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Entitled

DEVELOPING AN ENHANCED ADAPTIVE ANTENNA BEAMFORMING ALGORITHM FOR TELECOMMUNICATION APPLICATIONS

by

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Abstract

As a key enabler for advanced wireless communication technologies, smart antennas have become an intense field of study. Smart antennas use adaptive beamforming algorithms which allow the antenna system to search for specific signals even in a background of noise and interference. Beamforming is a signal processing technique used to shape the antenna array pattern according to prescribed criteria.

In this thesis, a comparative study is presented for various adaptive antenna beamforming algorithms. Least Mean Square (LMS), Normalized Least Mean Square (NLMS), Recursive Least Square (RLS) and Sample Matrix Inversion (SMI) algorithms are studied and analyzed. The study also considers some possible adaptive filters combinations and variations, such as: LMS with SMI weights initialization, and combined NLMS filters with a variable mixing parameter. Furthermore, a new adaptive Variable Step-Size Normalized Least Mean Square (VSS-NLMS) algorithm is proposed. Sparse adaptive algorithms, are also studied and analyzed, and two channel estimations sparse algorithms are applied to an adaptive beamformer, namely: Proportionate Normalized Least-Mean-Square (PNLMS), and $\boldsymbol{l_p}$ norm PNLMS (LP-PNLMS) Algorithms. Moreover, we apply the variable step size to both of these algorithms for improved performance. These algorithms are simulated for antenna arrays with different geometries and sizes, and results are discussed in terms of their Convergence speed, Max SLL, Null depths, Steady state error and Sensitivity to noise.

Our simulation results confirm the superiority of the proposed VSS-NLMS algorithms over the standard NLMS without the need of using combined filters. Results also show an improved performance for the sparse algorithms after applying the proposed variable step size.

Keywords: Adaptive beamforming, antenna array, adaptive filters algorithms, sparse signal processing.