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Routing Algorithm of Cluster Tree based on Complex Ring Sports Environment

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Abstract: Thanks to the advantages of ZigBee routing of IP packet without taking full of advantages of Aodvjr and Cluster-Tree protocol, and not providing the father node routing according to the node address, this paper comes up with the CLZBR arithmetic. This arithmetic combines with the respective advantages of the Aodvjr and Cluster-Tree protocol: Aodvjr arithmetic is used between the clusters; Cluster-Tree arithmetic is used of the cluster. Ways of the numbers of the RN nodes and calculating the father nodes routing have reduced the discovered process of route. The result of the simulation text show that this kind of arithmetic has decreased the redundancy RREQ packet and dissipation of the energy.

Keywords: Address allocation; Cluster structure; Data frame

1. Introduction

In recent years, with the development of the wireless sensor network technology, the small sensor network, got more and more attention not only in areas such as home automation, remote control, but also in large scale applications such as fire detection, surveillance and reconnaissance [1-3]. The ZigBee alliance has carried on the physical layer, data link layer, network layer, and application layer standardization, and released some standard: ZigBeeV1. 0, ZigBee2006, ZigBee2007. One of the main purpose of the ZigBee agreement is to achieve the data transmission which frees from constraints such as time, place.

Routing and shortest path Routing.Professor Dan Liu and others have put forward with the ZigBee Routing algorithm on the basis of Routing node properties.Professor Lin and Meng have put forward the control to the flooding of Route Request so as to reduce the RREQ (Route Request) grouping of flood and reduce the energy consumption. Professor Lee and Kim et al divide the ZigBee network into several logical clusters, and use cluster labels to identify cluster. Professor Bhatia and Professor Kaushik also have introduced the clustering into ZigBee routing [4-7]. However,this way also increases the burden of the control overhead. Professor Ran et al considered that while the AODVjr + Cluster - Tree hybrid routing algorithm was used in the ZigBee specification ,almost without improving network performance through balancing the two design method , and accordingly putting forward a kind of based on data service and neighbor node ZigBee network layer routing strategy of energy balance. But the method , only according to different data streams, set up a ZigBee agreement by parameters related to find the domain, not from routing itself to reduce the energy consumption.

2. ZigBee Address Assignment

Each node in ZigBee network has a 64 - bit extensive addresses and a 16-bit short address: the 64 - bit extensions address is similar to the MAC address, the Internet is a node of a unique identifier; the16-bit short address by joining the network node's parent for dynamic allocation, which is similar to the IP address, only used for routing mechanism and network data transmission.

Coordinator firstly needs to prescribe three parameters: Cm (the parent node number of child nodes can be connected at the most), Lm (maximum depth of the network), the Rm (child nodes can be connected routing node number). Computing network depth for d parent node for its assigned address offset Cskip (d), the specific computational formula as shown in type (1) :

$$E_{\min} = E_c + \lambda E_s \tag{1}$$

Only when the offset is greater than zero, the node has the ability of network address to assign his son node, which allows the child nodes to join. Specific allocation mechanism is as follows:

$$E_s = \int\int (\|\nabla u\|^2 + \|\nabla v\|^2) \tag{2}$$

When the first k terminal nodes to join, distribution address is as shown in type (3), $1 \le k \le (cm)$

$$\nabla^2 u = \frac{\partial^2 u}{\partial^2 x} + \frac{\partial^2 u}{\partial^2 y}, \nabla^2 v = \frac{\partial^2 v}{\partial^2 x} + \frac{\partial^2 v}{\partial^2 y} \tag{3}$$

By the address allocation, node according to the type (4), determine whether the destination node for their offspring.

$$\begin{cases} \dfrac{\partial E_{\min}}{\partial u} = 0 \\ \dfrac{\partial E_{\min}}{\partial v} = 0 \end{cases} \quad (4)$$

