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RESEARCH ARTICLE

A Peculiar Cluster Based Routing in Wireless Sensor Network

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Abstract-In wireless sensor networks energy conservation is one of the main problems, since wireless sensor network is used in many sensitive applications such as military surveillance and other applications where accurate monitoring is necessary. We need to reduce energy used by the sensor nodes to increase the performance and lifetime of sensors. Due to high density of nodes in wireless sensor network, the nearby nodes will detect the redundant data while sensing an event. In this case we can save energy by aggregating the data at intermediate nodes. In our work the data is aggregated by forming clusters, this aggregation technique reduces the number of messages exchanged and size thus it reduce the energy consumption of wireless sensor networks and cost of communication. Here we propose a peculiar cluster based data routing for in network aggregation. It reduces the number of messages required for setting routing tree and the numbers of overlapping routes are increased and it provide high aggregation rate.

Keywords- DCA; wireless sensor networks; routing; sensitivity; data aggregation; cluster

I INTRODUTION

The development in technologies produces micro sensors which are capable for sensing, data processing and communication. These sensors sense the physical and environmental conditions. The sensors are joints together to form a wireless sensor network. The wireless sensor network is used in many sensitive applications such as military surveillance where accurate monitoring is necessary. The performance and lifetime of sensor nodes depends upon the battery life.

One simple solution for this problem is replace the battery periodically but it very difficult because a single wireless sensor network consist of large number of nodes and in some applications such as monitoring volcanoes sensor nodes are inaccessible. The other solution for this problem is by designing the algorithms and protocols in such a way that it conserves less energy we can increase the battery life of sensor nodes which in turn increase the performance and life time of sensor nodes. Another solution is recharging the wireless sensors with some components. But this is difficult because of low efficiency and design complexity.

In wireless sensor network energy consumption is mainly due to communication and it increases when the distance increases, because in wireless sensor network energy consumption is directly proportional to the square of distance between the nodes. The wireless sensor networks are data driven network in which data is routed in multi hop fashion. So by optimizing the routing mechanism for transmitting the data we can reduce the energy consumption during communication which is the main cause of energy consumption in wireless sensor network.

The local computation will consume less energy while comparing with communication so the sensor nodes should be configured to take local decisions. The in-network data aggregation is one of the techniques used for making local decisions which utilizes the processing capacity of sensor nodes along the route. Due to high density of nodes in wireless sensor network, the nearby nodes will detect the redundant data while sensing an event. By using in-network aggregation the redundant data can be removed and so we can reduce the communication cost.

Another challenge we need to face while designing a routing algorithm is guarantee of sensed data delivery. The critical situations like occurrence of node failure or interruption will affect the guarantee of sensed data delivery. Because in data aggregated wireless sensor network if a node failure occur then the information from various nodes are lost. So in our proposed method we develop an algorithm which reduce energy consumption as well as provide a mechanism for fault tolerance to guarantee the delivery of sensed data packets in the network.

II RELATED WORK

In-network data aggregation is a complex function because the aggregation algorithm is distributed and need coordination among the nodes to obtain good result. Timing strategies are used in applications such as monitoring where the nodes periodically report their sensed data to sink. Some of the common timing strategies are periodic simple aggregation, periodic per-hop aggregation, and periodic per-hop adjusted aggregation. The algorithms used for in-network data aggregation is classified as Tree based algorithms, Cluster based algorithms and Structure less algorithms.

Our proposed DCA (data combined alert algorithm) comes under cluster based algorithm. In the cluster based approach the nodes are divided in to clusters. For each cluster a head is selected this is called as cluster head. The data aggregation is performed locally in cluster heads. Some of the cluster based approaches are Low Energy Adaptive clustering Hierarchy (LEACH) and Information Fusion Based Role Assignment (InFRA).

A. LEACH Algorithm:

LEACH is cluster based self organizing protocol. It distributes the energy expenditure evenly between the nodes. This protocol has two main phases they are setup phase and steady state phase.

In the setup phase the nodes are grouped in to clusters and a cluster head is selected within each cluster. Each cluster head form TDMA schedule for local transmission to avoid collision. In the steady state phase the data transmission takes place. The cluster head receives the data from nodes within the cluster and perform aggregation and send them to sink in a single direct transmission.

In the LEACH algorithm the cluster heads are selected based on probability without considering the energy so here load balancing cannot be performed if the sensor nodes are with different initial energy. Moreover LEACH algorithm sends the data to sink in a single direct transmission which is not possible to large networks so it limits the size of the network.

B. InFRA Algorithm:

Information Fusion based Role Assignment (InFRA) is another cluster based routing algorithm. In this algorithm cluster is formed during each event by grouping the nodes which sense that event. Then the data within the cluster is aggregated by the cluster head and then the merged data is forwarded to the sink. In InFRA algorithm shortest path to reach the sink is created by aggregated coordinators distance which maximizes the information fusion.

