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A simplified massive MIMO implemented with pre or post-processing

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ABSTRACT

This paper considers the use of massive multiple input, multiple output (MIMO) combined with single-carrier with frequency-domain equalization (SC-FDE) modulations, associated to millimeter wave (mm-Wave) communications using precoding. For the sake of comparison, this paper performs a comparison of pre and post-processing methodology, using the same algorithms. In this paper, we consider three different types of algorithms: Zero Forcing Transmitter (ZFT), Maximum Ratio Transmitter (MRT), and Equal Gain Transmitter (EGT), both of the latter two with iterative detection schemes. The advantage of both MRT and EGT relies on avoiding the computation of pseudo-inverse of matrices. The performance of MRT and EGT are very close to the matched filter bound just after a few iterations of a new proposed interference cancellation, even when the number of receiving antennas is not very high.

1. Introduction

Massive MIMO (m-MIMO) schemes involving several tens or even hundreds of antenna elements are expected to be central technologies for 5G (Fifth Generation) systems [1], where higher capacity and spectral efficiency are required [2], as compared to current systems. To avoid implementation complexity, massive MIMO schemes should use simple techniques to separate data streams that avoid matrix inversions inherent to conventional MIMO receivers. mm-Wave communications are expected to be a crucial part of 5G systems due to their increased channel coherence bandwidth, as compared to centimeter wave. The same technological approach is utilized in the ieee 802.11 standard, as in 802.11ad [3]. These systems use carrier frequencies above 30 GHz where we have large unoccupied bandwidth (there are proposals for several bands in the vicinity of 40 GHz, 60 GHz, 70 GHz, or even above [4,5]). However, mm-Wave transmission has important problems like high free-space path losses, very small diffraction effects, huge losses due to obstacles and implementation difficulties, namely with the power amplification [6]. On the other hand, the small wavelength means that we can have small antennas and small-sized antenna aggregates with a large number of elements, facilitating the deployment of m-MIMO schemes [4]. Moreover, the high reflection effects can be used to improve coverage [6]. By taking advantage of these characteristics, we can design mm-Wave communications with capacities several orders magnitude above current wireless systems. In fact, mm-Wave systems can take full advantage of techniques like small cells networks (pico or femto) and m-MIMO schemes. By combining small cells with m-MIMO systems we can have large gains to cope with propagation losses and/or accommodate a large number of co-channel users, with high frequency reuse [2].

As with other wireless systems, mm-Wave communications should have high power and improved spectral efficiencies, which are conflicting requirements. In general, high spectral efficiency means using large constellations and strictly band-limited signals, which have high power requirements and the inherent high peak-to-average power ratio (PAPR) leads to low amplification efficiency [7]. It is well-known that high power and spectral efficiencies are contradictory goals. In fact, increased spectral efficiency means the use of larger constellations, which leads to higher power requirements since the average bit energy for a given minimum Euclidean distance increases with the constellation size. Moreover, in general larger constellations also have higher linearity requirements since the associated signals have higher envelope fluctuations and, consequently, lower amplification efficiency [8].

Block transmission techniques, with appropriate cyclic prefixes and employing Frequency-Domain Equalization (FDE) techniques, have been shown to be suitable for high data rate transmission over severely time-dispersive channels [7]. Orthogonal Frequency Division Multiplexing (OFDM) is the most popular modulation based on this technique. Single Carrier (SC) modulation using FDE is an alternative approach based on this principle. As with OFDM, the data blocks are preceded by a cyclic prefix, long enough to cope with the overall channel length. Due to the lower envelope

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