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A New Routing Maintenance Algorithm for Agricultural Wireless Sensor Networks

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Abstract: In order to improve the agriculture intelligent control efficiency for wireless sensor networks and solve the problem of routing maintenance, analyzed existing routing maintenance algorithm, ensure that one of the core technology for wireless sensor network performance. In this paper, Proposed the restructuring and leapfrog network-based local routing maintenance method, put forward two automatic routing adapt maintenance algorithm. Finally, experiments to test the mechanism for the maintenance of both routing. Application results show that the reorganization of the network is close to the original network performance, when the leapfrog network is created that the system time delay increases, but the other properties are not changed, and the two kinds of network maintenance method can be applied to agricultural production. *Copyright © 2013 IFSA.*

Keywords: Wireless sensor networks, Routing maintenance algorithm, Agriculture IOT, Data transmission.

1. Introduction

In recent years, the Internet of Things (IOT) as an international research hotspot, have obtained broad attention. It's represents the future trend of development of the network, and requires sharing interoperability and information, so as to realize human society, the information space, the physical world ternary comprehensive connectivity and integration as the goal. Therefore, the Internet of things is regarded as the third technological revolution in information field.

Sensing technology is an important part of the field of computer science and control science, for every object to implement networking of IOT environment "can be addressed; every object network can control [1]; every spatial networking can be communication" goal, sensing technology needs formatting commands from the past context-aware simple development to the natural perception of all-round [2], three-dimensional, modes of perception from a single man-machine perception extended to man, machine, material ternary world interaction mode. Therefore, research on key technology of intelligent sensing network environment, effectively solve the problem of environment perception of things, the realization of the human society, the information space, the physical world ternary has important theoretical significance and urgent reality needs.

Wireless network routing maintenance play in a very important position in wireless ad hoc

communication field [3]. That is different from wireless network and wired network, wireless ad hoc network is dynamic, easily affected by climate change signal weakened or signal blind area, cause interruption of original network path.

In the industrial field, wireless sensor network routing maintenance has been a research focus of transport protocol for wireless sensor networks. The domestic and foreign research application of route maintenance are targeted at nodes are densely arranged, the industrial application environment, short communication distance. In the dense network, core research route maintenance is mainly to study the reliability of dynamic routing in the maintenance and reduce the influence caused by the dynamic routing on network quality maintenance. While agriculture IOT applications in large-scale farmland [4], the distance between nodes, each node is difficult to simultaneously with multiple nodes to establish effective communication signal on the point coverage. Secondly, agricultural IOT node because of the special working environment, the nodes are powered by solar energy, therefore [5], in the long rainy weather in some nodes because the network is overloaded and the standby power consumption of the battery as much as possible. Lead to some node power failure and exit from the network, the communication link is destroyed [6]. In addition, the nodes in the power off because the weather improved power supply is sufficient, and recover the communication nodes [7], to rejoin the network, therefore, the new node can also change the network communication links, leading to the occurrence of the little change in the structure of the entire network. In addition, agricultural application [9-10], some nodes in the actual production according to the need to move, so the whole network communication link changes. To keep the network communication efficiency is the highest. The lowest energy consumption and stable operation, we must study the variation of network routing and network communication rules [11-12].

This paper study on Agricultural Internet routing maintenance mechanism, the maintenance method of local wireless network reorganization and leapfrog routing, implementation agriculture IOT basic fault in the daily work of maintenance.

2. Reorganization of the Network Routing Maintenance Mechanism

In the Internet of things transmission network, due to power supply situation or other causes or human case of node failure nodes removed circumstances often occur in practical applications, the removal of individual network node failure handling is particularly important, the network node failure is often the nature of non-one, resulting in the original network communication system effects are not identical, but these effects are only caused by a change in the local network, therefore, this paper will study the maintenance method of local network routing.

The premise of Local network recombination is that: in the network, v_i node of the first node is the node v_k , v_k node v_i original network nodes dependent on the routing path information when the node fails v_i, v_k node into blind. When the v_i lapse in v_k effective wireless coverage inside, there v_n and v_m node, and v_n to the node before the node can pass routing information to the sink node. Accordingly, v_k is via local network restructuring, routing nodes through v_n information shown in Fig. 1.

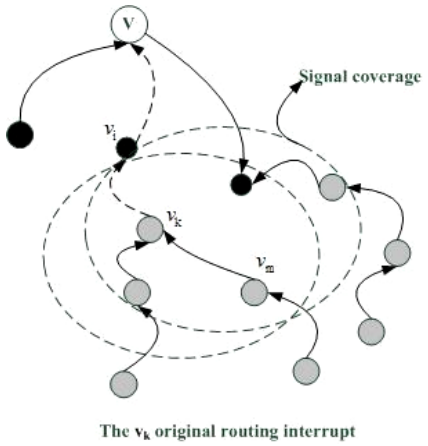

Fig. 1. Network layout reconfiguration.

