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Analysis and Implementation of Spectrum Efficiency,BER Analysis of Massive Systems with CE Equalizers Technique

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Abstract*— The demand for wireless throughput has grown exponentially in the past few years, with the increase in a number of wireless devices and number of new mobile users. The throughput is the product of Bandwidth (Hz) and Spectral efficiency (bits/s/Hz). To increase the throughput, either Bandwidth or Spectral efficiency has to be increased. A transmitted signal while propagating through the wireless channel undergoes multipath fading effect accompanied by noise and interference. Mitigation of these effects and increase in throughput is only possible if the channel is accurately estimated at the receiver in order to perform coherent detection. Existing literature mentions both coherent and non-coherent detection. As a first step of Coherent Detection in massive MIMO systems, different channel estimation methods are investigated. Depending on slow/fast channel fading conditions, several authors suggested adaptive least mean square (LMS), normalized least mean square (NLMS) and recursive least square (RLS) based channel estimation technique, which either require statistical information of the channel or inefficient in terms of performance or computations. In order to overcome the above effects, this research work mainly focuses on the square root recursive least square (QR-RLS) based channel estimation method for massive MIMO systems. The spectrum efficiency and bit error rate (BER) results are obtained for the proposed adaptive channel estimation for Massive MIMO system using QR RLS algorithm and previous a lgorithm. The proposed algorithm is best performance compared to previous technique.

Keywords*—Least Mean Square (LMS),Bandwidth (Hz) and Spectral efficiency (bits/s/Hz),square root recursive least square (QR-RLS), *etc…

I. INTRODUCTION

As a physical-layer performance booster for wireless communications, the technology of MIMO has been incorporated into wireless broadband standards, such as IEEE 802.11n, IEEE 802.11ac, HSPA+, WiMAX and Long-Term Evolution (LTE) [1]. Among these, the current LTE standard allows for up to eight antennas on base stations and on terminals [2]. Figure 1.1 shows examples of a cellular base station and a WiFi access point, both equipped with multiple antennas. Compared to single-antenna systems, the performance gain brought by the use of multiple antennas is due to the spatial degrees of freedom (DoF) that expand the dimensions available for signal processing. As wireless spectrum has become a precious resource, MIMO technology exploiting the spatial domain offers the opportunity of improving system performance without increasing the required spectrum.

(a) (b)

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Figure 1.1: Examples of MIMO technology used in our everyday life.

Let us briefly review MIMO systems. Generally, MIMO systems are divided into two categories: single-user MIMO (SU-MIMO) and multi-user MIMO (MU-MIMO). Figure 1.2 illustrates the two categories. In SU-MIMO, the transmitter and receiver are equipped with multiple antennas. Performance gain in terms of coverage, link reliability and data rate can be achieved through techniques such as beamforming, diversity-oriented space-time coding, and spatial multiplexing of several data streams.

A cellular base station tower (b) A Linksys wireless router

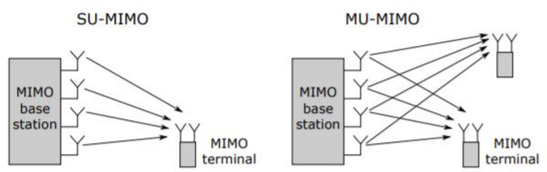

Figure 1.2: Single-user MIMO and multi-user MIMO

These techniques cannot be fully used at the same time, thus we typically find a tradeoff between them. For example, adaptive switching between spatial diversity and multiplexing schemes is adopted in LTE [3]. The situation with MU-MIMO [4] is radically different. The wireless channel is now spatially shared by different users, and the users transmit and receive without joint encoding and detection among them. By exploiting differences in spatial.

