

# CONSTRUCTION OF GEOGRAPHIC INFORMATICS ON KING SEJONG STATION IN ANTARCTICA USING LIGHTWEIGHT AERIAL PHOTOGRAMMETRY SYSTEM

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## ABSTRACT:

As a source of a range of science information, the Antarctic where the King Sejong Station is established deserves academic attention so that the ancient temperature and environment could be addressed. King George Island, in particular, is where the Station is located and it is conceived as a gateway to the continent. It also serves as an advance base, having a vast impact on enlarging research activity area. However, the precise measurement for the geographic information around the King Sejong Station has not been carried out, and there's no accurately-secured geographic data on Korea's activity area. On top of that, Korea has relied on other countries to use map, which is the most fundamental point in constructing geographic informatics and the "implied" communication in terms of global research activities at the King Sejong Station. This study aims to collect and construct geographic & topographic data on the surroundings of the King Sejong Station. Using lightweight aerial photogrammetry system, we developed digital topographic map which is needed for geographic informatics and then analyzed the possibility of creating a digital topographic map with a scale of 1:5,000.

## 1. INTRODUCTION

The majority of Antarctica, the 7<sup>th</sup> continent, remains untouched by mankind. Due to its harsh natural environment and geographic distance, the Antarctica did not attract the world's attention. However, its environment such as geographical, meteorological and biological features, is of great importance in terms of scientific study. More significantly, Antarctica's natural resources include marine products, oil, natural gas and minerals and they are one of the key interests of the world. Its environment and weather conditions, however, are too rigorous to conquest the continent, therefore not many researches have been done yet. Nevertheless, Korea has made effort to construct Antarctica map and geographic informatics. All these efforts are intended to get guaranteed international activity area for countering Antarctic glacier retreat, resources development, and environment protection. This research, therefore, conducted lightweight aerial photogrammetry, aiming at constructing basic database and geographic informatics in the surroundings of the King Sejong Station. Then we plan to create a digital topographic map which is needed for geographic informatics, thus contributing to boundary delimitation in the Antarctic and Antarctic base construction.

## 2. OBSERVATION AND DATA PROCESSING

A new photograph system, in which camera is adhered to the outside of helicopter, and digital camera help this research project save costs as well as increase usability. It also is able to cope with the Antarctic weather varying from moment to moment, therefore considered as economically prominent system when compared to general aerial photogrammetry. Fugawi software, adopted in the plan and navigation,

maximized the areas photographed, supported smooth communication between helicopter pilot and photographer, and properly followed the pre-arranged plan such as verifying and changing route.

### 2.1 Studied area

The King Sejong Station (established in 1988) is located on King George Island (close to the South West extremity on the Antarctica), and 1,200 km away from the tip of South America. 90% of King George Island is covered with snow, and the island is permanently occupied stations of 8 states including Korea, China, Russia, Chile, etc. The island often causes international debate, as it is geographically close to South America, acts as an advance base for the Antarctica, and is located in the strategically important area bordering the Antarctic base.

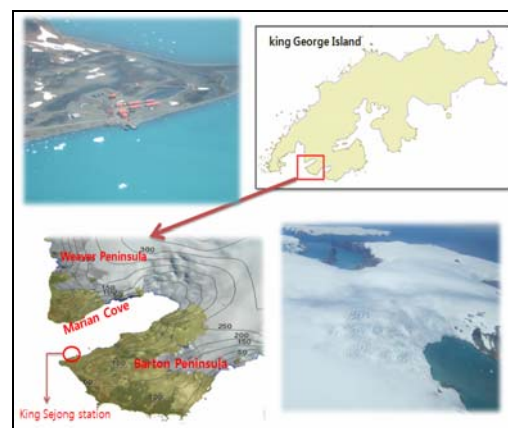


Figure. 1 . Test field in Antarctic

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The King Sejong Station is located on the Barton Peninsula, King George Island. The area studied in this research, as shown in Fig. 1, includes the King Sejong Station and Marian Cove seated between the Barton Peninsula and the Weaver Peninsula. The experiment was based on the summertime of the Southern Hemisphere: we stayed in the Station for 40 days from December 2006, and conducted GPS measurement observation, lightweight aerial photogrammetry, etc. The weather condition was not favorable for the research: we often got hit with strong wind gusts of average 12m/s and temperature -7°C, frequent blizzards, blind-fog, etc.

