Application of UAV Target Tracking Based on Computer Vision

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Abstract. With the progress and development of China's reform and opening up and economic globalization, China has made great progress in science and technology, especially in computer vision technology. From the current development of our country, the progress and development of computer vision technology plays an important role in the development and utilization of UAV automatic navigation. With the continuous development of automatic navigation technology, artificial intelligence has been widely used in various fields, and computer vision technology as the main direction of this field has also been rapid development in recent years, which also makes the important branch of computer vision moving object tracking technology has more and more extensive application, such as intelligent security, intelligent transportation, safe driving And video analysis.

Keywords: Computer Vision; UAV; Target Tracking

1. Introduction
With the continuous development of tracking technology, combined with the convenience of UAV platform, target tracking technology based on UAV platform has a huge application prospect in military and civil fields such as investigation and monitoring, and is also a hot direction at present and even in the future.

1.1. Background
Unmanned aerial vehicles (UAV) has great advantages in monitoring, detection, tracking and long-range attack.

With its own characteristics of sensitivity, long-time stagnation and long-range control, UAV has rapidly become the first choice of weapons and equipment at home and abroad [1]. It can be predicted that in the future battlefield, the performance and ownership of UAV will determine the overall combat level of a country or region, and it will also have extremely important strategic significance in military level and scientific and technological capability.

1.2. Research Significance
UAV target recognition and tracking is the basis of its perception and decision-making of unknown environment. It analyzes the environment through its own imaging sensor, so as to realize the understanding of the designated area and realize tracking.
The purpose of target tracking technology based on computer vision is to get the specific position of the target to be tracked in each frame in the video frame [2]. Specifically, it needs to initialize the target to be tracked in the initial frame, and then uses the tracker to get the position information of the object in the subsequent frames. In the tracking process, the object to be tracked is often subject to various environmental disturbances, which will affect the final tracking results. Especially in the UAV tracking scene, the shape and scale of the non-rigid target often changes due to its motion. In the long-term tracking process, the target will disappear due to occlusion, which poses a great challenge to the tracker. Based on the UAV platform, this paper proposes a high-precision fast target tracking algorithm to ensure that the UAV can track the object in real time. In the new period of socialist modernization, our country pays more attention to the development and application of high-tech in the process of economic construction.

2. System Framework

The system consists of hardware and software. The hardware part is mainly composed of monocular camera, vision computer and flight control system. The monocular camera transmits the video information around the quadrotor UAV to the vision computer; the vision computer recognizes and extracts the tracked target in the video stream, calculates the position of the target in the image, and converts the position information into the position under the UAV body coordinate system, and passes the location information through the Mavlink protocol is sent to UAV flight control system to guide UAV to realize dynamic target tracking.

2.1. Monocular Camera

The monocular camera on the quadrotor UAV can capture and capture the video information around the UAV in real time, such as moving vehicles and pedestrians on the ground, static ground markers, etc.

Because the quadrotor UAV is small in size, light in load, and not easy to hang heavy loads. In addition, once it is affected by its own vibration and gust during flight, the airborne monocular camera will produce obvious vibration, which will lead to blurred images taken by the monocular camera, which is not conducive to the recognition and extraction of targets by visual computer High definition monocular camera is particularly important [3]. For this reason, we choose Logitech’s c920 HD camera, which has a quality of about 162g and supports 1080p video recording.

2.2. Visual Computer

Vision computer is mainly used to process video information captured by monocular camera. The quadrotor UAV has strong maneuverability in the target search and tracking tasks. The visual computer needs to process a large number of visual data information, which requires high processing speed and processing ability [4].

At the same time, the size, weight and power consumption of the vision computer are required by the size, load and battery capacity of the quadrotor UAV. Therefore, we choose the embedded visual computing module Jetson TX1 of NVIDIA Maxwell architecture and 64 bit CPU to support the calculation of computer vision and deep learning. The vision computer runs the Ubuntu operating system and the open source software dronekit. The visual processing software is developed based on the open source computer vision library opencv, and communicates with the flight control system through UART serial port. As shown in Figure 1, the vision computer has three main functions: video reading, target searching and recognition, and target location calculation.

2.3. Flight Control System

Flight control system is the core component of UAV control.

