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detector formulation is compared to that of the original detector formulation, which is a special case based on explicit modeling of the reverberation second-order statistics that is exact for the case of Gaussian reverberation. Tradeoffs involving the prior knowledge, modeling assumptions and computational requirements are discussed. [Work supported by ONR, Ocean Acoustics.]

10:00

4aUW9. Equal-likelihood probability modeling in active and passive sonar. Richard Pitre (Naval Res. Lab., Washington, DC 20375-5350)

The equal-likelihood rationale [R. Pitre and N. R. Davis, J. Acoust. Soc. Am. (to be published)] for the selection of probability models has been extended and strengthened. The method is shown to be optimally robust, testable, and correctable. Nonlinear parameter estimation and filtering equations are developed based on this formalism and its application to modeling active sonar in a random waveguide is formulated. [Work sponsored by ONR.]

10:15–10:30 Break

10:30

4aUW10. Reconstruction of a periodic time-domain signal "buried" in Gaussian noise. Stefan T. Sidahmed and Antal A. Sarkady (Dept. of Elec. Eng., U.S. Naval Acad., Annapolis, MD 21402)

Power spectral analysis does a reasonably good job of signal detection but fares poorly in characterization because the phase information is ignored in the spectral computations. From spectral analysis, an initial or seed value for the period of the target signal is obtained. The original digitally sampled noisy time signal is resampled (up/down sample rate conversion) at such a rate that precisely an integer number of time samples are obtained on each cycle of the quasiperiodic target signal. These noisy cycles are synchronously averaged in the time domain and an estimate for the shape of the target signal is computed. The sample rate conversion, and the synchronous averaging is repeated until the rms value of the result is maximized (i.e., phase cancellation is minimized). The voltage signal-noise ratio of the reconstructed target signal is proportional to the square root of the number of target cycles averaged. This procedure was tested with laboratory type signals and found to have an excellent performance at signal-to-noise voltage ratios as low as −40 dB.

10:45

4aUW11. Asymptotic behavior of the matched-phase noise filter in the limit of low signal-to-noise ratio. B. Edward McDonald and Gregory J. Orris (Naval Res. Lab., Washington, DC 20375-5000)

It has been shown elsewhere that information about the shape of the noise spectrum with no phase knowledge can be used to construct a noise rejection algorithm which we call the matched-phase filter. Here, it is demonstrated that to first order in the signal-to-noise ratio (SNR), the matched-phase filter is capable of improving an arbitrarily low SNR ($\ll 1$) to order unity when the spectrum of the noise is known exactly. This analysis accounts for properties of numerical results with computer-generated signal and noise, with SNR values below −100 dB. Since computers have dynamic ranges far in excess of audio equipment, these results in an actual experiment would be limited by the dynamic ranges of the equipment used. Also shown are examples illustrating the performance of the algorithm when the noise spectrum is known only approximately.

11:00

4aUW12. A multiresolution, likelihood-based approach to pattern classification with application to characterization and automated recognition of marine mammal sounds. Thomas J. Hayward (Naval Res. Lab., Washington, DC 20375-5350)

A multiresolution, likelihood-based statistical approach is presented for characterizing labeled classes of samples (e.g., measured time series or time-frequency distributions of acoustic transients) and for classifying new samples based on this statistical characterization. The labeled classes are characterized by a histogram associated with a multiresolution decomposition of the data in each class. Classification of a new sample is then performed by calculating, for each labeled class, the conditional probability of the sample given the statistics of that class. These conditional probabilities, which are interpreted as relative likelihoods that the sample belongs to each of the classes, are calculated in a recursive computation that proceeds from coarse to fine resolution. A simple, efficient computer implementation using associative arrays is presented. Successful classification of both time series and time-frequency distributions of marine-mammal vocalizations is demonstrated using relatively small numbers of labeled samples (~10 per class). [Work supported by ONR.]

11:15

4aUW13. Remote identification of moving acoustic objects. Roger F. Dwyer (Naval Undersea Warfare Ctr., New London, CT 06320)

Often in applications it is desired to remotely identify an object from its acoustic signature. In active sonar the object is insonified by a transmitted waveform and the received pressure is processed to localize and identify the object. Here, the received pressure time series from spherical acoustic objects in motion that have been insonified by linear frequency modulated (LFM) waveforms are used to identify the objects. The unknown object's unknown constant velocity using a unique property of the fourth-order cumulant spectrum [J. Acoust. Soc. Am. **93**, 1460–1465 (1993)] is extracted and then its transfer function is extracted. The results for five spherical acoustic objects in motion are discussed. Three methods, deconvolution, matched filtering, and fourth-order cumulant spectrum deconvolution to extract the object's transfer function are compared.

11:30

4aUW14. Towed array geometry estimation during ship's maneuvering. S. M. Jesus, P. Felisberto (UCEH-Univ. of Algarve, PT-8000 Faro, Portugal), and F. Coelho (Hidrographic Inst.-PT-1000 Lisbon, Portugal)

Towed arrays of hydrophones are commonly used as receiving apparatus for determining the directionality of the underwater acoustic field. It is well known that a line array beam response has an inherent left–right ambiguity and that any deformation of the array will produce a distortion on the estimated acoustic field directionality. In particular, the array cannot be operated during ship's maneuvering which is a potential drawback to its operational usage. In theory, if the array is not straight but the hydrophone's position are known at each time instant, the beamformer could be compensated in order to obtain a corrected beam response. More, depending on the array shape, the left–right ambiguity could also be resolved. In practice, it is extremely difficult to obtain sufficiently accurate measurements of the hydrophone positions. This paper presents the measurements obtained at sea, with a 156 m aperture array, instrumented with several high precision tiltmeters, compasses, depth sensors, and accelerometers. After filtering and preliminary analysis of the sensor position data it is concluded that the array is never a straight horizontal line. The array has approximately a catenary shape with vertical deviations at the tail up to 15 m at constant tow speed. Under maneuvering, the array is largely deformated and a consistent shape could be estimated on real time from the nonposition sensors. The use of the estimated geometry for acoustic data processing, shows that consistent beam responses (close to theoretical) could be obtained even under strong array distortion. It is also shown, with real data, that the knowledge of array geometry significantly improves full-field matching for source localization and/or bottom characterization.

11:45

4aUW15. A fundamental study of multipath localization using bottomed receivers in shallow water. Randall W. Smith, Jaime F. Nualart, and David E. Grant (Appl. Res. Lab., Univ. of Texas at Austin, P.O. Box 8029, Austin, TX 78713-8029)

The basic characteristics of multipath propagation from a shallow source to a bottomed receiver in shallow water are investigated, with an

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