

2014

BioTechnology

An Indian Journal

FULL PAPER

BTAIJ, 10(17), 2014 [9790-9796]

Research of wireless sensor network node localization algorithm

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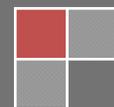
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ABSTRACT

This paper first introduces the basic concepts of wireless sensor network (WSN), system structure, key technology and related applications and research status at home and abroad. Secondly it introduced the wireless sensor network node localization in the process of many kinds of classic localization algorithm and the algorithm of the positioning performance of classification and evaluation standard, etc. Then without ranging localization algorithm of classic DV - Hop algorithm is carried on the thorough analysis and research. And in view of the DV - Hop algorithm in the process of positioning the insufficiency, it proposed a DV - Hop based on particle swarm optimization algorithm to improve the localization algorithm.

KEYWORDS

Wireless sensor networks; Localization algorithms; DV-Hop algorithm; Locating performance.



INTRODUCTION

With the continuous development of computer technology in recent years, integrated circuits, wireless network communication, such as micro electromechanical systems technology has also had the very big enhancement^[1]. This makes the low power consumption, low cost, high efficiency of the wide application of wireless sensor network. Simulation topology is seen as Figure 1. By multiple wireless communication, data collection and processing, mutual collaboration, and other features of the sensor nodes of wireless sensor network (WSN), brings a new mode of information collection, processing and application, network extend from the virtual world to real world^[2]. Traditional network change only from person to person, man and society, way of communication and exchanges and wireless sensor network (WSN) is a logical on the virtual world and the real physical world have merged together, further improve the communication between human and nature.

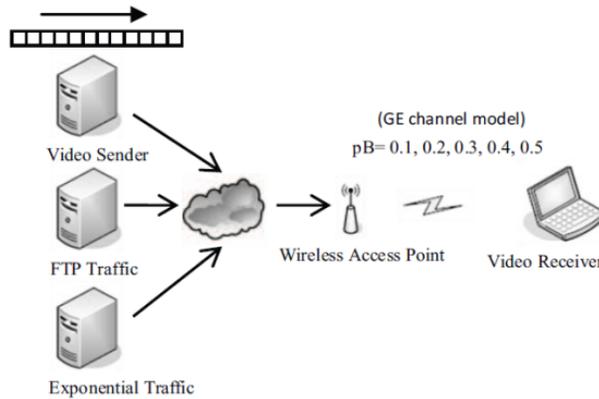


Figure 1 : Simulation topology

Node location technology is the key point in the research of wireless sensor network (WSN). The study of localization algorithm in wireless sensor networks for its development and application has very important meaning and function^[3]. On the one hand, the node localization is the foundation of many applications the core problem. On the other hand, the positioning technology to support the many other key techniques in wireless sensor networks.

BASIC OVERVIEW OF WIRELESS SENSOR NETWORK

Sensor nodes with surrounding environment perception and the ability to transmit information, researchers will they are random or artificially deployed in monitoring area. It make each node can be in the form of self-organization constitutes a whole interconnected networks. According to the role of the nodes in wireless sensor networks and of the location^[4]. It can be a kind of typical wireless sensor network system structure. Among them, the base station is responsible for the wireless sensor network and external network connection and the connection between the different types of wireless sensor network (WSN), the complete agreement for the conversion and information sharing between can publish user management tasks at the same time and work information in wireless sensor network data fusion, etc. But relative to the base station, the node's processing, communication and storage capacity is relatively weak energy. Proposed cognition cycle is seen as Figure 2. Each node can act as the role of data collector and router alone or integrated multiple roles realize data acquisition and processing and the intermediate data transfer and collaboration with other nodes and its specific task.

