A Novel Adaptive Pilot Estimation for Channel Estimation in Massive-MIMO-OFDM System

Tariq Hussain[1], Asst. Prof. Nehul Mathur[2]

[1]M.Tech. Scholar, [2]Guide

Department of Electronics and Communication Engineering, BIT, Bhopal

Abstract* – Channel state information is very useful in the applications where wireless channel is so much random in nature and estimation of the channel can be done by various methods. Channel estimation methods can be varying according to the system. As for current generation of wireless communication 5G or 3GPP-LTE is the latest generation. So keeping that point this research work has been completed. This work is developed to estimate channel efficiently using adaptive pilot estimator (APE) for the Massive-MIMO-OFDM system. In this work mean square error (MSE) is calculated and the outcomes are very impressive for 15dB and higher range of SNR. The proposed system is simulated with m-PSK modulation scheme to keep communication on faster rate. As we go higher values of m-PSK system requires more SNR level to perform, but with lower values of m-PSK it is quite lower values.

***Keywords* – APE, Massive MIMO, OFDM, MSE, Pilot Estimator, m-PSK.**

I. INTRODUCTION

It is the demand for high-speed reliable communications with significantly improved user experience that drives the development of the Fifth Generation (5G) wireless communication networks. It has been widely accepted that the capacity of 5G wireless communication systems should achieve 1000 times larger than the Fourth Generation (4G) Long Term Evolution (LTE)/LTE-Advanced (LTE-A) wireless communication system. Also, spectral efficiency is required to reach 10 times with respect to current 4G LTE-A, which is equivalent to 10 Gbps peak data rate for low mobility users and 1 Gbps peak data rate for high mobility users.

Multiple-Input Multiple-Output (MIMO) technology has been attracting researchers' attention for its capability of providing improved link reliability and system capacity without extra spectral resources. MIMO has been deployed in a number of advanced wireless communication systems such as WiMAX and LTE. The latest LTE standard, for instance, can support up to 8-layer transmission which is equivalent to at least 8 antennas at the Base Station (BS) and 8 antennas at the mobile station Mobile Station (MS).

Recently, massive MIMO technology has appealed to many researchers due to its promising capability of greatly improving spectral efficiency, energy efficiency, and robustness of the system. In a massive MIMO system, both the transmitter and receiver are equipped with a large number of antenna elements (typically tens or even hundreds) as illustrated in Fig. 1.1. It should be noticed that the transmit antennas can be co-located or distributed in different applications. Also, the enormous number of receive antennas can be possessed by one device or distributed to many devices. A massive MIMO system can not only enjoy the benefits of conventional MIMO systems, but also significantly enhance both spectral efficiency and energy efficiency, because Inter-Channel Interference (ICI) is averaged in massive MIMO when the number of antennas is sufficiently large according to the Law of Large Numbers (LLN). Hence, channel capacity can be achieved even with simple match filtering beamforming or receiver.

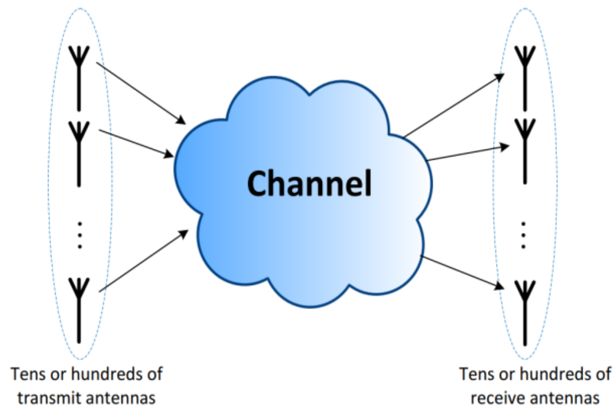

Fig.1.1 A diagram of massive MIMO system

Although massive MIMO systems can offer many advantages, there are several major challenges that have to be addressed before their practical deployment. First, it is essential for the transmitter to acquire the Channel State Information (CSI) to fully enjoy the capacity gain offered by massive MIMO systems, especially for multi-user scenarios. However, as the number of antennas increases, the overhead of acquiring CSI grows accordingly. To overcome the issues and to enhance the performance a novel adaptive pilot estimation for channel estimation in Massive-MIMO-OFDM system has been reported in this examination work.

