CHANNEL ESTIMATION FOR SPACE-TIME BLOCK CODING MIMO OFDM WIRELESS NETWORKS

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Abstract- Channel estimation is a challenging problem for space time block coding (STBC) multipleinput and multiple-output orthogonal frequency division multiplexing (MIMO-OFDM) systems in dynamic environments. To handle this problem and improve the system performance, this paper proposes a Kalman filter (KF) based channel estimation method applied to 2 × 2 and 4 × 4 STBC MIMO-OFDM systems. The proposed method based on the dynamic tracking property of KF is well adopted for dynamic channel estimation. First, a new orthogonal space-time codeword is adopted, and the orthogonal pilot sequences are designed to suppress the interference among transmit antennas. Then, the prediction and update characteristics of KF are researched, and the state space model is established for STBC MIMO-OFDM system. Subsequently, the channel state information (CSI) is estimated iteratively according to the KF estimation equation. At last, to further improve the accuracy of KF channel estimation, the threshold is utilized to suppress the noise in the channel impulse response (CIR) estimated by KF method. Simulation results verify that the proposed KF channel estimation method with orthogonal pilots and STBC provides better bit error rate (BER) and normalized mean square error (NMSE) performance compared with other conventional channel estimation methods, and it can be effectively adapted to dynamic multipath propagation conditions with different low and high order modulations.

Index Terms - Channel estimation, Kalman filter (KF), multiple input multiple output-orthogonal frequency division multiplexing (MIMO-OFDM), space time block coding (STBC).

I. INTRODUCTION:

Multiple-input multiple-output (MIMO) , and orthogonal frequency division multiplexing (OFDM) are the core technologies of 4G, and also the key technologies of 5G. MIMO technology configures multiple antennas at the transmitter and receiver, which can increase the system capacity and link reliability in multipath channel propagation environment. OFDM technology could transform the frequency selective fading channel into multiple flat fading sub-channels, which has the advantages of high spectral efficiency, simple implementation, and effective resistance to narrowband interference and multipath fading. Combining MIMO technology with OFDM technology can make full use of wireless resources in time, frequency, and space domains . Space-time block coding (STBC) can provide diversity gains and combat channel fading effectively by using designed channel code words at the transmitter and corresponding channel decoding at the receiver. Hence, STBC is widely used in MIMO-OFDM system. In current communication environment, both sides of communication are in a fast moving state, with high Doppler frequency shift, and the channel is in a fast changing state [10]. How to estimate CSI under time-varying channel has high challenge. Many scholars are researching the channel estimation under fast time-varying channel. Channel estimation based on Kalman filter (KF) an track the time-varying channel under low to medium Doppler frequency shift, which has been widely concerned by scholars. A Kalman interpolation filter for channel estimation of long term evolution (LTE) downlink in high-mobility environments was proposed in . It uses extended KF (EKF) to linearize the system model.

In this paper, the proposed KF channel estimation method is applied in 2 × 2 and 4 × 4 STBC MIMO-OFDM systems. For the 4 × 4 STBC MIMO-OFDM system with higher diversity gains and channel fading resistance ability, a new orthogonal space-time codeword is adopted, and the orthogonal pilot sequences are designed to suppress the interference among antennas. The prediction and update characteristics of KF are researched, and the state space model is established for STBC MIMO-OFDM system. Then, the CFR is estimated iteratively according to the KF estimation equation. At last, to further improve the accuracy of KF channel estimation, a threshold is utilized to suppress the AWGN in the CIR estimated by KF method . In paper EKF is used to linearize the system. In this paper, the designed orthogonal pilot sequences can be utilized to linearize the STBC MIMO-OFDM system, and then KF can be applied to estimate the CFR directly, which has low calculation complexity. This paper uses 16 quadrature amplitude modulation (16QAM) modulated China DTV Test 1st (CDT1), CDT6, and Brazil A channels to test the performance of STBC MIMO-OFDM system . Simulation results demonstrate that the proposed KF method could track the dynamic channel well and has better BER and normalized mean square error (NMSE) performance than singular value decomposition (SVD), discrete Fourier transform (DFT), and least square (LS) channel estimation methods. At the same time, the 4 × 4 STBC MIMO-OFDM system has more diversity gains and higher ability of resisting channel fading than 2 × 2 STBC MIMO-OFDM system.

