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Editorial

Development of Computed Tomography Algorithms

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Over the past several years, computed tomography (CT) methods have advanced significantly, yielding novel analytic and iterative solutions applicable to medical CT and micro-CT. The resulting algorithms promise to improve spatial, contrast, or temporal resolution as well as to suppress artifacts and reduce radiation dose. Significant attention has been devoted to optimizing computational performance and to balancing conflicting requirements. Both theoretically oriented and application-specific issues are also being addressed. As a snapshot of the dynamically changing field of CT, this special issue includes 10 high-quality original papers.

Because spiral cone-beam CT can be used for rapid volumetric imaging with high longitudinal resolution, the development of exact and efficient algorithms for image reconstruction from spiral cone-beam projection data has been a subject of active research in recent years. Katsevich's filtered backprojection (FBP) formula represents a significant breakthrough in this field [1]. In this special issue, Yang et al. propose a parallel implementation of Katsevich's FBP formula [2] by the one-beam cover method, in which the backprojection procedure is independently driven by cone-beam projections. Based on Katsevich's work, generalized backprojection filtration (BPF) and FBP algorithms are developed to reconstruct images from data collected along more flexible scanning trajectories [3]. Using these recently developed algorithms, Yu et al. propose a local region reconstruction scheme [4]. The principal idea is to deliver a normal radiation dose to a local region of interest (ROI) that may contain a lesion while applying a very low radiation dose to the structures outside the ROI. Both the FBP and BPF algorithms can produce excellent results with a minimal increment to the dose needed for purely local CT.

Despite important advancements in the development of exact cone-beam reconstruction, approximate algorithms remain practically and theoretically valuable. Feldkamp et al. heuristically adapted the fan-beam FBP algorithm for approximate cone-beam reconstruction in the case of a circular scanning locus [5]. This formulation, called the FDK algorithm, is more desirable in many cases than exact cone-beam reconstruction approaches in terms of several aspects of image quality and computational implementation. Since then, many efforts have been made to extend the FDK algorithm to other scanning configurations, leading to a series of FDK-like algorithms. In this special issue, Yan et al. propose an approximate FDK-like reconstruction algorithm for tilted-gantry CT imaging [6]. The method improves the image reconstruction by filtering the projection data along a direction that is determined by CT parameters and the tilted-gantry angle. Based on the idea that there is less redundancy for the projection data away from the central scanning plane, Yang and Ning develop a heuristic cone-beam geometric dependent weighting scheme [7], which leads to a new FDK-like half-scan algorithm. For correcting cone-beam artifacts in off-centered geometry, Valton et al. compare and evaluate four different reconstruction methods [8], which are the Alpha-FDK algorithm, a shift-invariant FBP method derived from the T-FDK, an FBP method based on the Grangeat formula, and an iterative algebraic method. Tang et al. extend the 3D weighted helical CB-FBP algorithm to handle helical pitches that are lower than 1 : 1 [9]. For helical over-scan, the extended 3D weighted helical CB-FBP algorithm can significantly improve noise characteristics or dose efficiency compared to the original algorithm, while other advantages of the original algorithm, such as reconstruction accuracy and computational efficiency, can be maintained.

In addition to the exact and approximate CBCT algorithms, iterative algorithms are important technologies in medical X-ray CT. It is well known that a major weakness of the noniterative algorithms, either exact or approximate, is that projection data are implicitly assumed to be noise-free. However, noise is an inherent aspect of projection data, especially for low-dose scans. Iterative algorithms are well suited to deal with image artifacts caused by photon noise or other physical effects. Qi compares maximum a posteriori (MAP) reconstructions with Gaussian and non-Gaussian priors [10]. After evaluating three representative priors: the Gaussian prior, the Huber prior, and the Geman-McClure prior, Qi concludes that the Gaussian prior is as effective as the more complex non-Gaussian priors for lesion detection and quantification tasks. Rather than performing full-blown iterative reconstruction involving projecting and reprojecting the image, La Riviere et al. explore iterative approaches to sinogram restoration followed by analytic reconstruction. Here they compare the use of quadratic- and median-based roughness penalties [11], and they find that the two approaches produce similar resolution-variance tradeoffs to each other, which suggests that the particular choice of penalty may be less important than the decision to use a penalty at all. Israel-Jost et al. propose build frequency-adapted (FA) algorithms based on a condition of incomplete backprojection [12], leading to an FA-simultaneous algebraic reconstruction technique (FA-SART) algorithm. The results obtained with the FA-SART algorithm on a highly detailed phantom demonstrate a very fast convergence compared to the original SART algorithm.

The recent advances in X-ray technology provide high-contrast and spatiotemporal resolution, which offer new potential for evaluation of cardiac kinetics with 4D dynamic sequences. In this special issue, Garreau et al. propose a new method for cardiac motion extraction in multislice CT based on a 4D hierarchical surface-volume matching process [13]. Their aim is to detect the left heart cavities along the acquired sequence and estimate their 3D surface velocity fields. A Markov random field model is defined to find, according to topological descriptors, the best correspondences between a 3D mesh describing the left endocardium at one time-point and the 3D acquired volume at the following time-point. The global optimization of the correspondences is realized with a multiresolution process.

