Advances in Engineering Research, volume 197
Proceedings of the 2020 9th International Conference on Applied Science, Engineering and Technology (ICASET 2020)

Research on Energy-Saving Optimization of Improved DV-Hop Localization Algorithm in Wireless Sensor Networks

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ABSTRACT
Based on the existing wireless sensor network DV-Hop algorithm and its improvement ideas, inheriting the advantages of various thinking algorithms, and combining with the low energy consumption requirements of wireless sensor networks, this paper proposes an energy-saving and high-precision DV-Hop positioning method, and the corresponding simulation experiment has be carried out. The experimental results show that under the experimental scenario, when the proportion of anchor nodes is 10%, the number of flooding packages is reduced by more than 80%. If the connectivity is above 15, the saving rate is basically maintained at more than 90%. In the case of different anchor node ratios and network connectivity at 10, the number of flooding packets can still be reduced by more than 10%. Therefore, the improved DV-Hop algorithm has better energy efficiency than the classical DV-Hop algorithm, achieving the purpose of energy saving.
Keywords: *WSN, DV-Hop, Energy-saving Optimization.*

1. INTRODUCTION

Wireless sensor network is a new type of information acquisition and processing system combining technologies such as wireless communications, sensing, embedded computing, and distributed information processing [1]. The wireless sensor node structure includes a power supply module, a sensor sensing module, a processor processing data module, and a wireless communication module. The wireless communication module includes four operating states: a sending state, a receiving state, an idle state, and a sleep state. Reference 2 points out that the wireless communication module consumes more than 80% of the energy of the node, in which the sending state consumes the most. Node to send information takes more energy than the node to perform the calculation [3]. Since communication is the main part of energy consumption, reducing the amount of traffic in the node can effectively reduce the energy consumption of the node. Therefore, this paper mainly analyses the energy consumption of nodes in communication.

2. PROBLEMS WITH THE EXISTING IMPROVED DV-HOP ALGORITHM

The positioning of wireless sensor networks mainly uses DV-Hop algorithm, but its positioning accuracy is low. Many scholars have proposed an improved positioning algorithm for wireless sensor networks, which has effectively improved the positioning accuracy while increasing the node's energy consumption. Most of the ideas for improvement are to reduce the error of the hop distance between nodes at the expense of the node's traffic and calculations, thereby improving the positioning accuracy. A small part of improved ideas such as updating anchor nodes and recirculating algorithms have greatly aggravated the node communication overhead [4][5].

3. IMPROVED ENERGY-SAVING AND HIGH ACCURACY DV-HOP LOCALIZATION ALGORITHM

For DV-Hop algorithm shortcomings, this paper mainly discusses how to minimize the energy consumption of nodes and prolong the life of the nodes. The improved DV-Hop algorithm is divided into four stages including information broadcast stage, distance calculation stage, location computed stage and misbehavior nodes positioning stage.

The first stage: When the network is being initialized, all nodes acquire the neighbor node set of the neighboring nodes. After initialization is complete, information is used, all nodes obtain the hop count between the node and all the anchor nodes, the GPS coordinates of each anchor node through the controlled flooding broadcast, and all the last-hop node IDs in the shortest path to all anchors.

The second stage: Firstly, the shortest path table stage of selective correction is performed to correct the minimum hops that may be too large. Secondly, the anchor node uses the optimal unbiased estimation method to calculate the average hop distance of the entire network of the node and broadcast it to the network. While calculating the average hop distance at the anchor node, the unknown node calculates the hop distance of the anchor node with a minimum hop count of one hop in the shortest path table by using the degree of overlap of neighbor nodes. Thirdly, after the unknown node receives the average hopping distance broadcasted by each anchor node, to calculate the average hop distance of the optimal unbiased estimate for this node taking into account the entire network and local. Finally, to calculate the hop distance between this node and the non-single hop anchor node.

The third stage: to obtain more than three nodes with anchor node information, and use the anchor node to select the optimal strategy to select the appropriate anchor node group. Then the maximum likelihood estimation method is used for location computed.