II. LITERATURE SURVEY AND EXISTING SYSTEM

The seminal paper on massive MIMO uses a Least Squares (LS) estimator. Despite its low complexity, the LS estimator achieves significantly less accurate channel estimation than minimum mean square error (MMSE) estimation, which has been used in subsequent massive MIMO studies. Although the impact of channel estimation quality is profound in massive MIMO, employing an MMSE estimator is undesirable for two main reasons. It requires an accurate estimate of the channel correlation matrix between the base station and each user, the estimation of which requires a very large number of samples in proportion to the number of antennas and has to be repeated frequently due to mobility. In summary, the existing 4G communication system suffers from several significant disadvantages that limit its performance and efficiency. These include high power wastage due to the use of isotropic antennas, poor utilization of available spectrum, and challenges associated with handoffs and call dropouts as the number of mobile users continues to increase. These drawbacks must be addressed in the design of future wireless networks to ensure optimal performance and user experience.

The complexity of MMSE estimation is much higher than LS estimation. For both reasons, MMSE estimation scales very poorly in terms of the base station array size.A key challenge for massive MIMO is pilot contamination, which is a fundamental limiting factor, since small scaling fading and noise vanish as the number of antennas grows large.The key idea is usually to exploit the differences among the channel covariance matrices of different users. A similar idea was utilized to develop a covariance-aware pilot assignment algorithm with some coordination among base stations. A special pilot scheduling algorithm was developed for sparse massive MIMO channels.

