- 초청강연 -

이형천
Ajou University

Invited Talk

Centroidal Voronoi Tessellation-Based Reduced-Order Modeling of Navier-Stokes Equations

In this talk, a reduced-order modeling methodology based on centroidal Voronoi tessellations (CVT's)is introduced. CVT's are special Voronoi tessellations for which the generators of the Voronoi diagram are also the centers of mass (means) of the corresponding Voronoi cells. The discrete data sets, CVT's are closely related to the h-means clustering techniques.

Even with the use of good mesh generators, discretization schemes, and solution algorithms, the computational simulation of complex, turbulent, or chaotic systems still remains a formidable endeavor. For example, typical finite element codes may require many thousands of degrees of freedom for the accurate simulation of fluid flows. The situation is even worse for optimization problems for which multiple solutions of the complex state system are usually required or in feedback control problems for which real-time solutions of the complex state system are needed. There hava been many studies devoted to the development, testing, and use of reduced-order models for complex systems such as unsteady fluid flows.

The types of reduced-ordered models that we study are those attempt to determine accurate approximate solutions of a complex system using very few degrees of freedom. To do so, such models have to use basis functions that are in some way intimately connected to the problem being approximated. Once a very low-dimensional reduced basis has been determined, one can employ it to solve the complex system by applying, e.g., a Galerkin method. In general, reduced bases are globally supported so that the discrete systems are dense; however, if the reduced basis is of very low dimension, one does not care about the lack of sparsity in the discrete system.

A discussion of reduced-ordering modeling for complex systems such as fluid flows is given to provide a context for the application of reduced-order bases. Then, detailed descriptions of CVT-based reduced-order bases and how they can be constructed of complex systems are given. Subsequently, some concrete incompressible flow examples are used to illustrate the construction and use of CVT-based reduced-order bases. The CVT-based reduced-order modeling methodology is shown to be effective for these examples and is also shown to be inexpensive to apply compared to other reduced-order methods.