The fourth stage: After the network location is completed, the unknown node that failed to self-locate sends a location request to its neighbor node, to obtain the coordinate information of the located unknown neighbor nodes, and to use the overlapping neighbor nodes to calculate the hop distance. When the acquired anchor node information is greater than three, to perform self-positioning.

flooding broadcast process for an anchor node by using Matlab. As shown in Figure 1.

Firstly, each anchor node maintains a flooding broadcast table of nodes, as shown in Table 1.

Among them, the node includes an anchor node and an unknown node. The initial value of the node hop count is infinite, indicating that the communication cannot be performed. If the table is a flooding node table of the anchor node i, the number of hop corresponding to the node with the number i is zero.

Secondly, the hops corresponding to the neighboring nodes of the anchor node i are assigned a value of 1, indicating that they are single-hop nodes of the anchor node. After that, to determine whether there are any infinite terms in the table, or nodes with updated hops. If true, then enter the loop. In the loop stage, to read the node number in the table whose hop count is hop. If the hop value of its neighboring node is infinite, it is assigned as hop+1, indicating that they are hop+1 hop nodes of the anchor node.

Table 1. Flooding broadcast table of nodes

Node Number	1	2	3	…	i	…	n
Node hops	hop_1	hop_2	hop_3	…	0	…	hop_n

4. SIMULATION EXPERIMENT ANALYSIS AND RESULTS

Simulation environment is MATLAB7.0.1, unless otherwise specified, the experiment in this chapter uses the following settings:

(1) Monitoring area: 1000 meters x 1000 meters; (2) Node communication radius (R): 200 meters;

(3) Total number of nodes: 200 ;(4) Anchor node ratio: 10%.

4.1. Node energy consumption model

Since MATLAB does not have a more intuitive node energy analysis model, the algorithm uses the flooding protocol to broadcast when it acquires anchor node information in the first stage and average hop distance in the second stage. Therefore, this paper uses the number of data packets transmitted by the network flooding broadcast to measure the communication overhead and energy consumption of the node from another perspective, and perform modeling analysis for the number of packets sent by the flooding protocol. The following is a modeling of a

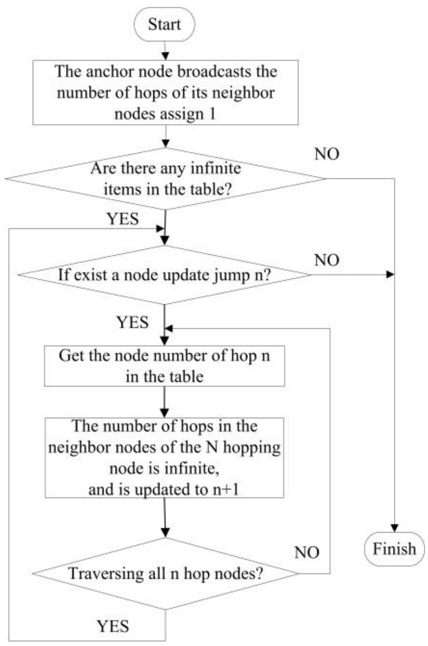


Figure 1 Flow chart of flooding process

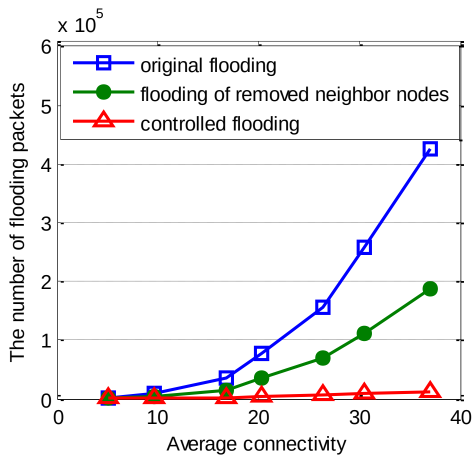
4.2. Experimental results

In the case of an anchor node ratio of 10% and different network connectivity, the original flooding broadcast, the flood mode of common neighbor nodes only removing the sending nodes, and number of broadcast packets in flooding mode of simultaneously removing the off and tem-off forwarding nodes, as shown in Figure 2(a); The corresponding percentage of packets saved, as shown in Figure 2(b).

