DEVELOPMENT OF POSITIONING INFORMATION REALIZED DIGITAL CLOSE-RANGE PHOTOGRAMMETRIC SYSTEM

Hyun Choi [a,] *, Chang-Hwan Ahn [a], Jin-Soo Kim [b], Ho-Wook Han [a]

[a] Dept. of Civil Engineering, Kyungnam University, Masan 631701, S.Korea. - (hchoi, survey21c, hwhan)@kyungnam.ac.kr
[b] Dept. of Civil Engineering, Pukyung National University, Busan 608737, S.Korea - pksurveying@pknu.ac.kr

Commission V, WG-V-5

KEY WORDS: Digital Close-Range Photogrammetirc System, GPS-assisted Photogrammetry, CCD Camera, Nicon D200, GPSmap 60CSx

ABSTRACT:

Digital photogrammetric system has shown many possibilities in image analysis division for real time digital photogrammetric treatment use of the digital camera which take storage capacity itself and digital photogrammetric measuring method. And GPS, positioning system using satellites, is acquired its utilities in many parts because it is very easy to get the three dimensional coordinates using GPS around the world. In this research, in comparison with Precise Control Point Surveying used GPS(Sokkia GRS2600), Ordinary system(Nicon D200+GPS101) and development of positioning information realized digital close-range photogrammetric system(Nicon D200+GPSmap 60CSx) surveying results, Ordinary System surveying latitude error is 19.383m, longitude error is 9.090m and Altitude error is 8.413m. However development system has shown that latitude error is 7.203m, longitude error is 4.544m and altitude error is 5.735m. Also, consumption of battery is one of the most important things for photogrammetry, the old system can observe about 30 pictures but development system can observe about 200 pictures and the weight is lessen than 3kg so that one person can operate alone. Therefore, the point of development of Positioning Information realized Digital Close-Range Photogrammetric System is to increase efficiency when renewing old result of digital map for changed topography rapidly and when you need real time information.

1. THE INTRODUCTION

Digital photogrammetric system has shown many possibilities in image analysis division for real time digital photogrammetric treatment use of the digital camera which take storage capacity itself and digital photogrammetric measuring method.

Digital close-range photogrammetric, which treats a target by digital photogrammetric, possesses various advantages. The advantages are; high resolution, application on diverse digital photogrammetric, efficiency of real time treatment, and automation. More extensive applications include; machinery, medical, measuring of cultural assets and detailed division. It is impracticable to efficiently create data, because digital photogrammetric required enormous cost and time that it takes location information of a target to use triangulation or GPS surveying in a datum point. In this research elaborates that it is possible to efficiently create data by developing combined digital close-range photogrammetric system which collaborating GPS and digital close-range photogrammetric system.

Combined Digital close-range photogrammetric system incorporates location information and map information.

Consequently, it is possible to acquire real time location by digital photogrammetric. This will be a great approach to save time and create economic efficiency.

2. THEORETIAL BACKGROUND OF SYSTEM

2.1 Image acquisition Using CCD Camera

CCD(Charge-Coupled Device) can sense total area at a time because it has function that can sense total area. Sense that is discontinuous in interior semi-conductor and fixed state has been attached, and very become precision-made. Each sensor acquires reflex after not reading directly by computer forming linear wave first in scanning line.

$$\begin{aligned} I + n_I(t) &= v_x x \\ I + n_j(t) &= v_y y \end{aligned} \quad (1)$$

v_x, v_y is a reflex acquisition ratio of x, y direction, and $n_I(t), n_j(t)$ has generally few value. CCD is suitable for the use of photogrammetry having good geometrical attribute and can acquire reflex by Real-Time. Therefore, it is suitable sensor for Real-Time photogrammetry application. But, two dimensions CCD used usually current is shortcoming that resolution is low as apply photogrammetry extensively because have 512×512 reflex pixel resolution generally. Light reflected in object is collected to series signal by lens of CCD camera and by CCD sensor senses strength, light collected is passed to analogue voltage signal. Conversion of this signal consists to numerical information by A/D conversion, this strength for observation purpose is changed typically from 0(black) to 255(white) extents' gray scale. Usually, frame grabber of

* Corresponding author.

computer reflex board runs conversion and display to picture of monitor to get numerical picture using CCD camera.

