DEM-based Epipolar Rectification for Radargrammetry

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Radargrammetry is a well-established technique for deriving digital surface models (DSMs) from synthetic aperture radar (SAR) images [Toutin and Gray, 2000; Raggam et al., 2010]. To increase the quality of the image matching step and thus the quality of the desired DSM the epipolar constraint should be incorporated in the radargrammetric workflow [Gutjahr et al., 2014]. Here the main idea is to rectify the images onto a local tangential plane [Wang et al., 2011] which is rotated such that all stereo parallaxes are aligned in horizontal direction. Then the image matching step is reduced to a 1D search problem, i.e. a correspondence has only to be searched along an axis-parallel line. However, SAR specific geometric effects, in particular foreshortening, remain in these epipolar images, which cause major problems in image matching. This work focuses on a novel epipolar rectification method for SAR images, that rectify the images using a coarse DEM (e.g. SRTM, ASTER, ALOS-PRISM). Since the images are not rectified on a single plane but on a given surface, the images are non-linearly scaled in epipolar direction and thus the local scaling changes in range direction is reversed. In contrast to [Meric et al., 2011] who proposed a local scaling of the cross-correlation kernel for each pixel, our method is (1) much faster, as the non-linear scaling effects are removed in the rectification step and (2) more elegant, since we calculate the local scaling from a given DSM instead of trying a range of scales. The following up image matching procedure does not need to take the SAR geometry into account. Therefore, already existing very efficient implementations can be applied (e.g. CUDA-based stereo matching algorithms). The presented work describes the whole radargrammetric processing chain with emphasis on the novel DSM-based epipolar rectification. For several test sites TerraSAR-X images with varying imaging mode, including Stripmap and Staring Spotlight, are processed. The resulting DSMs are compared to reference airborne LiDAR DSMs in order to evaluation the accuracy gain of the presented methodology.

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