In InFRA algorithm when a new event occurs then the information should be flooded to indicate the other nodes about the occurrence of the new event and the aggregated coordinators distance must be updated. The flooding of information during the occurrence of each new event needs more energy for communication which in turn increases the energy consumption of the wireless sensor network.

III METHODOLOGY

In our proposed DCA methodology when a new event occurs the nodes which detect the event is grouped together to form the cluster and the cluster head is also selected. After selecting the cluster head routes are created by selecting the nodes in the shortest path to the nearest node which is the part of the existing routing infra structure. Our routing algorithm tends to maximize the aggregation points and use few control packets to build the routing tree. Our algorithm does not flood the message to the whole network when a new event occurs so the consumption for communication is reduced. The proposed routing method consists of three stages. The first stage is developing a tree to represent the hopping between the nodes. The second stage is forming the cluster and selection of cluster head. The third stage is route formation. Along with this stages our proposed method contain a route repair mechanism and privacy preserving mechanism to make the network to operate when a node fails to function or when a node is attacked by other opponents.

A. Network Initializing and creating the hop chart

In this stage first the wireless sensor network must be initialized by creating a sink node and sensor nodes. The sensor nodes can be of any numbers based on the size of the network. The distance of each sensor node from sink node is represented in terms of number of hops it takes to reach them. The sink node first sends a message to all sensor nodes present in the network with hop value equal to one and an identifier representing the node which sends this message. The nodes which are within the coverage region of sink receive this message and check one condition whether the already existing hop value is greater than the newly received hop value. If the newly received hop value is less than already existing hop value then the new value is stored. If the newly received hop value is greater than already existing one then the node discards the message received. After verifying the condition the nodes store the data present in the message. Now the distance from sink and these nodes is one hop. These nodes then increase the hop value by one and add its identifier value and retransmit the message again. The nodes come within the coverage area of these nodes receive this message. This process continues till the entire network is covered.

B. Grouping in to clusters and selecting a cluster head

The next stage is grouping the nodes in to various clusters based on the event they detect and selecting a cluster head. The cluster head selected in this stage is used to aggregate the data sensed by all nodes present within that cluster. In this stage when an event is detected the nodes which detect the same event is grouped together as cluster. The node which is nearest to the sink node selected as the cluster head if the event detected is the first one. For the next subsequent events the nodes nearest to the preexisting route is selected as the cluster head. In the case where lot of nodes within the cluster has same distance to sink node a problem occurs in selecting the cluster head at this situation the nodes which has large identifier value serves as a sensing nodes and the node which has less identifier value among all nodes which has same distance to sink is selected as the cluster head. Other way to solve the problem of selecting the cluster head if large number of nodes has same distance to sink is based on energy level. The node which has high energy level is selected as the cluster head.

Any way finally only one node is selected as cluster head. The nodes which fail in cluster head selection process simply serve as sensing node and the node which is selected as cluster perform both sensing and data aggregation. This cluster head collect the information from all sensing nodes within the cluster and send the aggregated information to the sink node.

C. Formation of exact route for sending data:

In this stage the exact route to send the data to the sink is formed. If the event is detected first the route is formed in such a way to reach the sink for the subsequent events the route is formed in such a way to reach the already existing route. When an event is detected the cluster is formed and the data is aggregated in the cluster head after aggregation the cluster head send a message to the next hop node to form a route the node which receives the message for route establishment forward that message to next node this process continues till it reaches the sink if the event is a first event or till it reaches the preexisting route if event is a subsequent event. The resulting route is the route that formed by connecting various cluster heads to reach the sink. After the route is established the hop chart must be updated. The update in hop chart is performed by the intermediate node which is already a part of existing route. This intermediate node send a message for hop update similarly the sink sends first for calculating the distance between sink and node. There is a possibility for the occurrence of data aggregation to takes place in three places. They are inside the cluster, in cluster head, outside the cluster. The aggregation is performed inside the cluster by the sensing node if the routes overlap within the cluster. The aggregation is performed by the cluster head normally, it collect the data sensed by the sensing node aggregate it and send to the sink. If the events overlap along the routing the aggregation is performed outside the cluster by the intermediate nodes which is already a part of existing route. If the node has any data for transmission it first verifies that whether any successors that receives and send its data if yes the node will wait for some time and then collect all data and aggregate it and send it to the next hop node. When the data is send to next hop node the sender node want to verify whether the data is send correctly. For that the sender node waits for some time to receive delivery conformation message from the receiver node. If the conformation message is received the node continues the next transaction. If the conformation message is not received then the node selects a new next hop node and retransmits the data to the newly selected node.

D. Mechanism for clearing the fault occurs in the node

In the nodes connected in the network the failure occurs mainly because of blockage in communication, physical damage, and low battery power and due to third party attack. The route used for transmitting the collected data to the sink is unique so even a destruction of single node will affect the transmission of the data. In our proposed method we use a conformation message based route repair mechanism. In our proposed method when a node sends the data to the next node the sender node will wait for certain period to receive the conformation message from the receiver.

