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Trajectory correction for terrestrial mobile mapping platform using combined adjustment approach

Proposal for a Master thesis topic (EN)

Mobile mapping (MM) is the process of collecting geospatial data from a mobile vehicle (e.g. land vehicle, air vehicle). Such systems are equipped with an integrated and time-synchronized set of navigation sensors and mapping sensors which are mounted on a mobile platform, and it has been widely used for the 3D topographic mapping of extended areas. In our case, we use a terrestrial MMS with stereo camera, a Global Navigation Satellite System (GNSS) and an inertial navigation system (INS) for city topographic survey. Camera will be used for 3D reconstruction of the city. The trajectory of the platform is assumed to be estimated in advance by the integration of and an inertial navigation system (INS) in a Kalman filter. As a result, the original position and orientation estimates are given, together with their precisions, as a function of time. The original trajectory forms the basis for the direct georegerence of images. However, GNSS and INS measurements are strongly affected by external influence (e.g. satellite constellation, blackouts or multipath problems) and consequently their accuracy cannot be assumed to be constant in time. This in turn leads to time-dependent errors of the estimated trajectory, and its accuracy are usually insufficient, especially if a very high georegerence accuracy is demanded, e.g. for deformation monitoring or modelling of complex objects like buildings or trees.

One approach to solve this problem is to integrate the original trajectory measurements and images into a reliable estimate. The measurement process is thereby rigorously modelled using the images and the trajectory of the vehicle. In order to get a more accuracy exterior orientation for images and reduce the number of trajectory unknowns, the original trajectory should be segmented into pieces in time or distance domain and some strategies need to be used for modelling these correction functions. After that, the correction model and image perspective model will be incorporated into adjustment. This way, systematic measurement errors of the trajectory can be corrected. In this case, an appropriate segment interval and the correction model are expected to be chosen, as in such cases the estimated trajectory correction parameters compensate not only trajectory errors, but also the effect of other error sources (e.g. a wrongly calibrated camera). For large-scale measurement processing, we need to handle large amounts of data captured from a specific urban area, so how to efficiently incorporate a huge amount of city-scale data into a global estimation is another problem to be solved.

The main goal of this thesis is to develop a robust overall estimation approach to get a globally consistent georeference for mapping sensors mounted on a vehicle driving down a street. This problem is in many ways similar to the large-scale Structure-from-Motion (SFM) in urban environment. We may face two challenges which is not encountered in typical SFM problems: add trajectory correction model into adjustment, and global estimation with a huge number of observations and unknowns. With this motivation, a sequence of sub-tasks is necessary to complete: (1) Expansion of existing SFM pipeline tailored for stereo cameras to handle large amounts of images, (2) Integration of trajectory correction model to a consistent solution, (3) Overall adjustment using a monolithic approach with appropriate error modelling. These tasks are the main components of this thesis.

This thesis will be supervised by Yajie Chen, M.Sc.

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