FEASIBILITY ON GENERATING STEREO MOSAIC IMAGE

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ABSTRACT:

Recently, the generation of panoramic images and high quality mosaic images from video sequences has been attempted by a variety of investigations. Among a matter of investigation, in this paper, left and right stereo mosaic image generation utilizing airborne-video sequence images is focused upon. The stereo mosaic image is generated by creating left and right mosaic image which is generated by front and rear slit having different viewing angle in consecutive video frame images. The generation of stereo mosaic image proposed in this paper consists of several processes: camera parameter estimation for each video frame image, rectification, slicing, motion parallax elimination and image mosaicking. However it is necessary to check the feasibility on generating stereo mosaic image as explained processes. Therefore, in this paper, we performed the feasibility test on generating stereo mosaic image using video frame images. In doing so, anaglyphic image for stereo mosaic images is generated and tested for feasibility check.

KEY WORDS: Airborne-Video Sequence, Stereo Mosaic, Motion Parallax, Rectification

1. INTRODUCTION

Recently, there have been attempts in a variety of applications to add 3D information into a mosaic representation. Geo-registration method was proposed by Kumar, et al[1998]. It is a method that makes an addition to geo-data for camera location in images acquired by video camera. Stereo mosaics generation from two rotating cameras was proposed by Huang & Hung[1998]. Generation of stereo mosaics from a single rotating camera has been suggested by Peleg & Ben-Ezra[1999] and Shum & Szeliski[1999]. In generating seamless 2D mosaics from a hand camera, Shum & Szeliski [1998] used a de-ghosting technique to correct for the small amount of motion parallax caused by small translations of the camera. Based on mathematical model for correcting motion parallax, Zhu, et al. [1999, 2000, 2001] proposed general method considering both motion parallax and multi-perspective projection. Among these mosaic representation, mosaic images generated from consecutive frame images as video sequences can be utilized in several fields such as mapping system, environmental monitoring and military target. Especially in case of stereo mosaic image generated from consecutive images taken in different viewing angles, it is much effective and efficient to obtain 3D geometric information as well as 2D geometric information. However, the stereo mosaics from a rotating camera and translational motion suffer from the difficulty of generation. The aim of paper is to provide a theoretical background and procedure for stereo mosaicking and to test the feasibility of proposed method on generating stereo mosaic image using consecutive video frame images from a translating camera.

2. STEREO MOSIAC IMAGE GENERATION

2.1 Mosaic Generation

The stereo mosaic generation method proposed in the paper can be classified into two categories which are shown in Fig. 1. The first method is the geo-referenced mosaic method and the second one is the free mosaic-to-geo mosaic method. The geo-referenced mosaic method generates stereo mosaic image using the geographical data from the beginning of process. The geographical data ("geo-data") includes 3D locations from the GPS, 3D rotation angles from the Inertial Navigation System (INS), and the range data along the flight path from a laser range finder. Contrary to geo-referenced mosaic method, the free mosaic method creates stereo mosaic image using relative position and attitude of consecutive images in the beginning. After then, free mosaic image is transformed into geo mosaic image using geographical data(GPS, INS, range data). In this paper, we check the feasibility on free mosaic-to-geo mosaic method.

