Mini-Workshop on Scientific Computing

University of Macau
Macao, P. R. China
Date: 25 – 26th, July, 2012

"Mini-Workshop on Scientific Computing" will be held on 25-26th, July 2012 in University of Macau. It aims to provide a forum for experts to introduce their new topics and exciting new directions on scientific computing. There have been very rapid developments of Scientific Computing in Macao over the past decades. This mini workshop will further promote research interests in scientific computation in Macao.

Venue:
Room J213
Silver Jubilee Building
University of Macau
http://www.umac.mo/docs/UM_campus_map.pdf (**J** building in the map)

July 25, Wednesday, A shuttle to UM is arranged at 14:30pm in Grandview Hotel.

14:55-15:00	**Opening Speech**
	Session I (Chair: Qin Sheng)
15:00-15:40	Raymond H. Chan *Tight-Frame Approach for Image Processing*
15:40-16:20	Tie-yong Zeng *Multiplicative Noise Removal*
16:20-16:40	**Break**
	Session II (Chair: Raymond H. Chan)
16:30-17:10	Fiorella Sgallari *Texture Adaptive Image Restoration Using Fractional Order Regularization*
17:10-17:50	Serena Morigi *A p-Laplacian Cascadic Multilevel Method for Mesh Ssimplification*

July 26, Thursday, A shuttle to UM is arranged at 8:20am in Grandview Hotel.

	Session III (Chair: Fiorella Sgallari)
8:40-9:20	Qin Sheng *The ADI Method and Its Matrix Challenges*
9:20-10:00	Man-chung Yeung *ML(n) BiCGStabt: a ML(n) BiCGStab Algorithm with A-transpose*
10:00-10:20	**Break**
	Session IV (Chair: Hai-wei Sun)
10:20-11:00	Fu-rong Lin

	A Preconditioned Conjugate Gradient Method for Fractional Diffusion Equation
11:00-11:40	Zheng-jian Bai *A Regularized Directional Derivative-Based Newton Method for Inverse Eigenvalue Problems*

Abstract

A Regularized Directional Derivative-Based Newton Method for Inverse Eigenvalue Problems

Zheng-Jian Bai
School of Mathematics, Xiamen University

In this paper, based on the strong semi-smoothness of eigenvalues of symmetric matrices, we propose a regularized directional derivative-based Newton method for solving the inverse eigenvalue problem. Our method is also globalized by using the directional derivative-based Wolfe conditions. Under some mild assumptions, the global and quadratic convergence of our method is established. Numerical experiments show that our method is very effective for the inverse problem with distinct and multiple eigenvalues. This is a joint work with Wei Ma (XMU).

Tight-frame Approach for Image Processing

Raymond H. Chan
Department of Mathematics, The Chinese University of Hong Kong

In many practical problems in image processing, the observed data sets are often incomplete in the sense that features of interest in the image are missing partially or corrupted by noise. The recovery of missing data from incomplete data is an essential part of any image processing procedures whether the final image is utilized for visual interpretation or for automatic analysis. In this talk, we present our tight-frame algorithm for missing data recovery. Tight-frames are extension of wavelets. They generalize orthonormal wavelet systems and give more flexibility in filter designs. We begin our talk with an introduction of tight-frames. Then we illustrate how to apply the idea to different image processing applications such as inpainting, impulse noise removal, super-resolution image reconstruction and video enhancement.

A Preconditioned Conjugate Gradient Method for Fractional Diffusion Equation

Fu-Rong Lin
Department of Mathematics, Shantou University

In this talk, we are concerned with numerical solution methods for an initial-boundary value problem of an anomalous diffusion equation of order $\alpha \in (1, 2)$. The classical Crank-Nicholson method is used to discretize the fractional diffusion equation and the spatial extrapolation is used to improve the accurate of the numerical solution. Thus final numerical solution is second-order accurate temporally and spatially. A preconditioned conjugate gradient (PCG) method is proposed to relevant linear systems. Numerical experiments are given to illustrate the efficiency of the method. This is a joint work with Xiao-qing Jin.

