Research on Serial Communication in Unmanned Aerial Vehicle Ground Detection System Based on Improved Artificial Potential Field Method

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Abstract: Before the take-off of UAV, the detection of TT& C equipment is one of the key factors to ensure the safe flight of UAV. Therefore, the ground detection function of a certain type of UAV is studied, and the improved artificial potential field method is used for in-depth analysis. It is concluded that the algorithm improves the gravitational function of the artificial potential field method, and through multiple iterations, and performs curvature check to obtain a sufficiently smooth flyable path. This means that the improved artificial potential field algorithm can meet the requirements of UAV path planning, and it is simple and feasible, with strong optimization ability and adaptability.

1. Introduction

The ground control station system in the UAV system was gradually proposed in the development process of the UAV application. The modern UAV has emerged from the original single combat mission and loaded with various equipments [1]. The UAV system is a complex and intelligent system. The UAV airborne equipment mainly uses the serial interface for communication [2]. At present, the UAV system occupies an increasingly important position in modern warfare due to its flexible, long-lasting flight and "zero casualties" [3]. Compared with traditional manned aircraft, drones can perform air missions for a long time, make large overload maneuvers, maximize flight attitudes, have good stealth, and go deep into dangerous areas without the risk of casualties [4]. Fixed-wing UAV has been studied earlier, because it has certain gliding ability, strong wind resistance, and can realize flight control independently. In the fields of long-distance cruise, military bombing and so on, the application of fixed-wing UAV is becoming more and more popular [5]. Because the working environment of the UAV in flight is very complex, many situations are difficult to predict, so a lot of ground detection must be done [6]. At the same time, in order to ensure that UAV can reliably and effectively carry out all kinds of flight tasks, it is necessary to carry out full testing before taking off to ensure the integrity of the equipment in use [7].

2. Methodology

Threat modeling is an important prerequisite in the research of UAV route planning. Quantitative description of the size of UAV battlefield threat and the interaction between threats is a difficult problem in threat modeling [8]. Each property can be set by specifying an integer index and its corresponding value, or by using the integer index value to obtain the property value of the control [9]. The ground detection system can be divided into two parts: hardware and software. The software mainly refers to the ground station control software system. It provides the ground operator with the convenience of remote control of UAV. Through the ground station software system, the flight status of the aircraft can be monitored conveniently and intuitively, and the control commands can be sent to the UAV through the ground station [10]. However, when a fault occurs in the TT&C subsystem, it is necessary to first determine which part of the fault occurs on the airborne and ground, and then to determine the location of the fault. In order to meet the needs of serial testing of unmanned aerial equipment, improve the efficiency of testing and

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maintenance of airborne equipment, ensure the reliability of testing and reduce the working intensity of testers, develop an automatic on-board equipment for drones. A test system with serial testing and human-computer interaction is necessary. The user can also set the flight data parameters of each airborne device independently, and send it to the flight control computer through the serial port for the calculation of the control law, which can be used for the flight control simulation of the flight control computer.

The remote ground device is composed of an instruction coding terminal, a remote control transmitter and a remote control transmitting antenna. The generation and coding of the remote control command are completed and transmitted through the transmitter and the antenna feeder unit. The main technical indicators are shown in Table 1.

Table 1 Main indicators of a certain type of drone remote control ground equipment

Name	Technical index
System	DSSS-DBPSK
Number of channels	Nine, 0.4 MHz apart
Signal bandwidth	700kHz
Spreading gain	18dB
Roll command number	3

Because the radio communication interface protocol between ground detection system and autopilot is RS422, serial port is designed to realize the communication between them. The system has the functions of human-computer interaction, serial data unpacking display and data packaging and sending. When the airborne and ground parts of the TT& C subsystem are far apart (for example, when the UAV test flight, the TT& C ground station may need to be located at the far point), it is difficult to judge whether the TT& C ground station is normal before the UAV takes off. The hardware of the ground detection system includes remote control handles, data lines, and so on. The wireless communication data link includes a transmitting wireless communication device on the airframe of the drone, and a receiving radio station connected to the ground station through a serial port, and the wireless communication data link is an airborne drone body and a ground station system on the ground. Data transmission channel. If the receive buffer is set to a large size, multiple frames of data are stored in the receive buffer before the data calculation process is completed. Once the working time is increased, the data frame in the buffer will increase. When the receiving buffer is full, some new data cannot be collected into the receiving buffer in time. However, the current real working situation and the processing result of the detection system are greatly deviated, which is disadvantageous for real-time monitoring and real-time control.

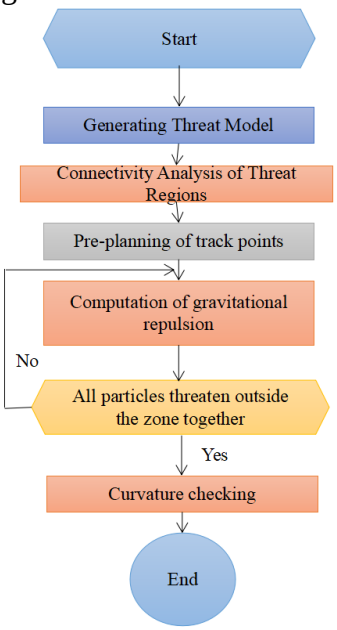

Fig.1. the overall flow chart of the algorithm is shown in the figure.

