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Multiple Antenna Techniques for MIMO Systems in Wireless Communication

Priyanshu Garg, priyanshugarg0019@gmail.com
Dr. Dinesh Arora, drdinesh169@gmail.com
Chandigarh Engineering College,
Landran, Mohali, Punjab

ABSTRACT
Wireless networks are progressively more complex. Cell site architectures and infrastructure have evolved over five generations of technology. The quantity of traffic they support is overwhelming. Base station and microwave antenna technologies have evolved to contest the amplified usage demand. MIMO technology has been residential over many years. There are many a range of capable enablers for 5G wireless communication systems, such as massive multiple-input multiple-output (massive-MIMO) and millimeter-wave (mm-wave) communications, spectrum and energy efficient communications, cognitive radio networks, visible light communications, densification of accessible cellular networks with the massive adding up of small cells and a condition for peer-to-peer (P2P) communication like device-to-device (D2D), machine-to-machine (M2M), vehicle-to-vehicle (V2V)-enabled, The objective is to analyze and increase the speed of mobile data and provide peer-to-peer communication. In this paper, various multiple antenna techniques and cooperative relaying schemes have been reviewed.

Keywords: Multi-Input-Multi-Output, Peer-to-Peer, Cloud-based Radio Access Network, Internet of things, Universal Mobile Telecommunication Service

1. INTRODUCTION

THE exponential development of wireless data services determined by mobile Internet and smart devices has motivated the study of the 5G cellular network. There are many a range of promising enablers for 5G wireless communication systems, such as massive multiple-input multiple-output (massive-MIMO) and millimeter-wave (mm-wave) communications, spectrum and energy efficient communications, cognitive radio networks, visible light communications, densification of existing cellular networks with the massive adding of small cells and a provision for peer-to-peer (P2P) communication like device-to-device (D2D), machine-to-machine (M2M), vehicle-to-vehicle (V2V)-enabled, multitier heterogeneous networks (Het Net), simultaneous transmission and reception (full-duplex communication), energy harvesting, cloud-based radio access network (CRAN), software defined network (SDN), and virtualization of wireless resources,

P2P communication refers to a radio technology that enables peers to communicate directly with each other, without routing the data path through a network infrastructure. P2P communication helps enhance spectral efficiency, enhance user experience, and expand communication applications. Resources between P2P users can be reused, and this results in resource reuse gain.P2P communications make it possible for communication terminals to set up ad hoc networks. If the wireless connections is damaged or terminals are not enclosed by a wireless network, multi-hop P2P can be used for P2P communication or even contact to cellular networks.

Potential applications of P2P include local service, emergency communication, public safety, proximity based games and social networking, advertisement for by passers, traffic control and safety, intelligent transport system, Internet of things (IoT) improvement, etc. [1].

1.1 Evaluation of MIMO-OFDM modeling for UMTS-Long Term Evaluation downlink system

The demand for high data rate motivated the 3GPP (Third Generation Partnership Project) organization, in December 1998.3GPP is devoted to deliver globally conventional and applicable mobile phone specification for high data rate. UMTS (Universal Mobile Telecommunication Service) is a 3G mobile communication. The objective of UMTS LTE introduce in 3GPP release8 is to attain high data rate, packet optimized radio access technology, low latency, superior spectral efficiency. LTE is also referred as the evolved UMTS terrestrial radio access and evolved UMTS terrestrial radio access network. In LTE OFDMA cycle prefix is used in downlink. 3GPP selected OFDM because of its toughness to multipath fading and spectral efficiency. MIMO channel undergoes frequency selective, in MIMO –OFDM this frequency selective MIMO channel can be transformed into a set of equivalent frequency flat MIMO channel and thus the receiver difficulty is decreased [9].