## 2.2 Lightweight aerial photogrammetry plan

The main purpose of lightweight aerial photogrammetry is to analyze geographic information promptly, in case of possible dispute over the activity area and resources development in the Antarctica. Korea, in particular, is in a desperate position to construct detailed topographic map and geographic informatics for establishing the 2nd base, therefore requires economic and timely observation system. This research, therefore, aims to obtain topographic data required for studying the surroundings of King Sejong Station and constructing geographic informatics, by using the lightweight aerial photogrammetry. Thus we intend to make use of the result of this research when constructing the 2nd base in the Antarctic continent.

**2.2.1 Aerial photogrammetry tools:** BO105 helicopter used for this study went into full-scale production in 1972 in Germany. It is widely used in the Frei Station, Chile, and was leased to us for 4 hours for the research. Its maximum speed is 242km/hr, weight is 2,000kg with no extra weapons loaded, length is 11.9m and width is 1.9m – up to 6 people including 2 pilots can board.



Figure 2 . B105 Helicopter

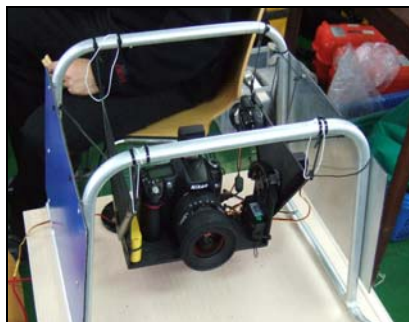


Figure 3 . Gimbal mount

The BO105 helicopter arrived on-site for the aerial photogrammetry is shown in Fig. 2. It was photographed with 10.75 million pixels Nikon D80, the one used for Fig. 3. It has 10.2 million effective pixels with 23.6×15.8mm CCD. The gimbal system helped photograph in-flight and enabled vertical & horizontal movement. It was made up of aluminum, wood, rubber, etc. to minimize the elastic change caused by fluctuating temperature. The gimbal system also had elastic joints to cope with external shocks.

**2.2.2 Measuring ground control points:** Kinematic GPS positioning was carried out for ground control point measurement. This was intended to create an analog model with the actual model. In order to conduct image matching, we installed 351 points so that 3-4 ground control points are extracted. In case of unique topography, the topography itself was used as the ground control point.

## 2.3 Lightweight aerial photogrammetry

We started taking photos at 13:00 (local time) on December 30 2006. The visibility on that day was clear, as seen in the Fig. 4, which is not often in the Antarctica. The wind speed as 3m/s ~ 5m/s and the temperature was maintained at -1~ 2°C level, the best condition for photography. Fig. 5 shows how the gimbal system was installed in the helicopter. We took the photos of overall area twice, it took 3.5 hours to complete experiment, including interim check-up and fueling. Weather condition was sometimes temporarily deteriorated, stopping photo-taking from time to time. The overlapping route explains re-taking for those not photographed. The actual flight path is in the Fig. 6.

