Design of Four Rotor Unmanned Aerial Vehicle Based on Open CV

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Abstract. This design is based on the OpenCV technology of the four rotor UAV, mainly by the control module and image module of two parts. The control module contains a STM32 micro controller, it can generate multiple PWM to control the motor to produce basic movements, while the body is equipped with three axis acceleration of three axis gyroscope MPU-6050 module, electronic compass, barometer and wireless communication module, and use STM32 to read sensor data for gesture calculation and control motor action; The image module is equipped with a ARM Cortex-A53 processor, running the Python-OpenCV operating system in the embedded Linux environment, OpenCV implementation of the UAV aerial features, in addition, the onboard Wifi module can be accessed by SSH remote desktop to obtain detection images, which can be widely used in security monitoring, exploration engineering, home security and other fields.

1. Introduction
With the development of science and technology, people are stepping into the era of computer cloud, and various kinds of intelligent terminal devices are emerging, constantly changing human-computer interaction. Li Shishi's fight against alpha dog has attracted many people's attention. Can artificial intelligence technology bring convenience to people? In recent years, many fields of artificial intelligence have been greatly developed. For example, machine vision is the research hotspot of many researchers. Three years ago, machine vision was still at a relatively primary level, and now machine vision has surpassed human vision in many aspects. The development purpose of machine vision is to maximize the convenience of human life. Machine vision can be said that in industry, life acts as a human eye working 24 hours a day, it constantly monitors human safety and provides a monitoring of machine safety and it is an expansion of human intelligence.

OpenCV (open source computer vision library) is an open source cross platform computer vision library, which can run on Linux, windows, Android and Mac OS [1] [2]. Its main feature is lightweight and efficient. OpenCV provides python, Ruby, MATLAB and other language interfaces, but it is basically written by C / C ++ language, which is very flexible and powerful in the field of computer vision and image processing.

2. Overall Design of Four Rotor UAV
The overall design structure of the four rotor UAV Based on OpenCV is shown in Figure 1, including hardware and software. The hardware includes the minimum system of single-chip microcomputer, WiFi module, power module, motor drive. The software is mainly OpenCV image processing
development in Linux system environment, which is also the key and difficulty. The second is the motor drive code based on STM32 single-chip microcomputer to realize the movement of UAV. At the same time, STM32 also realizes data exchange through serial port communication. Finally, in the Linux environment, SSH Remote Login is the key to obtain video [3] [4].

Figure 1. Overall design structure frame

In order to achieve a smooth flight, the four-axis vehicle must be equipped with an inertial unit, namely IMU. The processor reads the sensor data in real time to do the corresponding filtering processing and calculation, and uses the serial PID algorithm [5] [6] for self stability control. This process will use a lot of CPU resources, and requires a high processing speed of the CPU. In the image processing part, OpenCV can only run in the mature windows or Linux operating system, select the high-end embedded processor cortex-a53, and install opencv in the embedded Linux environment to make the scheme feasible.

2.1. Design Requirements

2.1.1. Basic design requirements.
- UAV can complete basic actions, including forward, backward, left, right, etc;
- The PC end can get the detection video by connecting the LAN;
- PC can control UAV;
- PC can control UAV to record video.

2.1.2. Design extension requirements
- UAV can recognize human face;
- UAV can count the number of people;
- Gesture recognition control can be realized remotely.

3. Overall Hardware System Design
The hardware part of this design mainly consists of motion control with STM32 single-chip microcomputer as the core, sensor data acquisition and operation unit, and image processing unit with arm cortex-a53 as the core.
4. Software Design of Four Rotor UAV

The control algorithm of UAV includes PID algorithm, digital filtering algorithm and complementary filtering algorithm. The data processing and control of the whole aircraft and sensors are completed in a 20ms timer interrupt, that is to say, 20ms is the cycle for control. In the image part, Python is chosen as the development language. Based on Linux platform, opencv library function is called to complete the image development. Linux starts SSH service and obtains the image return remotely through WiFi. Many image recognition functions can be realized based on OpenCV library development, and the program flow of its core algorithm is shown in the figure below.
5. Scheme Difficulties and Key Technologies
The difficulties of this design scheme are as follows:
- PID algorithm realizes the control of UAV’s balanced flight;
- PID fixed height algorithm;
- Course locking algorithm;
- Quaternion algorithm is used for attitude calculation, Kalman filter algorithm for sensor data processing;
- OpenCV image processing under Linux;
- PC can realize remote image return.

The key technologies are:
- Python;
- image processing;
- attitude solution;
- PID algorithm.

6. Test Results Analysis of the System
- The flight of the aircraft is controlled by a self-designed programmable wireless remote controller;
- Sensors can be calibrated automatically before flying;
- The aircraft has the function of flight unlocking and locking to ensure the safety of flight operation;
- The aircraft can fly stably and hover at fixed altitude;
- The PC can log in the UAV remotely through SSH service and acquire images;
- Many complex image processing algorithms can be implemented on UAV.
7. Conclusion
The UAV Based on OpenCV can be applied to many occasions, such as the inspection of high-voltage power lines, the inspection of traffic accidents, the detection of human flow density, the detection of Lake area size, the length of highway and other relevant numerical statistics and calculation occasions.

Image has always been the carrier of huge amount of information. Nowadays, the collection of image information is more and more important. In the future, no matter what kind of intelligent technology development, image collection is indispensable. Machine vision technology is rising, even surpassing human vision in some fields. With the deepening of this research, it will bring more convenience to people in the future.

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9. References
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