In closing this introduction to the special issue, we would like to express our appreciation to all the authors and reviewers for the tremendous efforts that have made the timely completion of our assignment successful and pleasant. Hope this special issue would attract a major attention of the peers and inspire more creative research ideas in the CT field.

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EURASIP Journal on Advances in Signal Processing

Special Issue on Robust Processing of Nonstationary Signals

Call for Papers

Techniques for processing signals corrupted by non-Gaussian noise are referred to as the robust techniques. They are established and used in science in the past 40 years. The principles of robust statistics have found fruitful applications in numerous signal processing disciplines especially in digital image processing and signal processing for communications. Median, myriad, meridian, L filters (with their modifications), and signal-adaptive realizations form a powerful toolbox for diverse applications. All of these filters have lowpass characteristic. This characteristic limits their application in analysis of diverse nonstationary signals where impulse, heavy-tailed, or other forms of the non-Gaussian noise can appear: FM, radar and speech signal processing, and so forth. Recent research activities and studies have shown that combination of nonstationary signals and non-Gaussian noise can be observed in some novel emerging applications such as internet traffic monitoring and digital video coding.

Several techniques have been recently proposed for handling the signal filtering, parametric/nonparametric estimation, feature extraction of nonstationary and signals with high-frequency content corrupted by non-Gaussian noise. One approach is based on filtering in the time-domain. Here, the standard median/myriad forms are modified in such a manner to allow negative- and complex-valued weights. This group of techniques is able to produce all filtering characteristics: highpass, stopband, and bandpass. As an alternative, the robust filtering techniques are proposed in spectral (frequency- Fourier, DCT, wavelet, or in the time-frequency) domain. The idea is to determine robust transforms having the ability to eliminate or surpass influence of non-Gaussian noise. Then filtering, parameter estimation, and/or feature extraction is performed using the standard means. Other alternatives are based on the standard approaches (optimization, iterative, ML strategies) modified for nonstationary signals or signals with high-frequency content.

Since these techniques are increasingly popular, the goal of this special issue is to review and compare them, propose new techniques, study novel application fields, and consider their implementations.

Topics of interest include, but are not limited to:

- Robust statistical signal processing (estimation, detection, decisions)
- Robust tracking, classification and control
- Performance analysis, comparison, benchmark setting, and achievable bounds
- Robust parametric/non-parametric estimation, filtering, and feature extraction of nonstationary signals
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EURASIP Journal on Advances in Signal Processing

Special Issue on Video Analysis for Human Behavior Understanding

Call for Papers

Video cameras are becoming increasingly ubiquitous and pervasive in our daily life. Along with the fast growing number of exchanged and archived videos, there is an urgent need for advanced video analysis techniques that can systematically interpret and understand the semantics of video contents, within the application domains of security surveillance, intelligent transportation, health/home care, video indexing/retrieving, video summarization/highlighting, and so on. Understanding human behaviors based on video analysis calls for even greater challenges due to very large variations of human bodies and their motion activities under all kinds of contexts such as different viewing perspectives, dressing colors, changing human poses, human-human occlusions, and body parts self-occlusions. To overcome these challenges, not only the traditional image processing, computer vision, pattern recognition, and machine learning techniques are required, but also advanced estimation theory and statistical inference, articulated 2D/3D human body modeling and synthesis, sophisticated database or rules for events/behaviors, and so on are critically desired.

The primary focus of this special issue will be on the advanced video analysis techniques for understanding human behaviors, starting from human object detection, segmentation and tracking, 2D/3D spatial and temporal features extraction, 2D/3D human body modeling and synthesis, event discovery and behavior learning, system performance evaluation, and potential applications of these techniques. The special issue is intended to become an international forum for researches to summarize the most recent developments and ideas in the field. The topics to be covered include, but are not limited to:

- Modern wireless communication system techniques such as multiantenna and multiaccess, spectrum sensing and cognitive radio, wireless ad hoc and sensor networks, cooperative signal processing, and information theory
- Human object detection and segmentation
- Tracking of human objects
- Tracking under multiple cameras
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EURASIP Journal on Advances in Signal Processing

Special Issue on
Advances in Random Matrix Theory for Signal Processing Applications

Call for Papers

In recent years, the mathematical field of random matrix theory (RMT) has emerged as an extremely powerful tool for a variety of signal processing applications. Recent advances, both in the areas of exact (finite-dimensional) and asymptotic (large-dimensional) RMTs, have received strong interest from amongst the signal processing community and have been instrumental for a number of recent breakthroughs. For example, advances in RMT techniques have paved the way for the design of powerful multiantenna and multiuser signal processing modules which are currently revolutionizing the field of wireless communications; they have led to fundamental insights into the information-theoretic limits (achievable by any signal processing strategy) in multidimensional wireless channels; they have pushed forward the development of advanced synthetic aperture radar (SAR) imaging techniques; they have provided the key ingredient for designing powerful new detection and estimation techniques in array signal processing.

This Special Issue aims to bring together state-of-the-art research contributions that address open problems in signal processing using RMT methods. While papers that are primarily of mathematical interest will be considered, the main focus is on applications of these techniques to real-world signal processing problems. Potential topics include (but are not limited to) the following areas:

- Modern wireless communication systems techniques, such as multiantenna and multiaccess, spectrum sensing and cognitive radio, wireless ad hoc and sensor networks, cooperative signal processing, information theory
- Detection and estimation, array processing
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