Some Enhancement in Processing Aerial Videography Data for 3D Corridor Mapping

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Key words: 3D corridor mapping, aerial videography, point-matching, sub-pixel enhancement, camera calibration, orthomosaic, anaglyph 3D viewing.

SUMMARY

Aerial videography technique has some interesting advantages if it be applied in the corridor mapping system, such as: low-cost, fast in production, simply in operation, and adaptable (meet the need) in area with corridor shape. Obviously, there is not much attention to use it in practice (specially in Indonesia), because there are some limitations in the final product in contrast with conventional aerial photography. Some of it such as low-spatial resolution, less accuracy in orthophoto product, and can not produce 3D. This paper tries to solve those limitations by enhancement in processing.

Several enhancements in processing aerial videography data will explain to reduce the limitation. Some of those are camera calibration, point-matching, sub-pixel enhancement, near-orthomosaic formation, and 3D viewing. The data is a video movie in PAL-VCD format with low resolution pixel size (288 x 352 pixel). It is assumed can be represent a low cost and limitation in production.

The two real data as an example take in Kalimalang–Bekasi (by cessna plane) and East-Kalimantan (by piper plane) will show the result of enhancement. The results show the near-orthomosaic image with sharp image and also an anaglyph 3D viewing for some selected corridor area.

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1. BACKGROUND

The Indonesian land area that it is about 1.9 kilometer squares have not been completed in mapping yet. Regulation says that every municipality ("kabupaten") has to make some regional planning maps in scale 1/50.000, 1/25.000, or 1/10.000. Unfortunately, not all local government has enough fund resources to do survey-mapping activities. The challenge is to create a mapping system that has some characteristics such as: cost-effective, simply in operation, can be done by local staff, and adaptable (meet the need). In this paper, the choice is to use aerial videography technique, because sometimes mapping with satellite has limitation in cloud free covered image.

Aerial videography technique has some interesting advantages if it be applied in the corridor mapping, because the ability to follow the coridor feature in contrast with conventional way that make a "block-based" shape. Obviously, there is not much attention to use it in practice (specially in Indonesia), because there are some limitations in the final product in contrast with conventional aerial photography. Some of it such as low-spatial resolution, less accuracy in orthophoto product, and can not produce 3D. This paper will focus on processing activities to handle aerial videography data. Only some of the processing such as camera calibration, sub-pixel enhancement, near-orthomosaic formation, and 3D viewing will be explained. This paper not explaine the accuisition processs and also the image registration process to local ground coordinates.

The two real data as some examples take in Kalimalang–Bekasi (by cessna plane) and East-Kalimantan (by piper plane) will show how the processing work.

2. WHY AERIAL VIDEOGRAPHY ?

In this paper, aerial videography technique is defined as a system that use a camcorder or handycam that mounted on the aerial platform such as (trike, microlight, or plane) to record video data of the surface of the earth. The handycam is used as a remote sensing sensor for capturing object on the earth in the visual electromagnetic band. The GPS navigation type receiver has added to navigate the pilot during the aerial photo flight. A Simply gyro camera mounting have been made to stabilize the camcorder during operation. All the equipment that used can be found easily in the electronic consumers market.

The aerial videography have some interesting characteristic such as low-cost, simplicity, general availability, and portability (see Meisner, 1986, Sumarto, 1997). Another advantage is it can be recorded many data frame (up to 30 frame per second). In the operation of photo flight, the pilot is only need to maintain flight direction as in the flight plan map. There is no need to do camera exposure interval activity.

Unfortunately, there are some limitations that make aerial videography not superior as conventional aerial photography such as low pixel resolution, narrow field of view, and slow in exposure time (Mausel, 1986). Another problem is the interlace system scanning in video recording.

Some researchers have applied aerial videography technique (See Everitt and Nixon, 1985, Um and Wright, 2000, Dare, 2002, Broers, 2000, Elevelds, and Blok, 1999, Sumarto, 1997, McCarthy, T., 2002, Raper and McCarthy, 1999, Zhu, 2004, etc.). In the future, the equipment that support aerial videography technique will be more better such as sensor technology in digital camcorder (CCD or CMOS), GPS receiver, computer and memory storage capacity.

3. THE PROCESSING STRATEGY

The main challenges of the processing of aerial videography data are to reduce the limitation and emphasize the advantages of the characteristic of the aerial videography data. Some enhancement in processing can produce a better orthomosaic and possible to extract a 3D information. Some of those process such as camera calibration, matching otomatization, sub-pixel enhancement, near-orthomosaic formation, and 3D viewing. Some of the procedure have been implemented by script file in Matlab software. The two real data as an example take in Kalimalang–Bekasi and East-Kalimantan will show the result of enhancement process.

3.1 Calibration Camera

One of the dominant limitations that it makes degradation of the geometric quality of videography data is lens distortion. Consumers camcorder do not have a metric lenses and also not as rigid as the metric camera. Calibration process shows the dominant distortion is in the border of the frame (see Figure 1). The bundle adjustment with self-calibration algorithm is used to process the calibration. The result of calibration process can reduce the distortion error until ± 0.2 pixels.

