For favor of posting

The Hong Kong University of Science and Technology

Department of Mathematics

A 'Half-day' Workshop on Applied Mathematics

2:00pm – 2:45pm
Prof. Xiao-Chuan CAI, University of Colorado Boulder
Recent Progress on Numerical Simulation of Blood Flows

2:45pm – 3:30pm
Prof. Feng-Nan HWANG, National Central University
A Nonlinear Preconditioning Technique for
Full-space Lagrange-Newton-Krylov Algorithms with
applications in Large-scale PDE-constrained Optimization Problems

3:30pm – 3:45pm
B R E A K

3:45pm – 4:30pm
Prof. Dennis W. HWANG, Academia Sinica
Molecular Imaging Developments for Biomedical Applications

Date: ***Wednesday, 22 November 2017***
Time: ***2:00p.m. – 4:30p.m.***
Venue: ***Room 2405 (near Lifts 17 & 18)***

All are welcome!

2:00pm – 2:45pm
Prof. Xiao-Chuan CAI, University of Colorado Boulder
Recent Progress on Numerical Simulation of Blood Flows
Abstract:
We discuss some recent progress on the numerical simulation of blood flows in human arteries. The artery geometry is obtained with a learning based approach from 3D MRI or CT images, and the fluid-artery calculation is carried out by a domain decomposition algorithm. The numerical model consists of an elasticity equation for the artery wall and an incompressible Navier-Stokes system for the blood flow. The system is discretized with a finite element method on unstructured moving meshes in 3D and solved by a Newton-Krylov algorithm preconditioned with an overlapping Schwarz method.

2:45pm – 3:30pm
Prof. Feng-Nan HWANG, National Central University
A Nonlinear Preconditioning Technique for
Full-space Lagrange-Newton-Krylov Algorithms with
applications in Large-scale PDE-constrained Optimization Problems
Abstract:
PDE-constrained optimization problems are a class of important and computationally challenging problems. The full-space Lagrange-Newton algorithm is one of the most popular numerical algorithms for solving the problems since Newton-type method enjoys fast convergence when the nonlinearities in the system are well balanced. However, in many practical problems such as flow control, if some of the equations are much more nonlinear than the others in the system, the convergence of the method becomes slow or at worse the convergence failure happens. The radius of convergence is often constrained by a small number of the variables of equations in the system with the strong nonlinearities. In the talk, we introduce and study a parallel nonlinear elimination preconditioned inexact Newton algorithm for the boundary control of thermally convective flows based on the field variable partition. In this approach, in the standard manner, once the objective function and the PDE constrained problem discretized by some numerical schemes, we

convert the constrained optimization problem into unconstrained optimization problem by introducing the augmented Lagrange function, then find the candidate optimal solution by solving the first order necessary condition using an inexact Newton method with backtracking techniques. The key point of the new algorithm is that before performing the global Newton update, we first identify the to-be-eliminated components that cause Newton method's a slow convergence, and then remove the high nonlinearity by using a subspace correction, which can be interpreted the application of nonlinear elimination based preconditioner to the nonlinear system. As a result, the new approach shows a significantly improved performance when compared to a standard Lagrange-Newton type method or its grid-sequencing version. Some numerical results are presented to demonstrate the robustness and efficiency of the proposed algorithm.

3:45pm – 4:30pm
Prof. Dennis W. HWANG, Academia Sinica
Molecular Imaging Developments for Biomedical Applications
Abstract:
MR molecular imaging is non-invasive and enables the visualization of the molecular process in living organisms. Contrast enhancement in MR molecular imaging by the understanding of both molecular and spin dynamics. This talk will present some new techniques developed in our group. These new methods were developed to specifically highlight the lesion in the tumor including the newly developed T1 and T2 dual-modality contrast agents, pH imaging, and the frequency lock-in suppression technique for “colored” images. These new methods will allow clinical MRI to be conducted with lower contrast agent dosages as well as making MRI a more powerful diagnostic tool.