INVESTIGATING THE ACCURACY OF AERIAL TRIANGULATION ON THE BAEKSAJANG BEACH, WEST COAST OF KOREA

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ABSTRACT: In this presentation, it was analyzed that the accuracy of aerial triangulation which was conducted for the long-term shoreline changes on the Baeksajang beach, west coast of Republic of Korea. For this purpose, field works were done for the acquisition of GCPs (Ground Control Points) and check points using VRS-GPS surveying. Since photo controls such as GCPs and tie points are distributed dominantly on the land side due to the presence of sea water in coastal environments, aerial triangulation gives unreliable results. To resolve this problem, we performed two-step triangulation associated with elevation-adjusted GCPs. There exists elevation difference between photogrammetric based DEM and check points. Elevation adjustment with GCPs was conducted by reducing distribution of elevation difference.

1. INTRODUCTION

Photogrammetry is a very useful tool not only in the field of conventional photo-map generation but also diverse applications such as landslide studies (Brunsden and Chandler, 1996; Zhang et al., 2009), glaciers researches (Baltsavias *et al*., 2001) and coastal monitoring (Chandler, 1999; Adams and Chandler, 2002; Mills *et al.*, 2003; Kim *et al.*, 2014). Traditional photogrammetric processing has been based on a set of independently measured ground features to scale and orientate multiple aerial photographs by relating them into converting reference coordinate system (Wolf and Dewitt, 2000; Mills *et al.*, 2003). In the application for shoreline detection and monitoring with the help of photogrammetric method, there remains inefficient part of the orientations stages as well as having the least potential for automation (Schenk, 1999).

For the most of parts of shoreline mapping areas, it is very unfeasible to identify and acquire GCPs due to the existence of water body. Therefore unevenly distributed GCPs which is dominantly located in the land side may generate photogrammetric poor results. For overcoming this obstacle some solutions have been investigated. A potential alternative solution is the use of existing DEM to generate a photogrammetric elevation model. However for the use of time-series multiple aerial photos that solution has some disadvantages in the possibilities having elevation variations derived from natural phenomena or human activities for the long period. Also another method was reported by *Kim et al.*(2014). They proposed two step adjustments for correcting elevation discrepancy in the process of bundle block adjustments.

In this study, approximately during 16 years for the coastal study scanned and digital aerial photos were collected and processed. We tested and verified the accuracy of the bundle block adjustment by adopting two-step elevation-adjustment method for the coastal research.

2. STUDY AREA AND DATA SETS

The study area is relatively small region (latitude 36° 34.2' N to 36° 35', longitude 126° 18.5' E to 126° 18.8' E) of approximately 600 km2 located in Baeksajang beach, west coast of Republic of Korea. It is about 3~4m above sea level and has relatively very flat terrain relief of 0.5 to 1.5m. Figure 1 shows the study site. Some selected information about for study is listed in Table 1. Photographs were taken along the course in the east to west direction which is perpendicular to the shoreline. Generally to obtain a stereo model containing the shoreline, it is enough to use one pair of photographs; one is seaward and the other landward photograph with respect to the shoreline. One inland photograph is added to build a block of photographs in an attempt to test whether this addition of photographs may resolve the problem of photogrammetry in coastal areas. GCPs were carefully selected 34 points from more than 90 candidates found from photographic images, considering that (1) they must have time-invariant characteristics, meaning that they are identical over photographs of different years, (2) they have enough space for the GPS-VRS

Surveying, and last (3) they are evenly distributed over the research area. Before the GPS-VRS surveying, they were explored to check whether they really exist, how to access them and how suitable to use GPS-VRS. The distribution of GCPs is shown in Figure 2.

Figure 1. Coverage of this study area marked with red ellipsoid: (Image source: earth.google.com)

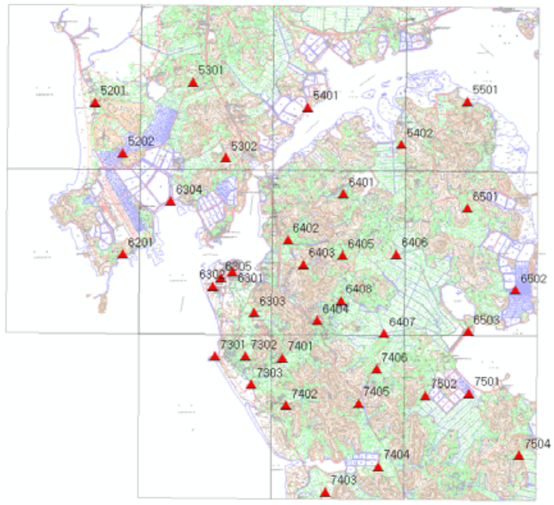


Figure 2. The distribution of GCPs marked red triangle :Total 34 Points

Table 1. Selected information of historical aerial photographs used in this study

