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Application and Analysis of Computer Vision Algorithms in Graphics and Image Processing

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Abstract

After decades of research by researchers, there have been many mature algorithms and systems that can meet the requirements for the application of computer vision algorithms in many fields. There are applications of computer algorithms in many industries, such as car navigation, video detection, industrial production and other industries. Most industries have synchronization requirements in terms of time, that is, real-time. Because of the limitation on the amount of calculation, many realtime vision systems will use the local window algorithm, but the image quality generated by the local algorithm and the image quality generated by the global algorithm have a large gap. According to the latest research results, if you use precisely adjusted matching calculation and collection methods, the local algorithm is as good as the global algorithm in terms of matching rate. This article mainly takes UAV as the research object, and studies the UAV's processing function of graphics and image based on computer vision algorithms. The research content mainly includes the single passage of the UAV in different environments of straight lines, corners, and slopes, and the passage of the UAV in the overall process. Through the application of computer vision algorithms in the UAV's graphics and image processing process, the experimental data is analyzed and the corresponding conclusions are drawn.

Keywords: Computer Vision Algorithm, Drone, Graphics and Image Processing, Real-time System

1. Introduction

As a way for many devices to obtain information from the outside world, computer data algorithms can realize the functions of identification, inspection, and testing of the target after systematic calculation of the distribution, intensity and color of the pixels in the graphics, and then send the results to the corresponding devices, And then complete the next step [1]. The computer vision algorithm system can understand the external situation in a short time, and the calculation process is very fast, and then draws a conclusion. Graphics processing is the data calculation link of the computer vision algorithm system, and it is very important to the final result, so the graphics and image processing is the key core of the computer vision algorithm system. Regarding the method of identifying the shape and contour of the object, the similarity should be described by corresponding rules [2]. The matching between multiple shapes is usually expressed by a numerical value, which is called the shape similarity. According to the different characteristics of the boundary points, it can be divided into different description methods, curvature space and Fourier description according to the different characteristics [3].

Beall Tippetts has published a lot of research in the field of stereo vision in the past ten years. Considerable progress has been made in improving the accuracy of the results and the real-time performance of obtaining these results. This work provides a comprehensive review of stereo vision algorithms, with special emphasis on real-time performance to identify those algorithms that are suitable for systems with limited resources. Attempts have been made to compile and provide accuracy and runtime performance data for all stereo vision algorithms developed in the past decade [4]. Xinghuo Ye believes that image segmentation is a key technology in the field of image processing and computer

image processing. Among them, the segmentation method based on the effective contour model has developed rapidly in recent years due to the effective processing of complex images such as medical images, and has achieved remarkable results in the fields of medicine, military and industry [5]. Nan Jiang pointed out that in the computer field, graphics and image processing technology occupies a relatively key core position in computer technology. Image processing not only provides convenience for people's daily life, but also has a strong impact on people's visual experience. In today's information age, science and technology play a leading role. Whether it is a career, a field, a country or the world, without the integration and application of science and technology and digital digital images, it is impossible to achieve rapid development and progress [6].

This paper mainly analyzes the graphics and image processing functions of UAVs based on computer vision algorithms, combined with relevant research at home and abroad, conducts in-depth research on the key technologies of stereo vision, and builds an experimental system for the use of stereo vision. The algorithm was experimented. Taking into account the special requirements of graphic image processing, the two-dimensional plane calibration template is used for calibration, and the stereo image pair is corrected according to the internal and external parameters of the calibration work. This is an important step for realizing the fast algorithm of stereo matching. The current relatively fast real-time stereo matching algorithms are analyzed, and the influence of various conditions on the matching results of various algorithms is discussed. And focused on the analysis of the window size on the matching results. Aiming at the real-time problem, an acceleration algorithm for stereo matching is given. Finally, the computer vision algorithm process and implementation plan are given, and the experimental results of calibration, stereo image correction, and stereo matching are given.

