

# Image Matching Using Edge and Corner Detection

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**Abstract**— This system is modeled on the distance perception of human eyes. It uses DSP to process the images obtained by two CCD cameras. The distance is calculated by the principle of parallax using image matching techniques. This paper describes the working principle and hardware platform design. It focuses on the image matching methods based on Canny edge detection and Harris corner detection. The results of the experiment shows that the system is efficient and reliable.

**Keywords**— binocular stereo vision; image matching; Edge detection; Harris corner detection

## I. INTRODUCTION

Binocular stereo vision means we use two cameras instead of one. We use two cameras so that we get more information about the object being clicked. It is a technique aimed at inferring depth from two or more cameras. Distance measurement based on binocular stereo vision is a passive way, Compared to traditional distance measurement methods such as infrared and laser. Its advantage is that, it is hidden, safe, simple hardware and so on. However, the software design is very complicated. To obtain the distance information, we need to perform, a series of complex operations on the detected images. Therefore, the focus of the paper is on designing a high performance real-time image processing algorithm. In recent years, it has been gradually applied to autonomous navigation, engineering surveying and other areas.

## II. WORKING PRINCIPLE

Binocular stereo vision distance measurement is modeled on the distance perception methods of human eyes. Two eyes from two different points of view observe the object considered. Due to the optical geometry projection, image will be formed with different distance on the retina, which can be easily understood from the figure 1. Such position difference on the retina is known as binocular parallax, it can harness the objective distance from the object. Use two or more cameras on the same scene from different locations to obtain stereo images, through a variety of matching algorithms find the corresponding point in order to calculate the parallax and then the distance from the object can be calculated by triangulation

method. In this paper, the system uses two CCD cameras with the same parameters. Figure 1 is the schematic diagram of the system. The distance of two cameras' optical center is  $b$ , baseline. The optical axes of the two cameras are kept parallel. They possess same focal length  $f$ .  $A$  is the object with the vertical distance from the cameras' as  $L$ . Its images on the two cameras are  $A_1$  and  $A_2$ .  $x = x_1 + x_2$  is the parallax.

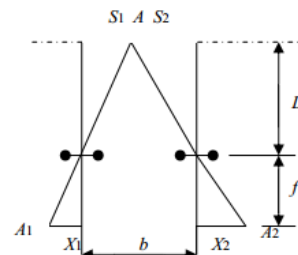


Figure 1. schematic diagram of system

In the diagram of the system, according to the principle of similar triangle, we know,

$$\frac{s_1}{x_1} = \frac{L}{f} \quad (1)$$

$$\frac{s_2}{x_2} = \frac{L}{f} \quad (2)$$

$$b = s_1 + s_2 \quad (3)$$

$$L = \frac{bf}{x_1 + x_2} \quad (4)$$

$$x = x_1 + x_2 \quad (5)$$

$$L = bf/x \quad (6)$$

We see that objective distance is inversely proportional to parallax. This is the mathematical model of the system.

## III. SYSTEM DESIGN AND ALGORITHM

### A. Hardware Platform

The image processing in this system is done on TMS320 DM642 EVM board. It is a general-purpose hardware. Due to the strong computing capability of the DSP chip on the board, we can do real-time multi-channel video capturing, realize complex image processing and run video compression algorithm. We have chosen two CCD cameras

with the same parameters. They are located at the same level with 15cm interval between them. The ccd cameras captures the image from different viewpoints. A/D converter converts analog image to digital array. This is stored in buffer. The digital array of the image is given to DSP chip for processing. The logic control block has the algorithm, which gives instructions for the DSP for processing. Both the original image and the processed image is displayed on the screen.