Year	GSD (m)	Number of photograph	Camera Type
1985	0.23	6	RC10-13032
1989	0.48	3	RC8-404
1991	0.37	6	NEWRMK-119051
1998	0.46	6	RC20-13084
2003	0.44	6	RC30-13230
2007	0.47	3	RC30-13441
2012	0.23	6	UltraCam XP

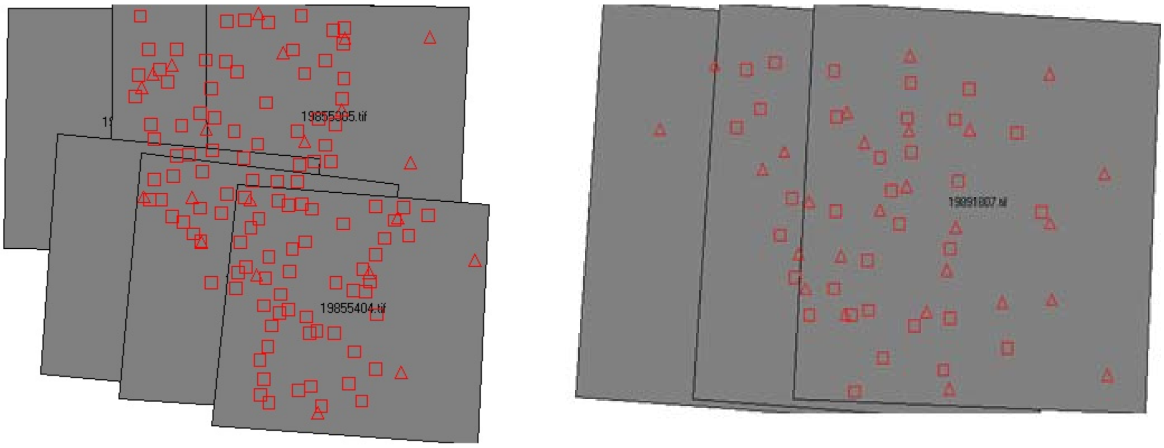
3. AERIAL TRIANGULATION

3.1 General Work of Bundle Block Adjustments

Generally the bundle block adjustment does orientation process using more than two photographs simultaneously using GCPs and tie points under the collinearity condition. Six exterior orientation parameters in each photograph and 3-D ground coordinates of tie points could be solved. In doing works, measurement of GCPs and tie points is very time-consuming and most important because it makes a significant effect on the quality of photogrammetric outcome. Tie points were measured in such way that many tie points per overlap area were to be evenly distributed.

3.2 Two Steps Approach for Correcting Height Discrepancy

In spite of intending to acquire evenly distributed GCPs, photographs including sea water might be affected by uneven GCPs and tie points. Figure 3 shows the distribution of GCPs and tie points in the year 1985 and 1989. Left photographs have relatively much smaller control points than landside photographs's. To solve this problem we adapted two steps procedure by correcting height discrepancy between first step outcomes and the existing sea water elevation data. This method was explained in the Kim *et al.*'s research work in detail (Kim *et al*., 2014).



(a) Image block in the year 1985 (b) Image block in the year 1989

Figure 3. The distribution of GCPs and tie points in image blocks

3.3 Analysis of Geopositioning Accuracy

To assess the accuracy of bundle block adjustment, DEM was generated with 1m grid spacing by space intersection using stereo models of photographs. And then we calculated differences between intersection-based elevation and existing check-points height (See Table 2). The result could be acceptable in the year 1991, 2003, 2007 if considering the accuracy requirement of topographic mapping at the given scale in Republic of Korea. However, the potential to improve the accuracy still remains in the 1985,1989, and 1998. To accomplish it we implemented second bundle block adjustment by compensating the measurement of GCPs using differences between stereo model based and check-points height. As a consequence, it enables us to improve the accuracy of Aerial triangulation in the remaining three one-year periods respectively.

Table 2. Accuracy of vertical position in the Implementation of First and Second Bundle Adjustments

Year	Before Correction		After Correction	
	Mean Error(m)	RMSE	Mean Error(m)	RMSE
1985	-0.26	1.13	0.46	1.09
1989	1.08	1.41	0.55	1.07
1991	0.29	0.83	-	-
1998	0.75	1.13	0.23	0.88
2003	0.03	0.69	-	-
2007	0.07	0.70	-	-
2012	1.04	1.15	0.00	0.48

4. CONCULSIONS

Traditionally digital photogrammetric solutions have the difficulties to overcome the orientation problem in such areas, where available GCPs does not exist or is very few. In the similar researches to overcome this, among the numerous methods DEM-based surface matching techniques are preferred. However, its ability is still limited in dealing with aerial photos containing large sea-water feature. This paper has demonstrated the efficacy of two step approach in implementing bundle block adjustment. It also has the ability to eliminate the systematic or bias error. Therefore used approach shows that it could be an alternative to the digital photogrammetric processing work especially in dealing with such areas where, topographic features dominantly located in the landside.

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