Research on the Trend of UAV Communication Signal Indication System

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Abstract. In recent years, with the application of high-definition video coding and decoding technology, high-precision satellite navigation technology, mobile base station positioning technology and wireless UAV wireless communication technology, the performance indicators and application scope of UA have been significantly improved. Whether it is industrial applications or specific applications, drones play an important role. With the continuous improvement of technical indicators, UAV wireless transmission technology needs further exploration and development. Although there is a lot of research on UAVs, there are still some shortcomings. Based on the AD9361 + ZYNQ7045 platform, this paper has completed the design and implementation of the UAV wireless transmission system. Although there are various integrated UAV wireless solutions on the market, the UAV communication frequency can be allocated to non-fixed frequency points that still do not meet the requirements, such as frequency band L, frequency band S or frequency band C. The design proposed in this paper is that the adjustable radio frequency range is 70MHz to 6GHz, which is sufficient to meet the application requirements of multiple communication frequency points. The UAV wireless transmission system proposed in this paper has strong scalability, wide application range and high integration, which has special reference significance for the design of UAV wireless transmission system. This article uses the flight control algorithm and PID control to analyze the signal range of the UAV communication signal indicating system and explore the future development trend. Through the method in this article, the UAV communication signal increased by 15%.

Keywords: Uav; Communication Signal Indicator System; Trend Research; Flight Control Algorithm

1. Introduction

1.1. Background and Significance
UAV (Unmanned Aerial Vehicle) is called unmanned aerial vehicle. Since the birth of the world's first drone in 1917, the drone industry has developed rapidly. From the beginning of a flight to the present, dozens of industries with an output value of more than tens of billions have been subdivided [1]. It has been dynamically developed and implemented in many fields [2]. Especially in the military field, due
to the advantages of low cost, zero casualties and military aircraft reuse, it has promoted its wide application in the military field [3]: in the industrial and commercial fields, aircraft are mainly engaged in missions. Surveillance and reconnaissance, remote relay communication, power line detection and maintenance, target simulation, sea power protection and other tasks; in scientific research, aircraft surveillance of dangerous goods, weather forecasting and other fields in the political field, drones in aerial photography, photography, Design and agricultural production play a unique role [4].

Today, the development of consumer-quality drones is in full swing. Among them, the configuration of multiple short-distance rotors is the most prominent, mainly used for aerial photography, exploring complex terrain and outdoor photography enthusiasts [5]. Its biggest feature is that it can not only capture high-definition video, but also transmit high-definition video to the ground in real time. Consumer drones have huge development potential [6-7].

1.2. Related Work
Because of the importance of drones to our modern society, more and more scholars and research teams have begun to focus on the research of interpersonal communication signals, and have achieved quite good results [8]. Fawaz once did research on the navigation of UAVs. He proposed that UAVs can be used in many aspects in the future [9]. From the present point of view, he is right, but the UAV's signal indicating system is not Problems that need to be solved by man and machine. The research on the UAV signal indicator system will affect the future development of UAV, and it is also a key issue that we need to solve [10].

1.3. Main Content
This paper uses literature research methods and other methods to study the past UAV communication systems, summarizes some good past experiences and methods, and then calculates the flight of UAVs through methods such as flight control algorithms. Through the method in this article, the UAV communication signal has increased by 15%.

2. Research Method of the Trend of Uav Communication Signal Indicating System

2.1. Flight Control Algorithm
At present, the rotors of small quadroplane UAVs are divided into two structures: "Ten" and "Cross" [18]. This article takes a UAV with a "crossover" structure as an example.
Move up and down: When the total thrust of the Sifang rotor is equal to the sum of the shaft mass and air resistance, the Sifang rotor will hover in the air and maintain this position until the force becomes larger. When the air resistance and air resistance are combined, the quadroplane drone rotor will perform a vertical upward movement. When the total thrust of the quad-rotor UAV is less than the sum of the fuselage mass and air resistance, the quad-rotor UAV will perform a vertical descent movement along a straight line.
Transfer movement: When the four rotors rotate, due to air resistance, a reaction torque opposite to the rotation direction will be generated. The magnitude of this value is proportional to the speed of the rotor. Rotating drone blades are based on the same set of propellers with the same rotation speed and direction. The positive and negative propeller sets are at different rotation speeds and opposite directions. Therefore, due to two different torques, the rotating blades of the drone have a gyroscope. Due to the different magnitudes of the generated torque, the square UAV rotates at different angles around the Z axis. The rotation angle is defined as the deflection angle $\psi$, and the motion state is the deflection motion.

2.2. Pid Control
There are many theories for the control algorithm of UAV rotating blades, such as feedback linearization, intelligent control methods, and adaptive backstepping. These control theories have been
proven through experimental simulations, and dynamic rotor UAV models can be executed. Very good control. Because the current development of material technology lags far behind scientific research theory, it is difficult to apply it to practical engineering. Therefore, the research object of this work is the traditional PID control algorithm, which has the advantages of simple structure, high reliability, and good stability.

PID control is a kind of controller with feedback correction, which has lower requirements on the control object model. The system is controlled by comparing the actual system input with the expected real-time input, and using the error value of the two to configure the system. The ultimate goal of control is to allow the input to see the expected input in the shortest time. PID controller consists of three parts: proportional factor, integral factor and derivative factor. The proportional coefficient represents the current value, the integer coefficient represents the historical value, and the differential coefficient represents the future value.

Proportion check: first calculate the error value based on the actual input and the expected input. The product of the analog coefficient $K_p$ and the error value $err$ is the correction value of the control. Therefore, if the $K_p$ value is high, the actual input value will be close to the expected input value. The speed is fast, but the aspect ratio is too high, so when the error value between the two is small, a lot of oscillations will occur. If the $K_p$ value is low, when the actual input value is close to the expected input value but the actual input value is close to the expected input speed, the oscillation will become smaller.