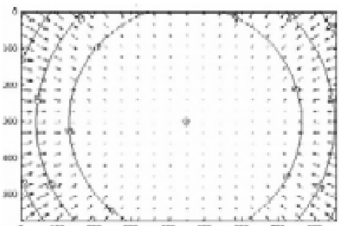


Figure 1: the camera distortion pattern

3.2 Point Matching Automation

The point matching operation in this paper is defined as matching one template pixel (as point object) from one image frame to the correspondence template pixel in another image frame. The purpose of this process is to transfer the correspondence points from one image to another one. The point transfer process is one of the bottle necks in the process production, so automation in this process will decrease the production time significantly. The point matching quality has significant impact in the final image mosaic quality. This need to have a sub-pixel accuracy point matching.

The characteristic between adjacent video frames have a good correlation, so the normalized cross-correlation algorithm can be used to do point matching. We only need a looping process to process between adjacent video frames. The sub-pixel quality can be done by finding the biggest coefficient correlation value by maxima operation. Figure 2 shows the example of point matching result.

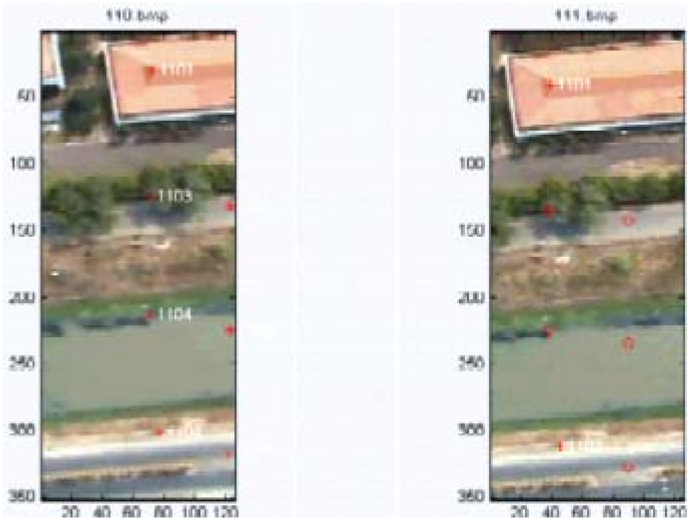


Figure 2: Point matching result (location: Kalimalang)

3.3 Sub-Pixel Enhancement

The consumers video recording format has a low pixel resolution in contrast with conventional aerial photography. This is because video system has to record 25-30 frames image in one secon (PAL and NTSC system); meanwhile we have not large band width data transfer capability. To solve this limitation, we can adopt the same idea that it used in production SPOT image 2.5m or desktop scanner interpolation. Sub-pixel enhancement can be processed by make interpolation (interleaving) between adjacent frame video. This is done in the spatial domain at the same time in the image mosaicing process. Figure 3 give some example of the sub-pixel enhancement.

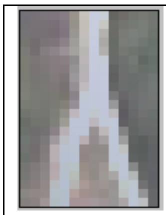
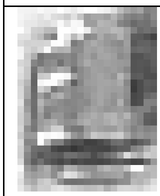
	 (location: east-kalimantan) object: road junction
	 (location: east-kalimantan) object: small-house
	 (location: Kalimalang) object: small-roof texture

Figure 3: Some of sub-pixel enhancement

As a consequence this process will take a computation time significantly.

3.4 Near-Orthomosaic Formation

This process is related to effort that makes an orthomosaic image efficiently. The video data have a large frame number, so the robust geometric such as collinear condition in photogrammetry will need a big computation time. We have to use image-to-image registration process that it more simple i.e. like the 2D Affine transformation. Firstly, the process is to make the sequence video frame just like a *"three line scanner"* image formation (see figure 4). This will have two advantages, firstly: it can be made a near-orthogonal mosaic (nadir viewing), and secondly it can be possible to extract 3D information (backward and forward viewing). The quality of the mosaic formation is depending on the quality of the point matching process. This process idea is close similar to the process that have been published by Zhigang Zhu (See Zhu, et.all, 2004).

(b) (a)