1.2 Multiple-Antenna Techniques in LTE (Long Term Evaluation)-advanced

Since the mid1990s that MIMO has been capturing large-scale attention, Single-user MIMO (SUMIMO) techniques were first considered, and they can be categorized into spatial diversity, beam forming, and spatial multiplexing techniques. Spatial diversity techniques were recognized to transmit or receive the same information over dissimilar antennas. Beam forming techniques were considered to maximize the signal-to-noise ratio (SNR) or signal-to-interference-plus-noise ratio (SINR) over a given set of links. Spatial multiplexing techniques were introduced to send multiple data layers in parallel over diverse spatial dimensions. Multi-user MIMO (MUMIMO) techniques were then considered starting in the early 2000s, with the goal of allowing instantaneous communications of multiple users over the same time-frequency resources. More lately, coordinated multipoint (CoMP) techniques have been anticipated to allow coordinated transmission/reception from antennas belonging to different sites or sectors. The Third Generation Partnership Project (3GPP) standard for Long Term Evolution (LTE) was one of the first wireless standards intended with MIMO in mind from the beginning. LTE adopt various MIMO technologies. Without relying on channel-reciprocity-based techniques, LTE downlink transmission supports up to four antennas at the base station.

MU-MIMO is also supported in the uplink. The first release of LTE is termed LTE Release (Rel.) 8, which indicates the release year of 2008. Stimulated by the supplies from the International Telecommunication Union Radio Communication Sector (ITU-R) and 3GPP, LTE-Advanced introduce enhanced MIMO technologies. In the downlink new situation signals are adopted to allow the use of so-called non-codebook-based (e.g., zero-forcing [ZF]) MIMO transmissions. New codebook and feedback designs are introduced to support spatial multiplexing with up to eight independent spatial streams and enhanced MU-MIMO transmissions. Dynamic switching between SU-MIMO and MU-MIMO is also supported [2].

1.3 Role of MIMO in Improvements of OFDM-CDMA System with Pilot Tone

Future mobile-radio systems should be able to deal with continuously increasing user demands for high bandwidth services and applications. Multi-carrier (MC) techniques can be considered as striking solutions for achieving essential requirements in that sense. Moreover, increased downlink capacities can be talented by the arrangement of MC and code division multiple access (CDMA). If orthogonal subcarriers are used, that MC-CDMA scheme is known as orthogonal frequency division multiplexing (OFDM–CDMA). OFDM– CDMA downlink scheme with pilot tone and threshold recognition combining technique at the receiver (optimum TDC) is presented. It has been exposed that optimum TDC outperforms some of the other combining schemes considered, such as: orthogonal restoring combining (ORC) and controlled equalization combining (CEC). In the case of high subcarriers offset due to Doppler spreading, the system obtainable in shows very poor BER performance. Thus, a resolution was proposed in for improving BER performance of the OFDM–CDMA system with pilot tone and finest TDC, in the case of propagation circumstances characterized with high Doppler spread. Along significant performance upgrading, the BER performance of the proposed model is dependent on the accessible frequency bandwidth, e.g. BER increases when the number of subcarriers used for transmitting single data symbol decreases.

Multiple-input multiple-output (MIMO) OFDM– CDMA system with space–time block coding (STBC) is proposed as a solution for improving BER performance and spectrum efficiency of the OFDM–CDMA scheme from. It is shown that, with the same spectrum efficiency. Enables better BER performance even with the abridged frequency bandwidth. System provides more competent use of the frequency resources. [3].

1.4 Distributed MIMO system Based on Overhead consideration

Distributed-Multiple Input Multiple Output (D-MIMO) networks (also known as network MIMO) have concerned great research interest for their potential to satisfy very high data rates requirements of future wireless networks, Depending on the ratio between the number of APs and clients.

The data overhead considerably increases with the number of APs and clients, due to the considerable amount of information that must be collective among the network elements for performing various operations, e.g., channel state information (CSI) estimation, time/frequency synchronization, and data sharing. The overhead reduction of D-MIMO networks gained much research interest, with the efforts focusing on the selection (scheduling) of the APs involved in the network MIMO, the decrease of CSI interactions among the network and inter-cluster interference mitigation techniques.

D-MIMO network employing IA is partitioned into smaller orthogonal D-MIMO groups, the partitioning algorithms in objective at the maximization of the effective sum-rate, assuming that the size of the overhead sub frame within the complete frame can change dynamical. The partitioning concept to D-MIMO networks employ JMB, which does not require the network channel matrices to be acknowledged at both the transmitter and receiver sides [4].

