DEVELOPMENTS IN METHODS FOR VERY HIGH RESOLUTION ELIMINATION OF INTERFERENCE AT ARRAYS WITH APPLICATIONS FOR RADIO ASTRONOMY

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Abstract Recently, a new approach for eliminating interference at arrays was presented [1,] which employs purely algebraic methods by projecting the interference, represented as vectors, into the null space of the projection operator. The interference is annihilated by transformation into the zero vector, and we denote this method as algebraic interference cancellation (AIC). The scheme was shown to be fundamentally different from conventional methods that reject interference by means of beam forming operations, but no quantitative comparison of the two techniques was made. Here a detailed quantitative comparison of AIC with beamforming/nulling (BFN) methods is presented on the basis of 1) Distortion experienced by the signals of interest in the course of rejecting interference and 2) Degradation in signal-to-noise ratio that accompanies rejection of interference, particularly for interference entering through the main beam. BFN systems operate by employing beam patterns that are deliberately distorted by placement of nulls ,for those angles corresponding to the interference directions. As is well known, attempts to apply ABF to interference entering through the main beam, within an array beam width of a signal of interest, encounter severe problems associated with degradation in signal-to-noise ratio (SNR) as well as distortion of the signals of interest, which in any case is unavoidable because of the deliberate distortion of the array beam pattern. Since beam forming plays no part in AIC operations, resolution in the elimination of interference is therefore not limited by the resolution of the array. There is no fundamental limit on the minimum — but non zero — separation between interfering sources that can be rejected and a signal of interest that can be recovered intact, in its original state, undisturbed and undistorted either by the interference or by the process of rejecting it; the practical limit is determined by receiver noise. Projection of interference vectors into the null space of the projection operator can be viewed as, at each sampling instant, forming linear combinations of the interference components over the array that sum to zero. This eliminates the interference selectively at each array element. Hence, for an M-element array after elimination of interference we have, rather than a single unavoidably distorted signal output as yielded by BFN, M interference free signal outputs, from which the transformation imposed by the null-space transformation can be removed, yielding an undistorted signal output. For an M-element array up to M -1 interference vectors can be eliminated in this manner. The results demonstrate superior performance of AIC over BFN systems both with regard to signal distortion as well as SNR degradation for interference entering through the main beam. It is shown that, depending on the number of interferers, and their proximity to, beam center, SNR degradation in in AIC can be less than that experienced in BFN by several orders of magnitude. . 1. Minkoff, J A new very high resolution interference rejection meyhod with potential for radio astronomy applications, Radio Science, Vol. 38, No. 3 1042 doi:10.1029/2002RS002841,2003, May 2003

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