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Mobile TLS application for fluvial studies

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In fluvial studies, different survey and modelling approaches have been used to study the interaction of landscape and flow processes, including response thresholds, feedback elements and other such complexities, requiring both high-quality topographical and bathymetrical data at different scales. Currently, tachymetry and GPS surveys are widely used in fluvial geomorphology, while more sophisticated survey methods such as close-range photogrammetry and terrestrial laser scanning (TLS) are less common. Static TLS measurements provide a point density, ranging from 100–10000 points/m2 with a root mean square error of ± 2 to ± 25 mm. Although the TLS system allows the collection of data at a higher resolution and precision than ALS at a lower cost, its area is more limited than the latter method. This area limitation can be improved using mobile laser scanning. The typical requirements for a mobile mapping system (MMS) are that visible objects should be measured to an accuracy of a few centimetres with a maximum speed of 50-60 km h-1 and that desired objects should be collected within a radius of several tens of metres. Recently, it has been reported mobile mapping systems, which are based on laser scanning, the former work including an account of the FGI ROAMER system and a detailed description of its data processing.

The boat-based, mobile mapping system (BoMMS, based on FGI ROAMER system) with a laser scanner for fluvial applications allows the derivation of detailed topographical data in river studies. Combined with data acquisition from static terrestrial laser scanning (TLS), boat-based laser scanning enables a totally new field mapping approach for fluvial studies. In this paper, we demonstrate a BoMMS with a laser scanner for fluvial applications. This system enables rapid field surveying with accuracy of approximately 2 cm (relatively sub-centimetre) for river banks, point-bars and other features of the riverine landscape. This application offers a highly dense point cloud spatially; making the three-dimensional mapping of sub-centimetre fluvial morphology feasible. The BoMMS approach was an extremely rapid methodology for surveying riverine topography, taking only 85 minutes to survey a reach approximately six kilometres in length. The BoMMS scanning was completed with static terrestrial laser scanning to further increase the density of the entire DTM collected from the point bar. Further, this paper demonstrates the three-dimensional mapping of a point-bar and its detailed morphology. Compared to the BoMMS surface, approximately, 80 % and 96% of the TLS points showed a height deviation of less than 2 cm and 5 cm, respectively, with an overall standard deviation of $\pm$ 2.7 cm. This level of accuracy and promptness enables the mapping of post-flood deposition directly after a flood event without an extensive time lag. Additionally, the improved object characterisation allowed for better calculation of the point bar volume, as well as the sediment budget of the river, using multi-temporal data.

Due to the rapid development of laser scanning technology, the cost of systems like BoMMS are constantly becoming cheaper, promoting their increased use. More research is needed in the future to verify the full potential of boat-based scanning, combined with TLS and ALS, for fluvial studies. Based on the collected data, automatic algorithms require development, as do those needed for the semi-automatic mapping of the fluvial depositions. Additionally, multi-temporal laser scanning data must be further developed for the calibration and validation data of computational fluid dynamics.