WSN Node Localization Algorithm Based On Range Free Localization

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Abstract. Wireless sensor network target tracking node selection has a significant impact on the life cycle of wireless sensor networks, therefore this paper proposes a tracking node selection algorithm with tracking quality assurance. First, analyzes three elements wich have impact on residual energy of node lifetime , energy consumption of target tracking task execution and possibility of node sends false alarms. Secondly, put forward the node selection problem of optimizing the network lifetime under the premise of ensuring tracking quality requirements, and gives two kinds of node selection algorithm. Finally, study the establishment and maintenance of dynamic tracking sub-tree to support the proposed node selection algorithm. So far, this is the first research work which considers the target tracking of maximum network lifetime.

Introduction

In the process of deploying sensor networks, the problem that when to activate the sensor node in order to obtain valuable information from the network and the minimal energy consumption of the sensor node has attracted wide attention and made a variety of algorithms. However, these methods often assume that the sensor nodes are better able to complete observation of its task sensing area, cannot perceive things outside the region. This assumption cannot complete the task that through mutual collaboration of multiple noise sensors to find the place which has better predictive information for modeling.

In recent years, target tracking based on wireless sensor network has attracted wide attention, and made effective tracking method and proposed target tracking mechanism based on node selection, by predicting the regional emergence of target or setting node classification rules to select some node to track target. Zhao F and so on put forward information-driven target tracking method, which consider node communication resources and computing resource constraints, integrates sensor nodes' collected data and receives data information of the neighbors and selects some nodes to collaboratively finish target tracking tasks [1]. Brooks R and so on put forward a distributed target classification and tracking methods [2]. Under the method, the sensor network monitoring area is divided into a plurality of sub-areas, so that potential nodes around the target track cooperatively detect target appears. When concerned goals appear, tracking process will be activated. Li D and so on put forward target tracking mechanism based on cooperative signal processing [3]. The proposed tracking method wakes the nodes in four corners of monitoring position to monitor potential targets. Liu L and so on divides the whole tracking process into target monitoring and targeting [4]. In the target monitoring phase, using density control algorithm to select the appropriate subset of nodes to monitor objectives. In the targeting phase, proposing a node with minimum energy consumption to ensure node selection and targeting methods.

Network Topology

In order to achieve the target tracking process node selection strategy, this paper adopts network topology based on dynamic sub-tree. In this topology, the monitored target nodes form a dynamic tracking sub-tree. In order to save the energy consumption of the network, the structure may be combined with the energy management protocol.

When the target occurs within the monitoring area of the network, node i which monitors the target (node makes a decision that $d_i = 1$) calculates the value FA_i. If $FA_i \le \delta$, then the node i found the target packets DT-Packet within the broadcast network. DT-Packet consists of a $tuple\langle FA_i, l_i \rangle$, wherein l_i is the expected lifetime of the node, the fourth section will define l_i. When father node j receives DT-Packet from the child node i, it conduct the packet processing, and then forwarded it to the parent node. All radio and DT-Packet forwarding nodes form a dynamic tracking sub-tree.

Any node j, collection of child nodes in dynamic tracking sub-tree can be represented as

$$d_i = \{ i | FA_i \le \delta, i \le R_s, 1 \le i \le m \} \quad (1)$$

When father node receives its child node data, it performs a series of data processing operations. According to the received packet type, the father node's performed processing operation mainly includes two types: (1) choose child nodes to participate in tracking; (2) aggregate and forward data packets.

Definition 2 Discovered nodes

For any node i, if i can monitor goals, and meet the conditions $FA_i \le \delta$, we call that node i is found node.

Definition 3 Tracking node

Discovery node selected by the node selection algorithm to take part in target tracking is called a track node. After father node receives DT-Packet from children (found) node, then it calculates the number of received DT-Packet, if the received packet is greater than the number k (the minimum number of trace nodes, k is specified by the user or targeting algorithm needs), the father node will be prune the dynamic sub-tree's branches, namely through the execution node selection algorithm to select the candidate tracking node and unselected discovery nodes will be cut off. Otherwise, all discovered nodes as a candidate tracking node. Section B will give a specific node selection algorithm.

Father node gathers candidate tracking node information then forward to sink node, Sink node perform selection algorithm again on the candidate tracking node to determine the final tracking nodes. The selected nodes will monitor the tracking target node, and generates sensory data. Other non-tracking nodes leave the dynamic tracking sub-tree, these nodes can according to scheduling rules periodically fall into sleep mode to conserve energy. Father tracking node receives sensory data generated on the target, after gathering forwarded to Sink node, Sink node performs targeting algorithms. Most existing targeting algorithms can be applied to the proposed algorithm.

As the target moves, part of the track nodes will not be able to monitor the target node (at this time, said tracking node failure), while there will be a new non-target tracking node discover targets, so the dynamic sub-trees need to be periodically updated and maintained. This section focuses on the dynamic sub-tree maintenance issues about nodes join dynamic sub-tree and failure tracking nodes exit dynamic sub-tree.

(1) Node joins the dynamic tracking sub-tree.

With the tracking target moves, there will be a new node to monitor the target, these nodes will broadcast DT-Packet, applied to join the dynamic sub-tree.

The specific process is as follows: Any non-tracking node i which monitors the target, if $FA_i \le \delta$, node i broadcasts DT-Packet. When the time interval is fixed, if the node receives a confirmation message from the father, i will join the dynamic tracking sub-tree. Otherwise, the node i will maintain the original scheduling mode.

