Real-Time Simulation of Rotor Inflow Using a Coupled Flight Dynamics and Fluid Dynamics Simulation

Abstract:
In order to predict the rotorcraft motion in the vicinity of objects or their wake, a real-time capable model is presented. The dynamic inflow into the rotors was extracted from a real-time Lattice-Boltzmann fluid simulation and fed into a blade element based rotorcraft flight dynamics code. To represent the influence of arbitrary objects on the flight dynamics, the objects were modeled by boundary conditions in the Lattice-Boltzmann fluid simulation and updated dynamically in every time step. This two-way coupled simulation enabled the prediction of the rotorcraft motion and flight dynamics in arbitrary situations without prior knowledge of the flow field. To validate the effect of objects on the inflow, the required power in hover and forward flight in ground effect was evaluated. Furthermore, the rotorcraft motion due to a step input in hovering and forward flight was discussed. The results from the coupled fluid dynamics/flight dynamics model showed good agreement when compared to a more established reference model, namely the Pitt-Peters inflow model.