5G Multi-Carrier MIMO-OFDM Systems using Time-Frequency Joint Channel Estimation Technique

Navneet Kumar and Prof. Amrita Khera
M. Tech. Scholar, Dept. of Electronics and Communication Engg., TITR, Bhopal, India
Assistant Professor, Dept. of Electronics and Communication Engg., TITR, Bhopal, India

Abstract— The fifth generation of mobile communication systems (5G) promises unprecedented levels of connectivity and quality of service (QoS) to satisfy the incessant growth in the number of mobile smart devices and the huge increase in data demand. One of the primary ways 5G network technology will be accomplished is through network densification, namely increasing the number of antennas per site and deploying smaller and smaller cells. Massive MIMO, where MIMO stands for multiple-input multiple-output, is widely expected to be a key enabler of 5G. Further improvement of the performances of such systems is critical to practical applications and is achieved by the use of some intelligent algorithms proposed based on local optimization, defining fitness function and object function. Such intelligent algorithms can solve the optimization problems, such as calculating the maximum value or the minimum value of a function in a solution space. In signal detection, an intelligent algorithm takes the maximum likelihood function as the objective function, and the solution space are all possible transmit signal vectors.

Keywords— Massive MIMO, Channel State Information, Square Root-Recursive Least Square (QR-RLS), QAM Modulation

I. INTRODUCTION

Living styles of people and communication inter se have brought in feasibility and flexibility of wireless transmissions along. The escalating need to perfect wireless communication systems for faster data transmission and high information quality, multimedia communications, live video streaming and content sharing are expected to be delivered in an effective and efficient way. Some factors pose problems in perfecting an efficient wireless communication system, although wireless systems have overcome numerous challenges from wireline systems. There are two critical factors that prove to be obstacles to building an efficient communication system namely multipath fading and signal interference. Fading is a phenomenon that is caused by small-scale effects of the multipath that resulting in variations in time of channel strength. Large scale variation scan be the result of the path loss which arise from attenuation owing to long distances or the shadowing due to large obstacles. The wireless communications will be practiced with the over-the-air where systems that tend to face several issues in their transmission that leads to loss of signal. These interferences may be caused by the use of one transmitter to that of a common receiver. The learning for overcoming such challenges to improve the efficiency of a communication system is the prime focus this of research.

The features of such Wireless communication include, (1) The effectiveness of cost: Wired communication networks are less expensive and do not need any elaborate maintenance or infrastructure. In wireless communication, investment in time for planning and labor is not necessary. Even though wireless communication includes cabling, the expense involved is a very small fraction of what is required for wired communication. (2) Flexibility: A wireless communication enables people to stay in an office or a telephone booth for sending and receiving messages. Any wireless transmitter has the ability to accommodate a number of receivers in which the wired communication system is limited to the physical connections of the equipment. Furthermore, this also has a plan for disaster recovery. (3) Convenience: Wireless communication devices such as mobile phones are quite easy to use. This permits anyone to make use of the phone with no regard to their place. There is no requirement for physical interaction to pass messages. The constant connectivity ensures the ability of people to respond to emergencies quickly. Radio communication and television broadcasting are ideal examples for articulating the important role played by wireless communication in our lives. Both such applications make use of technology where they carry many signals simultaneously using the same channel. Such a technique is known as multiplexing of frequency division. This is a technique which divides the entire bandwidth into a series of some frequency sub-bands that are non-overlapping and carrying some individual signals.

