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Channel estimation and energy optimization for LTE and LTE-A MU-MIMO Uplink with RF transmission power consumption

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Abstract – Multi-user multi-input multi-output (MU-MIMO) transmission is being provided by in the uplink of the 3GPP LTE and LTE-A standards. To minimize the interference among different antenna channels care must be exercised in channel estimation according to the property of reference signals (RSs). When user equipments (UEs) are allocated narrow transmission bands channel estimation methods may yield relatively high inter-channel interference but typical DFT- and DCT-based channel estimation methods may have low complexity. Methods that have much higher computational requirements often attain better channel separation. To minimize an L1 norm of error, an MU channel estimation technique is being proposed in this paper. Linear minimum mean-square error (LMMSE) that has good numerical properties does not need second-order statistics as it yields a performance between the least-square (LS), the DFT, and the LMMSE techniques.

***Keywords**:* Channel estimation, MU-MIMO, uplink, LTE, L1- norm, OFDM

I. Introduction

Radio transmission has allowed people to communicate without any physical connection for more than hundred years. When Marconi managed to demonstrate a technique for wireless telegraphy, more than a century ago, it was a major breakthrough and the start of a completely new industry. The LS method is less complicated and simple respect to other methods and consequently is used to channel estimation, but it has a serious drawback which is more sensitive to channel noise. MMSE estimator has better performance than LS method but suffers from a high computational complexity because it requires knowledge of the channel statistics and the signal-to-noise ratio (SNR) [3]. Some different methods have been developed to reduce the complexity and improve the performance of the MMSE estimation such as modified MMSE and singular value decomposition (SVD) [4-5]. 1n 2006 Noh et al. proposed a method to decomposing the covariance matrix to the simple and low order sub matrix so that they can decrease the complexity of MMSE method [6]. Hsieh used a comb type pilot arrangement and second order interpolation method to channel estimation [7]. Coleri et al. compared the results of many interpolation techniques to channel estimation with Rayleigh fading such as linear, second order, cubic, low pass filtering and spline interpolation methods The recently introduced principle and methodology of compressed sensing (CS) allows the efficient reconstruction of sparse signals from a very limited number of measurements (samples) [1, 2].

CS has gained a fast-growing interest in applied mathematics. In this paper, we apply CS to pilot-based channel estimation in highly mo-bile environments. We consider pulse-shaping multicarrier (MC) systems, which include orthogonal frequency-division multiplexing (OFDM) as a special case [3]. Conventional methods for channel estimation (e.g., [4]) are not able to exploit the inherent sparsity of the transmission channel that is due to the sparse distribution of scat-terers in space. As we will demonstrate, CS provides a constructive way for exploiting this sparsity in order to reduce the number of pi-lots and, hence, increase spectral efficiency.

II. METHOD

Channel estimation To increase the capacity of orthogonal frequency division multiple access (OFDMA), channel estimation plays an important part in an OFDM system. System performance is improved in terms of bit error rate.

Cell-specific reference signals (pilot symbols) inserted in both time and frequency are being used by LTE to facilitate the estimation of the channel characteristics. Within a subframe, an estimate of the channel at given locations is being provided by these pilot symbols. Estimation of channel across an arbitrary number of subframes is possible through interpolation. Depending on the transmitting antenna being used and on the eNodeB cell identification number, the pilot symbols in LTE are assigned positions within a subframe as shown in the following figure.

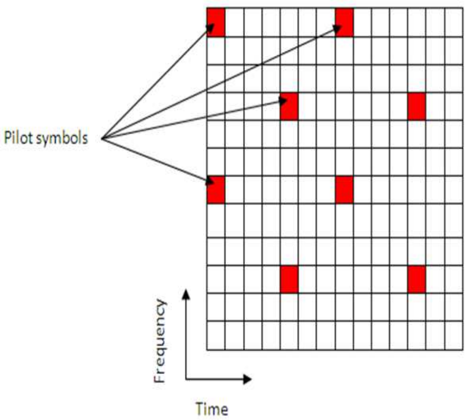

Fig:1 Pilot

For non interference of pilot symb*ols* with one another the unique positioning is done. This can provide a reliable estimate of the complex gains imparted onto each resource element within the transmitted grid by the propagation channel

2.2. MU-MIMO

IEEE 802.11ac standard is the first Wi-Fi standard to offer speeds in the gigabit per second range and MU-MIMO is a part of it. An access point can transmit to up to four client devices simultaneously. Contention delays are eliminated. To properly direct the signals frequent channel measurements is required. Of the eight spatial streams available each user may employ up to four of them.

