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Analysis on Node Selection and Algorithm of Target Tracking in Wireless Sensor Networks

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Abstract: In all areas of wireless sensors, target tracking technologies have been widely used, wireless sensors node can collaborate and monitor one or more mobile target, at the same time transmit perception data to the sink node, thus making process and decision making. This paper makes a systematic analysis on the node selection in wireless sensor networks for target tracking, and propose the corresponding node algorithm, this algorithm is proposed to optimize the lifetime of the network to provide a reliable guarantee. As the basis for setting the node survival function, enabling users to gradually increase the reliability of target tracking, so as to maximize the lifetime of network on node target tracking. *Copyright © 2013 IFSA.*

Keywords: Wireless sensor, Target tracking in network, Node selection algorithm analysis.

1. Introduction

Mobile target tracking is one of the most important at this stage in the application of wireless sensor network, and has been applied in the intelligent traffic, disaster prediction and field monitoring and other fields on the basis of sensor networks. In these application fields, in order to locate the object accurately and real-time monitoring of mobile for each position, the monitoring region must completely cover the target tracking network. Data error sensing can significantly improve the quality of research application and the difficulty of target tracking. Although gradually improving, node applications reliable perception data in the target tracking process can realize the positioning and tracking reliability and accuracy but, because the energy consumption of the nodes are all wireless sensor differences, therefore, how the network lifetime optimization and improve the tracking quality, choose the most suitable for target tracking node it is a challenging problem of higher. On the one hand, wireless sensing area of a sensor node is limited, can only perceive the mobile target nearby wireless sensor nodes, and the track of mobile target and scope of randomness, in general, higher rate of emergence of node energy consumption of large wireless sensor node sensing range. On the other hand, wireless sensor nodes with specific communication range, node and sink distance smaller, due to the remote node forwarding data, and has large energy consumption, this will cause the energy consumption of wireless sensor nodes are not balanced, the energy consumption of nodes will have a direct impact on wireless sensor network lifetime, therefore, the effectiveness of target tracking algorithm will be also affected by the network nodes energy consumption balance and tracking of factors such as quality assurance.

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2. Model Definition

2.1. Hypothesis of Network

Set up a wireless sensor includes a total of 'n' nodes and the node ID numbers from '1' to 'n', all nodes have the same perception, communication and computing capabilities. Wireless sensor node battery power source, and the computing power, communication bandwidth and energy have a certain limit, in order to improve the algorithm described in the simplicity, the author makes the following two assumptions:

First, assuming all the wireless sensor nodes have the same sensing range, and can be represented by 'R1', the radius of the disc area, all nodes in the wireless communication range of the sensor are identical, the maximum communication distance of 'R2'. Then 'R2' can be expressed as an integer multiple of 'R1' [1].

Second, set up a wireless sensor monitoring within the region, which these nodes evenly distributed, and each node can take advantage of GPS and other related positioning system, attain their own accurate position information [2].

The author of the entire wireless sensor nodes for routing tree posed a further additional and Sink node is located in the root of the tree routing tree, is the root node layer '0'. All wireless sensor nodes are able to store the total number of layers routing tree, the number of nodes and the father of the child node ID and other routing information [3].

2.2. Energy Model

Assume the initial wireless sensor nodes have the same energy, the 'C1' and 'C2' represent respectively receiving and sending node 'i', a packet generated by the energy consumption. the wireless sensor node communication reliability and so will the distance between the nodes 'C1' and 'C2'values a direct impact on the general case, when the wireless sensor nodes have the same frequency and power transmitting and receiving data. Then all nodes have the same value of the 'C1' and 'C2' [4]. In order to reduce communication wireless sensor nodes consume energy value, a message received for the position of known target node, the source node can be the operating frequency of the wireless components adjusted accordingly, so in node 'i' with the long-distance wireless sensor sends node data, 'C2' values are relatively large [5]. Meanwhile, the wireless sensor communication system energy consumption will be directly required for the communication of process reliability. High reliability requirements of the communication system. Then the node's power will be relatively large, and the value of 'C1' and 'C2' is larger. Because before communicating it, the wireless sensor nodes operating frequency and power has been clearly defined, so that all values of the wireless sensor nodes'C1' and 'C2' are also known . 'C3' represents the wireless sensor node i sensory data consumed energy value. This value will be directly affected by the signal properties and other factors [6].