II. CHANNEL ESTIMATION

Radio propagation in a mobile radio channel is characterized mainly by its multipath nature. Multiple reflections are sometimes a Line of sight component of the transmitted signal arrive at the receiver via different propagation path and with different amplitude and delay time. Multipath propagation is a resultant phenomenon of the radio signals reaching receiving antenna by more than one path. Reflection from terrestrial objects like mountains and buildings, atmospheric ducting, ionospheric reflection and refraction is among the effects of multipath. Constructive and destructive signal interference and phase shifting of the signal are known effects of the multipath propagation. This leads to Rayleigh fading which has been named after Lord Rayleigh. A distribution called the Rayleigh distribution is obtained by the standard statistical model of this. Fading is defined as the distortion, which a carrier modulated telecommunication signal experiences over a propagation medium. It is sometimes referred to as multipath induced fading. Itis caused by multipath propagation. Fading channels are the alternative class of channel which in modeling a communication system. This is due to the adverse effects of multipath propagation on mobile reception.

III. PROPOSED METHODOLOGY

The MIMO-OFDM device modified into applied with the useful resource of MATLAB/SIMULINK. The execution device is binary facts this is modulated the use of QAM and mapped into the constellation elements.

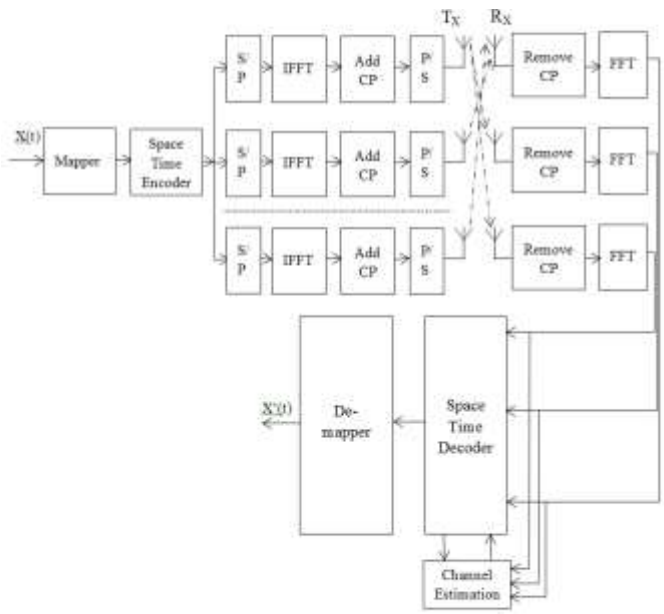

Figure 1: Massive MIMO System Models with Channel Estimation Technique

The virtual modulation scheme will transmit the records in parallel by means of manner of assigning symbols to every sub channel and the modulation scheme will determine the phase mapping of sub-channels thru a complex I-Q mapping vector show in figure 1. The complicated parallel facts stream must be converted into an analogue signal this is suitable to the transmission channel.

The complicated parallel facts stream has to be transformed into an analogue sign that is suitable to the transmission channel. It is performed to the cyclic prefix add to the baseband modulation signal because the baseband signal is not overlap. After than the signal is splitter the two or more part according to the requirement.

Time-Frequency Joint Channel Estimation

A channel tracking for the TFT-OFDM is realized from that of the time-frequency training symbol in TFT-OFDM by the time-frequency joint channel estimation in different sequential steps: 1) A TS- based estimation of path delay estimation 2) A Pilot-based path gain estimation. The outline of a time-frequency joint estimation is shown in Figure 2.

