TIN-BASED IMAGE SEGMENTATION FOR SEAMLESS MOSAICKING OF UAV IMAGES

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Abstract: UAV (Unmanned Aerial Vehicle) remote sensing has been actively used in various fields, such as architecture monitoring, crop status analysis and facility management. To increase usability of UAVs, image mosaicking is essential and numerous small UAV images should be combined into one large image. Image mosaicking could be divided into processing in an absolute space and in a relative space. The latter generates an image mosaic using only UAV's EOPs (Exterior Orientation Parameters) without other spatial data. The relative mosaicking offers broader applicability. On the other hands, it requires intelligent schemes for seamless image stitching, in particular, in the presence of height relief. In this study, we developed a TIN (Triangulated Irregular Network)-based image segmentation for the relative mosaicking. We tried seamless stitching from TIN structure analysis and developed UAV image mosaicking procedures without orthorectification. In this paper, we will focus on TIN structure analysis and the quality of mosaic generation.

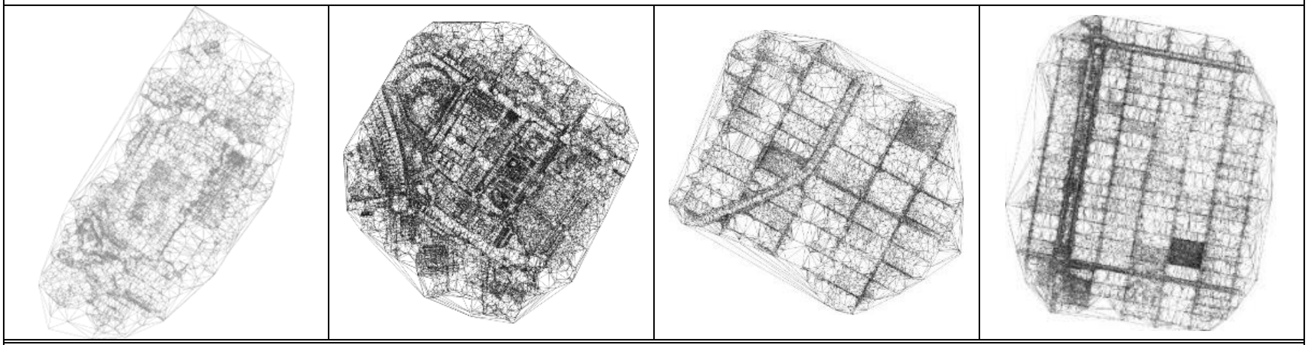
Our method extracts tie points through feature matching and renews them into a point cloud through bundle adjustment. Feature points were extracted by SURF (Speeded Up Robust Features) algorithm. They were accepted as inliers when matched consistently in four or more images. Then, our method corrected EOPs and determined ground coordinates of the inlier points through bundle adjustment. A point cloud was formed by the inlier points with image and ground coordinates. Then, it generates TIN and segments a target area in TIN units for image mosaicking. We firstly checked reprojection errors of the point cloud generated while projecting it onto images. The points with a reprojection error less than 3 pixels were defined as available. The available point cloud was converted to a TIN by Delaunay triangulation and assigned to each image. A TIN generated through this process usually had many smaller triangles including very sharp acute triangles. We classified triangles into three categories: outmost, outer, inner region. The outmost region was defined in non-mosaicking areas to minimize over-transformation. After that, the outer region was defined, and affine-based transformation was applied to outmost triangles. Mismatches of the seamlines were suppressed. The inner region was then defined. A Homography-based transformation was applied to inner triangles to get rid of excessive triangle unit computations.

We constructed experiment cases according to target area, and the quality of UAVs as Figure 1. In Case 1 of the experimental analysis, we compared the mosaicking results in urban areas and in farmland. In farmland close to flat areas, our method made much fewer mis-junction elements in mosaicked images. In Case 2 of the experimental analysis, we analysed according to the precision of the UAV equipment. The UAV sensor's precision was propagated to the accuracy of the bundle

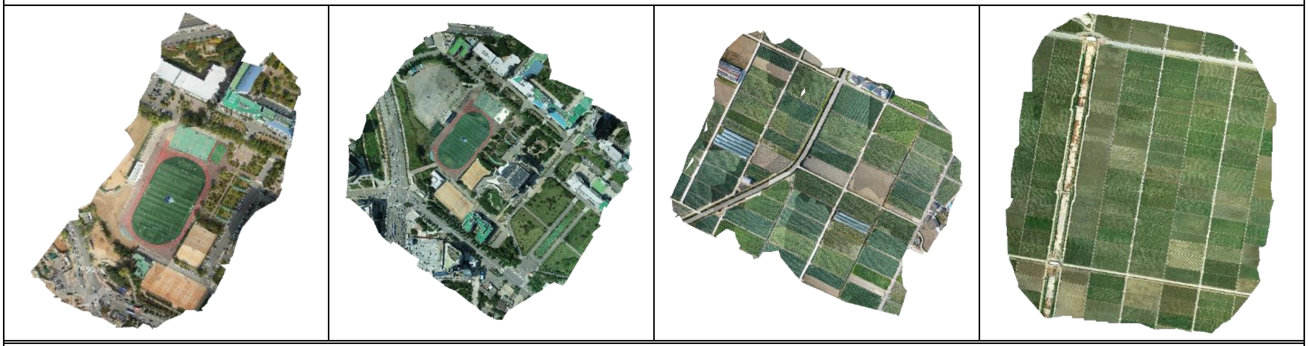
adjustment, affecting the quantity of triangle on the TIN. The proposed method could support stable quality despite of using images only. We expected this study may be suggested to improve the accuracy of relative image mosaicking.

Dataset 1	Dataset 2	Dataset 3	Dataset 4
- UAV: SmartOne - Area: Urban area1	- UAV: Phantom4 RTK - Area: Urban area1	- UAV: KD-2 Mapper - Area: Farmland1	- UAV: Phantom4 RTK - Area: Farmland2

Results of TIN generation



Results of mosaicking with proposed method



Results of mosaicking without seamline extraction

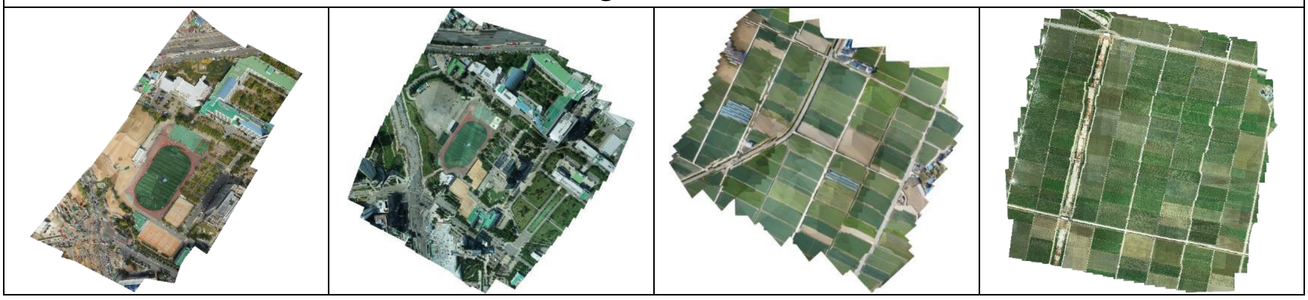


Figure 1. Results of mosaicking by datasets

Keywords: Triangulated Irregular Network, Segmentation, Affine-based Triangle Unit Mosaicking, Homography-based Image Unit Mosaicking

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