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Trust Calculation for Improving Reliability of Routing and Data Aggregation in WSN

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Abstract A wireless sensor network (WSN) is collection of distributed sensors nodes to monitor physical or environmental conditions, at different locations and to collectively pass their data through the network to a sink node or base station. Wireless sensor nodes have limited energy supply. Nodes in wireless sensor network are nearly located and redundant data will be detected. This happens because of multiple sensor nodes sensing same event. Since data duplication is responsible for wastage of node energy. Since energy conservation is the major key issue in WSN. So, data aggregation should be used in order to save energy. Whereas Trust is an important issue in wireless sensor networks which resolves the problem of secure routing scheme, privacy, access control, and reliable communication. Data aggregation is method for eliminating redundancy and to minimize the number of packet transmission. The ultimate objective of data aggregation is to gather and aggregate data in an efficient manner so that lifetime of the network increases by reducing the number of packets to be sent to the base station which decreases the communication costs and energy consumption. Here introduces a new approach for improving reliability of routing and data aggregation in WSN using trust value.

Keywords: Cluster; Data Aggregation; In-network Data Aggregation; Trust; Wireless sensor network.

1. Introduction

WIRELESS sensor network (WSN) is of a group of spatially disperse sensors nodes for monitoring the physical conditions of the environment like temperature, sound, pollution levels, pressure, etc. [9],[4]. These networks have been used in different applications such as environmental or physical monitoring, land security, manufacturing systems, critical organization systems, etc. WSNs usually produce a large amount of information that needs to be routed across the networks in multihop fashion toward a sink or base station, which works as a gateway to monitoring center as shown in Figure 1 [9].In this fig, routing data is important task in the data gathering process. As sensor nodes are energy-constrained devices. The energy consumption is generally associated with the amount of gathered data. Thus, energy conservation is major key issue in WSN. Data fusion and Data aggregation techniques used in order to save energy [1],[14]. A strategy to optimize the routing task for the available processing capacity can be provided by the intermediate sensor nodes along with the routing paths. Data aggregation defined as a process of aggregating the data from multiple sensor nodes to eliminate redundant transmission and provide fused information

to the sink or base station. Due to the redundancy in raw data gathered by the sensor nodes, in-network aggregation can be used to decrease the communication cost by eliminating redundancy and forwarding only smaller aggregated data which intern decreasing the communication costs and energy consumption due to this the network lifetime is increases.

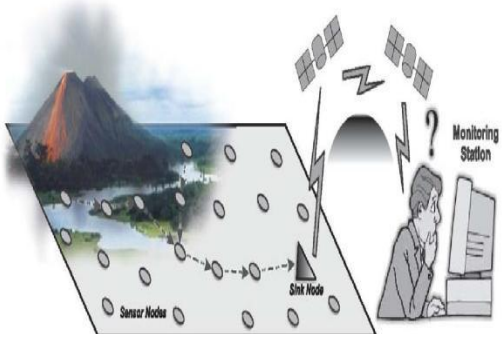

Fig. 1. The data acquisition process in WSN.

Trust in WSN plays an important role in constructing the network and making the addition or deletion of sensor nodes from a network very smooth and transparent. Due to the dynamic nature of the WSN and the massive deployment of WSN to sense an event and report data and the characteristics of sensor nodes, coupled with the short range of communications, nodes must cooperate between themselves to finish a certain task. Simply if there is no cooperation between nodes there is no functioning network. For example if a sensor network is being deployed for target tracking purposes, nodes report to each other about sensed target and then to the other nodes in the routing
path until reaches to the cluster head and the cluster head then reports to the base station. To get the sensed data to the cluster head from a sensor which is far away from the cluster head, cooperation must occur between nodes to be able to forward the data. And for cooperation to happen between nodes, a trust must exist, which means cooperation influences trust and vice versa.

