ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

**International Journal of Innovative Research in Computer and Communication Engineering**

*(An ISO 3297: 2007 Certified Organization)*

*Website: www.ijircce.com*

**Vol. 5, Special Issue 3, April 2017**

# Channel Estimation for Massive MIMO

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**ABSTRACT**: Massive MIMO is promising technique for future generation due to its high spectrum and energy efficiency. To understand the performance of massive MIMO, accurate channel estimation is essential. However due to the more number of antenna at the base station (BS), the pilot required will be unaffordable. To overcome this problem, propose a spatio-temporal correlation scheme to reduce the required pilot overhead. Particularly, first propose the non orthogonal pilot scheme at the base station (BS). Then, an adaptive structured subspace pursuit (ASSP) algorithm at the user is proposed to estimate channel with limited number of pilots, whereby the spatio -temporal common sparsity of MIMO channels is exploited to improve the channel estimation accuracy. Simulation results demonstrate that the proposed scheme can correctly estimate Channel with the reduced pilot overhead.

**KEYWORDS**: Massive MIMO, Spatio temporal correlation, Non Orthogonal pilots, Channel estimation.

## I. INTRODUCTION

Massive MIMO consist of more number of antennas at the base station to simultaneously serve the multiple user to provide more spectral and energy efficiency. In current MIMO technology is being incorporated in to emerging wireless broadband standards like Long Term Evolution Advanced (LTE-A) allow for up to eight antenna ports at the base station but in massive MIMO more than 100 antennas are used at the Base Station (BS). Massive MIMO is a promising technique for future 5G communications due to its high spectrum and energy efficiency. However, due to massive antennas at the BS, channel estimation at each antenna results in to prohibitively high pilot overhead. To overcome this problem, propose a Non orthogonal pilot scheme at the base station (BS) is to reduce the required pilot overhead and to estimate the channel by using spatio temporal correlation based Adaptive Structured Subspace Pursuit (ASSP) algorithm. Simulation result demonstrate that the proposed channel estimation scheme is to estimate the channel state information (CSI) and it is possible to adapt the transmitter side to current channel conditions, which is crucial for achieving reliable communication with high data rate.

### *A. Spatial-Temporal correlation*

Channel Impulse Responses (CIR) between different antenna and one user exhibit the very similar channel variation. The reason is that, in typical massive MIMO, channel associated with different transmitter receiver antenna pair share the common intermediate object that is called spatial correlation and the temporal correlation would measure the similarity of one signal over time. The spatial and temporal correlation jointly called as spatio-temporal correlation. This channel property is usually not considered in existing technology.

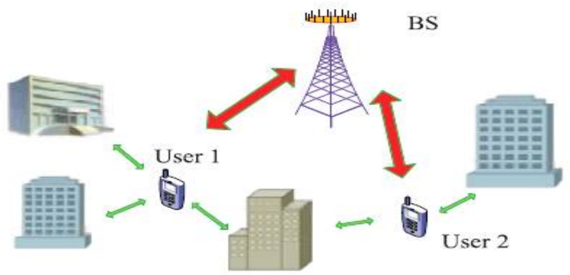


Fig. 1a. Spatial correlation

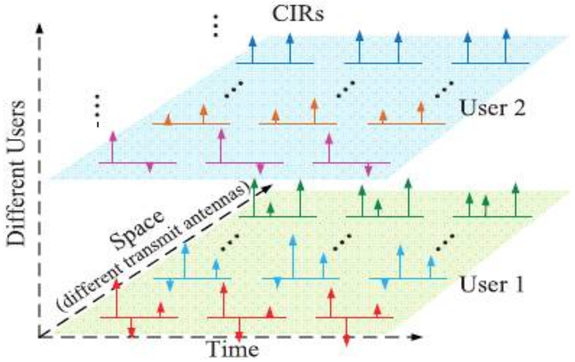


Fig. 1b. Spatio-Temporal correlation

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## II. CHANNEL ESTIMATION SCHEME

In this section, first propose the non-orthogonal pilot scheme at the base station (BS) to reduce the required pilot overhead and to estimate the channel using Adaptive Structured Subspace Pursuit (ASSP) algorithm.

