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Lightweight and Reliable Routing Approach for In-Network Aggregation in Wireless Sensor Networks

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ABSTRACT: Wireless Sensor Networks (WSNs) in a large scale, will be increasingly deployed in different classes of applications for accurate monitoring. Due to the high density of nodes in these networks, it is likely that redundant data will be detected by nearby nodes when sensing an event. 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 Routing algorithm for aggregation of nodes in the network, that has some key aspects such as a reduced number of messages number, high aggregation rate, and reliable data aggregation and transmission. The proposed Routing algorithm was extensively compared to two other known solutions: the Information Fusion-based Role Assignment (InFRA) and Shortest Path Tree (SPT) algorithms. Our results indicate clearly that the routing tree built by Routing algorithm provides the best aggregation quality when compared to these other algorithms. The obtained results show that our proposed solution outperforms these solutions in different scenarios and in different key aspects required by WSNs.

KEYWORDS: Wireless Sensor Network, data aggregation, routing algorithm

I INTRODUCTION

A Wireless Sensor Network (WSN) consists of spatially distributed several devices that continuously sense physical or environmental conditions, such as temperature, sound, vibration, pressure, motion, or pollutants at different locations[1], [2]. WSNs have been used in many applications such as environmental monitoring, homeland security, critical infrastructure systems, communications, manufacturing etc. It may also used in many critical application to save lives and assets [3], [4], [5]. WSNs are data-driven networks that usually produce a large amount of information that needs to be routed, often in a multihop fashion, toward a sink node, which works as a gateway to a monitoring center. A possible strategy to optimize the routing task is to use the available processing capacity provided by the intermediate sensor nodes along the routing paths. This is known as data-centric routing or innetwork data aggregation [1]. The resource utilization has to be minimized for the efficient data gathering in the networks. Data aggregation forwards only smaller number of data, reducing the redundant data, leads to lower communication cost, energy saving and thus improves the lifetime of the network.The nodes forward the aggregated data packets to the sink. Routing algorithm used plays an important role in aggregated data forwarding and it should be capable of providing guaranteed service even in the case of node failure situations. Here, a novel approach for data routing called Routing algorithm is proposed. Our proposed method can maximize the data aggregation along communication route in reliable way, through a fault tolerant routing mechanism. 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. Data aggregation requires a forwarding paradigm that is different from the classic routing, which typically involves the shortest path to forward data toward the sink node. Differently from the classic approach in data aggregation aware routing algorithms, nodes route packets based on their content and choose the next hop that

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maximizes the overlap of routes in order to promote in-network data aggregation. 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. Three main timing strategies are found in the literature [15], [16].

(a).Periodic simple aggregation.
Requires each node to wait for a predefined period of time while aggregating all received data packet and, then, forward a single packet with the result of the aggregation.

(b).Periodic per-hop aggregation.
Quite similar to the previous approach, but the aggregated data packet is transmitted as soon as the node hears from all of its children. This approach requires each node to know the number of its children. In addition, a timeout may be used for the case of some children's packet being lost.

(c).Periodic per-hop adjusted aggregation.
Adjusts the transmission time of a node according to this node's position in the gathering tree. Note that the choice of the timing strategy strongly affects the design of the routing protocol as well as its performance. In-network data aggregation plays an important role in energy constrained WSNs since data correlation is exploited and aggregation is performed at intermediate nodes reducing size and the number of messages exchanged across the network. In data gathering-based applications, a considerable number of communication packets can be reduced by in-network aggregation, resulting in a longer network lifetime.

II. PROPOSED ARCHITECTURE

In this work, we propose an effective routing for In-Network Aggregation, that has some key aspects such as a reduced number of messages for setting up a routing tree, maximized number of overlapping routes, high aggregation rate, and reliable data aggregation and transmission. The proposed Routing algorithm was extensively compared to two other known solutions: the Information Fusion-based Role Assignment (InFRA) and Shortest Path Tree (SPT) algorithms.

The main goal of proposed the Routing algorithm is to build a routing tree with the shortest paths that connect all source nodes to the sink while maximizing data aggregation. 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 sending 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 Routing algorithm can be divided into three phases.

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.

III HARDWARE IMPLEMENTATION

The proposed routing algorithm can be implemented by following three stages

1. HOP Tree Configuration
2. Cluster formation Leader Election
3. Route establishment and HOP TREE Update

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Stage 1: HOP Tree Configuration

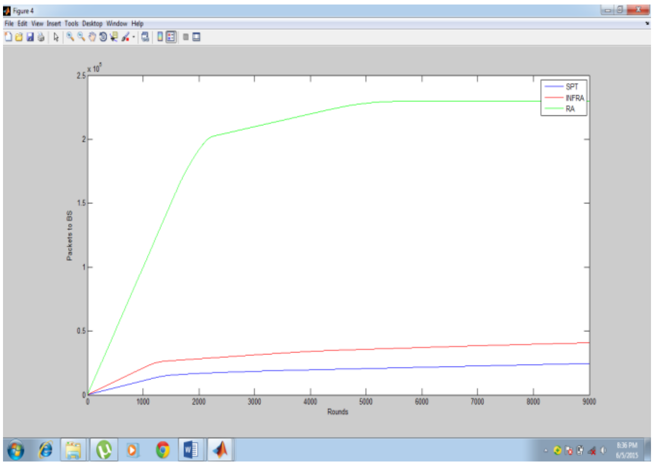
In this phase, the distance from the sink to each node is computed in hopsand starts by sink node.The HOP to Tree value is started from Sink node and travels towards its neighbors. During this stage each nodes receives HCM message from the sink node and compares with its HCM message.Based on the above points it builds the hop tree with the smallest distance in the network.Each node, upon receiving the message HCM, verifies if the value of Hop too Tree in the HCM message is less than the value of Hop to Tree that it has stored.If the condition is true then the node updates the value of the Next Hop variable with the value of the field ID of message HCM, as well as the value of the Hop to Tree variable.If the condition is false, which means that the node already received the HCM by a shorted distance, then the node discards the received HCM message.

