Implementation of DRINA Algorithm for Energy Efficient Routing in Wireless Sensor Network

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Abstract— Wireless Sensor Networks (WSNs) are widely implemented in different area of applications like Military surveillance, Home automation and Pollution monitoring etc. It is possible that the data collected by adjacent nodes can be redundant due to large numbers of nodes in these networks, so aggregation of data should be exploited for energy conservation in WSNs. It is very important to transmit the aggregated data to the sink node effectively and reliably. Here, DRINA (Data routing for in-network aggregation) algorithm is proposed. It uses data aggregation as key point and reliably route data using a fault-tolerant routing mechanism. The proposed algorithm is compared with two algorithms namely Shortest Path Tree and Information Fusion Based Role Assignment. The derived results shows that the total number of packet sent for same information is 67% less than Information Fusion Based Role Assignment algorithm and 73% less than Shortest Path Tree algorithm. The packet delivery ratio of proposed algorithm is 95 %.

Key words: Wireless sensor networks, Data aggregation, DRINA

I. INTRODUCTION

A wireless sensor network (WSN) is formed of an average number of sensor nodes, which are thickly spread out and all together sense environmental or physical conditions, such as temperature, pressure, vibration, pollutants or motion at distinct places. Sensor Nodes have capability to interact with themselves and to a sink node .The number of sensor nodes in a network can be varied from few to several hundreds or even thousands of nodes. Wireless Sensor Networks have been used in various application areas like military, security and health [1], [2].

Wireless Sensor Networks are also a special type of ad hoc networks. Every node in a multi-hop ad hoc sensor network detects and routes data through the network. The nodes communicate with each other through wireless medium. The wireless medium can be formed by infrared, radio or optical media [2]. Wireless medium must be available worldwide for global operation of these networks. Many times, wireless sensor networks have tough restraint about energy resources and computational capability because sensor nodes are usually battery powered. Wireless Sensor Networks are data driven networks and generate large information that needed to be forward generally in multi-hop pattern towards a sink node, where sink node performs as an entrance to a controlling station [3]. Basically the nodes perform three operations in the network, i.e. a) event detection b) data processing and c) communicating data. Hence, power consumption is partitioned into three areas, namely sensing, data processing and transmission. The energy requirement in data transmission is greater as compared to data processing [2]. So, algorithms and protocols devised for Wireless Sensor Networks should take care of the energy utilization. Routing technique plays very vital role in data transmission. Routing technique can be exploit by using the processing capacity of the in-between sensor nodes along the communication paths, This is called as in network data aggregation or data centric routing [2], [3], [4]. Data caused from adjacent sensors is usually correlated and redundant. Aggregation of data excludes redundancy and forwards less number of data packets. Sending of less number of packets causes lower communication cost. In-network data aggregation is a leading method to be supported by Wireless Sensor Networks. Main challenge for routing algorithm is to deliver the sensed data during node failure and communication interruption. The transmitted data should be routed reliably because loss in data packet affects data analysis at monitoring center. We required an approach for merging a data into better quality information at the sensors or middle nodes, which can minimize the data packets forwarded to the sink, concluded in energy conservation. The proposed DRINA algorithm exploit the data aggregations extensively by increasing the number of overlapping routes and connects all the source nodes to the sink via shortest path also guarantees the reliable data transmission.

The related work is discussed in section II. Section III gives idea about DRINA algorithm. Section IV describes complete methodology of algorithm. Section V, VI shows performance evaluation and simulation results .Research is concluded in section VII.

II. RELATED WORK

There are different algorithms have been proposed which uses data aggregation as a leading technique during routing for WSNs. They are mainly classified as tree-based algorithms, cluster-based algorithms and structure-less algorithms.

Shortest path tree (SPT) algorithm [5] is a tree-based algorithm and generally depends on arrangement of the nodes. A very simple technique used to create the route structure in the SPT. Every node that catches an event forwards its collected information to the sink by using shortest way between both nodes. Whenever the two different routes overlap for different source nodes, aggregation of data occurs.

The Greedy Incremental Tree (GIT) [6] algorithm was inspired from Directed Diffusion technique. The GIT protocol builds an energy saving aggregation tree .GIT is the sequential scheme. When event is occurred for first time, the nodes send data packets by shortest path to the sink node. After first event, the source closest to the already established path connected to the path. For every different event there can be different aggregation point. GIT requires more communication and memory usage because all nodes in the network have to know the shortest path between them [7].

Center at Nearest (CNS) algorithm [5] uses data aggregation technique in different way. A specific node which is closest to the sink node called aggregator node is declared. The collected data packet by source node sends them to aggregator node via shortest path. Afterwards aggregator node sends aggregated packets to sink node.

