

# **A Scheme for Cancelling Interference to Provide Full Diversity**

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**ABSTRACT:** In multiple access channels, when users know each other's channels, precoders can be designed utilizing channel information to cancel the interference at the receiver without sacrificing the diversity or the complexity of the system. Recently, it was shown that when there are only two users, a receiver can completely cancel the interference of the two users and provide full diversity for each user. The system can be extended to more than 2 users. In this system to achieve interference cancellation and full diversity with low complexity for any number of users. This proposed system precoder are designed using the channel information, to make it possible for different users to transmit over orthogonal directions. Then, using the orthogonality of the transmitted signals, the receiver can separate them and decode the signals independently. We also analytically prove that our system provides full diversity to each user. Simulation results confirm our analytical proof and show that our proposed scheme outperforms other existing interference cancellation schemes.

**KEYWORDS:** Multi-user detection, multiple antennas, interference cancellation, precoder, orthogonal designs.

## **I.INTRODUCTION**

Recently a lot of attention has been given to multi-user detection schemes with simple receiver structures. Multiple transmit and receive antennas have been used to increase rate and improve the reliability of wireless systems. In this paper we consider a multiple-antenna multi-access scenario where interference cancellation is achieved by utilizing channel information. When there is no channel information at the transmitter simple array processing methods using orthogonal space-time block codes (OSTBCs) and quasi-orthogonal space-time block codes (QOSTBCs) have been proposed. For users each with transmit antennas it has been shown that in order to achieve interference cancellation a receiver does not need more than receive antennas. In addition the diversity of each user is equal to using maximum-likelihood detection and using low complexity array-processing schemes. Even a few bits of feedback at the transmitter can be used to improve the system performance. In addition the performance of each user in multi-antenna multiuser systems can also be enhanced using limited feedback. The common goal and the main characteristics of multi-user systems are the small number of required receive antennas and the low complexity of the array-processing decoding. However full diversity for each user is only achieved using maximum-likelihood detection. On the other hand, maximum-likelihood detection is usually not practical because its complexity increases exponentially as a function of the number of antennas the number of users and the bandwidth efficiency (measured in bits per channel use).

To overcome this drawback channel information is utilized at the transmitters to increase the diversity of the system while keeping the low complexity of the decoding. In other words we do not use receive antennas to cancel the interference. As a result interference suppression is achieved without utilizing the receive antenna resources and therefore full diversity is achieved naturally.

However the scheme only works for two users. In this project I will extend the work and propose a scheme that works for four number of users. The outline of the paper follows next. In section II, we introduce our scheme for 4 users each with 4 transmit antennas. our scheme can simultaneously achieve interference cancellation and full diversity for each user. we provide the details of decoding in section III and proof of full diversity in section IV.

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## II. RELATED WORK

The existing multi-user systems are the small number of required receive antennas and the low complexity of the array-processing decoding. However, as mentioned before, full diversity for each user is only achieved using maximum-likelihood detection. On the other hand, maximum-likelihood detection is usually not practical, because its complexity increases exponentially as a function of the number of antennas, the number of users, and the bandwidth efficiency

When two users transmit signals to a common receiver, one can design precoders to cancel the interference for each user, if each user knows all the channel information perfectly. Also the diversity for each user is full. However, in practice, perfect channel information is not available. In this project, we design precoders for two users with two transmit antennas and one receiver with two receive antennas using quantized feedback.

