DSP for Radiation Pattern Measurement utilizing UAV

A Flexible and Cost-Effective UAV-Assisted Measurement Method

Students

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Introduction: This thesis investigates the feasibility of using an unmanned aerial vehicle (UAV) as a mobile measurement platform for characterizing the radiation pattern of an antenna developed in a separate project. Conventional antenna measurement facilities are often costly and inflexible, motivating the exploration of alternative measurement approaches. UAV-based measurements offer the potential for a flexible, low-cost solution capable of spatially distributed data acquisition in real-world environments.

Approach: A lightweight RF measurement payload is developed and integrated onto a quadcopter UAV. The payload combines software-defined radio (SDR) receivers, a dual-linearly polarized patch antenna, and centimeter-accurate real-time kinematic global navigation satellite system (RTK-GNSS) positioning. The UAV follows predefined grid-based flight trajectories in the antenna far field, enabling systematic spatial sampling of the radiated field. During flight, complex baseband signal samples are recorded and synchronized with precise position data. These measurements are processed using digital signal processing techniques to reconstruct relative radiation characteristics. A surface-driven Gaussian radial interpolation method is applied to the spatial measurement data to reconstruct a continuous two-dimensional gain plane, from which elevation cuts are subsequently derived.

Result: The reconstructed radiation patterns are compared qualitatively with simulated antenna characteristics to assess plausibility. The results demonstrate that UAV-based antenna measurements are practically feasible for relative radiation pattern evaluation under controlled conditions. While absolute measurement accuracy is limited by system constraints and environmental influences, the proposed approach provides a flexible and low-cost alternative to conventional antenna measurement facilities. The findings establish a foundation for future refinement and development of UAV-assisted antenna characterization methods.

Figure 1: UAV equipped with the RF measurement payload.
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Figure 2: Two-dimensional interpolated measurement plane above the transmitting antenna.
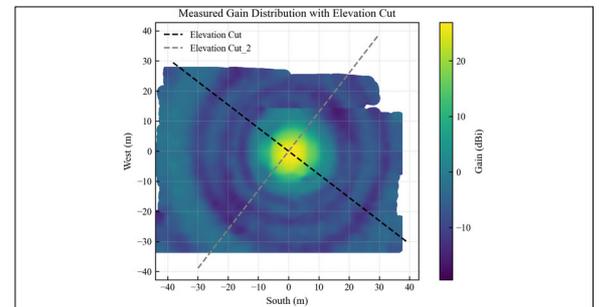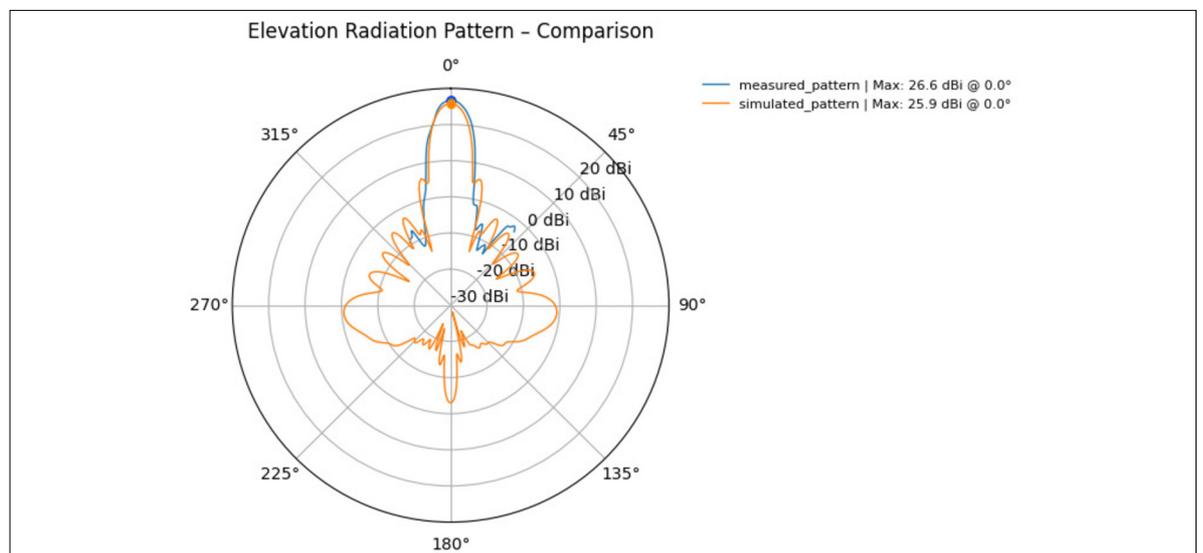Own presentment

Figure 3: Comparison of the measured and reconstructed radiation pattern and the simulated antenna radiation pattern.
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