

Research Progress of Wireless Sensor Network Router Protocol

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Abstract: This paper reviewed some recent novel theories and algorithms of geographic routing for wireless sensor networks, and described the taxonomy. And discussed several typical next2hop node policies, presented the disadvantages of them. More specifically, captured the local minimum problem and gave the solutions to it in detail. In the end, pointed out the open research issues in this field.

1. Introduction

Wireless sensor network is a network composed of a large number of nodes that have functions of information collection, data processing and wireless communication through wireless communication. It aims to collaboratively perceive, collect, and process information about the perceived objects in the network coverage area, so that the observer knows when and where to happen. In wireless sensor networks, many applications need geographical location information. For example, in a large area of interest in environmental detection need to know the location of the incident; forest fire disaster monitoring, need to know the fire area; in the military battlefield situation monitoring, not only to understand battlefield events or not, but also to know the events in the region, in order to quickly take effective action.

The information that is perceived in wireless sensor networks is regional. Geographic location information service plays a very important role. At the same time, as the basis of route selection, geographic location information has a strong guidance to the forwarding of data. The routing protocol of wireless sensor network is responsible for finding a transmission path, and forwarding the data packets from the data source nodes to the target nodes through the network multihop.

A lot of work has been done in this field at home and abroad, and some achievements have been achieved, and some agreements have been put forward in succession. Most of these protocols are to determine the route and store the routing table by obtaining the connection and link characteristics between nodes in the network through the route detection package. The end-to-end routing based on link state is often interrupted due to the failure or mobility of one or several nodes in routing, and routing maintenance is needed. It does not adapt to the situation of fast dynamic changes in the network topology.

Hierarchical routing strategy is a combination of local preactive routing and global reactive routing, in order to achieve the purpose of improving data transmission efficiency and network scalability. However, despite the above two routing mechanisms, it still needs to maintain the end-to-end routing information that is being used, and the network dynamic changes that it can bear is limited. The routing protocol based on geographic location information can solve the above problems well. With the development of positioning technology, the node can easily obtain the geographic information of its own, adjacent nodes and target nodes. Nodes use these location information to avoid blind flooding of routing packets, effective routing, discovery and routing maintenance, or even based on stateless distributed non end to end data forwarding. One of them is geographically.

2. Location Aided Routing Protocol

The difference between location aided routing algorithm with DSDV, AODV and DSR that the

routing request packet transmission without the need for comprehensive flooding, but the geographical position information under the guidance of a limited regional flooding, enhanced target route discovery, reduce a lot of useless packet transmission is improved the routing request packet flooding protocol based on network.

The typical algorithm is Lar. In this algorithm, the source node S obtains the location of at t_0 time location $(L: (X_d, Y_d))$ and average mobile speed V by location service, so it can estimate the area of appearing at T_1 time. The region is a circle with a $X_d (Y_d)$ as the center and a radius of $r = v(t_1 - t_0)$, which is called the expected domain. According to the expected domain, the routing search can be restricted within a certain area, which is called the search domain.

Only the nodes in the search domain transmit the routing request packet, thus reducing the overhead of routing. If the appropriate path is not found in the prescribed time, S expands the search for domain resend routing request packets. With the expansion of the search domain, the possibility of routing discovery is increased correspondingly. When the search domain is extended to the whole network, a general flood algorithm is made. The key of the algorithm is to find the limit of the domain. Too small search domains will reduce the probability of routing discovery success, and there will be no routing. Too large search domain will lead to excessive control overhead. In literature, two methods to limit the search domain are given.

Method for domain 1 is determined by the rectangular source node S and a desired area, as shown. The source node S to the destination node of the distance is $dist_s$. The node I is included in the search domain in route discovery. The protocol reduces the nodes that participate in routing request packet forwarding, but is still an end to end routing based on link state, which is not suitable for fast network topology dynamic change network.

