Tutorial

Topic: **Finite Element Model Updating**

Speaker: **Wen-Wei Lin**
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Outline

1. Problem, FE Model, Vibration Testing

2. Spectral Theory of QEP

3. Updating Methods

4. Some Remarks

Balanced Realization of Periodic Descriptor Systems

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Abstract

In this talk necessary and sufficient conditions are derived for complete reachability and observability of periodic time-vaying descriptor systems. Applying these conditions, the symmetric positive semi-definite reachability/observability Gramians are defned and can be shown to satisfy some projected generalized discrete-time periodic Lyapunov equations (GDPLE). We propose a numerical method for solving these periodic Lyapunov equations, and an illustrative numerical example is given. As an application of our results, the balanced realization of periodic descriptor systems is discussed.

A Continuation BSOR-Lanczos-Galerkin Method for Solving Multi-Component Bose-Einstein Condensate

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Abstract

We develop a continuation BSOR-Lanczos-Galerkin method for the computation of positive bound states of time-independent, coupled Gross-Pitaevskii equations (CGPEs) which describe a multi-component Bose-Einstein condensate (BEC). A discretization of the CGPEs leads to a nonlinear algebraic eigenvalue problem (NAEP). The solution curve with respect to some parameter of the NAEP is then followed by the proposed method. For a single-component BEC, we prove that there exists a unique global minimizer (the ground state) which is represented by an ordinary differential equation with the initial value. For a multi-component BEC, we prove that m identical ground/bound states will bifurcate into m different ground/bound states at a finite repulsive inter-component scattering length. Numerical results show that various positive bound states of a two/three-component BEC are solved efficiently and reliably by the continuation BSOR-Lanczos-Galerkin method.

Bifurcation Analysis of a Two-Component Bose-Einstein Condensate

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Abstract

We prove that the solution curve of the ground/positive bound states of a two-component Bose-Einstein condensate undergoes supercritical pitchfork bifurcations at some finite values of the inter-component scattering length. The ground state solutions bifurcate into two symmetric solutions with respect to some suitable axis on the symmetric domain, when a two-component BEC has equal intra- and inter-component scattering lengths. Furthermore, we show that the ground/positive bound states repel each other and form segregated nodal domains when the repulsive scattering length goes to infinity.

Chaos in discrete dynamical systems

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Abstract

First of all, in this talk, a quick introduction to the chaotic dynamical systems will be given. The second, some special orbits of dynamical systems shall be discussed, for instance, snap-back repellers, homoclinic orbits and heteroclinic orbits, etc..

Convergence Acceleration by Self-Adjusted Relaxation Factor for Turbulent Flow Computation

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Abstract

The applications of higher-order turbulent models for complex turbulent flow computation has been widely recognized and becomes popular, but slow convergence (even divergence) of the turbulent computations still hinders the use of advanced turbulence models. In this study, we propose a method to determine the values of the under relaxation factors so that faster convergence can be achieved. The new method adopts the concept from the Bi-CGSTAB algorithm. The scheme updates the solution vectors such that the 2-norm minimized residuals of the governing equations can be obtained. The turbulent flow past a pipe, a ribbed channel with (or without) periodic boundary conditions are computed to demonstrate the effectiveness of the present method. The numerical results indicate that the under relaxation factors self-adjusted by the Bi-CGSTAB method indeed accelerate the convergence rate for the computation of turbulent separated flow

Key words: Convergence Acceleration, Under Relaxation Factor, Bi-CGSTAB Method

Numerical Computation for Eigenvalue problems of Discretization of Membranes with Stringers

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Abstract

We study the algebraic problems arising from the discretization of vibrating membranes with stringers by using finite difference method (FDM). It is well known that the resulting matrices are always in a huge size such that numerical implement is challenged. Especially, the computation complexity is increasing in case several eigenvalues in a given region are wanted. Therefore, the issues relative to reliability and economy shall be investigated in order to develop an efficient numerical method for solving the eigenvalue problems.

In view of economy of computation, the proposed method in here has to be simple and efficient. Fortunately, during the past decades, several elegant numerical methods, named by "fast solvers", consisted of Fast Fourier Transform (FFT) were proposed for the problems of vibration systems. Therefore, a fast solver that adopts FFT technique and advantage of the structure of the resulting matrices is hence investigated for the eigenproblem of a vibrating membrane with stringer. In view of reliability of numerical implement, we add a technique, called "deflation", to the proposed method for more reliable and accurate computation of the wanted eigenpairs. To deal with a large-scale eigenvalue problem, the iterative method is often exploited. However, as iterative methods are adopted, a crucial challenge is how to avoid a duplicate or blind computation for searching the desired eigenvalues or eigenvectors. To overcome the challenge, a deflation technique is necessary. There were some deflation techniques proposed in literatures [???]. Here we exploited a deflation technique which is consists of a lower rank update to avoid the mentioned drawback.

Identifying Positive Lyapunov Exponents by Basis Response Surface Method

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Abstract

We develop algorithms to find so-called effective values (EV) $x \in R^n$, such that the corresponding response $f(x) \in R$ is located in a specific region of interest (ROI). Examples of the region of interest include extreme values, bounded intervals, positivity, and others. Following assumptions make the problem challenging: (i) the definition of $f(x)$ is complicated or implicit; (ii) the response surface does not fit to specific patterns; (iii) cost for evaluating the function values is expensive. We iteratively approximate the true yet unknown response surface by simplified surrogate models that are formed by a pre-defined atomics (or bases). The surrogate models are then used to predict the possible effective values. The algorithms are applied to find a positive Lyapunov exponent of a dynamical system. Numerical results show that the algorithms are efficient and practical.

*: Speaker