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A new Algorithm for Estimating covariance AND cvi matrix for Co channel Interference in Wireless Mobile Networks for Lte

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ABSTRACT

In Wireless and mobile networks often it is required to estimate channel characteristics and interference from other networks.In this paper a new approach is suggested for estimating channel charcteristics and CVI(Co Variance Interference) matrix. The new approach is based on introducing new pilot scene in the downlink channel of the wireless network. The pilot scene is simulated for the LTE(Long Term Evaluation) Technology

Key Words : LTE, ICV Matrix, CQI Matrix, Down Link Channel, Pilot Scene .

I. INTRODUCTION

In the first part of the paper a pilot scheme is described in 3GPP LTE standard is implemented after that a new pilot scheme COFIP(Collision free interlaced Pilot scene) is implemented. The channel estimator using FFT is implemented and we study the performance of the channel estimator for both pilot schemes and observe that the new pilot scheme COFIP is giving better performance than old pilot scheme. In the second part of the paper estimator for ICV (Interference CO Variance) matrix is implemented from the simulation results we observe that the ICV matrix estimation for the new pilot scheme is giving accurate estimate than the old pilot scheme but thermal noise contribution to ICV estimate is three times than the old pilot scheme. Then estimator for CQI(Channel Quality Indicator) is implemented to do this first SINR is calculated after that SINR is mapped to MCS index

II. BASIC DEFINITIONS

i) OFDM

High data-rate is desired in many applications. However, as the symbol duration reduces with the increase of data-rate, the systems using single carrier modulation suffer from more severe inter symbol interference (ISI) caused by the dispersive fading of wireless channels, thereby needing more complex equalization. To reduce the effect of ISI in un equalized systems, the symbol duration must be much larger than the delay spread of wireless channels. In a conventional serial data system, the symbols are transmitted sequentially, with the frequency spectrum of each data symbol allowed to occupy the entire available bandwidth. In OFDM, the entire channel is divided into many narrow sub channels, which are transmitted in parallel, thereby increasing the symbol duration and reducing the ISI . Therefore, OFDM is an effective technique for combating multipath fading and for high-bit-rate transmission over mobile wireless channels OFDM can be simply defined as a form of multi-carrier modulation where its carrier spacing is carefully selected so that each sub-carrier is orthogonal to the other sub-carriers. As is well known, orthogonal signals can be separated at the receiver by correlation techniques; hence, inter-symbol interference among channels can be eliminated. Orthogonality can be achieved by carefully selecting carrier spacing, such as letting the carrier spacing be equal to the reciprocal of the useful symbol period. In order to occupy sufficient bandwidth to gain advantages of the OFDM system, it would be good to group a number of users together to form a wide-band system, and to interleave data in time and frequency.

The orthogonality of sub-channels in OFDM can be maintained and individual Sub channels can be completely separated by the FFT at the receiver when there are No inter-symbol interference (ISI) and inter-carrier interference (ICI) introduced by Transmission channel distortion. In practice these conditions cannot be obtained. Since the spectra of an OFDM signal is not strictly band limited (sinc(f) function), linear distortion such as multi-path cause each sub-channel to spread energy into the adjacent channels and consequently cause ISI. A simple solution is to increase symbol duration or the number of carriers so that distortion becomes insignificant. However, this method may be difficult to implement in terms of carrier stability, Doppler shift, FFT size and latency. In order to avoid ISI and ICI, the guard period must be formed by a cyclic extension of the symbol period. This is done by taking symbol period samples from the end of the period and appending them to the front of the period. The concept of being able to do this, and what it means, comes from the nature of the IFFT/FFT process. When the IFFT is taken for a symbol period (during OFDM modulation), the resulting time sample sequence is technically periodic. This is because the IFFT/FFT is an extension of the Fourier transform which is an extension of the Fourier Series for periodic waveforms. All of these transforms operate on signals with either real or manufactured periodicity. For the IFFT/FFT, the period is the number of samples used With cyclic extension, the

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symbol period is longer, but it represents the exact same frequency spectrum. As long as the correct number of samples are taken for the decode, they may be taken anywhere within the extended symbol. Since a complete period is integrated, orthogonality is maintained. Therefore, both ISI and ICI are eliminated. Note that some bandwidth efficiency is lost with the addition of the guard period (symbol period is increased and symbol rate is decreased).

Although the receiver is typically configured to discard the cyclic prefix samples, the cyclic prefix serves two purposes.- As a guard interval, it eliminates the inter symbol interference from the previous symbol. -As a repetition of the end of the symbol, it allows the linear convolution of a frequency-selective multipath channel to be modeled as circular convolution, which in turn may be transformed to the frequency domain using a discrete waveforms. All of these transforms operate on signals with either real or manufactured.

