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Flight Path Planning Using Graph Theory in UAV-based Antenna Measurements

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The characterization of antennas by their far-field radiation pattern is a task that has been around for decades. A powerful way to obtain the far-field of an antenna employs near-field measurements in combination with a near-field to far-field transformation (NFFFT). Those measurements are usually undertaken in anechoic chambers which provide a controlled environment with an acceptable approximation of free-space. Recently, the field of in-situ antenna measurements gained more attraction as large antennas cannot be brought into anechoic chambers and often also the performance of mounted antenna systems is of interest. One of the most promising technologies in this field is the employment of an unmanned aerial vehicle (UAV) [1], where the UAV carries the probe antenna instead of using a highly sophisticated positioning system. The advantage of a UAV is that it can move to a predefined position without much effort and restrictions. However, one major drawback of UAVs is their limited flight time due to battery capacity.

So far, antenna measurement geometries and the corresponding flight paths have been designed intuitively even if advanced flight path planning, concerning battery usage, can enhance flight times. There are several publications which deal with the energy usage of UAVs and optimize the flight paths accordingly [2, 3]. However, most of these publications aim for finding the best path between start and destination. In contrast, the flight path for UAV-based antenna measurements must be very different from these well-known approaches as some additional field-related measures should be taken into account.

In this contribution, we present a method for flight path modeling that is based on graph theory. The single measurement positions are represented by nodes while the edges of a graph represent possible flight paths. For each edge a cost function can be defined, including battery usage and other flight specific measures, which are finally processed by standard algorithms to find the best flight path.

References

[1] M. García-Fernández, Y. Álvarez López, A. Arboleya, B. González-Valdés, Y. Rodríguez-Vaqueiro, M. E. De Cos Gómez, and F. Las-Heras Andrés, "Antenna diagnostics and characterization using unmanned aerial vehicles," *IEEE Access*, vol. 5, pp. 23 563–23 575, 2017.

[2] J. T. Economou, G. Kladis, A. Tsourdos, and B. A. White, "UAV optimum energy assignment using Dijkstra's algorithm," in *European Control Conference (ECC)*, 2007, pp. 287–292.

[3] T. Dietrich, S. Krug, and A. Zimmermann, "An empirical study on generic multicopter energy consumption profiles," in *Annual IEEE International Systems Conference (SysCon)*, 2017, pp. 1–6.