Tiny Aggregation (TAG) [8][9] Service is one of the good service for data collection. In TAG algorithm all collaborator nodes knows the predefined time for gathering the data before forwarding it to the cluster head. The sleeping time for each node can be maintained according to the waiting time. It requires quite large number of message for tree structure.

Information Fusion Based Role Assignment (InFRA) [7] algorithm is cluster based approach. The nodes are arranged into cluster for every event .One of the node is selected as cluster head from cluster basis on algorithm criteria. Now, the cluster head forms the route up to sink node. Infra algorithm increases data fusion and forwards data via shortest path to the sink node. Information about occurrence of event is flooded throughout the network for telling all about the event occurrence .It limits scalability of algorithm as communication cost is increases.

III. DRINA: DATA ROUTING FOR IN NETWORK AGGREGATION

The DRINA algorithm is a cluster based technique. It exploits data aggregation technique in which all source nodes connects with the sink via shortest path. When source node has to send data to the sink node, they form a cluster. One cluster head is elected from cluster. It aggregates all the data from remaining nodes in cluster and forms path up to sink node via shortest path .Routing tree cost and communication cost for DRINA is less. Different nodes have different role in the network.

1) Coordinator: - These nodes collect all data packets from collaborator nodes, aggregate them and forward towards sink node.
2) Collaborator:-these nodes send data packets to the coordinator node.
3) Relay:-These are middle nodes between coordinator and sink.
4) Sink:-It is gateway to monitoring centre and interested in data collected from coordinators and collaborators.

IV. MODULE DESCRIPTION

The DRINA algorithm is divided into three phases.

A. *Hop Tree Building:*

The distance of every node from sink is computed in hops. Hop Configuration Message (HCM) composed of hop to tree (HTT) and node ID. HTT is the distance in hops from source node. The sink forwards HCM throughout the network with HTT value =1.Initially HTT value for all nodes in network is infinity. When node receives HCM, it compares its HTT value with HTT value of HCM. If HTT value of HCM is less than HTT value of node then node updates its value with HCM value. Now, that node sends HCM to next hop node with updated value. In this way the whole network is configured. Fig. 1. Shows flowchart for Hop tree building.

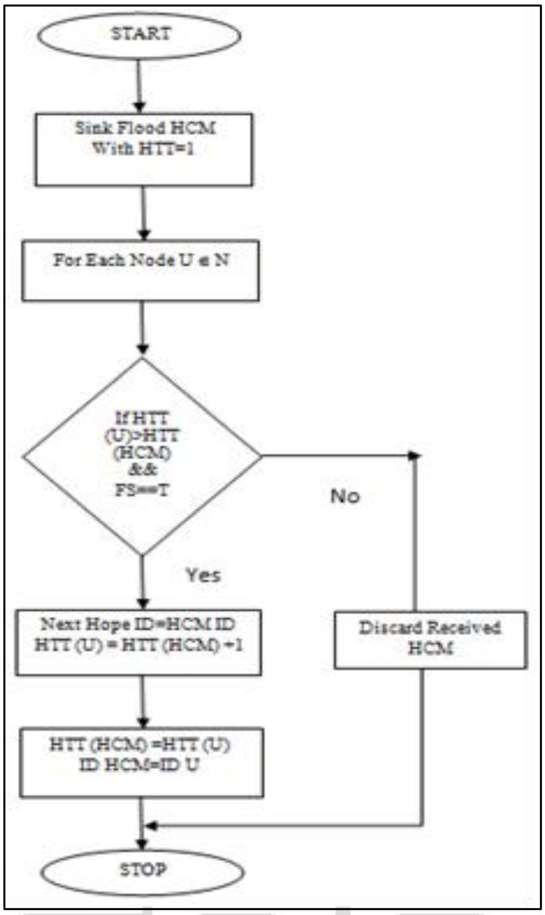

Fig. 1: Hop tree building

B. *Cluster Formation and Leader Election:*

In this phase coordinator and collaborator nodes are selected. Whenever two or more node detects an event, they form a cluster. Every node of cluster is tries to be leader or cluster head (CH) of the group but leader of group is selected on two criteria. For first event the node which is closest to the sink node is selected as leader after that node which is nearer to already created path is selected as CH. Sometimes tie can occur, in such times Node ID or node energy can be used as tie-break solution. At the end of this phase a set of coordinator and collaborator nodes is created. Aggregation of data sent by collaborators takes place at CH.

C. *Route Formation and Repair:*

The route is established between the cluster head and sink. Route Establishment Message (REM) is forwarded by CH via relay nodes until the sink is reached or node belongs to previous path is found. The route is always established via shortest path. The hop tree is updated after root creation by relay node of established path. Relay nodes update their hop to tree value in order to consider created path for next round. The aggregation of data takes place by relay nodes during routing. Relay nodes check there descendants while data transmission. If relay found more descendants, it collects data from them and aggregates it. Flowchart for route formation is shown in Fig. 2.

