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Pilot Encoded Wireless Communication System with 5G MIMO Approach

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Abstract - Long Term Evolution (LTE) is the prominent system for QoS and high performance data communication. It is an advanced generation of communication which is being implemented around the world to connect each and every corner of the world together with its high deliverability. The advancements are keep in the progress to get more and more out of it so that it can the form itself its successor and become 5 generation of technology. But it needs lots of improvements to get its first step of and keep in the way of long term as its name. In this context this work has been trying to figure out the one of the advanced technology for high reliability high performance future generation of communication which are being evaluated and being tested by several researchers. This technology is 5G-MIMO. The 5G MIMO based LTE system is simulated with distinct antenna configurations along with higher indexed phase shift keying. A simulation outcome shows the benefits and advantages of 5G-MIMO in the future communication system.

Keywords - MIMO, PSK, Pilot Encoding, 5G, LTE.

I. INTRODUCTION

The information and communication technology (ICT) industry currently connects and man- ages billions of devices across the globe. Currently, we are in the era of 4G and 4.5G networks, which are referred to as Long Term Evolution (LTE) and LTE-Advanced networks respec- tively by standardization bodies. Global trends suggest that future 5G networks should handle up to a 1000-fold increase in the current traffic demands. In addition, a wide spec- trum of services should be supported.

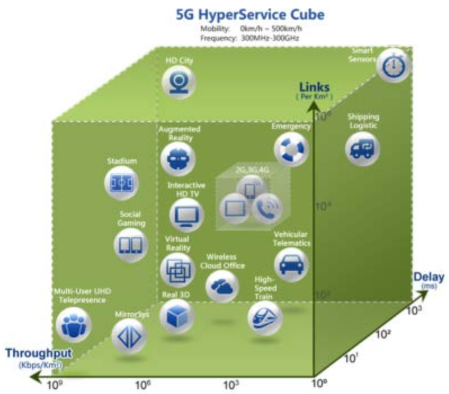


Figure 1.1 Overview of services expected in future 5G networks.

An enormous amount of data has to cross the network, and internet services deliver most of this data. The QoS demands and the rapid growth in bandwidth make 4G mobile networks insufficient to afford user requirements. The next generation mobile network should provide a bandwidth from 100Mbps up to 1Gbps per User Terminal (UT), and a density of connection that exceeds 1M connection/Km2 and high-speed vehicles mobility of up to 500 km/hr and an End-to-End (E2E) delay less than 10ms.

Massive MIMO system is a significant breakthrough, going beyond the conventional MIMO system. In current wireless systems, Massive MIMO is also known as large-scale antenna system, very large MIMO, hyper MIMO and full- dimension MIMO [2]. The most notable characteristic for this new technique is that the number of the antennas deployed at each base station (BS) in every cell is usually several tens or even more, and simultaneously serving tens of users. Moreover, for the same cell, the number of antennas at each BS greatly exceeds the number of active users in the same time-frequency resource.

The large number of antennas at each BS brings many advantages to Massive MIMO systems [5]. Compared with conventional MIMO systems, Massive MIMO systems have the ability to get much more system capacity and energy efficiency [2]. Furthermore, Massive MIMO systems offer robustness to interference such as intentional jamming and unintended man-made interference. Therefore, Massive MIMO systems become a significant part of future 5G wireless communication system. However, as a developing technique, Massive MIMO potentially suffers from some problems, including pilot contamination and architectural challenges.

Massive MIMO is a key component of proposed 5G cellular systems, which has the potential to provide capacity to meet ever-growing data requirements of wireless devices. However, as an emerging technology, Massive MIMO also suffers some challenges. The most serious is pilot contamination, which can greatly reduce the prospective gains of Massive MIMO.

Recent work has extended these results to multiple cell setting, including multi-cell MIMO cooperation. It can be seen from that if the number of users is held fixed, the sum-rate of the system increases with the increase of the number of antennas at the BS, provided that the users themselves have antenna arrays which grow large and the number of data stream per user then needs to grow large (the per-user data rate grows large in this case).

Fig. 1.1 describes the idea of multi-user MIMO systems. In this figure the BS serves a lot of users using the same time and frequency resources. The BS has a antenna array which displays with several antennas, and each user has one antenna.