*A. Non-orthogonal pilot scheme*

In the conventional MIMO system, Orthogonal pilot scheme is used in which pilot associated with different transmit antenna occupy different subcarrier but in massive MIMO, large number of antennas are used such orthogonal pilot will suffer from high pilot overhead ratio. non-orthogonal pilot scheme is proposed in which pilot associated with the different transmit antenna occupy completely the same subcarrier ,so the pilot overhead is reduced substantially

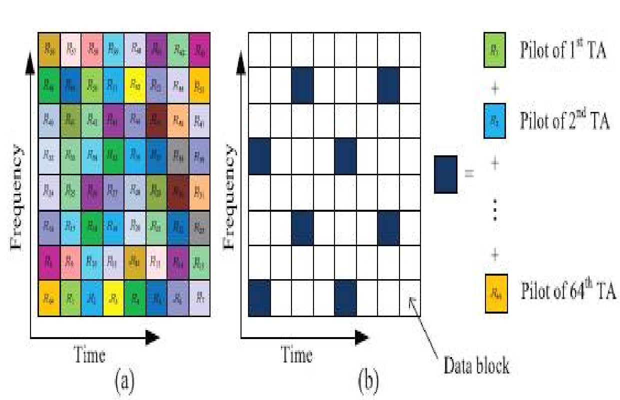


Fig. 2a. Orthogonal Pilot design 2b. Non orthogonal

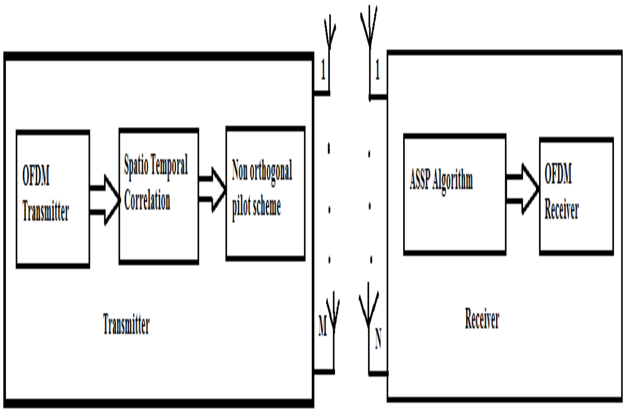


Fig. 3. Block diagram for massive MIMO pilot deign

*B. Channel Estimation at the user*

At the user, after the removal of guard interval, the received signal at the user is (1)

Where the D is the channel matrix, Ψ is the sensing matrix and W is additive white gaussian noise. The conventional SP algorithm and the model based SP algorithm want sparsity level as the important information for reliable channel estimation but in ASSP algorithm does not require this unrealistic assumption and it adaptively acquire the sparsity level depend upon wireless MIMO channel. Channel State Information (CSI) make it possible to adapt the transmitter side to current channel condition and this information is essential for signal detection, beam forming and resource allocation. At the user, very sensitive algorithm is used for receiving the signal because the antenna with high directivity is mostly used in massive MIMO.

In this fig. 3 depicts about the non orthogonal pilot scheme is used for reducing the pilot overhead and the spatio-temporal correlation is to group the transmission antenna and assign one pilot for this one group of antenna. Finally, calculate the correlation among the received signal at user and known pilot signal which is used for estimating the channel.

*C. ASSP Algorithm*

This algorithm utilizes the structured sparsity of D for further improved sparse signal recovery performance.

Input: Noisy received signal at user Y and Sensing Matrix Ψ.

Algorithm steps:

Step 1: Using received signal at user Y and sensing matrix Ψ, the estimated channel matrix is

Then

Step 2: Calculate the residue

Step 3: if

is the estimated channel matrix

Else, Update the sparsity level

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Step 4: (2)

and obtain the estimation of channel according to (1) – (2).

This algorithm exploits the sparsity of D for further improved performance. It developed from classical subspace pursuit algorithm, subspace pursuit and model based SP requires the sparsity as the important information but in the ASSP algorithm does not require this priority information, since it can adaptively acquire the sparsity level. The ASP algorithm does not work properly due to insufficient pilot. The time-frequency channel estimation scheme work poorly due to mutual interference among time domain pilot signal of various transmit antenna andfinally the ASSP algorithm work perfectly with reduced pilot overhead and the sparsity is updated according to the time varying scenario of wireless communication.

## III.SIMULATION RESULT

In this section, first analyse the MSE performance of different channel estimation scheme and pilot placement scheme then analyse the BER performance of channel estimation scheme. Finally signal interference to noise ratio of proposed system for massive MIMO system.

