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Comparison of code rate and transmit diversity in MIMO systems

Churms, Duane

2016

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Churms, Duane (2016) Comparison of code rate and transmit diversity in MIMO systems, University of Witwatersrand, Johannesburg, <http://wiredspace.wits.ac.za/handle/10539/21155>

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M.Sc. Dissertation Amendments

Duane Churms

March 16, 2016

Abstract

All amendments that were made to the dissertation titled "Comparison of Code Rate and Transmit Diversity in MIMO Systems" following examiner feedback are discussed in this report. The most notable amendment was a correction to the channel model used, which effected non-trivial changes in the simulation results.

1 Channel Model Correction

Examiner 2 note under "Additional detailed findings" that the channel matrix $\mathbf{H}$ must be normalised such that the average Frobenius norm across the entire simulation is 1, rather than the Frobenius norm of each channel matrix being equal to 1. This is a major change and affected most of the results including:

- All Rayleigh fading based simulations showed poorer performance using the revised channel model.
- Soft decision decoding was found to be ineffective for the code rates and lengths used. At best SD decoding offered a gain of 0.2 dB, and in some cases performed significantly worse than HD decoding. The research question was thus addressed using only hard decision decoding results.
- The error floors that were observed when using TBLAST were not evident. The analysis based on these error floors was therefore removed.
- The conclusion regarding the research question remained the same, since the margin between the two types of systems remained large.

There were too many changes in the *Results* and *Conclusion* sections to list them individually, since the results were somewhat different. The types of comparisons performed were not changed, though. To review the changes it is recommended to read the above mentioned two sections in their entirety.

2 Miscellaneous Amendments

2.1 Abstract

- Mentioned that systems to be compared have the same throughput, as recommended. Suggestion that the RS(15,10) code should be in a specific figure is not correct as that comparison is made in a different figure.

2.2 Introduction

- Added additional references to introduction where requested.
- Clarified wording to make it clear that the controlled variable is $\frac{E_s}{N_0}$, not SNR.
- Reworded SD description to avoid using the word marginalised.
- Changed wording to clarify that an example was a simplified case, rather than a generalised bound.
- Changed wording since not all codes that offer diversity do so at the expense of transmit rate. The use of TAST codes, as recommended by the examiner, was not done, as this constitutes a significant deviation from the original research.
- Clarified that lower rate codes offer more error correcting capability than higher rate codes *of the same type*.

2.3 Literature Survey

- Added additional references to introduction where requested.
- Added scatterer movement as a potential cause of changes in the channel.
- Mentioned that DBLAST offers some diversity, as requested.
- Mentioned that cancelling decoded symbols is referred to as Decision Feedback.
- Reformatted equations 2.16 and 2.17 as matrices for clarity.
- In equations 2.18 and 2.19, corrected notation so that $\mathbf{B}$ is bold.
- Following equation 2.28, elaborated on $d^2(a, b)$ being the Euclidean distance between a and b.
- Replaced $\mathbb{F}_{n+1}$ with $\mathbb{F}_q$ (from cardinality definition), replaced n with $n = q - 1$ at the start of section 2.3.2.
- The examiner asked why the Feng-Tzeng algorithm was chosen over Koetter's algorithm. It appears from McEliece's paper that the FT algorithm offers lower complexity for low values of m, however, this research is not based on complexity of algorithms and thus the choice of algorithm in this instance need not be validated.
- Reworded to use $\frac{E_s}{N_0}$ rather than the incorrect use of the term SNR.
- Added "The mimimum number of symbol errors required for each data point is chosen to be proportional to the number of information symbols in each codeword, k. This produces reasonably consistent graph smoothness across all code rates. Due to the increased complexity of soft decision decoding, Guruswami-Sudan simulations are limited to $15k$ symbol errors while Berlekamp-Massey simulations are limited to $50k$ symbol errors."

3 Conclusion

All examiner comments were evaluated and the necessary changes were made to the dissertation. Among many trivial changes, the examiner also requested a correction in the channel model, which impacted a large portion of the results and conclusion.