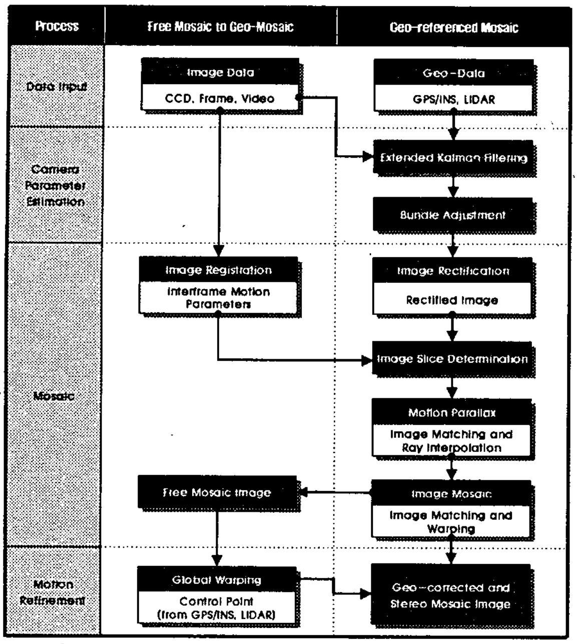

Figure 1. Stereo mosaic generation method

2.2 Geometric Model for Stereo Mosaic

To generate stereo mosaic image, an appropriate geometric model for a moving camera allowing viewing angle changes must be established. Geometric model for stereo mosaic was proposed by Zhu, et al. (2001) as shown in Fig. 2. This model assumes that motion of moving camera is presented one-dimensional (1D) translation. If the camera motion is a 1D translation of constant speed, the camera optical axis is perpendicular to the camera motion. In addition, if the video frames are dense enough, we can set up the geometric model for stereo mosaic as shown in Fig. 2(a), (b).

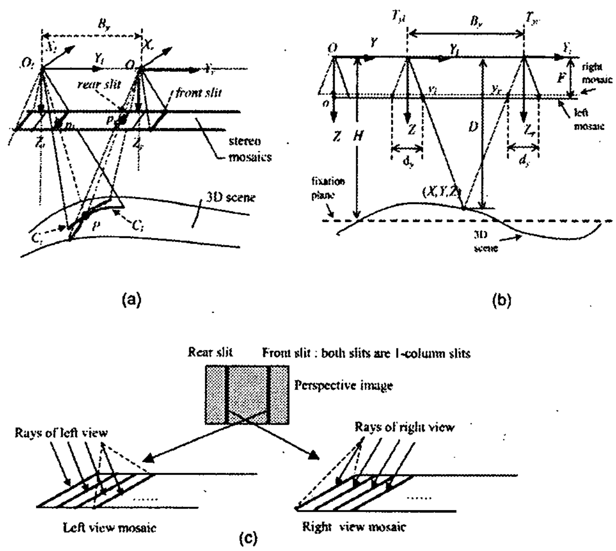

Figure 2. Geometric model (Zhu, et al, 2001) : (a)left and right image acquisition, (b)geometric structure of stereo disparity, (c)parallel-perspective model

Based on the geometric model, front and rear sliced images consisting of several pixel widths of column-wise image patches are extracted from each frame image shown in Fig. 2(c). As shown Fig. 2(c), left mosaic image is generated by tying consecutive front sliced images and right mosaic image generated by tying consecutive rear sliced images, respectively. As results, left and right mosaic images are in parallel projection along motion direction and in perspective projection across motion direction. Since we tied and attached consecutive sliced column images, the resultant left and right mosaicked images have different viewing angles which lead to perceptual depth and stereopsis. In reality, there is no such a case of 1D translation of camera motion. To meet the assumption of geometric model of stereo mosaic, image rectification of each frame image should be performed beforehand using relative camera motion vector.

2.3 Camera Parameter Estimation

In case of geo-referenced stereo mosaic method, the camera parameter is delivered by geospatial sensors such as GPS, INS and laser range profiler. However, free mosaic-to-geo mosaic method doesn't take use of sensor data, but it establishes relative geometric relationship of video image sequence. The relative camera parameter can be estimated by relative bundle adjustment

2.4 Image Registration

The relative camera parameter means inter-frame camera motion vector in relative fashion. To satisfy the basic assumption of geometric model for stereo mosaic, the relative camera parameter is utilized for performing image registration. In case of geo-referenced stereo mosaic method, image rectification can be performed by using sensor data such as GPS, INS, laser range profiler data. Instead of image rectification in geo-referenced stereo mosaic method, the free mosaic-to-geo mosaic method applies image registration for stereo mosaic.