II. SYSTEM MODEL

Multipath fading channels for broadband communication are usually frequency selective. Channel estimations make it possible to adapt transmissions to channel conditions in order to achieve acceptable performance in multipath fading environments. For instance, implementing equalization to avoid ISI requires CSI. In massive MIMO system, channel estimation is crucial for downlink precoding. Without reliable CSI estimation, the performances of the massive MIMO system will degrade assume the OFDM technique is used in combination of the MIMO system, i.e., MIMO-OFDM system.

In multipath fading channel, due to the mobility of the user and the scattering of the propagation environment, many signal paths exist and this path can add up constructively or destructively. As a result, the channel changes randomly with time and frequency. Compared with transmitted signal bandwidth and symbol duration, wireless channel is roughly divided into four types: flat fading, frequency selective fading, fast fading, and slow fading. For high data rate streams, since the transmitted signals occupy wide bandwidths, the multipath channels are usually frequency selective channel (provided that the coherence bandwidth of the channel is comparable or smaller than the transmitted signal bandwidth). A time-varying and frequency-selective channel can be modeled in Fig. 2.1.where T_s sampling interval,$c_1(t)$and $\tau_1$lare the channel impulse response of the l-th channel tap,respectively, and there are in total L channel taps.

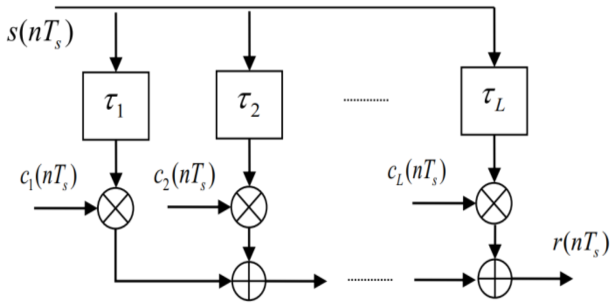

Fig.2.1 Discrete-time model a time frequency-varying channel

Channel estimation techniques can be divided into two categories: data aided (using training symbols) and non-data aided (blind channel estimation). For OFDM systems, the non-data aided method usually makes use of the presence of CP or finite alphabet property of the input data. Since it does not require any preamble, the non-data aided channel estimation enjoys high spectrum efficiency. However, it usually requires many signal samples before reaching convergence, which results in long estimation latency. The data-aided channel estimation, on the other hand, is widely used because of its reliable estimation performance. There are many data-aided channel estimation techniques, for example: least square (LS), minimum mean-square error (MMSE), and maximum likelihood (ML) algorithms.

III. PROPOSED METHODOLOGY

Large antenna array in a MIMO system simplifies the process (due to the averaging nature of an oversized array), in an exceedingly method that even matched channel will be used asymptotically in a perfect channel for detection and beamformin. Todesign and evaluate the performance of large MIMO wireless communication systems, correct and economical channel models capturing key characteristics of large MIMO channels are indispensable. However, sure key characteristics of massive MIMO channels like the near field result and non-stationary behaviors of cluster on the array axis are missing in existing typical MIMO channel models. In other words, these conventional MIMO channel models are not sufficiently accurate for performance evaluation of massive MIMO wireless communication systems. Wireless communication researchers may have diverse requirements on the wireless channel models. More accurate channel models are required for practical wireless system design and simulation. Efficient and mathematically tractable channels are useful for theoretical analysis. A novel adaptive pilot estimation for channel estimation in Massive-MIMO-OFDM system has been developed and simulated in MATLAB simulation environment. Schematic model of projected system has been shown in Fig. 3.1. A massive Multiple-Input Multiple-Output (MIMO) system is equipped with much more antennas, typically tens or hundreds, than conventional MIMO systems. With such a massive range of antennas, it's been illustrated that a massive MIMO system is ready to supply several advantages, like greatly increasing the capability, simplifying planning style within the frequency domain, and averaging interference in keeping with the large number theorem. Typically speaking, a Massive MIMO system is thought of as an updated version of typical MIMO by utilizing a vast range of antennas. As a result, its system performance, in terms of capability, efficiency, and reliability, is considerably higher than standard MIMO systems. To design and evaluate MIMO systems, an accurate small-scale fading MIMO channel model is necessary. The fundamental blocks of proposed system are discussed below.