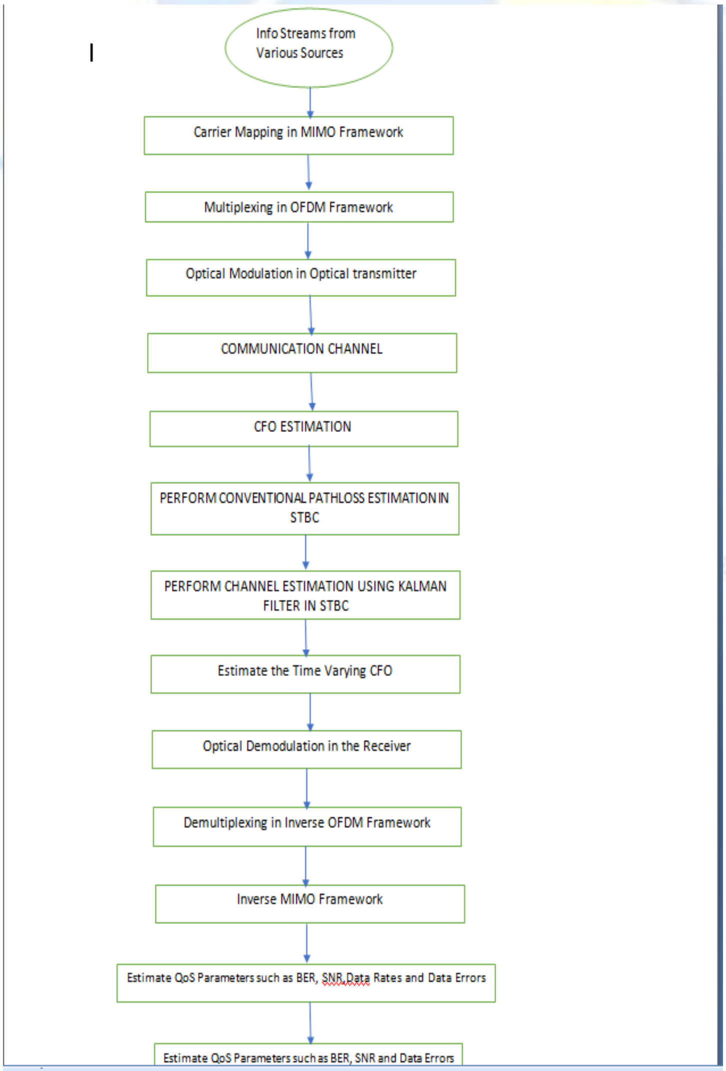
III. PROPOSED WORK

In this project we proposes a Kalman filter (KF) based channel estimation method applied to 2 × 2 and 4 × 4 STBC MIMO-OFDM systems. In this project, the proposed KF channel estimation method is applied in 2 × 2 and 4 × 4 STBC MIMO-OFDM systems. For the 4 × 4 STBC MIMO-OFDM system with higher diversity gains and channel fading resistance ability, a new orthogonal space-time codeword is adopted, and the orthogonal pilot sequences are designed to suppress the interference among antennas. The prediction and update characteristics of KF are researched, and the state space model is established for STBC MIMO-OFDM system. Then, the CFR is estimated iteratively according to the KF estimation equation. At last, to further improve the accuracy of KF channel estimation, a threshold is utilized to suppress the AWGN in the CIR estimated by KF method. In project, EKF is used to linearize the system. In this paper, the designed orthogonal pilot sequences can be utilized to linearize the STBC MIMO-OFDM system, and then KF can be applied to estimate the CFR directly, which has low calculation complexity. his project uses 16 quadrature amplitude modulation (16QAM) modulated China DTV Test 1st (CDT1), CDT6, and Brazil A channels to test the performance of STBC MIMO-OFDM system.Simulation results demonstrate that the proposed KF method could track the dynamic channel well and has better BER and normalized mean square error (NMSE) performance than singular value decomposition (SVD) , discrete Fourier transform (DFT) , and least square (LS)channel estimation methods.

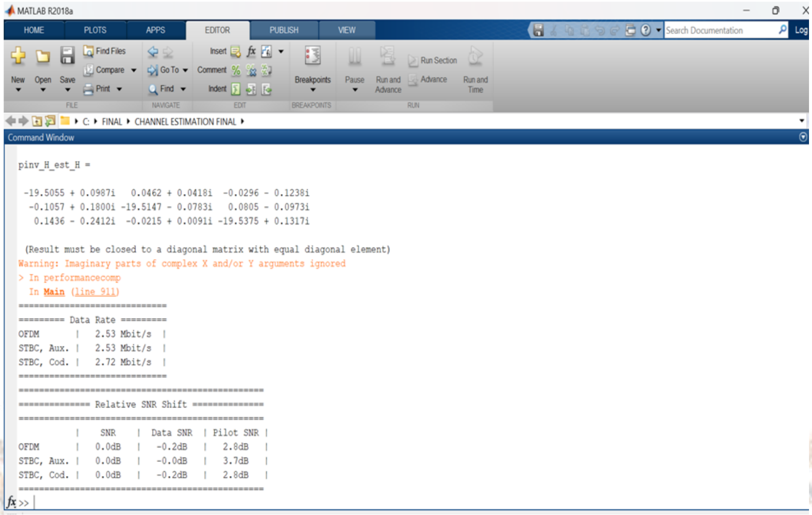
At the same time, the 4 × 4 STBC MIMO-OFDM system has more diversity gains and higher ability of resisting channel.

At the receiver, the received serial OFDM symbols are converted to parallel in the S/P block and then CP is removed. After the FFT transform, the time-domain symbol $y\beta i(k)$ on the β-th antenna, i-th OFDM symbol, k-th subcarrier is converted into frequency-domain symbol $Y\beta i(k)$. Then the comb pilot sequences are extracted to estimate the CSI. Through the estimated CSI, the symbols received from each antenna are sent to the space-time decoder. Hence, channel estimation is an important part of STBC MIMO-OFDM system. Finally, output bits are obtained by constellation demodulation.