3. Routing Protocol Based on Location Information

Location information based protocol nodes do not need to find routing before sending data, do not need to save routing tables, and nodes directly formulate data forwarding strategies according to their location information of neighboring nodes and target nodes. According to the different forwarding strategies, they can be divided into three types: greedy routing, directional flood routing and hierarchical routing. In the first two kinds of routing protocols, the source node will send a data packet (greedy routing) or more (directional flooding) neighbor distance closer to the target node; hierarchical network structure, different levels of network using different routing protocols, at some level by forwarding need position information support.

4. Directional Flooding Area

In the directional flood routing protocol, the node will forward data packets to all adjacent nodes in the direction of the target node. The algorithm has good robustness, but it will increase the network load. Dream is a typical directional area flooding routing protocol. In the protocol, the source node and each intermediate node calculate the direction of their own to the target node respectively. The expected domain can be determined by the mobile information based on the target node, which is the same as that of Lar. A range of angles can be determined from the expected domain, called the forwarding domain. The intermediate nodes forward the data packets to all the one hop nodes in the forwarding domain until the data packet is successfully submitted to the target node.

The key of the algorithm is the determination of forwarding domain: from S to two tangent lines in the expected area, the area between the two tangents, the angle $[v - \alpha \text{ and } v + \alpha]$ is the determined forwarding domain. The Dream algorithm can guarantee the acyclic routing, and it has good robustness.

Each data packet forwarding is sent to multiple nodes in the direction of the destination node, which is similar to providing multiple paths to the target node. The discarding of a link group will not affect the grouping on other links. Relative to the location aided routing algorithm, Dream algorithm to control the packet only location update packets and Ack packets, carry less information,

the node moving speed and cycle based location update packet released determine the number and range of control packets are further optimized. However, although the flooding scope of the target node is limited, the data packet flooding in the forwarding area will consume a lot of energy in the network with large number of nodes and large data volume.

5. Greedy Routing Algorithm

This kind of algorithm only needs the location information of the node, all adjacent nodes and the target nodes, and it is only a small amount of storage algorithm. The source node passes the data to the nearest neighbor node, which is closer to the target node, and then goes down to the target node. For the intermediate node S , there are usually a number of adjacent nodes closer to the target node. These adjacent nodes, which are closer to the target node, are called $N(S)$.

Based on the selection of the next hop node in $N(S)$ based on different metrics, the greedy algorithm has different performance. At present, mainly put forward the next hop node selection strategy has the following four types: a Mostnea2resttodestination) is from $N(S)$ in the selection of the distance. The nearest node, such as graph nodes in B5, so as to reach the target node of the least hops, reduces the time delay in the node for queuing, processing and the.

If the signal energy is large enough, the larger the radius of the one hop transmission range will be. But the greater the radius, the greater the possibility that the nodes interfere with each other, and the greater the energy consumption. Because the selected node is on the edge of the communication, its movement is very easy to cause the routing interruption. In response to this problem, the literature proposed another mechanism, namely, mostnearestwith2inradius.

Under this mechanism, node S chooses the nearest neighbor node from $N(S)$ as the next hop node, such as node, thus reducing the possibility of mutual interference between nodes. The disadvantage of this algorithm is that the nodes, which are very close to the middle node S , are often selected to increase the number of hops to the target nodes.

Although it reduces the energy consumption of communication, it greatly increases the number of hops of communication. The advantages of greedy routing algorithm. No maintenance of link state information of the global network, each node only needs to know the location information of neighbor node; every forwarding is local decisions can be fully distributed stateless non end-to-end data forwarding; do not need to store routing information table, also do not need to send routing updates, only requires accurate to store state information to neighbor node, not only saves energy consumption, but also reduces the node's memory, processing data transmission requirements; provide good guarantee, good network scalability and robustness.