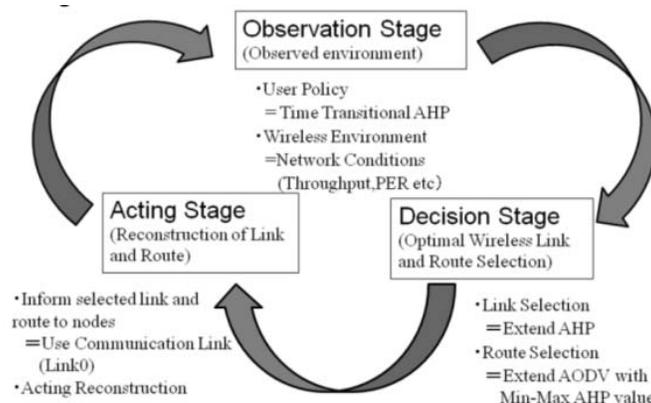


Figure 2 : Proposed cognition cycle

Appear as a separate computer networks, wireless sensor network (WSN) consists of a large number of sensor nodes by wireless communication network technology since the tissue. The network can realize quantitative calculation of data set, processing, integration and transmission applications^[5]. It belongs to a new field of information technology. In military and civil fields it has a very broad application prospects. Small volume, small quality and node used in the battery energy is limited. The node's energy is limited and the application of wireless sensor network environment. Special node once launched will not be reused, so the node energy is quite limited. Node huge number, and were randomly spread, so nodes without global IP. Only the local label. However, wireless sensor network to collect information, environmental perception and processing data, so it's a data-centric but does not depend on the label.

Coverage of each node is limited, and need to collect the data and the area of the monitoring area is large, if use single jump way^[6]. The collected information is sent to the Sink node by node. Some of the very far distance to Sink node because the energy depletion, premature death to produce energy. Therefore the information in the wireless sensor network (WSN) is done through nodes communicate with adjacent node information, once out of coverage area with the help of intermediate nodes are needed to implement multiple hops routing. Due to the network node density is big, so there are many repeat transmission of information between adjacent nodes, so the node to the information for data fusion, first to be passed on to the next node to reduce the nodes need to pass information, reduce energy consumption.

WIRELESS SENSOR NETWORK NODE LOCATION TECHNOLOGY

In sensor networks, there is no unified optimal positioning algorithm suitable only for the environment of localization algorithm. In a specific environment, some algorithms of some of the performance may be better than other algorithms. So, in view of the different environments have different localization algorithm. Proposed disaster information network is seen as Figure 3. In statistics and summarized on the basis of the existing localization algorithm, it can be in accordance with the following standard to classify localization algorithm.



Figure 3 : Proposed disaster information network

Absolute positioning of the positioning result is the coordinates of the standard, such as the degree of taboo; Relative positioning is usually part of the node in the network as a reference, set up the network of relative coordinate system. Absolute positioning for the network to provide the only space, less affected by the network changes, more extensive application fields. And relative positioning can also achieve some routing protocols, especially routing based on geographic location. Most of the positioning system can realize the absolute positioning, relative positioning can be achieved only part of the positioning system and algorithm.

Localization algorithm according to the positioning of the different methods of calculation can be divided into centralized and distributed computing. Centralized computing means will need positioning information transmitted to a central node, and centralized is calculated by the node to the unknown node location. Distributed computing to point to by the exchange of information between nodes, unknown nodes according to their own get enough information. The calculation way is for their own position. The advantages of centralized computing can be from a global perspective to plan better, to obtain relatively accurate positioning. Defect is centralized computing because it around the center of the node communication overhead is too large. Energy consumption is too fast and easy cause individual nodes premature death, thus affect the positioning of the other nodes. Distributed computing can be calculated in the position of all nodes in the network simultaneously. Such as incremental calculation usually starts from the fault node distribution, beginning around the trace node first began positioning extending outward in turn gradually achieve the entire network. Incremental algorithm of defect is in the process of positioning error are easy to accumulate and enlarge.

Based on the time of arrival (TOA) positioning mechanism, the signal propagation velocity is known according to the signal propagation time of the distance between computing nodes, reuse of the existing algorithm can calculate the position of the unknown node. TOA positioning mechanism require precise time synchronization between nodes. Based on arrival time difference positioning mechanism, launch the node at the same time emit two different propagation velocity of the wireless signal. The receiving node according to the two kinds of signal arrival time difference and the two signal transmission speed can be concluded that the distance between two nodes, then the location of the nodes is calculated by the

