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Transmit Beamforming for Capacity and Reliability Enhancement in MC-CDMA System

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Abstract

In wireless communication, Co-channel interference degrades the capacity of the Multiple Input Multiple Output Multicarrier Code division Multiple access(MIMO MC-CDMA) system. Implementing beamforming suppress the co-channel interference with the help of spatial information from antenna array. The combination of space time block code(STBC) and adaptive beamforming enhance the reliability and capacity of the MC-CDMA system respectively. The proposed Maximum Sidelobe Cancellation(MSC)algorithm for beamforming in MIMO MCCDMA system reduces the beam width and concentrates the signal towards the desired users based upon the direction of arrival with suppressed null towards the co-channel signals. The simulation results of the proposed MSC algorithm shows that the beam pattern formed based on MSC algorithm is very narrow which increases the capacity of the system by reducing number of sidelobes that are due to co-channel interference

1. INTRODUCTION

The contrive of communication channel became more difficult when more multipath is produced due to the building, tree.. etc.. When the user is in the mobile ISI (Inter Symbol Interference) is produced due to the change in phase and amplitude. The Doppler shift is also produced due to the mobility of the user. To overcome this kind of issues and to increase the data rate MC-CDMA (multi carrier code division multiple access) system is used it is a combination of CDMA and OFDM. It has several advantages like high spectral efficiency, high space and frequency selective fading channel and efficient frequency reuse. The integration of MIMO (Multiple input and multiple output) and MC-CDMA is a promising technique to increase the bandwidth efficiency where different users can use the similar spectrum and it is the key solution for fading channels. To achieve higher reliability and to obtain bandwidth consumption STBC technique such that spatial diversity is used. The capacity is further enhanced and interference is reduced by the use of beamforming in adaptive antenna. In our paper MSC algorithm is used to focus the beam towards the desired user and place null in all other angle.

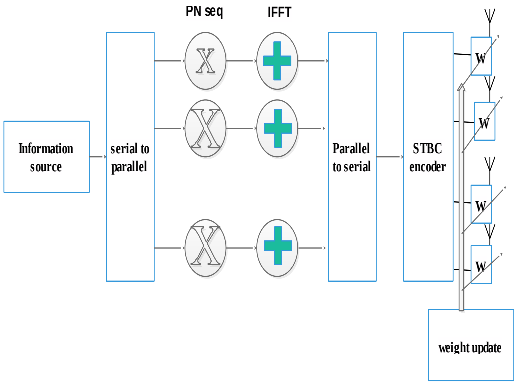
2. LITERATURE SURVEY

The existing system Generalize Sidelobe Cancellation (GSC) Algorithm [5] Exhibit adaptive beamforming for MC- CDMA system, where the transmit diversity is achieved through space time block code. The same data are transmitted over the multiple antenna. The direction of arrival of the signal is estimated by MUSIC algorithm. Based on the direction of arrival the beam is formed towards the desired user. In the existing system when the SNR reduces there is a huge increase in BER. For CDMA systems SNR=1/M-1, M-No of users. So when the number of users increases Multi access interference(MAI) is also increases. which can be overcome by directing the beam towards the desired user. GSC is less accurate in direction estimation. So the direction of the beam towards the desired user is less accurate.

3. PROPOSED SYSTEM

3.1 Improved Music algorithm

The improved MUSIC algorithm used in the MC_CDMA system shown in Fig.1 and Fig.2 estimates relevant direction of arrival of signal and direction of arrival of irrelevant signal even in the very low SNR value.