1.2 MIMO GOES MASSIVE :- In both SU-MIMO and MU-MIMO, theoretically, the more antennas the transmitter and/or receiver are equipped with, the larger the scale on which the spatial domain can be exploited. This leads to better performance in terms of the above-mentioned MIMO advantages. Let the number of base station antennas grow without limit in MU-MIMO scenarios, the first important phenomenon is that the effects of additive receive noise and small-scale fading disappear, as does intra-cellular interference among users. The only remaining impediment is inter-cellular interference from transmissions that are associated with the same pilot sequence used in channel estimation. The paper concludes that the throughput per cell and the number of terminals per cell are independent of the cell size, the spectral efficiency is independent of the system bandwidth, and required transmit energy per bit vanishes. Scaling up MIMO provides many more degrees of freedom in the spatial domain than any of today's systems.

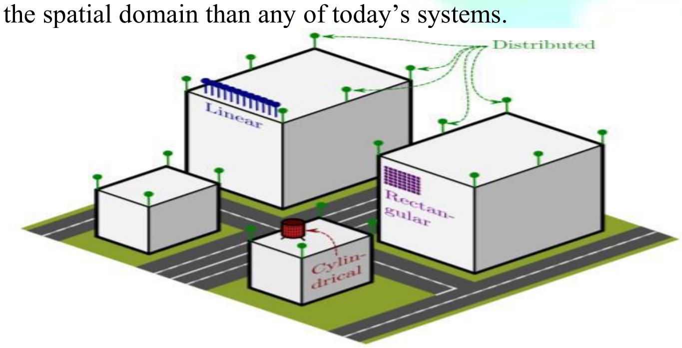

Figure 1.3: Illustration of possible deployments of massive MIMO antenna arrays

As a simple illustration, Figure 1.3 shows possible deployments of massive MIMO antenna arrays. Antennas can be co-located in a linear, planar or cylindrical structure, or can be placed in a distributed manner. In massive MIMO operation, we consider an MU-MIMO scenario, where a base station equipped with a large number of antennas serves many terminals in the same time-frequency resource. Processing efforts can be mostly made at the base station side, and terminals have simple and cheap hardware. Until now, many theoretical and experimental studies have been done in the massive MIMO context, e.g., [5].

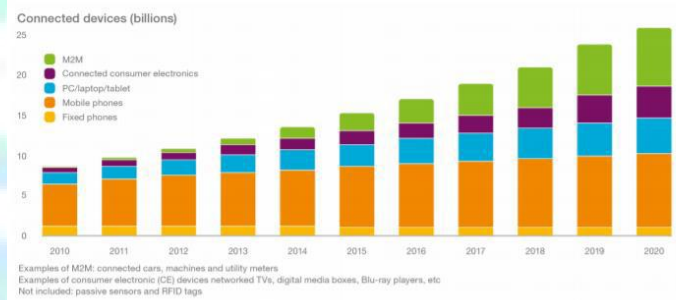

Figure 1.4: Growth in the number of connected devices.

II. LITERATURE REVIEW

Aravinda Babu et al. [1], a Cell-Free Massive MIMO (different info numerous yield) framework involves countless disseminated passageways (APs), which all the while serve an a lot more modest number of clients over a similar time/recurrence assets dependent on legitimately estimated channel attributes. The APs and clients have just a single reception apparatus each. The APs gain channel state data through time-division duplex activity and the gathering of uplink pilot sign transmitted by the clients. The APs perform multiplexing/de-multiplexing through conjugate beamforming on the downlink and coordinated separating on the uplink. Shut structure articulations for individual client uplink and downlink throughputs lead to max-min power control calculations. Max-min power control guarantees consistently great administration all through the region of inclusion. A pilot task calculation mitigates the impacts of pilot sullying, yet power control is unquestionably progressively significant in such manner. Massive MIMO has significantly improved execution regarding an ordinary little cell conspire, whereby every client is served by a devoted AP, as far as both 95%-likely per-client throughput and resistance to shadow blurring spatial connection. Under uncorrelated shadow blurring conditions, the phone free plan gives almost fivefold improvement in 95%-likely per-client throughput over the little cell plot, and ten times improvement when shadow blurring is related.