Father node j receives DT-Packet from the child node i, it makes a decision on whether node i can be added to dynamical tracking sub-tree: If there is a node which wants to leave tracking dynamic sub-tree in a branch of the tree, or know that there are information of recruiting new tracking node, then it will send confirmation to the node i about allowing it to join the dynamic tracking sub-tree.

(2) Father node exits dynamical sub-tree. For any tracking node i, when the target shifts in its perception range, i will send out requests about exiting sub-tree to the father node. When father node receives a request message, it updates the dynamic sub-tree node information within the track, while broadcast information to recruit new tracking node.

Selection algorithm based on greedy heuristic (G-TQANS) adopt well-known greedy strategy to incrementally choose track nodes from the collection of discovery nodes. In order to use greedy strategy, we define a revenue function g. G-TQANS each time selects nodes which can maximize the revenue function g. Given found node set $N=\{n_1,n_2,...,n|N|\}$, the problem solved by the present section, the node n_i revenue function g is defined as follows

$g(n_i)=l_i$ (2)

According to equation (10) defined by greedy rules, the paper designs a greedy heuristic algorithm based on G-TQANS, as shown in Algorithm 1. During initialization, determine the set N of found nodes , and set the initial value of $|N|$ element vector $(y_1,y_2,...y|N|)$ as 0 (statements 1-3). Next, the algorithm selects the current optimal node n_i and make its corresponding value y_i as 1 (statements 5-8). Thereafter, the algorithm enters a loop process, each time it selects from the remaining node set a node n_j which can maximize the revenue function g , and set its corresponding value y_j as 1 (statement 9 to 16). When the full condition (2) and (3) are met, out of the loop, then the algorithm ends. The node whose corresponding y_i is 1 in vector $(y_1,y_2,...y|N|)$ the tracking node. It takes time O (1) to calculate $g(n_i)$, so the whole algorithm's time complexity is $o(|N|\log|N|)$.

Algorithm 1 G-TQANS algorithm

Input: Found nodes N , FA_T

Output: Satisfy FA_i the $l_{network}$ threshold condition and make largest $|N|$ Element vector $(y_1,y_2,...y|N|)$

1) FOR ($i=1$ to k) DO

2) $y_i=0$

3) END FOR

4) $FA_{\max}=0$

5) $y_i=1$

6) $N=N-\{n_i\}$

7) $FA_{\max}+N=FA_i$

8) WHILE $\left(\sum_{i\in w} FA_i \; and |N| \succ 0\right)$ DO

9) Select N from the $g(g_i)$, n_j maximum value node

10) $y_i=1$

11) $FA_{\max}+=FA_i$

12) END IF

13) $N=N-\{n_i\}$

14) END WHILE

15) Output $|N|$ Element vector $(y_1,y_2,...y|N|)$

Figures 1 and 2 show experimental results of the proposed target tracking algorithm for linear motion tracking when the number of selecting track nodes is 3 and 4,and the number of nodes in the network is respectively 1200,1600,2500 and 3000 . We can see from the figure, with the increase in the number of sensor nodes, network lifetime significantly increased. This is because the increase in the number of nodes in the network makes the network density increases, algorithm has more choices in selecting tracking node. It is more conducive to reducing average energy consumption of nodes. The proposed algorithm is designed to ensure balanced energy within the network nodes. When the network density increases, the number of discovered nodes increase, the average number of each node be selected to be trace nodes reduces, each node’s average energy consumption reduces, resulting in increase in the lifetime of each node. The lifetime of the network is decided by the node with the shortest lifetime, the overall increase of the node will inevitably lead to increases of lifetime of the network.

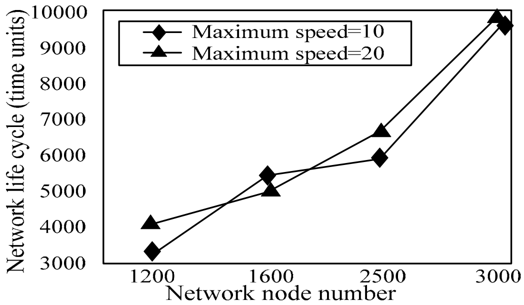

Fig1. Target as linear motion, the number of tracking nodes=3, the impact of the number of nodes in the network on the network life cycle

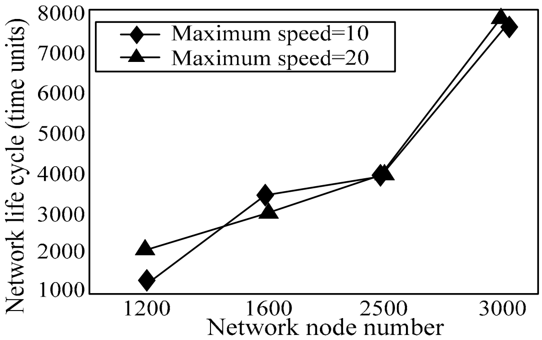

Fig2. Goals as linear motion, the number of tracking nodes = 4, the impact of the number of nodes in the network on the network life cycle

Conclusion

In this paper, we research the node selection algorithm which with tracking quality assurance in target tracking application, considering the perception data error and the impact of energy consumption of nodes on tracking quality and node lifetime, and study network lifetime maximization problem on the premise of assured tracking quality, and puts forward valid node selection algorithm.

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