Development of GPS Time-Based Reference Trajectories for Quality Assessment of Multi-Sensor Systems

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SUMMARY

The development of multi-sensor systems (MSS) goes hand in hand with the assessment of the quality of these complex systems. Therefore, reliable reference information of superior accuracy is of great importance for validations. When the assessment is based on 3D point cloud comparison, appropriate reference environments with suitable geometries are applied. However, validation can also be performed directly on their 3D position or even their 6D pose. This is particularly suitable for MSS without environmental acquisition sensors such as laser scanners or cameras.

When using kinematic measurement systems, the temporal relationship between the MSS and the reference trajectory must be considered, which is challenging. Modern MSS sensors are often synchronized to GPS time. However, for high accuracy tracking sensors such as Robotic Total Stations (RTS) or Laser Trackers (LT), this global time information is not provided directly by the manufacturer. Instead, only a reference to an internal sensor time is implemented, which does not meet the described application purposes regarding the highest quality requirements for reference trajectories. Depending on the speed of movement of the system being tracked, time offsets in the millisecond range can lead to significant trajectory falsification.

This contribution, therefore, presents methods and investigations for GPS-based synchronization of the polar measuring elements of both RTSs and LTs from Leica Geosystems. While a precise trigger signal is used for the LT for the temporal link, the Measure & Stream application distributed by the instrument manufacturer is required for an RTS. The two different approaches for both types of instruments are presented theoretically. Based on empirical (long-term) studies, their possibilities and limitations are critically discussed. While precise synchronization with GPS time is possible for the LT as a high-frequency measurement sensor for the establishment of reference trajectories (in 3D and 6D), time offsets in the mid-millisecond range remain for the RTS. In addition, the RTS is

dependent on the tracking speed tested. In general, the developed approaches for the realization of GPS-synchronized reference trajectories can be used not only for the quality assessment of MSS, but also for e.g. monitoring surveys or kinematic positioning applications.