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Acoustic signal characterization using hidden Markov models with applications in acoustical oceanography.

Costas SMARAGDAKIS[(1)], Michael TAROUDAKIS[(2)]

[(1)]IACM/FORTH & University of Crete, Greece, kesmarag@iacm.forth.gr
[(2)]IACM/FORTH & University of Crete, Greece, taroud@uoc.gr

Abstract

The work presents a new probabilistic characterization scheme for acoustic signals with applications in Acoustical Oceanography. This scheme assign the stationary wavelet packet coefficients of the signal, to a representative left-to-right Hidden Markov Model (HMM). In particular, the coefficients of the signal are modeled via a set of Gaussian emission distributions and a matrix of transiting probabilities. The training of the HMM is performed using the Expectation-Maximization algorithm. Similarities measurements between signals then are calculated in terms of the Kullback-Leibler divergence (KLD) by comparing their corresponding HMMs. The applications in Acoustical Oceanography consist of both simulated and experimental data, in all test cases, a single acoustic signal due to a known acoustic source, recorded at a single hydrophone is considered for the retrieval of environmental parameters (ocean acoustic tomography or sea-bed classification applications). The inversion process follows an optimization approach on the basis of KLD, through a Genetic Algorithm. Finally, the results are compared with those obtained using the Statistical Signal Characterization Scheme (SSCS) proposed by Taroudakis et al. [JASA, Vol 119, 1396-1405 (2006)]. Moreover, the results corresponding to the real experiment are compared to reference values from the literature.

Keywords: Probabilistic Signal Characterization Scheme, Similarity Measurements, Inverse Problems