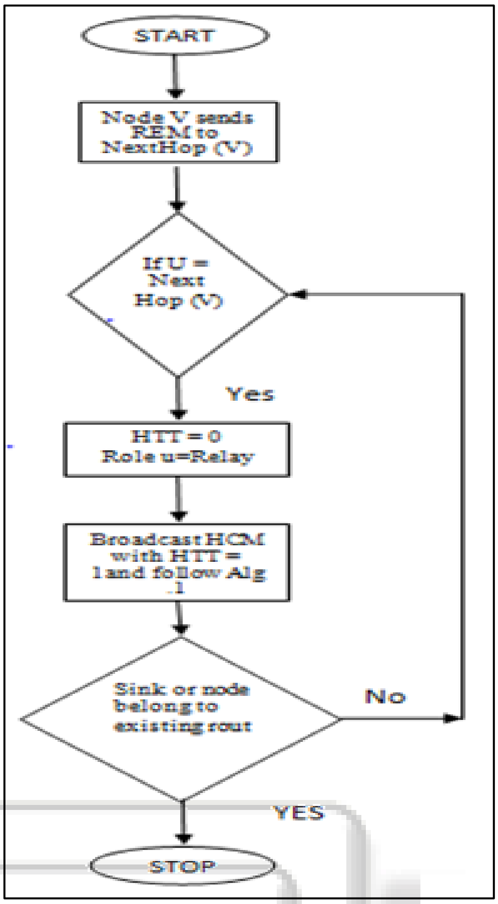

Fig. 2: Route formation

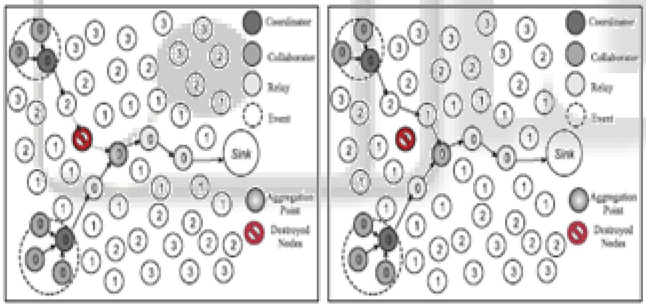

Fig. 3: Route repair Mechanism

The created root to the sink for data transmission is unique and it maximizes aggregation along the route. As the route is unique, one of its node failures cause severe impact on data analysis at the monitoring station. timeout is set by relay nodes for sending of data packets . Retransmission of the data packet from NextHop works as an acknowledgement for sender node. The status of node is decided by acknowledgement. If one of relay node is offline sender node finds another NextHop node to forward the packet. This ensures the reliable data transmission in the network.Fig.3. Shows route repair mechanism of DRINA algorithm.

V. PERFORMANCE EVALUATION

The derived results of DRINA algorithm are compared with two well-known algorithm namely information fusion based role assignment and shortest Path Tree which are cluster based and tree based techniques respectively. Purpose of Both algorithms is same that of DRINA. The performance is checked for various parameters. The simulation is done in network simulator 2 [10].The simulation parameter used are shown in Table I.

1) Data Packet: - These are total number of packets transmitted in whole network.
2) Packet Delivery Ratio: It is the ratio of total number of packets received and total number of packet sent.
3) Delay:-It is the time taken by packets for transmission from source to destination node in the network.
4) Energy Efficiency: - Total energy used to process all data packets generated by source nodes. It is measured in Joules per data processed.

Simulation Parameters	Description
Simulator	NS2.34
Network Size	1000m × 1000m
Nodes	100
Medium	Wireless
Interference Queue Type	Drop Tail; PriQueue
Simulation Time	6 Sec
Packet Size	1000(bytes)

Table I: Simulation Parameters

VI. SIMULATION RESULTS

The Fig. 4. is simulation window of network simulator showing the network of 100 nodes which are communicating with each other and to the sink.

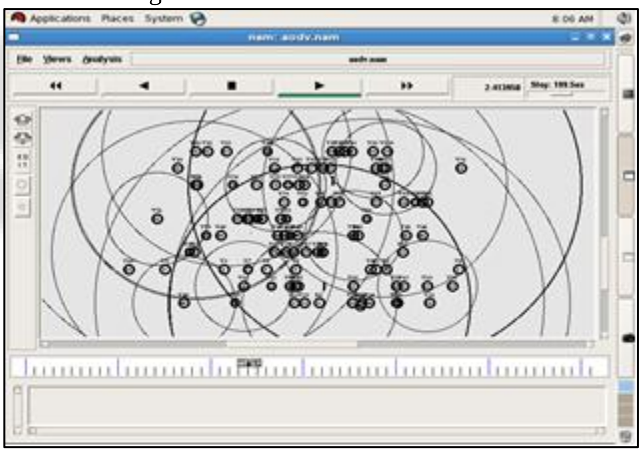

Fig. 4: Simulation Window

Fig. 5. shows the comparison of DRINA, InFRA and SPT algorithms for total data packets send. It is clearly seen than the total number of packets send for DRINA algorithm is very less than the Infra and SPT algorithm, Because DRINA algorithm uses data aggregation technique very efficiently.