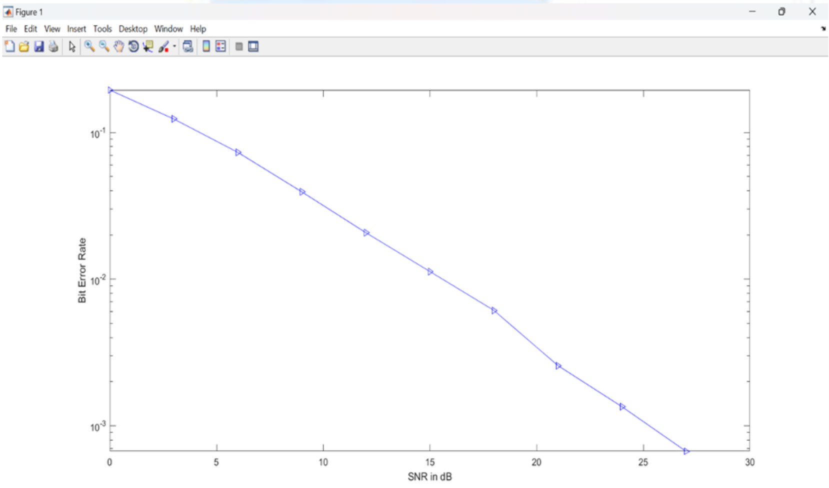
III.FLOWCHART



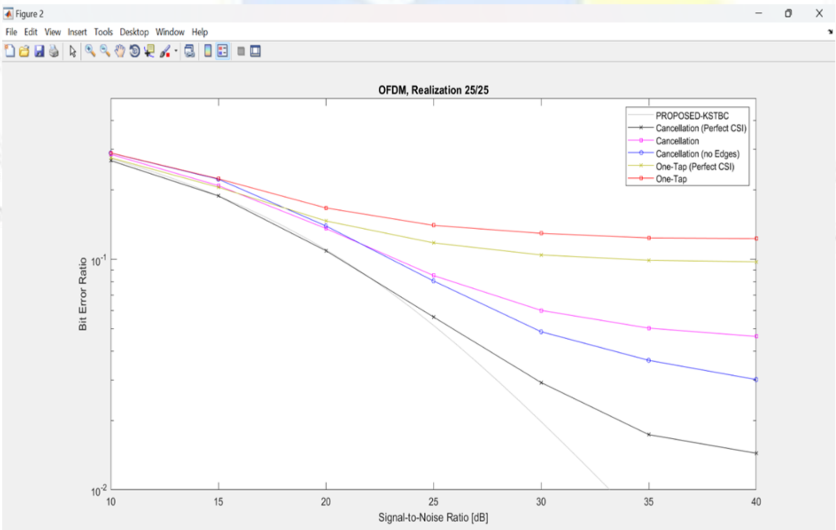
V. RESULTS AND DISCUSSION :



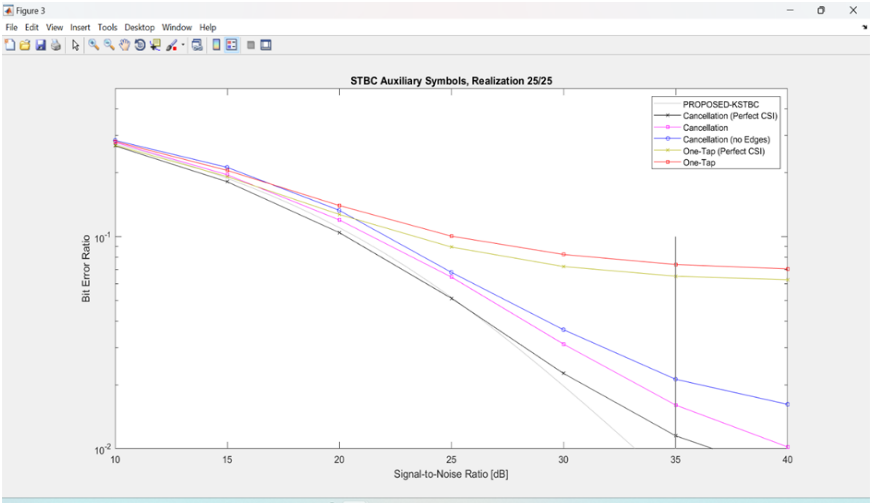
Fig(a):



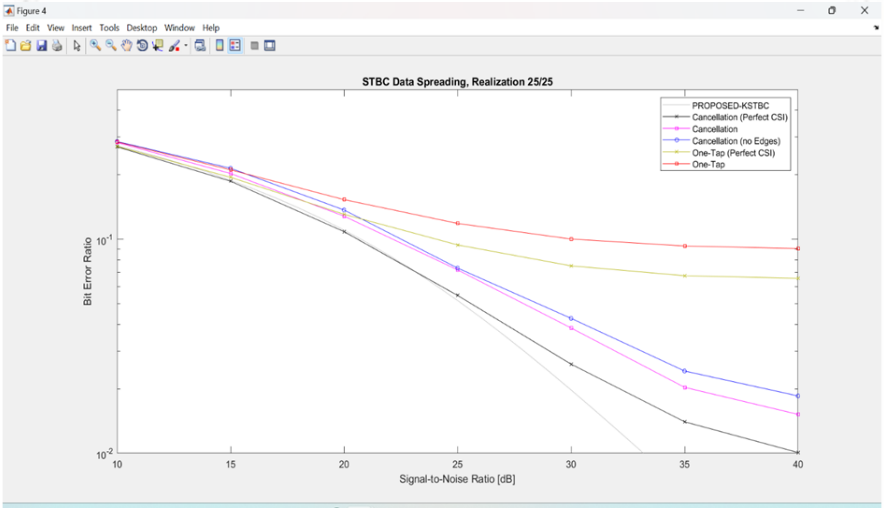
Fig(b):.General format of the bit error rate and snr in dB of a signal.



