Modified Rumor Routing for Wireless Sensor Networks

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Abstract

Due to the limited processing power, and finite power available to each sensor node, regular ad-hoc routing techniques cannot be directly applied to sensor networks domain. Thus, energy-efficient routing algorithms suitable to the inherent characteristics of these types of networks are needed. However highly efficient data centric model of routing will improve the longevity of the network. This paper describes a mechanism of improvisation through simulation of existing feature of Rumor routing. The improvised rumor routing algorithm handles node failures and allows for tradeoffs between setup overhead and delivery reliability.

Keywords: *Rumor routing, flooding algorithm, spanning trees, PROWLER*

1. Introduction

Rumor routing [1] allows the routing of queries to nodes that have observed an event of interest. As a result, retrieval of data is based on events and not on an addressing scheme. An event is an activity related to the phenomena being sensed (e.g. increased movement in an area being monitored). In this paper, events are assumed to be localized phenomena which occur in fixed regions of space. A query is issued by the sink node for one of two reasons, as an order to collect more data, or as a request for information. Once a query arrives at its destination, data is issued to the originator of the query. Depending on the amount of data (whether it is more or less) being issued to the originator of the query, shorter paths from the source to the sink are discovered. If flooding was to happen on a regular basis, network resources would be consumed quickly, thus Rumor routing was created to be an alternative to flooding queries and events. When a query is generated, it is sent randomly through the network until it finds the event path instead of flooding it. When the query finds the event path, it is routed directly to the event. Only if the path cannot be found, it is flooded as a last resort. Rumor routing can achieve a high delivery rate as will be shown in the performance study.

Rumor routing uses agents, which have a limited life determined by a TTL field; these agents create paths in the direction of any events they may come across. If an agent crosses a path to an event that it has not yet come across in the network, it creates a path that leads to both events.

An event is an abstraction, identifying anything from a set of sensor readings, to the node's processing capabilities. For the purpose of the simulation studies in this paper, events are assumed to be localized phenomenon, occurring in a fixed region of space. This assumption will hold for a wide variety of sensor net applications, since many external events are localized themselves. A query can be a request for information, or orders to collect more data. Once the query arrives at its destination, data can begin to flow back to the query's originator. If the amount of returning data is significant, it makes sense to invest in discovering short paths from the source to the sink. methods such as directed diffusion [2] resort to flooding the query throughout the entire network [4], in order to discover the best path.

If geographic information is available, the best path is the greedy shortest path, and does not require flooding [3][5].

2. Related Work

Here is a list of various protocols for WSN and they have been developed in the view of overcoming the draw backs of the traditional protocols.

 SPIN [6][7] : Sensor Protocols for Information

via Negotiation.
 DD[2].: Directed Diffusion
 RR[1].: Rumor Routing
 GBR [8]: Gradient Based Routing.
 CADR [9]: Constrained Anisotropic Diffusion Routing.
 COUGAR [10]
 ACQUIRE [11]: ACtive QUery forwarding In sensoR nEtworks.
 LEACH [12]: Low Energy Adaptive Clustering Hierarchy.
 TEEN & APTEEN [13] :[Adaptive] Threshold sensitive Energy Efficient sensor Network.
 PEGASIS [14] : The Power-Efficient GAthering in Sensor Information Systems [27].
 VGA [21]:Virtual Grid Architecture Routing .
 SOP [15] : Self Organizing Protocol
 GAF [16]: Geographic Adaptive Fidelity.
 SPAN[17]
 GEAR[18]: Geographical and Energy Aware Routing
 SAR [19] : Sequential Assignment Routing.
 SPEED [20] :A real time routing protocol.
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It can be seen that Rumor Routing is a compromise between flooding event and flooding queries notifications. The idea is to create paths leading to each event; whereas event flooding creates a network-wide gradient field [8]. In this way, when a query is generated it can be sent on a random walk until it finds the event path; instead of flooding it throughout the network .As soon as the query discovers the event path, it can be routed directly to the event. If the path cannot be found, the application can try re-submitting the query, or as a last resort, flooding it. Under a wide range of conditions, it is possible to achieve an extremely high delivery rate [1].

3. The Algorithm Overview

The network is modeled as a set of densely distributed wireless sensor nodes, with relatively short but symmetric radio ranges. These nodes record unique events, and the application needs to be able to route queries to a node that has recorded a particular event.

A heuristic view of the rumor routing algorithm is described below:

• A 2*2 matrix is used by the nodes to maintain a list of the distances with their neighbors, as well as an events table, with forwarding information to all the events it knows. The neighbor list can be actively created and maintained as and when required. All diagonal elements are set to zero representing the distance of a node with itself.

• The nodes in an event are realized and the event path along with the length of the event path is determined and stored elsewhere. As and when a node witnesses an event, it adds it to its event table, with a distance of zero to the event.

• The number of each node constituting the event is stored in a suitable array for the agent to verify if the node encountered is an event node during query transmission.