2. Literature Review

Computer vision algorithms have been widely applied in the field of graphics and image processing for a variety of tasks such as object recognition, image segmentation, and motion estimation. These algorithms use techniques from fields such as machine learning and computer graphics to analyze and understand the content of digital images. One popular application of computer vision algorithms in graphics and image processing is in the field of computer graphics. These algorithms are used to create realistic images and animations by analyzing the properties of real-world objects and scenes [7]. For example, researchers have used computer vision algorithms to create realistic virtual environments by analyzing real-world images and replicating the lighting, shading, and texture of the objects and scenes in the images. Another popular application of computer vision algorithms is in the field of image processing. These algorithms are used to analyze and manipulate digital images [8]. For example, researchers have used computer vision algorithms to develop methods for image enhancement, such as improving the contrast and color of images, and for image compression, such as reducing the size of image files. One key area of research in the field of computer vision for graphics and image processing is object recognition [9]. Object recognition algorithms use machine learning techniques to analyze images and identify specific objects or classes of objects within the images. These algorithms have been applied to a variety of tasks such as image retrieval, self-driving cars, and augmented reality [10].

Another important area of research is image segmentation, which involves the process of dividing an image into multiple segments or regions, each of which corresponds to a different object or part of an object. Image segmentation algorithms are used in many applications such as medical imaging, video surveillance, and object tracking. Motion estimation is also an important area of research in computer vision, which involves the process of determining the motion of objects in a sequence of images. This is essential for applications such as video compression, video stabilization and video tracking [11].

In recent years, deep learning techniques have become increasingly popular in the field of computer vision for graphics and image processing. Convolutional neural networks (CNNs) have been used to achieve state-of-the-art performance in tasks such as object recognition and image segmentation. In conclusion, computer vision algorithms have become increasingly important tools in the field of graphics and image processing. They are used for a variety of tasks such as object recognition, image segmentation, and motion estimation. With the help of deep learning techniques, these algorithms have achieved state-of-the-art performance in these tasks and have a wide range of applications in different fields [12].

In addition to the applications and techniques mentioned previously, computer vision algorithms have also been widely used in the field of image and video processing for tasks such as image restoration, image super-resolution, and video stabilization. Image restoration algorithms are used to remove noise and blur from images, while image super-resolution algorithms are used to increase the resolution of images. Video stabilization algorithms are used to remove camera shake and jitter from videos, making them more stable and watchable [12].

Another important application of computer vision algorithms is in the field of 3D reconstruction. These algorithms use techniques such as stereo matching and structure from motion to create 3D models of objects and scenes from 2D images. These models can be used in a variety of applications such as virtual reality, augmented reality, and robotic navigation. Moreover, computer vision algorithms have also been used in the field of medical imaging for tasks such as image analysis, diagnosis, and treatment planning [13]. These algorithms have been used to analyze medical images such as X-rays, CT scans, and MRI scans to detect diseases and injuries, and to plan treatments. Computer vision algorithms also have a wide range of applications in the field of robotics, such as object detection and tracking, visual servoing, and visual odometry. These algorithms enable robots to perceive and understand their environment, allowing them to navigate, manipulate objects, and interact with humans [14].

In recent years, with the development of deep learning, computer vision has made significant progress, especially in the field of object detection, semantic segmentation, and instance segmentation. CNN-based architectures such as YOLO, Faster R-CNN, and Mask R-CNN have achieved state-of-the-art performance on benchmark datasets such as COCO and PASCAL VOC. In conclusion, computer vision algorithms have become essential tools in the field of graphics and image processing, as well as in various fields such as computer graphics, image and video processing, 3D reconstruction, medical imaging, robotics and deep learning. These algorithms have made it possible to analyze, understand, and manipulate digital images and videos in ways that were previously not possible. As the field of computer vision continues to evolve, it is expected that these algorithms will become even more powerful and widely used in a variety of applications.