6. Hierarchical Routing Algorithm

Hierarchical routing can reduce the complexity of node processing events in the grid, which has good scalability and is suitable for large-scale networks. A typical hierarchical routing algorithm based on location information has terminal routing and grid routing, and these two algorithms are based on two layer routing.

One layer uses a routing protocol based on location information. Terminal routing is a combination of two routing algorithms, TLR (terminode local routing) and TRR (termi2noderemoterouting). TLR uses distance vector information to determine routing and forwarding data packets, but the range (hop) of packet forwarding is limited, and its upper limit is called the local radius. All nodes of the distance node S whose hops are not greater than the local radius are the TLR reachable nodes of the S . For nodes that are not reachable by TLR algorithm, TRR algorithm is used to forward data packets.

TRR is similar to the source routing protocol, and the source node gives a routing estimate to the target node. It is marked by a series of anchor, carrying a list of anchor in each of the data packets sent by the source node in Baotou. The data packets will be transmitted along the path of the anchor flag.

Routing loops can be avoided by combining TRR and TLR. The success rate and routing

overhead of the packet delivery are improved in comparison with the DSR protocol. Each node only relies on the information of this node or a few other nodes in forwarding data packets, so the protocol has a good scalability. 21312 grid routing in grid, the network coverage area is divided into small square regions, each region is called a grid. In each grid, a node is selected as the head of the group of all nodes of the grid (leader), which is responsible for forwarding data packets. In each grid, the node runs the group first selection protocol to maintain the group head of the grid. In the past, all routing protocols are hop by hop look up routing, and the grid protocol adopts a grid by grid look up route. It uses a search domain similar to LAR to narrow the routing search range for routing. Only the group head of the grid can forward the routing request packet.

The forwarding data packet does not use the node ID flag node, but uses the grid ID. The selection of the head of the grid group is dynamic. When the original group head leaves the grid, the new head of the group will be selected to maintain the routing. Relative to DSR, AODV, LAR and other protocols, there is a node failure or mobility in the route determined, so the whole route interruption is different. Other nodes in a grid can be used as backup nodes. As long as there are nodes in the grid, the routing of the grid will not be interrupted by the failure and movement of a single node. The algorithm increases the routing survival time, which makes the routing less sensitive to the movement of nodes, and reduces the control overhead of routing maintenance.

7. Problems to be Solved and in-depth Study

The routing protocol based on location information is better than previous link link protocol in scalability, adaptability to dynamic topology and energy saving, and has broad application prospects. However, further attention and research are still needed for routing protocols using geographic location information.

The positioning accuracy of the agreement of the performance of two present position information obtaining method used is GPS and the signal intensity estimation of relative coordinates. The node can get its own location information by GPS receiver, but it has a certain error, usually around 15m. The range of node hop communication in the network is usually tens to one hundred or two hundred meters, so large position error will seriously affect the correctness of the routing algorithm. Similarly, in wireless environment, signals are affected by attenuation and noise interference. The use of signal intensity to estimate the relative coordinates of nodes is greatly restricted in practical applications.

Therefore, it is necessary to analyze the effect of position error on the performance of the protocol, and improve the protocol to better adapt to the error environment. Effect of beacon exchange frequency to maintain state information of neighbor nodes and the control overhead is commonly used for transmitting the beacon periodically to maintain state information of neighboring nodes.

This method is effective for the topology stable network, but this method can not respond to the dynamically changing network timely and accurately. In order to apply location information based routing protocol in active sensor networks with mobile nodes, the frequency of beacon switching should be related to the mobility of nodes, the distance from neighboring nodes and the dynamic change of state information. How to accurately reflect the state information of the adjacent nodes in the case of minimizing the control overhead remains to be further studied.

How to make the next hop node to choose the best strategy the next hop node selection strategy deficiencies in the greedy routing algorithm. Considering reducing the number of hops to reduce the time delay, it does not consider saving energy. On the contrary, considering energy saving, it greatly sacrifices data transmission delay. At the same time, energy consumption is also not considered for equalization.

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