UAV-based Far-Field and Near-Field Antenna Measurements

Abstract

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In recent years, Unmanned Aerial Vehicle technology has been experimented as antenna measurement solution for very large antennas that cannot be placed in an anechoic chamber or have to be characterized in-situ. The UAV already proved to be a powerful tool for Far-Field (FF) measurements, thanks to its portability, low cost, and ability to perform arbitrary paths. In the first part of this thesis, UAV-based FF measurements of a Square Kilometre Array prototype station in VHF band are presented. One full SKA-Low station consists of 256 digital-beam-formed dual-polarized elements randomly distributed on a 40-m size area. This activity demonstrated the usage of the UAV to verify the large electromagnetic models of the SKA in harsh environments such as the Australian desert.

However, Near-Field (NF) strategies become necessary when the Antenna Under Test (AUT) is so large that the Fraunhofer distance is no longer compliant with flight altitude regulations (hundreds of meters). In these cases, a Near Field to Far Field (NF-FF) transformation must be used to determine the FF quantities of interest from NF data. Such technique generally requires the knowledge of both magnitude and phase of the sampled NF signal. However, in the UAV-based measurement setup, where source and receiver are generally not connected, the measured phase is continuously drifting during the flight. In current literature, different solutions have been exploited in order to retrieve the correct phase information, e.g., a fiber optic link connecting the UAV to the ground or phaseless techniques. In the second part of this thesis, a known antenna (called reference antenna) placed in the proximity of the AUT is instead used to reconstruct the phase of the measured NF signal. UAV-based NF measurements on a SKA-Low prototype at 175 MHz are presented to demonstrate the feasibility of the approach. The UAV equipped with a RF source is exploited as a large (40 m x 40 m) horizontal planar NF scanner. An inverse source NF-FF transformation is applied to such NF acquisitions. In this way, FF Embedded Element Patterns, array calibration coefficients and pattern are obtained. NF-FF transformed results are validated with simulations and FF measurements.

The promising results suggest the usage of the presented technique in other applications such as radars, base stations and satellite antenna measurements.