National Aeronautics and Space Administration

Aircraft

Improvements to Navier-Stokes Simulations of Rotor Wakes and Feature Extraction

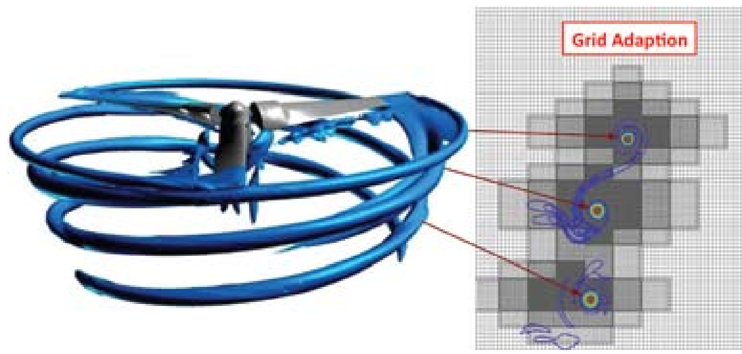
Helicopters and tiltrotor aircraft provide many crucial services, including emergency medical and rescue evacuation, security patrols, offshore oil platform access, heavy-lift capability, and military operations. Development of improved physics-based computational tools will eventually lead to reduced rotorcraft noise pollution and greater heavy-lift capabilities where airports are not practical or available.

Many of the physical phenomena associated with rotorcraft flight—including blade deformations, noise, ice buildup, vortical wakes, and blade-wake and wake-wake interactions—are not clearly understood and difficult to accurately predict.

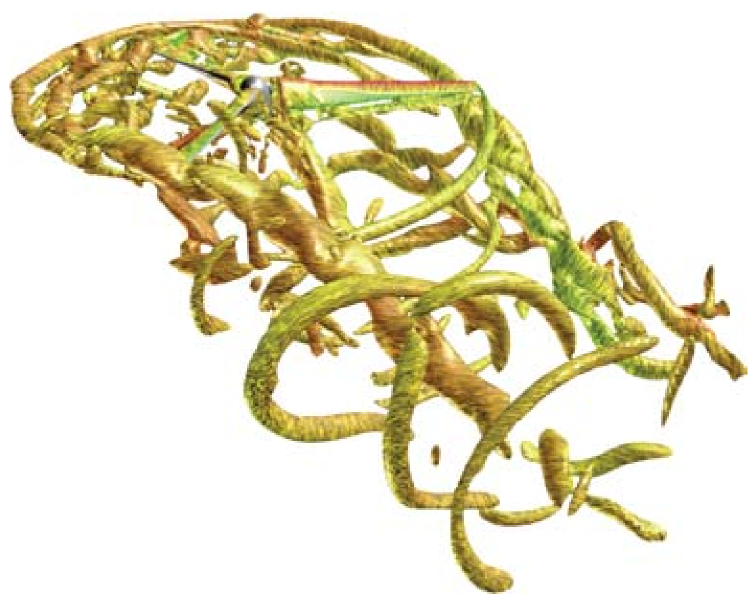
The focus of this effort is to improve the accuracy of rotor wake simulations by using the OVERFLOW 2.1 computational fluid dynamics (CFD) code, which solves the time-dependent, Reynolds-averaged Navier-Stokes equations. This is accomplished by introducing grid adaption and high-order-accurate numerical algorithms to better resolve the vortex wake. State-of-the-art, time-dependent flow visualization is also used to identify features of the vortex wake and extract data for analysis and comparison with experimental data.

NASA's supercomputers enable verification and validation of new aeromechanics computational tools that are not possible on smaller systems. Solutions often require more than one million processor-hours per case.

This project supports NASA's Subsonic Rotary Wing (SRW) Project (part of the Fundamental Aeronautics Program) to develop improved physics-based computational tools to address accuracy requirements for the prediction of rotorcraft performance and flight.



Navier-Stokes simulation of an isolated V-22 rotor in hover. Three levels of grid adaption improve rotor vortex resolution.



Navier-Stokes simulation of an isolated V-22 rotor in forward flight. Vortices are rendered with iso-surfaces based on the Q-criterion. Texture mapping is used to reveal the flow direction on the iso-surfaces.

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