existing algorithms. TDOA technical shortcomings of ultrasonic propagation distance is limited and the line-of-sight transmission, affect the spread of ultrasonic signal. Arrive in Angle (AOA) is based on the positioning of the mechanism, the receiving node first through multiple ultrasonic receiver or antenna array perceived node of signal and calculate the relative Angle between the receiving node and launch or bearing, using the triangulation method to calculate out the location of the node. AOA due to the need for additional hardware, and the external environment influence in the aspect of hardware size and power consumption may not be used in sensor nodes. Wireless network architecture is seen as Figure 4. Based on distance positioning mechanism puts forward higher demands on network hardware facilities, such algorithm to obtain relative accuracy positioning results have a large amount of computation and communication let pin, but not distance positioning mechanism with its advantages in cost and power consumption is more and more attention, such as centroid algorithm, DV - Hop algorithm, Amorphous algorithm and convex programming algorithm. And so on they are typical without ranging positioning technology.

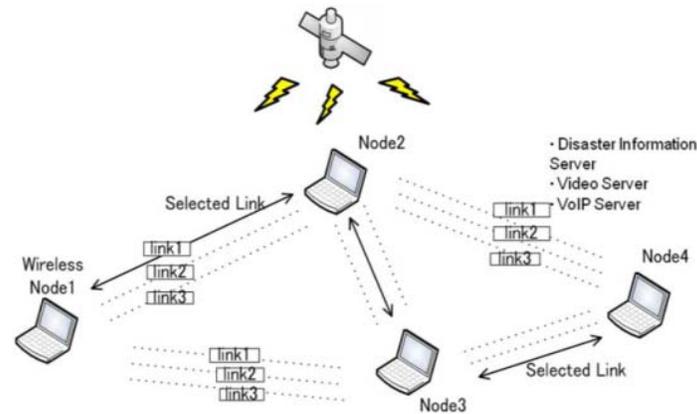


Figure 4 : Wireless network architecture

DV-HOP LOCALIZATION PROCESS OF THE ALGORITHM

DV-Hop localization algorithm is the localization algorithm in wireless sensor network (WSN) one of the most widely used algorithms. It belongs to a kind of distributed localization algorithm. A small number of nodes in network equipped with GPS devices. It can realize own orientation. These nodes called anchor node. According to the cats and other unknown node location information and the estimated distance between anchor nodes to realize own positioning. Because of their own as long as the algorithm based on network topology information can realize positioning, do not need to measure the distance or Angle information, so the hardware requirements is low. The main is relatively simple. DV-Hop algorithm to locate people provides a new train of thought, research and development in the without ranging localization algorithm.

The first stage for exchange phase distance vector. The main work of this phase is the distance between anchor nodes using the typical vector exchange protocol. In the form of broadcast, it makes all the nodes in the network have to jump with all other trace nodes information section number. The jump refers to the section number after a few jump can reach between nodes, which is to the smallest jump between the two nodes number.

The second stage for school JH value calculation and radio stage. The main method of each cat node according to the actual distance with other anchor nodes and the first stage to jump between the two anchor node numbers of information, can achieve every hop average distance. And finally as a correction in the form of broadcast is sent to the network. Unknown nodes according to the received recent correction of anchor nodes, calculated and estimated distance of every trace nodes.

The error of the internal cause mainly comes from the algorithm itself localization process and the use of mathematical methods, by DV-Hop algorithm itself positioning process analysis shows that the error source divided into three aspects. What size is the number of neighbor nodes fault node ratio and the mechanism of jump distances. Have done in-depth research on this aspect research scholars and through the simulation experiment proves that the pin nodes proportion size can affect the positioning error, finally the conclusion is: the average all the unknown nodes in the network location accuracy is increased with the increase of trace node ratio increasing. When after reaching a certain proportion, positioning accuracy is stable and maintain in a specific range.

But too much on the number of anchor nodes will make the cost of the entire network increase sharply. Therefore, it should from the optimized deployment of anchor nodes. Neighbor node number will directly affect the number of nodes and unknown node can be directly communication. Scholars have proved the unknown nodes around the neighbor nodes, the positioning accuracy of unknown nodes in the network. System Architecture is seen as Figure 5. But if the neighbor node is too much may be falling of positioning accuracy, because the average jump distance is relatively low. More jump distance mechanism is mainly the influence of the existence of the cumulative error, because the average hop distance is itself exists error. More jump distance error is bound to be amplified and thus reduce the positioning accuracy.