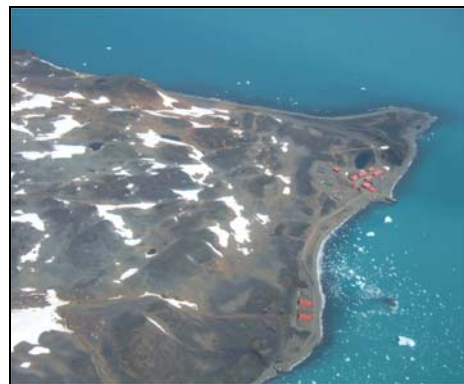


Figure 4 . Field of view

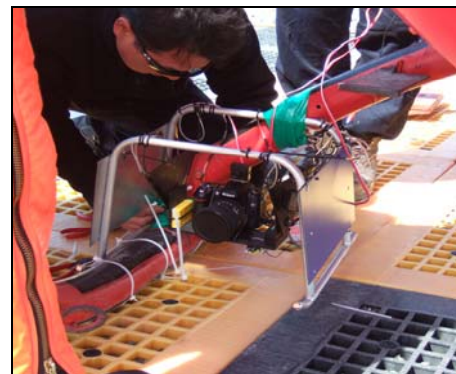


Figure 5 . Setting Gimbal mount

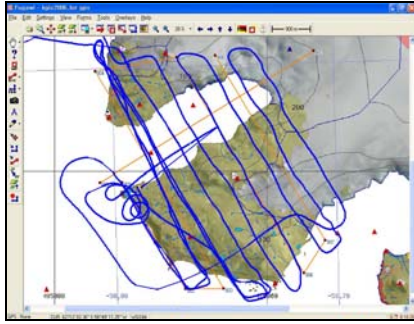


Figure 6 . Whole flight path in Fugawi

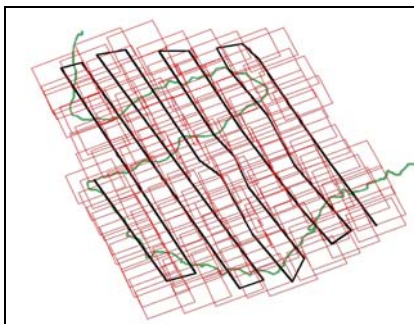


Figure 7 . Footprint of image

We conducted continuous shooting in the helicopter, obtaining 573 images. Flawed photos caused by self-oscillation and backlight were eliminated. Among the rest, we used 72 photos which included 3 minimal control points. Fig. 7 diagrams strips and routes of the used images.

#### 2.4 Image matching

PI-3000 software was used for image matching of 71 photos. With photo interpretation software, we aimed to obtain the digital images including 3D coordinates. First, calibration data from the camera calibration was imported. Then we introduced the row data to have the orthographic processing for correcting geometric distortion. represents image matching using ground control point included in the photo of the software.

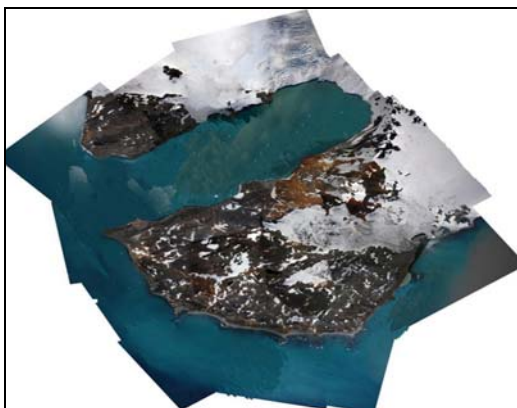


Figure 8 . Digital image

All the rough parts of image, after image matching process, went through image merging to look like single photo. The result of final images was exported to JPEF file. As seen in Fig. 8, the digital image database of the King Sejong Station was obtained for the first time, and we intended to create a digital topography map using this image.

### 3. CONCLUSION

In this research, we conducted lightweight aerial photogrammetry to generate Digital Orthoimage and evaluated its possible use. After analyzing the result of lightweight aerial photogrammetry, the following conclusion was reached.

When developing digital topographic map, we compared check point and the outcome of lightweight aerial measurement to the standard deviation. As a result, following data was obtained; 2.369m (X coordinate), 2.128m (Y coordinate), and 1.381m (Z coordinate). This satisfies the public survey guidance of 1:5000 scale digital topographic map.

In order to analyze the ice cliff retreat and glacier change in Marian Cove, digital topographic map should be regularly developed in the future and it will help cope with on-going climate change in the Antarctica. There also is a need to conduct continuous research for constructing geographic informatics around the King Sejong Station.

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