# Error free transmission of mc CDMA signals through multiple antennas

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Abstract—The MIMO MC-CDMA is the promising technique for the future wireless communications, because of being effective in mitigating fading and increasing data rate. The usage of the same codes over the Multiple Transmission antennas causes IAI (Inter antenna interference). And also, when the correlation between the waveforms are very low which produces MAI (Multi access interference) to all other users apart from the corresponding user. In this paper we proposed a new error free transmission of MC CDMA signal through multiple antennas using MIIR algorithm, Which increases the data rate by removing the MUI and IAI. The proposed algorithm is justified by MATLA B simulation.

Keywords —MIMO-M C-CDMA, MUI, IAI, MIIR algorithm

## I. INT RODUCTION

Wireless Communication is used in both private and public access for its high data rate. Large bandwidth is required for transmitting data at high rate and at high mobility [1]. But the bandwidth of the Radio signal is limited, So we have to implement high spectral efficiency technique.

In last few years MC system accursed importance in multipath environment. The efficiency of the system is further increased by combining MC with CDMA. The M C-CDMA scheme mitigate the multipath and also efficient in high speed mobility environment. The multiple transmission and multiple reception of the MIMO system increases the bandwidth efficiency.

The M C-CDMA initially spreads the data to parallel and are modulated by the sub carriers and each sub carrier is based on the PN codes and the modulation and demodulation are done based on IDFT AND DFT [2]. The total bandwidth is divided into number of sub channels based on the B/N spacing.

In order to increase the efficiency we are using MIMO antenna's where the same data is transmitted over the multiple antenna as a result IAI (Inter antenna Interference) is produced and also when the transmitter transmit the CDMA signal only the corresponding receiver knows the code and for the remaining users it will act as an interference, which is named as MAI [3]. We Propose the MIIR (multi-access and inter-antenna interference reluctant) algorithm by which the MUI AND IAI is totally removed [4][5] , So that we can provide error free trans mission.

## II. SYSTEM MODEL

Let Nt be the transmit antenna and Nr be the receiving antenna, We assume that there are T users in the system and L chips of the code is assigned for the particular user.

$$s_i(n) = b_{1,i}(n)c_1(0) + \cdots + b_{T,i}(n)c_T(0)$$

$$\ldots \qquad \ldots$$

$$s_i(n+L-1) = b_{1,i}(n)c_1(L-1) + \cdots + b_{T,i}(n)c_T(L-1)$$

Where Bi is the data bits and Ci is the chips of the code

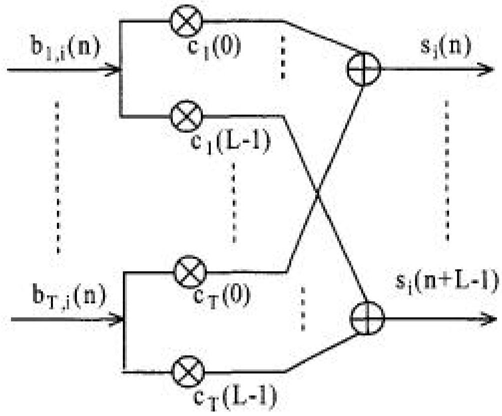



Fig.1 Sources of the i-th Transmitter Antenna

$$s_{n,i} = [\, s_i(n), \ldots, s_i(n+L-1)]^T$$

The elements of the antenna are grouped and then IDFT is applied to .

$$s_{n,i} = [\, s_i(n;0), \ldots, s_i(n;L-1)]^T$$

Where

$$s_i(n;k) = \sum_{m=0}^{L-1} s_i(n+m)\, e^{\frac{j2\pi km}{L}}$$
$$k = 0 \ldots . L-1$$

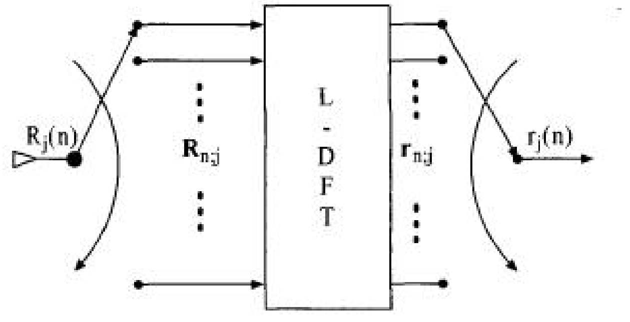



Fig 2 *j*-th Receiver antenna

The elements in the receiver receives the combination of the signal through different channels and for the ith receiver is

$$R_{n;j} = \sum_{i=1}^{N_t} S_i(n) \otimes h_{i,j} + V_{n;j}$$

where

$$R_{n;j} = [R_j(n), \ldots, R_j(n+L-1)]^T$$

H(n) is the channel matrix and the additive Gaussian noise which produced in the channel represented as . And the received is applied with DFT.