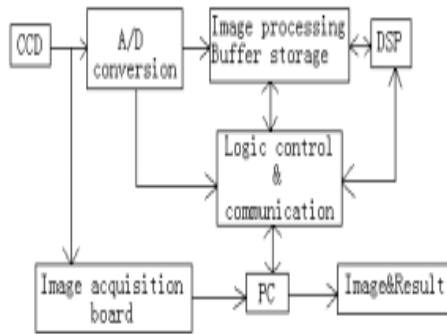


Figure 2 is the system block diagram

### B. Algorithm Study

The main aim to use positioning technology of binocular stereo vision is to calculate the coordinates to accurately extract the binocular parallax. It requires high precision image matching technology. Therefore, solving the image matching problem is the main target of the software design. We obtain stereo images that are left image and right image. Area-based and feature-based are the two methods of image matching. Area-based matching is to choose the neighborhood of a certain point in one image(say left) as a reference, search a corresponding point with the similar distribution of gray value in the other image(right) according to similarity measure sequence and then achieve the image matching. Area-based matching is a method where we use image pixel gray value directly. Therefore, it is very sensitive to the change of noise, light and contrasts. In practice, because of the inherent differences between the two CCD cameras, sensors' defect and image noise, leads to lack of sharpness, often false match, poor reproducibility and it is difficult to obtain accurate results from the image matching. Feature-based matching is not using gray value directly, but through the gray-derived values. So it is not so sensitive to the change of light and contrast. This paper puts forward a method that combines area-based and feature-based matching.

#### 1) Image filter.

In order to reduce the noise influence to the image matching results, first smooth filter is done to the images. We have studied the neighborhood average filter and median filter. With the effects of edge detection, we find that the neighborhood average filter is more effective than the median filter. According to the results of the experiment, we choose the Gauss filter with 3×3 template. Figure 3 is the results of the experiment.



Fig.3.The original image



Fig 4. Median filter



Fig 5. Gauss filter

#### 2) Edge detection:

In experiment, we have studied and compared a variety of edge detection algorithm commonly used. Canny edge detection proves to be more appropriate than others. Figure 4 shows the effects of edge detection algorithm



Fig 6. Prewitt edge detection



Fig 7. Robert edge detection



Fig 8. Sobel edge detection



Fig 9. Canny edge detection

### 3) Image matching based on Harris corner detection.

Corner detection is an approach used within computer vision systems to extract certain kinds of features and infer the contents of an image. Corner detection is frequently used in motion detection, image registration, video tracking, image mosaicing, panorama stitching, 3D modeling and object recognition. Corner detection overlaps with the topic of interest point detection. It has advantage of simple calculation and stability, Harris is an operator based on signal point characteristics extraction. In addition, it can extract point characteristics quantitatively and reasonably.

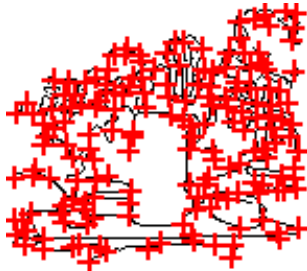


Fig 10. Harris corner detection

## IV. RESULT ANALYSIS

### A. The Experiment Results

The programs of this system are all developed in Microsoft Visual C++ 6.0 environment. Then the programs are dumped into the DSP chip for processing. After image Processing, the results are displayed on the PC screen. At last, we take measurements to the same object from different points of view and different distance. Table 1 gives the specific experimental results. The results of binocular stereo vision distance measurement

The actual Distance(m)	The measured distance(m)	The error (%)
0.7	0.661	5.57
1.0	0.988	1.20
1.5	1.513	0.87
3.0	2.966	1.13
5.0	5.062	1.24
6.0	6.078	1.30
7.5	7.784	3.79

The measuring range of binocular stereo vision distance measurement system is related to the cameras' focal length,

resolution and baseline chosen. According to the results of this experiment, the system has high accuracy in the range considered.

### B. Error Analysis

Measured error in the system is mainly due to image match error and optical sensor error. Image match error is the problem of programs. To reduce this error, we should find a more efficient way of image matching technique. Optical sensor error is either due to the unparallel optical axis or cameras' focal length error or baseline error. To reduce the optical sensor error, we need to select high-quality optical instruments. Adjust them carefully in the experimental process and fix the equipments firmly after adjusting.

## V. CONCLUSION AND FUTURE WORK

Be aware of the different meanings of the homophones In this paper, we have studied the binocular stereo vision distance measurement based on parallax principle, introduced and analyzed the key algorithm, brought out the image match method based on Harris corner detection, obtained the reliable results. In the following system for optimization process, we can use matlab to write the programs to make the entire system more efficient and reliable. It is expected that the system will be widely applied in defence and engineering automatic control systems.

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