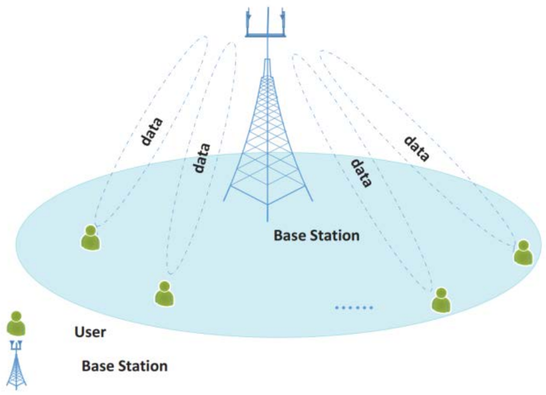


Figure 1.1 A multi-user MIMO system.

II. SYSTEM MODEL

The primary idea behind massive MIMO systems is to massively scale up MU-MIMO systems, by deploying a huge number of antennas in transmitters/receivers, in the order of hundreds or more. In massive MIMO systems, the number of antennas in base stations excessively surpasses the number of active users. Moreover, the base station serves all active users, simultaneously, in the same time-frequency resource.

MIMO systems equipped with multiple antennas at both BSs and users have much higher sum-rate than corresponding single-antenna systems. Generally speaking, the sum-rate of MIMO systems increases linearly with the minimum number of antennas both at each BS and users, as long as the channel knowledge can be available for both communication sides. However, for conventional MIMO systems, the number of antennas is limited. For example, according to the Long Term Evolution (LTE) standard, the data rates during uplink communication are 75 Mbps using 20 MHz of spectrum with 4×4 antennas. Unfortunately, this spectral efficiency is far from enough to meet the requirement of future 5G wireless communication system. Therefore, it is time that a new technique is developed which is able to supply much higher data rate than a traditional MIMO system. The Massive MIMO system, which has much stronger ability to increase the data rate of system, becomes an excellent candidate.

In communications systems with few antennas, signal strength can be momentarily very low due to fading. This happens when scattered signals reach the receiver and the combined waves interfere destructively with each other and the only solution is to wait until the channel has changed enough so the data can be properly received. This delay in reception is called latency. However, as the law of large numbers predicts, if the number of scattered signals is largely increased and the number of antennas is increased as well, it will be more likely that the received signal will be closer to the expected, so fading no longer limits latency. Another result of the large number of antennas is shown in [1] where using a number of base station antennas that greatly exceeds the number of active users linear processing is nearly optimal (with single-antenna users). Additionally, by using maximum-ratio combining (MRC) or maximum-ratio transmission (MRT) in uplink or downlink, respectively, the effects of uncorrelated noise and intracell interference tend to disappear because, as the law of large numbers implies, the channel matrix for a desired user tends to be more orthogonal to an interfering user channel matrix, rendering simple spatial multiplexing procedures with optimal results. Massive MIMO also provides a large excess of degrees of freedom, which can be exploited to provide extremely cheap and power efficient RF amplifiers.

Massive MIMO offers a high level of energy efficiency, in comparison to former wireless systems. In downlink, the base station applies beamforming, which is enhanced with the increased number of antennas, resulting in a more spatially accurate transmission while reducing the radiated power. Furthermore, doubling the number of antennas at base station, the transmit power can be reduced by 3 dB, keeping the same overall performance, in optimal conditions of propagation and processing. In uplink, coherent beamforming achieves a higher array again, allowing a reduced transmit power of each user, favoring all mobile devices.

Since massive MIMO is supposed to be a practical cellular network, it is distributed along multiple cells, as a multicell system. For channel estimation, every terminal has a correspondent training sequence to eliminate intra-cell interference. Additionally, channel estimation must be performed during each coherence interval, and for that reason, the number of mutually orthogonal training sequences must be smaller than the number of elements in each coherence interval. So, depending on the number of coherent time-frequency elements, the training sequences must be reused in other cells. Due to this limitation, pilot contamination may happen. A signal suffers from pilot contamination, when a receiver gets the same pilot sequence from different sources of different cells resulting in an incorrect channel estimate (Figure 2.1). Therefore, pilot contamination limits the performance of non-cooperative MU-MIMO systems.

As the base station estimates inaccurately the desired channel responses, the precoding performed on the transmitted signal is also incorrect. The erroneous precoding decreases significantly the signal-to-interference-plus-noise ratio (SINR) of the whole transmission. Since the base station performs beamforming, in a MRT precoding scheme, the signal power is misplaced due to the estimated channel values, i.e., the desired user receives a less powered signal, and the power lost is redirected as interference to the undesired users with the same training sequence.

