

Promotionsthema

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## **Automatic texturing of 3d models of urban areas using image sequences from airborne TIR cameras**

Thermal infrared (TIR) images of the building hull are often used for detecting damaged and weak spots in the insulation of the building hull. However, imaging and manually analysing each face is very time consuming. This process can be carried out more efficiently using a mobile mapping system (MMS) equipped with a TIR video camera. Frontal façades of the buildings which are visible from street level are captured by a terrestrial TIR camera mounted on a moving vehicle. To capture the roofs, an airborne platform has to be used. Façades in inner courtyard which are not visible to the street-view camera can be photographed using an oblique looking camera. An assignment of the TIR images to the 3-dimensional (3D) building models should be carried out to obtain the spatial reference and combine the images with the spatial information. This can be achieved via texture mapping. Building textures can be extracted automatically if the exterior orientation of the sensor is known. An approximated exterior orientation is given by the navigation data. As the accuracy of the navigation data is not sufficient for a precise texture extraction, a co-registration method is necessary to achieve well fitting textures. Furthermore, in image sequences every face of the 3D model appears multiple times, thus a strategy for the best texture selection needs to be developed. Finally, objects and thermal structures should be detected in textures and embedded in 3D building models.

Aim of research work in this thesis is to find best quality textures automatically extracted from airborne oblique view TIR image sequences and enrichment of the 3D building model with thermal information. This work will follow three main aspects: (i) co-registration, (ii) texture extraction with best texture selection and (iii) object detection in extracted façades. Knowing the approximated exterior orientation parameters of the camera taken from a GPS/INS system, matching of the 3D models with structures detected in the images will be carried out. Exterior orientation parameters will be corrected to get the best fit between the 3D models and the images. Particularly line segments as most representative features for man-made objects will be used. In the matching process, the inaccuracies of the 3D building model will be taken into account. Due to the large overlap between the frames of an image sequence the line segments assigned to the model will be tracked and compared to the assignments in the successive frames to enhance the reliability of the assignments. Furthermore, a texture quality measure for best texture selection based on resolution and occlusion factor will be developed. Methods for object detection in the textures will also be investigated. All methods will be developed and adapted to the properties of TIR domain.

Expected results of this thesis are high quality thermal textures with detected façade structures integrated with the 3D building models. An image sequence taken from a helicopter in a densely built-up area and corresponding 3D building model will be used as test data. To access the quality of the extracted textures, two measures will be considered: the quality of the texture based on its resolution and the quality of the match between the images and the TIR image sequences. The capability to compensate the inaccuracies in a 3D building model such as an unmodeled roof overhang will be tested. The applicability of the airborne TIR image sequences for thermal inspection with respect to the geometric resolution, occlusion and recognition of thermal leakages will be discussed. Additionally, the potential to use images taken from an unmanned aerial vehicle (UAV) will also be investigated.