3D City Modeling in Singapore

Mobile Mapping and UAV Data

The SEC-FCL (Singapore ETH Centre-Future Cities Laboratory) has commissioned a mission to laser-scan the Campus of NUS (National University of Singapore) with a Mobile Mapping System. It will be added to the already existing 800 aerial images produced with a UAV (octocopter) in February 2012. The final aim is to produce a very high resolution 3D model of the NUS campus.

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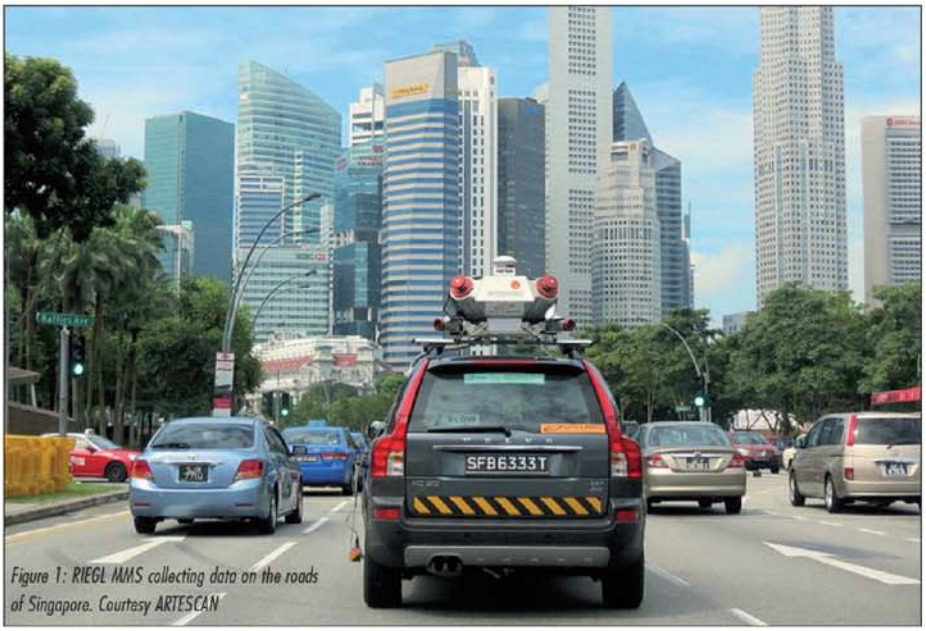

Figure 1: RIEGL MMS collecting data on the roads of Singapore. Courtesy ARTESCAN

Introduction

In a worldwide unique effort a multi-source dataset has been generated which can provide for new algorithmic and procedural approaches in 3D city modeling. The SEC-FCL (Singapore ETH Centre-Future Cities Laboratory) has commissioned a mission to laser-scan the Campus of NUS (National University of Singapore) with a Mobile Mapping System. This was achieved within 3 hours. This data reflects 16.7 km of scanned roads, consists of 154 GB of point clouds and large sequences of video street images (8166 images at 34 GB). It will be added to the already existing 800 aerial images produced with a UAV (octocopter) in February 2012. The final aim is to produce a very high resolution 3D model of the NUS campus.

Data acquisition

The data was produced having several purposes in mind:

- For practical applications: Generation of a most complete campus model, including terrain, buildings (partially) with facades, roads, other infrastructures like sports facilities, vegetation, etc.
- For research: To have a data set available for advanced studies, which can both serve to test newly developed algorithms and procedures and as a basis for quality control

This is for the first time worldwide that such data are being combined in an effort to make best use of information contained in aerial and terrestrial images as well as in terrestrial point clouds. The processing of the data is quite challenging and requires new approaches to 3D modeling from multi-source data.

The Mobile Mapping project was performed by ARTESCAN - 3D Scanning, a company based in Portugal. The system consists of a RIEGL VMX-250, including two RIEGL VQ-250 scanners and a IMU/GNSS unit. This is amended by two video cameras and an odometer. The system provides a measuring rate of up to 600 kHz and online waveform processing. Figure 1 shows the MMS at work in Singapore.

The value adding stage

While raw data acquisition both with UAV sand MMS is quite efficient, the true challenge lies in the value adding stage, the derivation of precise, reliable and complete models. Here the fact that UAV aerial images and terrestrial point clouds and images have been collected at different times (about 3 month time difference) will pose an added complication to an otherwise already very demanding problem.

We also must note a few other problems, which are inherent to this kind of application and technology. The NUS campus is a very complex object, with up to 75 m internal terrain height differences, some very high and many complex buildings and extensive tropical vegetation, interfering in many places with man-made objects. The blocking of signals in GNSS data acquisition poses a serious problem, which cannot be fully compensated by the other sensors on board (IMU and odometer). But by combining the processing of the terrestrial MMS data with that of aerial UAV images, the drift of the point clouds (caused by the uncontrolled drift of the IMU system) can be compensated. The usual addition of more GCPs determined terrestrially can thus be avoided.

Since the directions of the roads on campus vary greatly within small areas, the optical axis of the MMS cameras will point in all, often in unwanted directions (e.g. towards the sun). Thus the resulting image acquisition is very problematic and the image quality poor in many cases.

In another effort 6.4 km of Little India (Rochor) was also recorded by the MMS. This data will be combined with a 3D roof landscape model, which was already derived from IKONOS stereo satellite images.

Finally we would like to acknowledge the very good cooperation with the company ARTESCAN – 3D Scanning Lda., Portugal, which was responsible for the MMS raw data acquisition in Singapore.

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