A p-Laplacian Cascadic Multilevel Method for Mesh Simplification

Serena Morigi
Department of Mathematics, Faculty of Engineering, University of Bologna

Multiresolution meshes are a common basis for building representations of a large and complex object model at different levels of refinement. In a multiresolution modeling environment we need tools to coarsen a given fine mesh as well as tools for refining a coarse mesh. We present a new approach to multilevel surface mesh simplification based on the evolution of surfaces under p-Laplacian regularization. Such an evolution can be understood as a natural geometric filter process applied to an initial high resolution mesh which leads to a coarse limit surface, preserving structural details. This enables to reach different level of simplification. Simplification can be regarded as a cascadic iteration scheme, where one successively applies decimation and smoothing steps based on a weighted p-Laplace operator. Combining the developed approach with elastica surface deformation methods we will provide a complete multiresolution deformation framework for surface meshes.

Texture Adaptive Image Restoration Using Fractional Order Regularization

Fiorella Sgallari
Department of Mathematics-CIRAM, University of Bologna

We present an adaptive strategy for the restoration of images contaminated by blur and noise that allows to preserve textures. Total Variation regularization has good performance in noise removal and edge preservation but lacks in texture restoration. According to a texture detection strategy, we apply fractional-integer order diffusion. This can be related to a weighted norm regularization. A fast algorithm based on the half-quadratic technique is used. Numerical results show the effectiveness of our strategy. This is a joint work with R. Chan, A. Lanza, and S. Morigi.

The ADI Method and Its Matrix Challenges

Qin Sheng
Department of Mathematics , Baylor University

Finite difference methods have been extremely important to the numerical solution of partial differential equations. The ADI method is one of them with extraordinary features in structure simplicity, computational efficiency and great flexibility in computations.

The strategy of an ADI approach can be readily explained in a contemporary way of modern numerical analysis. For this, we can start with a semi-discretization of a given partial differential equation, probably together with a suitable linearization if certain nonlinearities are involved. This often leads to a system of differential equations flourished via matrices with distinguished properties inherited from multiphysics applications.

Based on this fascinating platform of systems of equations, this talk will try to explore following interconnected issues:

1. Concepts of modern ADI, along with the LOD and Exponential Splitting Methods;
2. Matrix challenges in splitting from exciting multiphysics applications.

ML(*n*)BiCGStabt: an ML(*n*)BiCGStab Algorithm with *A*-transpose

Man-chung Yeung
Department of Mathematics, University of Wyoming

ML(*n*)BiCGStab is a Krylov subspace method for the solution of large and non-symmetric linear systems $Ax = b$ where A is N-by-N and b is N-by-1. In theory, it is a method that lies between the well-known BiCGStab and GMRES/FOM. In fact, when n=1, it is BiCGStab and when n=N, it is GMRES/FOM. Therefore, ML(*n*)BiCGStab is a bridge that connects the Lanczos-based BiCGStab and the Arnoldi-based MRES/FOM. In computation, ML(*n*)BiCGStab can be much stabler and converge much faster than BiCGStab. We once tested ML(*n*)BiCGStab on the standard reservoir simulation test data called SPE9 and we found that ML(*n*)BiCGStab reduced the total computational time by more than 60% when compared to BiCGStab. Tests made on the data from Matrix Market also support the superiority of ML(*n*)BiCGStab over BiCGStab. Because of the $O(N^2)$ storage requirement in the full GMRES, one has to adopt a restart strategy to get the storage under control when GMRES is implemented. In comparison, ML(*n*)BiCGStab is a method with only $O(nN)$ storage requirement and therefore it does not need a restart strategy.

All ML(*n*)BiCGStab algorithms are derived from ML(*n*)BiCG, a BiCG-like algorithm, through the Sonneveld-van der Vorst-Lanczos Procedure. In this talk, we shall introduce the algorithms, especially the new ML(*n*)BiCGStabt algorithm. Properties and implementations are also addressed.

Multiplicative noise removal

Tie-yong Zeng
Department of Mathematics, Hong Kong Baptist University

Multiplicative noise removal is a challenging image processing problem, and most existing methods are based on the Maximum A Posteriori (MAP) formulation and the logarithmic transformation of multiplicative denoising problems into additive denoising problems. On the other hand, sparse representationsof images have shown to be efficient approaches for image recovery. Following this idea, we propose in this talk to learn a dictionary from the logarithmic transformed image, and then to use it in a variational model built for noise removal. Extensive experimental results suggest that in terms of visual quality, PSNR and mean absolute deviation error, the proposed algorithm outperforms state-of-the-art methods. The deblurring issue could also be addressed if time permitted.