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Design and Realization of Parking Assistant System Based On Binocular Vision

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Abstract: **With the improvement of people's living standards, the number of cars per owned continuously increases. The problem of parking in space more easily, which many owners face. In view of this phenomenon, the 3D information reconstruction based on binocular vision and image splicing technology is applied, and a system of parking assistance is designed to provide the intuitional backward image information and obstacles to owners in order to help drivers conveniently and quickly stop into parking space. After the image preprocessing and analysis of image splicing algorithm based on SIFT algorithm simulation, the image splicing is realized. Using the principle of machine vision, Harris algorithm is used to detect feature points and match feature points. A system is designed based on the binocular vision technology, which can effectively detect the recent distance between the obstacles with the rear of car.**

Keywords: Binocular vision; Distance measurement; Image matching; Obstacle detection

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1. Introduction

Nowadays backward image has been widely used in vehicles. From the backward image we can directly see the rear obstacles. But there are also some disadvantages, we cannot see it clearly because the obstacle away from the car. Sometimes there are some distances from the car to obstacles, but shown in the backward image is very close. Because of the popular backward images are based on the monocular camera, the driver's vision is lesser than binocular vision. By studying the binocular vision and adopting binocular vision range finding principle, a method of distance measurement put forward, which can more accurately measure the recent distance between the obstacle distance and the rear of car in order to improve the deficiencies of reverse image. In addition using the technology of image stitching expands the field of vision.

The study is based on binocular distance measurement principle and machine vision, mainly including several aspects. First, using conventional steps processes the image, such as image gray, edge detection and image binary, image preprocessing and get the binary image, and then use a custom template of image filtering to filter out most of the background noise. Second, the advantage of binocular camera is rationally utilized, joining together of two images to enlarge the driver's field of vision. Third, Zhang Zhengyou's corner detection algorithm is used to detect obstacles within parking spaces, and an algorithm is designed to detect recent distance of automobile tail toward the obstacles. Image stitching as well as the recent distance of obstacles toward the car have auxiliary function, which help the driver more faster and safer park in space.

2. The overall plan design of the system

2.1. The experimental platform

Hardware platform of binocular stereo vision range finding system consists of two CCD cameras, a card of image acquisition and the holder, overall structure as shown in figure 1.

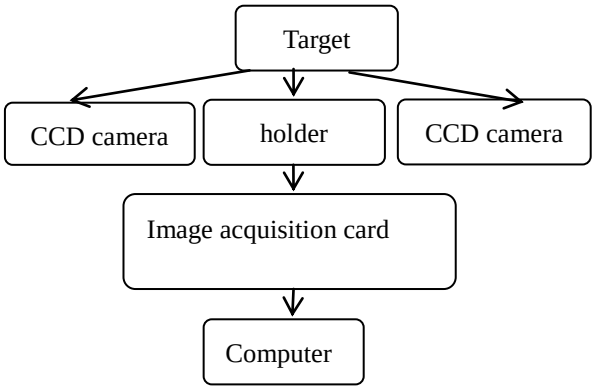

Figure 1. Hardware platform of binocular stereo vision system.

(1) The CCD camera: two CCD cameras has the same model of NTSC format, and the resolution is 680 x 480. Two cameras light heart has smaller Angle and horizontal alignment status, level height equal to the position of the license plate of experiment car.

(2) The card of image acquisition: image acquisition card we choose the CG400 acquisition card, which has the acquisition card PCI interface, sampling rate is high, can use the DMA channel transmission. The image acquisition directly to memory, and do not take up the computer CPU time, support of real-time image processing, and convenient to switch video sources road, two short switching time is 28.

(3) A computer: CPU 2.53 GHz, 2.0 G memory.

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2.2. System design

Parking assistant system mainly consists of five parts, namely image acquisition, image preprocessing, image jointing, camera calibration and the reduction of parking information in three dimensions. The main steps of image processing are shown in figure 2.

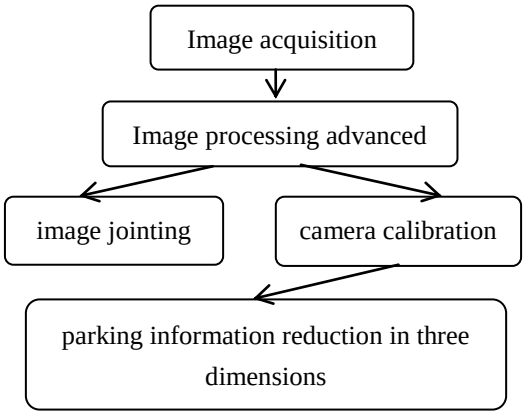

Figure 2. Image processing steps.

