河南大学建校 105 周年系列活动----

图像处理理论及其应用高峰论坛

主办单位：河南大学数学与统计学院
协　　办：国家自然科学基金项目
　　国家重点基础研究发展计划(973 项目)
　　河南省数字图形图像学会
　　河南大学应用数学研究所
　　河南大学数据分析技术实验室
会议地址：数学与统计学院一楼报告厅

为了更好地提升河南大学数学与统计学院计算数学学科国内外影响力, 尤其是促进图像处理方向实现跨越式发展, 增进学术交流的广度和深度, 为此在河南大学建校 105 周年之际, 数学与统计学院将于 2017 年 11 月 17-19 日举办”图像处理理论及其应用高峰论坛”.

本次会议旨在为图像处理领域的专家提供一个良好的交流平台. 会议主题涵盖图像处理研究的各个领域以及相关的数学理论和数值方法. 其中, 会议主要侧重于图像复原和分割、重建、分析与模式识别等方面的理论与应用, 同时也涵盖数理反问题和大数据理论研究等内容.

● 报告专家(姓氏拼音排序):

白敏茹 (湖南大学)　　R. Chan (香港中文大学)

陈发来(中国科技大学)　　董　彬(北京大学)

何炳生(南京大学/南方科技大学)　　贾志刚(江苏师范大学)

金其余(内蒙古大学)　　孔德兴(浙江大学)

李　季(北京计算科学研究中心)　　李景治(南方科技大学)

罗守胜(河南大学)　　M. Ng(香港浸会大学)

文有为(湖南师范大学)　　武婷婷(南京邮电大学)

杨晓慧(河南大学)　　殷　钶(华中科技大学)

张　娟(浙江省肿瘤医院)　　Yalin Zheng(利物浦大学)

● 组织委员会

主席: 冯淑霞

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11 月 18 日　　数学与统计学院 1 楼报告厅		
8:00-:8:05	**照相:河南大学数学与统计学院门口**	
8:05-8:10	**开幕式: 冯淑霞院长**	
时间	**报告人**	**报告题目**
主持人: M.　Ng		
8:10-8:50	R.Chan	A Nuclear-norm Model for Multi-Frame Super-resolution Reconstruction (P6)
8:50-9:30	陈发来	Applications of Quasi-Conformal Mapping in Geometry, Graphics and Image Processing (P16)
9:30-10:10	孔德兴	医学人工智能及其临床应用 (P12)
10:10-10:20	**茶　歇**	
主持人:孔德兴		
10:20-10:45	董　彬	“Deep Revolution” in Image Restoration and Beyond (P7)
10:45-11:10	白敏茹	图像处理中的低秩优化校正方法研究（P5）
11:10-11:35	张　娟	乳腺磁共振弥散成像检查技术及应用 (P21)
11:35-12:00	金其余	Optimal weights for noise removal and Controlled total variation regularization for image deconvolution (P11)
12:00-14:00	**中州国际金明酒店自助餐/午休**	

11 月 18 日　　数学与统计学院 1 楼报告厅		
主持人: 董　彬		
14:00-14:40	何炳生	结构型凸优化的分裂收缩算法及其在图像学中的应用 (P8)
14:40-15:20	李景治	A time domain imaging method for inverse acoustic scattering problems (P13)
15:20-15:45	贾志刚	The Relaxed Two Dimensional Principal Component Analysis by Lp-Norm for Image Reconstruction and Recognition (P9)
15:45-15:55	**茶　歇**	
主持人:李景治		
15:55-16:20	殷　钶	New region force for variational models in image segmentation (P20)
16:20-16:45	李　季	An Algorithmic Overview of Phase Retrieval (P10)
16:45-17:10	武婷婷	Fast ADMM schemes for solving constrained TGV-shearlet based CS-MRI reconstruction (P18)
17:10-17:35	杨晓慧	Pseudo-Full-Space Representation Based Classification for Robust Face Recognition (P19)
17:35-18:00	罗守胜	XCT Image Reconstruction by a Modified Superiorized Iteration and Theoretical Analysis (P14)
18:00-20:00		**欢 迎 宴 会**

11 月 19 日　　数学与统计学院 1 楼报告厅		
时间	报告人	报告题目
主持人:白敏茹		
8:00--8:40	M. Ng	Variational Models for Image Processing (P15)
8:40--9:20	郑亚林	Translational imaging research in eye disease: past, present and future (P22)
9:20-10:00	文有为	Regularization Parameter Selection for Total Variation Based Image Restoration (P17)
10:15-12:00	参观河南大学校史馆	
12:00-14:00	中州国际金明酒店自助餐	
会议结束		

题　目: 图像处理中的低秩优化校正方法研究

报告人: 白敏茹 (湖南大学数学与计量经济学院)

