MONO PLOTTING USING HDTV IMAGERY

Junko SUGIMORI, TSURU Kosuke, Akira OHTA
Air & Space Photogrammetry Office, Aero Asahi Co.
Minamidai 3-1-1, Kawagoe-shi, Saitama, 350-1165
JAPAN

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ABSTRACT:

HDTV (High definition television) is a broadcasting system developed to enjoy watching television on wide screen. One of important characteristics of the HDTV is a high brilliance digital image.
HDTV image can be applied for surveying with the help of aerial photography. Besides, continuous images like as getting from linear array sensors can be acquired by mosaicing principal scanning lines from each HDTV images. By using this continuous video image, we can execute digital mono plotting briefly. Moreover, HDTV images can be used in CAD directly, without getting a risk of collapsing images by scanning.
This paper inspects mono plotting accuracy of continuous video image.

1. INTRODUCTION

The recent spread of computer technology have been forced to change the mapping system remarkably. For example, GIS such as car navigation systems would bring a map close to our daily life. The map is expected to be digital data. And expected to be much the same as real world. Rapid update of changing place is desired. Besides, scale transformation ability of computer weaken the idea of scale and changes idea of map accuracy.
As a result of them, demand of digital map producing which don't need so high accuracy but rapid reproducing becomes higher, except ordinary surveying and the map producing which needs mastery of skills. There are a lot of way to reply such requests, but this paper will study for the possibility of using video images which taken by HDTV system.

2. HDTV IMAGE

HDTV(High Definition Television) is technology of acquiring the high accuracy digital image. HDTV is a broadcasting system developed to enjoy watching television on wide screen.
The greatest characteristic of HDTV is numerousness of information of 1 image. HDTV has about 2.2 times scanning lines of present NTSC-TV, and a line of HDTV has 3 times pixels of present NTSC-TV. Totally, a image of HDTV maintains about 6 times of information of that of present NTSC-TV. The accuracy is not so high as aerial photograph, but can be applied in a simple measurement (Nakamura, 1997, Inoue, 1997).

Table-1 quality of HDTV image

	HDTV image	present TV
number of lines	1035	480
number of pixels	1920	640
screen ratio	9:16	3:4

The camera for HDTV photography was boarded on an aircraft. Video image is acquired by continuously photographing of nadir side of aircraft. Gyro is used for keeping nadir photographing and GPS is used for recognizing a position of photographing spot. Few scanning lines near the principal point are selected and mosaic. By that way, continuous video image will be produced.

Followings are characteristics of continuous video image .

(1)Continuous image is provided, which is like as acquired by line scanner.

(2)Enable to use without orientation, because coordinate of each principal points are already identified by GPS and giro system.

(3)Easy to use the image on computer, because it is already degitalized by the beginning. And there is not danger of accuracy deterioration by degitalization.

Consider these characteristics, the continuous video image is good for rapid map updating, monitoring and management of line type institution, such as road, railway, river, power line and so on. So, in this study, data accuracy of mono plotting is inspected, which image is photographed mainly on an overhead part of the Sinkansen.

3. STUDY METHOD

3-1 Photography

Aerial HDTV image measurement system which has developed by Aero Asahi Co. is used for acquiring video image. Aerial HDTV image measurement system can acquire extremely high quality images by using high accuracy stabilizer and differential GPS. Image and measurement data, such as position, direction, altitude, camera focus and zoom ratio are acquired in the same time. So position and size of an object can be measured.

In this study, images are acquired along the overhead part of railway about 200 m wide.

Table-2 Performance Characteristic

	RMS	remark
GPS	1m	differential
radio altimeter	±(2feet-0.05H)	
magnetometer	±1°	
3-axies sensor	1° ≧	AZ,EL,RL

Table-3 Photographing data

focus distance	13.99mm
ground height	374m
photographing area	200m
flight speed	about 40 km / h
photographing speed	60 pieces / second

3-2 Making of continuous video image

Each one scanning lines on the principal point of the images are selected and mosaic to be changed to the line sensor type image. Then, image collection is performed by using measurement data for final continuous video image. Concerning about this study, calibrate the image without lens distortion data by using only focus distance.

Table-4 is the data of using continuous video image

Table-4 The data of continuous video image

PIX/LINE	2070 - 4000
Pixel size (m)	0.125
Origin of the image (m)	(557566,3853935)
UTM zone number	ZONE 53
Rotation angle	35.9 °

3-3 Mono plotting

Mono plotting is performed on CAD system using continuous video image. The middle of the image (225 m *375 m) is used for mono plotting. Railway, road and house are plotted for the purpose of accuracy inspection.