(1)Image acquisition: for image processing system, image acquisition is often the first step [1].

(2)Image preprocessing: image feature extraction, a former step of image processing, whose main purpose is to eliminate irrelevant information in the image and restore the useful information and strengthen the ability of detecting the information and maximally simplify data, so as to improve the feature extraction, image segmentation, matching and recognition reliability. It also reduces the noise in the image. Inhibit the ratio of background noise and increase digital image data. It can facilitate the follow-up for data processing, more to meet the requirements of the system real-time performance. Treatment in advance is directly related to the subsequent feature extraction and stereo matching [2].

(3)Image jointing: this study is based on the SIFT image matching and the whole process automation and timeliness are higher. Image splicing is reasonably used of advantages of binocular vision, carried out the left and right image stitching, to expand the driver's vision and to provide supplementary role for parking.

(4)The camera calibration: the camera calibration is the essential step of the whole system. The camera imaging model describes the relationship between the spatial three-dimensional coordinates of the object and its corresponding points in the camera imaging plane, which establishes the geometrical imaging model of camera, the camera internal and external parameters is determined by the relationship among the imaging pixel location and the space coordinate system midfielder scenic location [3].

(5)The reduction of parking information in three dimensions: the binocular vision system is based on the principle of machine vision, which is used to get the information of the obstacles within the parking spaces. Through the design of system calculation, find out the distance of obstacle to the rear of the car, recently complete parking auxiliary function, and let the driver safety, accurate, fast to park in space.

3. Image processing in advance

3.1. Image gray scale processing

Now camera image is color image for most fields, also called RGB figure. Contains a lot of color information, color image makes its storage space larger and the processing speed slower. Given the experiments of requirement is not high for the three different colors of components in the image processing, the original color image is converted into intensity information without gray image color information. The human eye is sensitive to green mostly, red times followed and the most not sensitive is blue. So we use the weighted average method to process the gray scale image. Weighted average of RGB three-component reasonable gray image can be obtained.

3.2. The suppression of image noise

Image noise can be understood as the source which interferes the human visual perception and the sensor system or the factors which influence the image analysis. It also has deviation between real signals and ideal. Generally speaking, the noise is a random signal which unpredictable, usually adopt the method of probability and statistics to analyze it. The suppression of image noise on image processing is very important, it affects all aspects of image processing, especially in the image input and collection. If the input with large noise, it will inevitably influence the outcome of image stitching. This study adopts the method of median filter. Median filtering based on the theory of order statistics is a nonlinear signal processing technology which can effectively eliminate noise. Its core algorithm is a data sorted in the template. If there is a bright or dark noise which will be ranked in the right side or left side in the process of sorting data. Therefore, ultimately selected data sequence in visual position value generally are not noise, which can achieve the purpose of suppressing noise.

4. Image matching

This section is mainly about the research of realizing image mosaic with the image matching and fusion technology. Through the existing matching algorithms are introduced and comparing it, the image mosaic algorithm based on the SIFT algorithm is selected. The algorithm and weighted average algorithm [4] are used to realize the image fusion and splicing. Analyzing the process and the result, then the deficiency and improvement of the algorithm put forward. This subject adopts the algorithm of Scale-invariant feature transform (SIFT), it is an algorithm that is used to detect and describe the local characteristics of the image in computer vision, it can also find the extreme points in scale space and extract the location, scale, and rotation invariant.

Image mosaic is mainly composed of four steps: image acquisition, geometric correction, image registration and image fusion. The splicing processes

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are shown in figure 3.

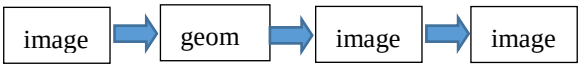

Figure 3. Image splicing process.

(1) Image acquisition, simply, is a method of obtain the scenery or scene image, which should be used as far as possible for helping generate the final image.

(2) Image geometric correction is a image geometric operation. The shape and spatial position of the object can be changed in the image.

(3) Image registration is a key step in image mosaic. In this step, the point-to-point mapping relationship among different views in one scene should be calculated, which is often called as the "Corresponding transformation", these transformations can be expressed as translation, rotation, affine, projection and so on.

(4) Image fusion is to improve the visual effect of the rendering image, smoothing the image. Namely, smooth function is used to remove the overlap of the regional gap in image synthesis.