Huang A. Burr et al. [2], in this paper, we consider the uplink of sans cell huge MIMO frameworks, where countless conveyed single reception apparatus passageways (APs) serve an a lot more modest number of clients at the same time by means of restricted backhaul. Just because, we explore the presentation of register and-forward (C&F) in such a ultra-thick system with a reasonable channel model (counting blurring, path-loss and shadowing). By using the normal for path-loss, a low unpredictability coefficient determination calculation for C&F is proposed. We likewise give a covetous AP determination technique for message recuperation. Moreover, we contrast the presentation of C&F with some other promising straight systems for conveyed monstrous MIMO, for example, little cells (SC) and most extreme proportion consolidating (MRC). Numerical outcomes uncover that C&F lessens the backhaul load, yet additionally fundamentally expands the framework throughput for the symmetric situation.

H. Al-Hraishawi et al. [3], in this paper, the unfavorable impacts of intra-cell pilot defilement for physical layer secure correspondence in subjective multi-client huge numerous information different yield (MIMO) frameworks with underlay range sharing are researched. The channel gauges at the essential base-station (PBS) and auxiliary base-station are gotten by utilizing non-symmetrical pilot successions transmitted by the essential client hubs and optional client hubs, separately. Henceforth, these channel appraisals are influenced by intra-cell pilot sullying. Besides, an inactive multi-receiving wire busybody is thought to spy upon either the essential or auxiliary secret transmissions. In this specific circumstance, a physical layer security procedure is provisioned for the essential and auxiliary transmissions by means of fake commotion age at the PBS and zero-compelling preorders. For this framework set-up, the normal and asymptotic feasible mystery rate articulations are inferred in shut structure, and in this manner, the mystery rate debasement due to intra-cell pilot sullying is evaluated. Our examination uncovers that a physical layer secure correspondence can be provisioned for both essential and auxiliary enormous MIMO frameworks even with channel estimation mistakes and pilot defilement.

V. D. Nguyen et al. [4], in this paper, the detrimental effects of intra-cell pilot contamination for physical layer secure communication in cognitive multi-user massive multiple-input multiple-output (MIMO) systems with underlay spectrum sharing are investigated. The channel estimates at the primary base-station (PBS) and secondary base-station are obtained by using non-orthogonal pilot sequences transmitted by the primary user nodes and secondary user nodes, respectively. Hence, these channel estimates are affected by intra-cell pilot contamination. Furthermore, a passive multi-antenna eavesdropper is assumed to be eavesdropping upon either the primary or secondary confidential transmissions. In this context, a physical layer security strategy is provisioned for the primary and secondary transmissions via artificial noise generation at the PBS and zero-forcing precoders. For this system set-up, the average and asymptotic achievable secrecy rate expressions are derived in closed-form, and thereby, the secrecy rate degradation due to intra-cell pilot contamination is quantified. Our analysis reveals that a physical layer secure communication can be provisioned for both primary and secondary massive MIMO systems even with channel estimation errors and pilot contamination.

R. Zhao et al. [5], this paper examines the physical layer security issue of psychological decipher and-forward hand-off systems over Nakagami-m blurring channels. We consider the handing-off correspondence between one auxiliary client (SU) source and one SU goal by utilizing a pioneering transfer choice from numerous SU transfers and sharing the authorized range of different essential clients (PUs) in the underlay arrange. While the transmission between the SUs forces impedance on every PU, the handed-off transmission is caught by one SU meddler. Without the busybody's channel state data, the hand-off determination depends on the biggest channel addition of transfer to-goal connect, which is thought to be obsolete because of input delay. We infer the definite likelihood of non-zero mystery limit and the precise mystery blackout likelihood (SOP) in the shut structure. Besides, we determine the asymptotic SOP in two distinct cases, and unequivocally demonstrate the impacts of framework parameters on the mystery decent variety request and the mystery assorted variety gain, individually. Both asymptotic investigation and reenactment results demonstrate that the mystery execution can be improved by expanding either the quantity of transfers or the Nakagami parameter of the authentic hand-off channels, while the mystery decent variety addition disintegrates as the quantity of the PUs increments.

