Project 046 Surface Analysis to Support AEDT APM Development

Massachusetts Institute of Technology, MIT Lincoln Laboratory

Project Lead Investigator

Hamsa Balakrishnan
Associate Professor
Aeronautics and Astronautics
Massachusetts Institute of Technology
77 Massachusetts Ave., 33-328
Cambridge, MA 02139
617-253-6101
hamsa@mit.edu

University Participants

MIT

- P.I.(s): Hamsa Balakrishnan
- FAA Award Number: 13-C-AJFE-MIT, Amendment No. 021
- Period of Performance: July 7, 2016 to Aug. 31, 2017
- Task(s):
    1. Assess AEDT aircraft surface performance modeling needs
    2. Develop enhanced aircraft surface performance models
    3. Validate enhanced aircraft surface performance models
    4. Recommend AEDT APM enhancements

Project Funding Level

$75,000 FAA funding and $75,000 matching funds. Source of match is approximately $75,000 all from MIT.

Investigation Team

Prof. Hamsa Balakrishnan, Co-Principal Investigator (MIT)
Dr. Tom Reynolds, Co-Principal Investigator (Lincoln Laboratory, via separate contract)
Yashovardhan Chati (Graduate student)
Sandeep Badrinath (Graduate student)

Project Overview

The taxi phase in the Aviation Environmental Design Tool (AEDT) is currently modeled using default or user-specified taxi times, coupled with engine idle fuel and emissions assumptions from the ICAO Aircraft Engine Emissions Databank. This simplification reduces the accuracy of taxi performance modeling in AEDT. The proposed research aims to enhance the taxi models in AEDT's Aircraft Performance Module (APM) by combining surface surveillance data (from ASDE-X) with statistical models developed using information from Flight Data Recorders.

Task Progress and Plans

Objective(s)

The objective of this research project is to identify and evaluate methods for improving taxi performance modeling in AEDT in order to better reflect actual operations. This objective will be met through the use of surface surveillance (ASDE-X) data, in combination with a comprehensive statistical analysis of Flight Data Recorder (FDR) archives.

Research Approach

Task 1: Assess AEDT aircraft surface performance modeling needs: this includes soliciting input from stakeholders (including FAA AEE sponsors, AEDT developers, users, etc.) and related research (e.g., ACRP studies 02-45 and 02-27) on known gaps and associated needs in current aircraft surface modeling capabilities. In addition, prior research into high fidelity aircraft surface modeling will be assessed and leveraged as appropriate. For example, taxi models resulting in thrust and fuel flow estimates were previously built using Flight Data Recorder (FDR) data. Such aircraft-derived data is the "gold standard" for high fidelity modeling, but its limited availability often results in models with limited applicability.

We conducted a discussion with AEDT developers and users (at the FAA and Volpe) to discuss gaps identified during the literature review and from ACRP studies 02-45 and 02-27. We have also begun familiarizing ourselves with the AEDT APM's current capabilities.

Task 2: Develop enhanced aircraft surface performance models: enhanced aircraft surface performance models will be developed which address needs identified in Task 1. For example, one of the anticipated needs is the development of models which are representative of a wider range of taxi conditions, aircraft types, airports, airlines and weather conditions than current modeling approaches. The research team has access to significant archives of ASDE-X surface surveillance and FDR data covering a wide range of these variables of interest from which improved surface models can be built. For example, ASDE-X data can be used to identify a large range of taxi conditions (e.g., locations, dwell times and speeds between surface events such as engine start, spot, taxiway intersections, runway crossing, departure runway queue, line-up-and-wait, etc.) for a range of major airports, aircraft types, airlines and weather conditions. By correlating to FDR "truth" data, improved thrust and fuel flow models can be developed. This task will also consider the results of prior related studies, such as ACRP 02-45 and 02-27. The research team has good contacts within the stakeholder community to acquire additional FDR data archives if required for this exercise.

We have begun the analysis of ASDE-X data, with an initial focus on CLT airport.

Task 3: Validate enhanced aircraft surface performance models: a subset of the ASDE-X and FDR data archives will be held back from the enhanced model development activity in the previous step so it can be used as independent validation data. For example, fuel burn and thrust profiles based on "new" ASDE-X tracks will be estimated using the enhanced models developed from the previous step and compared to the estimates direct from FDR data. If the differences between the two profiles exceed some appropriate threshold, further refinements to the surface models developed in Task 2 are required (as illustrated by the dashed arrow between steps 3 and 2 in the diagram).

We are in the process of acquiring additional FDR datasets for validation.

Task 4: Recommend AEDT APM enhancements: based on the surface modeling enhancements developed from this process, specific targeted recommendations for AEDT APM improvements for the surface domain will be made.

Awaiting the completion of Tasks 2-3.

Publications
None.

Outreach Efforts
None.

Awards
Yashovardhan Chati. ACRP Graduate Research Award, 2016.

Student Involvement
Graduate students have been involved in all aspects of this research.