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Design and Research of Quadcopter Navigator

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Abstract: This paper studies the autonomous navigation equipment of Quadcopter. SINS/GPS integrated navigation technology, ultrasonic ranging and barometric altimeter is used in the autonomous navigation system. Navigation board includes measuring height subsystem and measurement position subsystem. The former includes an inertial navigation module and GPS module using the Kalman filter for data fusion, which gets a more accurate and stable location information. Quadcopter height measurement subsystem, using ultrasound and barometers. Complementary filter for effective data fusion, is used to ensure the reliability of height measurement.

Background

Navigation systems have applications in many areas, such as navigation, guidance, transportation and other areas. Now commonly used systems are Satellite Navigation systems and Inertial Navigation Systems (Inertial Navigation System, INS), Satellite Navigation System, there are some shortcomings, such as: low precision, cannot determine the user's location. INS divides into flatbed inertial navigation systems and inertial navigation system. Inertial navigation system reduces the weight, volume and cost of the system to improve the maintainability and availability of the system, so it is widely used. But it also has some shortcomings, such as high cost, navigational errors accumulated over time.

Today, people demand more and more of the carrier in motion of tracking accuracy and navigation, only relying on a single sensor for navigation, tracking and control which have been unable to meet this demand. So people turn to a combination of multi-sensor navigation system, hoping to improve the reliability, accuracy and ability to adapt to the environment through the complementary advantages navigation system. GPS and SINS have good complementary strengths. Combining the two systems, between the two systems will be able to learn from each other, the combined system will be better than two single navigation system on the accuracy and reliability. And SINS/GPS integrated navigation system is not only small, cheap, but also high precision, obvious advantages, so it is widely used in various fields.

Overall design

GPS navigation system as the prime measurement, is a core part of the overall design. The Quadcopter using GPS for peripheral location, such as height, route to take a flight. The SINS inertial navigation system as a complement to the GPS navigation system, mainly compensates for the inadequacies of GPS navigation through its strengths, maximizing the accuracy and timeliness of navigation and positioning. The second main feature is the height data measurement and

acquisition. The system consists of ultrasonic altimeter and barometric altimeter. Although GPS navigation system itself can be to get high, but the height data does not guarantee the accuracy. The module responsible for height measurement is in demand. Ultrasonic testing can obtain more precise data, very practical, but a fatal drawback is the small measuring range, cannot obtain the height of the high-altitude aircraft. When more than 6 m, barometer is used. Although barometer not as precise ultrasonic inspection system, but it has large measuring range, more than kilometers, Integrated the two, Navigator on the height data acquisition is improved. General System diagram is as follows.

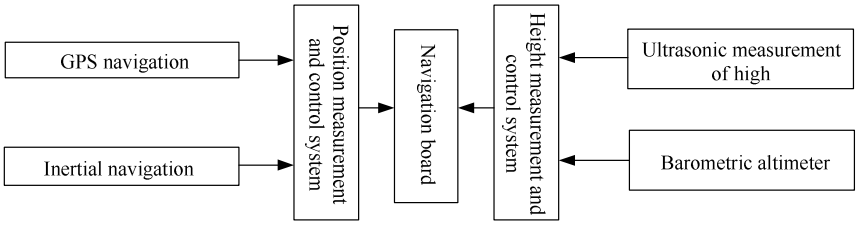

Figure 2-1 General System diagram

Design of measuring position subsystem

3.1 GPS module

GPS hardware circuit is based on STC89C52 microcontroller to design. The whole GPS hardware consists of its receiving module [1]. The entire GPS receiving module, and analysis processing is complete, using MAX232 chip level conversion, allowing the microcontroller serial communication with the host computer, sending the results to the measured position feedback system and the aircraft control system.

The GPS software module consists of the initialization, receiving information, processing and transmitting data. After starting the GPS module, the chip (MCU) initialize the whole system, after the completion of initialization, transmission of the satellite signal reception is started by the receiving module. When the data is received, the system begins to analyze the data, and then transmits the data through the serial port to measuring position system, completing a cycle.