• Any node may generate a query, which should be routed to a particular event. If the node has a route to the event, it will transmit the query. If it does not, it will forward the query in a random direction. The forwarding is done along a minimum spanning graph using a suitable algorithm, until the agent encounters an event node. As soon as the event node is encountered the remaining length of the event path is added. This continues until the query TTL (**Lq**) expires, or until the query reaches a node that has observed the target event.

• If the node that originated the query determines that the query did not reach a destination, it can try retransmitting, give up, or flood the query. Retransmission is a risk, but the chance of delivery is exponential with the number of transmissions. Hopefully only a very small percentage of queries would have to be flooded.

4. The Simulation Details

PROWLER - Probabilistic Wireless Network Simulator V1.25 was used for simulation with a test bed of 100 sensors placed in a matrix of 10X10 sq units, here the Spanning tree formation is based on randomly distributed network. The list of assumptions made while running the simulation on PROWLER-V1.25 :

1. Each node has the following fields in the routing table
   xID: The identifier of the neighbor.
   InLink: Quality of the directed link (*xID* → *ID*)
   OutLink: Quality of the directed link (*ID* → x*ID*)
   Hop: the hop-number of mote *xID*
   Note: Each node is assigned with unique ID, hop number (initially NaN except the root node where its zero)
2. Each node wakes up periodically and transmits its *ID*, hop number, and table data .Upon receipt of message from node i ,node j updates its own table
   • Updates the *InLink* property of *i*.
   • Updates the *Hop* property of *i*.
   • Updates the *OutLink* property of *i*, if the received table contains information about *j* (the *InLink* value is used).
3. Each nodes transmits the table data with certain finite probability. The transmission probability is the

function of design parameter and the content of the table.

1. Initially $p=P/8$.
2. For all the nodes with a hop-number *NaN*, $p=P/8$.
3. If the hop-number of the node changes, p is set to P.
4. If a mote j receives a message from node i, indicating that i has no information about j, but j has a good *InLink* property of i, then node j sets $p= P$
5. After each transmitted message $p=p/2$.

Using the above considerations the spanning tree algorithm was run on the test bed, the following are the performance graphs obtained:

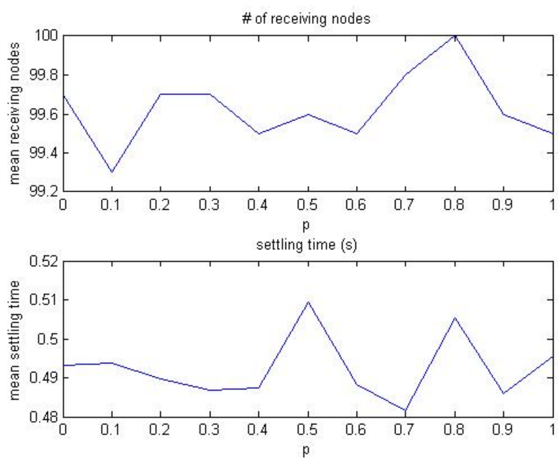

Fig 1: Performance graph for Spanning Tree Algorithm

Using the same considerations as above the flooding algorithm was simulated and the performance graph was as obtained:

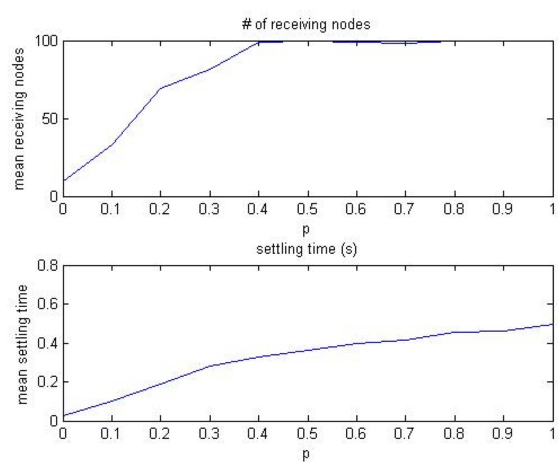

Fig 2: Performance graph for Flooding Algorithm

From the above two cases the interpretation can be made as in case of spanning tree algorithm the percentage of receiving nodes are less as compared to the flooding algorithm with respect to transmission probability. The settling time increases when the transmission probability is increased for flooding algorithm but the variation of settling time is seen for spanning tree algorithm. This condition indicates high congestion probability and power expense in flooding algorithm than spanning tree algorithm.

4. Conclusions

It may be safely concluded that the spanning tree protocol can be used for event –query information dissemination throughout the static network more efficiently than the existing flooding algorithm. Only problem with spanning tree is that the nodes farther from the root node cannot be linked to the closest nodes due to the additional constraints.

4. Scope for Future Work

The simulator PROWLER V1.5 used here never accounted for the battery model used for this WSN. Hence to obtain more detailed analysis NS-2 should be used.

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