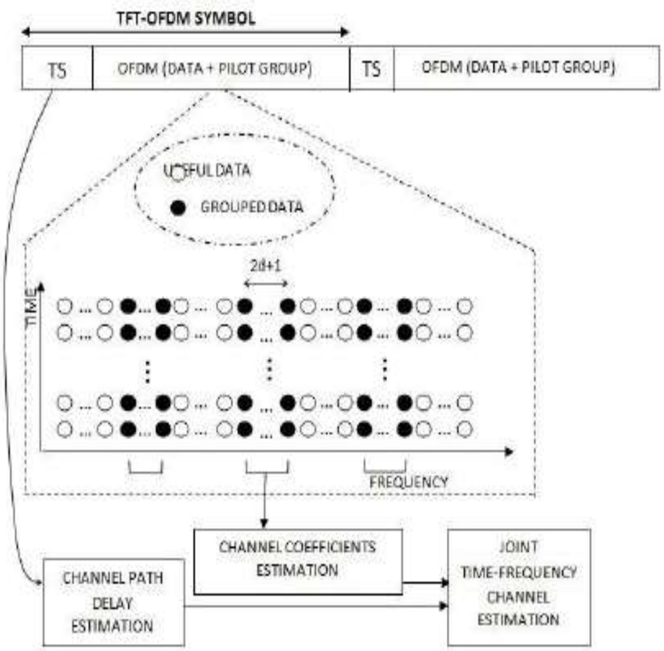

Figure 2: Time – Frequency Joint Channel Estimation

The Training Sequence of ith TFT-OFDM symbol received has been defined as

$$d_i = \sum_{p=1}^{N_t}\left(h_{-i,ISI}^{(p)}\, z_i^{(p)} + h_{-i,IBI}^{(p)}\, x_{i,N-M:N-1}^{(p)}\right) + v_i$$

and in the second term, the received TS in the d_i is contaminated by an IBI, through preceding the OFDM data blocks. Even without the cancellation of the interference, a path delay is considered as leading to an inaccurate estimation. On the basis of the wireless channels in which the variation the path delay slower than that of the path gains, the actual averaged path delay and its estimation for the β adjacent TFT-OFDM symbols taking β are considerably (> 10). This averaged path delay, and its estimations shown as, and their path gains are discarded directly as it is inaccurate owing to the absence of cancellation of interference.

Different Modulation Technique:-

Binary Phase Shift Keying (BPSK) is a two phase modulation scheme, where the 0's and 1's in a binary message are represented by two different phase states in the carrier signal: θ=0∘ for binary 1 and θ=180∘ for binary 0.

Quadrature Amplitude Modulation (QAM)

Many data transmission systems migrate between the different orders of QAM, 16-QAM, 32-QAM and 64-QAM, dependent upon the link conditions. If there is a good margin, higher orders of QAM can be used to gain a faster data rate, but if the link deteriorates, lower orders are used to preserve the noise margin and ensure that a low bit error rate is preserved.

As the QAM order increases, so the distance between the different points on the constellation diagram decreases and there is a higher possibility of data errors being introduced. To utilize the high order QAM formats, the link must have a very good E_b/No otherwise data errors will be present. When the E_b/No deteriorate, then other the power level must be increased, or the QAM order reduced if the bit error rate is to be preserved.

IV. SIMULATION RESULT

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 system is shown in figure 3. For different value of SNR, the implemented QR-RLS based channel estimation for 8×8 system shows BER reduction performance.

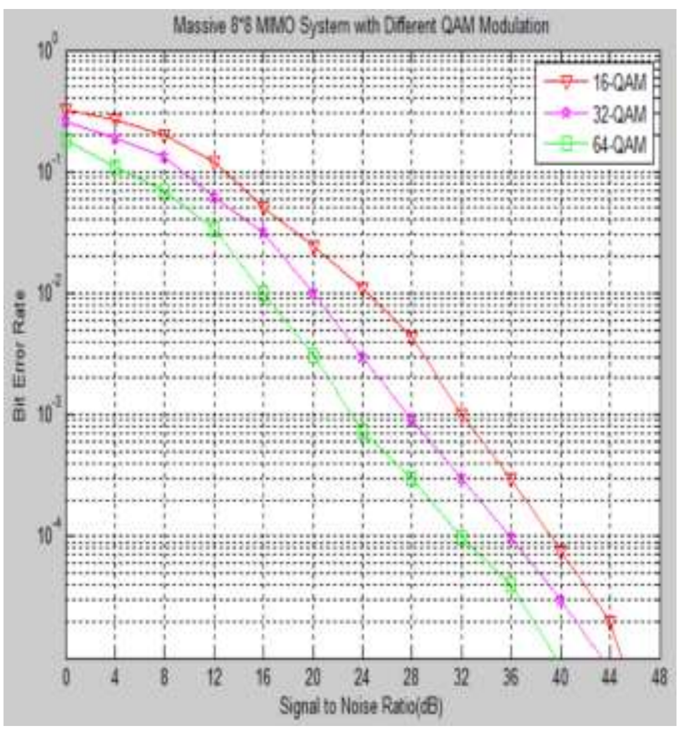

Figure 3: BER vs SNR for Massive 8×8 System with Time – Frequency Joint Channel Estimation