2.1. Hough Line Transformation

Hough transform is a feature extraction technology that detects straight lines and curves in images. This method is one of the basic methods for identifying geometric shapes of objects in images [15]. In terms of detecting straight lines in the image, there are mainly two types. Hough line transformation and probabilistic Hough line transformation. The main steps of Hough line transformation on an image are as follows: (1) Perform edge detection processing on the image to obtain a binary image of the edge of the image, often using the Canny edge detection algorithm. (2) Count the number of all nonzero edge points on the image, and obtain the corresponding curve of the line cluster passing through the point in the polar coordinate system. (3) Calculate the intersection points of all straight line clusters, and calculate the sine curve of each intersection point. (4) Set a threshold. If the number of curves that a certain point intersects is greater than the set threshold, it means that the line represented by the point is a straight line on the image. From the process of Hough line transformation, it can be seen that it needs to map the non-zero points in the edge detection binary image to the polar coordinate system one by one, and then count the number of sinusoids that intersect at a point one by one [16]. The main idea of the probabilistic Hough line transformation is similar to that of the Hough line transformation. The difference is that the probabilistic Hough line transformation first randomly detects part of the line on the image, and then excludes the points on the detected line, and then performs the subsequent line detection, which improves the line At the same time of detection efficiency, it can avoid the situation that multiple branch lines are detected on the same edge in the Hough line transformation, and in addition, the endpoint coordinates of the straight line can be obtained [17].

2.2. Stereo Matching Algorithm

In a computer vision system, stereo matching is the most important and most cumbersome. The disparity map is obtained by the algorithm by finding matching points in the stereo graphics, and then using geometric relations to calculate the depth, so as to obtain the depth map of the graphics When an object in space is projected into a plane image, all the optical information of the object is represented by the gray value in the image [18]. That is to say, the stereo matching needs to use a small part of the optical information of the object in the space to complete the matching of the pixels is very difficult. According to the graphic pixel area participating in the calculation, it can be

divided into local matching algorithms and global matching algorithm [18]. Although the local algorithm is very fast in calculation speed, the matching error rate for regions with different disparity is usually very large. The global algorithm can deal with these problems because of the corresponding algorithm. The global algorithm has a large amount of calculation. Frequently used local algorithms include regional matching algorithms, gradient algorithms, and feature algorithms, and frequently used global algorithms include planning algorithms, interpolation algorithms, and propagation algorithms.

2.3. Multiple functional space composite integration

The significance of space compound design lies in the Limited space-time conditions, according to the characteristics of the building and urban public space, it gives it different levels and different nature of use functions, and gives full play to the potential economic and social benefits of space [19]. The roof green space can not only be used as single building space, but also used as urban public facilities construction, which realizes the innovation and derivation from the function of single building to the two-way development of urban function. Through RG, the urban public space is introduced into the interior of the building. Through the intermediary role of green space, the urban public space will flow, penetrate and continue to the interior of the building. The combination of space and terrain, the special properties of underground, semi underground, ground, building and building roof are used to give the composite functions in planning space.

2.4. Local Matching Algorithm

For the local matching algorithm, the important part is the cost calculation and cost collection, and the disparity calculation is relatively simpler. Find the least costly point from the maximum disparity as a matching point, and then calculate the disparity. Because the local matching algorithm is very fast, most real-time vision systems use the local matching algorithm [20]. However, the uniqueness of the match cannot be guaranteed. If a mismatch occurs, post-processing can be used to eliminate it. The area matching algorithm finds the matching points by comparing the difference in the matching cost between the area around the point in the source image and the area around the point to be matched in the target image. Because there are quite a lot of other calculations in the region matching algorithm, the region matching algorithm needs to be optimized before being applied. Since the 1980s, feature based matching methods have attracted widespread attention in the field of stereo vision due to their high efficiency. However, due to the increasing need to obtain dense disparity maps and the improvement of region matching performance in applications, the research on feature matching has begun to decrease in the last ten years [21]. Because both the region matching and the gradient. matching points assume that the disparity in the matching region is smooth, these two methods have a larger mismatch rate for discontinuous disparity and no texture details. The feature-based matching method can solve the above problems by matching reliable graphics features, but the disadvantage is that the parallax density is reduced.