2.3. The Model of Sensory Data Error

In the wireless sensor network monitoring range of tracking target, target tracking nearby wireless sensor nodes will appear sensing data because perception part by environmental and precision and other factors, perception data often appear different sizes error value, 'S' represents wireless sensor node 'i' collected perception data, wireless sensor nodes 'i' actually get the perception data is 'O' [7]:

$$O\begin{cases}\varepsilon+S,(a)\\ \varepsilon,(b)\end{cases}, \tag{1}$$

where (a) presents the distance R between nodes i and the tracking object, (b) presents other distance.

In the Formula, ε means that sensory data error value, the paper described sensory data error value by Gaussian distribution method. That is $\varepsilon\sim(0,\ \sigma)$, the primary data source of σ is come from the historical reference values [8].

Sensing data threshold 'T' is known, if 'T' is less than σ , then the node 'i' monitoring proved to track the target, sensing node 'i' is within the scope of the tracking target. Node 'i' to the destination decision not monitored as 'o', to the target node 'i' to monitor the decision is 1 [9]. Because the wireless sensor network node can be independent decision-making, and thus measured by the wireless sensor node 'i', 'B' can enter the following representation:

$$B\begin{cases}0,(o<T)\\ 1,(o\geq T)\end{cases}, \tag{2}$$

Sensing data as a certain degree of error, and the wireless sensor nodes wrong decision probability of the presence, for example, if node i is not present within the sensing target tracking, the decision result of node 'i' is 'B' is 1; if node 'i' is within sensing range there tracking target, the decision result of node 'i' is 'B' is 0. Under normal circumstances, people pay more attention to the former made an error decision risk, the main reason is that the data that appears in this case is usually involved in targeting process and its impact on accuracy. This article appeared on the node incidence risk of wrong decisions were analyzed [10].

Concept 1: false positive probability, the node does not appear within the sensing target tracking, the Node 'B' is 1 'i' appears decision, is expressed as P1:

$$P1 = P(B=1 \mid S < T \wedge o \ge T) = Q\left(\frac{T}{\delta}\right), \quad (3)$$

In order to realize the wireless sensor nodes quantify the risk of wrong decisions, this article will appear node i is the probability of error is expressed as:

$$L\left(0, \frac{\delta}{T} \mid P_1 = \frac{1}{(2\pi\delta^2 / T^2)^{\frac{1}{2}}}\right), \quad \exp\left(-\frac{P_1^2 T^2}{2\delta^2}\right) = \frac{\delta}{T}\varphi\left(-\frac{TP_1}{\delta}\right) \quad (4)$$

In the formula, represents the standard normal distribution of the probability density function, P1 logarithmic likelihood function can be expressed as follows:

$$L_n L_1(0, \frac{\sigma}{T} / P_1) = , \quad -\frac{1}{2}\ln(\frac{\sigma^2}{T^2})\ln(\varphi(-\frac{TP_1}{\sigma}) \quad (5)$$

3. Interpretation of Results

If the tracking number of nodes is 3 or 4, the wireless sensor network nodes is 1200, 1600, 2500, 3000, as shown in Fig. 2 [11].

