

Session 2pSPe

Signal Processing in Acoustics, Acoustical Oceanography, and ECUA: Bayesian Signal Processing I
(Poster Session)

Zoi-Heleni Michalopoulou, Cochair

Department of Mathematical Sciences, New Jersey Institute of Technology

Simon Godsill, Cochair

Dept. of Engineering, University of Cambridge, Trumpington St., CB2 1PZ Cambridge, UK

All posters will be on display from 3:40 p.m. to 5:20 p.m. To allow contributors an opportunity to see other posters, contributors of odd-numbered papers will be at their posters from 3:40 p.m. to 4:30 p.m. and contributors of even-numbered papers will be at their posters from 4:30 p.m. to 5:20 p.m.

Contributed Papers

2pSPe1. Continuous estimation of VTL from vowels using a linearly VTL-covariant speech feature. Christian Feldbauer (Centre for the Neural Basis of Hearing, Department of Physiology, Development and Neuroscience, University of Cambridge, Downing Site, CB23EG Cambridge, UK, feldbauer@tugraz.at), Jessica J. Monaghan (Centre for the Neural Basis of Hearing, Department of Physiology, Development and Neuroscience, University of Cambridge, Downing Site, CB23EG Cambridge, UK, jjmm2@cam.ac.uk), Roy D. Patterson (Centre for the Neural Basis of Hearing, Department of Physiology, Development and Neuroscience, University of Cambridge, Downing Site, CB23EG Cambridge, UK, rdp1@cam.ac.uk)

Vowel sounds encode information about the speaker's vocal tract length (VTL) as well as vowel type. This paper shows how VTL can be estimated on a frame-by-frame basis from vowels to facilitate speaker tracking and make automatic speech recognition (ASR) more robust in multi-speaker environments. The algorithm is based on a new, VTL-covariant speech feature that encodes the size information linearly. The paper shows that this new speech feature is better suited for VTL estimation than the more traditional cepstral coefficients. The VTL estimation is based on a Gaussian mixture model that was trained on the speech material of speakers with known body height but unknown VTL. Research supported by the Austrian Science Fund (FWF) [J2541-N15], EOARD [FA8655-05-1-3043], and the UK-MRC [G0500221].

2pSPe2. A sequential Bayesian approach to vertical slice tomography of a shallow water environment. Olivier Carrière (Université libre de Bruxelles (U.L.B.) - Environmental hydroacoustics lab, av. Franklin D. Roosevelt 50, CP 194/5, 1050 Bruxelles, Belgium, ocarrier@ulb.ac.be), Jean-Pierre Hermand (Université libre de Bruxelles (U.L.B.) - Environmental hydroacoustics lab, av. Franklin D. Roosevelt 50, CP 194/5, 1050 Bruxelles, Belgium, jhermand@ulb.ac.be)

A major challenge of acoustic tomography in shallow water environments is to track physical features that are highly variable in time and space and to properly account for sound interaction with the subbottom. In a previous work an extended Kalman filter (EKF) scheme was proposed to track the sound-speed field variations in a vertical slice of the water column for known bottom geoacoustic parameters. Although the results were encouraging, it was shown that some biases were encountered when using the standard EKF, principally because of the high nonlinearity between the observations (the multi-frequency pressure field) and the environmental parameters (here the sound-speed field). In this paper, we show that Ensemble Kalman or sequential Monte Carlo filtering significantly enhance the estimation of the sound-speed field, for both range-independent and range-dependent cases. Reproducible results show that the temporal variations are

well tracked, even in presence of measurement noise and model uncertainty. Furthermore the sampling approach allows to increase the time interval between successive measurements, which is an advantage from an operational viewpoint. The performances of the different nonlinear filters are also discussed.

2pSPe3. Source localization and tracking in a waveguide via sequential bayesian estimation. Kevin Cockrell (MIT, 77 Mass Ave, 5-204, Cambridge, MA 02139, USA, cockrell@mit.edu), Henrik Schmidt (MIT, 77 Mass Ave, 5-204, Cambridge, MA 02139, USA, henrik@mit.edu)

This talk addresses the problem of sequentially estimating the location of a moving acoustic source in a waveguide, given a series of acoustic field measurements from an array. The approach taken, in its most general form, is known as sequential Bayesian estimation. A well known special case of sequential Bayesian estimation is the Kalman filter. However, the Kalman filter is only optimal when the relationship between the measured parameters and the ones to be estimated is linear with Gaussian noise. Given the highly non-linear relationship between the acoustic source location and the measured acoustic field, other approaches must be taken. The performance and computational feasibility of various approaches, such as grid-based methods, will be explored using simulated data.

2pSPe4. The role of reproducing densities in a joint likelihood approach to multi-sensor detection and estimation. Michael Roan (Virginia Tech, 917 Village Way North, Blacksburg, VA 24060, USA, mroan@vt.edu), Elizabeth Hoppe (Virginia Polytechnic Institute and State University, 141 Durham Hall, Blacksburg, VA 24060, USA, ehoppe@vt.edu)

In this work, a Bayesian, joint estimation-detection approach is used for computation of sufficient statistics and development of a general multi-sensor information fusion architecture. An approach borrowed from sequential Bayesian processing is used to compute prior densities for joint Bayesian estimation-detection. In this approach, a posteriori densities calculated at one sensor become priors at the next sensor after a coordinate transformation that transforms the outputs of each sensor to a common reference frame for all sensors. Reproducing prior densities are used to simplify the Bayesian iteration scheme and reduce communications requirements. The framework that is developed is equally applicable to networks where all sensors communicate with a centralized detection and estimation processor as well as those networks where sensors relay information from point to point.