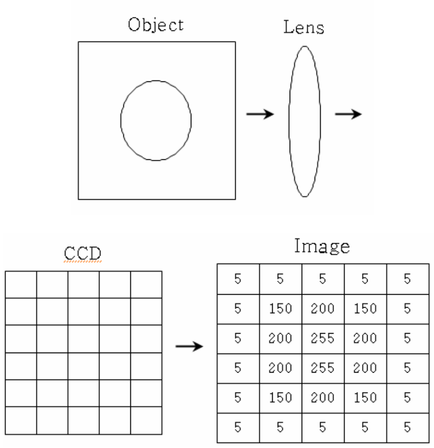

Figure 1. CCD Camera Image acquisition

2.2 Positioning that use GPS

GPS is global positioning system that use artificial satellite. In receiving electric wave that shoot in satellite that find correct location observation point need there system that get location of observation point by observing be. Current use NAVSTAR GPS because U.S. AIRFORCE gets into leading after 1 is shot August, 1984, 26 total is operating and end part of the 20th century or satellite that aim early of the 21th century are planning and manufacture. GPS satellite is loading mathematic cesium clock, this cesium clock correct time whenever is transmitted in ground, Therefore, GPS satellite have system same time. Actually, GPS satellite has atomic-time dimension. A receiver watch includes watch error on problem explaining to do positioning because daytime than GPS has correctness degree.

Δt is observation value of arrival time, and if E does watch error, distance r_{1p} can get by way(2.22)from satellite S_1 to receiver.

$$r_{1p} = (\Delta t - E)c \qquad (2)$$

c is speed of light way (2.22)E. Observation equation way (2.23) course same.

$$\{(X_P - X_1)^2 + (Y_P - Y_1)^2 + (Z_P - Z_1)^2\}^{1/2} = (\Delta t - E)c \quad (3)$$

Δt has observation possibility in way(2.23), and come four unknown quantity X_P, Y_P, Z_P and E exists. Therefore, can get station of receiver and watch error that want if is observed in four satellite at least. Positioning method that use current GPS is used in positioning that is the airplane and positioning of ship and approximation that sail. Work takes advantage of continuous phase observation method what is called most land surveying work and mechanical work that use GPS, this method takes advantage of Heterodyning reception method that mix signal(wave) that is made when receive with carrier signal(wave) that receive essentially and get observation value that come by result specification time. Speak as "Continuous phase" that calculate phase change number from number of circulation, $360° \sim 0°$ from when receiver begins phase values observation the moment in extent $0° \sim 360°$.

Of course, receiver must remove change of code modulation by $180°$ satellite change to approach in received carrier wave.

This method is settled by signal squaring method, and it is achieved taking advantage of precision knowledge about pseudo random number binary arrangement to make carrier wave of original. GPS reference network was consisted of about 400 GPS control point been operating being established world wide current and about 1,400 GPS control point is planning for establishment and operation. GPS reference network is used by various kinds purpose such as navigation, Geo-spatial information system and practical use degree is expect to be magnified rapidly. Wide area reference network is planed to magnify by 125 forward although numbers of current control point are 75 when see worldwide. Increased to 360 hereafter although numbers of control point of reference network are 70 in the United States America current, and capital of control point in country reference network from 250 now to 875, is increased.

3. DEVELOPMENT SYSTEM AND COMPARING OBSERVED VALUE

3.1 Precise Control Point Surveying used GPS

In the area of the research, we computed GPS baseline by connecting permanent GPS site with the triangulation point for precise control point surveying used GPS. In consideration of distance from the triangulation point, permanent GPS site decided to use National Geographic Information Institute Daegu GPS active station, Jinju GPS active station and Ministry of

Kind of Machine	
 Sokkia GSR2600	
Specification	
RTK (1)	1.0cm + 1ppm(Horizontal) 2.0cm + 1ppm(Vertical)
Static	3mm + 0.5ppm(Horizontal) 10mm + 1ppm(Vertical)
DGPS	WAAS/EGNOS : 0.8m CEP
Channel	12Channel L1/L2 Full code, Carrier
Cold Start	50sec
Signal Reacquisition	L1 0.5sec, L2 0.6sec
Standard Input/Output Format	RTCA, CMR, RTCM, NMEA 1PPS(out), mak-in

