UAV Radar imaging for cultural heritage: a first prototype

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Nowadays, the use of Unmanned Aircraft Vehicle (UAV) based sensing technologies is widely considered in most disparate fields, including archaeology and cultural heritage inspections. The main advantages offered by UAV technology are the possibility of investigating large areas in a very short time, the simplification of the organization and implementation of the measurement campaigns thus reducing their costs, and finally the increasing availability of autonomous systems that push more and more towards plug and fly solutions.

The widespread remote sensing technologies mounted on-board UAV systems are essentially optical, thermal and multi-spectral sensors, which are passive technologies designed to measure the signal emitted into the optical and (near and far) infrared portions of the electromagnetic spectrum. These technologies exploit techniques like aero-photogrammetry to get high resolutions images of the surface features of the investigated scene and provide useful information to evaluate structural and material degradation, such as surface cracks, humid zones and biological patinas.

Radar systems represent a further technological solution, which exploits the penetration capability into non-metallic media of the microwaves, thus offering the key advantage to perform surface and sub-surface inspections. However, UAV based radar systems are still under development due to the numerous challenges related to the acquisition modality and data processing. Being radar an active technology, both transmitting and receiving units must be installed on-board the UAV and this introduces not trivial issues related to payload and assets constrains. Moreover, in order to obtain focused images, a high precision knowledge of the UAV position during its flight must be available.

As a contribution to this topic, an ultra-light radar system mounted on a micro drone has been developed and its imaging capabilities have been assessed in controlled conditions. The UAV radar imaging system is an enhanced version of that presented in [1]. Specifically, the main components of the assembled prototype are the UAV DJI F550- hexacopter platform and the Pulson P440 radar sensor. The radar system has been equipped with two log-periodic antennas pointed at nadir, and it operates in the frequency range of [3.1, 4.8] GHz. Moreover, to accurately reconstruct the UAV platform positioning, the Differential GPS technology has been also implemented by exploiting two
GPS receivers placed one onboard the platform and the other one in a fixed ground station. Finally, the data processing is cast as the solution of an inverse scattering problem by exploiting the Born Approximation to model the wave-material interaction. The results of some flight tests will be presented at the conference.


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