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Reconstruction of building objects and materials from point clouds mapping a construction site

With the rapid development of urbanization, demands for monitoring of construction site have dramatically grown for applications on work progress control, productivity improvement, security assurance, and accident investigationin construction community. To obtain 3D information and changes of building objects playing key roles in the work performance assessing and the working progress controlling the precise acquisition and reconstruction of building objects are necessary.

As the improvement on spatial and radiometric resolution, it is possible for us to reconstruct the building objects of a construction site via remote sensing data. However, traditional researches on the reconstruction of buildings mainly focus on the static information of the buildings, while the researches on the change detection are often conducted with 2D data (images), which can hardly provide 3D dynamic information or changes. Moreover, the attributes such as the materials are significant parts of the reconstructed models as well, which are usually neglected in related researches..

In this work, point clouds generated from the optical image sequences using semi-global-matching (SGM), which are acquired from UAV based or crane platform based oblique photogrammetric system, will be employed as the basis to detect and reconstruct the building objects, including the basic structures, the scaffolds, the construction equipment, the annexes, etc. The multi-view optical images will act as supplementary data to detect and locate the building objects and identify materials.

The aim of the research in this thesis is the reconstruction and monitoring of building objects and materials in construction site. To achieve this goal, the research will involve the following essential aspects:

- ❒ Detection and recognition of building objects from points cloud and optical images. The graph cut and adaptive mean-shift algorithms are utilized to segment the 3D points cloud. The building objects will be detected and located and then recognized from the segmented points cloud by robust estimator and 3D shape descriptors, with its geometric and semantic parameters obtained;
- ❒ Identification of materials using optical images. The spectrum information and texture pattern will be decomposed and analyzed, in order to recognize and identify the materials of building objects in the construction site from the multi-view optical images;
- ❒ Reconstruction of the building objects and materials. The building objects are modeled and adjusted with geometric and semantic constraints using the recognized parameters and then refined with the adaptive RANSAC algorithm. The models of building objects will be gridded into voxels and enriched with identified building material information;
- ❒ Change detection between the reconstructed building models. The co-registration between reconstructed 3D models of different times will be conducted through control points. By densely matching the voxel grids of temporal reconstructed models, detailed changes can be detected.

The expected results contain two folds: The primary results are the high quality reconstruction results ofbuilding objects and materials in the construction site. The real BIM will act as true data to validate its performance. The methods and algorithms associated with object detection, model establishment, etc, will be developed and verified. The monitoring results between the reconstructed models will also be performed, while changes in the construction site can be obtained. A set of novel or improved techniques, including co-registration between models, change detection, etc, will be tested and discussed.