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Research on Routing Protocol for UAV Flock Network

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Abstract: This paper studies the OLSR routing protocol, which is often used in UAV ad hoc network, deeply understands the working principle of this routing algorithm, and proposes a routing algorithm based on minimum ID clustering, which can reduce the overhead of routing algorithm and flooding broadcast, and is suitable for UAV formation networking requirements under high dynamic conditions.

Keywords: Modeling; OLSR; Unmanned Aerial Vehicle; Routing Protocol; Networking technology

INTRODUCTION

Unmanned aerial vehicles (UAVs) are widely used in the military field of the world today. They are widely used for reconnaissance, cruise and fast strike. Considering such factors as strike radius, attack precision and information sharing, people pay more and more attention to the formation networking of UAV, and many countries, especially the world's military powers, take it as the focus of weapon development.

UAV network is a wireless mobile communication system with big dynamic changes, so the situation the system faces will be very complex. To design UAV network system in wireless high-speed mobile environment, the most important thing is to choose appropriate networking method and routing technology. Despite international mobile ad-hoc network technology research has been conducted for many years, but usually the nodes in the network of mobile rate slower, moving rate about several meters to more than ten meters per second, and unmanned aerial vehicle (UAV) movement speed generally about dozens of meters per second, in other words, the unmanned aircraft and ground mobile terminal difference in speed is great, which caused the unmanned aerial vehicle (UAV) network topology changes too frequently, it seriously affects the performance of the network. Therefore, it is necessary to put forward higher requirements for UAV network routing strategy and carry out targeted research.

OLSR ROUTING PROTOCOL

Unmanned aerial vehicles (UAVs) are widely used in the military field of the world today. They are widely used for reconnaissance, cruise and fast strike. Considering such factors as strike radius, attack precision and information sharing, people pay more and more attention to the formation networking of UAV, and many countries, especially the world's military powers, take it as the focus of weapon development.

OLSR routing protocol is a common protocol of UAV ad hoc network, and its core idea is multi-point relay mechanism. The number of broadcast packets in wireless AD hoc network is obviously controlled, and the number of flood object nodes is controlled through selective flood, which greatly reduces the number of TC packets forwarded. The TC format is shown in Figure 2.

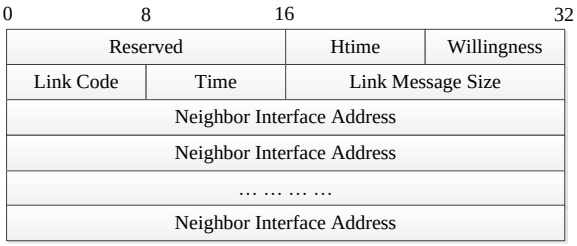

Figure 1. The HELLO format

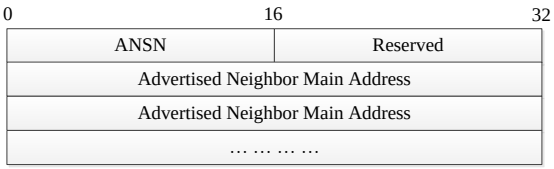

Figure 2. The TC format

OLSR ROUTING PROTOCOL TABLE

Local Link Table

The local link table holds the link information between the node and its neighbors. The table is saved as shown in Figure 3 below.

Figure 3. The local link table holds the link information

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The Neighborhood Information

Neighbor information table contains neighbor information, two-hop neighbor information, MPR information and MPR selector information

The specific storage format of the neighbor table of the node is shown in FIG. 4.

N_neighbor_main_addr	N_Status	N_willingness

Figure 4. The storage format of neighborhood table

The specific storage format of two-hop neighbor table is shown in Figure 5.

N_neighbor_main_addr	N_2hop_addr	N_time

Figure 5. The storage format of two-hop neighbor table

The commonly used OLSR routing protocol is studied and the principle of the routing algorithm is deeply understood.

MPR Selector information table

The storage format of how MPR selecting node information table is shown in Figure 6.

M_main_addr	MS_time

Figure 6. The storage format of how MPR selecting node information table

However, the traditional OLSR routing protocol cannot be used when the UAV does not maintain formation of high-dynamic network communications. Especially when the network is large, the use of clustering network structure, can reduce the routing algorithms and flooding broadcast, conveniently manage mobile nodes, control nodes access to wireless channels, and can improve network scalability and Qos security capabilities. The choice of clustering algorithm depends on the needs of the application, the environment of the network, and the characteristics of the nodes. Different clustering algorithms have different optimization objectives, including minimizing cluster calculation and maintenance, minimizing cluster heads, maximizing cluster stability, and maximizing node lifetime. CBRP uses the smallest ID algorithm for clustering.

