



RADIOSCIENCES AU SERVICE DE L'HUMANITE

Energy Spectrum Sensing using Two-Antenna Probes based on the Measurement of Field-Field Auto-Correlation and Cross-Correlation Functions

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Abstract : This paper discusses energy spectrum sensing using Two-Antenna probes based on the measurement and analysis of Field-Field Auto-Correlation and Cross-correlation functions.

The main results concern the following experimental analysis:

- 1) Comparative analysis between Time and Frequency domains Field-Field Auto-correlation and Cross-Correlation functions
- 2) Evaluation of TX-RX UAV link as function of radiated Near-Field and Far-Field EMC and EMI interferences

The proposed contribution evaluates effects of Analog-Digital co-habitation (coupling between DSP/Microcontroller and sensitive analog circuit blocks) on correlation functions accounting for environmental uncertainties. In particular the emissions and interferences in successive generations of embedded electronic systems integrated on autonomous mini-UAV are compared according to different phases of on-board calculation processes.

Fig.1 depicts Multi-Channel link demonstrator used for energy spectrum sensing using Two-Antenna arrays probing embedded in UAV systems. Radiation patterns are characterized as function of Cut and Off-set angles with perspectives for wireless TX-RX link setup between UAV systems for effective control/monitoring of multi-channel performances of small-cells to enhance communication capacity and coverage in 5G critical missions.

Unmanned Aerial Vehicles (UAVs) equipped with lightweight embedded sensors offer new potentialities for contactless measurement with the following perceived benefits:

- Use of non-stationary (mobile in remote control) floating platform for electromagnetic field probing (both Near-Field and Far Field).
- GPS (alternatively laser reflector combined with gyroplane) assisted position tracking of probing sensors with stabilization of RF-probes for accurate angle measurement on spherical contours.
- Wireless data flow management including signal processing for remote sensing.

Feasibility studies pushed to real implementation phases have demonstrated practical benefits of using UAVs as floating measurement platforms in diverse civilian (agriculture [1], telemetry including RF test and measurement [2]) and military (defense/security [3]) applications.

However, the effective use of UAVs as floating measurement platforms is mainly limited by battery life (autonomy) and the requirement for human interaction to deal with power management in addition to data flow management. Wireless charging appears as a promising solution for dealing with both challenges. Furthermore, use of UAVs for real-time measurement and probing of electromagnetic fields need proper mitigation of different noise contributors among which are couplings between motors and embedded RFIC circuitry with potential environmental uncertainties (e.g., external interferers due to outdoor moving boundary conditions).

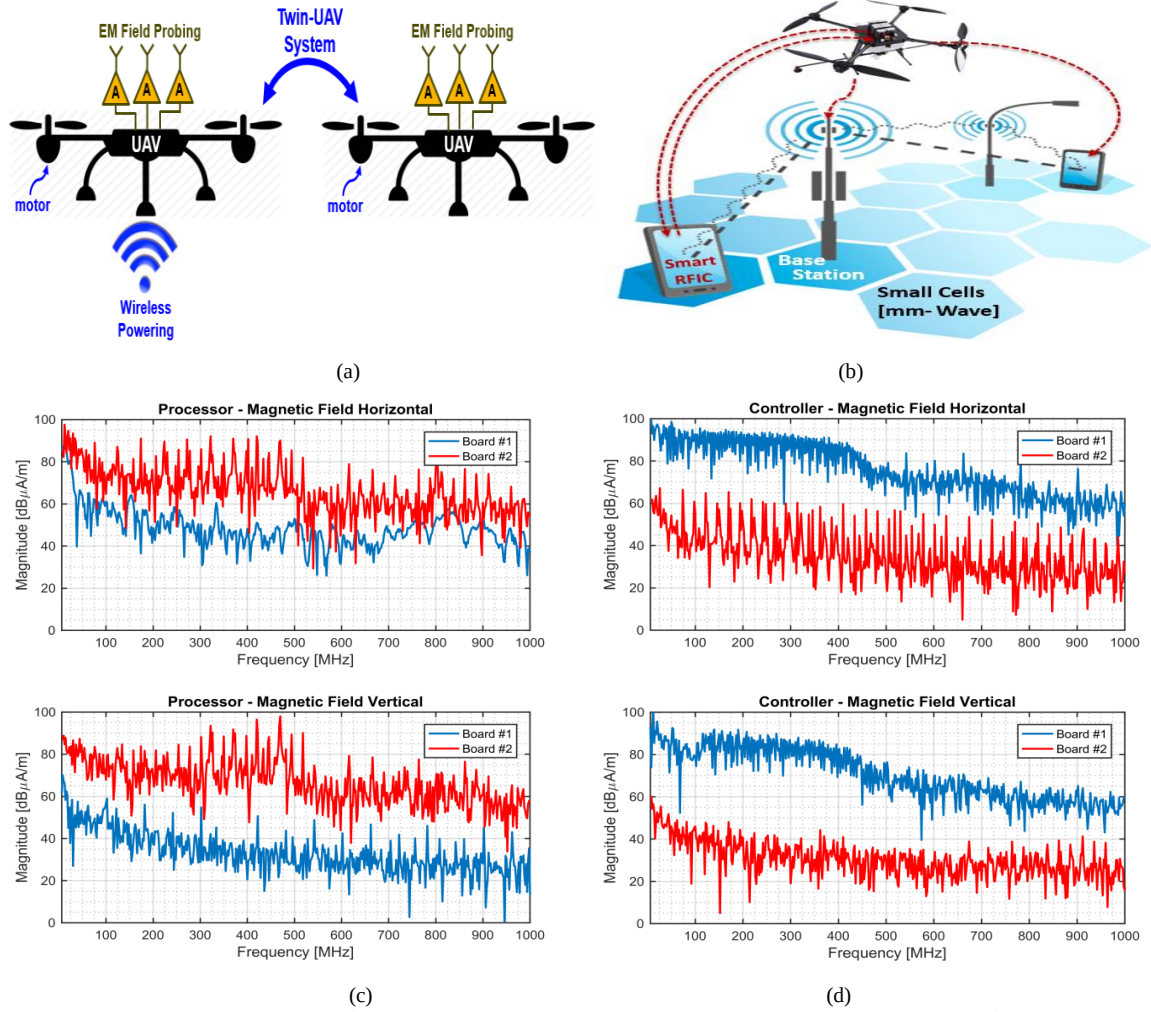


Figure 1: Multi-Channel link demonstrator for energy spectrum sensing using Twin-Antenna Array Probes (a). Use of UAV systems in 5G critical missions (b). Near-Field probing of radiated stochastic emissions from Processor (c) and Controller (d) units embedded in UAV systems.

CONCLUSION

Energy spectrum sensing using Two-Antenna probes based on the measurement and analysis of Field-Field Auto-Correlation and Cross-correlation functions is proposed for evaluating effects of Analog-Digital co-habitation (coupling between DSP/Microcontroller and sensitive analog circuit blocks) on system-level performances. Stochastic emissions from electronic systems embedded in autonomous mini-UAVs are experimentally characterized in frequency and time domains using Near-Field scanning solutions [4-5]. These interferences can limit the sensitivity of embedded Near-Field probes when UAV systems are used as remote floating platform for test and measurement purposes. Ongoing work concerns benchmarking of electrical (magnetic/electric) and optical probing in terms of their immunity and sensitivity as well. Redundancy and complementarity principles can be exploited using the concept of Twin [6] UAV systems backed-up by contactless powering in the context of outdoor applications.

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