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On Robust Sensor Fusion of GNSS and IMU for Airborne Wind Energy Systems

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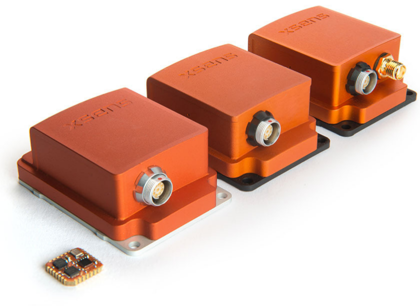
One of the biggest challenges facing commercialization of airborne wind energy (AWE) systems is to prove robustness of the technology under various environment conditions. Besides advanced control strategies, an accurate estimate of the system's state is required to guarantee a fault tolerant operation.

In this study, we present a state estimation approach to track the motion of a kite of an AWE system using exclusively onboard sensors. We use nonlinear optimization methods to formulate a sensor fusion problem, which includes measurements from an inertial measurement unit (IMU) and a global navigation satellite system (GNSS) receiver. The highly dynamic maneuvers of energy kites present challenging conditions for consumer grade sensors. Fast turn maneuvers, which are typical for flight trajectories during power generation, can provoke GNSS outages or result in a poor measurement accuracy leading to a degraded estimation performance. The observed behavior raises objections regarding the practical use of GNSS measurement updates for AWE systems [1,2]. We show that these issues can be overcome by considering the sensor-specific limitations in a moving horizon approach for sensor fusion of IMU and GNSS. The presented algorithm allows to robustly track the motion of a kite, which is validated using a recorded flight dataset of a soft-kite AWE system during power generation.



Xsens MTi motion tracker portfolio. The MTi-G710 (right) was used for the data collection in this study.

References:

[1] M. Erhard and H. Strauch: Sensors and navigation algorithms for flight control of tethered kites, 2013 European Control Conference (ECC), Zurich, pp. 998-1003 (2013).

[2] L. Fagiano, K. Huynh, B. Bamieh and M. Khammash: On Sensor Fusion for Airborne Wind Energy Systems, in IEEE Transactions on Control Systems Technology, vol. 22, no. 3, pp. 930-943 (2014).