III. PROPOSED METHODOLOGY

Space-time processing technique for MIMO generally has two objectives one is to increase the data rate and another is to achieve maximum possible diversity. The space-time processing techniques are:

Spatial Multiplexing

Spatial multiplexing is a transmission system to transmit a few unique information bits called streams through an autonomous spatial channel to accomplish the more prominent throughput. Normally there are four sorts of spatial multiplexing plans V-BLAST, corner to corner impact, level impact and turbo impact. Among them, V-BLAST is the most encouraging plan to apply [12].

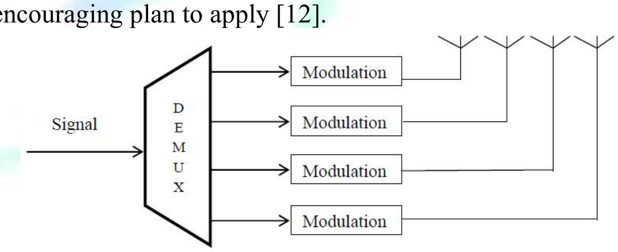

Figure 3.1: Simple Example of Spatial Multiplexing

The square chart of the straightforward case of spatial multiplexing is appeared in figure 3.1. The above basic model delineated the thought behind spatial multiplexing. The information bits stream is partitioned into N autonomous sub-streams utilizing sequential to parallel DE multiplexer and each stream is transmitted from a few extraordinary with output N symbol per channel. So the throughput increases N times and therefore, spatial multiplexing becomes the better candidate for high data rate.

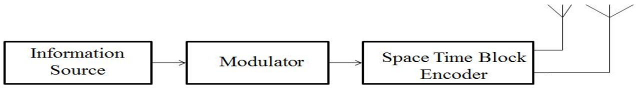

Figure 3.2: Encoder for STBC

Orthogonal design: An orthogonal design of size Nt * Nt with transmission matrix

Xn exists if and only if a number of transmit antennas are t N = 2, 4, or 8. Examples of orthogonal design are

When $N_t=2$

$$\begin{bmatrix} x_1 & -x_2 \\ x_2 & x_1 \end{bmatrix}$$

When $N_t=4$

$$\begin{bmatrix} x_1 & -x_2 & -x_3 & -x_4 \\ x_2 & x_1 & x_4 & -x_3 \\ x_3 & -x_4 & x_1 & x_2 \\ x_4 & x_3 & -x_2 & x_1 \end{bmatrix}$$

When $N_t=8$

$$\begin{bmatrix} x_1 & -x_2 & -x_3 & -x_4 & -x_5 & -x_6 & -x_7 & -x_8 \\ x_2 & x_1 & x_4 & -x_3 & x_6 & x_5 & x_8 & -x_7 \\ x_3 & -x_4 & x_1 & x_2 & x_7 & -x_8 & x_5 & x_6 \\ x_4 & x_3 & -x_2 & x_1 & x_4 & x_3 & -x_2 & x_1 \\ x_5 & -x_6 & -x_7 & -x_8 & x_1 & -x_2 & -x_{31} & -x_4 \\ x_6 & x_5 & x_8 & -x_7 & x_2 & x_1 & x_4 & -x_3 \\ x_7 & -x_8 & x_5 & x_6 & x_3 & -x_4 & x_1 & x_2 \\ x_8 & x_3 & -x_2 & x_1 & x_4 & x_3 & -x_2 & x_1 \end{bmatrix}$$

IV. SIMULATION RESULTS

A Simulation study has become increasingly popular over the last few decades. Its appropriateness, particularly in the enhancement and control of refrigeration and cooling hardware has been acknowledged by the industry. In order to simulate a system and to obtain the desired result, a mathematical model of the system should be generated. Using the simulation software, the mathematical model developed could be analyzed. There is numerous simulation software available, but the most prominent one used by researchers is the editor window present under the MATLAB environment. MATLAB is a high-level language oriented towards engineering and scientific applications. It has evolved over a ten-year period to become a popular, flexible, powerful, yet simple language. It has filled in as a viable stage for more than twenty tool compartments supporting specific building and logical applications, covering regions from representative calculation to computerized channel configuration, control hypothesis, remote correspondence and neural systems. It is utilized intuitively and it likewise underpins the capacity to characterize capacities and contents, and progressively interfaces with C and FORTRAN programs.

