

The Vienna Laser Scanning Survey 2007

The capital of Austria digitized at an average of 20 points per square meter.

The necessity of highly accurate and highly detailed spatial data as a base for efficient city planning increases with the rising demand of new properties for the constantly growing city population. Also the stocktaking of valuable historic buildings, controlling the adherence to construction regulations, and the development of evacuation plans in case of catastrophes require geo-referenced survey data of exceptional high resolution and accuracy.

The tender

Airborne LIDAR scanning technology was the preferred choice of Vienna's city surveying office – the municipal department 41 "urban surveyors" – for generating a database which meets the requirements of the applications mentioned above. An evenly distributed point pattern of 8-9 points per square meter acquired with a "full waveform" laser scanner covering 454 square kilometres of the federal state of Vienna with a demanded accuracy of 30 cm standard deviation was requested in an official tender notice.

Diamond Airborne Sensing, a subsidiary of the Austrian aircraft manufacturer *Diamond Aircraft Industries* and provider of the first completely integrated and fully EASA-certified surveying aircraft equipped with the *RIEGL* airborne laser scanning system BP560, seized the opportunity and participated in the competition for the contract. "*It is necessary to prove the promised cost efficiency together with the high applicability of our turnkey surveying system to convince our future customers. The demands of the project are complex, the target area is located practically at our doorstep, and after all Vienna is a world famous city we are proud to demonstrate the capabilities of our system by means of this project*" explains Wolfgang Grumeth, CEO of *Diamond Airborne Sensing*, when the contract award notice to his advantage was officially disclosed.



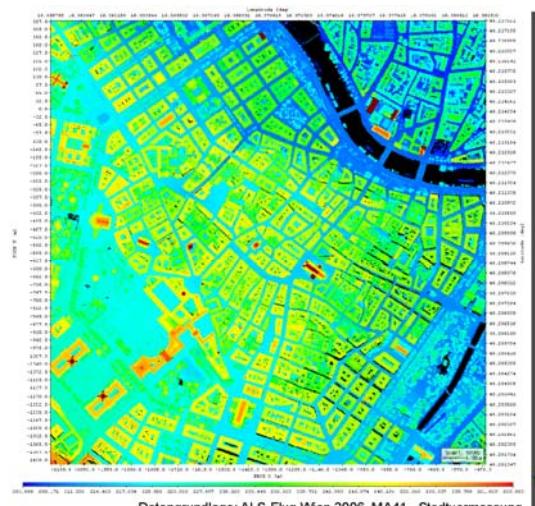
The *Diamond Aircraft* multi purpose platform fleet: DA42-MPP and HK36-MPP each equipped with *RIEGL* airborne laser scanners LMS-Q560

The project

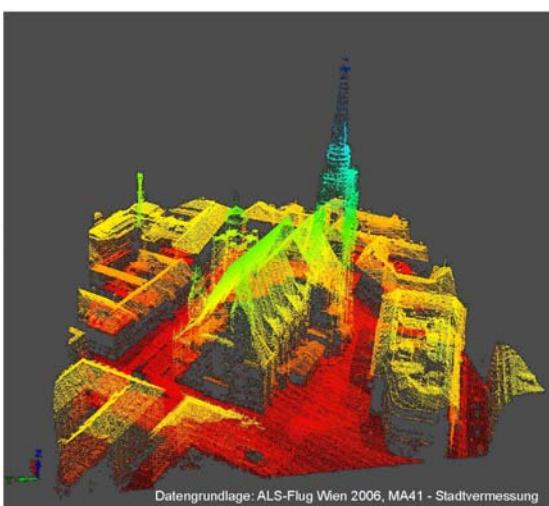
The aircraft, a *Diamond Aircraft MPP* ("multi purpose platform"), was equipped with a high-speed full waveform digitizing laser scanner *RIEGL LMS-Q560*, offering 200 kHz pulse repetition rate, in order to be able to reach the requested high point density. Taking into consideration the aircraft's manoeuvring abilities, speed range, and endurance, the survey flight for the target region was planned. More than 600 flight lines with a side-overlap of 50 percent at an altitude of 450 to 500 metres above ground level were planned to be flown at a speed of 80 knots. The special challenge of carrying out an airborne survey in Vienna is the necessity of inevitably arranging the flights with the coordinators at the international airport, as airliners are crossing the target area through broad air corridors. To overcome getting in the way of heavy air traffic the target area was split into seven separate blocks, each with its own planned flight path. The necessary preparations of the mission were realized in close cooperation with *AREA Vermessung*, an Austrian surveying company which was also responsible for the data processing later on. Prior to the first flights of data acquisition, a terrestrial GPS reference station network was prepared to aid the processing of the position- and attitude data acquired by the on-board installed IMU/GPS system. This network consisted of 6 GPS reference receivers located evenly distributed inside the target area and was provided by local power supply companies.

The data acquisition was successfully carried out in early spring 2007. A total of 80 flying hours were necessary to cover the complete region – including flight time from the local aerodrome to the target area and many redirections by the air traffic controller to whom the pilot held continuous radio contact. The system integrity and stability was checked prior to every flight for user data acquisition by acquiring scan data over a small village in the vicinity of Vienna. The data acquired during this check flights was also used for the systems primary boresight calibration process, carried out with *RIEGL*'s unique airborne scan data processing software package RiPROCESS.

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Area	454km ²
Number of flight lines	648
point count	10·10 ⁹
point density on 1/4 of the survey area	20 pts/m ²
Absolute measurement accuracy	11 cm
Measurement altitude	450-500m AGL
Laser measurement equipment	RIEGL LMS-Q560
Pulse repetition rate	200kHz



Left: DSM of the old town of Vienna, coloured according to ellipsoidal heights.



Right: the St Stephan's cathedral in the centre of Vienna

The subsequent data processing was accomplished in three major steps:

- Processing of the position and attitude information to highest accuracy.
- Analysing the laser scanner's full waveform data, combining the laser scan data with the position and attitude information, and carrying out the strip lines adjustment - all done using RiPROCESS resulting in a point cloud in the WGS84 (ETRF89) coordinate system.
- Coordinate transformation and projection from WGS84 (ETRF89) to the Austrian local Gauss Krueger coordinate system.

The final result, an amount of about 10 billion measured points, impresses with an average point density of 20 points per square meter on approximately three quarters of the whole area, the remaining area is covered with a point density according to the requested specifications. The position accuracy of the scan data was determined to be better than 11 cm standard deviation.

Conclusion

The full-waveform capability of the laser scanner *RIEGL LMS-Q560* led to an even higher point density than expected during the mission planning. Also with respect to measurement accuracy, the data exceeds the initial requirements of the customer.

"The data is the perfect starting point for modelling the detailed roofscape of the city. The exceptional high resolution and accuracy of the data guarantee a long lasting basis for many applications to be developed in the next years" says Mr. Zöchling, head of the division "Digital City Map - Geographical Data", which is part of the municipal department "urban surveyors" and is responsible for providing geographical data of the whole province Vienna within the Vienna city administration.

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