The algorithm of this paper jumps out of the traditional construction method of gravity, and the combination of global pre-planning thought and artificial potential field method not only narrows the search scope, improves the planning efficiency, but also fundamentally solves the problem that the artificial potential field method is easy to fall into the local minimum. In the UAV path planning, the actual application is obtained. The overall flow of the algorithm is shown in Figure 1.

3. Result Analysis and Discussion

The artificial potential field method is a kind of virtual force method. The basic idea is to represent the environment as an artificial potential field, the target point is the gravitational field, and the obstacle is the repulsive field. Each serial port can transmit data and receive data. It is a full-duplex communication mode, which can realize the functions of telemetry data receiving and remote command transmission. Then, for the communication between the ground flight control station and the ground navigation station, in order to have high reliability and strong real-time performance, the network communication method of the connection-oriented flow mode, that is, the TCP/IP protocol is selected. Therefore, in actual work, the detection of the measurement and control subsystem, especially the detection of the ground part of the measurement and control system is crucial. The ground detection system monitors the UAV' s key flight parameters, such as track heading, cruise speed, climbing speed, sensor data, data link integrity and battery power. After receiving the ground detection system, the data will be parsed and displayed on virtual instruments and other controls. Therefore, in view of the large amount of data processing in the detection system, the receiving buffer can not be set too large. In this system, the receiving buffer is set to 64 bytes, and only the latest two frames of data are processed to ensure real-time data processing.

In this environment, when using the traditional potential field method, the repulsion force of the robot is dispersed and the direction is different because of many obstacles. Finally, the path planning trajectory of the robot is shown in Figure 2. Obstacle linking method is to link the obstacles in some areas of the map to make them become a whole obstacle, thus overcoming the influence of dispersed obstacles on mobile robots. The calculation of potential field is simplified. Therefore, the key of the algorithm lies in the detection of obstacles by robots, the connection of dispersed obstacles that need to be connected and the calculation of potential field after connection.

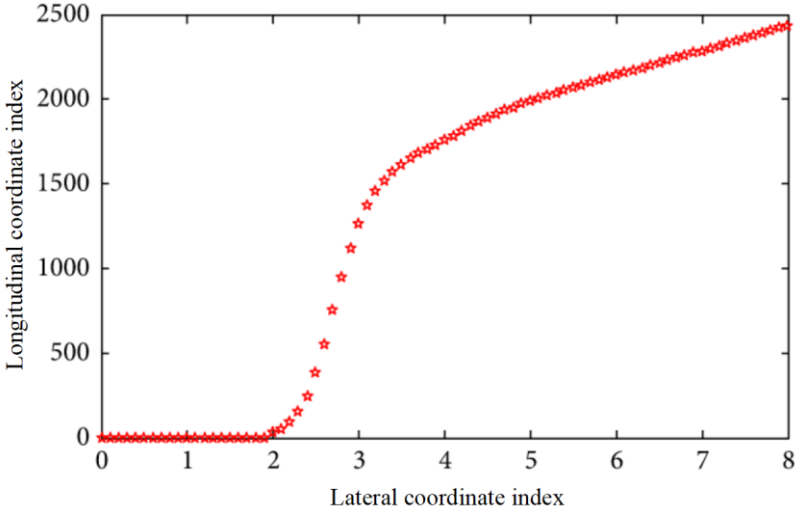

Fig.2. Path Planning of Experimental Robot in Multiple Distributed Obstacles Map

First, read the serial port parameters of the corresponding communication protocol from the database, and then initialize the serial communication, mainly to set the parameters of the communication and prepare for the operation of opening the port communication. If there are multiple threat center sets that intersect the line, the closest set is selected by comparing the projections of the threat centers in the sets on the line, and the set corresponding to the threat center closest to the starting point (new starting point). . For the sake of simplicity, it is assumed that the drone is flying at a high altitude and the threat is subjected to a two-dimensional interface. The

projection of the threat area in the horizontal plane of the predetermined flight height is centered on the threat center, and the effective range of the radar, such as the detection range of the radar and the attack range of the missile, is a radius, and a circular area is constructed to represent the threat. Therefore, the remote control of UAV by ground detection system can not only monitor the flight status of UAV and the operation of mission equipment in real time. In addition, the attitude of UAV can be adjusted by sending control commands from ground station, and the flight path and task can be planned at the same time. Therefore, ground station research plays a vital role in the whole UAV system. In the actual system debugging test, the functions of each part of the ground detection system have been well realized, but also has a strong real-time performance.

4. Conclusion

Unmanned aerial vehicle (UAV) ground measurement and control system is an important part of UAV measurement and control subsystem. Whether the measurement and control function is good or not plays an important role in the safe flight of UAV. Therefore, it is necessary to develop a UAV ground measurement and control system. In this paper, the traditional potential field method is improved and the effect is remarkable. Through the analysis of all threat information, the area that has no influence on the better route is excluded, which greatly reduces the search scope, improves the efficiency and adaptability of the algorithm. At the same time, a robot remote control system based on augmented reality is designed and implemented. At present, the system has been developed and debugged. It has been applied to the ground measurement and control test of a certain type of UAV, and its performance is stable and reliable. In addition, the system can be applied to other measurement and control testing equipment with a little modification, and the application range is wide, which has great application value. Practice shows that the human-computer interaction interface of the system is friendly, and the data display is intuitive and rich, which greatly improves the efficiency of testing and maintenance of airborne equipment. Combining the improved artificial potential field method with the UAV ground monitoring system is expected to combine the advantages of both, and is more suitable for the quality control requirements of mass customization.

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