregation aware routing, a key algorithm for data-driven WSNs.

when data aggregation is performed along the routing paths since packets with aggregated data contain informa- tion from various sources and, whenever one of these packets is lost a considerable amount of information will also be lost.. In order to overcome these challenges, in this work, we propose a novel Data Routing algorithm for In-Network Aggregation for WSNs, which we refer to as DRINA algorithm. Our proposed algorithm was conceived to maximize information fusion along the communication route in reliable way, through a fault-tolerant routing mechanism.

2 IN-NETWORK DATA AGGREGATION

In the context of WSNs, in-network data aggregation refers to the different ways intermediate nodes forward data packets toward the sink node while combining the data gathered from different source nodes. A key component for in-network data aggregation is the design of a data aggregation aware routing protocol. A key aspect of in-network data aggregation is the synchronization of data transmission among the nodes. In these algorithms, a node usually does not send data as soon as it is available since waiting for data from neighboring nodes may lead to better data aggregation opportunities. This in turn, will improve the performance of the algorithm and save energy.

2.1Tree-Based Approaches

Protocols in this are usually based on a hierarchical organization of the nodes in the network. In fact, the simplest way to aggregate data flowing from the sources to the sink node is to elect some special nodes that work as aggregation points and define a preferred direction to be followed when forwarding data.

In these protocols, a tree structure is constructed first and then used later to either route the gathered data or respond to queries sent by the sink node. Aggregation is performed during the routing when two or more data packets arrive at the same node of the tree.

2.2Cluster-Based Approaches

Similarly to the tree-based approaches, cluster-based schemes also consist of a hierarchical organization of the network. However, in these approaches, nodes are divided into clusters. Moreover, special nodes, referred to as cluster-heads, are elected to aggregate data locally and forward the result of such aggregation to the sink node.

2.3Structure-Less Approaches

Few algorithms for routing aware of data aggregation have been proposed that use a structure-less approach. The Data-Aware Anycast (DAA) algorithm a structure-less data aggregation algorithm, uses anycast to forward packets to one-hop neighbors that have packets for aggregation.

3DRINA: DATA ROUTING FOR IN-NETWORK AGGREGATION FOR WSNs

The main goal of our proposed the DRINA algorithm is to build a routing tree with the shortest paths that connect all source nodes to the sink while maximizing data aggrega- tion. The proposed algorithm considers the following roles in the routing infrastructure creation:

- Collaborator. A node that detects an event and reports the gathered data to a coordinator node.

- Coordinator. A node that also detects an event and is responsible for gathering all the gathered data sent by collaborator nodes, aggregating them and send- ing the result toward the sink node.
- Sink. A node interested in receiving data from a set of coordinator and collaborator nodes.
- Relay. A node that forwards data toward the sink. The DRINA algorithm can be divided into threephases.

In Phase 1, the hop tree from the sensor nodes to the sink node is built. In this phase, the sink node starts building the hop tree that will be used by Coordinators for data forwarding purposes. Phase 2 consists of cluster formation and cluster-head election among the nodes that detected the occurrence of a new event in the network. Finally, Phase 3 is responsible for both setting up a new route for the reliable delivering of packets and updating the hop tree.

3.1Phase 1: Building the Hop Tree

In this phase, the distance from the sink to each node is computed in hops. This phase is started by the sink node sending, by means of a flooding, the Hop Configuration Message (HCM) to all network nodes. The HCM message contains two fields: ID and HopToTree, where ID is node identifier that started or retransmitted the HCM message and HopToTree is the distance, in hops, by which an HCM message has passed.

3.2Cluster Formation

When an event is detected by one or more nodes, the leader election algorithm starts and sensing nodes will be running for leadership (group coordinator).For this election, all sensing nodes are eligible. If this is the first event, the leader node will be the one that is closest to the sink node. Otherwise, the leader will be the node that is closest to an already established route). In the case of a tie, i.e., two or more concurrent nodes have the same distance in hops to the sink (or to an established route), the node with the smallest ID maintains eligibility. Another possibility is to use the energy level as a tiebreak criterion.

3.3Routing Formation and Hop Tree Updates

The elected group leader, starts establishing the new route for the event dissemination.. For that, the Coordinator sends a route establishment message to its NextHop node. When the NextHop node receives a route establishment message, it retransmits the message to its NextHop and starts the hop tree updating process. These steps are repeated until either the sink is reached or a node that is part of an already established route is found. The routes are created by choosing the best neighbour at each hop. The choices for the best neighbour are twofold.when the first event occurs, the node that leads to the shortest path to the sink is chosen after the occurrence of subsequent events, the best neighbour is the one that leads to the closest node that is already part of an established route .This process tends to increase the aggregation points, ensuring that they occur as close as possible to the events.

The resulting route is a tree that connects the Coordi-nator nodes to the sink. When the route is established, the hop tree updating phase is started. The main goal of this

phase is to update the HopToTree value of all nodes so they can take into consideration the newly established route. This is done by the new relay nodes that are part of an established route. These nodes send an HCM message (by means of a controlled flooding) for the hop updating. The whole cost of this process is the same of a flooding, i.e., each node will send only one packet. This algorithm for the hop updating follows the same principles of the hop tree building algorithm

3.4Route Repair Mechanism

The route created to send the data toward the sink node is unique and efficient since it maximizes the points of aggregation and, consequently, the information fusion. However, because this route is unique, any failure in one of its nodes will cause disruption, preventing the delivery of several gathered event data. Possible causes of failure include low energy, physical destruction, and communica- tion blockage. Some fault-tolerant algorithms for WSNs have been proposed in the literature. Some are based on periodic flooding mechanisms and rooted at the sink, to repair broken paths and to discover new routes to forward traffic around faulty nodes. This mechanism is not satisfactory in terms of energy saving because it wastes a lot of energy with repairing messages. Furthermore, during the network flooding period, these algorithms are unable to route data around failed nodes, causing data losses.

4 Methodology

The performance evaluation is achieved through simulationsusing the SinalGo version v.0.75.3 network simulator [35].

6 CONCLUSION AND FUTURE WORK

Aggregation aware routing algorithms play an important role in event-based WSNs. In this work, we presented the DRINA algorithm, a novel and reliable Data Aggregation Aware Routing Protocol for WSNs. communication costs, delivery efficiency, aggregation rate,.As future work, spatial and temporal correlation of theaggregated data will also be taken into consideration as wellas the construction of a routing tree that meets applicationneeds. We also plan to modify the DRINA algorithm tostochastically select nodes that will be part of the communicationstructure. The goal is to find a balance between theoverhead and the quality of the routing tree. In addition,new strategies will be devised to control the waiting timefor aggregator nodes based on two criteria: average distanceof the event coordinators, and spatial and semantics eventcorrelation.

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