ACOUSTICS2008/3192
Robust Adaptive Vector Sensor Processing

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A sizable literature exists on the theory of processing signals for many vector sensor array applications. In practice, however, mismatch and several noise processes can pose significant problems. If adaptive beamforming is also used, the "snapshot" issue potentially increases by a factor of four since each element in a vector sensor array consists of a scalar hydrophone and up to three spatially orthogonal particle motion sensors. Both of these sensor types have very different response and noise characteristics. Particle motion sensors are more sensitive to non-acoustic, motion-induced noise than hydrophones. In towed line array configuration, those sensors orthogonal to the direction of motion are exposed to higher intensities of flow noise at low frequencies than those coincident to the array axis. Similarly, different dipole sensors may be exposed to varying degrees of rotational mismatch. Sensors may also rest on the seafloor, creating asymmetries. Physical constraints also relate pressure and particle velocity measurements via conservation of momentum and mass equations. We examine adaptive processing methods customized to the unique characteristics of vector sensors. Array gain and other performance metrics in the presence of system mismatch and uncertainties is presented using common ocean noise models, including directional jamming, isotropic and surface noise.