PERFORMANCE OF SPACE-TIME CODING WITH IMPERFECT CHANNEL ESTIMATION

by

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Certificate

This is to certify that the thesis entitled "**Performance of Space-Time Coding with Imperfect Channel Estimation**" being submitted by Parul Garg to the Department of Electrical Engineering, Indian Institute of Technology, Delhi, for the award of the degree of Doctor of Philosophy is the record of the bona-fide research work carried out by her under our supervision. In our opinion, the thesis has reached the standards fulfilling the requirements of the regulations relating to the degree.

The results contained in this thesis have not been submitted either in part or in full to any other university or institute for the award of any degree or diploma.

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To my grandparents

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Abstract

The focus of this thesis research is to analyze the error performance of space-time codes with imperfect channel estimation. A least-squares estimate (LSE) and the minimum mean-square estimate (MMSE) of the channel matrix is obtained from a sequence of pilot code vectors in a flat Rayleigh fading environment. The error performance is evaluated using two common performance measures, namely pairwise error probability (PEP) and decoding error probability (DEP).

The evaluation of the PEP is considered first. A least-squares based channel estimation technique is applied. A closed-form expression for the PEP, using the characteristic function of the decision variable, is derived. The PEP in case of perfect channel estimation is also obtained using the same expression. The results are applied to the performance evaluation of a system using the Alamouti code with binary phase-shift keying (BPSK).

Next, we focus on deriving an expression for the DEP for linear space-time orthogonal codes over constant envelope constellations. Both LSE-based and MMSE-based channel estimation techniques are applied. We also compute the coding gain when the average signal-to-noise ratio (SNR) per diversity branch is high. A comparative study of the LSE-based and the MMSE-based channel estimation techniques is carried out in terms of the average pilot power to signal power ratio (APPSPR). It is found that the error performance with LSE approaches that with MMSE with increase of average SNR per diversity branch or increase in APPSPR.

Finally, we consider a space-time coded system using sliding window channel estimation (SWCE), which is essentially decision feedback estimation (DFE) with a finite window size. Using a Markov model of the decision process, we

analyze the DEP of this scheme. It is observed that the DEP increases with increase in the time shift, but tends to saturate with time to a steady-state value. It is also found that the degradation in performance due to SWCE can be overcome by increasing the number of receive antennas.

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