1.5 Solution for simple Cooperative Relaying

Forever increasing anxiety for multimedia services and web-related content, a high data rate is becoming one of the major features, amongst many diversity techniques that can be used for improving communication performances and combat channel fading; spatial diversity techniques are mostly attractive since they supply diversity gain without incurring extra costs of transmission time and bandwidth.

Spatial diversity is achieved by using multiple antennas at the transmitter and/or receiver, where the spacing among antennas is with the sort of a half of wavelength. Because of the diversity gain, collocated MIMO architectures are efficient in improving bit error rate (BER), system capacity, spectrum efficiency, energy efficiency, etc. Apart from being engaged in a point-to-point communication link between mobile station (MS) and base station (BS), MIMO systems are also implemented in a scattered mode, with a goal to advance performance in cooperative and relay networks, where every node can be operational with only one antenna. The key difference between the effective and collocated MIMO is that multiple antennas are distributed among broadly separated nodes. In a virtual MIMO system, each node may be only operational with one antenna.

This new scheme is compared with uncomplicated cooperative relay with practical orthogonal space time block coding (OSTBC) and quasi orthogonal space time block coding (QOSTBC). The main benefit of QOSTBC in contrast with OSTBC is its code rate for more than 2nd order diversity. For 4th order diversity QOSTBC has better code rate, but with BER concert degradation as an conclusion. a new simple cooperative relaying scheme with similar BER performance as effortless cooperative relaying scheme with virtual OSTBC, but with greater code rate. It desires half of time slots between BS and RSs in comparison with simple cooperative scheme with virtual OSTBC. These free time slots can be used for other BS–MS, BS–RS communications, for enhanced channel estimation, etc. [5].

1.6 Energy Efficiency of Distributed MIMO System

Due to the remarkable growth in high data rate transmission and multimedia services determined by using smart iPhone and Android devices, and other wireless devices, a large amount of energy has been inspired by wireless systems. Compared with the traditional co-located MIMO, the distributed MIMO system can decrease the access distance between the remote access units (RAUs) and the mobile stations (MSs), which means subordinate propagation losses and higher spatial reuse. Thus the distributed MIMO can increase periodic sum rate, expand coverage, and improve energy efficiency (EE). EE is striking more and more important in future wireless communication systems. The EE performance has been discussed in, for the traditional co-located massive MIMO system. However, the distributed MIMO system suffers from different degrees of path losses caused by different access distances between the MS and the RAUs. As a result, the accessible EE results for the traditional co-located MIMO system cannot be openly applied to the distributed MIMO system. The channel model measured in this paper includes small scale and large scale fading since the RAUs are actually separated [7].

1.7 Outage Probability Analysis using Full-Duplex MIMO system

Full duplex and MIMO are technologies which have high opportunity to improve transfer rate and spectral efficiency of wireless communication. In full duplex mode, transmitter and receiver are acceptable to transmit and receive signal simultaneously at same frequency band. The receiver antenna receive not only signal from the source but also from its own transmitter called self-interference.

The active cancellation has better presentation in term of outage probability than passive cancellation. Active cancellation means that containment of self-interference power due to analog and digital signal cancellation techniques and unreceptive cancellation means that self-interference power is censored using antenna separation. It is showed that combining analog and digital domain cancellation techniques can lessen self-interference by up to 73 db.It examines an outage probability in bidirectional wireless communication using full duplex MIMO system with judged effect of self-interference [6].

1.8 Amplify-and-Forward (AF) Multi-Input-Multi-Output Relaying Network

Currently it is widely acknowledged that massive MIMO, dense networking, full duplex communications and high frequency communications are the pillars for future communication systems. Massive MIMO systems and dense network to allow the high data rate transmissions. Millimeter Wave communications (mm Wave) are a very talented technology credit to the large unlicensed spectral resource at millimeter wave frequency band. Mm Wave communications can offer gigabit-per-second data rates over 30-300 GHZ bandwidth. As a byproduct mm Wave communications enable the communication node to be prepared with a large number of antennas, which can defeat the high path-loss or additional losses (caused by hydrometeor and atmospheric gases absorption) by utilizing beam forming technologies. the secrecy beam forming designs for Mm Wave AF MIMO two way relaying networks. The unusual from most existing physical layer security designs in the following aspects:

•The multiple antennas are deployed at all nodes including source, relay and eavesdropper, which guarantee high spatial diversity gains. On the other hand, more antennas also make privacy beam forming designs more difficult.