The minimum ID algorithm is a simple clustering algorithm proposed by Greta and Tsai. Each node allocates a unique ID throughout the network, periodically broadcasts Hello messages including its ID value to other neighboring nodes, during which the node with the smallest ID among the adjacent nodes serves as the cluster head. This kind of clustering algorithm has features like simple design, small amount of calculation, easy implementation and fast convergence. The minimum ID algorithm has a slower updating of cluster heads, less overhead of maintaining clusters, and a higher throughput of the network due to the more reasonable number of nodes in clusters and clusters. The disadvantage of this algorithm is that it tends to select nodes with smaller IDs as cluster heads, which will consume more energy for these nodes and reduce the node lifetime when the energy is limited, and the algorithm does not consider such factors as load balancing.

OTHER TECHNOLOGIES FOR DRONE NETWORKS

MAC scheduling method

MAC design is one of the key technologies of wireless network. TDMA is an access control method that divides each member's sending time by time slice. It divides the time axis into moving length, repeated time frames, eliminating collisions and reducing energy consumption of nodes. In this paper, a distributed TDMA protocol is used as the MAC scheduling method for UAV networks.

The corresponding scheduling methods will change according to different modes of UAV network. As Unicom's peer-to-peer model is simple in structure, all nodes are peer-to-peer structures and adopt the same MAC. Therefore, each node needs to be assigned a corresponding time slot by using the traditional TDMA method. For clustered hierarchical mode, MAC scheduling is divided into two parts: cluster scheduling and intra-cluster scheduling, as shown in the figure.

Relay transmission technology

When beyond the radio coverage of the ground control station, UAVs will use relay to achieve communication with each other and with the ground control station. In accordance with the location of the relay device, relay can be divided into ground relay and air relay. Terrestrial repeater equipment is placed on the ground control station and drone between the commanding heights, air trunks are used as UAV repeater or satellite relay forwarding. The air relay cost higher than the relay mode. The repeater mode takes UAV as a relay device, and uses the ground station, relay UAVs, mission UAVs to form a network of over-the-horizon communication, as shown in Figure 1.2. It is characterized by fast moving speed, high maneuverability, low space limitations and low cost for radio waves, but the need to enhance the survivability of relay UAVs. Compared with the UAV relay mode, the satellite relay covers a wider area, and the satellite channel has relatively stable performance, available frequency bandwidth and larger communication capacity, but the cost is comparatively higher.

Communication antenna

The omnidirectional antenna is simple in structure and can easily meet the high-speed moving characteristics of the UAV node, and it also meets the complicated requirements of the UAV application environment, ensure the stability of the antenna performance and the design of the tracking device is relatively simple.

Directional antennas have high-performance, low-sidelobe pattern characteristics, with the advantages of high spatial multiplexing, long transmission distances, high transmission rates, low intercept and low detection.

UAV data link should be a combination of omnidirectional antenna and directional antenna, in order to give full play to their advantages, increase the physical layer performance, which can further improve the UAV network communication performance.

Antenna alignment means that the main lobe beams of the two antennas cover each other to achieve the maximum antenna gain. Antenna tracking uses antenna tracking devices and algorithms. While the positions of the two antennas are relatively changed, the antennas are always aligned with each other to reduce External interference and room interference.

In the initial stage of network initialization, omnidirectional antenna search ought to be used to find the location of neighboring nodes and network topology information due to the incomplete topology information and other reasons. The directional antenna obtains the maximum antenna gain by performing fast scanning in a small area to achieve the antenna alignment on the basis of obtaining the node location information of the omnidirectional antenna. Information like pitch angle, swing angle, attitude correction and other parameters should be included in the antenna alignment and tracking algorithm in order to get better performance, and ensure the communication dual hair antenna alignment.

CONCLUSION

This paper studies the networking technology and routing protocol which is commonly used in UAV ad hoc networks, provides profound understanding about the working principle of the routing algorithm and proposes a routing algorithm based on minimal ID clustering. This method can reduce the cost of routing algorithm and flooding broadcast, which is suitable for high dynamic UAV fleet networking.

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