Special Section on Mathematical Modeling, Statistical Estimation, and Inverse Problems

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Bayesian estimation methods have been used with success in a great number of applications. One major domain is the inverse problems of image reconstruction and restoration.

The particularity of an inverse problem in this domain is that, in general, these problems are ill posed and a satisfactory solution cannot be obtained without incorporating convenient prior information on the solution of the problem. The Bayesian estimation framework is a coherent and efficient way to translate this prior information in a probabilistic way and to combine it with the information contained in the data.

In 1998 and 1999, we organized two SPIE conferences focused on Bayesian estimation in inverse problems. We had great success and a great number of papers presented were devoted to different aspects of Bayesian techniques in different applications of image restoration and particularly in tomographic image reconstruction.

One of the major difficulties in Bayesian estimation in these applications is the algorithm and its computation cost. The four papers in this special section present solutions or compare different algorithms specifically for the tomographic image reconstruction domain. The first two papers, by Thibault, Sauer, and Bouman and Hsu, respectively, concern emission computed tomography. The third paper, by Lee, is a more general comparative work. The last paper, by Fox, Nicholls, and Palm, concerns a more specific imaging system which includes inverse scattering and boundary value problems such as electric impedance tomography.

Ali Mohammad-Djafari received his BSc in electrical engineering from Polytechnique of Teheran in 1975, his MSc from Ecole Supérieure d'Electricité (Supélec), Gif sur Yvette, France, in 1977, and his PhD degree and Doctorat d'Etat in physics from the Université Paris-Sud (UPS), Orsay, France, in 1981 and 1987, respectively. He was an associate professor at UPS from 1981 to 1983. Since 1984, he has been at CNRS and works at the Laboratoire des Signaux et Systèmes (L2S) at Supélec. Presently, he is Directeur de Recherche in Centre National de la Recherche Scientifique (CNRS) and is the head of the Department of Signal Processing at this laboratory. His main scientific interests are in developing new probabilistic methods based on information theory, maximum entropy and the Bayesian inference approaches for inverse problems in general, and more specifically signal and image reconstruction and restoration. The main application domain of his interests is computed tomography (x ray, PET, SPECT, MRI, microwave, ultrasound, and eddy current imaging) either for medical imaging or for nondestructive testing in industry. His website is at http://www.supelec.fr/lss/personnels/adjafari/index.htm.