•Consideration on the beam forming design for the physical layer security of AF MIMO two-way relaying networks. In precise, mutually optimizes the transmit and receive beam forming of two source nodes and the convey beam forming matrix to further decrease the amount of wiretapped information by eavesdropper.

•Considering the fact that over Mm Wave channels more analog-to-digital converters (ADCs) mean high power consumption and hardware cost, the number of ADCs must be prohibited for Mm Wave communications. The level of the beam forming matrix at relay is limited to be no larger than 2, which can strike a balance between complexity and performance [8].

1.9 Performance of Spatially Distributed MIMO System

Lately, there has been a great deal of concern in spatially distributed multiple-input multiple-output (MIMO) systems where transmit and receive antennas are distributed arbitrarily in spatial regions. Such systems can deliver all the attractive profit of conventional MIMO in the point-to-point wireless channel, but at a much larger scale. This employment considers a spatially distributed MIMO system between arbitrary shaped spatial regions with each region containing antennas distributed at casual in spite of the number of antennas or array geometry.

Some precise contributions made in this work are:

(i)It is well recognized in the literature that the mutual information (MI), also known as instantaneous capacity, of conventional MIMO system over Rayleigh fading channel is identified to be equivalent to a Gaussian random variable, In this, the instant capacity of planned distributed MIMO system for mode-to-mode communication is also comparable to a Gaussian random variable.

(ii) Analogous to conventional MIMO systems, the distributed MIMO systems present best presentation with each spatial region containing equal number of arbitrarily distributed antennas, since the number of efficient antennas is dependent on size of the region, to attain the best performance; we require considering equal sized regions.

(iii) To assist the total transmit power allocation amongst the effective independent channels, we look at a downward transmit power allocation algorithm. this algorithm depends on how the total transmit power is scattered in a descending order among the channels. The proposed power allocation algorithm outperforms the conventional equal power allocation scheme at both low and high average signal-to-noise ratios (SNRs).the proposed algorithm provides better performance compared with the conventional scheme at low average SNR. In contrast, a desired spectral efficiency is achievable (at both low and high average SNRs) with a higher probability by employing the proposed algorithm than applying the equal power allocation scheme [10].

2. LITERATURE REVIEW

Katsutoshi Kusume et al. [2012], In this article author talk about the different multiple antenna techniques introduced in LTE Advanced. Inspitr of describing the technical facts of the adopted solutions, author approach the difficulty starting from the design targets and the antenna deployments prioritized by the operators. Then author present the main enabling solutions introduced for downlink and uplink transmissions, and thus, assess the performance of these solutions in unusual scenarios.

Zoran Veljovic et al. [2014], In this, a new straightforward cooperative relaying scheme. The planned scheme is compared with simple cooperative schemes with practical (OSTBC) orthogonal space time block coding and quasi orthogonal space time block coding (QOSTBC). Each of these three schemes consist one base station with two antennas, two relay stations each with a single antenna and one mobile station with a single antenna. The plan of the proposed scheme is to protect, as much as it is possible bit error rate (BER) act of the cooperative method with virtual OSTBC, but with enlarged code rate.

Fu-Chun Zheng [2014], In this paper, we explore energy efficiency (EE) of the co-located and the distributed multiple-input multiple output (MIMO) system. First, we find an estimated EE expression for different power consumption models. Then two

EE properties are exposed for the distributed MIMO system. The logical results are confirmed by computer simulations.

Ugljesa Urosevic et al. [2016], The future generation of wireless networks is probable to support a drastically large amount of mobile data traffic, immense number of wireless connections and devices, attain better cost, increased energy and spectral efficiency, enhanced quality of service (QoS) in terms of communication delay, capacity, reliability and security. The key techniques that will allow these features are massive multiple- input, multiple-output (MIMO), utilization of higher frequencies, particularly millimeter-wave (mmWave) frequencies, excellent dense and deployment of cells, peer-to-peer (P2P) communications, heterogeneous network (Het Net) implementation, etc. Here we present new solutions for implementing distributed MIMO techniques for P2P communications.

