Binocular Stereo Vision Control Method for Landing Position of Four Rotor UAV

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Abstract: At present, the four rotor UAV has a wide range of applications in aerial measurement and mapping, line detection, aerial detection, aerial photos and other fields. With the development of computer vision and the rapid development of various algorithms, microprocessors and integrated circuits, computer vision provides the preconditions for the application of these UAVs. And computer vision contains a lot of information, with a high degree of independence. These characteristics can provide more abundant external information for Intelligent Flight of UAV. Therefore, UAV uses computer vision to navigate the intelligence of UAV. Flying can have a significant impact. Safe landing is an important part of UAV intelligent flight process. By landing autonomously, the UAV can move autonomously, just like landing on a high building and charging itself. Compared with the existing navigation methods, the UAV Based on farsighted has the advantages of high accuracy in autonomous landing and positioning, so it is not easy to be affected by other electronic interference. This paper focuses on the research of autonomous landing detection method of four rotor UAV Based on binocular stereo vision.

1. Introduction

In recent years, with the rapid development of microelectronics related technology, embedded related technology and image transmission technology, UAV is gradually developed, and UAV is gradually transiting from military industry to civil industry[1]. UAV has different applications such as measurement, mapping, aerial reconnaissance, aerial photography and power line detection. The advantage of UAVs is that they can have flexible flight ability and can fly in complex environment. The UAV chooses two control flight options: autonomous flight and remote control flight. The autonomous flight of the UAV means that the plane plan and flight route are planned by the UAV, and the navigation and landing are also planned by the UAV itself. The UAV remote control flight mode refers to the real-time remote control flight of the UAV in the flight scene. This flight mode requires a higher level of UAV, which is not suitable for long-distance flight. One of the most important stages of UAV flight is landing. According to relevant data, the failure rate of UAV in landing phase is about 80% of all flight failures. Therefore, the safe landing of UAV becomes the focus of research at this stage.

2. Research on Distance Measurement Method of Parallel Binocular Camera

2.1. Imaging Model of Camera

Similar to pinhole imaging, the basic principle of color changing mirror uses optical lens to map the actual object to the image lens. This imaging model describes the principle of imaging. Through different application scripts, the color change model is divided into two types[2]. The simplest linear imaging model is pinhole imaging model. However, due to the manufacturing process and external environment, the camera is not a simple linear model. In general, the nonlinear description of the camera can be displayed by pin curvature and barrel curvature. In order to better explain the linear system, the relationship among the world coordinate system, camera coordinate system and

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pixel coordinate system will be introduced in detail.

2.2. Coordinate System of Imaging System

Now, the basic principle of camera is to use the light receiving element (CCD) in the camera to transform the light signal. The optical detection device converts the external optical signal into a digital signal, and the computer can read and store it more easily[3]. For example, when the m * n image is obtained by photographing, the image storage unit is stored in the m * n matrix. The values of each element of the matrix are the brightness of the stored image pixels. Color images only need a channel matrix to store them.

2.3. Principle of Binocular Stereo Vision

Binocular stereo vision is an important research direction of computer vision. The basic principle is to use two cameras with a certain distance between them to obtain two views with parallax. Then, two views with parallax can be matched, and the imaging principle of the camera can be used to determine the distance of objects in triangular space. The method of calculating the distance between object and camera in space by binocular stereo vision has the advantages of simple structure, low price and high measurement accuracy, while binocular stereo vision has the advantages of virtual reality, non-contact detection, auxiliary drive and so on[4]. The following introduces the basic concept and structure of binocular stereopsis.

Figure 1 Radial distortion

3. Radial Distortion Correction and Calibration of Parallel Binocular Camera

Camera calibration is an important and indispensable link in image measurement in computer vision. The accuracy of the camera correction results directly affects the next result. Camera calibration is the basis and important part of the research of parallel binoculars camera[5]. At present, the research on camera calibration method is mainly divided into Zhang calibration method and Tsai two-stage method. Tsai's two-step method does not calibrate the coordinates and aspect ratio of the main points, and Tsai's two-step method cannot pass the plane calibration method. However, the following is an optimization method for dealing with camera distortion. Because the calibration object needs to be photographed from multiple angles, the results of calibration parameters obtained from images of different calibration plate groups are different. In order to solve the above two problems, the first one is to use a single segmentation model determined by the distortion center and the out of shape parameters of the binoculars, and the second one is to solve the characteristics of the two parallel binoculars. In order to solve the three parameter model method proposed in this topic, the steps of using the plane method and Zhang's are the problems of the parallel binoculars.