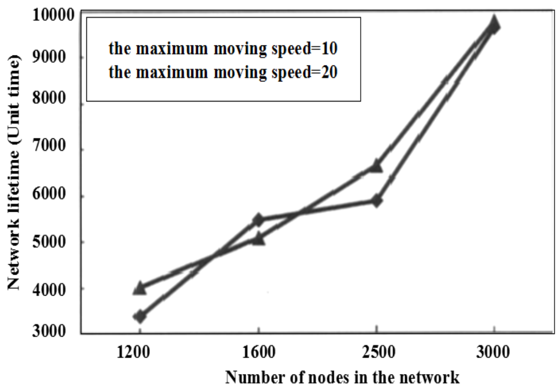

Fig. 1. When tracking number of nodes is 3, the network lifetime suffered the impact of network nodes.

The author of the linear motion tracking algorithm target tracking results of the analysis are described, from the above two figure, with the number of nodes in wireless sensor network gradually increased, the lifetime of the network also implements a corresponding increase, mainly due to the wireless sensor increase in the number of nodes within the network will increase the density of the network, and thus in the tracking node selection process, the algorithm has more options, and to achieve gradually reduce the average energy consumption of the node [12]. The author designed to target the algorithm for wireless sensor network node energy consumption balance to provide assurance to improve the density of the network, the number of nodes also increases, and all nodes are selected as target tracking node will reduce the risk, thus each node will have prolonged survival, but the survival of the smallest node in the network will directly determine the length of its production, and thus prolong the overall survival in node will certainly increase the lifetime of the whole network [13].

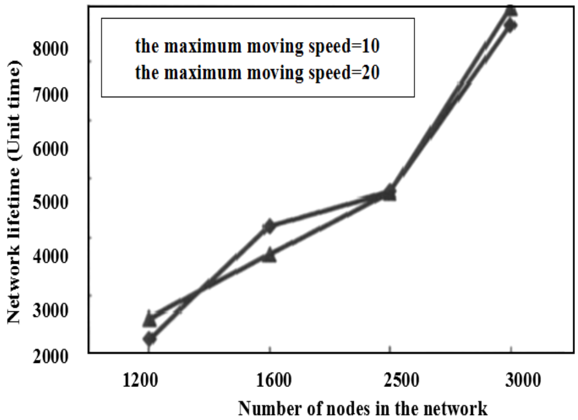

Fig. 2. When tracking number of nodes is 4, the network lifetime suffered the impact of network nodes.

Tracking the number of nodes in the choice of 3 or 4, the number of wireless sensor network nodes between 1200 and 3000 to change the situation, shown in Figs. 3, 4. The author of the curve moving target tracking algorithm research results were analyzed by Figs. 3 and 4 shows that the author of the performance of the algorithm depends on the size of the network, while in case of the same parameter settings, tracking the target will be curvilinear motion, and the algorithm is the lifetime of the network considerably less than the linear motion of the target lifetime of the network [14]. The main reason is that the wireless sensor target curve movement, the direction of movement sensing node randomness extension of the residence time within the target, it consumes more energy, and thus the energy consumption of the network adverse balance. making the whole network survival was significantly decreased [15]. However, the target for linear movement, all the nodes in the target within the sensing area of the residence time are more balanced, so more conducive to balance node energy consumption and extend the lifetime of the network [16].

From the above analysis results, the lifetime of wireless sensor networks and target tracking between the moving speed without the typical linear relationship, if the target's movement speed is slow, then all network nodes within the sensing area of the targeted average time to have continuous motion the extension, however, the target tracking process, all the nodes in the sensing area of the target tracking time were not changed significantly, so the network node balancing algorithm energy consumption is not affected [17]. The results described in this article the author also confirmed the proposed algorithm can all be effectively target tracking speed applications.

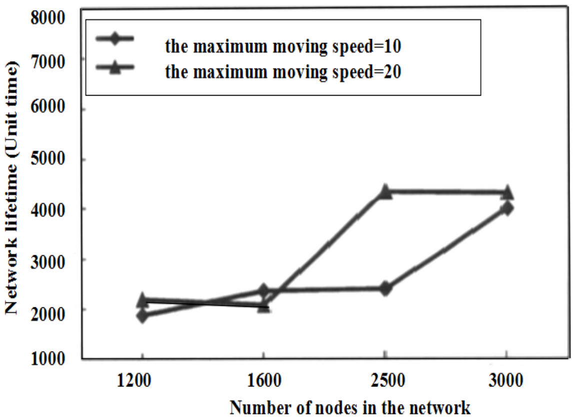

Fig. 3. When target is curve motion, the number of nodes is 3, the influence of network nodes on the network lifetime.