The expected contribution is building a probabilistic framework model to calculate and continuously update trust values between nodes in wireless sensor networks based on the sensed event and to exclude malicious and faulty nodes from the network. In other words, creating a framework to maintain the security and the reliability of a sensor network by examining the trust between nodes, so every node has a trust value for every other node in the surrounding area and based on that value the cooperation occurs between nodes. The main challenges in routing algorithms for WSNs are no assured guarantee to the delivery of the sensed data for the presence of nodes failures and interruptions in communications. As packets contain aggregated data information from different sensor nodes. Most of the time node failures become more critical in data aggregation performed along the routing paths. Whenever one of these packets is lost the amount of information will also be lost. In WSN, data aggregation routing protocols should present some characteristics such as reduced number of messages for setting up a routing tree, maximum aggregation rate, maximizing number of overlapping routes, and reliable data transmission. In order to overcome these challenges, one algorithm is proposed.

2. In-network Data Aggregation

In this process the intermediate nodes forward data packets toward the sink node while combining the data gathered from various 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 approach that is different from the classic routing, which typically involves the shortest path "in relation to some specific metric" to forward data toward the base station. In data aggregation routing algorithms, nodes route packets based on their data and choose the next hop that maximizes the overlap of routes in network data aggregation. In-network aggregation is important to reduce the overall amount of energy in WSN and it is performed at intermediate nodes to decrease size and the number of packets exchanged across the network. The various algorithms have been proposed that provide data aggregation while routing in WSNs. These routing algorithms are categorized into following two types.

1) Tree-Based Approach
2) Cluster Based Approach

2.1 Tree-Based Approach

In a tree based approach, tree is constructed by sensor nodes. This tree is used to route the gathered data. Data aggregation is performed at intermediate nodes along the tree. This aggregated data is transmitted to the sink node. Data aggregation is performed during the routing when two or more data packets arrive at the same node of the tree. This node then aggregate all received data with its own data and forward only one packet to its neighbor that is lower in the tree. But, this approach has few drawbacks. For instance, when a packet is lost at a certain level of the tree that time the data from the whole sub tree will be lost. Thus, these approaches are required a mechanism for fault tolerance to reliably forward the aggregated data. One of the main aspects of tree-based networks is the
construction of an energy efficient data aggregation tree.

2.2 Cluster Based Approach

Cluster-based approach also consists 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. In the Low-Energy Adaptive Clustering Hierarchy (LEACH) algorithm, clustered structures are exploited to perform data aggregation. In this algorithm, cluster heads can act as aggregation points and they communicate directly to the sink node. In order to evenly
distribute energy consumption among all nodes, cluster-heads are randomly elected in each round. LEACH-based algorithms assume that the sink can be reached by any node in only one hop, which limits the size of the network for which such protocols can be used. Figure 2 shows a Cluster based network structure which is used in Trust Management Model.

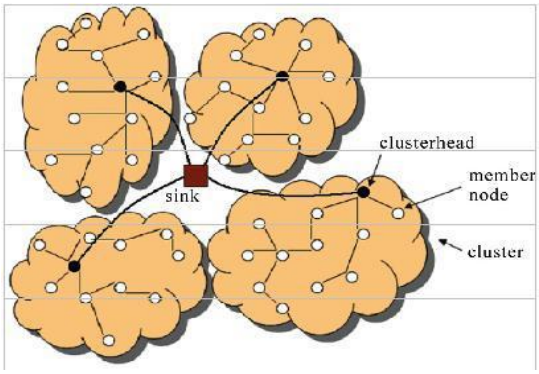

Fig. 2. Cluster based network structure.

