I. Workshop on Imaging, Optimization and Computation

Place: KAIST (Industrial Engineering Building (E2-1) Room 3221)

Date: January 5, 2016 (13:00 – 18:00)

13:00 - 13:40 Roland Glowinski (Univ. of Houston and HKBU)

On the control of Diffusion on Spheres: A computational Investigation

Abstract: The main goal of this presentation is to discuss the numerical solution of controllability problems for diffusion phenomena modeled by heat equations where the diffusion operator is the Beltrami Laplacian. After formulating the control problems we will discuss their numerical solution via a methodology combining:
(i) A penalty method to force the closeness to a target function.
(ii) A time discretization by finite differences.
(iii) A finite element based space approximation relying on triangulations of the spheres.
(iv) A conjugate gradient algorithm operating in the control space.
The results of numerical experiments will be presented

13:50 - 14:30 Jong Chul Ye (KAIST)

Compressive Sampling using Annihilating Filter-based Low Rank Interpolation

Abstract: While the recent theory of compressed sensing or compressive sampling (CS) provides an opportunity to overcome the Nyquist limit in recovering sparse signals, a recovery algorithm usually takes the form of penalized least squares or constraint optimization framework that is different from classical signal sampling theory. In this talk, we provide a drastically different compressive sampling framework that can exploit all the benefits of the CS, but can be still implemented in a classical sampling framework using a digital correction filter. The main idea is originated from the fundamental duality between the sparsity in the primary space and the low-rankness of the Hankel structure matrix in the reciprocal spaces, which demonstrates that the low-rank interpolator as a digital correction filter can enjoy all the optimality of the standard CS. We show that the idea can be generalised to recover signals in large class of signals such as piece-wise polynomial, and spline representations. Moreover, by restricting signal class as cardinal splines, the proposed low-rank interpolation approach can achieve inherent regularization to improve the robustness. Experimental results for various image processing and biomedical imaging applications confirmed that the proposed scheme has significant better results than the conventional CS approaches.

14:50 - 15:30 Byung-Ho Kang (CUHK)

STEM tomography imaging of thick plastic embedded cell samples for automatic segmentation

Abstract: Because of the weak penetrating power of electrons, the signal to noise ratio of a transmission electron micrograph (TEM) worsens as section thickness increases. This problem is alleviated by the use of the scanning transmission electron microscopy (STEM). Tomography analyses using STEM of thick sections from yeast and mammalian cells are of higher quality than are bright-field (BF) images. In this study, we compared regular BF tomograms and STEM tomograms from 500-nm thick sections from plant cell samples and tested the tomograms for automatic segmentation. Due to their thickness and intense heavy metal staining, BF tomograms of the thick sections suffer from poor contrast and high noise levels. We were able to mitigate these drawbacks of Golgi stacks and chloroplasts specimens by using STEM tomography. For morphometric analysis and 3D visualization, membranous structures in electron tomograms have to be segmented. The automatic segmentation feature of the IMOD software package traced organelle membranes in STEM tomograms better than those in BF tomograms. A longer time is required to collect a STEM tilt series than similar BF TEM images, and dynamic autofocusing required for STEM imaging often fails at high tilt angles. Despite these limitations, STEM tomography is a powerful method for analyzing structures of large or dense organelles of plant cells.

15:40 - 16:20 Yunho Kim (UNIST)

Intensity Non-uniformity Correction Method in the Brain MR Images

Abstract: Intensity non-uniformity (Bias field) in MR imaging is a common artifact caused by various reasons such as RF coil inhomogeneity, gradient-driven eddy current, interactions within the body, etc.
In general, removing this artefact is not an easy task, however, in the brain MR images, assuming that the brain consists of three regions, GM (gray matter), WM (white matter, CSF (cerebrospinal fluid), we can model such a smooth variation over the entire brain region accurately. In this talk, we will present a mathematical framework, where existence of a unique smooth variation is guaranteed, and an algorithm to solve it

16:30 - 17:10 Hyenkyun Woo (KOREATECH)

Matrix Factorization with bound constraints for Image Analysis

Abstract: The problems that involve low rank constrained minimization of a given data matrix have attracted a great attention in recent years in data analysis including image analysis such as background modeling and face recognition. In this talk, we introduce a new formulation called linf-norm based nonnegative matrix factorization and its various properties, such as the relation between stability and sparsity of the proposed model. Numerical analysis shows positive performance of the proposed model compared to the state of the art model such as nuclear norm based rank minimization method.

17:20 - 18:00 Xiaoming Yuan (HKBU)

ADMM and Beyond: Some Recent Advances in Convergence Analysis and Algorithm Design

Abstract: The alternating direction method of multipliers (ADMM) has been widely used in a broad spectrum of areas; but some critical issues of ADMM still remain interesting. In this talk, I will present some recent developments on ADMM in both convergence rate analysis and algorithmic design, including how to derive faster worst-case convergence rate measured by the iteration complexity for ADMM; how to generalize ADMM to a symmetric version with provable convergence; how to derive worst-case convergence rate for the Douglas-Rachford splitting method, the Peaceman-Rachford splitting method and the proximal point algorithm in generic settings; how to guarantee the convergence of ADMM when its subproblems (which could be huge-scale or ill-conditioned systems of linear equations) are solved only inexactly by standard numerical linear algebra solvers; and how to extend it to some nonconvex models with strong application backgrounds.

18:00 – 20:00 Workshop Dinner at Faculty Club in KAIST