3-4 Accuracy

In this study, following data are considered to be true position data.

Concerning about railway, road and solid buildings, Fundamental Spatial Information published by GSI Japan are considered to be true position data. It is a data which digitarized scale 1:2500 topographic map. About other houses, digitized data of scale 1:2500 regional plan map is used.

25m square lattice are created in the plotting range. And gap between plotting data and true position data in each lattice are measured and changed to vector. When there are no suitable object, that lattice is excluded from inspection. Corner of a house roof and turnings of road are used for inspect position.

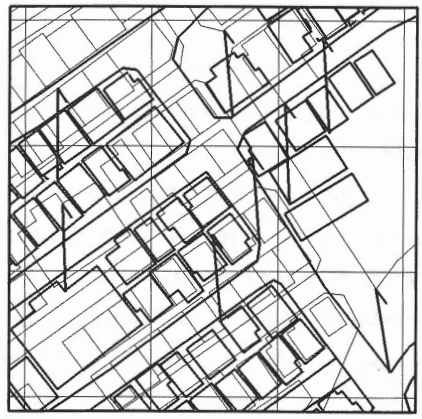
Figure 1 shows results of the inspection. Inspected gap vector is resolved into a vector of progress direction (the upper section) and a vector of vertical direction (the lower section).

17.9 -4.7	17.7 -0.2	17.9 -0.9	17.8 0.8		15.9 2.1	16.8 4.9	17.2 4.9	16.3 6.7
20.4 -3.2	19.3 -1.8	17.3 -0.6	17.5 -1.7	18.3 1.3	16.9 2.1	15.9 4.0	17.0 4.2	15.4 4.1
18.9 -3.0	17.1 -2.9	21.3 1.1	17.0 1.2	16.2 0.5	15.9 1.3	16.4 3.5		16.9 6.2
19.3 -0.2	17.8 -1.7		16.9 1.0	16.7 2.3		17.1 3.4	16.8 4.6	
19.9 0.9	18.0 -0.3	16.7 -0.4	18.3 0.2	17.6 1.8				
20.1 -3.2			17.5 0.8	16.2 1.9	20.7 3.9	18.1 5.3	17.2 8.5	
				17.2 2.1	17.5 2.8	18.5 6.2	19.7 6.5	
	18.6 0.3	17.6 1.5	18.6 1.5	17.7 1.4	18.4 3.3	16.2 4.6	16.1 5.5	16.6 7.6
18.6 0.1	17.6 1.2	17.2 1.8	19.0 1.2			18.0 5.9		19.0 6.9
15.8 3.5	18.2 0.1	18.1 1.6	20.0 0.9					
18.2 0.4	17.5 0.6	17.7 1.8	16.6 2.7	17.9 5.0				
17.8 1.3	17.4 3.6	17.7 3.0	18.4 1.8					
16.9 4.9		18.9 3.1				17.6 7.8		
17.9 4.8	17.5 2.4			18.4 4.0	17.4 7.5	18.9 5.1	17.0 7.9	
16.5 2.9			17.9 6.1		18.0 8.5		18.5 10.7	19.3 10.4

Figure-1 Gap vector size

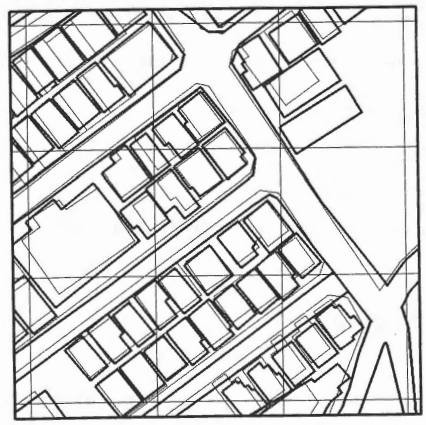
Standard deviation of gap to progress direction is 20.7m, maximum is 15.4m, minimum is 1.6m. And standard deviation of gap to vertical direction is 3.1m, maximum is 10.7m, minimum is 0.1m. Systematic error is happened to progress direction. Conjecture the reason, it is because of a time lag between GPS and time recorder of video.

Figure 2 is a part of the result and figure 3 is the result after carry out bias correction on a inspected gap vector. Thick lines are plotting data and thin lines are true position data.



