3D MODELLING OF BUILDINGS BY USING LINE SENSOR

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ABSTRACT:

Stereo method using two cameras can be got 3D information of all points in the scene. However, it is difficult to find out the corresponding point in both scenes. In 3D modeling of the landscape, distance measurement of plural point on the object is sufficient for modeling in most cases. It is possible to calculate the distance to the corresponding point, which has reflected on the scene obtained from many directions on the horizontal surface. But, it is difficult to get many directions from stile camera. It was considered to use of CCD line sensor for this situation. By putting the CCD line sensor on the mount, which rotates at the steady speed, and taking the images of 360 degrees. It would be able to easily realize the 3D measurement of the object. In this study, such system was used experimentally, and measurement accuracy was examined. The measurement was carried out using this system at university in Japan. We took 15 target points around campus. Mean measuring error was about 15mm at the target about 100m far from cameras.

1. INTRODUCTION

Generally, 3D measurement of most equipment uses the principle of the triangular measure. There are several methods for example stereo method using the binoculus, spot projected method, pattern projected method and moire topography, etc. Stereo method is the passive method, other methods are active method, which projects the light. Stereo method using two cameras is called the binoculus stereoscopic vision. This method can be got 3D information of all points in the scene. However, it is difficult to find out the corresponding point in both scenes. In 3D modeling of the landscape, distance measurement of plural point on the object is sufficient for modeling in most cases. It is possible to calculate the distance to the corresponding point, which has reflected on the scene obtained from many directions on the horizontal surface. But, it is difficult to get many directions from stile camera. In order to get many scenes from many directions, we used a video camera. This equipment is set at plural positions (for example, camera A, camera B, camera C and so on) on the identical circumference, and video scenes of 360 degree circumferences are obtained, and the images are incorporated in personal computer by the frame rate (30 scene/second) equal to the general television system. By putting the video camera on the mount, which rotates at the steady speed, and taking the images of 360 degrees. It would be able to easily realize the 3D measurement of the object. By counting the scene number of one camera (for example camera A), the angle from the direction of other camera (for example camera B) to the target marker can be calculated. Angle from the direction of camera A to the same target marker can be calculated by using the other camera B. As the result, distance from camera A to the target marker can be found out. The distances from each camera to the markers are calculated by using the above method. But, this method needs huge number of image scenes. For practical use, we need decrease the number of images. It was considered to use of CCD line sensor for this situation. By putting the CCD line sensor on the mount instead of video camera for above method. By using CCD line sensor, only one image is sufficient for calculating the angle from a CCD line sensor to the target maker. We can count line number instead of scene number. It would be able to easily realize the 3D measurement of the object. In this study, such system was used experimentally, and measurement accuracy was examined.

2. OUTLINE OF THE SYSTEM

This system has been composed of 3 components. These are CCD line sensor (CORE CCD camera CV-L103), servomotor (FUJI ELECTRIC, GYC101DC1-S) and decelerate gear system. This gear system is used to rotate the camera in fixed minutes. Lower part is servomotor. Rotating time of the sensor can be changed several steps. Middle part is decelerate gear system. Rotating speed of servomotor is too fast for obtaining object images. Decelerate gear system can be slow down the rotating speed of servomotor. Top part is CCD line sensor. This CCD line sensor can get object images by 2048pixels x 80 line /minute.

Figure 1. CCD Line Sensor System used in this study

3. MEASURING METHOD OF THE DISTANCE

This equipment is set at plural positions (for example, line sensor A, line sensor B, line sensor C and so on) on the identical circumference, and scenes of 360 degree circumferences are obtained, and the images are incorporated in personal computer. By putting the CCD line sensor on the mount, which rotates at the steady speed, and taking the images of 360 degrees. It would be able to easily realize the 3D measurement of the object. By counting the scene number of one line sensor (for example line sensor A), the angle from the direction of other camera (for example line sensor B) to the target marker can be calculated. Angle from the direction of line sensor A to the same target marker can be calculated by using the other line sensor B. As the result, distance from line sensor A to the target marker can be found out. The distances from each line sensor to the markers are calculated by using the above method.

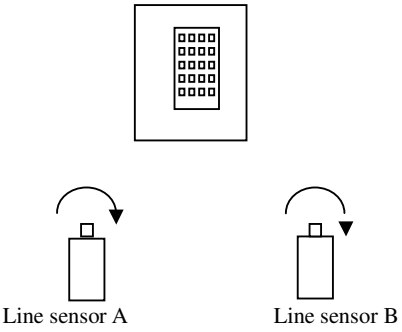

Figure 2. Obtaining method of target image

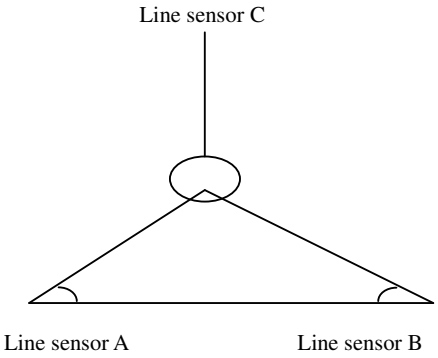

Figure 3. Measuring method of the angles

4. COMPARISON BETWEEN EXPERIMENTAL RESULT AND MEASURED DISTANCE

The measurement was carried out using this system at Kanazawa Institute of Technology in Japan on 28 June 2000. CCD line sensor was set at 3 points near library center in campus. CCD line sensor was set at 3 points near library center in campus. Two kinds of focal length were selected. One is 135mm and another is 300mm. Rotating speed was about 12.6 minutes for 135mm focal length and about 28 minutes for 300mm focal length per 360 degrees rotation respectively. We took 15 target points around campus. Number of pixels for each line are 2080. Sampling period is 21.39” for 135mm focal length and 9.62” for 300mm focal length respectively.

Number of lines can be calculated for 360 degree.

Focal Length 135mm: 21.39”

#Line/360 = 360 x 60 x 60 / 21.39 = 60,589 lines

Focal Length 300mm: 9.62”

#Line/360 = 360 x 60 x 60 / 9.62 = 134,719 lines

Calculated image sizes are as follows.

Focal Length 135mm:

2080 pixels x 60,589 lines

Focal Length 300mm:

2080 pixels x 134,719 lines

Figure 4. Experiment executed in Kanazawa Institute of Technology

Figure 4 shows the experiment executed in Kanazawa Institute of Technology. This position corresponds to the line sensor A.

We can find out the line number of each target point from other line sensor easy. Line number corresponds to the angle from other line sensor position to target point. Measurement resolution can be calculated theoretically as follows. If target point located 100m far from line sensor position, theoretical resolution can be calculated as follows.

Focal Length 135mm:

$$\text{Resolution} = 100000 \times \text{SIN}((\pi/180)*21.39/3600)$$

$$= 10.4\text{mm}$$

Focal Length 300mm:

$$\text{Resolution} = 100000 \times \text{SIN}((\pi/180)*9.62/3600)$$

$$= 4.7\text{mm}$$

Obtained images by using CCD line sensor are shown in Figure 5. Preliminary analysis of the obtained CCD line sensor images showed the following result. Mean measuring error for focal length 300mm was about 15mm at the target about 100m far from CCD line sensor.

5. SUMMARY

In this experiment, following things are become clear. CCD line sensor is effective for 3D measurement. Calculation of 3D position of target is very easy. Rotation of 360°is not necessary for measuring the 3D position of targets.

Figure 5. CCD line sensor images used in this study

References

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