Stage2: Cluster formation and Leader election This is an important stage where in the collaborator and coordinator is being electedWhen an event is detected by one or more nodes, our DRINA algorithm starts and sensing nodes will be running for leadership ie. to become coordinator.Only one node in the group will be declared as the leader (Coordinator).The remaining nodes that detected the same event will be the Collaborators.Once the coordinator is elected, then a route has been established from the coordinator to sink.For the successive events, the route is taken to find the other routes.

Stage 3. Routing formation and HOP TREE Updates.Once the coordinator and collaborator is elected , routing information is established and Hop tree is updated.

4.GRAPHS RELATED TO PROPOSED SYSTEM:

The proposed system has decreased the no of iterations based on the below enhancements(a).Shows the sensor nodes packets reaching to BS in several rounds as in the below figure



(b).Total Number of Alive nodes w.r.t total number of Rounds.

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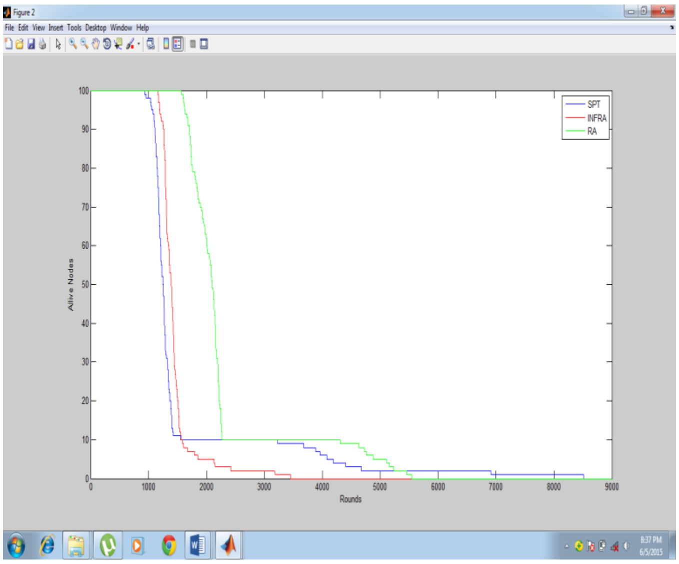
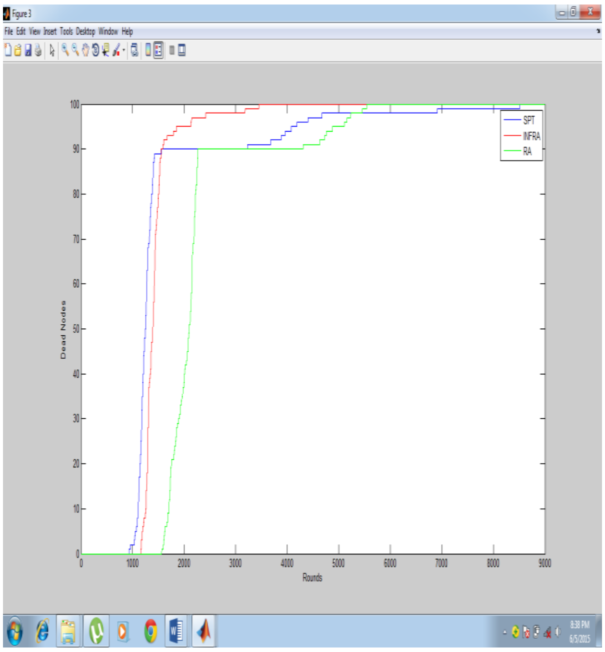


(c).Shows the Dead nodes w.r.t. Total number of Rounds.



VIII. Conclusion and Future Work

Aggregation aware routing algorithms play an important role in event-based WSNs. In this work, we presented the routing algorithm, a novel and reliable data aggregation for WSNs. Our proposed Routing algorithm was extensively compared to two other known routing algorithms, the InFRA and SPT, regarding scalability, communication costs, delivery efficiency, aggregation rate, and aggregated data delivery rate. By maximizing the aggregation points and offering a fault tolerant mechanism to improve delivery rate, the obtained results clearly show that Routing algorithm outperformed the InFRA and SPT algorithms for all evaluated scenarios. Also, we show that our proposed algorithm

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has some key aspects required by WSNs aggregation aware routing algorithms such as a reduced number of messages for setting up a routing tree, maximized number of overlapping routes, high aggregation rate, and reliable data aggregation and transmission.

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