Future Challenge in the Calibration of High-Resolution Hydrographic Multi-Sensor Systems

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SUMMARY

Data acquisition with mobile platforms has long been used in hydrography, especially with acoustic sensors like echo sounders. Especially multi beam echo sounders offer a high coverage in bathymetric data acquisition. Nevertheless, at present, the resolution and achievable accuracy are limited. Under optimal conditions, these are in the range of several centimetres for short distances. However, the underwater use of alternative optical measuring instruments in natural waters poses a number of challenges, as modelling the path of the optical axis is physically highly complex.

New developments in (optical) underwater measurement technology, like underwater laser scanners, promise higher resolutions, flexibly adjustable scan patterns and high measurement accuracy. First promising tests achieve a measurement range of more than 25 m in clear fresh water. The next step is to use these instruments for kinematic data acquisition, for which the instruments are installed on mobile platforms such as surveying vessels or unmanned surface vessels (USV). The underwater laser scanners are thus integrated as a component in a hydrographic multi-sensor system, which also includes at least an inertial navigation system and GNSS antennas. In order to achieve a high (geometric) data quality of the referenced point cloud in these cases, an accurate and reliable calibration of the complete multi-sensor system is required. In a first step, a solution for a sensor alignment survey on board of small surveying vessels, like the HCU surveying vessel DVocean, is developed. This includes the set-up configuration of the surveying instruments (e.g. total station) and the optimization of the used geodetic network, the selection of suitable fixed points in the vessel's coordinate system and the use of markings that are optimised for this purpose. Point cloud based and established point-based surveying approaches are compared for determining the reference point coordinates of the individual instruments in the multi-sensor system, in particular for new high-resolution instruments such as the underwater laser scanner. The achievable precision, accuracy and reliability are

evaluated.

This procedure has to be exceeded to determine also the installation angles of the sensor with respect to a given reference (either vessel coordinate system or the inertial sensor coordinate system). Therefore, established calibration methods have to be adapted. Additionally, high-precision synchronisation of the measurement data is required for kinematic measurements with the underwater laser scanner. For that purpose, a low-cost, local PTP (Precise Time Protocol) server is set up.

Applying these optimizations enables hydrographers to receive precise and reliable laser scanner point clouds representing underwater structures as a base for change detection and monitoring tasks. For that purpose, the outlined calibration procedure assists in providing a data base for a sustainable use and maintenance of built underwater structures, but also to map and preserve natural structures (e.g. underwater habitats) for future generations.