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Generation and analyses of digital surface models in urban areas based on aerial images.

Abstract

Digital surface models (DSMs) are describing the height of the terrain surface in a digital form by a large number of points; together with break lines discontinuities of the surface can be included. DSMs are a geometric description of the terrain surface and objects located on and above this surface like trees or buildings. They can be obtained by image matching from aerial images.

The time required for collecting a very large number of points is relatively short because of the remarkable progress of image matching and computer technique. Additionally, with the least squares matching algorithms, the points can be matched potentially with sub-pixel accuracy; but a stereo matching method has limitations due to occlusions and height discontinuities. Automatic DSM generation through image matching techniques is one of the main topics of this thesis, although this topic has gained much attention in the past years and a wide variety of approaches have been developed.

The purpose in DSM generation is the derivation of a complete 3D model of the visible surface with the highest possible accuracy, taking into account terrain discontinuities. State-of-the-art automatic algorithms based on stereo imagery are not able to distinguish between terrain surface and objects on and above this surface e.g. man-made structures such as buildings or trees. In urban areas the DSM quality mainly depends on the presence of texture at roof regions and the amount of contrast between roof and terrain surface.

Digital Surface Models (DSMs) are often referred as models for the first reflective or visible surface, while Digital Terrain Models (DTMs) are usually referred to the bare earth, i.e. without trees, buildings and other natural and man made features. The information of a DSM is restricted to surface geometry; the interpretation of this kind of data is easier compared to the interpretation of image data. They are classical and common products from digital Photogrammetric systems. In modern map production, DSMs/DTMs have become an information source for scene analysis and understanding, for change detection, for GIS database updating, for cartographic 3D feature extraction and reconstruction.

In particular, DSMs in suburban and urban areas are very useful for several applications, which include (true) orthoimage generation, mission planning and rehearsal, virtual and augmented reality applications and urban planning.

DSMs are also unavoidable information for scene analysis and understanding, for change detection for database updating and cartographic 3D feature extraction and reconstruction. For all of these applications, the requirements for the quality of DSMs may vary a lot, but at least some important morphological details need to be preserved in the resulting DSMs.

In the past years, due to simple access to digital stereo images, a large number of researchers around the world have investigated the extraction of elevation and/or the production of DSMs/DTMs. A wide variety of approaches have been

developed and automatic DSM/DTM generation software packages are meanwhile commercially available on several digital photogrammetric workstations.

In this work, I will focus on generation and analyses of digital surface models in urban areas based on aerial images, because this is the first step for getting 3D city models. Methods in generation the 3D city structures shall be investigated in available literature and possible solutions shall be discussed. As sample data DMC images have been used.