Dense pointclouds from combined nadir and oblique imagery by object-based semi-global multi-image matching

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Abstract

Semi-Global Matching (SGM) is a widespread algorithm for dense image matching which is used for very different applications, ranging from real-time applications (e.g. for generating 3D data for driver assistance systems) to aerial image matching. Originally developed for stereo-image matching, several extensions have been proposed to use more than two images within the matching process (multi-baseline matching, multi-view stereo). These extensions perform the image matching in (rectified) stereo images and combine the pairwise results afterwards to create the final solution. This paper proposes an alternative approach which is suitable for the introduction of an arbitrary number of images into the matching process and utilizes image matching by using non-rectified images. The new method differs from the original SGM method mainly in two aspects: Firstly, the cost calculation is formulated in object space within a dense voxel raster by using the grey (or colour) values of all images instead of pairwise cost calculation in image space. Secondly, the semi-global (path-wise) minimization process is transferred into object space as well, so that the result of semi-global optimization leads to index maps (instead of disparity maps) which directly indicate the 3D positions of the best matches. Altogether, object-based semi-global multi-image matching (OSGM) yields to an essential simplification of the matching process compared to multi-view stereo (MVS) approaches.

After a description of the new method, results achieved from different datasets (close-range and aerial, nadir and oblique) are presented and discussed. The main focus is driven to the processing of combined processing of nadir and oblique aerial imagery that provides a range of benefits for topographic and urban applications, e.g. derivation of 3D city models, true orthophotos, enhanced texture mapping or precise terrain models. The results obtained by OSGM show significant advances in completeness and accuracy with the evaluated data sets. Since the whole process is formulated in 3D object space, the approach promises interesting future enhancement, such as variable voxel resolutions, easy integration of existing 3D data (e.g. road or building models) and high degree for parallel processing.