Communication Control System of UAV Based On 5G Network

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Abstract. Remote control is the traditional control mode of unmanned aerial vehicle (UAV), which limits the signal transmission distance. To accomplish ultra-long-distance UAV control, we propose a communication control system which based on 5G network to transmit UAV control signals. We develop a backstage service platform based on 5G network to connect with the communication module installed on the remote UAV. In this paper, we describe the detail of this system which realizes the normal communication control of the remote UAV and the service platform. Our experiment results show that our system has the characteristics of stability and scalability.

1. Introduction
In recent years, the rapid development of UAV applies it to various fields such as forestry cruising, power inspection, video aerial photograph etc. It is estimated that by 2025, the market scale of domestic UAV aerial photography, agriculture, forestry and plant protection and the total market will reach 30 billion yuan, 20 billion yuan and 75 billion yuan, respectively [1]. In common application scenarios, the control mode of UAV is still the short-range remote control which is approximate 3 kilometers [2, 3, 4]. The research on the ultra-long-range UAV control system is rare [5]. Whereas 5G network can achieve ultra-long-distance communication with the characteristics of high speed, wide spectrum and tiny delay [6, 7].

In this paper, we propose a UAV background control system based on 5G to tackle the remote control problem. When the UAV and the controller are located at a distance, the controller can remotely control the UAV through the system, and conduct flight scheduling for the UAV. Meanwhile, the UAV feedbacks the information collected itself to the control system for data processing and the administrator is able to delivery instructions. The contribution of this paper can be summarized as: First, it can realize the remote control of UAV based on 5G network. Second, the controller can control numerous UAVs one to many through service platform. Third, the system has the characteristics of strong compatibility and expansibility which can be applied in different fields.
2. System composition
The composition of the system is shown in Fig. 1, including the background application software, the communication control system of the UAV terminal, the communication control system of the UAV takeoff and landing service desk, etc. The background application software aims at the communication between UAV and service platform through 5G network to accomplish the ultra-remote control. The background application software can send instructions to the UAV and service platform to control the UAV and service platform. We can easily monitor the status of the UAV system through the information transmitted back by the UAV and service platform.

3. System design
The background application software employs the interface mode, by clicking the application software control button to issue simple instructions. The communication control module uses the standard interface to facilitate the function expansion and equipment replacement.

Firstly, the system calls the Socket function [8] in WinForm to bind the IP address and port number. The IP address server uses an Alibaba Cloud server to establish a network connection with the remote communication control module motherboard. After establishing the network connection, the simple instruction can call the Button control in WinForm. When the Button is clicked, the instruction is sent to the communication control module motherboard, which is forwarded to the control motherboard by the serial port to realize the control of UAV and landing service desk. The instructions include scheduling start, cruise, return, etc.

For complex instructions, we employ TxtBox to input special instructions, and then send the instructions to the remote communication module main board. The instructions are in a fixed format to facilitate flight control reading and processing. The text message sent back from the communication board to the background can be displayed on the ListBox interface. The required information is collected by the sensors on UAV and the landing service desk, including temperature information and wind information, Aircraft PID parameter information, etc.

Secondly, the communication control system consists of the network communication main board and the device control main board. The video information returned by the communication motherboard is displayed by the Windows Media Player component, and the video processing button is set to realize the functions of recording, screenshot, and storage of the video. The control main board is divided into the UAV flight control main board and the take-off and landing service desk control main board. The primary task of the UAV flight control motherboard is to control the UAV to fly steadily while collecting sensor information for data processing. The flight control main board reads altitude information by connecting a barometer and an ultrasonic sensor, locates the latitude and longitude by connecting a GPS module, reads the aircraft inclination angle by a gyroscope, and calculates the drone speed inside the flight control main board. The information is transmitted to the communication motherboard through the serial port, and the communication motherboard is forwarded to the background for display. The coordinates of the UAV and the takeoff / landing service desk are
collected by the GPS module which is connected to the main board. After the information is transmitted back, they are displayed on the interface map. The map module employs the Html page to call the Baidu map API interface, connect the Baidu map to the WinForm interface, and return the GPS coordinates, latitude and longitude to mark points on the map. We can intuitively see the location information of the drone and the landing desk.

Finally, the background of the UAV flight scheduling and path planning, by marking points on the map, to obtain GPS information on the map, a series of marked point GPS data is sent to the communication motherboard in the order of number, the communication motherboard will all The commands are transmitted to the UAV flight control board through the serial port to control and plan the UAV's navigation.

4. Experiment results
The verification of the UAV background communication system is that after connecting the UAV and the service desk through the background application software, it issues instructions to the corresponding device. The device can receive instructions normally, indicating that the system can achieve communication control functions.

4.1. Background software sending instructions
In this paper, the command transmission function is defined in WinForm, such as the start, cruise, and return of the UAV, which issue the corresponding commands. After the connection is successfully established, the UAV will take off at a distance by clicking the corresponding button. Similarly, controllers can issue instructions to the landing desk. The landing desk serves as a box to contain UAV. The landing desk opens and closes controlled by users to allow UAV to enter and exit. The effect is shown in Fig. 2.

![Figure 2. UAV platform structure.](image1)

4.2. Background software receives information
Various sensors are installed on the UAVs and the service desk. The feedback information is shown in Fig. 3 which is the background interface. On the background software interface, the altitude data, GPS position and PID value of the current UAV is shown. The video information taken at the moment is shown in the video box.
4.3. **UAV path planning**

The UAV navigation function is shown in Fig. 4. After the position of the UAV is displayed on the map, controllers can mark the points on the map in sequence to plan the path. The system obtains the latitude and longitude of the point, numbers the latitude and longitude and sends it to the UAV. The UAV navigates according to the assigned latitude and longitude to accomplish path planning.

5. **Conclusion**

In this paper, we propose a system to achieve ultra-long-range UAV communication control. Employing the 5G network as the medium, the background carries out the transmission of instructions and the feedback of information. The background can also plan the latitude and longitude order to achieve the autonomous path planning of the UAV. The characteristics of tiny delay, rapid speed and wide coverage area of 5G network ensure the stability of the proposed system. Our system allows the operator to control the UAV remotely. As a result, it has a wide range of application prospects. Similarly, when the 5G era arrives, it is still possible to implement UAV control based on 5G communication, achieving a lower delay, higher definition video, and a more stable design of the system.

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