To sum up, each link in the image mosaic is contacted closely and which influence each other. A good image mosaic system can integrate various technical aspects and improve the efficiency of image mosaic and reduce processing time and enhance the adaptability of splicing systems according to the actual application.

5. Three-dimensional information reduction of parking spaces

5.1. The camera calibration

This study adopted the calibration method, which was put forward by Zhang Zhengyou in 1988. This method is simple and flexible. And it is a kind of calibration approach between the traditional calibration method and self-calibration method. It avoids the traditional method of the requirement of high equipment and complicated operation. The advantages of self-calibration method are higher accuracy and better robustness etc [5].

The camera parameters include external and internal parameters. External parameters calibration contains the rotation matrix T and translation vector R. Internal parameters calibration includes the camera focal length f, radial lens distortion k1, k2 and tangential distortion p1, p2, the main point coordinates (c_x , c_y).

5.2. The image feature extraction and stereo matching

(1) The extraction of image feature point

The local characteristics of the image reflected by feature points, in which contain a high amount of information. It indicates the location of the gray level which changes dramatically on the two-dimensional, and also has obvious differences comparing with the adjacent points [6]. Harris operator is used to extract feature point in this topic. The method of Harris operator is simple, less parameter, small amount of calculation and quick speed etc. Extracting minutiae are uniform and reasonable, it can extract the image in a straight line.

(2) Feature point matching

Image matching is to recognize the same name point by certain matching algorithm between two or more image. The essence of matching image is matching criteria under the condition of similarity of the primitive, using the optimal search problem. This paper mainly adopted Harris algorithm to extract the feature point, using Matched-Points function to match the feature points of images from left to right.

Table 1 The results of distance

points	1	2	3	4	5	6
Distance origin	3084.7	3180.0	5221.3	4559.5	3087.2	3158.8
Point 1	3068.9	3173.1	5242.7	4576.4	3071.2	3151.8
Point 2	3080.0	3177.7	5226.9	4563.8	3082.4	3156.5
Point 3	3090.3	3182.7	5215.0	4554.6	3092.8	3161.6
Point 4	3101.0	3188.1	5203.3	4545.6	3103.6	3167.1
Point 5	3115.6	3196.3	5190.3	4536.1	3118.3	3175.4

5.3. Depth recovery and three dimensional positioning

After extracting and matching the feature points the depth recovery proceeded. According to the results of the interior and exterior parameters of camera calibration the stereo matching corner is restored.

5.4. The strategy of measuring the nearest distance from the vehicle trail

Calculate the world coordinates of obstacles by matching section around the camera in the previous chapter. The model of car tail simplified is a polygon fitting. According to the world coordinate, the recent distance which is obstacle to the car tail is calculated. On the basis of the binocular distance measurement principle, the world coordinates of barriers is accessed. The car tail simplified is approximate graphics generation. Dealing with information through the central processor, the recent distance which is obstacles to car is gained.

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Automobile tail approximately fits with two symmetrical square. The length and the angle parameters has known. Binocular cameras installed in the middle of the tail position. Multilateral fitting of vehicle tail can be used in practice, to improving the accuracy of measurement. This study uses the quadrilateral approximation to improve the calculation speed. The results shown in table 1.

By many experiments which is adopted the strategy of measuring the nearest distance from the vehicle trail, the nearest distance is selected. The result which is screened is the closest distance to the obstacle, and it is 3068.9mm.

6. Conclusion

This study adopts a parking assist system based on binocular vision, which mainly includes two parts: image stitching and obstacle detection system.

The whole process of image mosaic is based on SIFT, which can be fully automated and timeliness. This idea can effectively overcome the traditional image mosaic for displacement, angle of view and the light under the condition of large amplitude change constraints, although the SIFT algorithm has the advantages of scale invariant features, but it is still flawed. In future applications, it is still necessary to improve the algorithm, in order to obtain more accurate and stable high-resolution images.

The nearest distance of the obstacle detection system can get three-dimensional information of the obstacles and measure the nearest distance which is the rear of the car toward the obstacles, supporting for the driver parking. Experiments show that the design of the algorithm is simple and quick, distance measuring tools can work quickly, and measurement error is small. For the precision of the measurement, the car tail fitting number of edges can be increased. The quadrilateral fitting meet the needs of astern basically. The experimental error mainly caused by less number of fitting edges. In practice, to increase the accuracy, the more multilateral fitting of tail can be carried out. Later in the application of this strategy can be applied in reverse image. It can show the position information of obstacles real-timely so that the driver can get more information about the rear.

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