2.5. Global Matching Algorithm

The calculation of disparity is the focus of the global algorithm. The global algorithm turns the matching problem into an optimal solution problem. The matching process uses optimization techniques in the field of mathematics and many methods in the field of graph theory. Because of the disconnection of parallax and the mismatch without texture details, the global algorithm can handle it well. At present, the most commonly used global algorithm is the planning algorithm, which optimizes the matching on the scan line through the unification of the parallax and the stability of the arrangement. The most serious limitation of the planning algorithm is that the horizontal and vertical parallax unity cannot be fully utilized. In the framework of planning algorithms, many new algorithms have been researched, but these algorithms still cannot fully exploit the potential of parallax unification. It is a feasible method to treat the stereo vision problem as the maximum flow problem [10]. In terms of the amount of calculation, the segmentation algorithm is generally larger than the planning algorithm, but many optimization schemes have been researched today. For stereo matching, there are not only planning algorithms and segmentation algorithms, but also some other algorithms.

3. Research Method

3.1. UAV Flying Straight

By looking for the vanishing point in the direction of the channel on the image, the position of the exit at the other end of the channel can be obtained, which can be used as the target of the drone flying in the channel. However, in the actual flight process, it is also necessary to consider the drone to avoid occurrence as much as possible. Collision ensures flight safety. In the research process of this article, the flying height of the UAV is controlled at 1.5m by non-visual sensors, that is, the middle position of the channel. Under this condition, there are two main types of collisions that may occur. The left and right walls of the channel collide and the UAV collides with potential obstacles in the channel during the flight [11]. The horizontal position of the drone can be adjusted to avoid collision with the walls on both sides while the drone is flying toward the vanishing point, and the distance from the vanishing point to the drone can be estimated by the binocular ranging principle. Since the research content of this paper is based on the environment without too many obstacles, in the space obstacle avoidance, only the obstacles that may appear in the flight of the UAV need to be avoided [12]. This article only needs to ensure the flight of the drone. Therefore, this paper uses computer vision algorithms to perform stereo matching on the middle part of the left and right image planes to obtain the depth map of the corresponding space to complete local obstacle avoidance. Compared with the traditional method, it reduces the area of image matching and reduces the calculation and complexity of the work.

3.2. Drone Flying on a Slope

The flying purpose of drones located in a slope environment is to safely fly to the upper end of the slope. Therefore, the drone must first determine the position of the slope on the image, and then adjust the position correctly according to the mutual position relationship between the drone itself and the slope, and then fly obliquely forward toward the upper end of the slope, similar to straight-line flight. Try to avoid collisions with slopes. Suppose that after Canny edge detection and probabilistic Hough line transformation preprocessing and filtering, the slope and intercept parameters of the straight line in the image are (ki,bi), $I \in \{1,2,...,L\}$, where L is The total number of lines detected on the image. Due to the interference of noise and other factors, the line clusters representing slopes are often not absolutely parallel to each other.

3.3. Drone Flying Around the Corner

The corner is generally located at the end of the straight line and is responsible for connecting the straight line and the slope, or at the end of the current slope is responsible for connecting the upper and lower two adjacent slopes. Unlike environments such as straight lines and slopes, corner environments do not have obvious visual features, that is, they cannot be detected by direct image processing methods. Therefore, after determining that the current environment is a corner, the drone needs to be completed by exploratory methods. Flying in a corner environment. When the drone is in a corner, first obtain the left and right images of the current scene through the computer vision algorithm system, and try to obtain the depth map of the current scene after stereo matching. However, since most corners do not have significant visual features, The depth map cannot be successfully obtained in some environments. At this time, just like drone flight height control, non-visual sensors are used to control the minimum distance of the drone from the front wall to 0.5m. When the UAV's environment is recognized as a corner, first the UAV keeps flying forward until it reaches a safe distance of 0.5m from the wall as measured by the computer vision algorithm system or non-visual sensors, and then the UAV stops flying forward. Through an exploratory method, rotate 90° to the left and right to measure the distance between the drone and the wall in the current scene, and then fly in the direction of the larger distance. Then the drone should rotate 90° to the right and then fly forward into a slope or straight environment connected by corners.

4. Analysis of Experimental Results

4.1. In Experiments under Different Channel Environments

In Experiments under Different Channel Environments, the Success Rate of UAV Flying through the Channel is Shown in Table 1 and Figure 1.