Single spatial stream devices are being benefitted by multi user MIMO beams forming. Before MU-MIMO beam forming, an access point could only transmit to one bit at a time while communicating with multiple client devices. An access point can transmit to up to four single stream devices at the same time on the same channel with MU-MIMO beam forming. For example, an AP being provided by four spatial streams with eight antennas can talk to two client devices with four antennas. Alternatively, the same AP with two antennas can talk to four client devices providing two spatial streams to each.

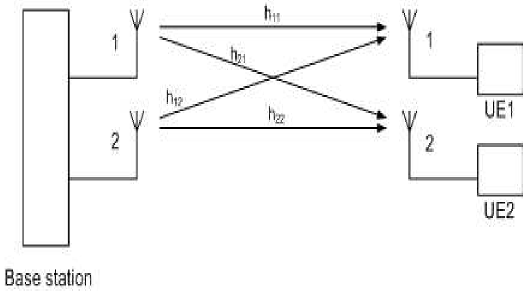

Fig.2 Multiuser MIMO

Multi-user MIMO beam forming even benefits single spatial stream devices. Prior to MU-MIMO beam forming, an access point communicating with multiple client devices could only transmit to one at a time. With MU-MIMO beam forming, the access point can transmit to up to four single stream devices at the same time on the same channel.

The 802.11ac standard also supports speeds up to 6.93 Gbit/s using eight spatial streams in single-user mode. The maximum data rate assumes use of the optional 160 MHz channel in the 5 GHz band and 256 QAM (quadrature amplitude modulation).

III. MATHEMATICAL CALCULATION

3.1 POWER ALLOCATION ALGORITHM

To achieve the energy efficiency optimal power allocation always Exists and gives the necessary and sufficient conditions for a power Allocation scheme.

Theorem 1. There exists a unique globally optimal energy efficient power allocation P^* that achieves the energy efficiency capacity, where P^*_{ik} is given by,

$$P^*_{ik} \begin{cases} \frac{B\zeta}{\alpha U^* \ln 2} - \frac{\Gamma\sigma^2}{\lambda^2_{ik}} & \text{if } \frac{B\zeta}{\alpha \Gamma\sigma^2 \ln 2} > U^* \\ 0 & otherwise \end{cases}$$

Theorem 1 says that the *k*th antenna of User *i* should be used only when the corresponding spatial channel, characterized byλ^2_{ik}, is sufficiently good such that using it improves the overall network energy efficiency.

$\mu_1 \leftarrow min_{i,j} \frac{\Gamma\sigma^2}{\lambda^2_{i,j}}$ (u^* is above $min_{i,j} \frac{\Gamma\sigma^2}{\lambda^2_{ik}}$; otherwise p_{ik} = 0 for all i, k)$\alpha \leftarrow a\ value$ above 1, e.g. 10; $\mu_2 \leftarrow \mu_1 * \alpha$

while $f'(\mu_2) > 0$

do $\mu_1 \leftarrow \mu_2$, $\mu_2 \leftarrow \mu_2 * \alpha$

while no convergence (Search the optimum iteratively)

do $\mu \leftarrow \frac{\mu_2 + \mu_1}{2}$

if $f'(\mu) > 0$then $\mu_1 \leftarrow \mu$;else $\mu_2 \leftarrow \mu$;

IV. Simulation and Results

MU-MIMO enables an access point to transmit to up to four client devices simultaneously. This eliminates contention delays, but requires frequent channel measurements to properly direct the signals. Each user may employ up to four of the available eight spatial streams.MU-MIMO system have the potential of achieving high spectral efficiency. High data rate, energy efficiency, with an acceptable implementation complexity in wireless systems. The design of low complexity, high energy, high performance and high throughput receivers is the key challenge in the design of any MU-MIMO receiver.
First generate the input signal. In first step 20 bit random number has been generated. In this graph X-axis time and Y-axis amplitude show in figure-

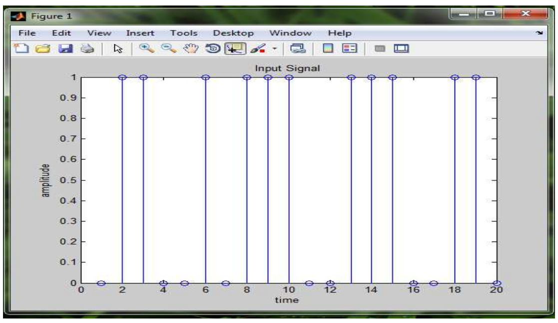

Fig.3 Input Signal

Encoding is the process of converting data into a format required for a number of information processing. Data transmission, storage and compression/decompression Program compiling and execution.The next process is convolution encoding, convolution process taking message and trellis output. As show in figure

