Investigation of the Inherent Trade-Off Between Bias Model Complexity and State Estimation Accuracy in INS-GNSS-Integration

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SUMMARY

The integration of inertial navigation and global navigation satellite systems represents the core navigation unit. The accuracy for most multi-sensor-systems operating in an open sky environment depends on the modelling and observability of the inertial sensor errors. Although incorporating various types of sensor errors is feasible in Kalman filtering estimation, not all errors are observable for low dynamic applications. Therefore, a first compromise consists of incorporating the most dominant inertial sensor errors, such as the residual biases, which contribute most to short-term navigation errors. It is common practice to attribute the residual biases a deterministic and a stochastic part. In order to model the latter, different stochastic processes are possible.

In this paper, the trade-off between stochastic model complexity of the residual biases and state estimation accuracy is explored in more detail to inform future decision-making regarding this trade-off. For this purpose, Allan variance analyses on static long-term inertial measurement recordings are performed. The extracted stochastic parameters are then used to characterise different stochastic error models. Based on simulations and experimental tests with an unmanned ground vehicle different modelling approaches are compared. Furthermore, the necessity to incorporate complex residual bias models is evaluated.