4.2 SIMULATION PARAMETERS

In Massive MIMO system, a bit error rate (BER) and spectrum efficiency estimator is an cognitive radio network which minimizes the BER and increase the spectrum efficiency.

The BER of massive MIMO system are defined by the following equations

$$BER = \frac{1}{2}\left(1 - \sqrt{\frac{E_b/N_0}{E_b/N_0 + 2}}\right)$$

$\frac{E_b}{N_0}$ is the relation between symbol energy and the bit energy of the signal.

4.3 SIMULATION RESULTS FOR MASSIVE SYSTEM :-

MATLAB simulations are performed for various combinations of transmitted and received antenna in massive MIMO system. Simulation experiments are conducted to evaluate the SNR verse bit error rate (BER) performance of the proposed QR-RLS based channel estimation with different modulation technique i.e. QAM-16, QAM-32 and QAM-64 for 8×8 systemis shown in figure 4.1. For different value of SNR, the implemented QR-RLS based channel estimation for 8×8 systemshows BER reduction performance.

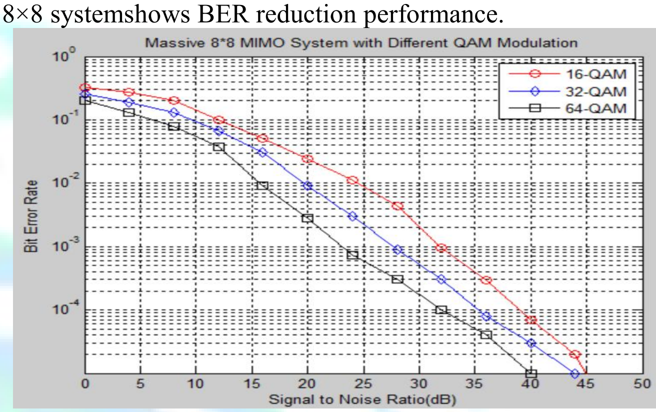

Figure 4.1: BER vs SNR for Massive 8×8 System with QR-RLS based Channel Estimation Technique

The reproduction covers a start to finish framework demonstrating the encoded and additionally transmitted sign, channel model and gathering and demodulation of the got sign. It is accepted that the channel is known impeccably at the collector for all frameworks. At that point run the recreation over a scope of Eb/No focuses to create BER results that permit contrasting the 16×16 frameworks is appeared in figure 4.2.

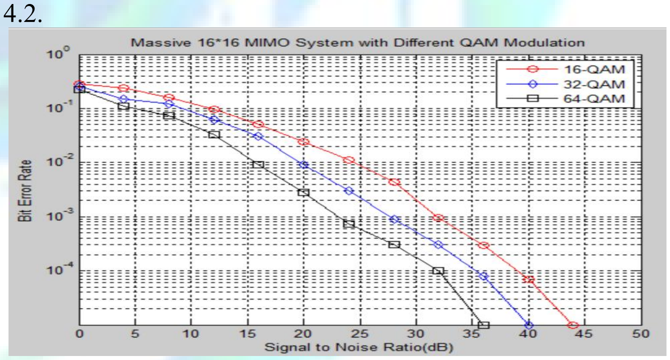

Figure 4.2: BER vs SNR for Massive 16×16 System with QR-RLS based Channel Estimation Technique

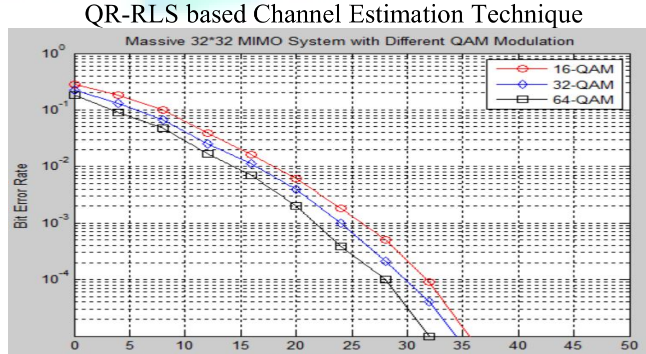

Figure 4.3: BER vs SNR for Massive 32×32 System with QR-RLS based Channel Estimation Technique

Figure 4.3 shows the simulation results using four transmit antenna and four receive antennas which provide the matched filter detection spectrum sensing MIMO system. It is observed that transmit diversity has a 3 dB disadvantage when compared to MRC receive diversity. From the analysis of MIMO system, the 32x32 antenna combination gives a minimum bit error rate.

