HydrOs – An Integrated Hydrographic Positioning System for Surveying Vessels

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Key words: Hydrography; Positioning; Multi-sensor System; Extended Kalman Filter; Squat Determination

SUMMARY

Generally, multibeam echo sounders are used for the acquisition of geospatial data such as shape and depth of inland waterways. For safety and ease of navigation these data need to be georeferenced and plotted in accurate and reliable sea charts and maps. Therefore, the positioning of the echo sounder and of the surveying vessel respectively is essential. Currently, positions of surveying vessels on German federal waterways are determined with GNSS (Global Navigation Satellite Systems) receivers or GNSS-INS (Inertial Navigation System) coupled systems. Reliability, availability and accuracy of GNSS positions are influenced by shadowing, refraction and multipath effects. Gaps mainly occur in regions with riparian vegetation, in narrow valleys with steep slopes and during crossing of bridges. The project HydrOs (Integrated Hydrographic Positioning System) focuses on the optimal estimation of three-dimensional coordinates of a reference point and the spatial orientation of the vessel. Even if GNSS signals are completely lost for one minute, the height shall be known with an accuracy of one decimeter (95% level of confidence). Therefore, a multi-sensor system is developed combining the measurements of multiple GNSS receivers, Inertial Measurement Unit (IMU), Doppler Velocity Log (DVL) as well as propulsion information. The measurements of each connected sensor are recorded and processed in an Extended Kalman Filter (EKF). For this purpose the motion of the vessel is predicted by a motion model which includes twelve state variables: turning rates, velocities, orientation angles and coordinates of the reference point. In contrast to other prediction models for vessel motion, a three dimensional prediction is realized. It is particularly important to check, if a valid and reliable GNSS solution is available for each single GNSS receiver just before shadowing events occur. Currently used integrity parameters do not meet the requirements concerning reliability. Therefore, new algorithms are developed and are used to detect outliers in the GNSS observations. In progress of the project, other absolute positioning sensors and hydrodynamic numerical models will be added to further stabilize the accuracy and integrity of the positioning. Height of water level and current stemming from hydrodynamic numerical models can only be used, if the ship squat is precisely known. In the project a new method to estimate the squat effect was developed. The basic principle is to measure the height of a reference point on the vessel in comparison to the undisturbed height of water level while the vessel crosses the water with varying speed. Additionally, the ship's trim, the velocity through water and the under keel clearance are considered. Hence, a vessel-specific 3D characteristic model for the squat depending on the mentioned influences can be estimated. The final

HydrOs system will be able to provide a highly reliable and accurate position of surveying vessels in real-time and in post-processing mode. Furthermore, quantities like water level and current velocity can be derived.