III. COFIP APPROACH

i)Implementation of Pilot Indexing

Pilot Pattern Generation for 3GPP LTE

The pilot pattern for given slot ns and port p is given by

$$K_{l,n_s} - 6m + (v + v_{shift})mod6$$

$$l = \begin{cases} 0, N_{symb}^{DL} - 3 & if\ p \in \{0,1\} \\ 1 & if\ p \in \{2,3\} \end{cases}$$

The variables v and v_{shift} define the position in the frequency domain for the different reference signals where v is given by

$$v = \begin{cases} 0 & if\ p = 0\ and\ l = 0 \\ 3 & if\ p = 0\ and\ l \neq 0 \\ 3 & if\ p = 1\ and\ l = 0 \\ 0 & if\ p = 1\ and\ l \neq 0 \\ 3(n_s mod2) & if\ p = 2 \\ 3 + 3(n_s mod2) & if\ p = 2 \end{cases}$$

The cell-specific frequency shift is given $v_{shift} = N_{ID}^{cell} mod6$, for the cell id 501 pilot pattern for different antenna ports is given below.

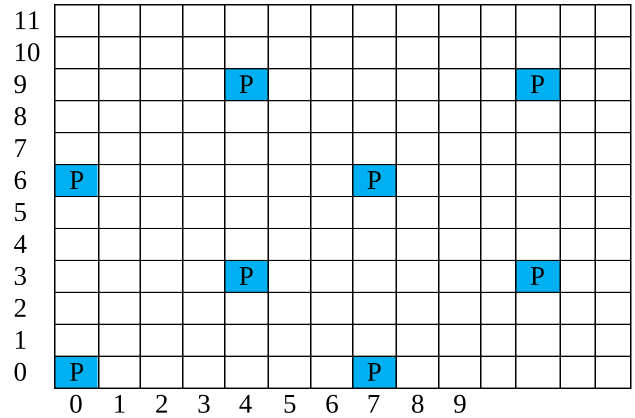

Fig 1 antenna port 0

ii) New Pilot Pattern COFIP Generation

The new pilot pattern COFIP is developed for mode-1 in LTE, in this mode transmitter
having only one antenna port. COFIP pilot pattern is uses only three shifts

Where
$$l = 0, N_{symb}^{DL} - 3$$

The variables v and v_{shift} define the position in the frequency domain for the different reference signals where v is given by The pilot pattern for given slot ns and port p is given by

$$K_{l,n_s} = 6m + (v + 2 * v_{shift})mod6$$

Where
$$l = 0, N_{symb}^{DL} - 3$$

The variables v and v_{shift} define the position in the frequency domain for the different reference signals where v is given by

$$v = \begin{cases} 0 & if\ l = 0 \\ 3 & if\ l \neq 0 \end{cases}$$

The cell-specific frequency shift is given by $v_{shift} = N_{ID}^{cell} mod3$. The COFIP pilot pattern for different shifts is shown in chapter 3.2.2 with null symbols insertion also.
Insertion of nulls is taken care of data indexing.

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iii) **ICV Matrix Estimation**

In our scenario the LTE transmission and reception is modeled as SIMO that is one transmitting antenna and two receiving antennas .

Received signal at receiver for each tone (subcarrier) is given by

$$Y(l,k) = Hx + \sum_{i=1}^{m} G_i x_i + n$$

$$Y = \begin{bmatrix} y_1 \\ y_2 \end{bmatrix}$$

y_1, y_2 are received symbols by receiver one and two on the subcarrier.

$$H = \begin{bmatrix} h_1 \\ h_2 \end{bmatrix}$$

H is channel matrix, h_1, h_2 are channel response on the subcarrier for receiver one and two . x is the symbol transmitted on the subcarrier.

$$G_i = \begin{bmatrix} g_{i,1} \\ g_{i,2} \end{bmatrix}$$

G_i is channel matrix of the i^{th} interferer , $g_{i,1}$, $g_{i,2}$ are channel response on the subcarrier for receiver one and two due to the i^{th} interferer. x_i is the symbol transmitted by i^{th} interfering base station on the subcarrier.

$$n = \begin{bmatrix} n_1 \\ n_2 \end{bmatrix}$$

n is complex AWGN noise matrix. n_1, n_2 are noise added at receiver one and two.

iv) **ICV Matrix Estimation for CRS pilot pattern**

To estimate the ICV matrix for pilot pattern correspond to LTE release8 as shown ,initially we estimate the channel response for two receivers at each tone.
The channel estimation is done by FFT based method as discussed in Then the actual response on the tone (l,k) is given by

$$Y_{act}(l,k) = H_{est}x$$

Here H_{est} by is estimated channel response on tone. x is pilot symbol transmitted on that tone .pilot symbols are generated at receiver by knowing the cell id of the transmitting base station. The difference between the actual response and received one is given by

$$I(l,k) - Y(l,k) - Y_{act}(l,k)$$

To eliminate the effect of AWGN noise in the covariance estimate we are doing Averaging over N_p no of pilots, then the covariance matrix is given by

$$R_{gg} - {}^{1}/_{N_p} * \sum R_{gg}(l,k)$$

T on for COFIP pilot pattern he COFIP pilot pattern as shown uses both pilot and null locations to estimate the ICV matrix, from the pilot location we get the ICV matrix for the base station which are using same interlace to transmit the pilots, from nulls we get the ICV matrix for the base stations which are using other interlaces. The received signal on pilot tone (subcarrier) is given by

$$Y_p(l,k) = Hx + \sum_{i=1}^{m} G_i x_i + n$$

To estimate the ICV matrix R_{gg_p} at pilot tones we fallow the same procedure as described .The received signal on null tone (subcarrier) is given by

$$Y_n(l,k) = \sum_{i-1}^{m} G_i x_i + n$$

Then the interference covariance matrix on that null tone is given by

$$R_{gg_n}(l,k) = Y_n(l,k) Y_n(l,k)^H$$

To eliminate the effect of AWGN noise in the covariance estimate we are doing.

