Preface

The 41 articles collected in this volume are selected from 170 submissions to the conference Wavelet Analysis and Applications 2005 (WAA2005) held during the 29th November to the 2nd December, 2005, at University of Macau. The articles selected are the outgrowth and further development of the talks presented at the conference by international participants from 22 different countries and areas, including Australia, Belgium, Brazil, China, Ethiopia, France, Germany, India, Iran, Hong Kong, Japan, Korea, Macao, Malaysia, Mexico, Portugal, Russia, Taiwan, Thailand, Tunisia, UK, United States, and in both the applied and pure mathematics fields. Most of them are up-to-date new research. We include a number of comprehensive surveys, also containing new results, in several particular areas of research. All the papers are strictly refereed. This volume reflects some of the latest development in the area of wavelet analysis and its applications. It contains two major components: Part I - Wavelet Theory, and Part II - Wavelet Applications. We note that for the reader's convenience the book contains a colored-printed RAM disc although the book itself is in black and white.

There are four chapters in Part I on wavelet theory. In Chapter one, we include seven articles on approximation theory and Fourier analysis. In a paper by S. K. Bloshanskaya and I. L. Bloshanskii some local smoothness conditions are obtained in order to guarantee convergence almost everywhere on some sets of positive measure of the double Walsh-Fourier series summed over rectangles. We also include a paper by the latter in which the problem on convergence of Fourier series of composed function $f \circ m$, where m is a linear transformation, is studied in terms of smoothness of the function f and properties of the transformation m. N. A. Sheikh in his article generalizes the Sidon inequality for the trigonometric system to wavelets and obtains convergence of wavelet series in the L^1 norm. The article of G-B. Ren and H. R. Malonek formulates and proves an extension of the Almansi decomposition for the iterated Dunkl-Helmholtz equation. Included in this chapter the article by M. G. Cowling and M. Sandari, and another by E. S. M. Hitzer and B. Mawardi, study Uncertainty Principles in different contexts. The former proves the Hardy's Uncertainty Principle for operators, and the latter proves an Uncertainty Principle for some Clifford geometric algebras based on Clifford Fourier Transformation.

Chapter two contains ten articles on frame theory and construction of wavelets. In the paper by H-X. Cao and B-M. Yu, wavelet theory for general Hilbert spaces is formulated. In the paper of C-Y. Li and H-X. Cao close relationship between

operator frames for bounded linear operators on a Hilbert space and the usual frames for the Hilbert space is studied. D. R. Larson in his paper presents, as an application of operator algebra, a profound operator-interpolation approach to wavelet theory in separable Hilbert spaces by using the local commutant of a unitary system. In other articles G. Wang and Z-X. Cheng study the stability of multi-wavelet frames; J-W. Yang, Y-Y. Tang, Z-X. Cheng and X-G. You construct bi-orthogonal wavelets from two-dimensional interpolatory functions; X-X. Feng, Z-X. Cheng and Z-P. Yang obtain a complete parametrization for the M-channel FIR orthogonal filter bank with linear phase while the number of the required parameters is reduced to $(N = 2)(\frac{\frac{M}{2}}{2})$; Y. Li, Z-D. Deng and Y-C. Liang study multivariate orthonormal wavelets with trigonometric vanishing moments and propose a practical construction algorithm; Z. Yao, N. Rajpoot and R. Wilson study multiscale directional cosine transform and multiscale Fourier transform in order to effectively describe oriented features and linear discountinuities in image processing; P. Cerejeiras, M. Ferreira and U. Kähler present a group-theoretical approach for the continuous wavelet transform on the sphere S^{n-1} based on the Lorentz group $\mathrm{Spin}(1, n)$ that provides different representations for the Hilbert space $L^2(S^{n-1})$ and the Hardy space $H^2(S^{n-1})$; finally, F. Brackx, N.D. Schepper and F. Sommen present their study on Clifford-Jacobi polynomials and the associated continuous wavelet transform in Euclidean spaces within the Clifford analysis framework.

Chapter three deals with fractal and multi-fractal theory, wavelet algorithms and wavelets in numerical analysis. In their comprehensive article S. Jaffard, B. Lashermes and P. Abry compare several multifractal formalisms based on wavelet coefficients from mathematical and numerical points of view, and show that the formalism has to be based on wavelet leaders in order to yield the entire and correct spectrum of Hölder singularities. K. Markwardt in his paper studies discrete embedding of system operators in identification models on the base of Fast Wavelet Transform. J. Bai and X-C. Feng in their paper propose a digital curvelet reconstruction algorithm to detect singularities in anisotropic images. H. Diao and Y. Wei study structured condition numbers for Toeplitz under-determined systems with full row rank, compared in the probability sense with unstructured condition numbers. J. Maes and A. Bultheel present their study on Powell-Sabin spline prewavelets on the hexagonal lattice, providing an explicit construction of compactly supported, two-dimensional, piecewise quadratic finite element space of $L^2(\mathbb{R}^2)$.

