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Selective Interference Rejection based Antenna Selection for MIMO over LTE Advanced Networks

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Abstract

An important goal for long term evolution advanced (LTE-A) network is to enhance the cell edge user throughput while achieving the link reliability and high data rate communication. However, the cell edge users' throughput is limited by inter-cell interference. To suppress the interference signal, interference rejection combining (IRC) receiver is an effective solution for Release 10/11. In Multiple-Input Multiple-Output (MIMO) technique, the IRC receiver utilizes multiple antennas, larger the number of antennas, the more interfering signals can be suppressed. Due to practical constraints of increase in radio-frequency units impose a limit in the number of antennas. In this paper, a new selective interference rejection based antenna selection (SIR-AS) scheme is proposed to perform the better selection of transmitting antenna for cell edge MIMO user and enhance the system throughput. The selective interference rejection is performed by incorporating the IRC receiver, where the covariance matrix (CM) of the received interference signals is estimated and the minimum of CM is selected. The corresponding antenna set with minimum of CM is selected for transmission. Simulation results show that the proposed algorithm can effectively detect intercellular interference at cell boundaries and select the optimal antenna to reduce block error rate (BLER) and improve throughput performance compared to ideal IRC and maximum ratio combining algorithm, making it suitable for LTE-A downlink receiver in multi-cell MIMO systems.

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*Keywords:*antenna selection; inter-cell interference; interference rejection combining; long term evolution advanced ; multiple-input multiple output ; selective interference rejection;

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1. Introduction

For LTE Advanced network, Multiple Input Multiple Output (MIMO) has been one of the emerging technology to meet the demands for higher data rate, spectral efficiency, network capacity and cell coverage without increasing the average transmit power or bandwidth [1]. Furthermore, it has been widely incorporated to improve the average cell throughput and cell-edge throughput, including single-user MIMO (SU-MIMO) and multi-user MIMO (MU- MIMO) [2]. It was proved that MIMO structure successfully constructs multiple spatial layers where multiple data streams are delivered on a given frequency time, resource and linearly increases the channel capacity and cell edge throughput[1].In LTE-Advanced, the maximum number of layers supported in SU-MIMO is extended to eight to increase the spectral efficiency in twofold [3]. In MIMO technology, the use of multiple antennas result in a significant increase in the channel capacity and performance, however the multiple antennas at the transceivers lead to additional requirement of radio-frequency (RF) chains, which increases the hardware complexity, implementation cost and energy consumption [4]. To deal with this issue, antenna selection techniques are developed, in which only a small number of antennas among available antennas are selected for transmission, were proposed.

Antenna selection (AS) is a simple but powerful scheme as it could attain the benefits of the MIMO technique with only a small number of RF chains. In AS approach, only subsets of antennas are selected for transmission based on given selection parameters. Therefore, this technique achieves a low implementation cost and less feedback load compared with other beamforming/precoding techniques [5,6]. Moreover, antenna selection is robust to channel estimation errors because the phase information is generally not required. Owing to these advantages, antenna selection has been considered for 4G LTE-advanced [7].Transmit antenna selection allows a reduction of the complexity of MIMO system as it was shown that it preserves the spatial diversity provided by a MIMO system while improving the channel capacity and system performance [8,9]. Non codebook based precoding is used for multilayer demodulation reference signals(DMRS) which provides improved precoding flexibility and performance of Release 10 MIMO operations [3]. In [10], transmit antenna selection (TAS) with receive generalized selection combining have been discussed for cognitive decode and-forward (DF) relaying with Nakagami- fading channels. In cognitive MIMO networks TAS with maximal ratio combining (TAS/MRC) and with selection combining (TAS/SC) has been proposed which scales with the minimum number of antennas at the secondary users over Rayleigh fading channel [11]. The secrecy outage performance with the consideration of the effect of weighting errors is analysed for transmit antenna selection/maximal-ratio combining system [12].

On the other hand, the user equipments (UEs) located near the cell boundary is suffered from severe interference from adjacent cells which degrades the system performance. The use of IRC receiver for the cell-edge user is effectively improved the throughput under this condition [13]. In [14], the IRC receiver is investigated which suppresses the interference signals with the aid of multiple antenna branches while detecting the desired signal. Since the IRC receiver strictly generates the received weight matrix based on the correlation information of interference signals, the interference signals can be suppressed according to the spatial degrees of freedom. In [15], the IRC receivers for open-loop transmit diversity that employing the SFBC is investigated. The extended covariance matrix estimation has been performed where some unknown elements in the covariance matrix are determined with appropriate values and specific insertion of zero values is performed. However, these methods are not optimal for antenna selection in the presence of substantial co-channel interference, particularly for cell edge user.

In this paper, the selective interference rejection based antenna selection (SIR-AS) technique is proposed for cell edge user for SU-MIMO. The selective interference rejection has been performed by incorporating the IRC receiver, where the covariance matrix (CM) of the received interference signals is estimated and the minimum of CM is selected. The transmit antenna selection is achieved with the impact of interference covariance matrix. The antenna set with minimum of CM is selected for low complexity receivers. In the presence of channel estimation errors, the CM can be more easily estimated, hence CM based AS techniques give better error-rate performance for cell edge user than their channel state information based counterparts. The system performance is evaluated in terms of block error rate (BLER) and throughput under different channel conditions and the optimal AS is performed in practical receiver configurations at cell boundaries.

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