FAST EIGEN-BASED SIGNAL COMBINING ALGORITHMS FOR LARGE ANTENNA ARRAYS

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A large antenna array can be used to enhance signals with very low signal-to-noise ratio and, in the future, large-aperture antennas such as the Deep Space Network 70-meter antenna can be replaced by an array of small-size antennas. The number of required antennas in an array grows as its aperture size and the received signal power decrease. For deep-space applications, such number can be huge and thus the signal combining process for a large array can be time consuming and expensive. In this article, we consider two combining algorithms that can handle very small received signal-to-noise ratios (-31dB) as well as multiple strong point-source interferences that are close to the desired source. Previously developed data pre-processing techniques that partially reconstruct the carrier are used in conjunction with our combining algorithm when strong interferences from the planets during a planetary encounter are present. Our approach is based on the Eigen method and is a blind combining technique, which does not require a priori knowledge of spacecraft's position, array's spatial information, training sequence, or reference signals. Our algorithms are implemented using the *Power* method, an iterative technique known for solving the dominant Eigenvalue problems. Our approach bypasses the requirement of forming the covariance matrix, which indeed yields significant advantages both in terms of storage and signal correlators. Detailed mathematical framework for the general two-dimensional arrays and the numerical algorithms are presented. Numerical simulations for large antenna arrays, focusing on problems commonly encountered in deep-space communications such very weak received signal-to-noise ratios and strong interferences, are investigated. The performance analyses indicate that our algorithms can yield the maximal combined signal-to-noise ratios while suppress the interferences, which make them suitable for deep-space applications. Other investigations including the required received symbol lengths and computational savings are also presented. The work in this article was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.