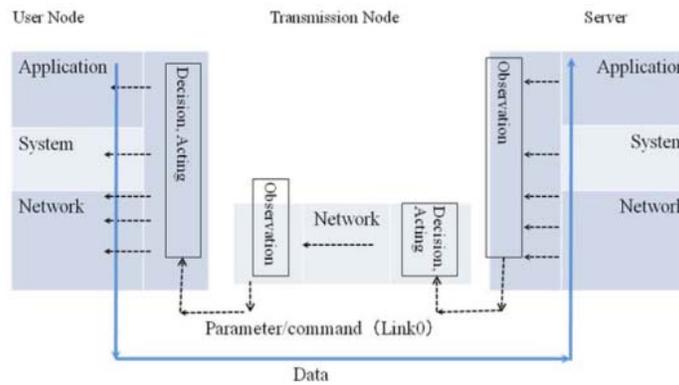


Figure 5 : System architecture

From the aspects of the calculation of mathematical method, positioning error is mainly from the third stage of DV-Hop algorithm, which USES trilateration method or maximum likelihood estimation method to estimate the unknown node location problems. Trilateration method using only three fault node location information to the unknown node. This caused by less redundant information cannot achieve high positioning accuracy. And the choice of three anchor nodes may be because of the distribution of different and makes the average jump distance error is large, thus further lead to the positioning accuracy of the algorithm is not high.

So in the case of network topology unpredictable, get more accurate average per jump distance will be improved algorithm localization algorithm accuracy is an effective way. Known from the analysis: the anchor nodes are far away from the unknown node, hop count between the unknown node and the node fault will be large. And the average distance itself is the existence of error, so when the hop the greater the cumulative error of estimated distance will lead to greater. If these distant spread node is used to estimate the distance to solve the unknown node coordinate. It will reduce the node location accuracy.

DV-HOP BASED ON PARTICLE SWARM OPTIMIZATION ALGORITHM TO IMPROVE THE LOCALIZATION ALGORITHM

For DV - Hop algorithm in network topology node random distribution in the environment limitation, positioning accuracy is not high, to improve. Improved algorithm is mainly divided into the following four steps. The four fault nodes and cloth are in the boundary point of monitoring area. Correction fault nodes per jump distance and the weighted the average jump distance of the unknown node itself. With the two-dimensional hyperbolic algorithm to calculate the unknown node location. Further correction using particle swarm optimization algorithm is to find the unknown node to estimate position to make it more close to the actual location.

DV-Hop algorithm as the output node is randomly and cloth. The anchor nodes may be concentrated in a certain area and use this node to estimate the unknown node coordinate requires network regional similarity is high, otherwise it will cause greater error, and bad stability. In order to solve this problem, this paper will in the four corners of the monitoring area. Respectively, the deployment of a trace node, the rest of the trace nodes randomly and such regional similarity is that there is no problem from the network. The coordinate error estimation has good stability. Maximum likelihood estimation method is sensitive to distance measurement error, when error range by maximum likelihood estimation method between estimated and actual location of the larger error. Aimed at this shortage, this article use the two-dimensional hyperbolic positioning algorithm instead of the traditional trilateral or multilateral localization method to estimate the unknown node location.

Particle swarm optimization algorithm as a kind of efficient optimization algorithm, is by simulating the flock foraging behavior and developed a kind of random search algorithm based on group collaboration. Routing tables by extend AODV is seen as Figure 6. The basic idea is to first target function to initialize a group of random particles, and then find the optimal solution through iteration. Each iteration is the particles by tracking the two extreme value to update themselves. The first is the particles themselves to find the optimal solution. Another is called individual whole populations are to find the optimal solution.

