**Feasibility Study of Flight Inspection Aid by UAS-Based Sensing and Calibration**

**WHAT**

Flight Inspection Services (FIS) ensure the integrity of instrument approaches and airway procedures that constitute our National Airspace System (NAS) infrastructure and the Federal Aviation Administration’s (FAA’s) international commitments. The project is to support the improvements of the FIS data quality and accuracy by providing physical simulation-based calibration of the existing FIS measurement instruments. The innovative technologies used include electromagnetic simulation of the navigation-aid antennas on the service aircrafts (King Air and Challenger III). Improvements to existing calibration software and procedures will not only benefit the FIS inspection process, but also potentially improve aviation safety and offer cost saving for labor, equipment and flight hours.

**GOALS**

The ultimate goal of this project is to verify the feasibility of achieving the ±3 dB (3dB absolute) measurement uncertainty of signal strength (SS) for all the navigational aid signals through a combination of EM simulation, radio system calibration and signal processing, and more autonomous operations through the usage of unmanned/autonomous test platforms.

The goals can be described as follows:

1. Validating the simulation models using flight test data.
2. Developing the software and procedures to make the simulation and measurement process more efficient.
3. Developing an integrated software system to aid antenna inspection light measurement calibration, more applications of simulation and measurement for Glide Slope.

**HOW**

The first step is aircraft modeling. In this step, we use both existing aircraft information and the 3D base model as reference, and manually build the 3D aircraft model. Therefore, the aircraft model is still a 3D CAD model that many details are not needed. However the models captures the dimensions, shape and key details that matter the EM simulation and 3D antenna pattern predictions. The models are improved iteratively based on the simulations process.

In the second step, the models are meshed properly in EM simulation environments. For the frequency of simulations related to VOR/DME/GS, there are usually millions to even billions of the model elements in the simulations.

Antennas modeling uses an effective and simplified “equivalent monopole” approach, which is based on equivalence theory to electromagnetic, and simplified the modeling and need of proprietary information from the antenna vendors.

The simulations runs are performed using an-AHPC Windows cluster and CST Microwave Studio software. The results are 3D antenna radiation patterns at different frequencies will be integrated into the flight inspection software system.

The approach has significant advantages over existing calibration solutions. First, it provides more accurate antenna pattern tables taking the effect of aircraft installation into consideration. Second, it is based on simulations, so the cost of the calibration procedure is reduced.

The following graph shows the “end to end” procedures to generate inspection calibration database based on computational EM simulations. It includes the steps to perform necessary “smoothing” over frequency points and over spatial angles.

**Validation**

Our focus for 2019 is the new flight test validations with better data collection and comparisons with better resolutions. For example, we compared measured Glide Slope (GS) signal strength patterns for King Air for both flight test #1 (which has 30 degs of angular resolution) and flight test #2 (which is based on equivalent theory to electromagnetic). For both cases, the model prediction errors are less than 3 dB in average for all the sample directions.

**WHY**

In general, this project is related to the missions of COE-SOAR in terms of (1) incorporated evolving technologies which include antenna modeling, aircraft simulation, EM validation and software-defined radio. It is also related to the long-term goal of seamless, UAS-based calibration processes (2) Improving the UAS capabilities, tasking, and the 3D laser-scanned model as reference, and manually build the 3D aircraft model. Therefore, the aircraft model is still a 3D CAD model that many details are not needed. However the models captures the dimensions, shape and key details that matter the EM simulation and 3D antenna pattern predictions. The models are improved iteratively based on the simulations process.

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**GOALS**

The ultimate goal of this project is to verify the feasibility of achieving the ±3 dB (3dB absolute) measurement uncertainty of signal strength (SS) for all the navigational aid signals through a combination of EM simulation, radio system calibration and signal processing, and more autonomous operations through the usage of unmanned/autonomous test platforms.

The short-term goal of the current project is developing 3D EM simulations of the antenna radiation patterns of the antennas mounted on the flight inspection aircrafts (such as King Air and Challenger III).

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