COE TTHP 5th Annual Virtual Administrative Meeting

Improvements of Flight Inspection Antenna Modeling and Simulation

OU-Team Members:

Yan (Rockee) Zhang, Matthew Gilliam, Jakob Fusselman

FAA Team Members:

Brad Snelling, Ricardo Carrizosa, Todd Bigham, Jay Sandwell

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Project Objectives

Motivation:

Further improve the modeling and simulations of the antenna radiation patterns, signal strength, and other possible impacts on the flight inspection of navigational aids (VOR/DME/TACAN, LOC/GS)

Project Objectives:

- Improve and consolidate the aircraft and FI antenna models for optimizations of the future FI aircraft.
- Optimization of antenna installation locations for multiple aircrafts operated or to be operated by the FAA flight inspection team.
- Investigate the modeling approach for VOR/DME/TACAN system inspections.

Goal#1: Complete and streamline the initial modeling, simulation and optimization process for flight inspection mission.

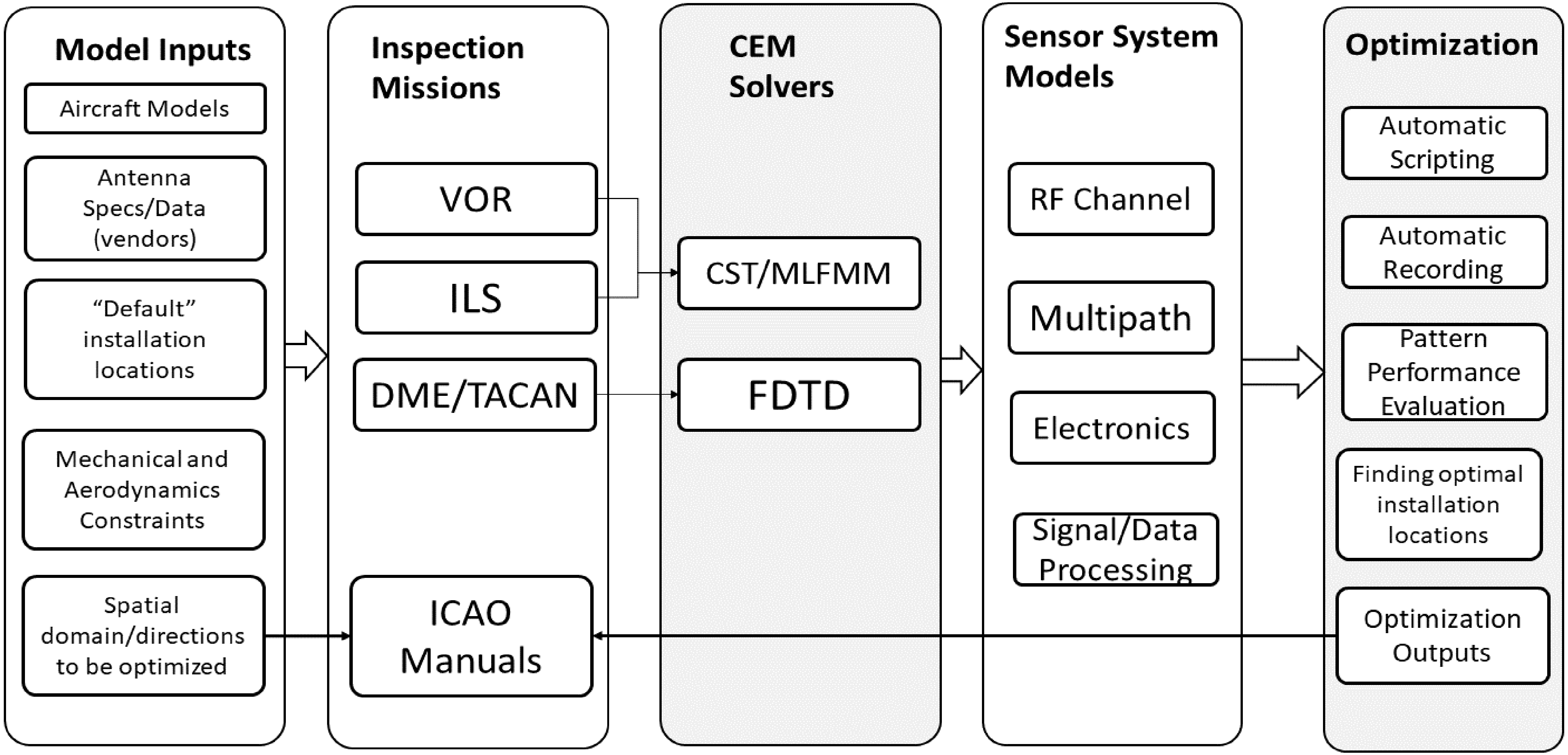
Goal#2: Deliver the models and data to FAA team, as required in the project tasks.