摘　要: 针对带有脉冲噪音的模糊图像, 提出了 TVL1 校正模型, 构建了邻近 ADMM 方法求解该模型, 证明算法收敛到该模型的最优解. 数值实验显示, 通过多步校正的方法能够极大地提高稀疏性, 更加有效地去除脉冲噪音, 尤其是高噪音水平. 实验还显示, TVL1 校正方法应用于人脸识别可以提高人脸的识别率. 进一步, 基于 MCP 函数, 提出了一个非凸优化模型, 利用 DC 方法, 构建了一个近似逼近算法, 证明该算法收敛于非凸优化模型的稳定点, 揭示了多部校正的实质. 最后, 研究低秩张量的完整化问题, 建立了相应的校正模型, 给出误差界, 基于误差界提出自适应多步校正方法, 建立了具有收敛性的 3 块 ADMM 方法. 数值实验表明, 所提方法不仅对随机数据, 而且对于彩色视频图像的恢复, 都有很好的效果.

Title: A Nuclear-norm Model for Multi-Frame Super-resolution Reconstruction

Speaker: Raymond Chan(Department of Mathematics, Chinese University of Hong Kong)

Abstract: In this talk, we give a new variational approach to obtain super-resolution images from multiple low-resolution image frames extracted from video clips. First the displacement between the low-resolution frames and the reference frame are computed by an optical flow algorithm. The displacement matrix is then decomposed into product of two matrices corresponding to the integer and fractional displacement matrices respectively. The integer displacement matrices give rise to a non-convex low-rank prior which is then convexified to give the nuclear-norm regularization term. By adding a standard 2-norm data fidelity term to it, we obtain our proposed nuclear-norm model. Alternating direction method of multipliers can then be used to solve the model. Comparison of our method with other models on synthetic and real video clips shows that our resulting images are more accurate with less artifacts. It also provides much finer and discernable details.

Joint work with Rui Zhao (CUHK). This work is partially supported by HKRGC GRF Grant No. CUHK300614 and CUHK14306316

Title: "Deep Revolution" in Image Restoration and Beyond

Speaker: Bin Dong(Beijing International Center for Mathematical Research, Peking University)

Abstract: Deep learning continues to dominate machine learning. It is now widely used in many research areas in science and engineering, and has major industrial impacts. Deep learning methods have achieved remarkable results in a variety of tasks, especially in a supervised learning environment. They have surpassed, or as good as, human in Go, playing video games, accurately identifying objects in images and videos, diagnosing certain diseases from medical images, etc.

In this talk, I will start with a brief review of classical (pre deep learning) image restoration methods, followed by some recent applications of deep learning in image restoration and image analysis. I will present my personal understanding of deep learning in image restoration from the perspective of applied mathematics, which inspired two of our recent work on combining numerical differential equation and deep convolutional architecture design. One is to design transparent deep feed-forward convolutional networks to accurately predict dynamics of complex systems and to uncover the underlying hidden PDE models. The other one is to interpret some of the popular deep CNNs, such as ResNet, FractalNet, PolyNet, RevNet, etc., in terms of numerical differential equations; and to propose new deep architectures that can further improve the prediction accuracy of the existing networks in image classification.

题　目: 结构型凸优化的分裂收缩算法及其在图像学中的应用

报告人: 何炳生(南方科技大学数学系/南京大学数学系）

摘　要: 图像处理中的一些典型问题可以归结为（或松弛成）一个具有可分离结构的线性约束凸优化问题. 凸优化问题的最优性条件是一个单调变分不等式. 在变分不等式的框架下研究凸优化的求解方法, 就像微积分中用导数求函数的极值, 常常会带来很大的方便. 这个观点近年被越来越多的应用数学家, 特别是从事图像学研究的学者所接受. 报告以图像处理中优化问题的几类典型优化模型为例, 介绍相应的求解方法. 包括变分不等式意义下定制的邻近点算法 (PPA), 两个可分离算子问题的交替方向法(ADMM)和它们的线性化模式, 以及处理多个算子问题的 ADMM 类方法. 汇报我们近两年的主要研究进展, 也提及人们普遍关心而又尚未解决的问题.

Title: The Relaxed Two Dimensional Principal Component Analysis by Lp-Norm for Image Reconstruction and Recognition

Speaker: Zhigang Jia(Department of Mathematics and Statistics, Jiangsu Normal University)

Abstract: For image reconstruction and recognition, we present a relaxed two dimensional principal component analysis (R2DPCA) by Lp-norm. Difference from the 2DPCA, the R2DPCA applies the priori knowledge, including the label information, of the training data. Each training sample will be weighted by a priori factor before the covariance matrix is generated, while a relaxed criterion is defined. The feasibility and efficiency of the proposed model and methods are demonstrated by numerical experiments based on several practical data sets.