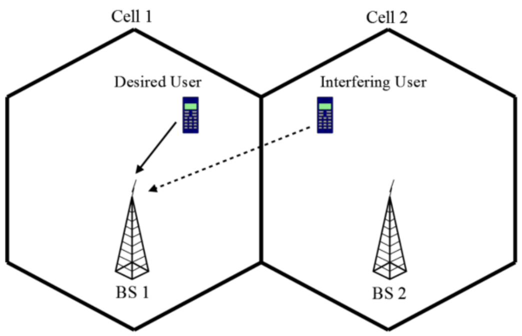


Figure 2.1 Pilot contamination examples when both users transmit mutually non-orthogonal training sequences.

III. PROPOSED SYSTEM

Massive MIMO is a promising concept in 5G cellular networks. The increased number of antennas at the base station combined with MU-MIMO transmission techniques makes massive MIMO more energy-efficient and capable to reach higher spectral efficiency. Figure 3.1 shows the block representation of proposed 5G MIMO system with pilot encoding.

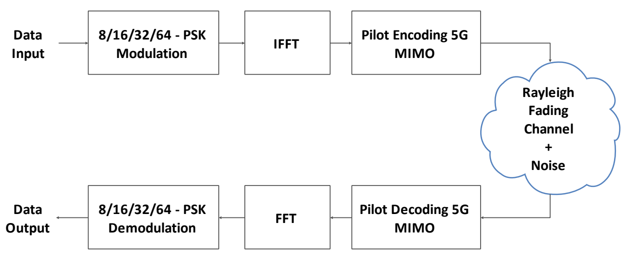


Figure 3.1 Block Diagram.

There following blocks are there in proposed model are described below.

PSK Modulation

Initially on input data PSK modulation has been applied on phase shift keying PSK is a digital modulation scheme. PSK change the phase of reference signal to covey data. Like any other form of shift keying there are different states or points used for data bit signaling. The basic form of binary phase shift keying is known as BPSK. A digital signal alternating between +1 and -1 create phase reversal.

IFFT

An IFFT is used to convert signal from frequency domain to time domain applied on PSK modulated signal. it is a power full tool used in this work to construct frequency component of signal.

Pilot Encoding

A Pilot encoding scheme is applied on the IFFT modulated signals and passed it to channel for transmission.

Channel

A Rayleigh fading channel is used to transmit signal in proposed model for multipath signal reception. The mobile antenna receives a large number, say N, reflected and scattered waves. Because of wave cancellation effects, the instantaneous received power seen by a moving antenna becomes a random variable, dependent on the location of the antenna.

Pilot Decoding

At reception end a pilot decoding scheme is used to decode pilot signal and pilot decoded signals are passed for fast furrier transform.

FFT

To receive original signal from IFFT signal fast furrier transform FFT is applied on pilot decoded received signal.

PSK Demodulation

Finally a PSK demodulation scheme is applied to get original signal from PSK modulated signal at received signal.

Data Output

After completion of entire demodulation process original signal is achieved at receiver end. The step of flow of process proposed scheme has shown in figure 3.2 flow chart of proposed scheme.