2.1. Network Node Failure Processing Method

The terminal nodes in network are only responsible for the information collection and information transmission. The terminal nodes in the host computer without re networking rule order, property system not arbitrarily change node. Each node has two attributes by upper machine configuration. The nodes in the network failure transmission path as shown in Fig. 2.

In the Fig. 2, when the v_i node is failure and v_i node does not accept routing information to other nodes in the task, so called for the terminal nodes in the network. The failure in the network node to the entire network is relatively small, additional information within the network transmission path unchanged. Therefore, such a node failure is handling mechanism periodic signal by scanning each of the updated data for each node in the case. Or exceed the maximum refresh cycle time T, the system will prompt the host computer alarm, alerting the network nodes have been evacuated, waiting for users to handle, so we can write

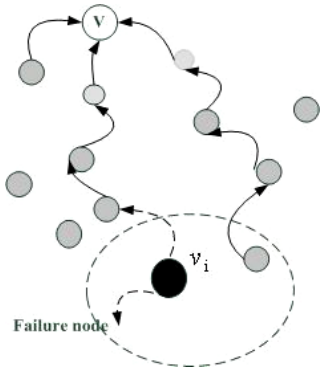

Fig. 2. Terminal node failure state diagram.

$$T_{updata} = \sum_{k=0}^{n} t_{net-link}(k) + \sum_{k=0}^{n} T_n + \sum t_{net-delay}, \quad (1)$$

When design limit cycle, taking into account uncertainties communication network, so the host computer receives the update time of node greater than 2 times the maximum update time, you can determine if the node has expired, the node will send a break warning message when the break = 1, indicating that the node has failed.

2.2. Routing Node Failure Maintenance Method

When used as a networking network routing node fails, the network communication interruption may occur and so on. Shown in Fig. 3, when v_i node fails, v_m routing node PC route was interrupted by the v_m original network nodes and node information v_n were unable to upload data.

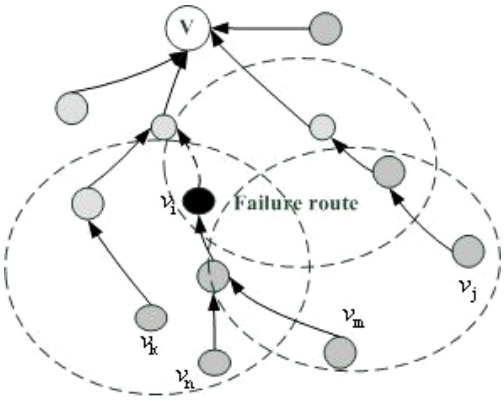

Fig. 3. Routing node failure mode.

When a node failure we must first develop discrimination measures for judging v_i node failure situations. Judgment as follows: Under normal circumstances, v_i node, v_m node, v_n nodes transmit data at regular intervals for the network. When v_i node disappears from the network, for PC management systems, v_m node and the node where the transfer of information is mired in blind, v_m node, v_n with v_i node a node failure PC cannot judge.

2.3. Add a Network Node Routing Maintenance Methods

Agricultural IOT nodes poor working conditions, and networking equipment belonging to the uninterrupted work equipment, all nodes are powered by solar energy in a long, rainy weather, some nodes may fail due to lack of power supply when the weather improved, power supply sufficient conditions, the node from the failure and are called, reenter the network. But after entering the network, the node node_net is not set to 1, that is to say, the node from the network. When a node in the network moves, the node moves to another place, and the distance traveled is large, in fact, can be used as the node failure and add a node processing. So, add a node in the network routing maintenance is very important.

This paper presents a new node conditions trigger mechanism handling mechanism in this paper, the design of agricultural Things nodes, each node has a network status information attributes node_net, this property is a binary Boolean, and the property value there is only a focal point assignment rights.

When the network node to the sink node transmission of data is completed, the sink node will immediately along the original route returns a data receiving the command, and the network state information is transmitted to the node, the node node_net state of the transmitted signal is set to 1, to indicate that the node has been connected into the network.

3. Farmland Routing Maintenance

3.1. Route Maintenance Principles

For both irrigation and networking equipment cost, large-scale farmland information acquisition in network nodes is very difficult in the effective communication within the diameter to find more information can establish the mechanism of communication. Therefore, in this case by using the software to control the transmitter power to increase the effective radius of communication ways, to establish contact with the other nodes objective, and finally into the self-organization network, to transmit their data, the specific method as shown in Fig. 4.