Title: An Algorithmic Overview of Phase Retrieval

Speaker: Li Ji(Beijing Computational Science Research Center, Beijing)

Abstract: Phase retrieval arises from the optics and engineering imaging sciences, such as X-ray coherence diffraction. It is to reconstruct the signal from its module of Fourier transform. Its difficulty results from the missing phase information. Besides its intrinsic importance in optical imaging, its connection to low rank matrix completion and provably nonconvex optimization makes its renew interests. A large body of researches focus on the numerical algorithms from different modelings. In this talk, an overview of the algorithms is given. The differences between the convex and nonconvex algorithms are highlighted and the recent developments are also presented.

Title: Optimal weights for noise removal and Controlled total variation regularization for image deconvolution

Speaker: Qiyu Jin (School of Mathematical Science, Inner Mongolia University)

Abstract: A new denoising algorithm to deal with the additive white Gaussian noise model is described. In the line of work of the Non-Local means approach, we propose an adaptive estimator based on the weighted average of observations taken in a neighborhood with weights depending on the similarity of local patches. The idea is to compute adaptive weights that best minimize an upper bound of the pointwise L2 risk. In the framework of adaptive estimation, we show that the ”oracle” weights are optimal if we consider triangular kernels instead of the commonly-used Gaussian kernel. Furthermore, we propose a way to automatically choose the spatially varying smoothing parameter for adaptive denoising. Under conventional minimal regularity conditions, the obtained estimator converges at the usual optimal rate. The implementation of the proposed algorithm is also straightforward and the simulations show that our algorithm improves significantly the classical NL-means and is competitive when compared to the more sophisticated NL-means filters both in terms of PSNR values and visual quality. To resolve the image deconvolution problem, the total variation (TV) minimization approach has been proved to be very efficient. However, we observe that this approach has an overminimizing TV effect in the sense that it gives a solution whose TV is usually smaller than that of the original image. This effect is due to the pre-pondering role of the TV in the corresponding minimization problem and prevents from finding the exact solution of the deconvolution problem when such a solution exists. We propose a modified version of the gradient descent algorithm, which leads to an exact solution of the deconvolution problem if it exists and to a satisfactory approximative solution if there is no exact one. The idea consists in introducing a control on the contribution of the TV in the classical gradient descent algorithm. The new algorithm has the advantage that the restored image has the TV closer to that of the original image, compared to the classical gradient descent approach.

题　目: 医学人工智能及其临床应用

报告人：孔德兴(浙江大学数学科学学院)

Title: A time domain imaging method for inverse acoustic scattering problems

Speaker: Jingzhi Li(Department of Mathematics, Southern University of Science and Technology)

Abstract: This talk concerns the inverse scattering problems of imaging unknown/inaccessible scatterers by transient acoustic near-field measurements. Based on the analysis of the migration method, we propose efficient and effective sampling schemes for imaging small and extended scatterers from knowledge of time-dependent scattered data due to incident impulsive point sources. Though the inverse scattering problems are known to be nonlinear and ill-posed, the proposed imaging algorithms are totally "direct" involving only integral calculations on the measurement surface. Theoretical justifications are presented and numerical experiments are conducted to demonstrate the effectiveness and robustness of our methods. In particular, the proposed static imaging functionals enhance the performance of the total focusing method (TFM) and the dynamic imaging functionals show analogous behavior to the time reversal inversion but without solving time-dependent wave equations.

Title: XCT Image Reconstruction by a Modified Superiorized Iteration and Theoretical Analysis

Speaker: Shousheng Luo(Department of Mathematics and Statistics, Henan University)

Abstract: In this paper, we propose an improved superiorization iteration for XCT image reconstruction. We simplify the classic superiorized iteration by removing two constraints on the perturbation. In addition, we propose a new method to compute the perturbation amount and direction for superiorization iteration.Some theoretical properties (convergence for instance) of the iteration sequence are analyzed . Experiments on simulated and real data show that the proposed approach can reconstruct desirable reconstructed images, and is superior to the classic superiorized iteration.

Title: Variational Models for Image Processing

Speaker: Michael Ng (Department of Mathematics, Hong Kong Baptist University)

Abstract: In this talk, we discuss some image processing applications (e.g., image restoration and denoising, image recovery, image correction image colorization), and present some variation models for such applications. The variational model extension to other image classification and retrieval will also be discussed.

Recently, tensor models are also studied for imaging science application.

Title: Applications of Quasi-Conformal Mapping in Geometry, Graphics and Image Processing

Speaker: Maodong Pan and **Falai Chen**(Department of Mathematics, University of Science and Technology of China, Hefei)

Abstract: Quasi-conformal mapping is a classic tool in complex analysis. In this talk, I will present some applications of quasi-conformal mapping in geometric design, computer graphics and image processing. Specifically, I will talk about planar domain parametrization for iso-geometric analysis, shape interpolation for computer animation and content-aware image resizing where quasi-conformal mapping provides a general framework.