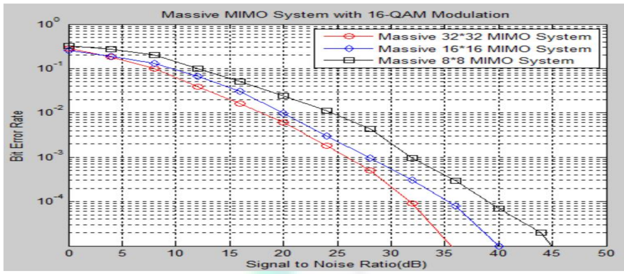

Figure 4.4: BER vs SNR for Massive Different System with QR-RLS based Channel Estimation Technique

Simulation experiments are conducted to evaluate the SNR verse BER performance of the proposed QR-RLS based channel estimation with different system is shown in figure 5.4. It is clear that the increase in the transmitter and receiver antenna than decrease the total error with respect to SNR. Table 4.1 shows the different value of bit error rate in different SNR for massive MIMO for QR-RLS based channel estimation technique. It is clear that the bit error rate for MIMO-OFDM system compared to other.

Table 4.1: Comparison of BER vs SNR in Different Antenna for QR-RLS based Channel Estimation Technique

BER	SNR (dB)						
	0	5	10	15	20	30	40
8×8 Massive System	3×10^{-1}	2.3×10^{-1}	2×10^{-1}	6×10^{-2}	2×10^{-2}	6×10^{-3}	7×10^{-4}
16×16 Massive System	2.5×10^{-1}	1.8×10^{-1}	1×10^{-1}	4×10^{-2}	9×10^{-3}	4×10^{-3}	1×10^{-5}
32×32 Massive System	2.1×10^{-1}	1.3×10^{-1}	6×10^{-2}	2×10^{-2}	7×10^{-3}	2×10^{-3}	0

V. CONCLUSION AND FUTURE WORK

5.1 Conclusions

In a cellular network, the demand for high throughput and reliable transmission is increasing in large scale. One of the architectures proposed for 5G wireless communication to satisfy the demand is Massive MIMO system. The massive system is equipped with the large array of antennas at the Base Station (BS) serving multiple single antenna users simultaneously i.e., number of BS antennas are typically more compared to the number of users in a cell. This additional number of antennas at the base station increases the spatial degree of freedom which helps to increase throughput, maximize the beamforming gain, simplify the signal processing technique and reduces the need of more transmit power. The advantages of massive MIMO can be achieved only if Channel State Information (CSI) is known at BS uplink and downlink operate on orthogonal channels - TDD and FDD modes. In TDD system, the signals are transmitted in the same frequency band for both uplink and downlink channel but in different time slots. Hence, uplink and downlink channels are reciprocal. The estimation of the uplink channel is preferred, as the number of pilots used to estimate the channel is less compared to the downlink channel. Most published research works have considered the rich scattering propagation environment in uplink TDD mode (i.e., number of scatterers tend to be infinity or more than the number of BS antenna and users in the cell).

5.2 Future Work

The Space in time and space in frequency different type of coding methodare usedto reduce BER as compare to the convolution coding method.

- Although coding is a simple, having good BERreduction performance and blessed with the unique advantage of error correction, but finding the best-suited coding technique and the optimal coding rate isavery iterative process.
- In MIMO technique performance depend on many factors such as the number of antenna, antenna spacing and channel. The design of the massive MIMO transmitter and receiver is complex.
- The work can be extended to reduce design complexity by implementing different algorithms. The performance can be verified by different antenna combination.
- The performance can be verified by different channel coding techniques. Further, the system blocks can be implemented on hardware using FPGA) or SDR platform.

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