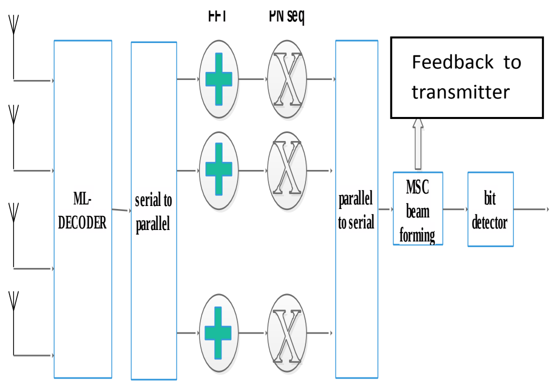


Fig.1. Transmitter of MC-CDMA system   Fig.2. Reciever of MC-CDMA system

L is the total number of received signal, Ǿ is the angle of reception of the certain signal and N be the total number of array elements. The received signal y(L) and noise n(L) are

$$A = [a(\emptyset_1), a(\emptyset_2) \ldots a(\emptyset_L)] \tag{1}$$

$$\mathrm{Y}(\mathrm{L}) = \mathrm{As}(\mathrm{L}) + \mathrm{n}(\mathrm{L}) \tag{2}$$

Where

$$S(L) = s_1(L), s_2(L) \ldots . s_k(L)$$

$$n(L) = n_1(L), n_2(L) \ldots . n_k(L)$$

The co-variance matrix of the received signal is

$$R_c = E\{y(L) y^H(L)\} \tag{3}$$

The music algorithm uses subspace algorithm to determine the DOA. The decomposition of co-variance matrix is

$$R_c = U_s A_d U_s^H + U_N A_I U_N^H \tag{4}$$

Where Us is the subspace of the signal , Un is the subspace of the noise.

$$U_s = [s_1(L), s_2(L) \ldots s_k(L)]$$

$$U_n = [n_1(L), n_2(L) \ldots n_k(L)]$$

The direction of arrival to the peak location is

$$A_d = \frac{1}{a^H(\emptyset) A_I A_I^H a(\emptyset)} \tag{5}$$

To improved the performance the total number of array element a($\emptyset$) divided into two subset. $a_1(\emptyset)$ is considered for first M elements, $a_2(\emptyset)$ is considered for remaining (N-M) elements.

$$a(\emptyset) = \begin{bmatrix} a_1(\emptyset) & 0 \\ 0 & a_2(\emptyset) \end{bmatrix} \begin{bmatrix} 1 \\ \cdots \\ 1 \end{bmatrix} = \hat{a}(\emptyset) \tag{6}$$

$$\hat{a}(\emptyset) = \begin{bmatrix} e^{-j2\pi dM/\gamma cos(a\pi/180)} & 0 \\ 0 & e^{-j2\pi d(N-M)/\gamma cos(a\pi/180)} \end{bmatrix} \begin{bmatrix} 1 \\ \cdots \\ 1 \end{bmatrix} \tag{7}$$

Hence the estimated direction of arrival is follows

$$A_d = \arg\max \frac{1}{\det[a^H(\emptyset) A_I A_I^H a(\emptyset)]} \tag{8}$$

The beam focus towards the desired direction, is denoted by

$$\mathrm{Y}_{01} = \mathrm{w}_d * A_d \tag{9}$$

w_d Is the weight of the desired signal, the weight $\mathrm{w_d}$ is applied to the measured direction of arrival it form the main beam in the user direction. Solving the value

$$Y_{01} = w_d * \arg\max \frac{1}{\det\left[a^H(\varnothing) A_I A_I^H a(\varnothing)\right]} \tag{10}$$

3.2 Null Steering Beamforming Algorithm

The null steering algorithm helps to form the beam in indented direction and nulls in the direction of the interference. It separates the desired signal and the interference signal.The logic of the algorithm is to make beam towards interference, Hence according to OLNS(Open loop null steering) algorithm. The interference signal is cancelled by

$$Y_{02} = [I_L - A_I (A_I A_I^H)^{-1} A_I^H] A_d \tag{11}$$

3.3 Combined Beamforming

When the two phases are combined together as in Fig.3 , which makes the beam to focus on the desired user and cancels the side lobes.