The Steps of Simulation are as follows

1. Start Simulation with Matlab Simulation.

2. Define System Parameters for 5G MIMO system.

3. Generate data for transmission over Network.

4. Modulation Data with 8/16/32/64-PSK modulation Scheme

5. Apply IFFT Operation

6. Calculate Signal and Noise Power

7. Generate Noise Signal

8. Apply Pilot Encoding and Transmit through fading channel.

9. Apply FFT Operation at receiver end.

10. Demodulate with 8/16/32/64 PSK demomodulation scheme.

11. Calculate BER and display BER on Matalb Scope.

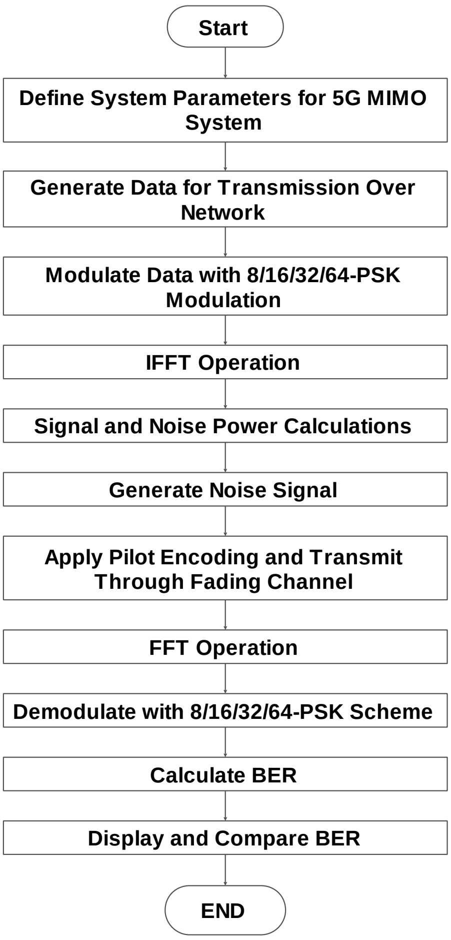


Figure 3.2 Flow Chart

IV. SIMULATION RESULTS

Smulation of proposed system has completed in Matlab Simulink. Simulation results are presented for different modulation orders, for pilot and data subcarriers. In addition, different number of transmit and receive antennas have been used as well as different number of pilot subcarriers.

Mtalab Scope Plot from the Figure 4.1 to Figure 4.5, it can be observed that reducing the modulation order of the pilot subcarrier leads to improvement compared to the case where same modulation order is used. An improvement of is also possible when higher number of pilot subcarriers is used.

It can also be observed from Fig. 4.1 to Fig. 4.5 From the that increasing the number of transmit or receive antennas improves the performances as well as the use of a lower modulation order.

Fig.4.1 show BER Vs SNR Curve observation for 5G MIMO with Antenna Configuration number of Transmitter antenna Tr=4 and number of receiver antenna Rx=4.

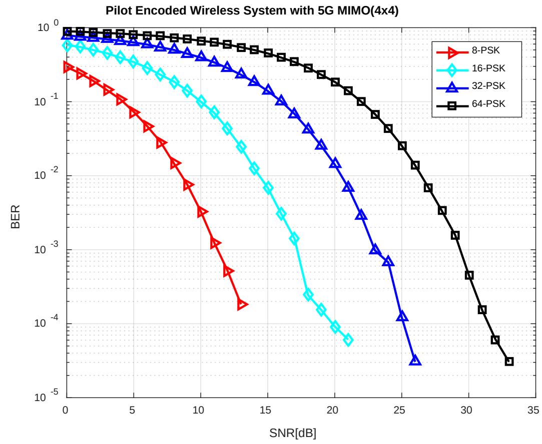


Fig.4.1 BER Vs SNR Curve for 5G MIMO with Antenna Configuration Tx=4 and Rx=4.

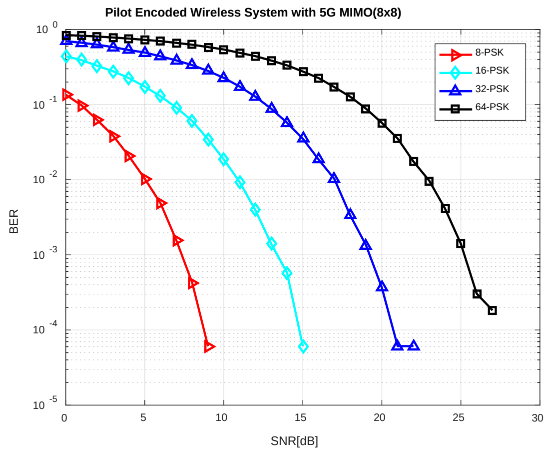
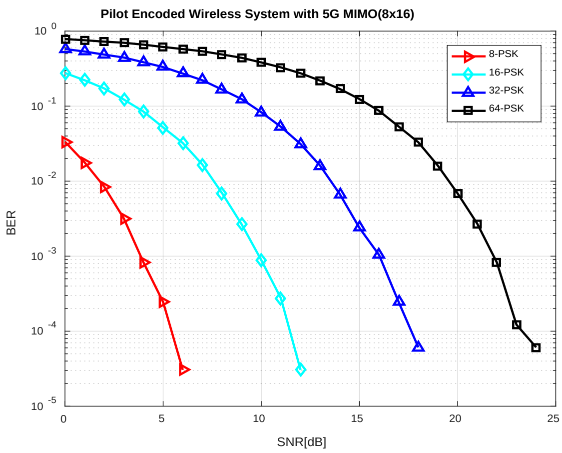


Fig. 4.2 BER Vs SNR Curve for 5G MIMO with Antenna Configuration Tx=8 and Rx=8.