Title: Regularization Parameter Selection for Total Variation Based Image Restoration

Speaker: Youwei Wen(College of Mathematics and Computer, Hunan Normal University)

Abstract: The problem of image restoration is ill-conditioned. A total variation based regularization method should be used in the image restoration process. It is a very important task to select a suitable regularization parameter. By adjusting regularization parameter, a compromise is achieved to suppress the noise and preserve the nature of the original image. The appropriate compromise highly depends on the choice of the regularization parameter. Usually, regularization parameter is determined manually by trial-and-error method, the generalized cross validation (GCV) method, the L-curve method, the discrepancy principle, etc. In this talk, we will show some results how to choose the regularization parameter for total variation based image restoration.

Title: Fast ADMM schemes for solving constrained TGV-shearlet based CS-MRI reconstruction

Speaker: Tingting Wu (College of Science, Nanjing University Of Posts and Telecommunications)

Abstract: This paper proposes a new constrained total generalized variation (TGV)-shearlet model to the compressive sensing magnetic resonance imaging (MRI) reconstruction via the simple parameter estimation. Due to the non-smoothing term included in the proposed model, we employ the alternating direction method of multipliers (ADMM) scheme to split the original problem into some easily solvable subproblems in order to use the convenient soft thresholding operator and the fast fourier transform (FFT). Experimental results demonstrate that the proposed method outperforms the state-of-the-art unconstrained reconstruction methods in removing artifacts and achieves lower reconstruction errors on the tested dataset.

Title: Pseudo-Full-Space Representation Based Classification for Robust Face Recognition

Speaker: **Xiaohui Yang**(College of Mathematics and Statistics , Henan University)

Abstract: Sparse representation based classification shows significant performance on face recognition (FR) when there are enough available training samples per subject. However, FR often suffers from insufficient training samples. To tackle this problem, a novel classification technique is presented based on utilizing existing available samples rather than constructing auxiliary training samples. An inverse projection-based pseudo-full-space representation (PFSR) is firstly proposed to stably and effectively exploit complementary information between samples. The representation ability of sparse representation-based methods is quantified by defining category concentration index. In order to match PFSR and complete classification, a simple classification criterion, category contribution rate, is designed. Extensive experimentations on the AR, Extended Yale B and CMU Multi-PIE databases demonstrate that PFSR-based classification method is competitive and robust for insufficient training samples FR problem.

This work is jointed work with Fang Liu, Li Tian, Haifei Li and Xiaoying Jiang

Title: New region force for variational models in image segmentation and high dimensional data clustering

Speaker: Ke Yin(Center for Mathematical Sciences, Huazhong University of Science and Technology)

Abstract: In this talk we propose an effective framework for multi-phase image segmentation and semi-supervised data clustering by introducing a novel region force term into the Potts model. Assume the probability that a pixel or a data point belongs to each class is known a priori. We show that the corresponding indicator function obeys the Bernoulli distribution and the new region force function can be computed as the negative log-likelihood function under the Bernoulli distribution. We solve the Potts model by the primal-dual hybrid gradient method and the augmented Lagrangian method, which are based on two different dual problems of the same primal problem. Empirical evaluations of the Potts model with the new region force function on benchmark problems show that it is competitive with existing variational methods in both image segmentation and semi-supervised data clustering.

题　目：乳腺磁共振弥散成像检查技术及应用

报告人：张 娟(浙江省肿瘤医院)

摘　要：扩散峰度成像（diffusion kurtosis inaging,DKT）是一种磁共振扩散成像的新兴技术，是反映生物组织非高斯分布的非正态水分子扩散运动的方法。它是基于扩散张量成像（diffusion tensor imaging,DKT）技术上的延伸，能够比 DTI 更加敏感的反映组织微结构的复杂程度。DKI 技术近年来在中枢神经系统的应用价值已经得到初步的研究。本次交流旨在介绍 DKI 技术及目前潜在的临床应用价值。

Title: Translational imaging research in eye disease: past, present and future

Speaker:Yalin Zheng(Department of Eye and Vision Science, University of Liverpool, UK)

Abstract: The most important organs of sense are our eyes. It is often said the eye is the window to the soul. Nearly 300 million people are estimated to be visually impaired worldwide of which 40 million are blind. The eye is the only inner organ that can be directed visualised or imaged as such a wide range of imaging modalities have been developed for the diagnosis and management of eye disease. There is also an increasing demand on automated image analysis for precision medicine. In this talk, I will first give an overview of eye anatomy, imaging technologies and major forms of eye disease, then present our recent progress in image analysis and computer-aided diagnosis of eye disease, introduce our recent innovative work in the development of imaging devices, and conclude with new challenges in mathematics and future directions