Akram Aldroubi Birthday Workshop

Saturday May 19

Wilson Hall 103

Schedule

Time	Speaker	Title
9:00-9:30	Peter Basser	Akram Aldroubi's role in the development of diffusion tensor MRI (DTI) 'streamline' tractography
9:35-10:05	Carlos Cabrelli	Akram's 1/2 question
10:10-10:40	Chris Heil	AA Tautalogy
Coffee Break – 10:40-11:05		
11:05-11:35	Ilya Krishtal	Sensing naturally
11:40-12:10	Ursula Molter	A^2 dynamics: Dynamical Sampling Akram's way
Lunch Break – 12:10-2:00		
2:00-2:30	Gustavo Rohde	Transport-based signal and image representation
2:35-3:05	Qiyu Sun	Nonsubsampled graph filter banks and distributed implementation
Coffee Break – 3:05-3:45		
3:50-4:20	Michel Unser	From analog to digital: On the unifying role of splines in Science and Engineering

Peter Basser (National Institutes of Health)

Title: Akram Aldroubi's role in the development of diffusion tensor MRI (DTI) 'streamline' tractography

Abstract: It is probably not well known, owing to Akram's extreme modesty, that he played a seminal role in the development of diffusion tensor MRI streamline tractography. In the early days of this technique, when I was proposing the possible use of streamlines obtained from the diffusion tensor field measured within an imaging volume, diffusion weighted image quality was poor and voxel resolution was coarse. It was apparent that following trajectories computed from a noisy and discrete estimates of a diffusion tensor field would produce many artifactual paths. After much discussion with Akram (actually over several years) he conceived of an elegant mathematical framework to continuously approximate discrete, noisy tensor field data for 2nd order tensors we measure in DTI, but which could also be generalized to higher-order tensors. Not only was his approach elegant, but it was efficient, too, and could be implemented using large image volumes. Routines that Akram developed with colleague Philippe Thevenaz and implemented by Sinisa Pajevic in IDL, enabled the first demonstration of diffusion tensor tractography. This entailed by following the direction of maximum diffusivity (i.e., the eigenvector associated with the largest eigenvalue or principal diffusivity) throughout the imaging volume. While the initial demonstration of streamline tractography took place in the summer of 1998, these continuous tensor field approximation routines are still in use today! The rest is history.

Carlos Cabrelli (University of Buenos Aires)

Title: Akram's 1/2 question

Abstract: In this talk we will review recent work originated some years ago from a question of Akram, about shift-invariant spaces that have some special kind of invariance.

Chris Heil (Georgia Institute of Technology)

Title: AA Tautalogy

Abstract: Three decades ago, the National Institutes of Health (NIH) assigned one of their crack researchers, known as A^2, to investigate the emerging theory of wavelets. This talk considers what this has to do with current events.

Ilya Krishtal (Northern Illinois University)

Title: Sensing naturally

Abstract: I will reflect on our joint work with Akram over the last decade and a half. The primary focus will be our recent work on dynamical sampling.

Ursula Molter (University of Buenos Aires)

Title: A^2 dynamics: Dynamical Sampling Akram's way

Abstract: In this talk we will present some new (and not so new) work in Dynamical Sampling, an area initiated by Akram some years ago inspired by some work of Vetterli and co-workers - when Akram was still very young: closer to fifty than to forty!

Gustavo Rohde (University of Virginia)

Title: Transport-based signal and image representation

Abstract: Professor Aldroubi's early work on mathematical modeling for signal and image processing included sampling, interpolation, and representation using filter banks, B-splines and wavelets, as well as image registration. This talk will detail how his thoughtful and mathematical approach to research has inspired mathematical signal and image representation methods based on the idea of "matching" two images. Transportation theory can help define a unique way of morphing two images, also yielding a metric space. This realization has opened the door for the definition of new signal and image transforms with well defined forward and inverse operations. We'll also review certain mathematical properties of the new transformation framework and show how the approach can be useful for modeling information in image databases, decoding invariances, and classifying data.

Qiyu Sun (University of Central Florida)

Title: Nonsubsampled graph filter banks and distributed implementation

Abstract: In this talk, I will discuss nonsubsampled graph filter banks (NSGFBs) to process data on a graph. Given an analysis filter bank with small bandwidth, we propose algebraic and optimization methods of constructing synthesis filter banks such that the corresponding NSGFBs provide a perfect signal reconstruction in the noiseless setting. For an NSGFB on a graph of large size, I will propose an iterative distributed algorithm to implement the proposed NSGFBs. Based on NSGFBs, we also develop a distributed denoising technique which is demonstrated to have satisfactory performance on noise suppression.

Michel Unser (EPFL)

Title: From analog to digital: On the unifying role of splines in Science and Engineering

Abstract: We like to view splines as a comprehensive and elegant framework that enables the representation of continuous-domain functions in a discrete form adapted to a computer; i.e., the mathematical version of analog-to-discrete conversion.

Splines are used extensively in computer aided design and are already playing a prominent role in the move of our society towards digitalization (Industry/Engineering 4.0). We shall argue that this is only a beginning and that their influence is spreading to other areas of science and engineering. Our main

point is that the framework is not only applicable to functions and signals, but also to whole domains of applications and theories. In particular, we shall discuss the unifying role of splines in

- sampling theory
- signal/image processing
- linear system theory
- stochastic processes
- machine learning.

The topics will be illustrated with concrete examples.