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## Design and implementation of model of linear solver in computer filed

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### ABSTRACT

The process of establishing the model of linear solver requires the application in computer field. So it can improve the practicability. According to the application of the model in the binocular stereoscopic visual system, this paper combines the particular situation and discusses the process. In this paper, firstly, according to the system structures of parallel optic axis, common optic axis and crossing optic axis, the effective determination is finished. Then liner solver can be used more widely and then unite the construction of two stereoscopic visual systems based on CCD camera to study the model specifically which provides a foundation for its establishment of mathematical models. Finally, the paper studies the matching process of the model of linear solver to ensure the course and purpose of the research. During this thesis, the design and construction of the model gains a powerful foundation, and through the specific application, the deficiency of the construction will be found and will be made up. As for the conclusions of this study can influence the following study positively and can ensure the scientificity and rationality of studies in this field.

### KEYWORDS

Linear solver; Computer filed; Design of model, Concrete implement.



**INTRODUCTION**

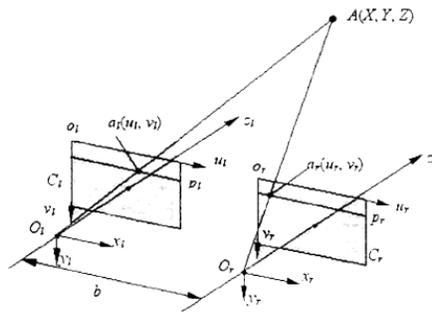
Linear solver is used widely, and in computer in particular. This study focuses on the application of linear solver in the construction of binocular stereoscopic visual system. The study mainly discusses these aspects: the structure of binocular stereoscopic visual system; stereoscopic visual systems established by two CCD cameras; mathematical model of computer visual system; stereo matching etc. In this way, the thought and application of the study can be more distinct and the theory of the study gains the practical support.

**STRUCTURE OF BINOCULAR STEREOSCOPIC VISUAL SYSTEM**

In the design of the model of the linear solver, firstly the study established the effective structure of binocular stereoscopic visual system. During this process, the different geometries of two cameras were fixed up, in which determined the influence of the common view and the range of image matching.

**Structure of parallel optical axis system**

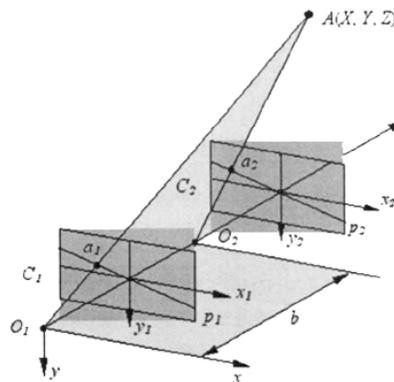
During the establishment of system of parallel optical axis (shown in the Figure 1), two cameras are laid in parallel and the internal specific parameters and focal length are same. And as for the imaging plane of camera the optical axis is vertical. And the X axis of two cameras can overlap; Y axis can be parallel. If the left camera moves along the X axis in certain distance (shown by  $b$ ), it can overlap the right one. Generally, during the installation procedure of camera, the optical axis cannot be shown. So this goal cannot be reached.



**Figure 1 : Optical axis in stereoscopic vision system**

**Structure of co-optical axis system**

In Figure 2, the optical axis stereoscopic vision system shows the parallel position of two cameras and their optical axis overlaps. And the maximum allowable distance between two cameras is  $b^{[2]}$ . So it also face the same problem in parallel optical axis stereoscopic visual system above, and it is impossible to let optical axis of two computers in same straight line. However, as for these two cameras in front and back, their distance should be so enough that the scene can be located in the same place. But it also has another disadvantage that the distance is so big that two pictures would cover each other and the surface of the object measured cannot form the projection nor on the picture of the two cameras. And in the 3D surface of the object, owing to the big distance, the cover will be bigger and cannot form the projection.



**Figure 2 : Co-optical axis stereoscopic vision system**

**Structure of crossing optical axis system**

In Figure 3, two cameras' optical axes are laid in crossing way and have certain angle. The two cameras are laid side by side and optical axes are  $z_1$  and  $z_r$ . In this way, the installation of camera is easier and more convenient and meanwhile the

distance and the angle between two cameras can be readjusted according to the needs of the object and the corresponding requirements of the system. And it can refrain from the cover in two situations above and from the limitation from field of view.

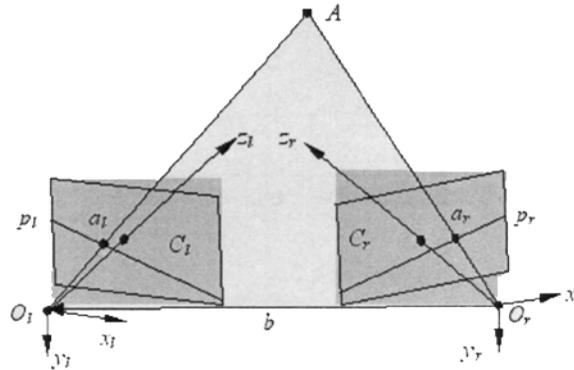


Figure 3 : Crossing optical axis stereoscopic vision system

### STEREOSCOPIC VISION SYSTEM ESTABLISHED BY TWO CCD CAMERAS

During adopting crossing optical axis structure, generally two CCD cameras and corresponding capture card and other facilities are used to establish the binocular stereoscopic visual system. All of these are necessary hardware equipments include following aspects:

First are two CCD cameras. In collecting images, the internal data is stable so the automatic focusing lens cannot be used.