Figured 4.3 BER Vs SNR Curve for 5G MIMO with Antenna Configuration Tx=8 and Rx=16.

Fig.4.2 show BER Vs SNR Curve observation for 5G MIMO with Antenna Configuration number of Transmitter antenna Tr=8 and number of receiver antenna Rx=8. It is clearly visible from last observation of 4 antenna configuration the performance of proposed system has enhancing.

Fig.4.3 show BER Vs SNR Curve observation for 5G MIMO with Antenna Configuration number of Transmitter antenna Tr=8 and number of receiver antenna Rx=16. It is clearly visible from last observation of 8 transmitters and receiver antennas configuration the performance of proposed system has enhancing.

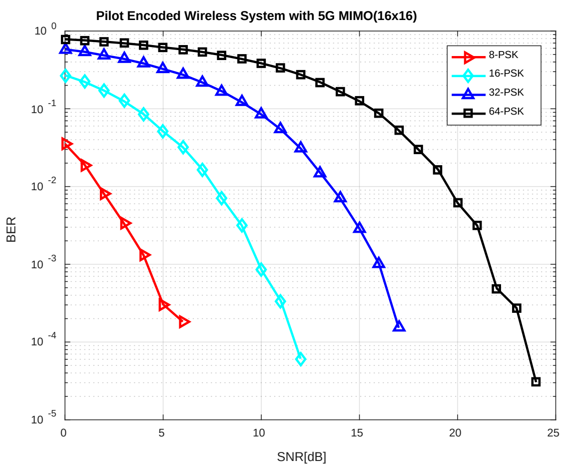


Fig. 4.4 BER Vs SNR Curve for 5G MIMO with Antenna Configuration Tx=16 and Rx=16.

Fig.4.4 show BER Vs SNR Curve observation for 5G MIMO with Antenna Configuration number of Transmitter antenna Tr=16 and number of receiver antenna Rx=16. It is clearly visible from last observation of 8 transmitters and 16 receiver antennas configuration the performance of proposed system has enhancing with respect to previous antenna configuration.

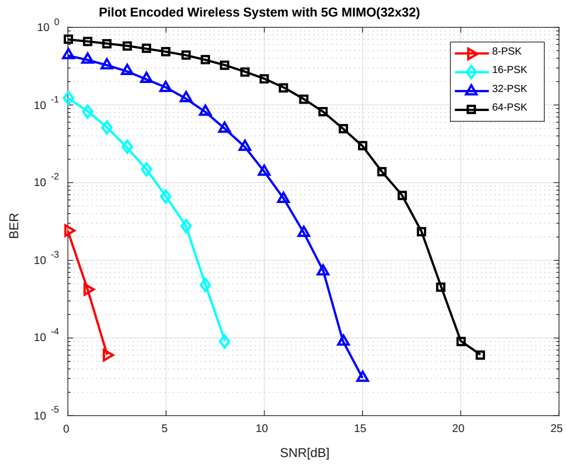


Fig. 4.5 BER Vs SNR Curve for 5G MIMO with Antenna Configuration Tx=32 and Rx=32.

Fig.4.5 show BER Vs SNR Curve observation for 5G MIMO with Antenna Configuration number of Transmitter antenna Tr=32 and number of receiver antenna Rx=32. It is clearly visible from last observation of 16 transmitters and 16 receiver antennas configuration the performance of proposed system has enhancing with respect to previous antenna configuration.

V. CONCLUSION AND FUTURE SCOPES

The rising demand of high speed data transmission over wireless communications for audio, video and internet applications has justified the necessity of upgrading proposed algorithms for narrowband systems to algorithms suitable for wideband systems. Many algorithms on the combination of MIMO with OFDM have been proposed due to its ability to enable a much more reliable and robust transmission in the harsh wireless environment by coding over space, time, and frequency domains.

5G is recognized to be the groundbreaking future of cellular networking. From 5G, massive MIMO is an innovative concept to revolutionize wireless communication systems, and it is intended to be implemented in the near future. In this work, some problems are analyzed that arise with 5G MIMO, more specifically, the increased complexity of channel estimation and proposed a pilot encoded wireless communication system with 5G MIMO approach.

The results presented in this work can be used for future efforts in order to haste the 5G revolution. The fundamental objective of this work is crucial for the development of 5G MIMO and imposes a critical limitation on the anticipated system’s performance in terms of BER and SNR.

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