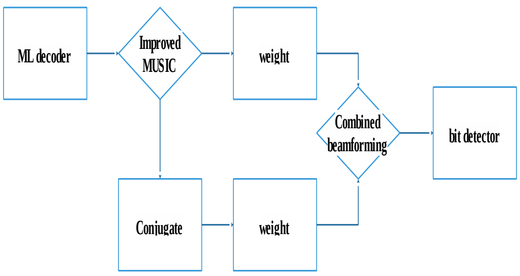


Fig.3. Internal Structure of MSC

$$Y_0 = Y_{01} * Y_{02} \tag{12}$$

It is the product of the two beams the beamformer output makes the beam narrow and sharp by focusing the beam towards the desired user and nulls the beam towards the interference

4. SIMULATION RESULTS

The parameters considered for Simulations are Height of the BS is 32m, Height of MS is 1.5m, Antenna Gain is 16dBi, cell radius 1 km, ERP is 40dBm in Rayleigh channel.

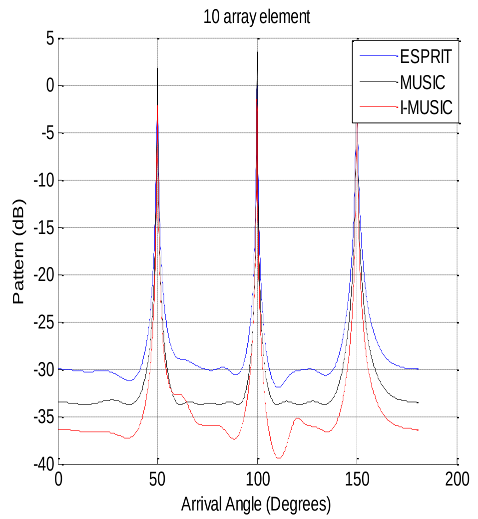


Fig.4. Angle of arrival

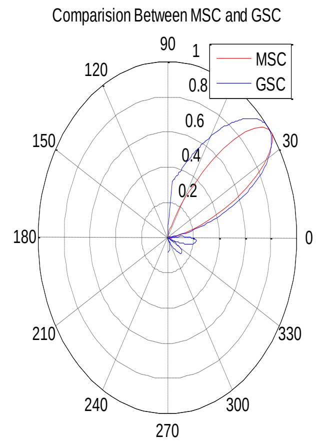


Fig.5. Beam patter comparison

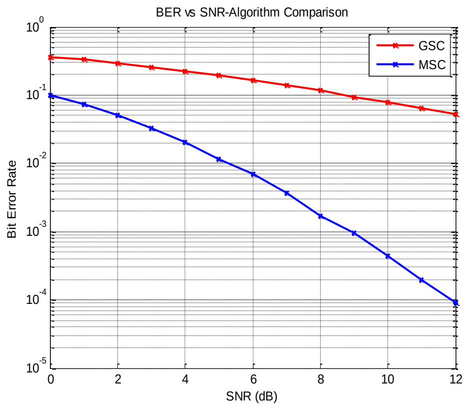


Fig.6. BER Comparison

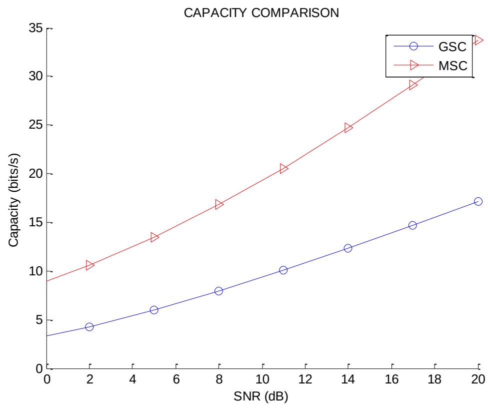


Fig.7. Capacity comparison

Fig.4 shows the I-MUSIC is best for determining angel of arrival, Fig.5 shows the beam Patten of the proposed system, Fig.6 shows the BER comparison with existing algorithm and Fig.7 shows the capacity comparison with existing algorithm

5. CONCLUSION

We proposed a design which combines the STBC and adaptive antenna. STBC increases the data rate and reliability through spatial diversity. An MSC algorithm for beam forming increases the capacity of the MC_CDMA system, By focusing the beam towards the desired user and place null in all other directions. The performance is measured using matlab.

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