Geophysical Research Abstracts
Vol. 14, EGU2012-8378, 2012
EGU General Assembly 2012

Potential of a novel airborne hydrographic laser scanner for capturing shallow water bodies

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In this paper, we present the general design of a hydrographic laser scanner (prototype instrument) manufactured by the company Riegl Laser Measurement Systems in cooperation with the University of Innsbruck, Unit of Hydraulic Engineering. The instrument utilizes very short laser pulses (1 ns) in the green wavelength domain (λ=532 nm) capable of penetrating the water column. The backscattered signal is digitized in a waveform recorder at high frequency enabling sophisticated waveform processing, both, online during the flight and in post processing. In combination with a traditional topographic airborne laser scanner (λ=1500 nm) mounted on the same platform a complete hydrographic and topographic survey of the riparian foreland, the water surface and river bed can be carried out in a single campaign. In contrast to existing bathymetric LiDAR systems, the presented system uses only medium pulse energy but a high pulse repetition rate of up to 250 kHz and, thus, focuses on a detailed description of shallow water bodies under clear water conditions.

Different potential fields of applications of the instrument (hydraulic modelling, hydro-morphology, hydro-biology, ecology, river restoration and monitoring) are discussed and the results of first real-world test flights in Austria and Germany are presented. It is shown that: (i) the high pulse repetition rate enables a point density on the ground of the water body of 10-20 pts/m^2, (ii) the short laser pulses together with waveform processing enable a discrimination between water and ground reflections at a water depth of less than 25 cm, (iii) the combination of a topographic and hydrographic laser scanner enable the acquisition of the geometry data for hydraulic modeling in a single survey, thus, providing a much more homogeneous data basis compared to traditional techniques, and (iv) the high point density and the ranging accuracy of less than 10 cm enable a detailed and precise description of the river bed morphology, thus, providing an excellent data source for calibrating and validating sediment transport models. With the focus on capturing shallow water bodies under clear water conditions, the instrument is not designed for mapping of broader rivers (turbid water due to suspended material). However, even for these rivers the presented technique can close the gap between the river bank (captured, e.g., by topographic LiDAR) and the main channel (e.g., by echo sounding).