Shiqi Gong et al. [2016], Gigahertz unlicensed bandwidth spectrum endows millimeter wave (mm Wave) communications with the large achievable of realizing high data transmission rates. Associated to all wireless transmission technologies, mm Wave communications are also disposed to security frightening. This problem becomes harsher for cooperative networks that need more information connections. In this paper, we examine the secrecy beam forming designs for mm Wave two-way amplify-and- forward multiple-input multiple-output (MIMO) relay networks. In order to manage hardware size and cost, an additional rank limit is posed on the forwarding matrix at relay to through the number of analog-to- digital converters. In wide-ranging, the measured optimization problem is non-convex and very demanding. Based on iterative optimization algorithms, the privacy beam forming designs are productively decoupled into a series of convex sub problems that can be capably solved. Finally, numerical experiments are conducted to reveal the performance compensation of the proposed silence beam forming designs.

Stella N. Batalama et al [2016], a novel receiver aim for distributed MIMO systems that accounts for multiple carrier frequency offsets (CFOs) and multiple timing offsets (TOs). The planned structure utilizes a bank of rhythm matched filters (one per effective CFO) at each receive antenna, followed by an information symbol detector. Each filter in the bank is sampled at the symbol rate with sampling timing chosen according to the corresponding TO. For the proposed receiver configuration, we obtain the maximum likelihood (ML) detector. Our theoretical developments are illustrated through widespread simulation studies and point to that the proposed receiver structure jointly with the optimal ML detection offers considerable performance gains compared to the current state of the art.

Vikash Sachan et al. (2019) provides a brief insight into the performance analysis of spatially modulated (STBC-SM) MIMO system employing Binary PSK and M'ary PSK techniques over Rician, Nakagami-m and Rayleigh fading channels. SM-MIMO system can be used in conjunction with the cooperative communication for improving the SER performance of higher order modulation schemes in future generation networks.

Table 1: Performance analysis of different techniques

Sr. No.	Year	Technology Used	Performance Analysis
1.	2012	Different multiple Antenna techniques adopted in LTE-Advanced	MIMO and CoMP techniques, where antennas of multiple cell sites (also called transmission points) are utilized in such a way that they can contribute in improving the received signal quality.
2.	2013	MIMO technique used as a solution for improving BER performance of the OFDM–CDMA system with pilot tone and optimum TDC combining.	System provides more competent use of the frequency resources. Besides improved reliability and spectrum efficiency
3.	2014	New cooperative Relaying scheme	Has greater code rate than cooperative scheme with virtual OSTBC, and very similar BER performance.
4.	2014	Energy Efficiency of Distributed MIMO Systems	When the circuit power is ignored, the EE decreases with the increase of the maximum transmit power. However, if the circuit power is considered, the EE of the downlink distributed MIMO system first increases and then decreases with the increase of the maximum transmit power
5.	2016	New approach for improving	Transmission on mmWave frequencies, i.e. utilization

		performances of virtual MIMO communications between peers is used	of higher frequencies, implementation, improve P2P communications through distributed MIMO systems.
6.	2016	An alternating optimization algorithm is used	algorithm has both faster convergence rate and better security performance in comparison to the existing schemes.
7.	2016	D-MIMO: RECEIVER DESIGN AND ML DETECTION	receiver structure together with the optimal ML detection achieves significant performance gains compared to the current state of the art

CONCLUSION

As a requirement of the use of multiple antennas, MIMO wireless technology is able to significantly increase the capacity of a given channel. By ever-increasing the number of receive and transmit antennas it is feasible to linearly increase the throughput of the channel with every pair of antennas added to the system. Since spectral bandwidth is fetching an increasingly valuable commodity for radio communications systems, techniques are needed to use the available bandwidth more successfully. Even while the MIMO technique can be worn with any modulation, OFDM and its derivative are primarily well suited to it as for each sub-carrier they translate the channel selective fading into near-flat fading, which is simple to model and equalize. Different multiple Antenna techniques are utilized in such a way that they can supply in improving the received signal quality and MIMO technique used as a explanation for improving BER performance of the OFDM–CDMA system with pilot tone provides more capable use of the frequency resources.

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