- Data Input
- m-PSK Modulation
- OFDM Modulator
- Massive MIMO
- Massive MIMO with Pilot Estimation
- OFDM Demodulation
- M-PSK Demodulation
- Data Output

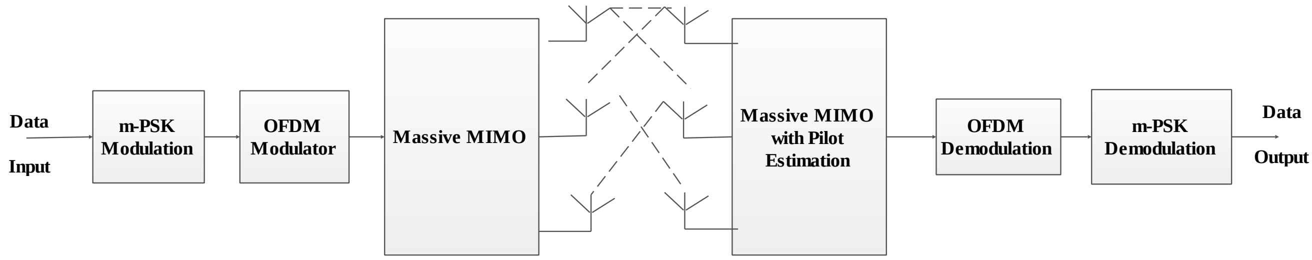

Fig. 3.1Schematic model of proposed system

At the transmitter end input data which is to be transmitted utilizingproposed system based on APE approach are provided as input data. The m-ary phase shift keying (m-PSK) modulation is employed during this methodology output may be a baseband illustration of the modulated input. The m-ary represents m number of points in the signal constellation.Now the OFDM modulation technique is applied on m-psk modulated signal. Now the prepared modulated signal is transmitted over massive MIMO system which is configured with massive number of antennas as shown in Fig.3.1. At the receiver end Massive MIMO with pilot estimation receive this signal and apply pilot estimation method on it.

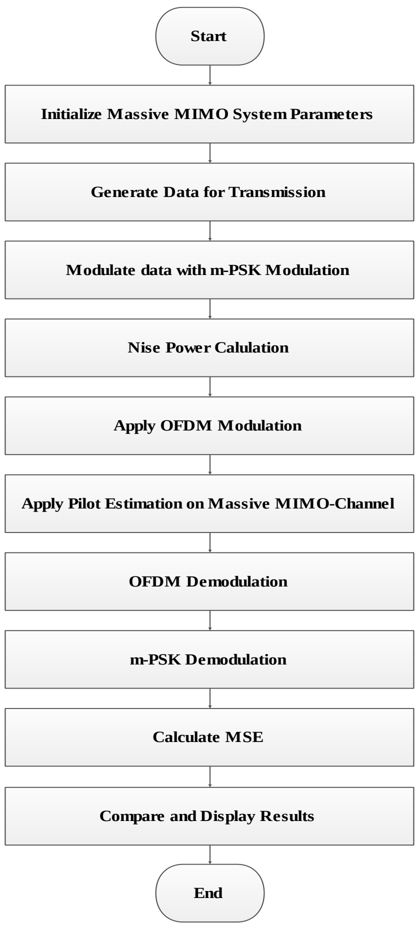

Fig.3.2 Process Flow of proposed approach

For an OFDM mobile communication system, the channel transfer operate at completely different subcarriers seems unequal in each frequency and time domains. Therefore, a dynamic estimation of the channel is critical. Most of the pilot methods are used to estimate the channel characteristics and alter and correct the received signal. The pilot signal allocated to a specific OFDM block, which is sent in the time domain on a regular basis. For slow-fading radio stations, this sort of pilot arrangement is particularly appropriate. Since the training block includes all pilots, there is no need for channel interpolation in the frequency domain. This sort of pilot scheme is therefore comparatively insensitive to selectivity of frequencies. Now the estimated signal by pilot estimation massive MIMO is demodulated with OFDM demodulator followed by m-PSK demodulation. Finally the actual information is recovered at the receiver end. Process flow of proposed system in MATLAB simulation environment has shown in Fig. 3.2.

IV. SIMULATION OUTCOMES

AMassive-MIMO-OFDM system is designed using Matlab to vary and test different parameters of the scheme. The aim of doing the simulations is to measure the performance of Massive-MIMO-OFDM system under different channel conditions, and to allow for different Massive-MIMO-OFDM configurations to be tested.The information to be transferred is modulated in M-ary PSK format for each carrier. The information is mapped for each symbol. Modulation is used in simulations 8-PSK, 16-PSK, 32-PSK.

The simulations show that under the ideal channel conditions, the performances of all the different methods converge, as the number of antennas grows large. This is not surprising, because it is already predicted by the theories. However, the rates of the convergence for different algorithms are not the same. Practical considerations put some constraints on the ultimate performance achievable by massive MIMO. One such restriction modeled in the simulations is correlation among antenna elements.