Second is image capture card and related computer application software<sup>[4]</sup>. Image capture card play a positive role in video image capture for twice developing software and meanwhile makes image capturing synchronous. So the video signal can synchronizes with image capture and in the end the image capture of camera and the procedure are more convenient.

Third is a demarcate board made of plain glass. On the board there are black and white checks whose size can maintain unified. During the demarcation, it can work along the X axis within the certain distance and it can collect synchronously stopping in the certain place and determine the two sides' image.

Finally a computer is required. The particular image capture is divided into two procedures: the first step is to demarcate image. After the installation and test of the facilities, the computer determines the location of the console and then gathers the video signal from two ways. During the repeating this procedure, according to the specific requirements of image capture, the computer completely capture the image from the demarcation.

During the image capture of surface of object, after the demarcation, the spatial positions maintained by two cameras would not change and into which the measured object is moved. Through the image capture of computer towards two cameras, the image of the objects' surface can be gained<sup>[5]</sup>. The procedure of measuring system is shown as Figure 4.

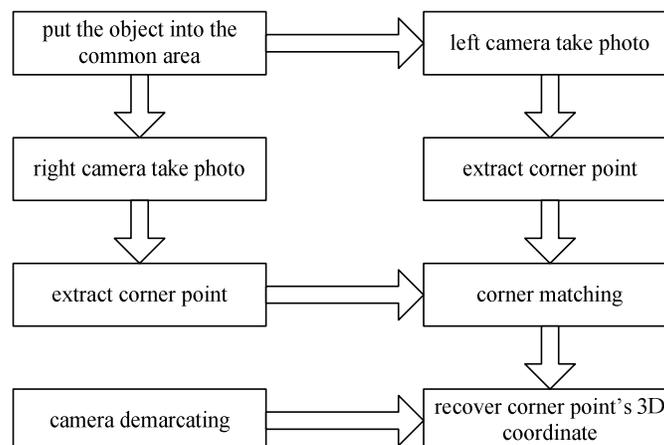


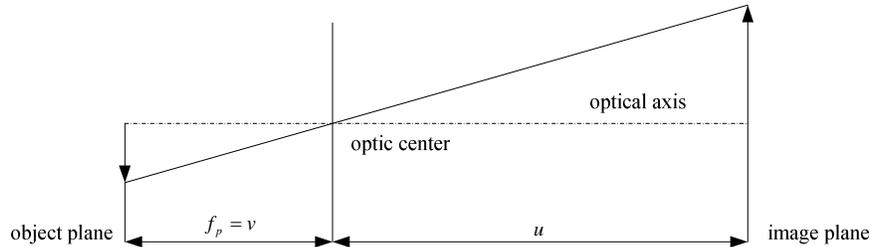
Figure 4 : The procedure of measuring system

During the process of setting up measuring system, the object would be put into the common area, and two cameras take the picture and then the system enter the pretreatment of two pictures. And at the same time, the exact corner point will be gained through the extracting. Then its focus is matched and finally the location of the corner point of two pictures is gained. The effective test of the camera facilitates getting the parameter. Combining the focus in these pictures' plane and

recovering them will produce the space coordinates. The space coordinates can effectively figure out the actual distances among these corner points.

**MATHEMATICAL MODEL OF COMPUTER VISUAL SYSTEM**

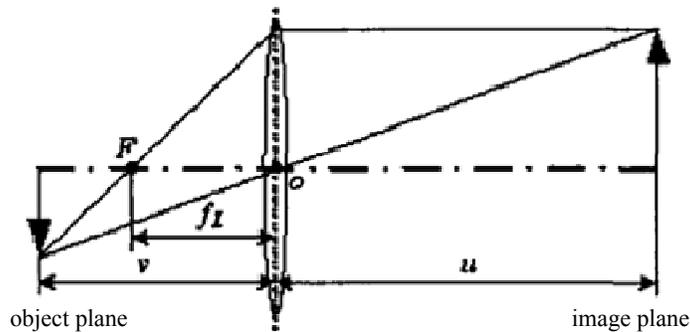
Establishment of mathematical model of computer visual system is a transform of geometrical relationship of the imaging-forming principle in which the plane projection is transformed through the geometrical relationship and the image model will be gained. And the most rational image projection model is the central projection in the photology which is also called linear model or pinhole model. While the pinhole model is the process that the light reflected from the surface of object can simultaneously pass a small hole and project on a plane mirror which is assumed<sup>[6]</sup>. In this phenomenon, optic center and image point will form a geometrical relationship which will be expressed by linear equation. The factor of the model mainly contains several aspects of Figure 5.