2.1. Routing algorithm

The Cluster - tree algorithm uses the tree-like hierarchical routing, if address for Ar, depth of d routing, the node receives the destination address for d frame; if the destination address for your receive directly, otherwise the type (5) was used to judge whether the destination address is its children, and if it is the child nodes, transfer to the appropriate child nodes, if not, then forwarded to the parent node.

$$u^{n+1} = \bar{u}^{n} - I_x \left[I_x \bar{u}^{n} + I_j \right] / (a^2 + I_x^2 + I_y^2) \quad (5)$$

Cluster tree algorithm is simple and the frame is always along the tree path forward. Since there is no routing, we don't need to store the routing table so that it saves storage space and node low cost. But it belongs to the static routing and the algorithm is not suitable for mobile as a result that the frame forwarding always along the tree path. At last, it can cause the closer the coordinator node forwarding task becoming heavier, consumption the greater, and the traffic busier.

The network address assigned by the distributed algorithm is based on a series of custom parameters to determine network. Any node wanting to join the network must pass through the existing network of FFD (fully functional devices, including routers and coordinator). After the success to join the network, the node is automatically received a unique network address. Define the Cm for the architectural node number, the Rm for child node routing node Numbers, the largest of the Lm for maximum depth of the network, the network depth for d routing nodes can allocate the address space of the Cskip (7), (d) meet type assigned to the first k is the address of the router node Ak meet type (8), assigned to the first n terminal node address the An content type (9): A for father representative distribution network address of the father node.

$$v^{n+1} = \bar{v}^{n} - I_y \left[I_x \bar{u}^{n} + I_{yv}^{-n} + I_j \right] / (a^2 + I_x^2 + I_y^2) \quad (7)$$

$$SA = 1 - \frac{P(B_{ref} \cap F_{seg}) + P(F_{ref} \cap B_{seg})}{P(F_{ref}) + P(B_{ref})} \quad (8)$$

3. CLZBR Algorithm

In order to facilitate the huge network management, this paper puts forward a kind of well algorithm with the advantages of AODVjr routing algorithm and advantages of ZigBee Cluster - Tree algorithm CLZBR algorithm. This algorithm introduces clustering technology in ZigBee network, Cluster and AODVjr algorithm is adopted to improve the data transmission between clusters, and the simple Cluster - Tree algorithm. Not only use the best routing path, and reduce the redundancy of RREQ packet, the network many nodes using simple Cluster - Tree algorithm, which reduces the energy consumption; In order to avoid the excessive energy consumption of cluster head so that cause the disruption of the network, the algorithm introduce the concept of standby node; This article also studied to address for ZigBee scheme, put up with a calculation according to the destination node address of its parent. The method reduces the establishment of the network path, reduces the network overhead,and thereby saves the energy.

3.1. Cluster structure

ZigBee network can be divided into a number of logic cluster CLZBR algorithm, nodes being divided into four types: cluster head , gateway nodes, the members of cluster and the standby node. The algorithm uses node flag bit r to judge the different node types, and r is 0 representing the cluster head (CH); R is 1 on behalf of the gateway node (GW); R is 2 on behalf of the standby node (AH); R is 3 on behalf of the cluster members.

Each cluster contains a cluster head. Cluster head within clusters of control and management function, including cluster-heads node address, routing information, etc. At the same time, in order to avoid failure due to excessive energy consumption of cluster head and then causes network disconnection, each cluster contains a standby node.When the cluster head low energy, it replaces a cluster head ACTS as a ponder first, namely when the remaining energy of cluster head is less than the rated threshold, it degenerates into a cluster member nodes, and sets the node itself marks a r to 3; Standby node ACTS as a ponder the first, and its node flag bit r is set to 0. In this paper, the formation of the cluster is set as follows:

Coordinator of a network first was established by the formation of the first logic cluster ,and become a cluster head, cluster depth (CLm) limit is 3 (can). The CLZBR cluster structure is shown as Figure 1.