Additionally, large-scale fading, i.e., pathloss and shadow fading for massive MIMO should be included in the standardized massive MIMO channel model. Moreover, other scenarios such as cooperative communications and HST communications in tunnels should be considered as well.

Fig.4.1 shows the MSE Performance of the proposed APE technique in Massive-MIMO-OFDM System with 32-PSK Scheme for different configuration of MIMO such as 8X8 Massive MIMO, 16X16 Massive MIMO, 32X32 Massive MIMO, 64X64 Massive MIMO.

Fig.4.2 shows MSE Performance of the proposed APE technique in Massive-MIMO-OFDM System with 16-PSK Scheme for various antenna configuration of MIMO such as 8X8 Massive MIMO, 16X16 Massive MIMO, 32X32 Massive MIMO, 64X64 Massive MIMO.

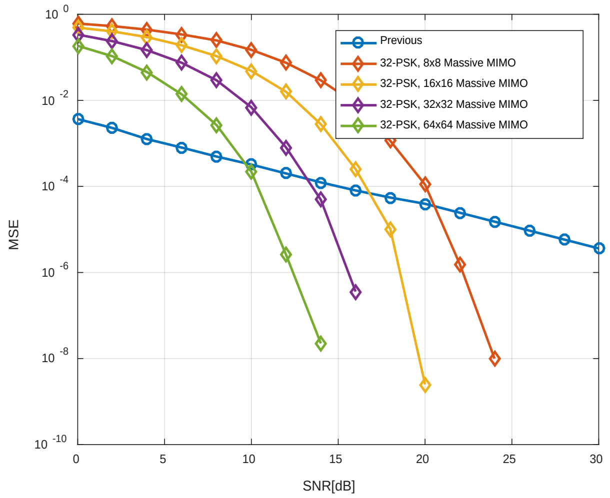

Fig.4.1 MSE Performance of the proposed APE technique in Massive-MIMO-OFDM System with 32-PSK Scheme

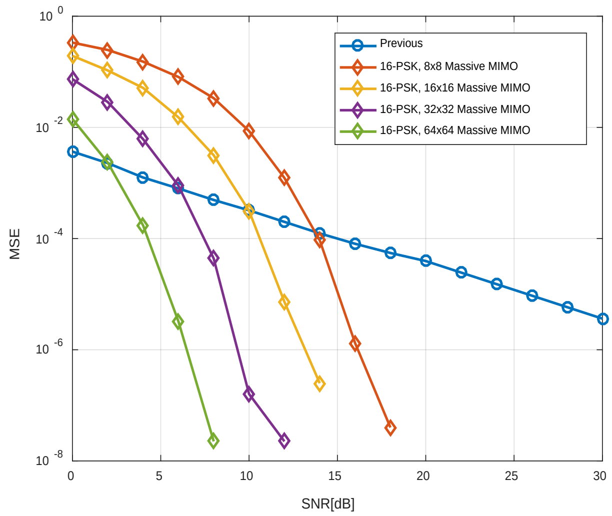

Fig.4.2 MSE Performance of the proposed APE technique in Massive-MIMO-OFDM System with 16-PSK Scheme

Fig.4.3 shows MSE Performance of the proposed APE technique in Massive-MIMO-OFDM System with 8-PSK Scheme for various antenna configuration of MIMO such as 8X8 Massive MIMO, 16X16 Massive MIMO, 32X32 Massive MIMO, 64X64 Massive MIMO

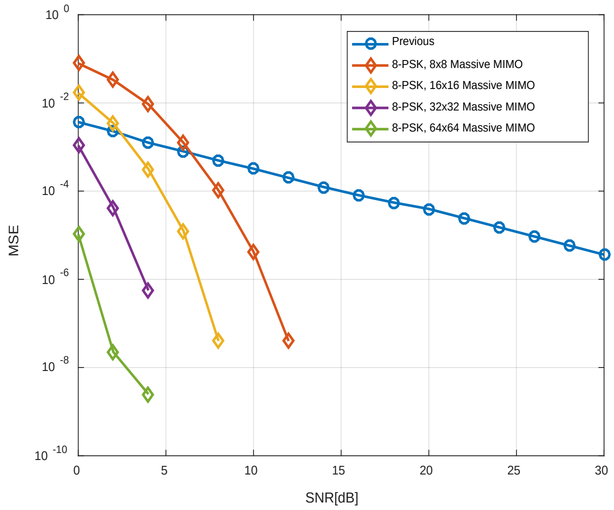

Fig.4.3 MSE Performance of the proposed APE technique in Massive-MIMO-OFDM System with 8-PSK Scheme