Averaging over no of pilots, Then the covariance matrix is given by

$$R_{gg_n} = {}^{1}/_{N_p} * \sum R_{gg_n}(l,k)$$

Then actual ICV matrix is given by

$$R_{gg}(l,k) - I(l,k) I(l,k)^H$$

Were $R_{gg_{n1}}$, $R_{gg_{n2}}$ are estimated ICV matrices corresponding at null one and two.

For example if we consider the figure….. the pilots are transmitted on zero subcarrier,

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nulls N1, N2 are transmitted on second and fourth subcarrier. Then R_{gg_p} gives the ICV matrix of interfering base stations which are transmitting pilots on zero subcarrier.

The other matrixes $R_{gg_{n1}}, R_{gg_{n2}}$ represents ICV matrix of interfering base station which are transmitting pilots on second and fourth subcarriers.

v. CQI Estimation

The received symbol at pilot location (l,k) is given by

$$Y_p(l,k) = Hx + \sum_{i=1}^{m} G_i x_i + n$$

Then the symbol estimated by MMSE receiver on that tone is

$$\hat{x}(l,k) = w(l,k)Y_p(l,k)$$

where

$$w(l,k) = H^H\left(HH^H + R_{gg}\right)^{-1}$$

The estimated signal at tone (l,k) can be written as

$$\hat{x}(l,k) = H^H\left(HH^H + R_{gg}\right)^{-1}Y_p$$

$$\hat{x}(l,k) = H^H\left(HH^H + R_{gg}\right)^{-1}(Hx + \sum_{i=1}^{m} G_i x_i + n)$$

From the above equation the required signal is

$$H^H\left(HH^H + R_{gg}\right)^{-1}Hx$$

unwanted signal or interfering signal is

$$H^H\left(HH^H + R_{gg}\right)^{-1}(\sum_{i=1}^{m} G_i x_i + n)$$

Signal power can be written as

$$\left|H^H\left(HH^H + R_{gg}\right)^{-1}H\right|^2$$

From the equation Noise and interference power can be written as

$$H^H\left(HH^H + R_{gg}\right)^{-1}R_{gg}\left(H^H\left(HH^H + R_{gg}\right)^{-1}\right)^H$$

Then SINR can be written as

$$SINR = \frac{\left|H^H\left(HH^H + R_{gg}\right)^{-1}H\right|^2}{H^H\left(HH^H + R_{gg}\right)^{-1}R_{gg}\left(H^H\left(HH^H + R_{gg}\right)^{-1}\right)^H}$$

SINR at each location is find out and average over a pair of resource unit after that
is converted into db scale. Then depending on wide band CQI or sub band CQI find
out the effective SINR using

IV. SIMULATION RESULTS

Towards simulation of the proposed scheme a Channel is created by taking ideal parameters random white Gaussian noise is added to the created Channel also some Interference signals have been inserted at various Pilot positions of the down link channel .By using COFIP Scheme the Channel is Estimated for assumed frames. The Estimated Channel further used in computing Co Variance Matrix of Noise and Interference and also to find Channel quality indicator.They are given in the following figures from the Simulation results it can be observed that New Pilot Scheme gives Vector Channel Estimation there on giving Better Co Variance Matrix and Channel Quality Indicator**.**

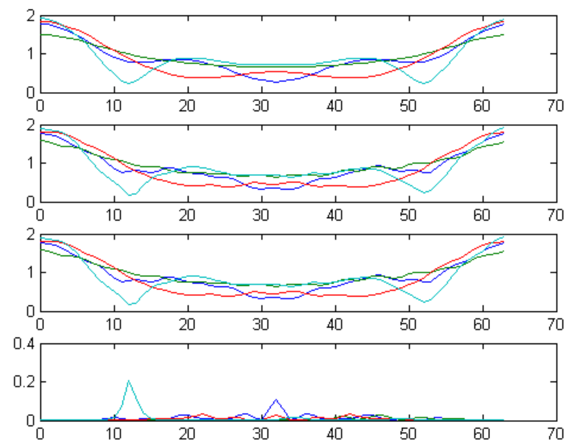

Fig 2 Comparison results

V CONCLUSION

The Paper discussed a new pilot scheme named ‘collision free interlaced pilots’ for estimating wide band channel and respectively to find C0 variance Interference Matrix and channel quality Indicator for wireless mobile networks .The paper can be further extended by placing pilots relatively at regular positions in down link data channel for LTE Technology. The simulation results show that channel is more efficiently predicted using COFIP in comparison with existing approach.

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