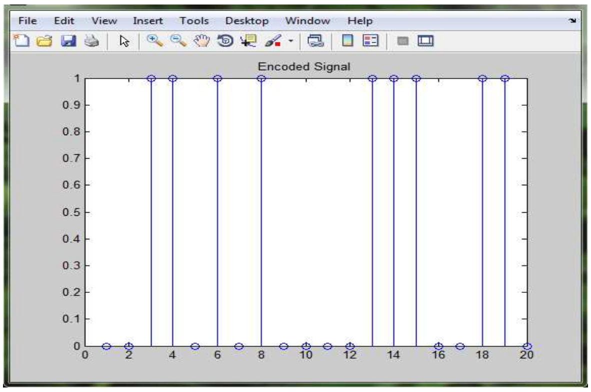

Fig.4 Encoded Signal

Power Spectral Density (PSD) is a measure of a signal's power intensity in the frequency domain. In practice, the PSD is computed from the FFT spectrum of a signal. The PSD provides a useful way to characterize the amplitude versus frequency content of a random signal. In the Random Control System, PSDs are used to represent the control and input channel signals.
In this step generating 0,1 with equal probability. Transmitted signal choose convolutional encoding, first choose constraint length and code generator. After that poly2trellis has been finding. After determining the convolution process the 2000 bit has been separated by 500×4. Now message size is 500×4. This can reshape by 4×500. This by using that interleaving has performed. The signal added white Gaussian noise, and then will transmit through channel.

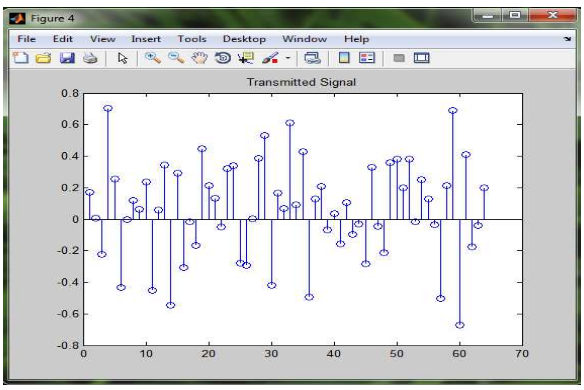

Fig.5 Transmitted Signal

In this graph reduce the bit error rate with 6×2 MIMO and zero forcing equalizer. We have first analyzed an MU-MIMO system based on distributed singular value decomposition of the channels of all users and derived the achieved energy efficient capacity and reduces the bit error rate up to $10^{\wedge 5}$dB, signal to noise ratio conditions for all users.

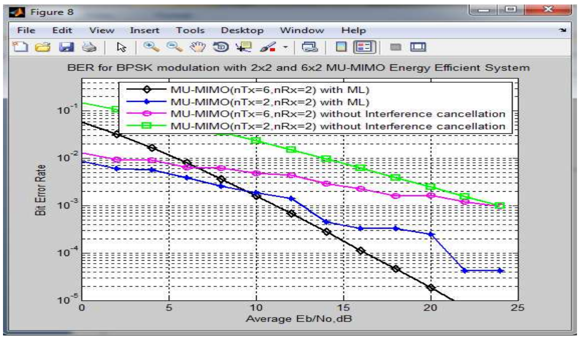

Fig.6 Bit error rate

In this graph reduce the interference and get we also increase throughput up to 100% with 6$\times$2 MIMO.The SINR is defined as the power of a certain signal of interest divided by the sum of the interference power (from all the other interfering signals) and the power of some background noise. In this graph reduce the signal to interference ratio up to 0. 025dB.Enrgy efficiency of system is 92.72.

V. Conclusion

Thus the optimal energy efficient uplink MU-MIMO consists of both electronic circuit and RF transmission power consumption. The distributed singular value decomposition was used to analyze an MU-MIMO system and channels of all users. Based on this energy efficient capacity has been derived and reduces the bit error rate up to 10^5 dB, SINR up to 0.025dB and increase throughput for all users. In this MU-MIMO by using globally optimal power allocation 92%, energy efficient capacity is achieved.

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