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Abstract
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Title

Knowledge-based Integration of Aircraft System Simulation within Aircraft Conceptual System Design

Authors

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Abstract

Heading for higher accuracy models within *aircraft conceptual design* is a well-known early design stage problem when transitioning from static point design towards time-dependent higher-fidelity models to incorporate dynamic effects. The latter is of especial of interest within various domains such as aircraft attitude and control, unsteady aerodynamics, component heat and cooling (thermal management system), and the sizing of onboard system based on (peak-)power requirements. This work presents approaches to realize (i) steady-state and (ii) dynamic *six degree of freedom* (6DOF) aircraft simulation models including the *primary flight control* (PFC) system and a subset of relevant onboard systems within the pre-design phase. The simulation models are with the help of *knowledge-based engineering* (KBE) and extensive submodule function-means models derived from a steady-state aircraft and onboard system architecture model. To motivate, explain and prove the suggested methodology, the paper consists of four parts:

- **Part1** explaining the **stat-of-the-art of aircraft conceptual design** with focus on on-board system architecture generation, previous work and current shortcomings with focus on the use of dynamic models within the early phase of design.
- **Part2** developing the **methodology to transform a systems architectural definition to (i) steady state and (ii) dynamic (simulation) models**. That includes the use of *knowledge-based engineering* (KBE) to automatically generate the required additional information and model topology, and the AI-based model tuning required to enable the creation of executable simulation models.
- **Part3** shows the **implementation strategy based on a use case, a surveillance UAV**. Here, several tools and standards (e.g., system structure and parametrization, SSP), XML/XSLT and Ontology have been used to a) retrieve the data from the aircraft model to b) generate the lacking information, and c) auto-tune the simulation model with the help of machine learning algorithms.
- **Part4** shows the **analysis of the realized use case including the findings based on the higher fidelity model**. This part also contains a critical review of the applied methodology, process and implementation. It concludes with recommendations for future applications and future implementation strategies to enable the overall goal of a seamless transition between models of different fidelity levels. It will be shown that this approach is especially useful for (onboard) system designers/engineers where system dynamics play an important role during the architectural design phase and the component scaling.

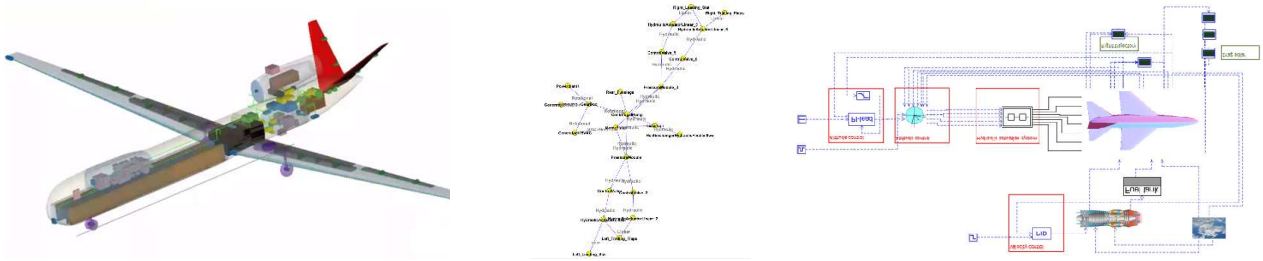

Figure 1: Overview of the model transition from the steady-state PaceLab model (left), the extracted domain-specific system architecture (middle) to the final dynamic 6DoF simulation model in Hopsan (right).