Figure 2. Base and Rover GPS specification

Network Design

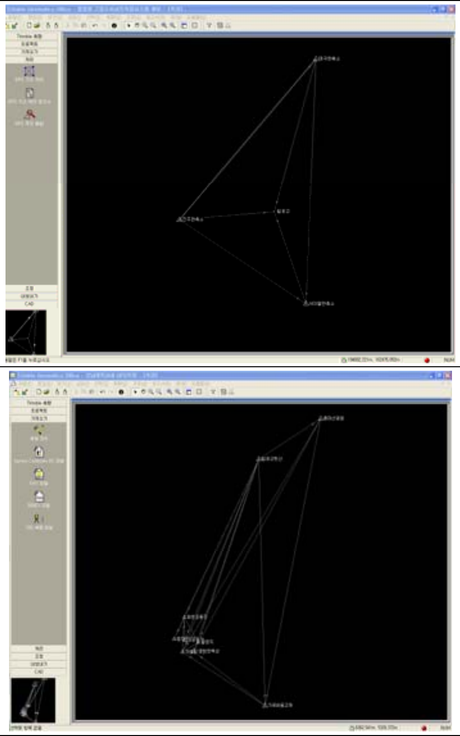

Figure 3. Precise Control Point Surveying used GPS Network Design

Maritime affairs & Fisheries Seoimal GPS active station No.304 triangulation point which is placed the mountain at the back of Habpo high school was used as a base. NO.404 triangulation point at Bium-pass in Gapo and no.405 triangulation point at Yongmasan park were used as rovers and the black point of GPS survey. We set six points out in Kyungnam University for rovers and operated GPS survey.

3.2 Development Positioning Information realized Digital Close-Range Photogrammetric System

Kind of Machine	
 Nikon D200	
Specification	
Type of Camera	Single-lens reflex digital Camera
Image Sensor	RGB CCD, 23.6×15.8mm, Total pixels 10.92million,
Image Size(pixels)	[L] 3872×2592 pixels [M] 2896×1944 pixels [S] 1936×1296 pixels
Picture Angle	Equicalent in 35mm[135] format is approx. 1.5 times lens focal length
Exposure Metering Range	1) EV 0~20(3D Color Matrix or center-weighted metering) 2) EV 2~20(spot metering)
GPS	NMEA 0183(Ver 2.01) interface standard supported with 9-pin D-sub cable

Figure 4. CCD Camera specification

Kind of Machine	
 GPSmap 60CSx	
Specification	
Receiver	WAAS chip/12Channel
Monitor	1.5×22inch, 256Color TFT
Range	-600m ~10,000m
Detail	Within 3m
Acquisition times	Warm : <1 sec Cold : <38 sec Auto-Locate : <45sec
Accuracy	Position : <10m, typical Velocity : .05m/s steady state
Antenna	Built-in quad helix receiving antenna, with external antenna connection.(MCX)

Figure 5. Using GPS specification

The way to experiment is total five times(from 10. 14. 2007 to 11. 02) we observed the six points which had been set out in Kyungnam University.

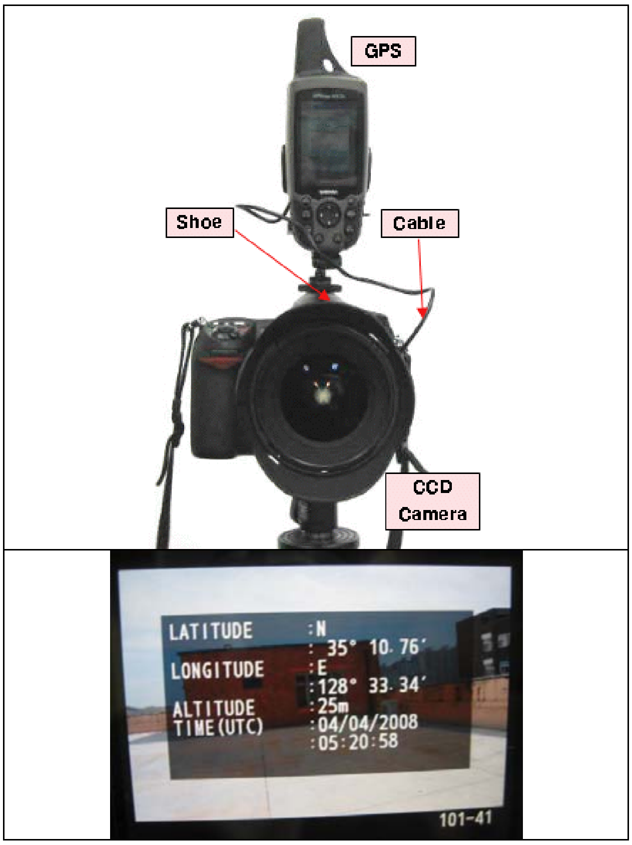

Figure 6. Development Positioning Information realized Digital Close-Range Photogrammetric System

Figure 7. Development Positioning Information realized Digital Close-Range Photogrammetric System used exercise

3.3 Comparing Observed Value

This table is compared with Precise Control Point Surveying used GPS(Sokkia GRS2600), Ordinary system(Nicon D200+GPS101) and development of positioning information realized digital close-range photogrammetric system(Nicon D200+GPSmap 60CSx) surveying results.

