Solving environmental monitoring problems using a miniature four-axis unmanned flying platform

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Abstract. A miniature quadcopter platform is low-cost, simple to control, has low take-off and landing requirements, a small size, is easy to carry, more flexible in use, has safety and other advantages, compared with the traditional quadcopter. This paper mainly uses the Arduino open-source program to develop the design and implement the micro quadcopter hardware, remote control and the ground station for solving environmental monitoring problems. It is necessary to propose the study of miniature four-axis drones, then to demonstrate the use of microelectronics technology, wireless communication technology, sensor technology for aircraft, remote control, and the ground station detailed design. Finally, the specific implementation of each part will be shown, and the theory will be verified experimentally.

1. Introduction

A miniature quadcopter represents a fuselage with a diagonal of less than 15 cm, consisting of four symmetrically distributed engines that can rise vertically and be easily controlled. Compared with the conventional quadcopter, it is safer, less damaged in accidents, easy to carry, and these advantages will extend the usage scenarios.

To achieve the above-mentioned requirements, we use the Arduino Nano motherboard. As shown in Figure 1, the Arduino Nano is a convenient, flexible, and easy-to-use open source hardware product with a compact size, rich interface, and support for SPI, IIC, and UART serial communication. It can sense the environment using multiple sensors, and its standardized interface allows drones to be equipped with personalized pods for various types of tasks. You can record various programs in a short time, change your flight mode, and adapt to different usage scenarios. Compared to other microcontrollers, it makes more flexible, powerful, and fast calculations. With the Arduino Nano, we chose the GY521 gyroscope as a three-dimensional aircraft acceleration sensor (Fig. 2).

![Figure 1. Arduino Nano motherboard [1].](image_url)
An integrated 6-axis motion processing component eliminates the problem of the difference between the axes with the combined gyroscope and acceleration sensor, reduces the packing space, and can output the full 9-axis fusion calculus technology to the application side. Its angular velocity measurement range is ±250, ± 500, and ±2000°/s (dps). The transmission bandwidth is up to 400 kHz 12C SPI. Its working voltage can be directly output by the Arduino Nano. For the convenience of daily use, we have selected the Bluetooth HC-06 communication module (Fig. 3).

It is based on the Bluetooth 2.0 specification with the Bluetooth EDR Protocol, which can be connected to the device via a TTL serial port. It ensures stable signal transmission, a wide range, has a small size, and can transmit the drone signal. The power supply we use is a 720 hollow Cup motor with 55 mm blades. The motor can be powered directly from the motherboard. Four engines provide 60 grams of thrust in standard conditions. The flying platform is powered by a 3.7 V 350 mAh lithium battery, which can provide it with about 5 minutes of working time. An external battery allows you to quickly replace a battery with a low battery level and increase the sending frequency.

2. Methods
As shown in Figure 4, for powertrains, we used N-MOS electrical circuit [4] instead of traditional electronic speed controller for quadcopters.

Its three contacts are connected to the motor section, a 10K resistor, and a common negative power pole. The other end of the motor is connected to another contact. The TXD pin of the HC-06 Bluetooth module is connected to the RXD nano pin, as shown in Figure 5.
In the same way, the RXD pin of the Bluetooth module is connected to the TXD nano pin. The SCL pin of the GY521 sensor is connected to the SCL nano pin. The SDA pin is connected to the SDA nano pin. The four pins of the power supply are connected to pins PD3, PB1, PB2, and PB3. Finally, all modules are connected in VCC and GND. To fulfill the principle of flight, it is necessary that two engines rotate diagonally in the opposite direction from the neighbouring engines (Fig. 6).

Finally, the motherboard is connected to the computer and the flight control program is recorded.

After recording the flight control program, the flight platform gyroscope is set up using the MWC ground station and you can use the ground station to detect the flight mode.
3. Results
The mission planning of UAV is carried out in the ground station, the open-source flight control program MWC [7], as shown in Figure 7.

In the groundstation, we can see the real-time working mode of the unmanned aerial vehicle (UAV) and adjust the flight path according to the returned value. At the same time, the GPS positioning module can be installed on UAV to adapt to longer distance flight. The display position has been reserved for the GPS signal in the groundstation.

In the scenarios of travel photography, military detection, location tracking, search and rescue after a disaster, traditional quadcopters, due to their large size, great danger, loud noise, and other disadvantages, do not really fit these scenarios. The mini quadcopter platform, however, features a compact body, is more convenient to carry on travel or military missions, and has such advantages as security and easy detection. It can move freely through various difficult indoor conditions. This article uses the Arduino Nano motherboard and Bluetooth connection to make the platform better open-source and to lower the usage threshold.
4. Conclusion
For the quadcopter platform presented in this article, a good extension of the design is provided for users. Even for subsequent extensions and modifications, the HC-06 Bluetooth module can be changed to a 2.4 G frequency receiver to transmit the signal over long distances. Without changing the rated voltage, switching to a battery with a higher C number can further increase the downtime of the flight platform and provide different solutions for different types of tasks.

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