3. Trust Management

In WSN, the trust can be defined as, "the combined characteristics model for providing the security, privacy, reliability, with respect to the mobility". Establishing the trust and evaluating the trust in WSN enables the node which have a secure, reliable communication with other node or network based on their trust values. Trust worthiness of the node in the network solves the problem of secure routing, providing reliable path for the packet and the selection of secure mobility model. The trust value is very essential for the sensor nodes deployed in the military environments. The evaluation of the trust worthiness is must between the nodes in the network to have trusted communication. We look at the issue of security and reliable communication with respect to the mobility of the node in the sensor network using the trust evaluation.
Trust modeling represents the trustworthiness of each node in the opinion of another node, thus each node associates a trust value with every other node [2], and based on that trust value a risk value required from the node to finish a task can be calculated. As illustrated in Fig. 3, node X might believe that node Y will fulfill 40% of the promises made, while node Z might believe that node Y will fulfill 50% of the promises made.

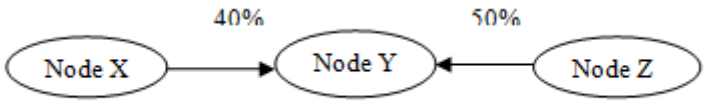

Fig. 3. A simple trust map.

4. Dissertation Work

The main goal of our proposed algorithm is to build a routing tree with the shortest paths that connect all source nodes to the sink while maximizing data aggregation using the trust values. 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 towards 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.

4.1 Proposed Algorithm

Algorithm

1: Hop tree construction

2: Cluster formation and cluster head selection

3: Every collaborator node Calculate trust values with its immediate neighbors with which it had communication using eq.(1) andeq. (2)

4: Every collaborator node selects path by calculating node weight.

5: During routing every collaborator node selects next node ni towards sink having maximum $ni,+1,w$ value.

4.2 Mathematical Model Design

Let N be the number of wireless sensor nodes. ni be the one sensor node Where i = {1, 2, 3, 4 …N} The trust between node $ni,i+1$ in time t is given by

$$T_{i,i+1,t} = (S_{i,i+1,t} - F_{i,i+1,t})/Sum_{i,i+1,t} \quad (1)$$

Where,
$S_{i,i+1}$ = success dealing time
$F_{i,i+1}$= False dealing time
$Sum_{i,i+1}$= sum dealing time

After introducing the punishment factor the expression of direct trust values

$$T_{i,i+1}\alpha\, T_{t-1,i,i+1} + (1-\alpha)\frac{S_{i,i+1}-F_{i,i+1}}{Sum_{i,i+1}} + \sum f(m) * \beta \quad (2)$$

where $f(m) = \begin{cases} -1 & \text{False dealing for m times} \\ 0 & \text{success dealing for m times} \end{cases}$

Here formulate the problem as route the packet to sink via route having maximum trust.

5. Results

5.1 Dataset

Following are the simulation parameters used as input to generate result.

Table1. Simulation Parameter

Simulation Parameter	Value
No of nodes	100-200
Sink node	1
Communication radius	20-40m
Control packet size	200 bits
Data packet size	4000 bits
Data generating	1pkt/min rate

5.2 Performance Evaluation

The following metrics were used for the performance evaluation:

- Data packet delivery rate: Number of packets that reach the sink node. This metric indicates the quality of therouting tree built by the algorithms, lower the packet delivery rate, greater the aggregation rate of the built tree.
- Control packet overhead: Number of control messages used to build the routing tree including the overhead toboth create the clusters and set up all the routing parameters for each algorithm.
- Efficiency: Packets per processed data. It is the rate between the total packets transmitted (data and control packets) and the number of data received by the sink.
- Routing tree cost: Total number of edges in the routing tree structure built by the algorithm.
- Loss of aggregated data: Number of aggregated data packets lost during the routing. In this metric, if a packet contains X aggregated packets and if this packet is lost, it is accounted that the loss of X packets.
- Number of transmissions: Sum of control overhead and data transmissions, i.e., the total packets transmitted.

6. Conclusion

Aggregation routing algorithms play an important role in event based WSN. Node aggregation strategy that eliminates data duplication in wireless sensor networks. The trust system works on the assumption that a majority of nodes in neighborhoods are reliable. This aggregation is done using tree and cluster based node formation structure. These node structures are then used to route packets to sink in efficient manner. In-network aggregation increases the lifetime of the network.

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