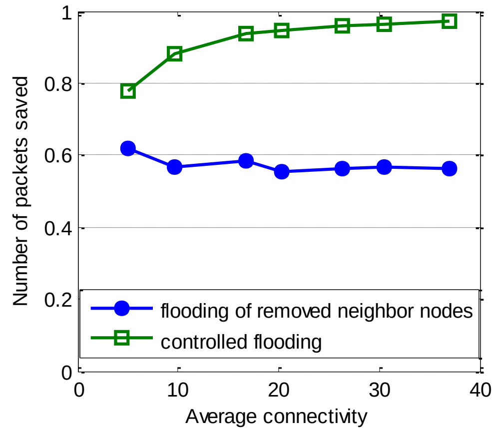
From Figure 2, it can be seen that during the flooding stage, if the forwarding node merely does not broadcast information to the sending node and neighboring nodes, the number of flooding packets will be reduced by 55%-60% immediately. When using the controllable flooding protocol of this paper, the number of flooding packets is reduced by more than 80%.When the degree of connectivity is 15 or more, the percentage of savings is maintained at more than 90%.

In the case of a network connectivity of 10 and a proportion of different anchor nodes, the number of broadcast packets in the three flooding modes, as shown in Figure 3(a). The corresponding percentage of saved packets, as shown in Figure 3(b).

From Figure 3, it can be seen that the traffic reduced by controlled flooding is not affected by the proportion of anchor nodes. When the reply process is added to ensure the reliability of the flooding broadcast, the number of response packets is about the number of sending packets, and slightly less than the number of sending packets. Even though the number of response packets and data packets is the same, since the content of the response packet is only a simple signal and its data length is very short, the energy required to transmit the information in the reply process is still lower than the energy required to transmit the data packet. Even if the energy used to transmit the response packet and data packet is the same, the controlled flooding studied in this paper can still reduce the number of communication packets by more than 10%.

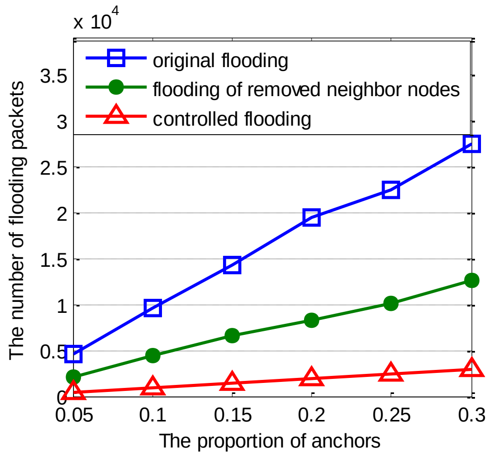


(a)

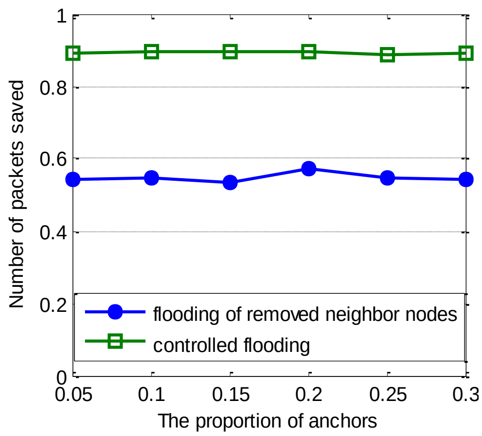


(b)

Figure 2 Traffic Comparison



(a)



(b)

Figure 3 Traffic Comparison

5. CONCLUSIONS

After analyzing the DV-Hop algorithm and its improvement ideas, this paper proposes an improved energy-saving high-accuracy DV-Hop positioning algorithm. To reduce information implosion through improved controlled flood broadcasting; To introduce joint probability density calculation method to modify the number of hops for packet broadcasting; To add a useful package flag to the packet to avoid loss of valid data; To select the optimal strategy according to the anchor node, use the maximum likelihood method to construct linear equations and correct the boundary of the positioning results; To increase the bad node positioning stage. The experimental results show that the improved algorithm has better energy efficiency than the classical DV-Hop algorithm and can achieve the effect of energy saving.

ACKNOWLEDGMENTS

This work was supported by the 2020 Guangxi Colleges and Universities Young and Middle-aged Teachers' Basic Ability Enhancement Program(Grants No. 2020KY80006).

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