2.5 Image Mosaic

Based on geometric model, video image sequences are registered and transformed into vertical position using relative camera parameters estimated. Both left and right mosaic image are then generated by tying consecutive front and rear sliced images. When tying consecutive sliced images, it is crucial to eliminate the mismatches between adjacent sliced images for generating seamless stereo mosaicked image. In order to overcome the artifacts, the matching process should be performed along stitching line. After matching over stitching line, image warping process will be followed afterwards. The detailed process of image mosaic is shown in Fig. 3. It should be noted that the seamless stereo mosaic image could be generated when camera parameters are estimated in high precision, slicing, matching and warping are well performed in locally and globally.

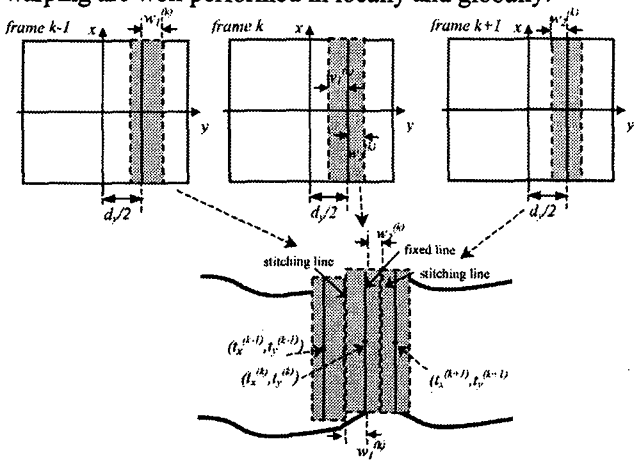

Figure 3. Stereo Mosaic

3. FEASIBILITY TEST

3.1 Data

Video sequence data is taken by Sony DCR-pc110 over central Daejun city area. Consecutive video frame images (73 frames) are captured by using Pinnacle studio version 7.0 in 30frame/second. Frame image resolution size is 720×480 pixels. Overlapped rate between 1st and 10th image is about 97.5% and flight height is about 430m above MSL. Focal length of video camera is about 15.7mm and FOV(Field Of View) is about 25.5° .

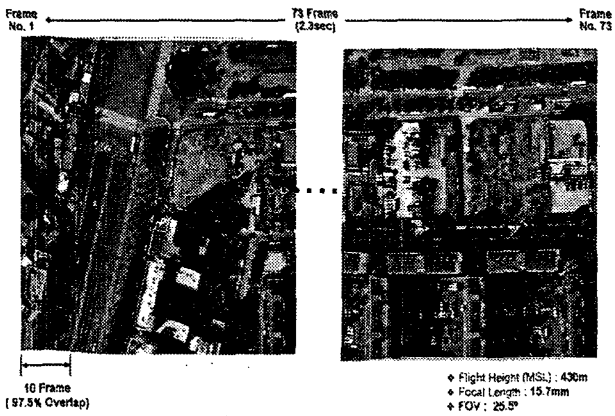

Figure 4. Extracted video frame image(73 frames)

3.2 Relative Camera Parameter Estimation

Relative camera parameters for extracted video frame images are determined by using digital photogrametry workstation system as "ImageStation SSK Pro" in image registration step. The result is shown in Fig. 5.