If the receiver sends the confirmation message then the sender consider that the node is active and it continues the transmission. If the receiver does not send the conformation message then the sender considers that the next node to which it sends data is offline and so it select the alternative node for transmitting the data. The alternative node selected by the sender node is the one with minimum hopping distance.

IV ANALYSIS AND EVALUATION

This section analyzes our method and compare with other existing algorithms. In InFRA algorithm the cost for communication is common because in this algorithm when each event occurs it floods the message to the whole network. We analyze the proposed algorithm and compare the performance of proposed method with two other known routing protocols: the InFRA and SPT algorithms. We evaluate the DCA performance based on the following metrics:

1. Delivery rate of packets.
2. Control overhead.
3. Efficiency (packets per processed data).
4. Cost for establishing routing tree

A. Method

The proposed method's performance evaluation is obtained through simulations using the SinalGo version v.0.75.3 network simulator [35]. The starting of first event is at time 1,000 s and the starting of all other events are at a equally distributed random time between the interval ½1;000; 3;000_ seconds. The occurrence of events is at random positions. Density of network is considered by the relation n_r2c =A, where n is number of nodes, rc is radius of communication, and A is sensor field area. The node density must be maintained at the same value for each simulation. Lower bound to the packet transmissions is provided, the aggregation function used receives p data packets and sends merged packet with fixed size. The aggregation points perform this function when the nodes send a packet. The aggregator nodes transmit the received and aggregated information periodically. The metrics given below were used for evaluation of proposed method:

Delivery rate of packets: Number of packets that reach the sink node. This metric is used for measuring the quality of the routing tree. If the packet delivery rate is low then the aggregation rate of the built tree is high.

Control overhead: The count of control messages used to build the routing tree depends upon the overhead to create the clusters and setting up the routing parameters.

Efficiency: It is the rate between transmitted packets number and the number of data received by the sink

Cost for establishing routing tree: It is the cost required for establishing the routing tree. It depends upon the number of edges in the routing tree.

The number of Steiner tree nodes (i.e., relay nodes) obtained after the construction of the routing tree is evaluated here. Here the size of network is varied from 256 to 2,048 sensor nodes; the density is varied from 20 to 30; and the number of events was also varied from 1 to 6. The number of Steiner nodes in the routing tree constructed by the DCA algorithm is lower than the SPT and InFRA algorithms. The result of DCA algorithm is due to its characteristic of prioritizing nodes that are closer to already existing routes. The InFRA algorithm prioritizes the distance to the sink node, resulting in lower aggregations, which in turn increases the number of Steiner nodes.

B. *Impression of the Network Dimensions*

The size of the network was varied from 128 to 1,024 to evaluate the scalability of the algorithm The InFRA sends only 77 percent data and SPT sends only 65 percent data this result shows that DCA keep the quality of the routing tree even after the number of nodes in the network increases. Our algorithm needs 30 percent less control messages to build the routing structure so it is more scalable than InFRA algorithm. The routing trees built by SPT results in 30 percent less efficiency than the trees built by DCA algorithm. So in conclusion DCA is 20 and 28 percent more efficient than the InFRA and SPT algorithms, respectively. This is because the DCA algorithm needs less control messages to build the routing tree and high aggregation quality when compared to InFRA and SPT. So our proposed algorithm is better than existing routing algorithms even though the size increases.

C Force of the Number of Events

By varying the number of events the behavior of the proposed DCA algorithms in networks is evaluated. The results shows the DCA sends less data packets than the InFRA and SPT algorithms. DCA sends 84 percent of packets send by InFRA and 64 percent of packets send by SPT. This indicates by varying the number of events, DCA builds routing trees to have higher data aggregation rates. Moreover, only 29 percent of the control messages used by InFRA to build the routing structure is required for DCA to build the routing tree. DCA is more efficient than SPT and InFRA for more than one event. The cost of the routing tree built by DCA is 10 percent smaller than in the InFRA algorithm and 30 percent smaller than in the SPT.

D. Force of the Event length

The event duration was varied from 1 to 5 hours. Our proposed DCA algorithm sends less data packets than the other evaluated algorithms. DCA sends approximately 84 percent of data send by InFRA and 64 percent of the data packets sent by SPT. DCA obtain a data aggregation rate greater than InFRA and SPT by varying the event duration. The DCA requires less control messages to create the routing structure than InFRA but it requires more control messages than the SPT algorithm. Although DCA requires 33 percent more control messages than SPT. At last the DCA is more efficient than InFRA and SPT

V CONCLUSION

Data Combined alert routing algorithms is used for event-based WSNs. Our work is compared with some well known algorithms such as InFRA and SPT algorithm. The comparison is performed for scalability, cost of communication, efficiency in delivering the data, and data combination rate. Our proposed method maximizes the combination points and provides mechanism for fault tolerance; the results we get clearly show that DCA is best when compared with other algorithms such as InFRA and SPT algorithms for all performance metrics used for comparison. Our algorithm use less messages for setting a routing chart, it has maximum number of overlapping routes and high aggregation rate which are more important for a aggregation aware algorithm. Moreover our proposed method provides reliable data communication.

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