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Design And Calibration Of Multi Camera Setup For Virtual 3D City Modeling

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Abstract

Demand of Virtual 3D City models is increasing day by day for various engineering and non-engineering fields. Now a day, various methods are available to create Virtual 3D City models. Photogrammetric method is one of the main method to create virtual 3D City model, because of many advantages. In Photogrammetric method, data acquisition is a main and important step for 3D City modeling. So Video recording is an easy way to capture the large city area in less time. From this video data image frame creates and identified the suitable image frames for close range photogrammetric processing. Thus a good multi camera setup is a very efficient tool for city data capture. In this work, we developed a multi camera setup for capture the video of a city or any area. After capturing the data, Camera calibration is also a important issue. So we also develop a simple method for multi camera setup calibration by using video data.

I. Introduction

Virtual 3-D city model generation is a very hot research topic for Geomatics scientist. There are various terms used for 3D city models such as "Virtual City", "Cybertown", "Cybercity", and "Digital City". 3D city models are basically a computerized or digital model of a city contains the graphic representation of buildings and other objects in 2.5 or 3D. The term 2.5D is used for describing models where there is only one unique Z-value (elevation value) defined for each pair of XY-coordinates. The most important characteristic of 3D city models are the possibility to navigate through the model by walking, flying and examining.

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Photogrammetry is an appropriate tool to provide information about man-made objects, vegetation cover and the like (Gruen, 1999). Photogrammetry and Digital Image Processing techniques play important role to make visualization technology practical and cost effective. In the 3D city modeling, simulation is done by using true information via Photogrammetry. Photogrammetry appears to provide the only economic means to acquire truly 3D city data (Förstner, 1999). By means of true information in the content of the precision and accuracy, the 3D city models can be used for simulation and analysis from visualization and animation (Emem, 2002b). In spite of high vertical and horizontal accuracy of photogrammetric maps, it is not possible to use them directly in the 3D city modeling. Especially the buildings on the digital maps have some vertical errors, when we examine them from the perspective view. Hence, these perspective errors should be edited before using them in the 3D city models (Emem, 2002a).

Video recording is a very easy and cost effective method for data acquisition. In close range photogrammetry, the art and method of taking photographs have been given by "3x3" rules (Waldhäusl & Ogleby., 1994). These rules which are to be observed for photography with amateur cameras in close range photogrammetry for best results. These rules are called so because they are structured in three items, with three sub-items each. (M.Shashi and Kamal Jain, 2007) There are: 3 Geometric, 3 Photographic, 3 Organizational.

So we make a solution for video data capturing which follow these photogrammetric rules.

II. Design of multi-camera setup

A hollow wooden box made and designs such to fix the camera.

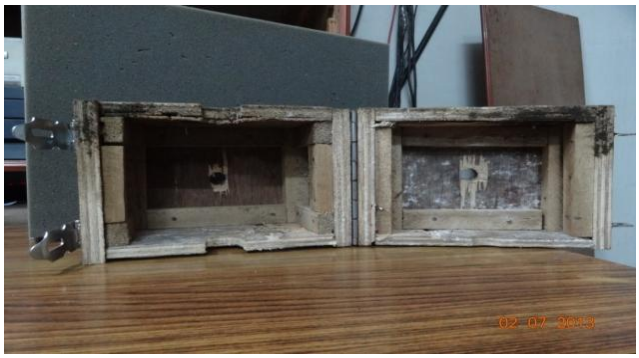

Fig-1 (a)

Fig.1 (b)

Fig. 1 (c)

Fig.1(a),(b),(c)-showing the hollow wooden box from different sides.

The main advantages of this hollow wooden box are:

a) It is cost effective.

b) It is easy to handle due to less weight.

c) Camera will be safe during operation.

d) Any type of camera may be used.

Fig. 2.

We make a hollow wooden box. A hole makes to insert the rod which fixes it to the top of the car or vehicle. We fixes four camera around the four side to capture the data. A set of four camera used for 360^0 video recording. This wooden box fixes on a moving car. In such way, video recording taken for a whole city or any specific area.

We can change the design of wooden box and camera according to project need.

III. Camera Calibration

Camera Calibration is also important for any close range Photogrammetry work. It is a process of determining the characteristics of a camera so it can be used as a measurement device. These characteristics specifications of camera are focal length of the lens (f), CCD format size of a digital camera (Fw, Fh), the Principal points (Xp,Yp), and Lens distortions (k1,k2,k3, and p1,p2). This description needs to be created only once and is used for every subsequent project done with this camera.