**Figure 5 : Pinhole imaging**

Through the principle of pinhole imaging, it is easy to see that the distance between the optic center and the image is equal to focal length and to the object distance. However, the disadvantage of the pinhole imaging is that the passing light is few that tend to lengthen the time of exposure and influence the sharpness of the image. This problem will be solved with the help of the lens. The method is to use the lens to get the lights closer to each other, so that produce a better exposure in a short time and a picture with a high sharpness. This is reflected in Figure 6. The following formula shows the relations among the object distance, image distance and focal length.

$$\frac{1}{f_L} = \frac{1}{u} + \frac{1}{v}$$



**Figure 6 : Lens imaging**

During the design process, because its workmanship is comparatively complex and the technology does not help the practical use, lens imaging cannot realize the central projection. This is the one major reason of lens distortion. The experiments proved that pinhole imaging cannot get an exact or effective result when it is used to describe the geometrical relationship. Generally the description of geometrical relationship adopts the linear model which can guarantee its accuracy.

**STEREO MATCHING**

The stereo matching refers to solve the important problem in the stereo image and is a key part of establishing the stereoscopic vision system. It can gain projection of the object of the space in the plane of two-dimensional image. And the same object can produce different images. It's difficult to get a effective stereo matching and the solution may not get a ideal effect.

### Matching area and feature

The arithmetic of stereo matching is mainly of two kinds: one is matching in the area; the other is matching based on the feature.

The matching in the area is that critical point of gray level of one point in a picture is the certain template and base on which seek for a similar gray level. Therefore the matched-degree of two pictures can be determined, and the specific similarity of two pictures will be found. And the function relationship is the key factor of the matched-degree of two pictures.

The stereo matching in the area is calculating corner points of each picture and exactly shows the intensive inspect, featuring huge calculation. Besides, direct matching with gray value of pixel makes the rotation and light intensity of image and change of contrast ratio sensitive. If there are repeated-structured textural features in two pictures or covers in the template neighborhood, it will lead to mix.

### The feature matching algorithm based on the point

According to limitations above, this study designs a set of stereo matching algorithm and steps are as following:

- (1) (1)Use operators  $H$  and  $s$  to extract the angular points which are feature points to be matched;
- (2) (2)According to the calibration parameter of camera calculate the fundamental matrix ;
- (3) In picture  $I_1$  get a feature point according to the epipolar line  $I_2$  in fundamental matrix calculation picture  $I_2$ ; get a point randomly on  $I_2$ , calculate the epipolar line  $I_1$  in  $I_1$ . According to epipolar constraint, all points of  $I_2$  can find corresponding points on  $I_1$ , and vice versa. Seek the feature points on  $I_2$  and save them in the array. Use robust match the cost function which is treated as similarity evaluation function, calculating the similarity evaluation of estimate among the feature points on  $I_2$  and establishing a planar table of evaluation of estimate  $M$ , the unit  $M(i,j)$  is similarity evaluation function of the  $i$  point of  $I_1$  and  $j$  point of  $I_2$ . If the  $M(i,j)$  both in its line and rows, columns are the minimum and it is smaller than a close value, the  $I$  will be relevant to  $j$ . During this process, mutual corresponding constraint, that is  $I$  finds the most similar point  $j$  and then use it to find the most similar point on  $I_2$ . If you can still find the  $I$ , the points are relevant. During this step, owing to the calibrated error of camera, the relevant point may not exist exactly on the epipolar line; pixel in a small neighborhood of epipolar line is included into the hunting zone. In order to cut the calculating time, parallax range constraint is used, and similarity of the certain point and a point on corresponding is only calculated.
- (4) Repeat the step (3), until finishing the calculation of all peripheral points. After every whole matching of two epipolar lines, the former points will not be considered again and be treated as satisfied.
- (5) (5)According to the gradient, choose the points gained above. Find the nearest candidate point inside the range of a certain candidate point. If you find it, calculate their parallax gradient. If  $G_d$  is lower than 2, these corresponding points are right matching. If not or  $G_d$  is bigger than 2, these will be considered later. Sequentially, all candidate points are repeated procedure above. Despite the result, the point has been checked will offer information for other points near it. Then, check candidate points on the  $I_2$  in above procedure; finally delete the points which are not checked. This step get rid of those points which fail to observe the continuity constrained matching and meanwhile, keeps the correct matching on the discontinuous boundary as much as possible. The comparison of matching error is shown as TABLE 1.

**TABLE 1 : Comparison of matching error**

Feature points	SSD wrong matching points	Wrong matching points in this calculation	Rate of wrong matching points	Rate of wrong matching points in this calculation	
box	316	28	18	8.8%	5.9%
bottle	69	6	4	8.7%	5.8%

### CONCLUSION

All of the above procedures are the study of the design and application of linear solver model in the computer field. In this study, the establishment of binocular stereoscopic vision system has been explored effectively. So this study has stronger theoretical property and the application value of the study is further realized, providing evidences for later study.

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