Point Name	Obs. Method	Latitude	Longitude	Altitude
KNU 1	Precise GPS	35°10'51.21563"	128°33'22.86132"	40.727
	Ordinary System	35°10'50.20000"	128°33'22.70000"	30.830
	Development System	35°10'51.00000"	128°33'22.80000"	33.500
KNU 2	Precise GPS	35°10'46.46329"	128°33'19.86032"	90.927
	Ordinary System	35°10'46.00000"	128°33'20.10000"	84.000
	Development System	35°10'46.20000"	128°33'19.80000"	87.000
KNU 3	Precise GPS	35°10'46.10025"	128°33'12.28028"	111.248
	Ordinary System	35°10'46.80000"	128°33'11.80000"	107.000
	Development System	35°10'46.30000"	128°33'12.00000"	106.700
KNU 4	Precise GPS	35°10'53.01175"	128°33'06.80453"	115.963
	Ordinary System	35°10'52.50000"	128°33'06.30000"	106.300
	Development System	35°10'52.80000"	128°33'06.60000"	110.500
KNU 5	Precise GPS	35°11'04.74898"	128°33'13.57297"	94.133
	Ordinary System	35°11'04.00000"	128°33'13.10000"	85.200
	Development System	35°11'04.50000"	128°33'13.20000"	87.000
KNU 6	Precise GPS	35°10'52.46493"	128°33'13.89272"	63.001
	Ordinary System	35°10'52.80000"	128°33'13.60000"	52.200
	Development System	35°10'52.20000"	128°33'13.80000"	56.900

Table 1. Each System Observed Value Result

Point Name	Obs. Method	Latitude Error (m)	Longitude Error (m)	Altitude Error (m)
KNU 1	Precise GPS	-	-	-
	Ordinary System	31.278	4.222	9.897
	Development System	6.638	1.581	7.227
KNU 2	Precise GPS	-	-	-
	Ordinary System	14.303	5.999	6.927
	Development System	8.106	1.563	3.927
KNU 3	Precise GPS	-	-	-
	Ordinary System	21.618	12.054	4.248
	Development System	6.188	7.022	4.548
KNU 4	Precise GPS	-	-	-
	Ordinary System	15.712	12.835	9.663
	Development System	6.502	5.204	5.463
KNU 5	Precise GPS	-	-	-
	Ordinary System	23.026	12.070	8.933
	Development System	7.630	9.512	7.133
KNU 6	Precise GPS	-	-	-
	Ordinary System	10.359	7.359	10.811
	Development System	8.153	2.382	6.111

Table 2. Each System Comparing Observed Value Error

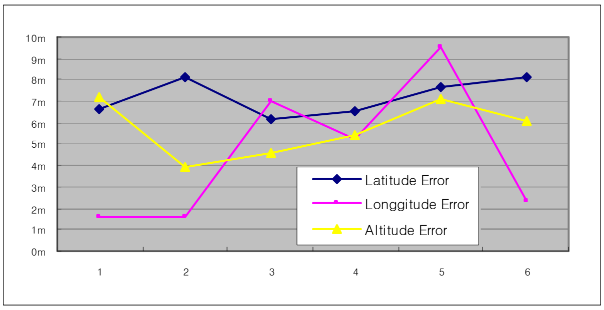

Figure 8. Comparing Observed Value Graph

4. CONCLUSIONS

In this research, the point of development of Positioning Information realized Digital Close-Range Photogrammetric System is to increase efficiency when renewing old result of digital map for changed topography rapidly and when you need real time information. And the results are :

The first, in comparison with Ordinary System surveying results, latitude error is 19.383m, longitude error is 9.090m and Altitude error is 8.413m. However development system has shown that latitude error is 7.203m, longitude error is 4.544m and altitude error is 5.735m.

The second, consumption of battery is one of the most important things for photogrammetry, the old system can observe about 30 pictures but development system can observe about 200 pictures. the weight is lessen than 3kg so that one person can operate alone.

The third, geo information can be gained and processed easily by Development of Positioning Information realized Digital Close-Range Photogrammetric System so that financial damage is can be decreased.

The forth, it can be used for developing cities as element data by monitoring geo information systematically.

In the future, we will improve civil industry and other industries by inventing high detail GPS receiver so that positional accuracy could be lessen than 3cm.

REFERENCE

Gayde, J.C., Humbertclaude, C. and Lasseur, C., 1997, Prospects of close range digital photogrammetry in large physics installations, Accelerator Alignment Workshop, Geneva, Switzerland.

K.B. Atkinson, 1996, *Close Range Photogrammetry and Machine Vision*, Whittles Publishing, pp.52~150

Kraus, K. 199) *Photogrammetry* I, II, 4th edition, Ferd. Dummlers Verlag, Germany.

Wolf, P.R. and B.A. Dewitt, 2000, *Elements of Photogrammetry with Application in GIS*, 3rd ed., MacGraw-Hill, New York