Differential control: Because of the analog control, the error error value gradually decreases, that is, the error error value is a curve with a negative inclination. It can be seen from the above formula that the greater the error within a certain period of time, the higher the absolute value of the differential, therefore, the reduction of the error speed is suppressed, so no large oscillations will occur. This suppression effect will not stop until the tilt angle is 0.

Integrated control: From the above point of view, analog control can only try to set the err error value to 0, while differential control can only control the inclination angle of the error curve to 0, but the err error value cannot indicate that when the inclination angle is 0, the $T_e$ value is also 0. Now the built-in controls come into play. We know that the integral of the curve is equivalent to calculating the area between the curve and the X-axis, so when the error value is 0, the integral value is 0. Even under the action of analog control, the system tends to be stable. In the case of differential control, as long as the error value is not 0, a static error will occur. The existence of static error will cause the integrated control to run until the error value is 0. Therefore, in theory, PID control will have very precise control results.

3. Trend Exploration Experiment of Uav Communication Signal Indicating System

3.1. Mti-g Module
MTI-G is a miniature header unit that contains GPS signals and can be used in aerospace, robotics and other fields. When using MTI-G on a drone, it will provide the drone with its current position and speed information. There is no GPS inclination (pitch, roll, yaw) 3D direction information, and calibration information about 3D angular velocity, acceleration, and geomagnetic field. This information is an important data source for flight control algorithms, and the accuracy and nature of the data must be ensured in real time. In order to reduce errors and improve data accuracy, there will be an offset compensation value. For example, the measured gravitational acceleration value and magnetic force will compensate for the infinitely increasing movement caused by the accumulation of rotation data errors. Thanks to the indoor GPS module, it can also provide accurate and dataless GPS data. As the internal calibration of 3D speed, 3D acceleration and 3D geomagnetic field data, MTI-G is an inertial measurement unit with excellent performance and can be used for unmanned driving. Machine navigation can provide accurate data information.

3.2. GPS Unit
From the topic of the MTI module above, it can be known that the topic contains the GPS information of the drone, but in order to obtain more accurate GPS information, this article decided to use a GPS module with higher accuracy. GPS first determines the target coordinates through satellite navigation, and then compares them with the map coordinates to determine the specific location of the target. The GPS positioning principle is based on the instantaneous position of the high-speed satellite as the initial position, and the method of calculating the position of the point to be measured by meeting the space distance. The global positioning system provides the world with all-weather, high-precision, continuous three-dimensional real-time coordinates.

(1) U-Blox protocol UBX protocol data Each data packet consists of three parts: header, data segment and control segment. The first two bytes of the header are: 0XB5 and 0X62. Through these two bytes, it can be judged whether the protocol adopted by the data packet is UBX. CLASS occupies one byte, indicating the type of message. ID occupies one byte, indicating that the specific parameter data under the CLASS parameter has been exported. LENGTH indicates the number of bytes occupied by the data module. CK-A and CK-B are two control bytes used to check whether the data packet is complete.

(2) NMEA protocol NMEA0183 is a communication protocol usually used for GPS data. However, in actual situations, not all NMEA information is used. The data required by the drone only requires the GPGGA data frame. The data frame is also the most widely used.

3.3. Barometer Unit
When it comes to drones, information such as air pressure, temperature, and altitude is also very important. The barometer can accurately calculate altitude from atmospheric pressure. Therefore, the barometer unit is also an essential part of the UAV flight control system. [14]. In terms of cost performance and barometer data accuracy, the MS58xx barometer series can meet the requirements of industrial-grade UAV flight control algorithms. Since the barometer unit is an independent physical device, it also includes the communication between the microprocessor and the barometer unit. There are two ways to communicate with the barometer unit, namely SPI and I2C. Since the aforementioned MTI has completed the interface associated with the SPI bus, the barometer also uses the SPI bus to communicate with the microprocessor, thereby improving the reusability of the software code and reducing subsequent maintenance costs.

4. Research And Analysis on the Trend of Uav Communication Signal Indication System

4.1. Scope Analysis of Communication Signal Indicating System
Because of the rapid development of the times, the development of communication signal indicating systems is also rapid. This paper found out the data indicating the range of the communication signal system through literature survey. The detailed data is shown in Table 1. Figure 1:

| Year | Range |
|------|-------|
| 1980 | 200   |
| 1990 | 273   |
| 2000 | 350   |
| 2010 | 530   |
| 2015 | 600   |
| 2018 | 1000  |
5. Conclusion

In recent years, with the application of high-definition video coding and decoding technology, high-precision satellite navigation technology, mobile base station positioning technology and wireless
wireless communication technology in UAVs, the performance indicators and application range of UAVs have been significantly improved. UAVs play an extremely important role in both industrial and commercial fields. With the continuous improvement of technical indicators, UAV wireless transmission technology also needs continuous innovation and development. Although this article has conducted in-depth research on the design and implementation of the UAV wireless communication system and proposed a specific application method, it has been verified by simulation and actual testing. However, there are still many shortcomings in this article, which require further research. First, the symbol rate tested for the wireless transmission system designed in this article is 10Mbps, and the future growth trend requires the transmission rate to exceed 100Mbps. Based on this article, how to further increase the transmission rate is the next issue to be considered. Secondly, this article mainly plans the design of the communication and transmission system between the ground and a single UAV, namely one-to-one design architecture. UAV team is the future development trend, that is to say, upgrading from one-to-one architecture to one-to-many design is also the next direction that needs in-depth research. In the future, I will conduct in-depth research on these two aspects to perfectly complete my academic career.

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