Project Impact

<u>S&T Impacts:</u> Based on existing solutions of aircraft and antenna modeling, computational electromagnetic solver (MLFMM), we are exploring a new approach to automatically optimize the solver configuration and antenna placement.

<u>Operational Impacts:</u> Further inclusion of “4D-normalization” data table to more aircrafts, antennas and FI receiver configurations. FAA team will Use the database produced from the project to enhance the accuracy of the Signal Strength (SS) measurements, to better achieve the ICAO FI requirements.

Overview of Simulation and Optimization



Project Management and Admin Tasks

Subtask 1*:* Assistance with ongoing partnership linkages for research institution to successfully incorporate industry into the design and field test.

Subtask 2*:* Support for field test site needs (e.g., expansion to additional sites, if necessary, to accommodate required research sample size).

Subtask 3*:* Monitoring of the technical scope of the research team.

Subtask 4*:* Tracking of the FAA program sponsor and technical monitor quarterly technical feedback to ensure technical scope and approach of research team continues to meet the FAA's needs.

Subtask 5*:* Quarterly and annual reporting and closeout.

Project Schedule

Milestones	End Date	Predecessor
CL-605 and 604 antenna model updated, verified.	Dec 1, 2020	NA
350 ER aircraft and antenna model updated, verified.	April 2021	NA
C90 aircraft and antenna model updated, verified.	July 2021	NA
Data tables completed for Army design	Aug 2021	NA
Deliverables	Due Date	Predecessor
Simulation Models	Dec 2020 and Aug 2021	NA
Simulation Data Tables	Dec 2020 and Aug 2021	NA

Key References

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Ultra Lightweight VOR/ILS Receiver For Flight Inspection

OU-Team Members:
Yan (Rockee) Zhang, Hernan Suarez,
Sudantha Perera, Matthew Gilliam, Jakob Fusselman
FAA Team Members:
Zhong Cheng, Brad Snelling
OSU Collaborators:
James West, Dane Johnson, Sabit Ekin, Gary Ambrose

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Project Goal and Approach

Technical Goals

Goal#1: Design, develop and test a prototype Software-Defined-Radio (SDR) receiver that meets the C-SWaP requirements for UAS-based developments and VOR/ILS signal measurements.

Goal#2: Test, validate and report the VOR/ILS signal parameter measurement performance of the prototype SDR receiver, based on ICAO, FAA and other standards.

Additional Goals

- UAS flight tests are also involved
- Expand knowledge of processing algorithms on how to use raw navigation signals for engineering and flight inspection
- Explore the possibility by working with industrial partner to turn the prototype into FAA-certified commercial product

Project Impact

<u>S&T Impacts:</u> The project has demonstrated the initial success of using software-defined radio as the core of an ultra-lightweight ILS/VOR flight inspection receiver.

<u>Operational Impacts:</u> A new way of flight inspection operation based on the SDR-based receiver and small UAS will have significant impact on the operations, leading to reduced labor and cost, faster and more efficient facility inspection report, and new way of training the flight inspection operators

Technical Solutions and Specifications

Lab testing and verification has been important part of project tasks

Specification Parameters	State of the Art	Our Objective
Size/Dimension	About 12 inches by 5 inches	5.5 by 5.5 by 3.5 inches
Weight (ILS receiver)	3 to 10 lbs	1.5 to 2 lbs
Power consumption	NA	5 watts max
Receiver technology	Customized	Open source GNU/SDR, 14-bit ADC
Receiver channels	Simultaneous LOC/GS/VOR	Simultaneous LOC/GS, plus VOR
Flight inspection product update rate	10 Hz	10 Hz
Internal signal sampling rate	NA	Up to 3 MSPS, much lower in normal operation
Data Products	Simultaneous analysis of dual-frequency LOC and capture-effect GS	Simultaneous analysis of dual-frequency LOC and capture-effect GS, combined DDM
Standard compliance	ICAO DOC 8071	ICAO DOC 8071 FAA-96E01B1
Raw data output DDM estimation errors	< 0.005	< 0.005
Filtered output DDM estimation errors	0.001 to 0.005	0.001 to 0.005
Cost	>$10,000	About $1000

Current Status and Schedule

Backup GPS-RTK receiver

UAS onboard Power and data interface

VOR/ILS Dual-band antenna input

- Initial lab test of receiver prototypes show ILS DDM accuracy (uncertainty) meet the basic ICAO requirements, running more lab tests Following standard.
- Further lab tests are performed for short sampling period (up to 0.1 sec), following FAA recommended test procedures for performance.
- Initial flight test in jointly with OSU team, verified basic capability of processing course/clearance signals. Planning further tests at local airports.
- VOR receiver functionality is still in lab-test stage, simulations are good.
- Real-time implementation is ongoing

- Receiver prototype Box#2 is being delivered for ground and flight tests and demonstrations. Prototype Box#3 is being developed.
- Initial release of real-time implementation (End of 20)
- Final real-time software verification (Early 21)
- FAA/ICAO initial verification data (Early 21)