Analysis of 3D Coastal Terrain by UAV Image and Bundle Adjustment

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INTRODUCTION

Recently, studies on the construction of 3D terrain modeling and location accuracy evaluation using UAV have been conducted, but the application to coastal areas lacking image matching points has not been made in detail yet.

In coastal topography survey using UAV, ortho-images and DSM (Digital Surface Model) data were constructed through imaging and ground control point (GCP) surveying on the ground. In the case of ortho-images, VRS survey was used to analyze horizontal and vertical errors between GCP points, to evaluate accuracy, and to construct terrain data from the ortho-image and DSM data.

Bundle Adjustment

Given a set of images depicting a number of 3D points from different viewpoints, bundle adjustment can be defined as the problem of simultaneously refining the 3D coordinates describing the scene geometry, the parameters of the relative motion, and the optical characteristics of the camera(s) employed to acquire the images, according to an optimality criterion involving the corresponding image projections of all points. Bundle adjustment is almost always used as the last step of every feature-based 3D reconstruction algorithm. It amounts to an optimization problem on the 3D structure and viewing parameters, to obtain a reconstruction which is optimal under certain assumptions regarding the noise pertaining to the observed image features: If the image error is zero-mean Gaussian, then bundle adjustment is the Maximum Likelihood Estimator. Its name refers to the bundles of light rays originating from each 3D feature and converging on each camera's optical center, which are adjusted optimally with respect to both the structure and viewing parameters.

Field Investigation

In order to measure the volume of the beach in detail, the height of the beach needs to be known. Therefore, in order to perform stereoscopic vision, a baseline for the image must be obtained and a new image perpendicular to the beach must be created. The UAV image has the initial external coordinate element value acquired by the onboard Global Positioning System / Inertial Navigation System (GPS / INS). The model will be precisely modeled using a bundle adjustment method that converts directly to ground coordinates, and a 3D point cloud will be generated through image registration. After that, they will go through the process of creating a digital elevation model and producing ortho images. The accuracy of the three-dimensional model was evaluated by comparing the RMS value of the difference between the height values (Z) obtained from the GPS survey and the image height. As a result, the higher the altitude, the higher the vertical position error, and it was better to shoot at an altitude of 100m or less.

CONCLUSION

Unmanned aerial vehicles (UAVs) have attracted attention as a means of effectively acquiring spatial information on small areas by replacing expensive aerial surveys. Recently, with the development of image processing software, it is possible to process the image with a relatively simple procedure regardless of the type of UAV, the popularity of UAV survey is accelerating. By using the 3D modeling technique performed in this study, it is possible to model 3D terrain using UAV in coastal areas where direct surveying is difficult, and to use it as a topographic survey result.

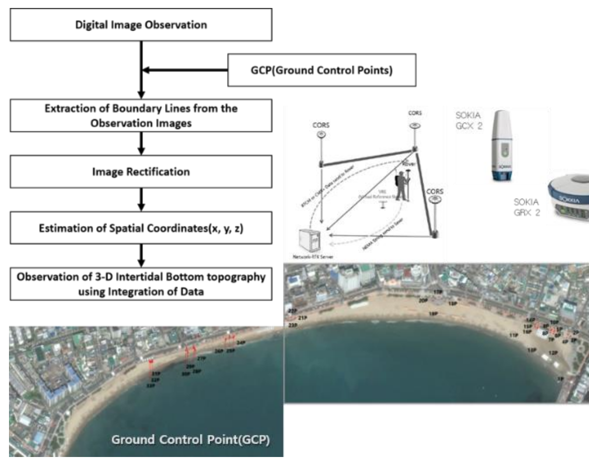

Figure 1 – Image Process and Analysis

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