$$R_{n;j} = [R_j(n), \ldots, R_j(n+L-1)]^T$$

Where

$$r_j(n) = \sum_{m=0}^{L-1} R_j(n+m)\, e^{\frac{-j2\pi km}{L}}$$

The DFT converts the convolution mixture [6] into instantaneous mixtu re, the frequency at the k-th user is

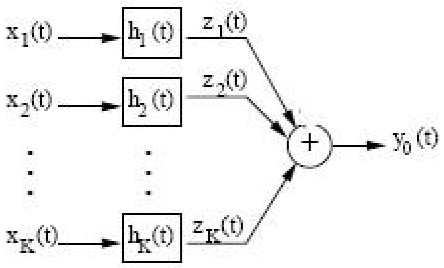



**Fig 3. Resultant signal**

$$r_n(k) = [\, r_1(n+k), r_2(n+k) \ldots, [\, r_n(n+k)]^T$$
$$= H(k)s_n(k) + V(k)$$

Where

$$H(k) = \begin{pmatrix} H_{1,1}(k) & H_{1,2}(k) & H_{1,nt}(k) \\ H_{2,1}(k) & H_{2,2}(k) & H_{2,nt}(k) \\ H_{nr,1}(k) & H_{nr,2}(k) & H_{nr,nt}(k) \end{pmatrix}$$
$$s_n(k) = [\, s_1(n+k), s_2(n+k) \ldots, [\, s_n(n+k)]^T$$

Where

$$[\, s_1(n+k) = [b_{1,1}(n)c_1(k) + \ldots + b_{T,1}(n)\, c_T(k)$$

$k = 0, \ldots, L-1$, interpreted in the frequency domain.

## III. MIIR ALGORITHM

### *A. Removal of Multi Access Interference*

The M C-CDMA technology can accommodate large number of users at the same time and frequency [8], And the waveform o f the signal varies with respect to the PN code.

The receiver which knows the code can only demodulate the signal and for the remaining users it would be like noise, hence there is low mutual correlation between the signal [9], which produces Multi access interferences.

When the user is nearer to the Base station, the signal strength for the user would be high and hence MAI becomes strong. The received low power signal is corrupted by the high power signal[10].

When geometric power distribution is known the MAI interference is cancelled fro m high power user to low power user.

When the signal passes through the LPF in the receiver. The Lk paths combined with equal gain combining because of the difficulty in SNR estimation. Then the estimated signal passes through the viterbi decoder where the k users are done in parallel.

Decision are done in the current bit to estimate the received signal for that particular user using SIC system.

The estimated signal is then removed fro m the composite signal thus the MAI is reduced[11].

For this the decoded bit are again encoded and they are spread with the particular PN sequence.

By using {a,b}we can determine the phase and amplitude of the signal.

$$\alpha_{k,l} = \frac{1}{N}\sum_{n=1}^{N} y_k[n].\, z\frac{I}{k,l}[n]$$
$$\beta_{k,l} = \frac{1}{N}\sum_{n=1}^{N} y_k[n].\, z\frac{0}{k,l}[n]$$

The composite signal is :

$$z_k[n] = \sum_{l=1}^{L_k}\left[\alpha_{k,l} z\frac{I}{k,l}[n] + \beta_{k,l} z\frac{0}{k,l}[n]\right]$$

The received signal is subtracted from the composite signal

$$y_k[n] = y_{k-1}[n] - z_{k-1}[n]$$
$$= y_0[n] - \sum_{i=1}^{k-1} z_i[n]$$

Some errors occurs in the process, Is represented in terms of log normal representation

$$x \sim N(0, \sigma^2)$$

represent the error in the estimation of the amplitude and phase of (alpha & beta)

*B. Removal of Inter Antenna Interference*

The signal quality and the amount of the information are degrades by the Inter antenna interference (IAI) [12], Which also affect the channel estimations. The reuse of same coder across the multiple transmitter and also the worst performance of the receiver in flat channel is the reason for the production of IAI [13]. The ability to reduce the IAI of the equalizer is low, so it consider the IAI as noise. The best method to reduce the IAI is by using non-linear techniques

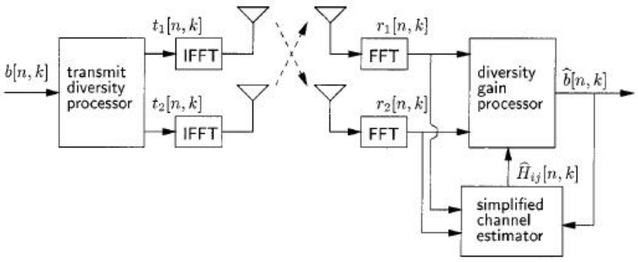



**Fig4. Estimation of IAI through channel estimation**

Since the same code is reused over the transmitters, the interference are removed by successive manner which is performed after dispreading the signal [14]. And the process of removing the IAI is based on the iteration method.

$$r_{i,j}^{0} = \left[r_j^1(1), \ldots, r_j^1(n_t + l_c - 1)\right]^T$$

Where,

Rj Is the chip received fro m the j-th antenna, and i-th sub stream in k-th iteration.