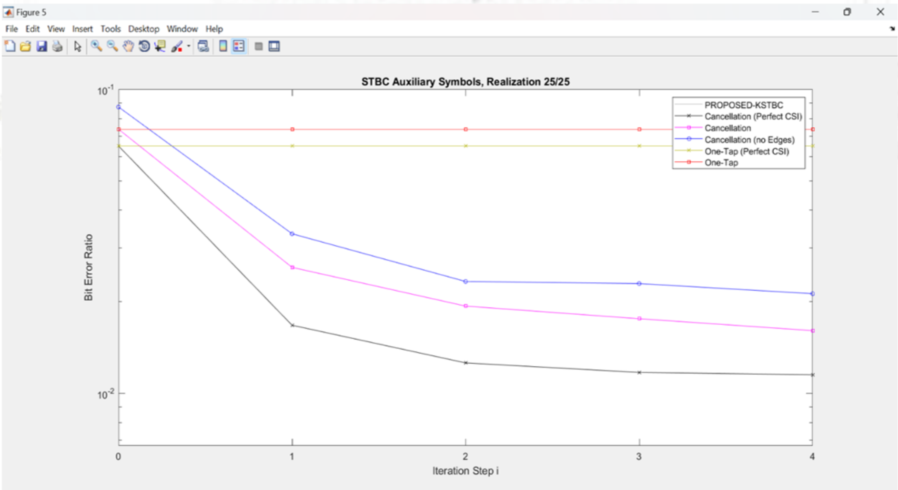
Fig(c): OFDM realization in different scenarios.



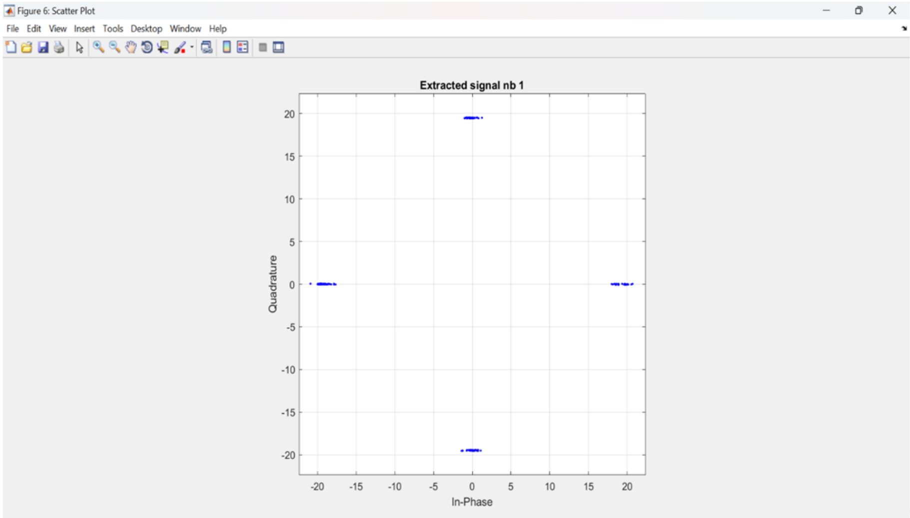
Fig(d): Stbc Auxiliary symbols, realization in different scenarios.



