Comparison of Various DSMs Derived from UAV Images Towards True Orthorectification of Satellite Images

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Abstract: The importance of satellite orthoimages is increasing as they enable information extraction over a wide area without geometric distortion. For this reason, many algorithms related to orthometric correction are being actively studied. The quality of orthoimages depends on the accuracy of the reference elevation data used during orthorectification process. In general, Digital Elevation Model(DEM) was used as the reference elevation data in orthometric correction. However, Digital Surface Model(DSM) was required to generate orthoimages against urban artifacts. The reference data could be very critical, in particular, for generating true orthoimages over urban areas with many high-rise buildings. In this paper, we analyzed the quality of orthoimages using various DSMs. Since Unmanned Aerial Vehicle(UAV) images have higher resolution than satellite images, it was expected that more precise DSM could be created from UAV images. In addition, we checked whether DSMs created from UAV images be relevant for true orthoimages.

For preparation of DSMs, we acquired UAV images at a Ground Sample Distance(GSD) of a few centimeters. We used images acquired by DJI Phantom 4 RTK UAV over Inha University Campus, Incheon. Point clouds were extracted from UAV images through image matching. They were interpolated at various sampling distances such as 0.5m, 5m and 10m. The resulting DSMs at different spatial resolutions were used for orthorectification process and we analyzed the effect of the accuracy of the data. We used a Kompsat-3A (K3A) image over in Incheon city, Republic of Korea. Orthoimages were generated using DSMs of different spatial resolution. Qualitative analysis of the generated orthoimages was performed by comparing the images with topographic maps. For quantitative analysis, accuracy comparison analysis was performed by calculating position errors in the orthoimages produced by various DSMs. For accuracy analysis, 15 Ground Control Points(GCP) were acquired by GPS surveying. We calculated image coordinates corresponding to GCP coordinates from the ortho-rectified images and assumed them as true values. To calculate the position error, we compared GCP image coordinates in the images after precise orthographic correction with true values.

Position distortion was occurred due to the difference in spatial resolution of DSMs when the orthoimage were visually checked. The RMSE calculated the position error with GCP coordinates was around 13 pixels. The minimum RMSEs of each 0.5 resolution, 5 resolution, and 10 resolution were about 2, 5, and 7 pixels. In case the pixel error of 0.5m resolution was larger than 5m resolution, distance error with GSD could be lower. The DSM with higher resolution tended to decrease the distortion and lower resolution DSM tended to increase the distortion. The position error occurred proportional to the GSD size of the DSM. The lower the spatial resolution of the reference data used, the distance error caused by a position error of 1 pixel size was increased. If the spatial resolution is low, the range of point coordinates included in one pixel becomes wider. Larger error occurred when estimating the coordinates to which the elevation value corresponds. Therefore, the linearity of the outer line of the building was deteriorated and distortion occurred due to the decrease in the precision of orthorectification. As a results, we observed that position distortion occurred due to a difference in spatial resolution of DSMs and that the DSM with higher resolution tended to decrease the distortion.

The results indicated that the necessity of high-resolution reference height data and the feasibility of UAV image-driven DSMs for true orthorectification. The importance of constructing high-precision height reference data was observed to generate improved orthoimages.
In this paper, we analyzed the effects of the quality of various DSMs for true orthorectification of satellite images. We confirmed the feasibility of DSM generated from UAV images on true orthoimage generation. In the future, verification through orthometric correction using more diverse DSM and satellite images is required.

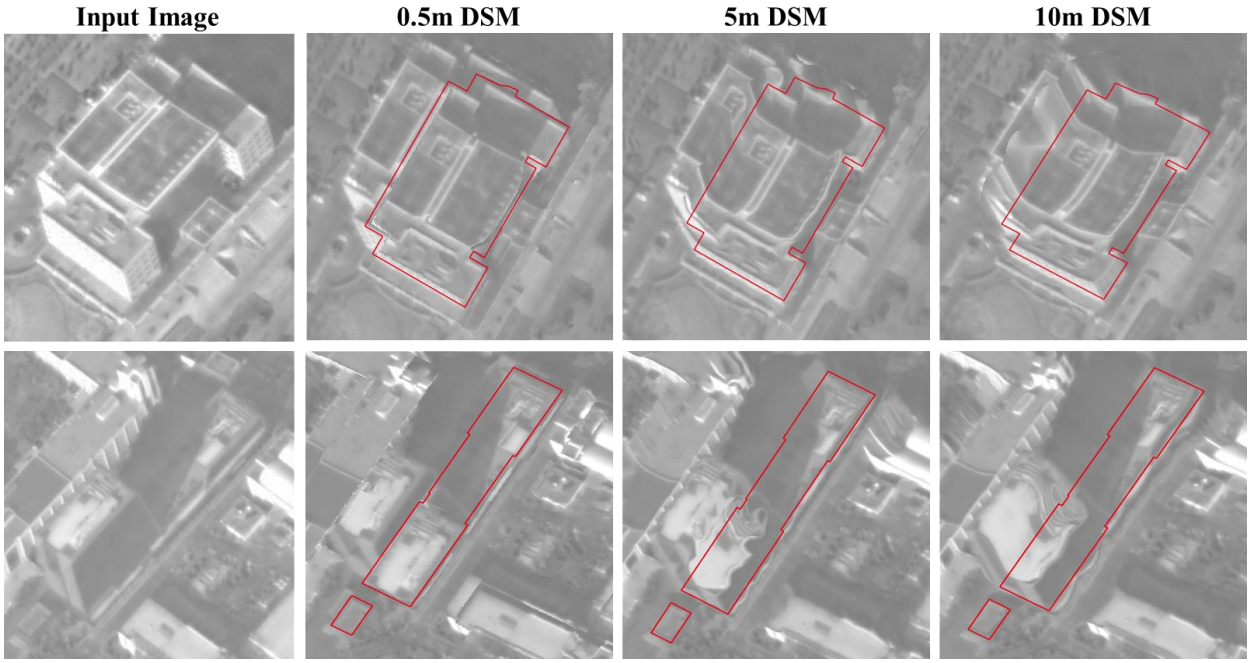

Figure 1. Building orthometric correction results according to DSM resolution

Keywords: Orthometric correction; Spatial Resolution; DSM; True Ortho Image;

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