Multi-model Approach for Rotor Dynamics in Helicopter and Wind Turbine Simulation

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Abstract

We present a multi-model approach for simulating complex systems with an example from helicopter dynamics. Our focus lies on the co-design of numerical methods, software engineering, and an engineering modelling process.

Our goal is to simulate the dynamic behaviour (from vibrations to flight dynamics) of rotor systems. This requires coupling of rigid structures, flexible elements, simple aerodynamics and other sub-systems such as controllers. We want to allow general rotor configurations avoiding "artificial" constraints in the coupling of these sub-systems. Therefore we use a generic formulation for coupling multiple ODE models which leads to an index-1 DAE system. The individual sub-models can be developed and tested independently. This means we obtain a loose coupling of the software components. In addition we can start with simple sub-models and add more complex behaviour when needed. We discuss the robust and fast implementation of the employed numerical methods for the time-integration of the index-1 DAE system. Here we focus on half-explicit Runge-Kutta methods combined with exponential integrators to tackle stiff systems.

References

1. E. Kremser. Towards Helicopter Simulation with an Index-1 Differential-Algebraic Equations System. Master's Thesis. University of Cologne. 2017.