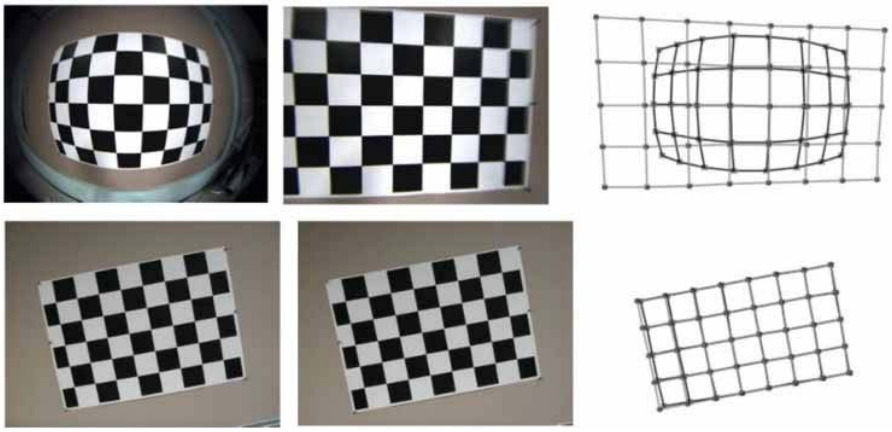

Figure 2 Correction effect of different distortion cameras

3.1. Research on the Location and Detection Method of Landing Landmark Qr Code

First of all, the detection of landing landmark position is the prerequisite for autonomous landing of UAV, which lays the foundation for subsequent processing[6]. At present, there are all kinds of T-type landing signs at home and abroad, which are simple design structure and easy to use. The positioning accuracy of T-type and the attitude angle accuracy of UAV must be improved. There are serious defects in space signs, and the calculated posture errors are large. However, the optimized situation is very necessary. The selection of landing landmarks has the following requirements: first, it must include sufficient feature information and attitude information for autonomous landing of UAV; second, the landmarks function must be easy to distinguish objects and other environments; finally, landmarks must be used for specific purposes. According to the above requirements, QR code is selected as landing landmark. In the landing flight of UAV, when the landing landmark appears in the camera field of view, the remote positioning algorithm is linked with the parallel binoculars camera to recover the three-dimensional information of the landing landmark. UAV is controlled by flight control system, which gradually reduces the three-dimensional information of landmark building. When the UAV moves in a small direction and reaches the threshold of the set distance, the approach algorithm is effective and the attitude angle of the UAV is estimated.

3.2. Research on Qr Code for Short Distance Location

The influence of noise on the amplitude and phase of image signal is very complex. Some noises and image signals are independent, uncorrelated, and some are correlated. Additional noise, multiplicative noise, quantization noise, pepper and salt noise are typical noise in image processing. Among them, quantization noise is the main noise source of digital image[7]. The most common way to reduce noise is to use the principle of adjacent area to smooth the noisy image in the spatial area. In the frequency domain, most of the noise spectrum is high frequency band, so many forms of low-pass filter can be used to reduce the noise. There are many methods of edge detection. Most of the common motion fields between them are realized by calculating the difference of images. There are two commonly used edge detection operators: gradient detection operator, edge detection operator and Gauss Laplace operator. Because gradient operator and Gauss Rassian use edge detection differential method, this operator is more sensitive to image noise. Generally speaking, when extracting the edge, we need to filter the image. However, after filtering the image, it is difficult to get the correct edge information.

3.3. Research on Qr Code Method of Long Distance Location

Image segmentation is the most basic precondition of image recognition and image understanding. Generally speaking, image segmentation algorithm is mainly based on two properties of gray. The threshold segmentation of image is based on the similarity of image, and the image is segmented into similar regions based on predetermined criteria. The function of image segmentation reflects the actual situation of objects, occupying different areas to distinguish objects

with different characteristics[8]. The quality of image segmentation directly affects the effect of subsequent image processing, and then determines its success or failure. Therefore, image segmentation is very important. In this paper, we use the principle of the maximum level dispersion (Dajin) in the threshold segmentation method to segment the image according to the threshold.

4. Conclusion

In this paper, from the perspective of binocular vision, the research and design of autonomous landing system of UAV using QR code as landing mark is proposed for the first time. The system has simple structure, high precision and high efficiency. From the viewpoint of binocular stereo vision, the principle of distance measurement for parallel binoculars is studied in this study, and three parameter model calibration algorithms for parallel binoculars are proposed[9]. In order to deal with the radial distortion of parallel binoculars, a single parameter segmentation model is used. Based on the design conditions of the landing sign, the short-range side of QR is used for landing as the road sign and QR code is used. The 3-position-4 mode of QR code determines the short-range side of QR code through the detection vertex to complete the proposal. In a long distance, the contour nesting information of the position detection pattern cannot be detected. A morphological method for searching QR code from a long distance is proposed. The design of visual standard attitude and position measurement system for UAV landing process and the packaging of the position relationship between land facing mark and pitch angle relative to landmark, pitch angle and yaw angle are required to be released, and finally the UAV autonomous landing is completed. Although the process of autonomous landing of UAV Based on parallel binoculars is complex, most of the research in this paper is carried out in the laboratory[10]. The actual flight environment of UAV is more complex than that of laboratory, so the system needs further improvement. Based on the current research, the following areas will be taken as the center for future research. During the actual flight of UAV, the landing landmark may be affected by other external interference factors. It is very important for the attitude estimation of UAV to locate the landing landmark more effectively, which can be further improved. In the system operation environment, there is less interference, and the system algorithm experiment is the most ideal, but in the case of complex and diverse local standard environment, the system experiment results are not good. In the future research field, the donkey strike of image processing algorithm may be improved.

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