EURASIP Journal on Applied Signal Processing 2002:1, 1–3


# Editorial

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This is part II of a two-part JASP Special Issue focusing on Nonlinear Signal Processing. In the introduction to part I of the Special Issue, we looked back at the growth of nonlinear methods and the reflection of that growth on the evolution of the IEEE-EURASIP Nonlinear Signal and Image Processing (NSIP) workshop, expanded papers from which constitute the Special Issues. Before giving an overview of the contents of part II of the Special Issue, we would like to look forward towards the future and NSIP-03.

The field of nonlinear signal processing is rapidly evolving and there is no doubt that exciting new discoveries will be made and demanding applications addressed by the year 2003. Many of these results will be reported at the 2003 IEEE-EURASIP NSIP workshop, which will be held in Grado-Trieste, Italy, in June of that year. So not only does the technical content promise to be inspiring, but the location should be truly spectacular. Full information on the workshop can be found at ipl.univ.trieste.it/nsip03/. We look forward to stimulating discussions and an open exchange of ideas that are the hallmarks of this unique workshop.

In terms of current results, this Special Issue features 13 papers loosely grouped into the areas of (1) method design and analysis, (2) communications methods and applications, (3) time-frequency methods and applications, and (4) imaging applications and implementations. Full appreciation of the results in each of these areas can only be realized by a thorough reading of the papers, but we give here a brief overview of each paper attempting to capture the main results and outcomes.

The first of four papers on method design and analysis is by Juan Gonzalez and Gonzalo Arce. In their paper, the authors develop myriad filters as a class of tunable estimators of location. This filter class is derived from the theory of robust statistics and is shown to be optimal for the heavy tailed $\alpha$-stable and generalized-$t$ distributions. Optimization procedures are developed and the utility of myriad filters is demonstrated through the presentation of several filtering examples and the development of a robust myriad-based Phase Lock Loop. In the following paper, Jun Han, James Zeidler, and Walter Ku investigate the nonlinear effects of the Least Mean Squared (LMS) adaptive predictor. Their analysis goes beyond the traditional assumption of statistical independence among successive observation vectors and shows that the nonlinear effects make it possible for adaptive transversal prediction filters to significantly outperform finite length Wiener predictors. Analysis is carried out for predictors with stationary and chirped input signals and is extended to the class of Recursive Least Square (RLS) adaptive predictors.

The contribution by Ragnar Wallin and Alf Isaksson considers the important problem of system identification in the presence of missing data, with a focus on periodically missing data. This phenomenon is similar to sampling of signals and

may lead to aliasing. Thus, in the context of system identification, several models may be optimal given the observed data and yet some may predict incorrect spectral behavior. The authors concentrate on AR and ARX models and show that the parameter estimation problem can be seen as a sampling of the correlation and cross-correlation functions of the input and output signals. As a consequence, they show that randomly missing data does not present a problem in model identification. In the final paper on method design and analysis, Yufei Huang and Petar Djuric consider the problem of variable selection. A promising approach to this problem is the Markov Chain Monte-Carlo (MCMC) method, one drawback of which is the difficulty in guaranteeing convergence of the Markov chain to its stationary distribution. Perfect sampling, which produces samples from the desired distribution, has been proposed as one method to address the convergence of MCMC methods. The authors investigate this approach for the problem of variable selection.

The next two papers consider problems in communications. In the first of these papers, Stephane Senecal and Pierre-Olivier Amblard propose the use of Markov chain simulation methods and Monte-Carlo estimation techniques for the equalization of satellite communication channels influenced by nonlinear effects. The aim of the approach described is to blindly restore the emitted messages taking into account the nonlinear distortions caused mainly by the amplifier stage in the satellite. In the next paper, Michael McGuire, Konstantinos Plataniotis, and Anastasios Venetsanopoulos address the important problem of estimating the position of mobile terminals in cellular networks. Nonlinear behaviors affecting wireless systems and propagation paths are considered and low cost methods of locating mobile terminals in urban environments are proposed.

The next set of papers considers time-frequency methods and applications. In the first of four papers on this subject, Lorenzo Galleani and Leon Cohen consider the time-frequency properties of dynamic systems characterized by linear ordinary differential equations. In their approach, the authors bypass solving the differential equations and instead write the exact Wigner distribution corresponding to the solution. The resulting time-frequency differential equation has a high degree of localization and can thus be effectively approximated. Numerical examples are presented showing good correspondence between derived approximations and exact solutions. In the next paper, Ana Ruedin develops a method to construct orthogonal nonseparable wavelets for image compression. The constructed wavelets are designed to have good low pass properties, which enables superior decomposition based compression. Experimental results show that the developed low pass nonseparable wavelets yield superior image compression compared to other nonseparable wavelets.

The next paper, authored by Douglas Nelson, addresses the estimation of the fundamental frequency of harmonics signals using cross-spectral methods and higher order features. The application of such methods to the estimation of the fundamental of speech in time and frequency is described. In the final time-frequency paper, Lorenzo Galleani, Leon Cohen, Douglas Nelson, and Jeffrey Scargle present a method for estimating time-frequency spectra of densities given in event-based form. Their approach consists of three stages: density estimation using a kernel method, high pass filtering, and the estimation of the time-frequency spectrum via a sliding Welch estimator. Synthetic event-based data is used to demonstrate the utility of the developed method.

The final three papers address imaging applications and implementations. In the first of these papers, Dan Yu, Farook Sattar, and Kai-Kuang Ma investigate watermark detection and extraction using Independent Component Analysis (ICA). The authors show that watermarks embedded in the spatial domain of an image can be successfully extracted with a nonlinear robust batch ICA algorithm. Moreover, this nonlinear extraction is robust to common image processing attacks, such as some geometric transformations, quantization, additive noise, low pass filtering, and multiple marks. Next, Oscar Bustos, María Lucini, and Alejandro Frey investigate the robust estimation of SAR model parameters. Multilook amplitude SAR images can be characterized utilizing a multiplicative model governed by unknown roughness and scale parameters. The authors derived robust M-estimators for these parameters. The advantages of robust parameter estimation over traditional maximum likelihood estimation are illustrated with SAR image examples contaminated by commonly occurring corner reflections. Finally, Kazimierz Wiatr discusses specialized processors for real-time median and morphological image processing. Specifically, programmable FPGA systems with pipeline architecture are developed for the median and morphological filter cases. Experimental results measuring delay time compare the developed fast implementations with general purpose and DSP processors.

The wide array of theories, methods, and problems addressed in the papers of parts I and II demonstrates the wide applicability of nonlinear methods. We hope that you find these papers instructive and enjoy reading them as much as we have enjoyed putting the Special Issues together—see you in Trieste Italy at NSIP-03!

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