AUTOMATED REGISTRATION OF HETEROGENEOUS SATELLITE IMAGES USING FEATURE MATCHING

Seunghwan Ban[1], Taejung Kim[2]

[1]*Program in Smart City Engineering, Inha University,*
100 inha-ro, Michuhol-gu, Incheon, Republic of Korea, 22211349@inha.edu
[2]*Dept.of Geoinformatic Engineering, Inha University,*
100 inha-ro, Michuhol-gu, Incheon, Republic of Korea, tezid@inha.ac.kr

Abstract: Satellite image registration is a processing technique in which two images are transformed and represented in one specific coordinate system, which is widely used in remote sensing. Recently, the type and number of satellites for earth observation have increased. Satellite images do not always provide accurate coordinates or geographic information. Geometric accuracy of satellite images significantly affects subsequent processing such as image fusion, change detection, and monitoring. Therefore, in order to utilize images provided from the various satellites and sensors, image registration and geometric correction is essential. In this paper, satellite image registration using feature point matching was conducted.

In this study, we used satellite images of Goyang, Seoul and Anyang in South Korea. Most part of the image of Goyang are mountainous. Therefore, feature point matching is difficult because there are few identifiable object such as roads or landmars. We relatively corrected the geometry of two images acquired from different satellites using a feature matching method. Image registration between two satellite images consisted of five processes: calculating overlapping area, feature detection, feature matching, transformation model estimation, and image resampling. To calculate overlap area, we used geo-transform information, which is an affine transformation from image coordinate space to georeferenced coordinate space. From the initial geometric information, we calculated the image coordinates corresponding to the overlapping area. We clipped the corresponding part using the overlap area and resized the image to be similar to the ground sample distances (GSDs) of a reference image. For feature point detection, an oriented and rotated brief robust independent elementary features (ORB) detector was used. The ORB detector can consider orientation and rotation with improved processing speed than the scale-invariant feature transform (SIFT). For feature descriptor, we used BRIEF based descriptor. BRIEF is known to perform poorly with rotation. The descriptor of ORB readjusts the BRIEF according to a direction of a feature. We performed feature matching by calculating similarity of each feature through the calculated descriptor. We estimated the transformation model into the reference image space using the form of a homography matrix and in the process, we removed outliers using the RANSAC algorithm. In the last step, the image was resampled based on the reference image by applying the estimated transformation model. We used bilinear interpolation method for image resampling.

For the experiment, we used two kinds of satellite images. One was Korea Multi-purpose Satellite-3A image, and the other was RapidEye-2 satellite image. We conducted experiment of heterogeneous satellite image registration on a total of six datasets. Since these two types of images have different GSD and image coverage, automated image registration was a challenging task. To confirm the performance of the proposed image registration method, we performed qualitative and quantitative validation. For qualitative validation, we constructed the two images in a form of a checkerboard, and visually checked whether the edges of the road or building were matched at the board boundary (Figure 1). For quantitative validation, we extracted check points and calculate errors of reprojection. As a result, the estimated model showed errors in a range of 1.12 to 1.41 pixels accuracy based on the RapidEye-2 image.

This paper proposed a method to solve the important problem of automated heterogeneous satellite image registration. This task is challenging since heterogeneous has different characteristics such as GSD, ground coverage and shooting angle. Our purpose of algorithm is based on feature point matching. In order to minimize the time required for image registration, we limited area where feature point extraction by calculating the overlapping area using the initial geometric information of satellite images. We also resize the image so that the GSD between two images is similar. The transformation model was estimated in the form of a homography matrix, and the RANSAC algorithm was applied in the process. Experiments were carried out with KOMPSAT-3A images at 50cm GSD and RapidEye images at 5m GSD. We archived relative registration accuracy of 1.26 pixels with respect to the GSD of RapidEye. We also validate performance of the proposed method visually by comparing the transformed image and reference image. As a result, we confirmed that the relative positional error between heterogeneous satellite images can be corrected through our proposed method.

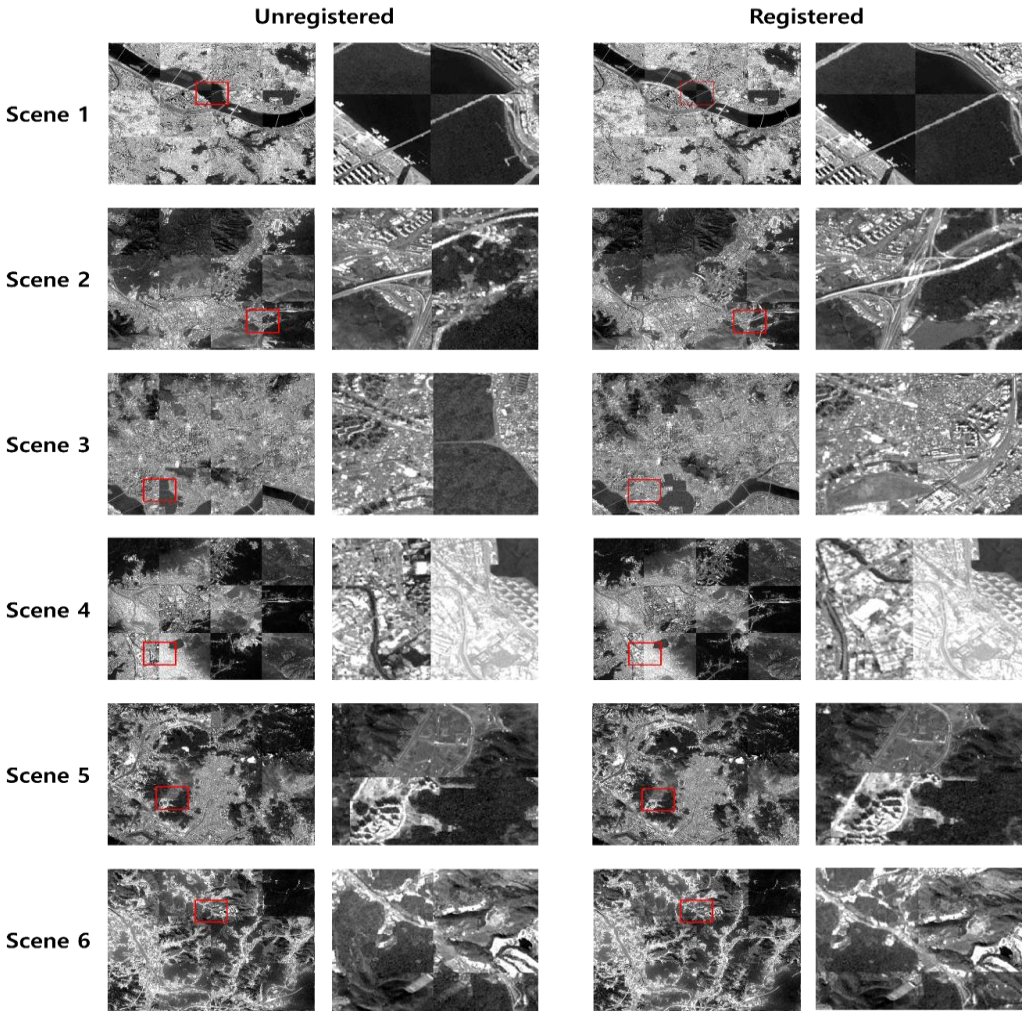

Figure 1. Qualitative evaluation of heterogeneous image registration.

Keywords: Feature detection, Image transform, ORB, Image registration, Geometric Correction

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