TU Delft

Delft University of Technology

Aerospace Structures & Computational Mechanics
Ph.D. Seminar Series

Erik Gillebaart

Reduced-Order Modeling of Continuous-Time Unsteady Aerodynamics

Current conceptual design of aircraft wings can be seen as a sequential process. In the first stage the aerodynamic properties of the wing are determined and the next stage covers the structural design of the wing. The final stage is to evaluate the aeroelastic performance of the wing. In the case of difficulties, the structural design of the wing is modified until satisfying aeroelastic behaviour is achieved.

Combining the three stages into a single optimization process could result into a more efficient wing. By including the possibility to also modify the aerodynamic shape of the wing to solve aeroelastic difficulties, the design space broadens and thus potentially more efficient wing designs can be obtained. Even though the aerodynamic performance might be decreased, the overall wing performance can be increased. The aeroelastic optimization will require many analysis runs to evaluate the behaviour of the wing in different conditions, making it important to have fast analysis tools.

The current aerodynamic analysis tool requires a significant number of aerodynamic states to obtain an accurate result. This research explores the possibility of computing a reduced-order model (ROM) that can provide accurate results with significantly fewer states and, consequently, lower computational cost. Multiple methods are available for this purpose and the goal is compare the performance of the most important of these in terms of accuracy, computational efficiency and robustness. Currently, four methods are investigated: modal truncation (know from the field of structural dynamics), balanced truncation, proper orthogonal decomposition, and balanced proper orthogonal decomposition.

The first two methods compute the ROM purely based on the mathematical description of the full-order model (FOM). Alternatively, proper orthogonal decomposition is a system identification method and formulates the ROM based on simulation data of the FOM. The two approaches are combined in BPOD, where POD is used to empirically approximate certain system matrices that are subsequently used for the determination of the ROM. The details of these methods will be presented, after a brief description of the full-order aerodynamic model. The results obtained with the methods will be shown and discussed.

time:	**Thursday, November 21st, 2013, 16:00**
location:	**meeting room 7**
organization:	**Dr. Martin Ruess ‹m.ruess@tudelft.nl›**