Simulation experiments are conducted to evaluate the SNR VS BER performance of the proposed algorithm 16×16 system is shown in figure 4.

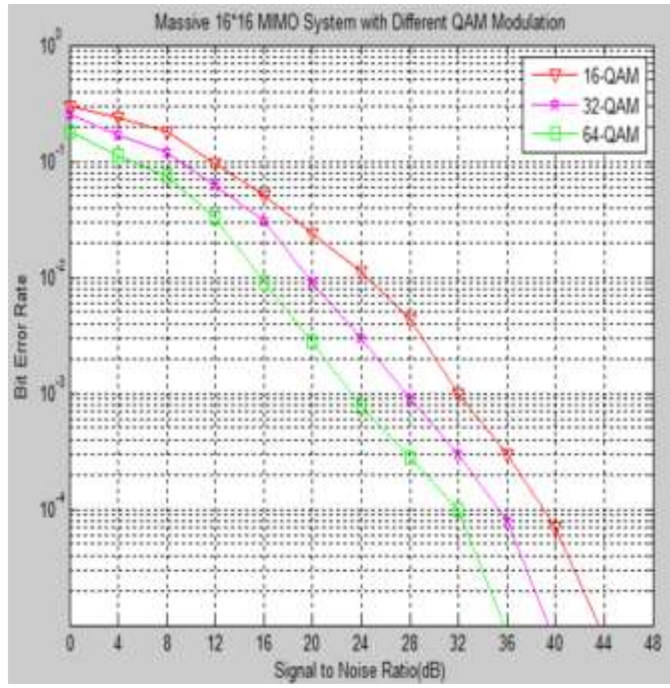

Figure 4: BER vs SNR for Massive 16×16 System with Time – Frequency Joint Channel Estimation

Simulation experiments are conducted to evaluate the SNR VS BER performance of the proposed algorithm 32×32 system is shown in figure 5.

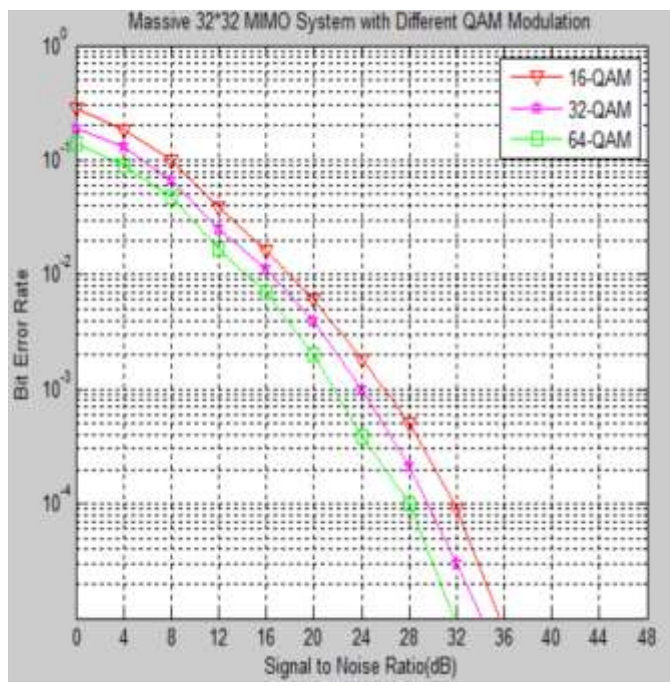

Figure 5: BER vs SNR for Massive 32×32 System with Time – Frequency Joint Channel Estimation

Simulation experiments are conducted to evaluate the SNR verse spectrum efficiency 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 system is shown in figure 6.