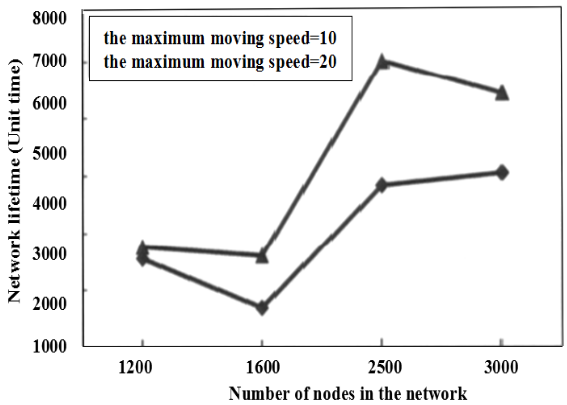

Fig. 4. When target is curve motion, the number of nodes is 4, the influence of network nodes on the network lifetime.

Tracking target curve and linear motion process, tracking the number of nodes 3, 4, 5 and 6 respectively. The wireless sensor network lifetime changing situation shown in Fig. 5. In this test. The wireless sensor network nodes are 1600. The maximum speed of the tracking target moves about 10 units of analysis results from Fig. 5. If the tracking target nodes by the three up to five. The wireless sensor network can be significantly reduced survival [18]; and if the tracking target nodes increased from five to six. It will gradually slow this trend. The main reason is that the lifetime of a wireless sensor network mainly depends large energy consumption in the network node. Typically. The forwarding intermediate node data track and trace nodes typically the large energy consumption of the node. As the number of nodes in the target tracking gradual increase in the number of forwarding nodes and target monitoring sensory data acquisition will increase the number of nodes, which will greatly increase the wireless sensor network node average energy consumption [19]. So, wireless sensor network lifetime will be greatly reduced. Increase the number of nodes in the forwarding to a specific level. Its speed will increase gradually slow down. So the number of nodes in the trace is between 5 and 6. The increasing trend in the number of nodes forwarding will gradually weaken. The energy consumption of wireless sensor networks will be reduced. Thereby slowing the lifetime of wireless sensor networks reduce the speed [20].

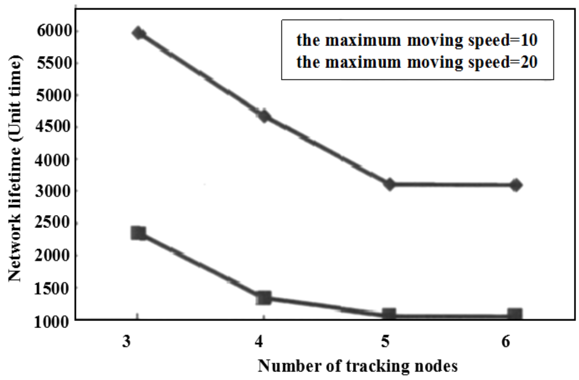

Fig. 5. The target curve motion and linear motion process, the effect of tracking the number of nodes on the network lifetime.

4. Conclusion

Target tracking as a wireless sensor network research process an important part in the practical application of the research process has been widespread concern. In this paper, the wireless sensor network target tracking process, to ensure the quality of the tracking algorithm selects nodes were analyzed, while the node lifetime and track quality suffered node energy consumption and data-aware error influence a comprehensive analysis. In this study, based on maximizing the track quality, the lifetime of the network are analyzed, and select the most efficient node algorithms. So far, the network described in this article on the basis of maximizing the lifetime of target tracking with high advanced, while this method using simulation experiments prove the effectiveness of the algorithm.

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