Motivation

- High fidelity models for full-envelope controller
- synthesis and simulation for HALE UAVs.

Problem Statement

- Validity of classical SysID derived models is limited to local regions where data is gathered.
- HALE UAVs cover wide ranges of altitude and Mach number.
- Repetition of local SysID procedure at all operating points in the flight envelope is inefficient.
- CFD and wind-tunnel experiments are time consuming, expensive and less accurate.

Goal: create a modeling process which is efficient, inexpensive and accurate.

Global System Identification Framework

A. Flight Experiment   B. VLM SysID   C. Correction Model Identification   D. Global SysID Scheme

VLM/CFD System Identification

- Create synthetic SysID data using Dynamic VLM/CFD simulation.
- Apply local SysID procedure to the synthetic data to obtain the model.
- Low fidelity but applicable over the whole flight envelope.
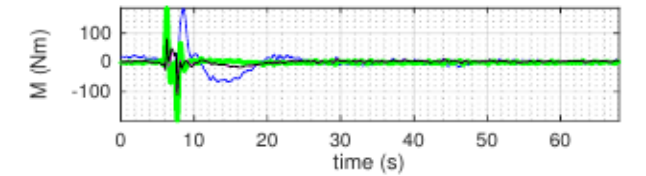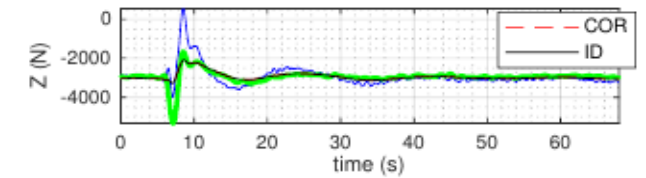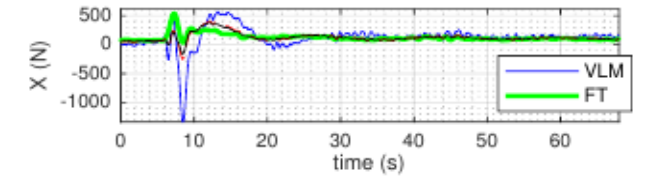
Correction Model Identification

- Apply local SysID to available real flight test data.
- Construct error model and apply linear regression techniques.
- Error between prediction of VLM/CFD SysID model and local SysID model is modeled as function of UAV states.
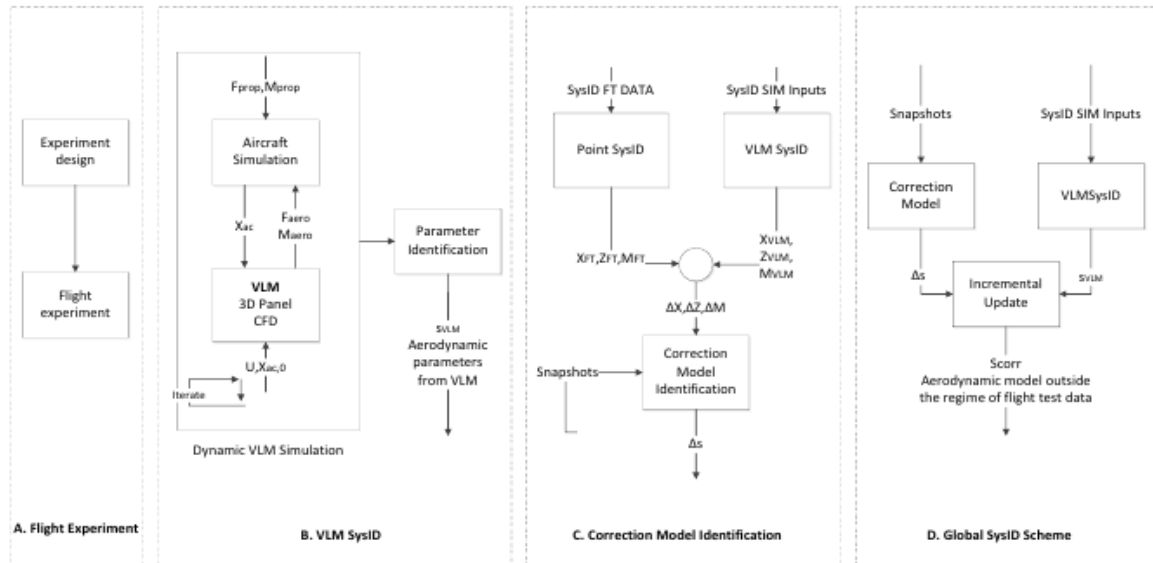
Global System Identification Scheme

- Increase fidelity of VLM/CFD SysID model by applying correction model.
- Aerodynamic model outside regimes of flight test data can be obtained.

Experiments

- SysID data at 4 different velocities
- 48 SysID manoeuvres in total
- Elektra 1 optionally piloted aircraft

- Set up to validate extrapolation: S1 & S2.
- Set up to validate interpolation: S3 & S4.

- E.g: black circles to identify correction model, validation on yellow circle

Results

- Overall reduction in root mean squared error by factors 0.59, 0.47 and 0.52 for x-axis, z-axis (aerodynamic forces) and y-axis (aerodynamic moments) respectively.
- Tolerances of 1.5 deg/s and 2 deg for pitch rate and angle.
- Validated for interpolation and extrapolation scenarios.
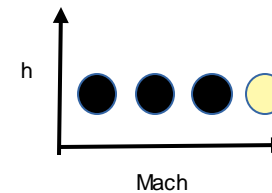- Validated for different directions of interpolation and extrapolation.

Conclusion

- Efficient global SysID for HALE UAVs.
- Numerical models corrected with available flight test data.
- Validated for test set of operating points.
- Further validation for real stratospheric mission with Elektra-2 solar UAV.

Towards Autonomous Stratospheric Flight:
A Generic Global System Identification Framework for Fixed-Wing Platforms

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