ADAPTIVE ARRAY SIGNAL PROCESSING USING THE CONCENTRIC RING ARRAY AND THE SPHERICAL ARRAY

Luis M. Vicente

Dr. K. C. Ho, Dissertation Supervisor

ABSTRACT

This thesis introduces new methods for partial adaptive beamforming using concentric ring and spherical arrays for acoustic signals on a partially known interference environment. We propose novel methods to choose intra-ring weights that take advantage of the prior knowledge about the characteristics of some of the interferences without reducing the beamformer's degrees of freedom. The appropriate amount of prior knowledge included in the design is in the form of a penalty factor value. The inter-ring weights are adaptively obtained to cancel the unknown interferences. Then, we propose the optimization of the penalty factor that is automatically obtained to minimize the amount of residual error in the beamformer output. We propose the novel idea of combining element space along with beamspace beamforming techniques, where the prior knowledge is added in form of beamspace beams pointing towards the interferences with known characteristics. The sub-arrays that use element space beamforming reduce the interferences with unknown characteristics. The beamformer is found to be robust against interference uncertainties and presents a consistent behavior. We then extend the element space partial adaptive beamformer to the spherical array. We suggest two novel sensor arrangements for narrowband partial adaptive beamforming. The proposed design achieves huge computational savings, faster convergence and similar performance than that of the fully adaptive beamformer. We present the design of a broadband beamformer using array nesting. Finally, we introduce two robust algorithms against sensor misplacement. The proposed algorithms use a better distortionless constraint that accounts for the sensor position errors, contrary to the classical constraint, which does not include the errors.