Chapter four is on time-frequency Analysis and adaptive representation of nonlinear and non-stationary signals. In his paper N. E. Huang introduces his empirical mode decomposition algorithm (EMD) and Hilbert spectral analysis (HHT), and briefly reviews the recent developments. He appeals for a mathematical foundation of the invented method. The article of Q-H. Chen, L-Q. Li and T. Qian shows that the non-linear Fourier atoms $e^{i\theta_a(t)}, |a| < 1$, which are the boundary values of the normalized Möbius transforms parameterized by the zeros of the transforms, form a Riesz basis, and possess a number of good properties including Shannon sampling. In his paper T. Qian reviews recent developments aiming to

establish mathematical foundation of EDM and HHT, and presents his new results on starlike mapping and constructing mono-components of the form $\rho(t)e^{i\theta_a(t)}$ for non-trivial $\rho(t) \geq 0$ without using Bedrosian's theorem.

In Part II on wavelet applications, in the paper by X-L. Tian, X-K. Li, Y-K. Sun and Z-S. Tang a new algorithm based on wavelet transform to transfer colors from images of Chinese Virtual Human Dada (CVHD) to Magnetic Resonance Images (MRI) is proposed and implemented. In their second paper a novel algorithm for the multimodalities medical images fusion based on wavelet transform is proposed and implemented. The paper by Y-Y. Qu, C-H. Li, N-N. Zheng, Z-J. Yuan and C-Y. Ye describes how wavelet transform may be used to detect salient building from a single nature image. In the paper of Y. Wu, X. Wang and G-S. Liao a despeckling method is proposed based on stationary wavelet transform (SWT) for synthetic aperture radar (SAR) images. In a paper by C-S. Tong and K-T. Leung, to reconstruct a high resolution image from a set of shifted and blurred low resolution images, a direct method based on Haar wavelet transform is proposed. In the paper of F-X. Yan, L-Z. Cheng and H-X. Wang, a design scheme for biorthogonal dual tree complex wavelet transform filter is proposed, and its implementation to iris image enhancement is presented. The other subjects include that the paper of S-K. Choy and C-S. Tong studies supervised learning using characteristic generalized Gaussian density and its applications to Chinese materia medica identification; T-Z. Tan and J-W. Huang propose an algorithm of singular points detection for fingerprint images by the Poincaré index method; G-J. Shi and S-L. Peng present a new receiver scheme for doubly-selective channels to combat the annoying Doppler diversity; by using the support vector machine method (SVM) C-F. Wong, J-K. Zhu, M-I. Vai, P-U. Mak and W-K. Ye present a face retrieval scheme based on lifting wavelets features; S-W. Pei, H-Y. Feng and M-H. Du propose a method based on a wavelet lifting scheme to increase the order of vanishing moments for high-resolution image reconstruction; B. Pradhan, K. Sandeep, S. Mansor, A.R. Ramli and A.R.B.M. Sharif in their paper study multiresolution spatial data compression using the lifting scheme; Y-Y. Ren, S. Wang, S-Y. Yang and L-C. Jiao put forward a method making use of ridgelet transform in remote sensing image recognition; Z-C. Cai, H. Ma, W. Sun and D-X. Qi present their analysis on frequency spectrum for geometric modelling of digital geometry; and, in the paper of M-H. Yang, Z-Y. Xiao and S-L. Peng they demonstrate a Hidden Markov Tree (HMT) model with localized parameters and a fast parameter estimation algorithm. Two papers on implementation of EMD and HHT are included of which one is by Z-H. Yang, L-H. Yang and D-X. Qi on detection of spindles in sleep EEGs; and the other by M. J. Brenner, S. L. Kukreja and R. J. Prazenica on the utility of the Hilbert-Huang algorithm for the analysis of aeroelastic flight data.

Since the corner-stone lecture of Yves Meyer presented in ICM1990, Kyoto, in some extent wavelet analysis in the last 15 years may be said to have been an applied and theoretical-applied area. Yet, we gladly noted that among the attendances of the conference a significant percentage were prominent mathematicians

working mainly in pure mathematical areas. This indicates that the concept of wavelets is one that stretches continuously across various disciplines of mathematics.

The idea of organizing the conference at University of Macau was first initialized by Daniel Chi Wai Tse, Chairman of University Council, and Rui Paulo da Silva Martins, Vice Rector of the university, that was endowed through Vai Pan Iu, Rector of the university, whose support made possible the success of the conference. The editors wish to sincerely thank the mentioned university leaders for their kind and generous support. This volume is specially designed to be dedicated to Rui Paulo da Silva Martins, for his unflagging support to mathematics in the university, including the conference. We are grateful to all the university staff members and those in the scientific and organization committees who made this conference possible. Finally, we sincerely thank the referees for their extremely valuable assistance in creating this volume. The publication of this volume is partially supported by Macao Science and Technology development Fund (FDCT) 051/2005/A.