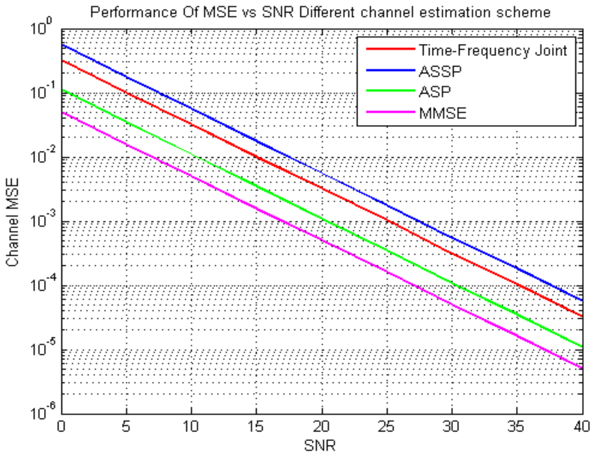


Fig. 4. MSE performance comparison of different scheme for massive MIMO system

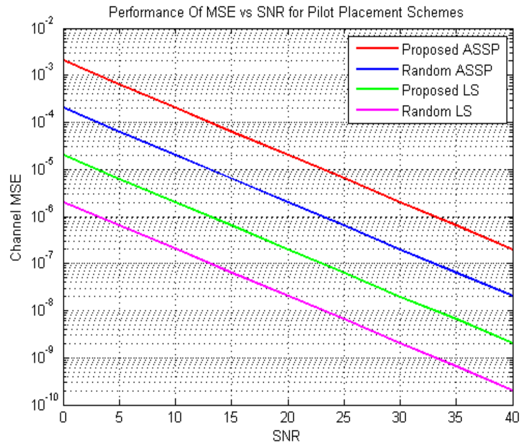


Fig. 5. MSE performance comparison of different pilot channel placement estimation scheme for massive MIMO system.

Fig. 4 depicts the ASSP algorithm provides the better result than other channel estimation scheme. At the 20 dB SNR, out of 100 bits transmitted 30 bit can occur error in MMSE channel estimation scheme but in the ASSP algorithm out of 100 bits transmitted 20 bit can occur error.

In this above fig 5 describes the proposed algorithm provides the better result than other pilot placement scheme. At 10 dB SNR, out of 100 bits transmitted 60 bit can occur error in random LS algorithm but in ASSP algorithm out of 100 bits transmitted 40 bit can occur error and this algorithm works better even at low SNR value.

In this above fig. 6 estimating the bit error rate performance of different channel estimation scheme. At 10 dB signal to noise ratio, out of transmitted 100 bits only 10 bit can occur other than the estimation scheme.

In this above fig. 7 explains about the signal interference to noise ratio performance. At the low SNR, SINR becomes very high similarly, at the high SNR, SINR becomes very low.

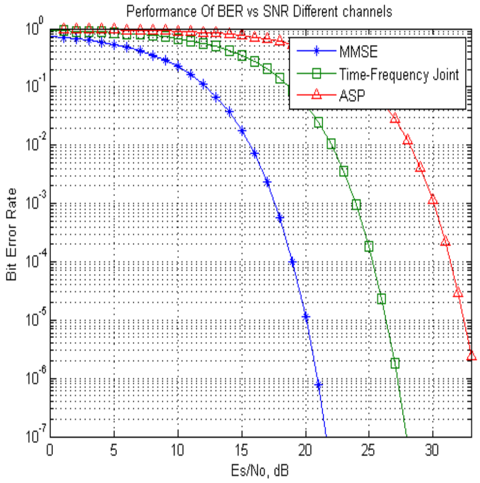


Fig. 6. BER performance comparison of different channel estimation scheme for massive MIMO system.

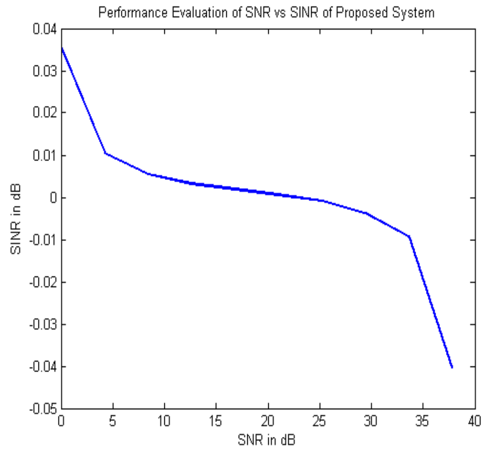


Fig. 7. SINR performance of proposed system for massive MIMO system.

## IV.CONCLUSION AND FUTURE WORK

The proposed Non orthogonal pilot scheme is implemented and intrinsic spatio-temporal common sparsity of wireless MIMO channels is exploited to reduce the pilot overhead. First, the non-orthogonal pilot scheme at the BS and the ASSP algorithm at the user can reliably estimate channels with significantly reduced pilot overhead. Additionally, discuss about non-orthogonal pilot design to achieve the reliable channel estimation under the framework of CS theory. Simulation results have shown that the proposed channel estimation scheme can achieve much better channel estimation performance than its counterparts with substantially reduced pilot overhead, and it only suffers from a negligible performance loss when compared with the performance bound.

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