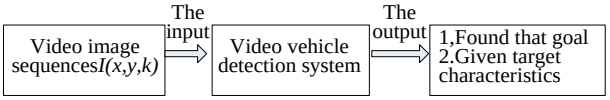

Figure 1. CLZBR cluster structure

A flag bit will own node r is set to 0. Other nodes to join the cluster, a join the child nodes of the distribution of 16-bit short addresses through the form of a type (2) and (3) .

A joins from son routing by choose a residual energy of node's biggest routing node b as a standby node of this

cluster, and selects the two most offspring node routing node c and d as the gateway node of the cluster.

A broadcasts in this cluster; c and d node will own flag bit r is set to 1 after receiving the broadcast; b node will own marks a r b set to 2,;other nodes within the cluster will own flag bit set r as 3.

3.2. The Parent Node Address

Based on ZigBee address allocation scheme for research, this paper designs a kind of method according to the destination node address calculation of its parent. Mainly by means of polling, and according to the destination node type (4) judgment address block, we finally find the destination address. When finding the corresponding address, we also calculate the address of the parent node.

Figure 2 introduces the calculation method of the parent node address in detail. The letter A is for direct parent node address; d is for the current depth; AL is lower bound for the offspring of the parent node node address; AU is upper bound for the offspring of the parent node node address; FD is true according to have found the corresponding destination address; R is for routing parameters. The Ap is on behalf of the parent node address of the final calculated, the depth of the Deep is on behalf of the destination node, And use the letter "B" stand for Cskip (d - 1) * Rm; C represents the Cskip (d) x Rm.

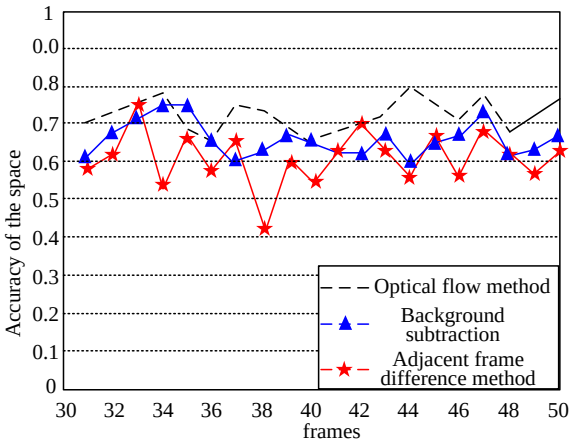

Figure 2. Parent node address calculation process

In Figure 2, digitals noted after node is node address calculated by ZigBee the digital address allocation calculation. The next is talking about the calculating process in details combined with Figure 2.

This method is mainly aimed at that when the source node has the data need to seed to the destination node. It can found that the routing table entries does not include destination node but the phenomenon of its parent address. Source node can directly send the data to the destination node of the parent node so that when the parent node receive the data, the parent node can adopt the way of Cluster - Tree to transmit the data to the destination node. This method saves routing discovery process, reduces the redundant packet, save the overhead of network and thus reduce the latency and energy consumption.

3.3. Data frame transmission

Cluster if you choose too large will lose significance of clustering. In general, a Cluster is not particularly big. Using AODVjr algorithm is relatively to need more energy consumption within the Cluster.At the same time, if excessive use of RN + node in the network at the same time will produce large amounts of RREQ packet redundancy and cause serious loss of energy, thus CLZBR algorithm to Cluster the depth limit is 3 (can be set according to the actual needs), and choose between Cluster and the Cluster using AODVjr algorithm for transmission, and within the Cluster to use Cluster transmission - Tree algorithm, the Cluster head nodes, gateway nodes and standby as an RN +, but need to limit on the standby node, usually only the Cluster - Tree algorithm, only when it acts as the ponder first, just can use AODVjr algorithm, the RN - other routing node.

The source node in the cluster source node in the cluster nodes of concrete after receives the data frame processing is shown in figure 3. When an source node information transmission, the source node needs the type (4) to determine whether destination node first own descendants. if so, transfer it to the next hop node of the branch; if not, determine its node types, and take a different approach according to different types of nodes.