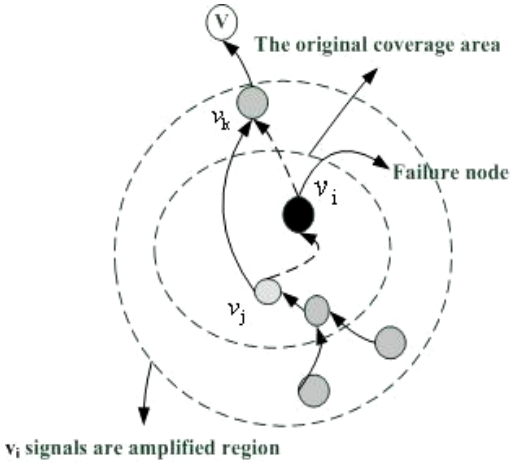

Fig. 4. Transmit signal power routing maintenance.

In Fig. 4, when the v_i node cannot find the forward channel, and then to the communication link cannot meet the information to the sink node transmission, network state Node_net attribute will v_i nodes from the original 1 to 0 and from the network. At this time, with nodes within the management software will automatically start to increase the transmission power of nodes transmit signal prior to the v_k node, v_i node into the effective signal coverage area, SJ nodes can establish a communication link and v_k nodes, and nodes can across all nodes directly and also communication. All of the information available through the transmission to the sink node, and the node to node only after full recovery into the network, the network link again. In this paper, every node can directly across the v_i node and v_k communication called maintenance bypass network routing.

3.2. Nodes Maintain Routing Rules

In the agriculture IoT, along with the continuous growth of crops, higher crop will likely have some of the wireless signal blocking effect. Alternatively, a single greenhouses cultivation of certain crops in certain growth cycle greenhouse will cover film, film on the wireless signal has some impediment, so things occurred in the agricultural route maintenance possibility of relatively large and since there are often large-scale farmland distribution information collection more dilute, leading to leapfrog route maintenance phenomena are more likely to occur large.

Comprehensive evaluation index of IOT, according to the definition of the IOT network path, that is the assembly sequence is a $P(v_s, v_d)$ path in the G side, v_s is the source node, v_d is the destination node v_s from the source node to the destination node path v_d and is given by

$$P(v_s, v_d) = (v_s, v_1), (v_1, v_2), ..., (v_{i-1}, v_i)...(v_n, v_d), \quad (2)$$

Also can be a collection of nodes to represent a path simplify represented as:

$$P(v_s, v_d) = v_s, v_1, v_1, v_2, ..., v_i ... v_n, v_d, \quad (3)$$

For any one path $P(v_s, v_d)$ can define the consolidated network performance. The index contains a variety of attributes as a result of different applications, in which only consider the actual demand indicators, delay, bandwidth, and packet loss rate.

4. Simulation Testing and Analysis

Placing the sensor nodes of farmland large-scale farmland 200 m × 300 m in the experiment, according to the actual characteristics of field information acquisition, analog information acquisition and routing process the scene. The following experimental scheme:

In the experimental area, all sensor nodes will transmit power amplification factor adjusted to 0, the signal of the wireless transmission distance will be significantly reduced. Trial two parts, part of the network node free network. 60 m furnished by every node, ensure that the node and the distance between nodes can be within the valid signal coverage.

Through the experimental test method, calculation of average bandwidth occupancy within the network gradually, the network performance of average delay and average energy consumption and packet loss rate, the average packet loss rate of the network of two nodes experimental data as presented in Table1,and the experimental results as shown in Fig. 5.

Table 1. Average Packet loss rate of the network.

Packet loss rate (%)		Time (s)
Local network nodes	Super routing	
0	21	0
0.2	0	1
1	0.5	2
0.5	2	3
1	0.1	4
0.2	3	5
1	1	6
1	3	7
2	0.3	8
1	1	9

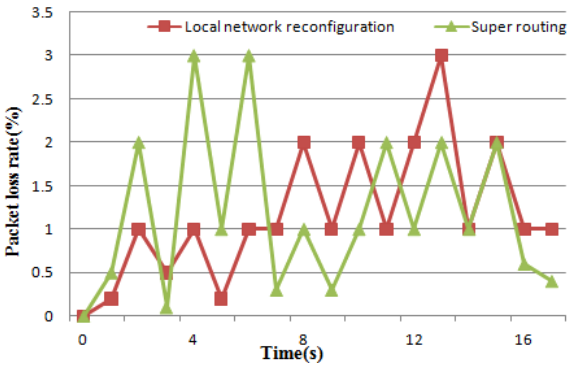

Fig. 5. The experimental results of network performance.

5. Conclusions

Wireless network routing maintenance play a very important role in wireless ad hoc communication field, it is Different from wireless network and wired network, wireless ad hoc network is dynamic, easily affected by climate change signal weakened or signal blind area, cause interruption of original network path. In this paper, first introduces the concept of the restructuring and leapfrog network-based local routing maintenance method, then put forward two automatic routing adapt maintenance algorithm, that the reorganization of the network is close to the original network performance, when the leapfrog network is created that the system time delay increases, but the other properties are not changed, and the two kinds of network maintenance method can be applied to agricultural production.

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