A Novel Feature Matching Technique Based on Multiple Textures for Cloud Images

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Extracting cloud information, such as cloud height, size, range and motion, is an important study for atmospheric cloud research, which can be achieved by instruments, such as lidar, ceilometer, and millimeter wavelength radar. However, these techniques often have limited spatial and temporal resolution and are expensive. To address these issues, photogrammetry-based techniques were proposed to observe and retrieve cloud information. A typical photogrammetry technique is based on stereoscopic reconstruction through triangulation, which involves two main steps, namely camera calibration and feature matching. In this paper, the focus is feature matching for cloud images, which is challenging due to the low contrast and non-rigid characteristics of cloud boundaries. Feature matching, namely identifying the pixel locations of the same physical feature point on two images, is an essential element in the 3D reconstruction. Current matching algorithms only utilize the grayscale information of the image. However, there are scenarios that the separation of cloud from sky is not clear in grayscale images. Thus, a novel matching algorithm based on multiple textures derived from the color images has been developed to address this issue. The textures can be easily generated and can capture the transition from the sky to the cloud. Consequently, this leads to improved detection and matching of feature points along the cloud boundary. In this paper, the Scale Invariant Feature Transform (SIFT) based matching algorithm is employed to pre-process images to achieve image scale and rotation invariances, the Hierarchical Blocking Matching algorithm (HBM) is utilized to deal with flat cloud base and high occurrence of similar features in cloud images, and normalized cross correlation is adopted as similarity measure to handle possible exposure difference resulting from camera settings. A total of 57pairs of real stereoscopic cloud images are processed to evaluate the performance of the proposed matching algorithm. Comparisons with other two typical matching algorithms (Epipolar geometry based and SIFT based) are performed, and it shows that the proposed matching algorithm outperforms the other two in terms of both feature points detection and matching. Photogrammetry-based techniques can reconstruct accurate 3D cloud boundary with high spatial and temporal resolution, which can provide significant complementary data for radar observation, especially for real-time forecast and severe weather.

Keywords: 3D cloud boundary, feature matching, multiple textures