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Improved VBLAST MAP: A Novel Point-to-Point Symbol Detection Algorithm for MIMO Wireless Communication Systems

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Abstract—A novel point-to-point symbol detection algorithm in multiple input multiple output (MIMO) system is proposed. This algorithm is an augmentation of two popular algorithms, namely, vertical Bell laboratories layered space-time (VBLAST) and maximum a posteriori probability (MAP). Here, layers are distinguished or ordered based on the a posteriori probabilities of output symbols and not on signal-to-noise ratio (SNR). For each layer, a set of a posteriori probabilities is computed for all output symbols using all possible signal constellations. The layer corresponding to the output symbol having minimum a posteriori probability is selected first from the set of a posteriori probabilities for detection by doing the comprehensive search over all the possible signal constellations. Then, the remaining layers are detected by the conventional VBLAST MAP technique. The relationship of MIMO symbol error rate (MIMO SER) versus MIMO symbol SNR is presented using simulations for 16×16 MIMO systems and 16-QAM constellation. The results show that the proposed algorithm outperforms conventional VBLAST MAP and improved VBLAST algorithms.

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1. INTRODUCTION

The current demand of high data-rate in wireless communications is fulfilled by using spatial multiplexing in multiple input multiple output (MIMO) systems [1]. Spatial multiplexing can be implemented by using the channel state information available at the transmitter. However, it needs dedicated feedback link, which increases complexity of the overall system. Therefore, to avoid the feedback link, maximum likelihood (ML) detection or sphere decoder (SD) is used. However, it substantially increases the complexity of the receiver, when we increase the number of antennas or use higher order modulation schemes [2–4].

The vertical Bell laboratories layered space-time (VBLAST) architecture is a nonlinear detector in spatial multiplexing with reasonable practical implementation [5]. To improve the performance of VBLAST, the VBLAST MAP algorithm was proposed [6]. However VBLAST MAP was unable to achieve a significant improvement in the performance, because VBLAST MAP uses layered structure of VBLAST and the bottleneck in the performance of VBLAST detection is the reliability of detection of the symbol in the layer having the lowest postdetection SNR (i.e. the weakest layer) [7]. Therefore, further modification was done in VBLAST and the improved VBLAST algorithm was proposed [8], which was able to achieve a significant improvement in the performance.

The scheme proposed in [8] considered spatially uncorrelated channels and $n_R = n_T$, while paper [9] shows that if $n_R > n_T$ for spatially uncorrelated channels, then the performances of VBLAST MAP [6] and improved VBLAST [8] are similar, where n_R denotes the number of receive antennas and n_T denotes the number of transmit antennas. This paper proposes a new layered symbol detection algorithm, which is an augmentation of VBLAST and MAP. Simulation results show that the proposed detection algorithm is having a better error rate performance as compared to all previously proposed detection algorithms.

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