We choose pixhawk, which is a mature and widely used open source aircraft control system, which adopts typical inner and outer loop control structure to control the attitude and position of quadrotor UAV. The system integrates xens inertial measurement unit and barometer sensor, which can provide
3D acceleration, 3D angular velocity, altitude and other information in UAV body coordinate system in real time [5]. The attitude of quadrotor UAV can be calculated by using these information, and the position information of UAV can be calculated by combining the information of GPS sensor carried by quadrotor UAV.

3. Target Search and Tracking Algorithm
In order to realize the target search and tracking task of quadrotor UAV Based on vision, it is necessary to recognize and extract the scene video of UAV captured by monocular camera, and calculate the position of tracked target in UAV coordinate system. Target search and tracking algorithm is mainly composed of three parts: target recognition and extraction, target position calculation and UAV control algorithm [6].

3.1. Target Recognition and Extraction
It is set that the target of quadrotor UAV to search and track is the pedestrian on the ground, and the tracked pedestrian is identified according to the color characteristics of pedestrian clothes. Based on this task, we need to complete the recognition and extraction of the tracked pedestrian's clothing color features

3.1.1. Color space conversion. In computer vision, the commonly used color space models are RGB and HSV. The video captured by monocular camera adopts RGB color. Each component of RGB color space model has strong correlation and large amount of calculation; HSV color space model contains three components, namely lightness, color and saturation, and the three components are independent of each other [7]. Compared with RGB model, HSV model is more close to the human visual processing mode, and the amount of calculation is moderate. In order to better express color information and save computing resources, images will be converted from RGB space to HSV space.

3.1.2. Image filtering. In the process of video shooting, due to the vibration of UAV and the influence of environment, the image captured by monocular camera has noise, which makes the image clarity decline, and even makes the target difficult to be accurately identified. Therefore, it is necessary to filter the image. In this paper, Gaussian filtering method is used to process the image.

3.1.3. Target recognition algorithm. Since the target to be tracked is a pedestrian walking freely on the ground, the tracked pedestrian can be identified according to the color characteristics of clothes. Suppose the UAV needs to track people in red on the ground [8]. The feature of red clothes is regarded as a set of many circular spots, and the recognition and extraction of red clothing features can be realized by extracting the features of circular spots. In this paper, based on the circular speckle feature point detection algorithm provided by open source computer vision library opencv, this paper identifies and extracts the red clothes pedestrian, uses the simplest and effective way to extract the target pedestrian, and calculates the size of the red spot on the clothes and the position of the target pedestrian in the image.

3.2. Trajectory Calculation of UAV Based on Computer Vision Technology
The automatic navigation of UAV plays an important role in real life. It is not only widely used in production and development, but also plays an important role in protecting the country. From the current development situation of our country, in the process of its UAV automatic navigation system application, due to its technical substandard and other reasons, there are a lot of signal loss, tracking object is not correct and so on, which greatly hindered the application and development of UAV automatic navigation. Therefore, in order to avoid the occurrence of similar situation, it is necessary to analyze the motion trajectory prediction of UAV automatic navigation system based on computer vision technology [9].
3.2.1. Calculation under slam principle. Slam is mainly aimed at the map construction of UAV in unknown environment and lack of previous experience, or map positioning update in known environment. In order to analyze the trajectory of UAV effectively, slam needs to analyze and deal with its uncertainty and error effectively. At the same time, it is necessary to effectively deal with the relevance of data information. Through slam, the corresponding data information model is established to better analyze and process the relevant information.

3.2.2. Calculation Based on the principle of visual slam. The popularity and application of visual slam is fully based on its advanced science and technology. Under the system, not only the application cost has a great advantage, but also has an important promoting significance to effectively alleviate the signal loss of UAV in unknown environment, especially in the harsh environment such as mountains. Therefore, from this point of view, it is necessary to actively apply the visual slam system, fully improve the level of UAV automatic navigation, so as to better promote the effectiveness of the application of computer vision technology in UAV automatic navigation [10].

4. Conclusion
To sum up, computer vision technology in the actual operation and application process, need to be established under a certain principle, and the wide application of UAV automatic navigation also needs to be flexibly improved and perfected according to the actual situation. For example, when it comes to weather factors, when UAV automatic navigation encounters severe weather such as strong wind and rainfall, the internal structure of UAV should be improved to better adapt to the development needs of UAV goals.

Therefore, in the future learning process, we should actively study the theoretical knowledge of computer vision technology systematically, combine with the actual development, research out more valuable machine technology principles, so as to better promote the progress and development of computer vision technology in China.

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