Can Laser Scanning from UAV's Replace Total Station and GPS Surveys

Developments in the field of laser scanners and laser scanning systems have increased in the past few years. Physical size has decreased while performance has increased. The number of laser pulses per second has reached a million and the measurement distance is in the hundreds of metres.

RIEGL has implemented these and other features in a variety of compact, powerful, and precise scanners. Attached IMU/GNSS units, governing control units and optional cameras collect/record a multitude of additional properties during each scan. Due to the straightforward attachment system, a quick and easy installation is possible onto helicopters, vehicles and even UAVs – the modern tools of choice to accurately surveying road infrastructure in the highest possible quality.

The system's flexibility became an important aspect in a project of RiCOPTER UAV GmbH, which was executed in December last year on behalf of Geoprojekt LLC, one of the major geodetic companies in Croatia. The company was interested in a practical demonstration of the benefits and advantages of laser scanning for their fields of operation. The mission was to acquire both mobile and aerial laser scan data of an area of 2km x 1.5km that had previously been surveyed conventionally using DGPS and total stations. The mobile data acquisition was conducted using a car while the RiCOPTER, RIEGL's unmanned octocopter, was used for the aerial data acquisition. To check both datasets for their relative and absolute accuracies, control points of varying sizes and reflective properties were spread across the area and measured with DGPS and total station.

A total of three flights with the RiCOPTER, including the VUX-SYS and additional cameras, were flown. To guarantee a sufficient line of sight between the pilot and the UAV in this quite large area, take-off positions had to be moved. Based on the flight plan created by the operator, the RiCOPTER's flight was fully automatic. For safety reasons the take-offs and landings were flown manually by the pilot. The system was configured for a pulse rate of 550kHz at a flight altitude of 50m above ground level and a mean velocity of 6m/s (22km/h). Each flight took about 25 minutes and produced point clouds with a mean density of 300 points/m².

After the survey flights, the VUX scanner including the INS/GNSS system was removed from the RiCOPTER and installed in the VMQ platform. The platform of the VMQ single scanner mobile mapping system consists of a 30º horizontally tilted mount for the scanner that is placed on an adjustable plate. The plate can be rotated around the vertical axis in steps of 15º to provide a maximum coverage of the environment – even for complex structures. The platform also offers possibilities to connect various cameras for simultaneous image acquisition to colourise the acquired data. No cameras were used for the mobile acquisition of the project as the scanner, additionally to the distance measurements provides numerous attributes, like a calibrated reflectance value, that suffices for further processing.

The data acquisition with the mobile system was done in two drives, one with the scanner rotated 30º to the right and one with it rotated 30º to the left. Both drives were done at a velocity of 30km/h. The scanner was configured to acquire data with a pulse repetition rate of 550kHz and 200 lines/second. This resulted in a very high point density (3,500 points/m² on the road surface for each drive), which provided a good visibility of the control objects in the point cloud. The mobile acquisition took a total of 45 minutes.

Both datasets were then processed with RIEGL's RiPROCESS software package. Based on the initial trajectories that were processed with base station data, first point clouds of about GPS accuracy of a few centimetres to decimetres were created. Afterwards, the point clouds were recalculated by RiPRECISION, a plug-in that corrects the differences between multiple passes of an acquired project fully automatically. The result thereof was a registered point cloud with a relative accuracy of 1-2cm and an absolute accuracy of 2-3cm. In this calculation, control objects can be included to provide highly accurate georeferencing. The UAV scan data – using the previously registered mobile data as a reference – was processed with RiPRECISION as well.

The result was a point cloud referenced to a high relative and absolute accuracy, combining the high point density of the mobile acquired street data with the wide coverage of the UAV-based system.

Including setup and mounting of the systems, all the data was acquired in less than a day. The consecutive processing of the data was finished within a few days as the bulk of the processing was done through automatic processes.

For comparison purposes: the conventional survey of the same area with DGPS and total station, resulting in some 100 points, took two to three teams of two people a few weeks. The information gained in that survey consisted solely of positional information of the measured points, whereas scan data also covers parts of the environment providing additional information thereof. Based on scan data, it is possible to get information about the surface of the driven road and detect cracks in it.