(Scale 1/1500)

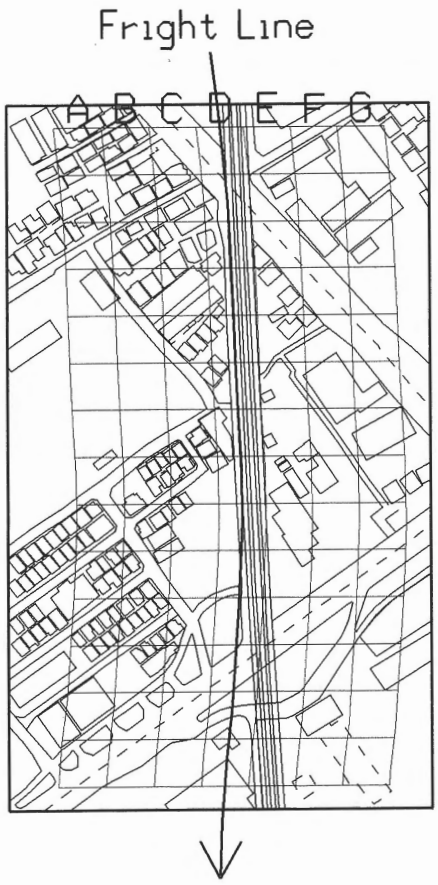
Figure-2



(Scale 1/1500)

Figure-3

Next, 25m buffer is generated on both side of the center line, and punctuate the buffer toward progress direction in every 25m for the purpose of making about 25m square lattice (figure 4). A central thick line shows the principal point of video image. Gap between plotting data and true position data in each lattice are measured.



(Scale 1/4000)

Figure-4

A	B	C	D	E	F	G
3.6	3.4	1.0		2.2	0.9	
3.0	1.9	1.0	1.7	2.3	2.4	4.2
1.3	2.5	2.6	0.9		3.4	5.5
2.8	2.7	0.7	0.8			
	1.4	1.1	0.4		3.0	
		0.8	0.7	2.4		7.1
1.1	0.5	1.8		2.8	4.3	10.5
2.3	1.3	0.9	1.8	4.4	5.1	5.9
1.6	0.9					
2.6	0.8					
1.0	1.3	1.9		3.5		
0.8	1.6					
1.0				4.1	6.5	
			2.7		8.7	
mean	1.9	1.7	1.3	1.1	3.1	4.3	6.6

Figure-5

Figure 5 is a list of gap vector length.

Examine a mean of each row, row-D shows the smallest gap and more far the row goes the bigger the gap becomes, even though there are difference between the quantity of gap of right and left. This result shows one of the characteristics of continuous video image. Because of the line sensor type data, center line of image has high accuracy, but the bigger the distant goes, the lower the accuracy shows.

4. CONSIDERATION

1:2500 maps which use for true position data was published in 1995, while video images was acquired in 1997. So the enough comparison of plotting items can't be done, because there are many changing places in the study area.

Like this case, the continuous video map is very suitable to carry out mono plotting. Because there are no local position gap such as ortho images make by scanned aerial photo, and the definition of image is so high as 0.125m per pixel.

Considered about data accuracy, standard deviation of gap is 1.8m, maximum is 21.9m, minimum is 7.0m, and mean of the accuracy is 18.1m before bias correction. After bias correction, standard

deviation of gap becomes 2.0m, maximum is 10.8m, minimum is 0.2m, and mean of the accuracy is 2.9m. By this study, some characteristic of continuous video image became clear.

First, accuracy for photography direction is high because of using GPS for acquiring coordinates. This high accuracy will not change, even if the photographing distance gets longer.

Second, accuracy of center line is much more higher than that of outer line. It is the proper subject of the line sensor type data, but it is necessary to pay attention with large difference of relative height as an experiment of this time. If the object will photographed properly in the center of the image, accuracy of the object will be stable and high.

5. CONCLUSION

In this study, data accuracy of mono plotting using continuous video image which acquired by using HDTV system is inspected.

The advantages of using video image are simplicity of use and rapidness to acquire images. Images which have enough accuracy for mono plotting can be acquired by using suitable calibration data. If use that way, complicated orientation or correcting process, which are necessary for aerial photography and image analysis, are not used. Concerning about this study, even if there are no lens distortion data, or even if timelag is generated , mono plotting can be carried out in 2.0m standard deviation, 2.9m mean and about 10.0m maximum with the help of bias correction.

6. REFERENCES

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