co-registration bewteen large scale difference images for aligning kompsat-3a multispectral and mid-wave infrared images

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**ABSTRACT:** Korean multi-purpose satellite 3A (KOMPSAT-3A) has been operated for acquiring various Earth surface information. Two payloads that obtain multispectral (MS) and middle wave infrared (MIR) images are equipped with KOMPSAT-3A. The MIR image with a wavelength range of 3.3-5.5 $μm$ provides high-temperature information regarding topology and objects which can be acquired both during the day-and-night. Despite the advantages of MIR image, the MIR image has limitations in providing detailed information because the spatial resolution of MIR image (30m) is relatively lower than the MS image (2.2m). To effectively provide both visible and thermal information, the fusion application of MS and MIR images is essential. However, relative geometric errors between the MS and MIR images occur owing to various external factors such as differences in viewpoint between the two payloads, Earth's rotation and curvature, radiometric characteristics of the surface, etc. These geometric errors obstruct the generation of accurate fusion results.

Therefore, we propose a co-registration method to reduce the relative geometric errors between the KOMPSAT-3A MS and MIR images having a large-scale difference. To reflect differences in spatial resolutions, pyramid image pairs that consist of five resolution steps (30 m, 15 m, 5.5 m, 4.4 m, and 2.2 m) are generated. Key points are extracted from the MS image in a block-wise way from the extrema in the difference of Gaussians, achieved by adjusting the scale of Gaussian filters. The key point distribution is optimized by selecting points with low density, as estimated by the Gaussian kernel density function. After mapping the key points to the MIR image, the local template is generated from the MS and MIR images based on the key points. Phase correlation (PC) method is applied to extract matching points based on the local template, and outliers are eliminated through the random sample consensus (RANSAC) method. Subsequently, grid areas containing the matching points are created, and the distribution of matching points is optimized by selecting a single matching point within each grid. Then, the location of local templates is adjusted using a transformation model estimated by the matching points. These processes are iteratively conducted on the pyramid image pairs to extract precise matching points. Finally, the MS image is warped to the coordinate of MIR image using a transformation model based on precise matching points.

The proposed method was evaluated in KOMPSAT-3A MS and MIR image pairs acquired over three different sites. The precise matching points were evenly extracted in all sites, and registered MS images by the proposed method were overlapped properly with the MIR images. To quantitively evaluate the registration accuracy of proposed method, root mean square error (RMSE), bad point portion (BPP), and Skew were estimated based on 40% of the precise matching points extracted by the proposed method as checkpoints. The RMSE was estimated with sub-pixel precision, and both BPP and Skew were measured as close to zero. Consequently, it is demonstrated that the proposed method can successfully correct the relative geometric errors between KOMPSAT-3A MS and MIR images.

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