# Low Complexity Near Optimal Hybrid Detectors for Large MIMO Uplink Systems Based on Complex Support Vector Regression

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**Abstract**

## I. Introduction

### *A. Large MIMO System*

Introduce the development and history of Large MIMO systems. The challenges and opportunities.

### *B. Large MIMO detections*

- Local Search (Likelihood Ascend Search and its variances, Reactive Tabu Search and its variances)
- Probabilistic Data Association (PDA and its variances)
- Message Passing Scheme based on Graph Model (Belief Propagation and its variances)
- Monte Carlo Markov Chain detection (Gibbs sampling and its variances)
- Element Based Lattice Reduction aided linear detectors (Lattice reduction)

Evaluate advantages and disadvantages.

### *C. Support Vector Regression*

History and applications.

### *D. Thesis Contribution*

*1) Propose a complex support vector detector which can generate more reliable preliminary estimates than linear detectors (ZF, MMSE) in large MIMO systems but cost less complexity:*

*2) Proposed a low complexity hybrid detector based on complex support vector preliminary detector and hybrid genetic algorithm which achieve near optimal performance at both low order and high order modulation scheme:*

*3) Provide theoretical analysis of channel hardening phenomenon and its application in the design of large MIMO detectors:*

### *E. Thesis Outline*

## II. Theoretical Analysis of Channel Hardening Phenomenon

## III. Complex Support Vector Preliminary Detector (CSVD) for Large MIMO systems

### *A. The Algorithm*

### *B. Channel Hardening Approximation*

Employ channel hardening phenomenon to the detector proposed based on the theoretical analysis.

*1) Complexity Analysis:* Including original version and modified version (with channel hardening approximation).

*2) CSVD Aided Detectors:*

- Ordered Parallel Interference Cancellation (OPIC).
- Likelihood Ascend Search (LAS)

*3) Computer Simulation Results (Spatial Uncorrelated Channel):*

- Bit error rate (BER) performance comparisons between CSVD and MMSE detectors.
- BER performance comparison between original CSVD and modified CSVD (with channel hardening approximation).
- BER performance comparisons between CSVD-OPIC and MMSE-OPIC detectors.
- BER performance comparisons between CSVD-LAS and MMSE-LAS detectors.

# IV. Low Complexity Near Optimal Hybrid Detector Based on Genetic Algorithm and Complex Support Vector Preliminary Detector

## *A. The Algorithm*

## *B. Parameter settings*

*1) Population Size:*

*2) Number of Generations:* Discuss the influence of the population size and number of generations to convergence performance (with respect to the performance of ML detector).

*3) Initial Searching Area:* Discuss the influence of initial searching area to the BER performance.

## *C. Computer Simulation Results (Spatial Uncorrelated Channel)*

- BER performance under fixed SNR against number of generations for different values of population sizes.
- BER performance under a fixed SNR against different initial searching areas.
- BER performance Comparison between CSVD-GA and other advanced detectors (LAS, RTS, LTS, R3TS).

## *D. Complexity Analysis*

# V. Influences of Spatial Correlated Channel and Imperfect Channel State Information (4QAM and 16QAM) ($32 \times 32$ MIMO, $64 \times 64$ MIMO, $128 \times 128$ MIMO)

## *A. BER performance of Complex Support Vector Preliminary Detectors*

CSVD, CSVD-LAS, CSVD-OPIC

### B. BER performance of Complex Support Vector Detector with Channel Hardening Approximation

### C. BER performance of Complex Support Vector Detector Aided Hybrid Genetic Algorithm (CSVD-GA)

## VI. Conclusion