Methodology for Multi camera setup camera calibration

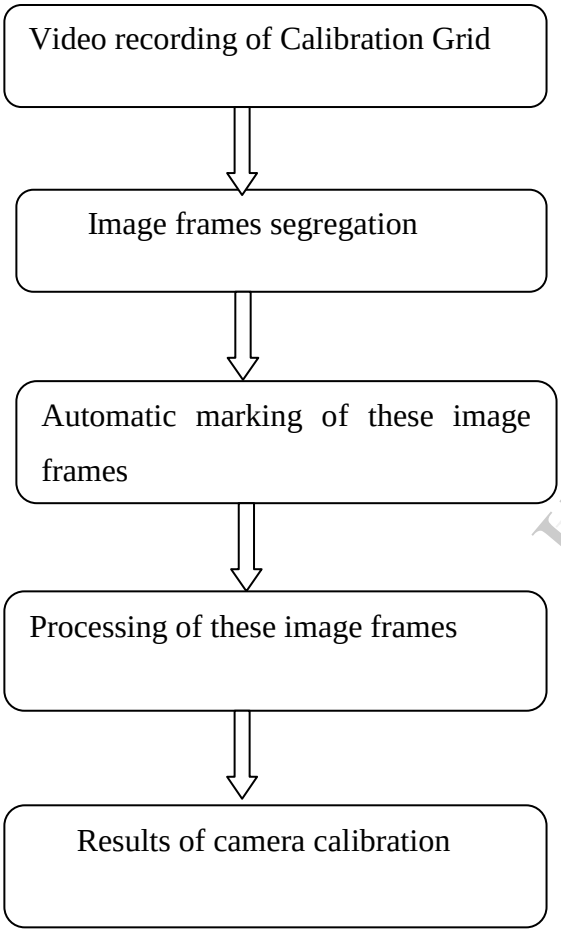

Fig.3 - Flow chart for methodology of Multi setup Camera Calibration

Video recording from various angles, taken of a specific design calibration grid. After this recording Image frames created and use these image frames for camera calibration. Figure showing the image frames created from video. These image frames used for processing to create camera calibration result.

The Calibration Grid is a pattern of dots specifically designed for the Camera Calibrator. After processing of this calibration grid images, camera parameters obtain.

These camera parameters are Focal length of lens, Format size, Image size, Principal poins (Xp,Yp),and Lens distortions parameters (k1, k2, k3, and p1,p2).

In this research work, two paired camera used. One pair from Sony DSC HX 7V, and other pair from Kodak EasyShare CX 7300.

Fig.4. a) Sony DSC HX7V Digital Camera.

Fig. 4. b) Kodak EasyShare CX 7300

Table.1: Results of camera calibration

Camera parameters	SonyDSC HX7V	Kodak Easyshare CX 7300
Focal length (f) (mm)	4.6661	6.3002
Format size (mm) (F-width, F-hight)	Fw= 6.0000 Fh= 4.5000	Fw= 5.7406 Fh= 4.2612
Principal point(Xp) (mm)	3.0000	2.6625
Principal point(Yp) (mm)	2.2500	2.3184
Lens distortions k1	0.000e+000	2.126e-003
Lens distortions k2=k3	0.000e+000	0.000e+000
Lens distortions p1	0.000e+000	5.438e-0004
Lens distortions p2	0.000e+000	1.949e-0004

After calibration of the camera, it is ready for video-recording. For a ideal photogrammetric survey, the base line/distance ratio i.e., the distance between two camera positions while taking photographs to the distance between the camera to the object ratio should be within reasonable limits and not be too small and that should be between 1/ 15 and 1/20. If the building façade is large then camera is kept at large distance from the building. (Shashi and Jain, 2007). We create the image frames from this calibrated video camera and utilized to create virtual 3D City model by close range photogrammetric theory. This Close Range Photogrammetric technique is also helpful to create Virtual 3D Building modeling (Surendra et al. 2012).

IV. Conclusion

The Virtual 3D City modeling is very important for various applications like to identify the encroachment in municipality, Virtual tourism, Historical fort and building conservation etc.
With the help of Multi camera setup, we can take 360^0 recording of a city by using a car or any other vehicle. Camera calibration is also possible by video image frames. From this video data, we create image frames suitable for close range photogrammetric work. (Surendra et al. 2012). The 3D City model has various applications like in e-Governance (Surendra et al. 2011).
In Indian city, this technique will be very useful to make virtual model of any city. This technique is very cost effective to create virtual 3D City model, compare to laser techniques.

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