Tutorial-T5 (Half Day, 4 hours)

CIRCULATION CONTROL BASED FIXED-WING UNMANNED AIRCRAFT DESIGN FOR ENHANCED PERFORMANCE

Organizers

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Tutorial Summary

This Tutorial presents a survey of active flow techniques to improve the aerodynamic performance of UAVs with a focus on Circulation Control (CC). It summarizes methods, techniques and tools required to: improve aerodynamic efficiency, reduce the runway distance during takeoff/landing, enhance payload capability and delay stall. This tutorial addresses and responds to the question "Is Circulation Control feasible for small-scale UAVs?" The research goes beyond the current state of the art by demonstrating feasibility of CC as applied to such UAVs. Challenges to overcome stem from payload, power and energy requirements that restrict considerably small-scale UAV utilization and flexibility, limiting them to complete only those specific missions they are designed for. However, given that CC is an active flow control method used to produce increased lift over the traditional systems (flaps, slats, etc...) currently in use, this tutorial presents the foundations of a comprehensive methodology from design to implementation and experimental testing of Coanda-based Circulation Control Wings (CCW) for unmanned aircraft. 2-D and 3-D wind tunnel tests at low Reynolds numbers, with momentum coefficients of upper slot blowing ($C\mu$) ranging from 0.0 to 0.3 are conducted. Wind tunnel results are evaluated through flight testing. The methodology discussed can be made suitable for use on commercial airliners, cargo planes and personal aerial vehicles because equipping these aircraft with cruise-efficient high-lift devices can give more valid runway choices at existing airports and help alleviate environmental noise problems near airports by allowing steeper climb-outs.

Tutorial Outline

1. Review of active flow blowing techniques for manned and unmanned aircraft.
2. Coanda effect and its applications.
3. Circulation Control: Advantages and challenges.
4. A comprehensive methodology from design to implementation and testing of Circulation Control Wings (CCW).
5. Design, implementation and testing of a Circulation Control System for small-scale UAVs.
6. Flight testing of the UC^{2}AV: Unmanned Circulation Control Aerial Vehicle.

Intended Audience

- Graduate students in electrical, mechanical, mechatronics and aerospace engineering;
- Scientists, researchers, practitioners, UAV system designers and engineers;
- UAV practitioners, researchers and developers.

Tutorial Material: *To be delivered to participants via Dropbox invitation and USB jump drive swap.*