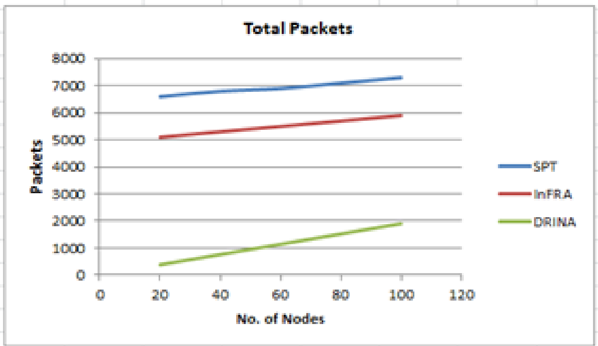

Fig. 5: Total Data Packets

Table II show comparison between DRINA and InFRA based on Packet Delivery Ratio (PDR) . PDR of DRINA algorithm is 20% more than Infra algorithm. Reliability of protocol depends on PDR higher the PDR, higher the reliability of algorithm. Results shows the data packets are routed reliably and small amount of data is lost during routing in DRINA.

Algorithm	Packet Delivery Ratio
Information Fusion Based Role Assignment	75%
Data routing for in-network aggregation	95%

Table II: Packet Delivery Ratio

Energy consumption is related with number of packets are transmitted throughout the network. It is obvious that more energy is consumed for routing more number of packets. The number of data packets transmitted is less in DRINA due to data aggregation technique results in less energy consumption. Fig. 6. Shows DRINA have greater energy efficiency than InFRA algorithm.

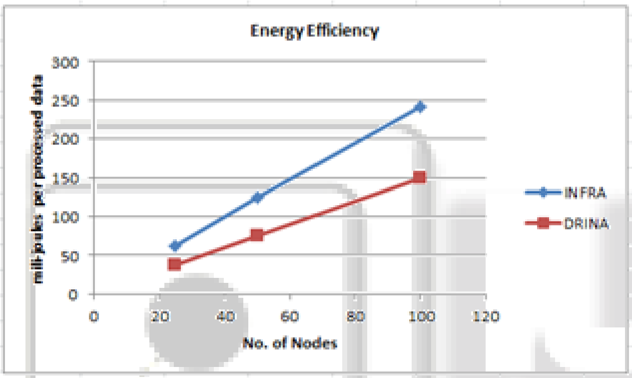

Fig. 6: Energy Efficiency

Delay plays an important role for increasing communication cost of network. Simulation result proves that delay is very less for DRINA algorithm as shown in Fig. 7.

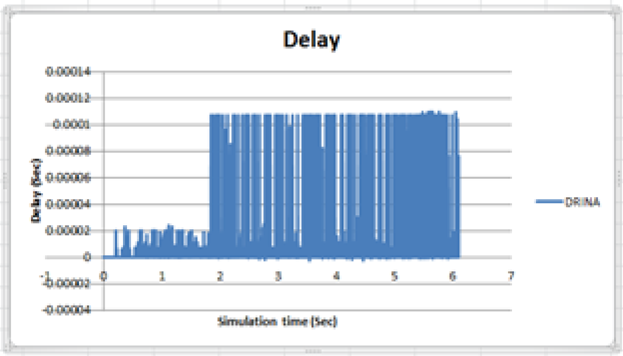

Fig. 7: Delay

VII. Conclusion

Data Routing for In-Network Aggregation (DRINA) is efficient and reliable data aggregation aware routing protocol for WSNs. This algorithm is compared with InFRA and SPT algorithm which comes under same category. The comparison clearly shows that total number of packets transmitted in DRINA is very much less than InFRA and SPT. So, the energy consumption for DRINA algorithm is less than other two compared algorithms .The obtained Packet delivery ratio shows that DRINA sends data in reliable way as it use Route Repair Mechanism technique. Small amount of packets are lost during simulation. Thus an overall simulation result concludes that DRINA can increase network life as it required low energy and delay.

VIII. Acknowledgment

The research work presented in this paper is carried out by Vivek Nakade student of 4th Semester in Embedded System & Computing under the guidance of Prof. Nekita Chavhan.

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