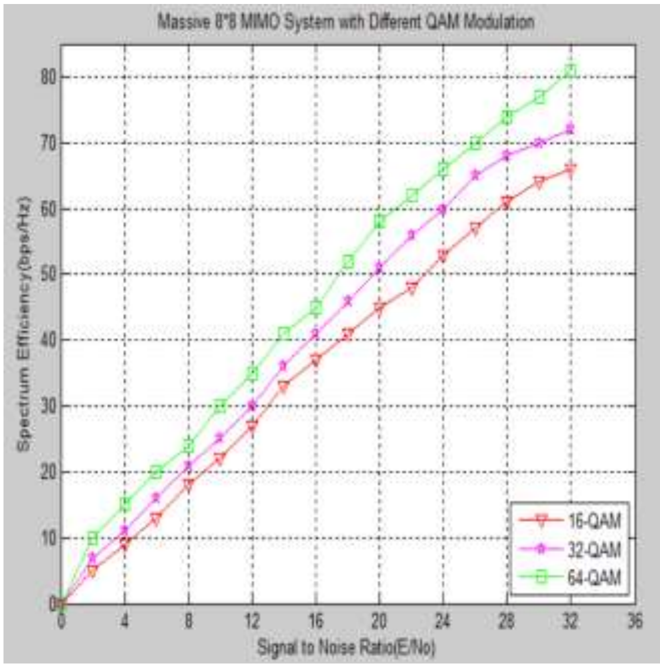

Figure 6: Spectrum Efficiency vs SNR for Massive 8×8 System with Time – Frequency Joint Channel Estimation

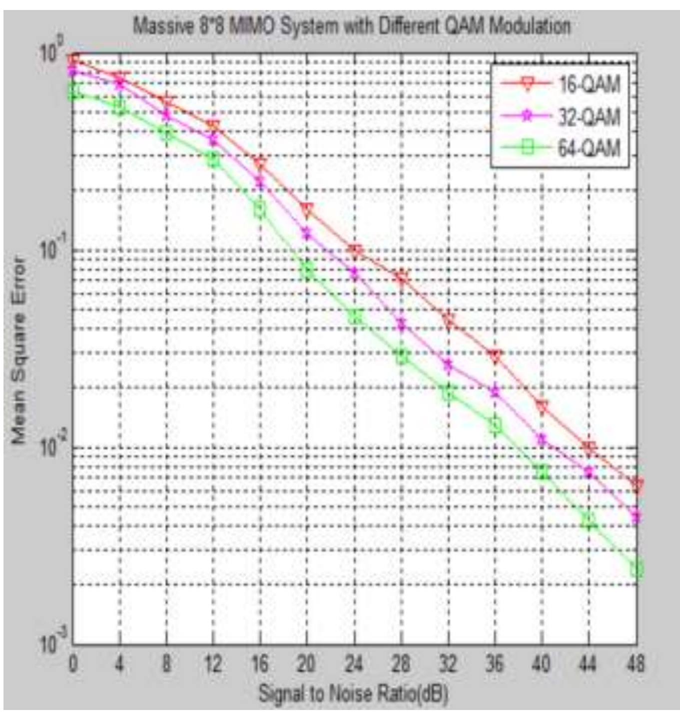

Figure 7: MSE vs SNR for Massive 8×8 System with Time – Frequency Joint Channel Estimation

V. CONCLUSION

We have developed a method for tracking the error for receiver side with knowing the transmit pre-coder or data. The proposed method is particularly useful in minimize the error in receiver side. The proposed time-frequency joint channel estimation technique with different QAM modulation technique is applied for different transmitter and receiver antenna and calculated bit error rate (BER) and spectrum efficiency with respect to signal to noise ratio (SNR). Simulation result is clear that the 32×32 transmitter and receiver antenna is best performance compared to 16×16, 8×8 transmitter and receiver antenna.