Table. 1. Experimental results in different environments

Surroundings	Channel 1	Channel 2	Channel 3	Channel 4
Number of experiments	10	10	10	10
Success rate	90%	80%	90%	86,67%

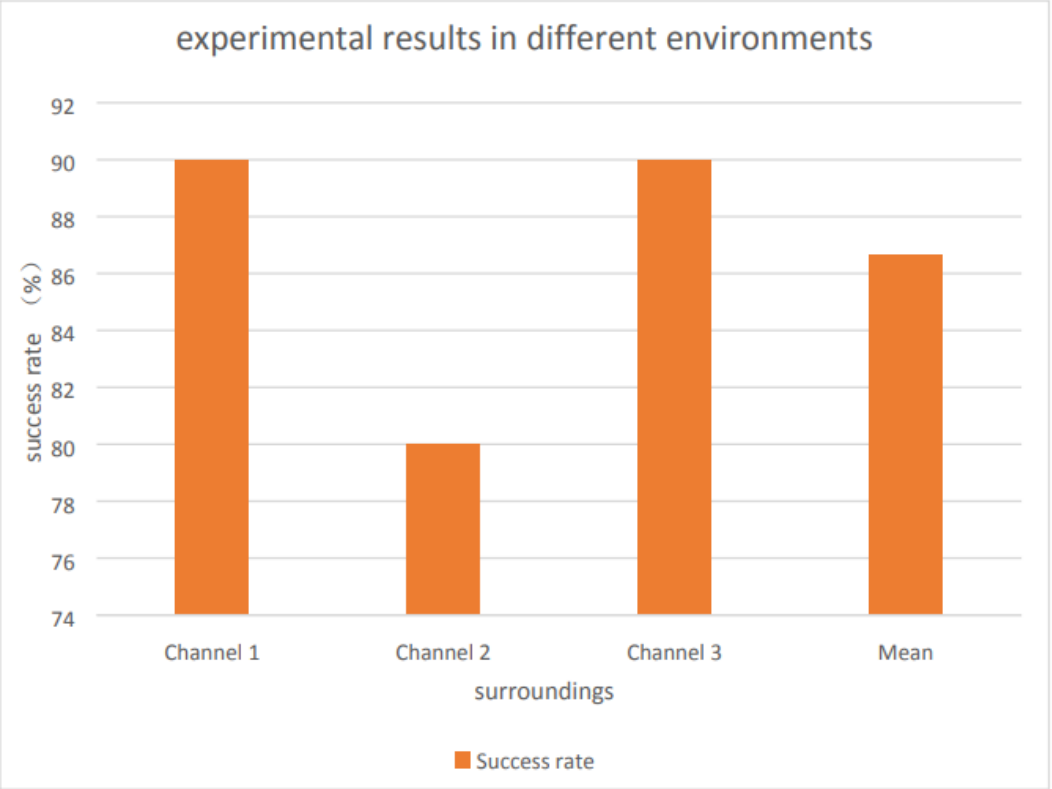

Fig. 1. Experimental results in different environments

According to Table 1 and Figure 1, in multiple experiments under different channel environments, the average success rate of UAV flying through the channel was 86.67%. When encountering a corner, through passive distance measurement, the UAV is guided to conduct an exploratory flight in the corner. When the flying distance of the drone reaches a safe value, the distance information on both sides is detected by rotating left and right, and the larger one is selected to fly in the corresponding direction. Therefore, the drone will not collide with obstacles such as walls in the corner, and it is found in the experiment that there are no Humans and machines can often reach the environment where they are connected smoothly at the corners.

To Further Verify the Graphics and Image Processing Function of the UAV Based on the Computer Vision Algorithm, the UAV Continuous Environment Flight Experiment Was Carried out. The Results are Shown in Table 2 and Figure 2.