Frame No.	X_0 (mm)	Y_0 (mm)	Z_0 (mm)	ω (deg)	φ (deg)	κ (deg)
1	0.000	0.000	15.700	0.000	0.000	0.000
2	0.131	0.012	15.708	-0.036	-0.140	0.007
3	0.262	0.025	15.716	-0.071	-0.281	0.013
4	0.393	0.037	15.724	-0.107	-0.421	0.020
5	0.524	0.049	15.732	-0.143	-0.562	0.026
6	0.655	0.061	15.739	-0.178	-0.702	0.033
7	0.786	0.074	15.747	-0.214	-0.842	0.039
8	0.917	0.086	15.755	-0.249	-0.983	0.046
9	1.048	0.098	15.763	-0.285	-1.123	0.052
10	1.181	0.103	15.772	-0.331	-1.270	0.063
⋮	⋮	⋮	⋮	⋮	⋮	⋮
⋮	⋮	⋮	⋮	⋮	⋮	⋮
71	9.150	0.401	16.869	-1.931	-9.761	0.055
72	9.266	0.406	16.895	-1.940	-9.934	0.015
73	9.381	0.412	16.922	-1.949	-10.108	-0.026

Figure 5. Relative camera parameter

Utilizing relative camera parameters, we can generate relatively registered images.

3.3 Image Slicing

Using relative rectification images, front and rear slit windows each image frame are located and extracted by using image analyst software. The distance between the front and the rear slice windows from the center of image is dy = 192 pixels, respectively and slit window width is 12pixels.

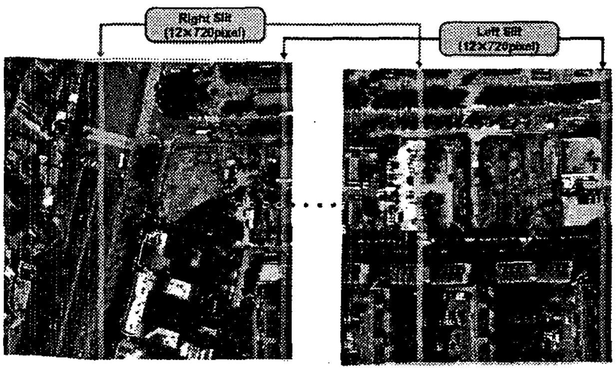

Figure 6. Image slicing

3.4 Image Mosaicing

Left and right mosaics are generated by mosaicking left slit windows and right slit windows separately. Fig. 7 shows the resultant left and right mosaicked images. Mosaicing is performed by using image analyst software. Left mosaic image size is 448×757 pixels and right mosaic image size is 449×727 pixels.

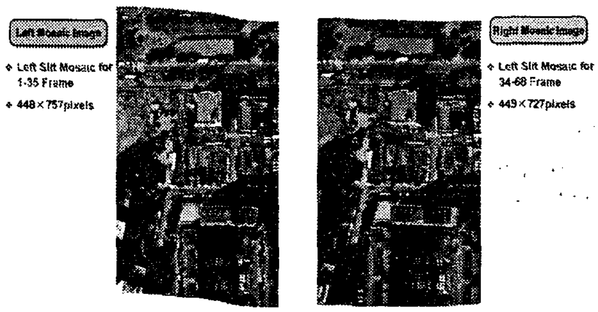

Figure 7. Left and right slit mosaic images

3.5 Anaglyphic Image Generation

To generate anaglyphic image, we selected red band image for left and right mosaic images. For overlapped window area between left and right mosaic image, we carried out color composite that left mosaic image is composed to red color image and right mosaic image is composed to blue color image. The generated anaglyphic image is shown in Fig. 8. Through this image, we can view stereo with anaglyphic grasses. It was found that the anaglyphic image is viewed in stereo, however there were found some artifacts over buildings due to misalignment of adjacent sliced images.

Figure 8. Anaglyphic image

4. CONCLUSIONS

In this paper, a stereo mosaic representation and a 3D mosaicing method have been presented for generating stereo mosaic image with a consecutive video frame images. The aim of this paper is to check feasibility on generating stereo mosaic. As shown in anaglyphic image, we can see stereo viewing although we used simple method. However, we can see misalignment in generated left and right mosaic images. This problem can be solved by using image matching method and view interpolation. This paper provides a theoretical base for stereo mosaicing and possibility to generate stereo mosaic. Future work is to generate seamless stereo mosaic image using proposed mosaic method more rigorously.

5. REFERENCES

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