V. CONCLUSION AND FUTURE SCOPES

In This research work, examination of the MSE results of the proposed APE in the Massive-MIMO-OFDM system with m-PSK modulation system has been carried out for pilot adaptive block type estimators. Given some information about channel statistics, the estimators in this research can be used to effectively predict the channel in Massive-MIMO-OFDM scheme. The estimators of MSE suppose a priori knowledge of noise variance and covariance of channels.For many facilities such as video, high-quality audio and mobile embedded service digital network, data transmission at high bit rates is crucial in present and future mobile communications systems.When information is transferred at high bit rates over mobile radio stations, the channel impulse response can stretch over many periods of symbols, resulting in interference with inter-symbols (ISI). One of the promising applicants to mitigate the ISI is the Orthogonal Frequency Multiplexing Division (OFDM).The massive MIMO system has received lots of attention for its potential of increasing data rate, improving reliability and energy efficiency, and reducing interferences. However, the massive MIMO system, equipped with hundreds of (or even more) BS antennas, also imposes challenges in signal processing complexity and hardware costs. While it is impossible to address all of the challenging issues in future study we will consider implementation of interpolation techniques for channel estimation and noise elimination from information.

REFERENCES

[1]. Y. Huang, Y. He, Q. Luo, L. Shi and Y. Wu, "Channel Estimation in MIMO - OFDM Systems based on a new adaptive greedy algorithm," in IEEE Wireless Communications Letters.

[2]. M. Mohammadkarimi, E. Karami, O. A. Dobre and M. Z. Win, "Doppler Spread Estimation in MIMO Frequency-Selective Fading Channels," in IEEE Transactions on Wireless Communications, vol. 17, no. 3, pp. 1951-1965, March 2018.

[3]. K. Mawatwal, D. Sen and R. Roy, "A Semi-Blind Channel Estimation Algorithm for Massive MIMO Systems," in IEEE Wireless Communications Letters, vol. 6, no. 1, pp. 70-73, Feb. 2017.

[4]. Q. Qin, L. Gui, B. Gong, J. Xiong and X. Zhang, "Compressive sensing based time-varying channel estimation for millimeter wave systems," 2017 IEEE International Symposium on Broadband Multimedia Systems and Broadcasting (BMSB), Cagliari, 2017, pp. 1-6.

[5]. Tianjun Liu, Kaili Zheng and Ping Wang, "Compressive sensing based channel estimation for scattered pilot OFDM Systems over doubly-selective Rician channel," 2016 25th Wireless and Optical Communication Conference (WOCC), Chengdu, 2016, pp. 1-5.

[6]. F. Zabini, G. Pasolini and O. Andrisano, "Design Criteria for FIR-Based Echo Cancellers," in IEEE Transactions on Broadcasting, vol. 62, no. 3, pp. 562-578, Sept. 2016.

[7]. S. Manzoor, A. S. Bamuhaisoon and A. N. Alifa, "Channel estimation for MIMO-OFDM systems," 2015 5th National Symposium on Information Technology: Towards New Smart World (NSITNSW), Riyadh, 2015, pp. 1-7.

[8]. Wang R, Cai J, Yu X, et al. Compressive channel estimation foruniversal filtered multi-carrier system in high-speed scenarios[J]. Iet Communications, 2017, 11(15):2274-2281.

[9]. Zhang Y, Venkatesan R, Dobre O A, et al. Novel Compressed Sensing- Based Channel Estimation Algorithm and Near-OptimalPilot Placement Scheme[J]. IEEE Transactions on Wireless Communications, 2016, 15(4):2590-2603.

[10]. He X, Song R, Zhu W P. Pilot Allocation for Distributed-Compressed- Sensing-Based Sparse Channel Estimation in MIMO-OFDM Systems[J]. IEEE Transactions on Vehicular Technology, 2016, 65(5):2990-3004.

[11]. Yang H, Chen J, Su S. Noise Reduction for Chaotic Time Series Based on Singular Entropy[C]. Sixth International Symposium on Computational Intelligence and Design. IEEE Computer Society, 2013:216-218.

[12]. Candès, Emmanuel J. The restricted isometry property and its implications for compressed sensing. Comptes rendus - Mathématique, 2008, 346(9):589-592.