Table. 2. Results of UAV continuous environmental flight experiment

Surroundings	Straight line success rat	Corner pass rate	Successful ramp rate	All successful pass rate
A	90%	100%	90%	80%

B	100%	100%	90%	90%

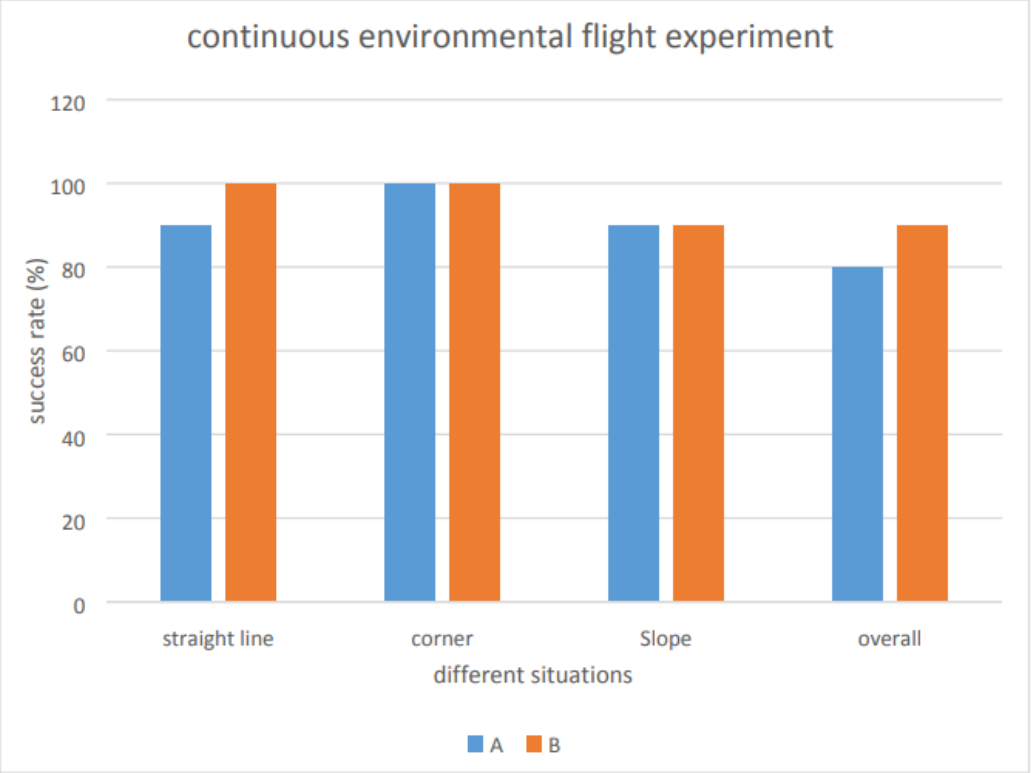

Fig. 2. Results of continuous environmental flight experiments of drones

According to Table 2 and Figure 2, in order to further verify the processing function of UAV based on computer vision algorithms on graphics and images, this paper selected two types of continuous environments A and B with straight lines, corners, and slopes for experiments. In the 20 experiments of environment A, the straight line pass rate was 90%, the corner pass rate was 100%, and the slope pass rate was 90%. The straight line and the slope failed to pass twice in different experiments, so the overall safe passing rate was 16 times with a passing rate of 80%; in the 20 experiments of environment B, the straight-line safe passing rate was 100%, the corner passing rate was 100%, and the slope safe passing rate was 90%, so the overall safe passing rate was 18 times, the pass rate is 90%.

5. Conclusion

This article focuses on the research and analysis of UAV flight situations. First, analyze the principles of two commonly used image preprocessing algorithms, such as Canny edge detection and Hough line transformation, and use them in subsequent image processing. Then, different nonlinear images are proposed for different environments such as straight lines, slopes, and corners. Human-machine flight experiment; Finally, the UAV flight is verified by experiments in different environments. The experimental results show that the flight strategy designed in this paper has a safe passing success rate of 88% in a straight line and a safe passing rate of 100% at corners. The success rate of safe passing in slope conditions is 86.67%, and the success rate of UAVs passing safely in the multi-environment continuous flight experiment is over 80%. The feasibility of the UAVs graphics and image processing function based on the computer vision algorithm proposed in this paper has been effectively verified.

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