A Concept for Lightweight UAV-Based Radar Remote Sensing assisted by Wireless Local Positioning

Martin Schütz, Martin Vossiek

Friedrich-Alexander University Erlangen-Nürnberg,
Institute of Microwaves and Photonics

In this talk, we will introduce a custom-built UAV-based sensor platform for radar remote sensing. It is controlled by a redundantly implemented, customized flight control system and equipped with a comprehensive embedded system for radar baseband processing. Both systems are synchronized by a common reference clock with low phase noise, which is temperature-stable and allows for the coherent acquisition and continuous recording of sensor data. A commercial differential GPS receiver is used for satellite-based positioning. The platform is suitable for interferometric remote sensing with synthetic apertures. In a first implementation, it is equipped with a bistatic 24 GHz MIMO radar system to create a side-looking airborne radar, allowing for full interferometric SAR processing.

Classical SAR imaging is realized with long range radar systems mounted on satellites or planes, making it challenging to achieve the high signal-to-noise ratio and high system bandwidth needed for valuable radar images. With low altitude systems, such as the proposed UAV-based sensor platform, higher carrier frequencies and thus greater bandwidths can be implemented without degenerating the signal-to-noise ratio. However, an increased carrier frequency comes along with increased precision requirements regarding the flight trajectory measurement and control. This is especially challenging for lightweight UAVs, and alternative techniques should be considered where satellite-based position and trajectory estimation techniques are no longer efficient.

Our presentation will illustrate the concept and a first prototype of a wireless local positioning network based on regenerative backscatter transponders. The approach allows for simultaneous trajectory estimation and SAR image generation with a single radar sensor. The hardware of the wireless positioning network is realized with low-cost, air droppable transponders. These reference transponders can easily be placed within or around a hazardous area to support the UAV during a high resolution SAR image formation. We will present first measurement results regarding the performance evaluation of the positioning technique as well as data acquired during flight that prove the effectiveness of our proposed concept in practice.