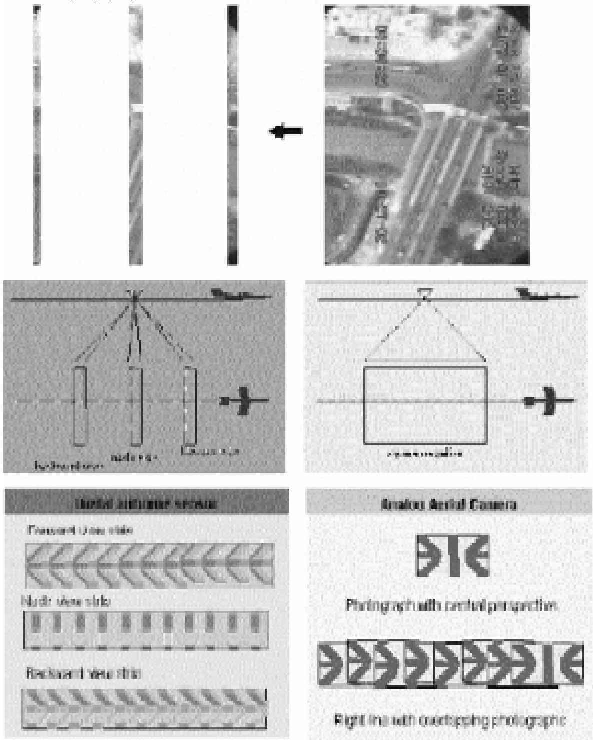


Figure 4: Idea for the geometric formation (a)conventional, (b)videography

3.5 Anagplyh Viewing

The one way to extract 3D information from the aerial videography data is to use the mosaic of backward and forward image. Between the forward and backward viewing we have a stereo viewing. The formation of forward and backward image mosaic give the result that both of the images have been in normalized stereo or epipolar geometry. The 3D information can be extracted by using parallax equation. The anaglyph viewing can be used to check whether the backward and forward mosaic have been in normalized stereo (see Figure 5).

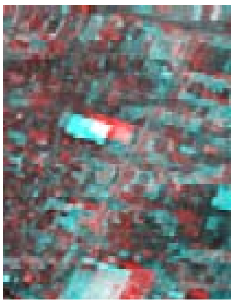


Figure 5: The anaglyph red-blue viewing. (location east-kalimantan)

4. THE EXPERIENCE

This process have been tested for process the two aerial videography data that taken in Kalimalang by cessna plane and East-Kalimantan by Pipper plane. The video data has been in PAL-VCD (MPEG-1 format) with low resolution pixel size (288 x 352 pixel). It has taken in vertical field of view with gyro stabilized camera mounting. So, it can be assumed a near vertical aerial videography. The Kalimalang data have ground resolution is about 0.35m and the East Kalimantan data have ground resolution is about 0.6m. Figure 6 show the nadir-mosaic image between processing and after registration. This mosaic is looks like near-orthogonal.

Figure 6: The result of nadir-mosaic formation. (a) Before, and (b) After registration

5. CONCLUSION

This paper shows the processing to handle the aerial videography data that can be enhanced to reduce the limitation characteristic of the videography data. The final product can be a near-orthomosaic image and also a 3D anaglyph viewing.

Future work that need to be done to answer several question such as how to transform image mosaic efficienly to the ground coordinates, how good is the 3D information, how can we make automation in feature extraction.

REFERENCES

Broers, H., 2000, Instrumentation for DEM-generation from Airborne Video Image Sequences, *M Sc. Thesis at University of Twente Department of Electrical Enggineering Control Science and Computer Technology Group Laboratory for Measurement and Instrumentation*, Netherland.

Dare. P., 2002, Linear infrastructure mapping using airborne video imagery, tersedia di : http://www.sli.unimelb.edu.au/ pdare/asprs2000.pdf, available Feb 2002.

Everitt, J.H., Nixon P.R., 1985, False Color Video Imagery A Potential remote Sensing Tool For Range Management, *Photogrametric Engineering and Remote Sensing, Vol. 51, No. 6, June 1985*.

McCarthy, T., 2002, *Role of spatially video in GIS A review of methologies and technology*, http://www.*blue*glen.com/Spatially_encoded_video.htm, available April 2002.

Jonathan Raper, Timothy McCarthy, 1999, *Using Airborne Videography To Assess Coastal Evolution and Hazards*, Department of Geography, Birkbeck College, London

Mausel, P.W.Everitt, J.H. Escopbar, D.E. and King, D.J., 1992, Ariborne Videography, *Photogrammetric Engineering & Remote Sensing, Vol.58 No.8* pp 1189-1195.

Meisner, Douglas, E., Lindstorm, Orville, M., 1985, Design and Operation of a Color Infrared Aerial Videosystem, *Photogrammetric Engineering and Remote Snsing, Vol.51, No.5*, May 1985

Meisner, D.E., 1986, Fundamental of Airborne Video Remote Sensing, *Jurnal Remote Sensing of Environment Vol 19 No.1*, Elsevier Science Publishing, New York

Sumarto, I., 1997, An Investigation Into The Aplicability of Airborne Videography for Tophographic Mapping, *Ph.D Thesis at School of Surveying and Land Information*, Curtin University of Technology, Australia.

Um, J.S., and R. Wright, 2000, Effect of angular Field of view of a video sensor on the image contention a strip target: the example of revegetation monitoring of a pipeline route, *Int. J. Remote Sensing, vol. 21, no. 4, pp. 723–734*

Zhu, Zigang, Allen R. H., and Edward M. R., 2004, Generalized Parallel-Perspective Stereo Mosaics from Airborne Video, *IEEE Transactions on Pattern Analysis and Machine Intellegence, Vol. 26*, No.2, pp. 226-237, Feb 2004

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