REFRENCES

[1] Tipparti Anil Kumar and Lokam Anjaneyulu, “Channel Estimation Techniques for Multicarrier OFDM 5G Wireless Communication Systems”, 10th International Conference on System Engineering and Technology (ICSET), IEEE 2020.

[2] X. Kuai, L. Chen, X. Yuan and A. Liu, "Structured Turbo Compressed Sensing for Downlink Massive MIMO-OFDM Channel Estimation," in IEEE Transactions on Wireless Communications, vol. 18,no.8,pp.3813-3826,Aug.2019.

[3] A. N. Uwaechia and N. M. Mahyuddin, "Spectrum-Efficient Distributed Compressed Sensing Based Channel Estimation for OFDM Systems Over Doubly Selective Channels," in IEEE Access, vol. 7,pp.35072-35088, 2019.

[4] Supraja Eduru and Nakkeeran Rangaswamy, “BER Analysis of Massive MIMO Systems under Correlated Rayleigh Fading Channel”, 9th ICCCNT IEEE 2018, IISC, Bengaluru, India.

[5] H. Q. Ngo A. Ashikhmin H. Yang E. G. Larsson T. L. Marzetta "Cell-free massive MIMO versus small cells" IEEE Trans. Wireless Commun. vol. 16 no. 3 pp. 1834-1850 Mar. 2017.

[6] Huang A. Burr "Compute-and-forward in cell-free massive MIMO: Great performance with low backhaul load" Proc. IEEE Int. Conf. Commun. (ICC) pp. 601-606 May 2017.

[7] H. Al-Hraishawi, G. Amarasuriya, and R. F. Schaefer, “Secure communication in underlay cognitive massive MIMO systems with pilot contamination,” in In Proc. IEEE Global Commun. Conf. (Globecom), pp. 1–7, Dec. 2017.

[8] V. D. Nguyen et al., “Enhancing PHY security of cooperative cognitive radio multicast communications,” IEEE Trans. Cognitive Communication And Networking, vol. 3, no. 4, pp. 599–613, Dec. 2017.

[9] R. Zhao, Y. Yuan, L. Fan, and Y. C. He, “Secrecy performance analysis of cognitive decode-and-forward relay networks in Nakagami-m fading channels,” IEEE Trans. Communication, vol. 65, no. 2, pp. 549–563, Feb. 2017.

[10] W. Zhu, J. and. Xu and N. Wang, “Secure massive MIMO systems with limited RF chains,” IEEE Trans. Veh. Technol., vol. 66, no. 6, pp. 5455–5460, Jun. 2017.

[11] R. Zhang, X. Cheng, and L. Yang, “Cooperation via spectrum sharing for physical layer security in device-to-

device communications under laying cellular networks," IEEE Trans. Wireless Communication, vol. 15, no. 8, pp. 5651–5663, Aug. 2016.

[12] K. Tourki and M. O. Hasna, "A collaboration incentive exploiting the primary-secondary systems cross interference for PHY security enhancement," IEEE J. Sel. Topics Signal Process., vol. 10, no. 8, pp. 1346–1358, Dec 2016.

[13] T. Zhang et al., "Secure transmission in cognitive MIMO relaying networks with outdated channel state information," IEEE Access, vol. 4, pp. 8212–8224, Sep. 2016.

[14] Y. Huang et al., "Secure transmission in spectrum sharing MIMO channels with generalized antenna selection over Nakagami-m channels," IEEE Access, vol. 4, pp. 4058–4065, Jul. 2016.

[15] Y. Deng et al., "Artificial-noise aided secure transmission in large scale spectrum sharing networks," IEEE Trans. Communication, vol. 64, no. 5, pp. 2116–2129, May 2016.