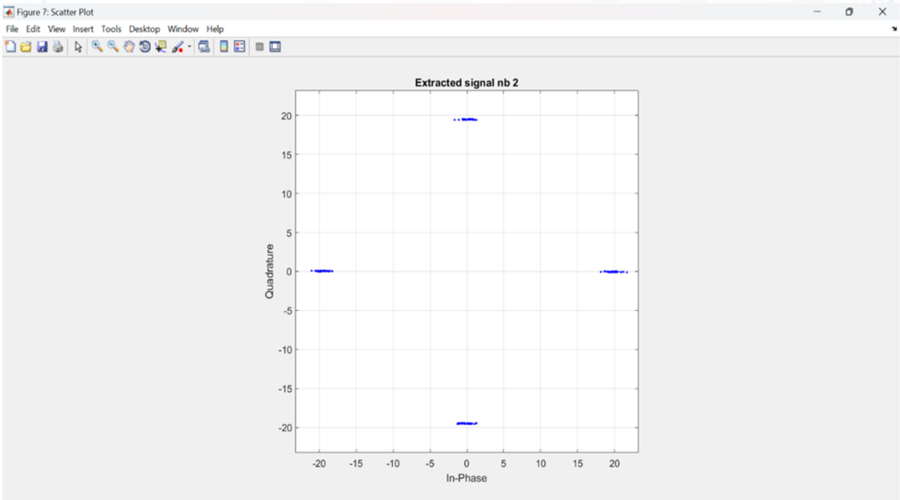
Fig(e): STBC Data spreading, realization.



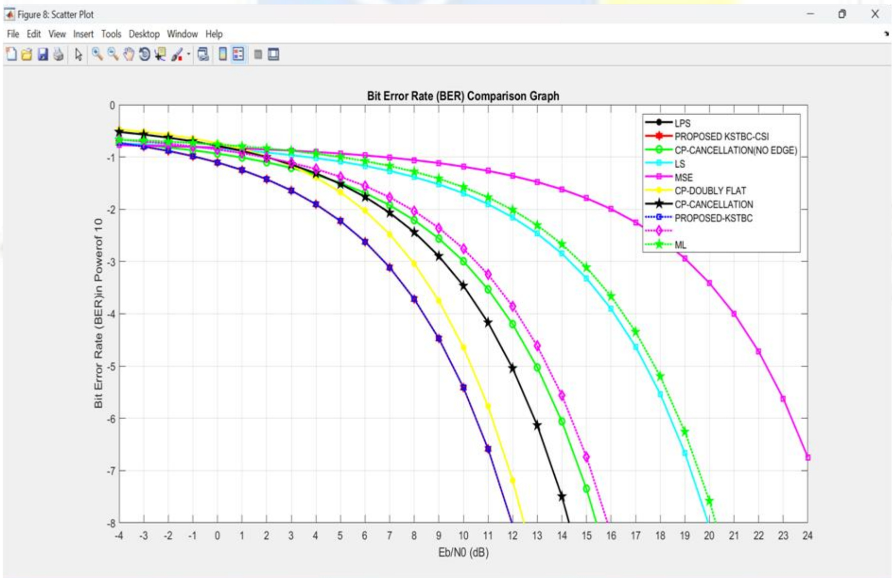
Fig(f): STBC Auxiliary symbols, Realization with x -axis Iteration step and y- axis Bit error rate.



Fig(g): Constellation diagram of first signal.



Fig(h): Constellation diagram of second signal.



Fig(i): Bit error rate comparison graph of different methods.

CONCLUSION:

In this paper, the proposed KF channel estimation method is applied in 2 × 2 and 4 × 4 STBC MIMO-OFDM systems. For the 4 × 4 STBC MIMO-OFDM system with high diversity gains and channel fading resistance ability, a new orthogonal space-time codeword is adopted, and the orthogonal pilot sequences are designed to suppress the interference among antennas. The prediction and update characteristics of KF are researched, and the state space model is established for STBC MIMO-OFDM system. Then, the CFR is estimated iteratively according to the KF estimation equation. At last, to further improve the accuracy of KF channel estimation, the threshold is utilized to suppress the AWGN in the CIR estimated by KF method. Simulation results demonstrate that the proposed KF method could track the dynamic channel well and has better BER and NMSE performance than conventional SVD, DFT, and LS methods. At the same time, the 4 × 4 STBC MIMO-OFDM system has higher diversity gains and higher ability of resisting channel fading than 2 × 2 STBC MIMOOFDM system.

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