Fading Channels and Interference Avoidance

Dimitrie C. Popescu and Christopher Rose
WINLAB, Rutgers University
73 Brett Rd., Piscataway, NJ 08854-8060
{cripop, crose}@winlab.rutgers.edu

Abstract

Interference avoidance for multiaccess fading channels is considered in the paper. Slowly varying (quasistatic) and rapidly varying (dynamic) frequency selective fading channels are considered. For the former application of interference avoidance is straightforward, while for the latter interference avoidance is applied to the average channel.

1 Introduction

Application of interference avoidance for dispersive channels has been presented in detail in [2] where it has been shown that the eigen-algorithm yields an optimal ensemble of codewords which maximizes the sum capacity of the channel. However, the time-varying nature of fading and multipath environments characteristic to wireless channels introduces additional challenges. As time variations appear to be unpredictable, wireless channels have randomly time variant impulse responses and are characterized statistically – which further implies that the sum capacity as defined in [2] will also be a random variable.

In our paper we analyze the capacity of multiaccess fading channels in the context of interference avoidance algorithms. In the case of quasistatic fading channels with large coherence times, channel parameters can be estimated and are assumed to be known for the duration of the transmission. Then, the eigen-algorithm for interference avoidance [2] can be applied and optimal codeword ensembles that maximize sum capacity can be computed and used for transmitting information. From time to time codewords are eventually updated according to variations of the channel.

When the coherence time is small implying a dynamic channel, it may not be possible to estimate channel characteristics and perform interference avoidance. A more realistic approach in this case is to use the average characteristics of the channel and compute codeword ensembles that are optimal for the average channel. These codeword ensembles would be used for the duration of the transmission, regardless of the intervening channel realizations.

Complementary cumulative distribution functions (CCDFs) obtained via Monte Carlo simulation that compare sum capacity for fading channels when using random codeword ensembles, codeword ensembles optimal for the average channel, and codeword ensembles optimal for each channel realization are also plotted.

2 Fading Channels and Interference Avoidance

We assume a frequency selective fading channel model with flat fading of the carriers [3] and concentrate our attention on indoor wireless channels for which extensive studies have been performed [1]. We note that even though applied via a multicarrier modulation scheme, the interference avoidance method is general and can be applied to other fading channel models as well.

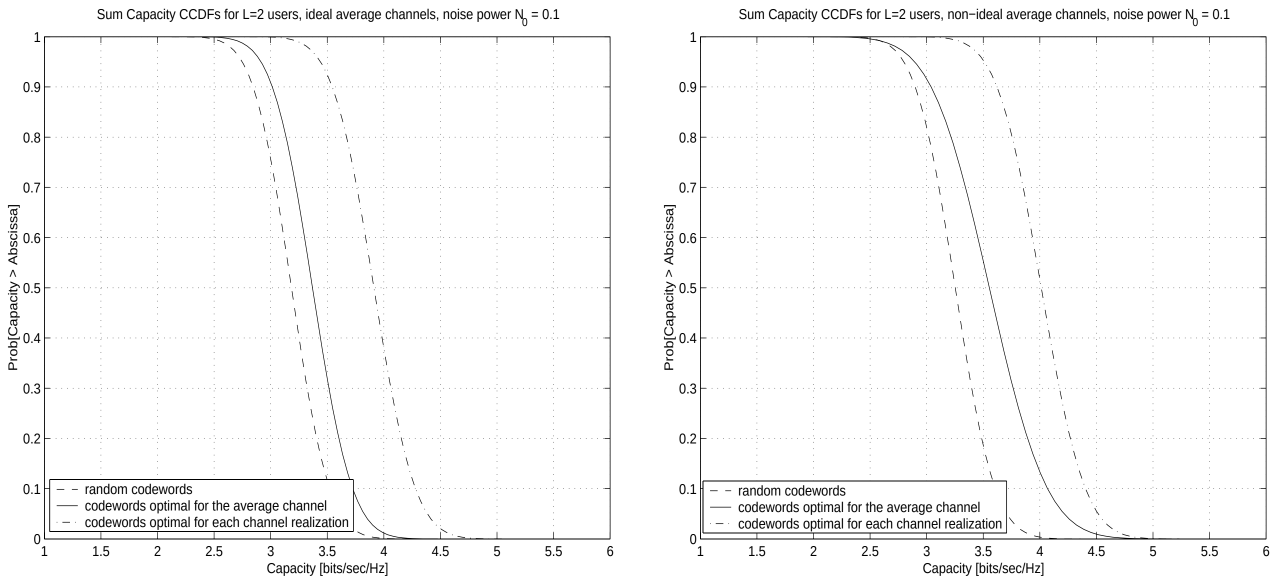

Figure 1: Sum Capacity CCDFs for multiaccess fading channels comparing random codeword ensembles with codeword ensembles optimal for the average channel and codeword ensembles optimal for each channel realization.

For slowly fading indoor channels, the amplitude scalings of different carriers can be identified and then the eigen-algorithm for interference avoidance [2] is applied to compute optimal codeword ensembles that maximize sum capacity. These codeword ensembles are then used for transmission, with periodic updates coupled to channel variation.

When the channel is dynamic and cannot be estimated rapidly enough to satisfy the quasistatic conditions necessary to apply interference avoidance for each channel instance we use the average characteristics of the channel and apply interference avoidance. Using Jensen's inequality it can be shown that codeword ensembles optimal for the average channel are always better in terms of sum capacity than random codeword ensembles. This fact can also be observed in the sum capacity CCDFs presented in figure 1: for the same probability of outage the sum capacity with codeword ensembles optimal for the average channel is always larger than the corresponding value for random codeword ensembles.

3 Conclusions

Application of interference avoidance in the context of fading channels was analyzed in the paper. In the case of slowly fading the channels which are assumed to be known and stable for the whole duration of the transmission, application of interference avoidance is straightforward. Otherwise, if channels variation is so rapid that optimal codeword ensembles cannot be computed before channels change, then interference avoidance can be used to compute codeword ensembles which are optimal for the average channel and still realize performance improvement.

References

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