3.2 Inertial Module

This system using the inertial navigation to compensate for the error of GPS. The working principle of inertial navigation is the acceleration and angular velocity measurement, calculation and analysis. It is concluded that the location of the next moment. A 6-axis motion processing sensor MPU6050 is used, which fully meet our requirements. But taking into consideration the position of the entire measuring system, not just a GPS module at work, we also added inertial module to compensate for errors in GPS , so individually designed a control circuit for measuring the position of the entire system of total control[2]. The system uses AT89S52 microcontroller, like the entire GPS module design and circuit design of the control circuit including the reset circuit, clock circuit, serial interface circuit, power circuit and so on[3].

INS module software module is designed primarily for three-axis acceleration sensor. MPU6050 contains a three-axis accelerometer and a three-axis gyroscope. The communication is based on the IIC bus protocol. IIC According to the working mechanism of the transmission bus, the system uses the chip I/O port simulation IIC bus data and clock the serial port serial port, according to the agreement of the two IIC bus port for software programming, it will cause the MCU and MPU6050 communication.

3.3 GPS/SINS Integrated Navigation

GPS navigation has advantages like long-range navigation, cheap, stable, etc., but the GPS navigation accuracy is low, cannot high-precision positioning. Inertial Navigation is the angular velocity and the acceleration measurement, calculation and analysis, and the navigation data can be obtained, short distance with high accuracy, but the accumulation of errors, it cannot locate a long distance. Two navigation methods have advantages and disadvantages, the system combines the advantages of two navigations, using the Kalman filter to process the data obtained in two ways, launched optimal data, the formation of SINS/GPS integrated navigation, so you can have long-range precision positioning, and in the case of the lack of visible GPS satellite, you can take advantage of location information SINS auxiliary projections.

Design of altimetry subsystem

4.1 Ultrasonic altimeter module

In order to make the design of ultrasonic ranging system can meet the requirements to obtain a high degree of Quadcopter, must do the followings: (1) Get the ultrasonic echo analysis and processing; (2) be capable of transmitting ultrasonic; (3) be able to pass in the far distance 4) calculate and display the measured distance; information and data. Therefore, in the transmission circuit, we must start with the transmitted pulse counter both actions simultaneously at the same time, followed by emission of the amplification circuit generating high voltage pulses to drive the transducer excitation.

Ultrasonic altimeter system software module consists of the main program, subroutines and interrupt service routines [4]. Process as follows: First of all power to the system, and then initialized, then start the measurement process, receive the echo time to get used to calculate the average by ten times, and then the data is sent to the display, returning after delaying, correcting circuit amplifies reception factor, and then start the measurement.

4.2 Barometric altimeter module

To compensate for the smaller ultrasonic distance measurement range, the system also uses a barometric altimeter. Although not as ultrasonic barometric altimeter so precise, but it has a larger range, so the use of a combination of both to get the height position of the aircraft in order to ensure accuracy and to meet the needs of the measuring range. The system selected BMP085 pressure sensor, the superior performance of this sensor, it can meet the design requirements.

The module program uses Language C, using a modular design approach. It mainly includes: the main program, system initialization, IIC serial data input subroutine, subroutines height calculation and display routines. The main program in the implementation process, mainly carried out in a cyclic manner. the data is passed to constantly get altimeter system[5].

4.3 Altimetry data fusion system

Ultrasonic within five meters higher precision, while the barometer measurement accuracy at low altitude is not accurate, so we mainly within 5 meters measured ultrasonic data based. But the actual altitude of the aircraft is not limited to 5 meters, in the range of more than five meters, we do not consider the data measured by the barometer completely actual height data. However, due to the height 5 m is too small, the aircraft during on flight, due to the different degree of rough ground, and sometimes mutated data measured this time and the actual height of the deviation occurs, and therefore, the combination of air pressure system taking into account the measured data, collected by Kalman filtering method as a data fusion algorithm, recursive precise height data.

Conclusion

In this paper, the design and study of quadcopter navigator are discussed, Research is mainly focused on the SINS/GPS integrated navigation system, ultrasonic ranging system and air pressure sensor ranging system. GPS navigation system combined with SINS inertial navigation system, the two complement each other, which makes the composition of SINS/GPS navigation system that performance is more superior. Ultrasound combined with a barometer, forming a high measurement system, which is more accurate. Altimeter measurement system and the location of the system designed in this paper together make up the navigator.

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