Geophysical Research Abstracts
Vol. 19, EGU2017-9665, 2017
EGU General Assembly 2017

Radar sensing via a Micro-UAV-borne system

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In recent years, the miniaturization of flight control systems and payloads has contributed to a fast and widespread diffusion of micro-UAV (Unmanned Aircraft Vehicle). While micro-UAV can be a powerful tool in several civil applications such as environmental monitoring and surveillance, unleashing their full potential for societal benefits requires augmenting their sensing capability beyond the realm of active/passive optical sensors [1]. In this frame, radar systems are drawing attention since they allow performing missions in all-weather and day/night conditions and, thanks to the microwave ability to penetrate opaque media, they enable the detection and localization not only of surface objects but also of sub-surface/hidden targets. However, micro-UAV-borne radar imaging represents still a new frontier, since it is much more than a matter of technology miniaturization or payload installation, which can take advantage of the newly developed ultralight systems. Indeed, micro-UAV-borne radar imaging entails scientific challenges in terms of electromagnetic modeling and knowledge of flight dynamics and control. As a consequence, despite Synthetic Aperture Radar (SAR) imaging is a traditional remote sensing tool, its adaptation to micro-UAV is an open issue and so far only few case studies concerning the integration of SAR and UAV technologies have been reported worldwide [2]. In addition, only early results concerning subsurface imaging by means of an UAV-mounted radar are available [3].
As a contribution to radar imaging via autonomous micro-UAV, this communication presents a proof-of-concept experiment. This experiment represents the first step towards the development of a general methodological approach that exploits expertise about (sub-)surface imaging and aerospace systems with the aim to provide high-resolution images of the surveyed scene. In details, at the conference, we will present the results of a flight campaign carried out by using a single radar-equipped drone. The system is made by a commercial radar system, whose mass, size, power and cost budgets is compatible with the installation on micro-UAV. The radar system has been mounted on a DJI 550 UAV, a flexible hexacopter allowing both complex flight operations and static flight, and has been equipped with small size log-periodic antennas, having a 6 dB gain over the frequency range from 2 GHz to 11 GHz. An ad-hoc signal processing chain has been adopted to process the collected raw data and obtain an image of the investigated scenario providing an accurate target detection and localization. This chain involves a SVD-based noise filter procedure and an advanced data processing approach, which assumes a linear model of the underlying scattering phenomenon.

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