Based on DV - Hop algorithm in network topology node random distribution in the environment limitation, positioning accuracy is not high. This paper proposes a new improved DV - Hop algorithm. To improve the stability of the algorithm, firstly some nodes randomly and cloth in the monitoring area border; Second correction of anchor nodes on average every jump distance, and the weighted average jump distance of the unknown node itself. Then use the two-dimensional hyperbolic algorithm instead of the original maximum likelihood estimation method to calculate the unknown node location; Finally, in order to make the estimation of unknown node position is closer to the actual value, correction using particle swarm optimization algorithm has been calculated estimates the unknown node location, finally gives the calculation process of the algorithm.

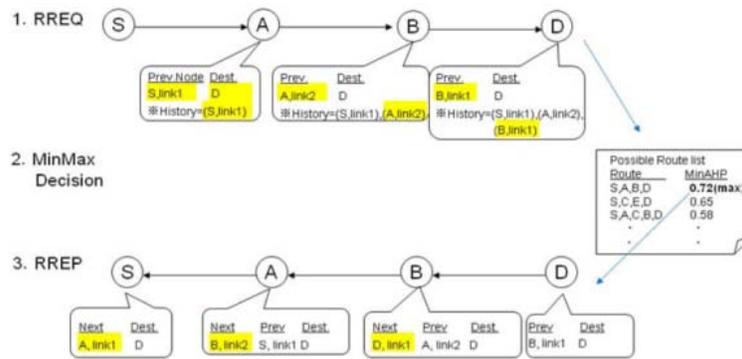


Figure 6 : Routing tables by extend AODV

DV-HOP ALGORITHM SIMULATION AND PERFORMANCE ANALYSIS

There are a lot of their own wireless sensor network positioning system and algorithm, which directly influences the performance of its availability, how to evaluate them is a problem needs to be further studied. Ability can be measured in multiple indicators at the same time. In addition to the general precision of the indicators, such as for resource constrained wireless sensor network (WSN), and index of power consumption can be special.

Positioning accuracy is to specify a system to provide the accurate location information, is the primary criterion in evaluation index. A localization algorithm of positioning precision determines the localization algorithm can be applied range, to the extent permitted only guarantee that the positioning accuracy and positioning results have practical significance. Generally speaking, the positioning accuracy with all the positioning error of the unknown nodes in the network and node communication radius ratio is expressed as a percentage of. Positioning accuracy is 10%. For example, that the positioning error of the unknown node is equivalent to 10% of the node communication radius. So in the case of known communication radius, it can clear more positioning precision of the algorithm.

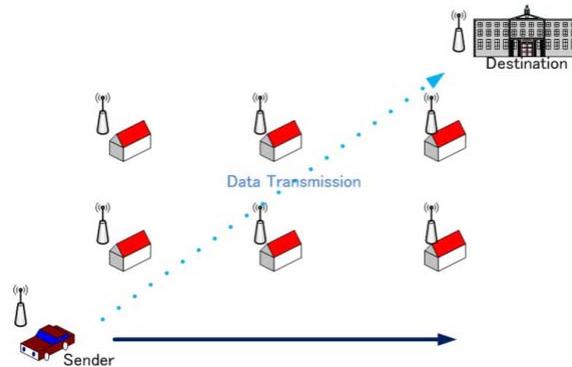


Figure 7 : Simulation scenario

RESULT AND DISSCUSS

As wireless communication, embedded computing, micro-motor and sensors, such as the development of technology and the increasingly mature make manufacture large quantities of low cost and small volume. Low power consumption of sensor nodes become a reality. Sensor node has not only awareness, but also with computing power, storage and communication ability. A large number of sensor nodes deployed in monitoring environment. Organization network by wireless communication way is wireless sensor network. Calculation of each node sets the environment data. The data in the corresponding processing, at the same time, through wireless communication to work together to complete a series of complex tasks and send important data to the user. In many aspects such as military, medical, family, environmental protection has a high application value.

CONCLUSIONS

Node localization is one of the key technologies of the application of wireless sensor network. Node location information is very important and can be used to identify the location of the monitoring data. The network topology management, routing protocol based on node location is based on the geographic location of the data storage technology, etc. In this paper, the application of wireless sensor network node location technology in has carried on the thorough discussion

and study, analyzed without ranging algorithm based in the DV - Hop algorithm on the basis of the positioning principle and positioning process. This paper proposes a DV - Hop based on particle swarm optimization algorithm to improve localization algorithm.

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