Sapienza PhD in ICT

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Seminar Announcement

May 28th, 2015 - DIET Dept. Room 206, 1:15 p.m.

Signal Processing: The Bayesian Approach

Speaker: Dr. James V. Candy

Abstract: Bayesian signal processing is a novel area migrated from statistical sampling theory enabling the solution of problems in which the posterior distribution is multimodal (many peaks) as compared to the usual single mode solutions (Gaussian distributions). Prior to the development of high speed/high throughput computers, Bayesian sampling techniques were considered much too computationally intense to warrant application for many complex, nonlinear, multimodal problems. The usual approach of numerical integration taxed the computational power of even the so-called supercomputers. Alternatives applying Monte Carlo methods certainly reduced much of the computational burden, but still were unwieldy until high speed/high throughput computer evolved enabling a reasonable solution. Finally, the introduction of sequential Bayesian processors rediscovered in the early 1990's has had a huge impact in signal processing enabling the solution of highly complex problems. Such techniques as iterative Monte Carlo sampling theory with the well-known Metropolis-Hasting and Gibbs sampler and its derivative began to evolve in the signal processing literature along with the sequential Bayesian approaches enabling an alternative to the iterative methods and offering a potentially timely solution. In this lecture, we concentrate on *sequential* Bayesian model-based processors and discuss a variety of the basic structures that are available in the literature. These processors are termed particle filters which are essentially a discrete representation of the posterior probability distribution. More properly, a *particle filter* is essentially a sequential Monte Carlo technique capable of solving nonlinear, multimodal problems by estimating the posterior probability distribution enabling the extraction of a wide variety of signal estimators (conditional mean, maximum a-posteriori, etc.) from noisy measurement data. We show how these powerful processors can incorporate the underlying physics, measurement instrumentation and noise into a model-based signal processing scheme to extract the desired information from the data. Thus, we develop the particle filter within the "model-based" framework to provide the Bayesian model-based solution applicable to a large variety of applications.

Bio: James V. Candy is the Chief Scientist for Engineering, a Distinguished Member of the Technical Staff and founder/former Director of the Center for Advanced Signal & Image Sciences (CASIS) at the Lawrence Livermore National Laboratory. Dr. Candy received a commission in the USAF in 1967 and was a Systems Engineer/Test Director from 1967 to 1971 (Captain/Vietnam Era Veteran). He has been a Researcher at the Lawrence Livermore National Laboratory since 1976 holding various positions including that of Project Engineer for Signal Processing and Thrust/Focus Area Leader for Signal and Control Engineering. Educationally, he received his B.S.E.E. degree from the University of Cincinnati and his M.S.E. and Ph.D. degrees in Electrical Engineering from the University of Florida. He is a registered professional Control System Engineer in the state of California. He has been an Adjunct Professor at San Francisco State University, University of Santa Clara, and UC Berkeley, Extension teaching graduate courses in signal and image processing. He is an Adjunct Full-Professor at the University of California, Santa Barbara. Dr. Candy is a Fellow of the IEEE “for contributions to model-based ocean acoustic signal processing” and a Fellow of the Acoustical Society of America (ASA) “for contributions to model-based acoustic signal processing.” He was elected as a Life Member (Fellow) at the University of Cambridge (Clare Hall College). He is a member of Eta Kappa Nu and Phi Kappa Phi honorary societies. He was elected as a Distinguished Alumnus by the University of Cincinnati “for meritorious achievement, recognized stature and conspicuous success in the imaginative blending of engineering education with highly productive endeavors in industry, professional activities, and public service.” Dr. Candy received the IEEE Distinguished Technical Achievement Award for the “development of model-based signal processing in ocean acoustics.” Dr. Candy is an IEEE Distinguished Lecturer for oceanic signal processing. He was nominated for the prestigious Edward Teller Fellowship at Lawrence Livermore National Laboratory. Dr. Candy has been awarded the Interdisciplinary Helmholtz-Rayleigh Silver Medal in Signal Processing/Underwater Acoustics by the Acoustical Society of America “for contributions to the advancement of science, engineering, or human welfare through research accomplishments.” He has most recently received the R&D100 award for his innovative invention in radiation threat detection. He has published over 225 journal articles, book chapters, and technical reports as well as written four texts in signal processing, "Signal Processing: the Model-Based Approach," (McGraw-Hill, 1986) and "Signal Processing: the Modern Approach," (McGraw-Hill, 1988), “Model-Based Signal Processing,” (Wiley/IEEE Press, 2006) and “Bayesian Signal Processing: Classical, Modern and Particle Filtering” (Wiley/IEEE Press, 2009). He was the General Chairman of the inaugural 2006 IEEE Nonlinear Statistical Signal Processing Workshop held at the Corpus Christi College, University of Cambridge. He has presented a variety of short courses and tutorials sponsored by the IEEE and ASA in Applied Signal Processing, Spectral Estimation, Advanced Digital Signal Processing, Applied Model-Based Signal Processing, Applied Acoustical Signal Processing, Model-Based Ocean Acoustic Signal Processing and most recently Bayesian Signal Processing for IEEE Oceanic Engineering Society/ASA. He has also presented short courses in Applied Model-Based Signal Processing for the SPIE Optical Society. He is currently the IEEE Chair of the Technical Committee on "Sonar Signal and Image Processing" and was the Chair of the ASA Technical Committee on "Signal Processing in Acoustics" as well as being an Associate Editor for Signal Processing of ASA (on-line JASAEL). He has recently been nominated for the Vice Presidency of the ASA and was elected to the Administrative Committee of IEEE OES. His research interests include Bayesian learning, estimation, identification, spatial estimation, signal and image processing, array signal processing, nonlinear signal processing, tomography, sonar/radar processing and biomedical applications.