Estimation step:

$$p_{i,j}^{(k-1)} = \left(\frac{1}{n_t}\sum_{n=1}^{n_t} d_i(n) d_i^T(n)\right)^{-1}\left(\frac{1}{n_t}\sum_{n=1}^{n_t} d_i(n) r_{i,j}^{k-1}(n)\right)$$

Determination step:

$$g_{i,j}^{(k-1)} = d_i^{train} p_{i,j}^{(k-1)}$$

where

$d_i(n) = [d_i(k) \ldots, d_i(k - L_c + 1)]^T$ is the i-th sub stream of the n-th chip, that composes

$d_k^{train} = [d_i(1) \ldots d_i(nt)]$ *Pi*=channel estimate,

$g_{i,j}^{(k)} = g_{i,j}(1), \ldots, g_{i,j}(n_t + l_c - 1)^T$ = reconstructed training sequence

$$r_{i,j}^{(k)} = r_{i,j}^{(0)} - \sum_{z=1}^{a_t} g_{z,j}^{(k-1)}$$

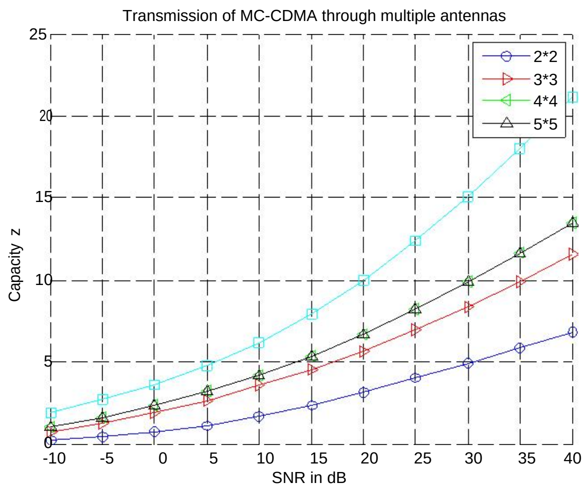
The signal fro m the transmitter are subtracted and reconstructed from the composite signal. Thus the signal is decoupled from different transmitter. Repeat estimate and determination steps until $k$ = iteration + 1.

## IV. Simulation Result s

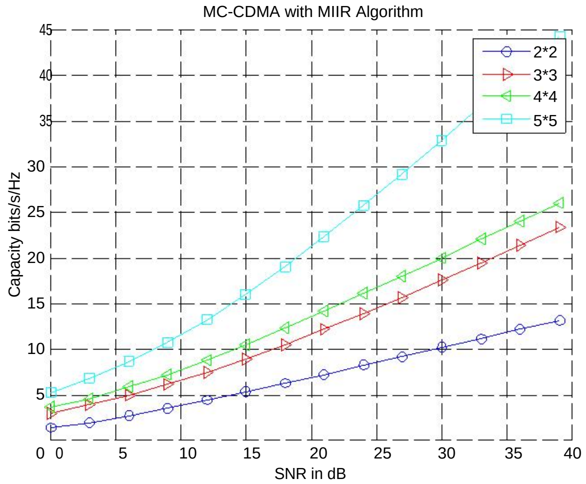
In this Research we focused on the downlink of the transmission. The QOS is investigated for various bandwidth usage. MC-CDMA is used to transmit data independently using coding schemes[15][16]. Our proposed scheme is to overcome the problems in the existing MIMO-M C-CDMA system by removing the interference (i.e) increasing the capacity further.

For simulation we assumed the frequency as 5Ghz, code rate of ½ , 16 subcarrier and M-QAM is used as a modulation technique. Our stimulation shows the difference between the normal MIM O-M C-CDMA system and MIIR implemented MIMO-M C-CDMA system.

The performance of the system is studied by varying the number of multiple antennas in the transmission and reception side. The capacity is the traffic in bps/hz, we estimate the performance of the system based on the capacity.




The above shown graph is without the implementation of the MIIR algorithm, It is found that the capacity of the system is low due to the large amount of interference. As the result for good capacity we need huge signal to noise ratio (ie) for reaching 20bits/hz capacity , 40 DB o f the SNR is required.




In this proposed system the capacity of the system doubled for the SNR value due to implementation of MIIR algorithm. From the graph it is clear that the capacity is high for the small value of SNR (ie) capacity reaches 40 bits/hz for 40DB of SNR. Hence it is clear that the performance doubled due to the implementation of MIIR algorithm

## V. Conclusion

The usage of the same codes over the MIMO M C-CDMA Transmission antennas causes IAI(Inter antenna interference).And also, when the correlation between the waveforms are very low which produces MAI(Multi access interference) to all other users apart from the corresponding user. In this paper we have proposed MIIR algorithm (multi-access and inter-antenna interference reluctant) with MMSE equalizer in receiver. The Performance is increased a lot when the interference cancellation stage is performed ,at the cost of increased computational complexity.

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