When the source node in the Cluster members receives the data frames or sends the data frames, only adopt the Cluster - tree algorithm ,can't storage routing table,and need to figure out whether their destination node in the first place is. If so, receive data; If not, determine that whether the destination node is own descendants; if so, turn to the next hop node of the branch. Otherwise, the node is needed to transfer the data according to the Cluster - Tree algorithm , and let the data frames sent to its parent, and eventually spread to ponder the first.

When the source node in the cluster gateway nodes receives data frames or sends data frames, the first step is to determine if their destination node is. If so, receive the data; If not, determine whether destination node is own descendants, if so, transfer it to the next hop node of the branch, or directly transfer to the data frame to ponder the first low cluster head (the lower depth of the cluster head).

When the source node is the first to receive the data frames or send data frames, the first step is to determine if their destination node is or not.

If yes, receive the data; If not, determine whether destination node is own descendants, then, if so, turns to the next hop node of the branch; if not, the cluster head

stores the data information , check if routing table entry contains the destination node address or not;if so, directly transfer data to the destination node according to specified path; if not, calculate its parent according to the destination node address, and view the routing table whether contains its parent address entries or not. If contains, transfer the data of the destination node directly to the parent node. If does not contain ,the routing discovery process is initiated to find the best path to reach the destination node.

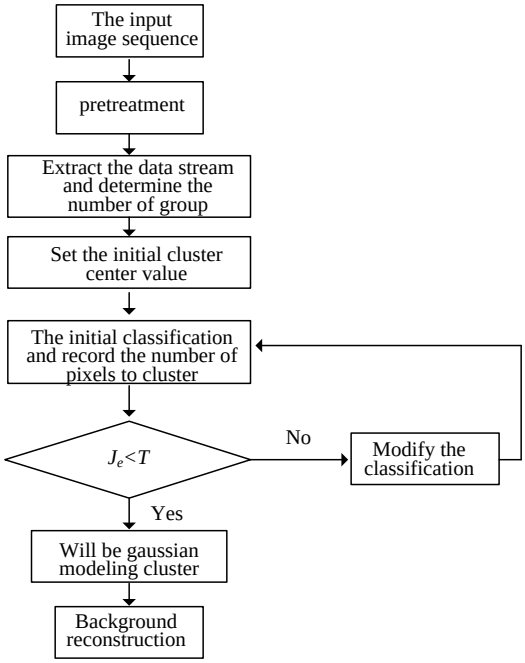

Figure 3. Source node in the cluster node processing flow of the data frame

After receiving the data frame, the destination node in the cluster of the destination node of the cluster nodes dealing process is shown in Figure 4.

Figure 4. Destination node in the cluster node processing flow of the data frame

When the information is transmitted to the head node of the destination node, head nodes will compare their saved cluster of cluster within the address information, and find a destination node address information. The cluster head temporary saves the data information, and will transmit the data to the destination node in the branch, and eventually turn to the destination node.

If the source node contains information to the parent node address of the destination node by calculation and sends data to the destination node parent node. The data directly to the parent node information delivered to the destination node; Otherwise, after receiving data frames, the destination node in the cluster of clusters branch will be at first to to determine whether their purpose or not. If yes, receive data; If not, the use of (5) would transmit the data to the destination node in the branch of the next-hop node, and sent to the destination node.

Figure 5. RREQ packet processing

Having received the RREP packet post-treatment process, the routing process node is shown in figure 6. When node initiates routing discovery process and radio RREQ packet, and will save to jump on the reverse routing while receiving RREQ grouping nodes of forwarding RREQ packet . Eventually, when the destination node is first receives of the RREQ packet, it has established reverse path. The cluster head only send the RREP packet to the source node to ponder the first in accordance with its path. When the source node to ponder the first receives the RREP packet from multiple paths, the cluster head chooses the path that costs least as the destination node routing. As they have multiple minimum cost path, it will select the cluster head first to receive the RREP packet of the path.

