Title: “The analytics of time synchronisation in photogrammetric and remote-sensing multi-sensor systems”

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Abstract:
Synchronization errors are one of the main headaches of anyone who has been involved in multi-sensor integration. The various instruments’ clocks that drive the instrumental temporal coordinate reference frames and the various delays that HW and SW introduce in the time transfer interfaces are the origin of the synchronisation problems. Sometimes, instrument manufacturers go through all sorts of pains to implement and interface stable and externally steerable coordinate reference time frames. Sometimes, this is just not possible and synchronisation errors, absolute (with respect to a global time frame) and relative (between the various sensors of a system), happen.

The impact of synchronisation errors varies according to sensor configuration and survey mission features. Sometimes, the time-related errors are absorbed by other spatial calibration parameters. However, usually, this weakens the geometry of the problem as one temporal calibration parameter has to be replaced by a number of 3D spatial vectors. Fortunately, most synchronisation errors behave as constant stochastic processes.

In the paper, the analytics of temporal calibration is presented and the detailed mathematical models are introduced and developed in detail for local geodetic and map projected coordinate systems. For this purpose, the convenience of extending the orientation parameters of the sensors with velocities is discussed and the use of INS/GNSS-derived velocity observations is introduced. The key idea of the proposed method is to relate synchronisation errors to spatial errors by using the sensor velocity orientation parameter or, alternatively, by transforming the INS/GNSS-derived velocity to sensor velocity.

The paper will concentrate on the analytical aspects and illustrate the performance of the method.