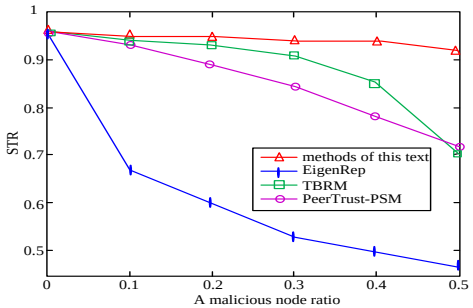

Figure 6. RREP packet processing

After receiving the RREP packet, Ponder the source node at first will send the temporary data to the first store the data of the destination node according to finding the best route to destination node to ponder the first place . At the same time, in order to save energy and avoid duplication of effort, the source node at first will save the first address information to the routing table after received the RREP packet and the destination node. When the

members want to send information to the destination node within the cluster, it can directly send the data to the cluster head.The cluster head goes on the transmission according to the previous path, and trigger the routing process no longer so as to achieve the sharing within clusters of the routing information

4. The Experiment and Simulation

4.1. Packet delivery ratio

Packet delivery ratio is measure the performance of whether the network topology successfully received data packet or not. It can show the reliability of the network: the packet delivery rate and the greater the higher the reliability of the network. Packet delivery ratio is the ratio of the destination node receiving the data packet number and the source node sending the data packet number. The specific calculation formula is shown in type (6) :

$$\text{Packet deliveryrate} = \frac{\text{The number of packetssuccessfully received data}}{\text{The number of sending out data}}$$

4.2. The Routing Overhead

Routing overhead refers to the number of the path control group of network routing overhead, though the percentage can response more clearly overhead in the network. The network energy consumption rises as the percentage increases. The main method to calculate the routing discovery and routing reply is the control group divided by the number of successfully received data packet number. The specific calculation formula is shown in type (7) :

$$\text{Routing overheadpercentage} = \frac{\text{The routing controlpackets number}}{\text{The received data packetnumber}}$$

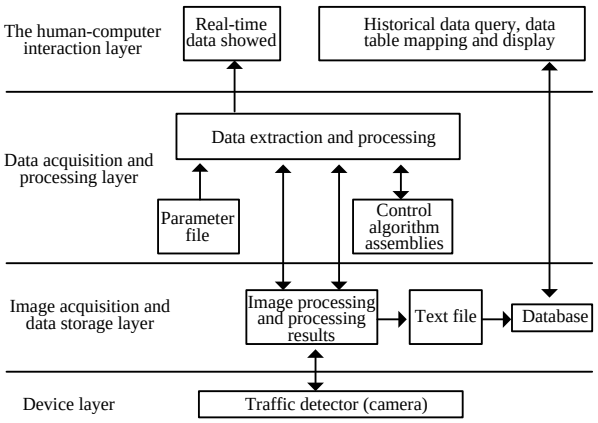

Figure 7. Percentage routing overhead

Figure 7 is the comparison of the CLZBR and ZBR algorithm under different number of nodes routing overhead percentage. The diagram shows that, as the number of nodes increases, the routing control group increases and the routing overhead percentage is on the rise. As CLZBR algorithm limits the sending RREQ packet node types, at the same time ,uses the parent node address calculation method to reduce the unnecessary routing discovery process, and thereby greatly reduces the RREQ packet in the network so that the routing overhead percentage significantly less than the ZBR algorithm.

5. Conclusion

To made full use of the advantages of AodVjr and Cluster - Tree protocol, CLZBR algorithm is proposed in this paper. The algorithm combines their respective advantages of the AodVjr and Cluster Tree agreement , using AodVjr algorithm between clusters and the Cluster - Tree algorithm within Cluster. It limits the number of the RN + nodes, and reduces the routing discovery process through the way of calculating the parent node address. These measures greatly reduces the RREQ packet of redundancy in the grid, and reduces the energy consumption; At the same time ,the CLZBR algorithm has proposed with a standby node instead of energy which is too low, the method of cluster head of its has improved the overall performance of the ZigBee network address.

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