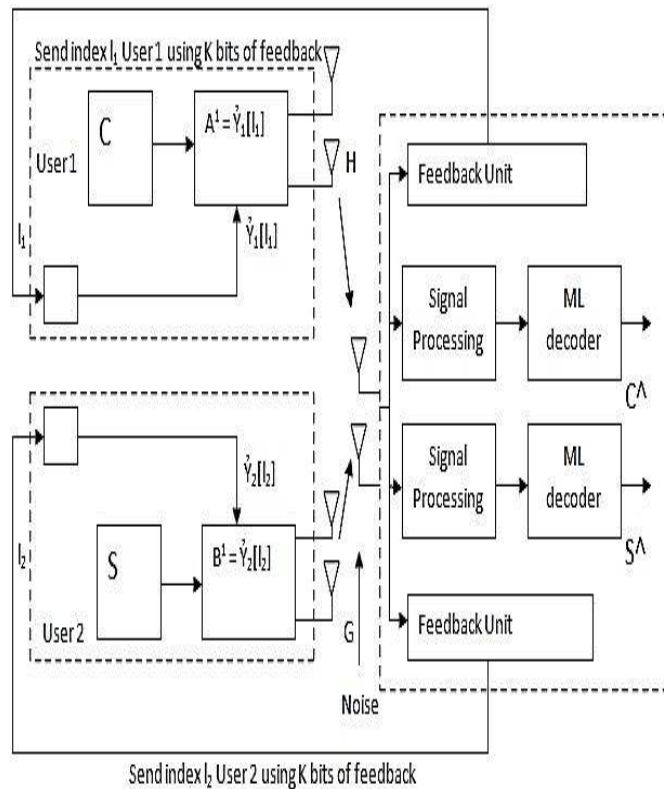


Fig 1. Block Diagram

### A ) Disadvantages of existing system:

- i. High interference
- ii. Limited users

## III. PROPOSED SYSTEM

Our main idea is to design precoders, using the channel information, to make it possible for different users to transmit over orthogonal directions. Then, using the orthogonality of the transmitted signals, the receiver can separate them and decode the signals independently.

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C,S,T,Z - User matrix, A1,A2,A3,A4 - Precoders, H1,H2,H3,H4 - Channel matrix, SP - Signal processing,ML - Maximum likelihood decoder, The above mentioned scheme for four users each with four transmits antennas and one receiver with four receive antennas.By adjusting the dimensions of channel matrices, our proposed scheme can be easily applied to. User with transmit antennas and one receiver with receiver antennas.

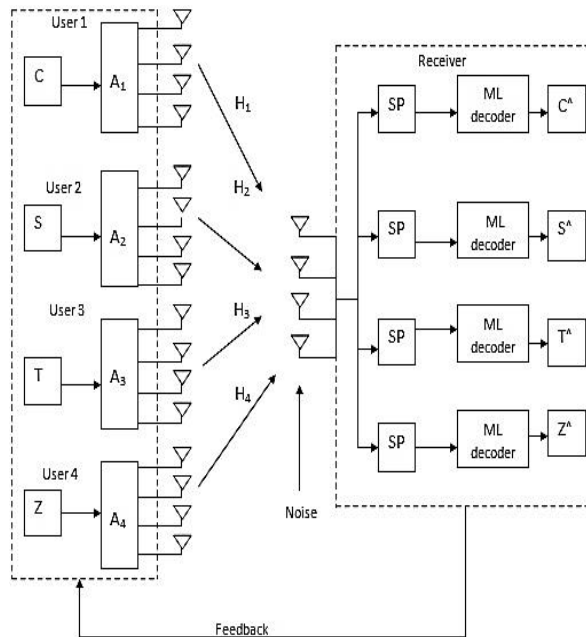


Fig 2.Block Diagram

## A) INTERFERENCE CANCELLATION FOR FOUR USERS EACH WITH FOUR TRANSMIT ANTENNAS

In this project, we assume a quasi-static flat Rayleigh fading channel model. The path gains are independent complex Gaussian random variables and are fixed during the transmission of one block. In addition, a short-term power constraint is assumed. For the sake of simplicity, we only present the scheme for four users each with four transmit antennas and one receiver with four receive antennas. By adjusting the dimensions of channel matrices, our proposed scheme can be easily applied to. User with transmit antennas and one receiver with receiver antennas.

## B) TRANSMITTER DESIGN

C is the user matrix for user1. Simultaneously S, T, Z are user matrix for user2, user3, user4.

$$C = \begin{bmatrix} c1 & -c2 * & c3 & -c4 * \\ c2 & c1 * & c4 & c3 * \\ c3 & -c4 * & c1 & -c2 * \\ c4 & c3 * & c2 & c1 * \end{bmatrix} \quad S = \begin{bmatrix} s1 & -s2 * & s3 & -s4 * \\ s2 & s1 * & s4 & s3 * \\ s3 & -s4 * & s1 & -s2 * \\ s4 & s3 * & s2 & s1 * \end{bmatrix}$$

$$T = \begin{bmatrix} t1 & -t2 * & t3 & -t4 * \\ t2 & t1 * & t4 & t3 * \\ t3 & -t4 * & t1 & -t2 * \\ t4 & t3 * & t2 & t1 * \end{bmatrix} \quad Z = \begin{bmatrix} z1 & -z2 * & z3 & -z4 * \\ z2 & z1 * & z4 & z3 * \\ z3 & -z4 * & z1 & -z2 * \\ z4 & z3 * & z2 & z1 * \end{bmatrix}$$

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## C) PRECODERS

Precoding is a generalization of beam forming to support multi-layer transmission in multi-antenna wireless communications. In conventional single-layer beam forming the same signal is emitted from each of the transmit antennas with appropriate weighting such that the signal power is maximized at the receiver output. When the receiver has multiple antennas single-layer beam forming cannot simultaneously maximize the signal level at all of the receive antennas. Thus, in order to maximize the throughput in multiple receive antenna systems, multi-layer beam forming is required.

$l$  denotes the time slot for each precoder.  $l=1,2,3,4$ .  $A_1$  is the precoder for user 1 so that user 1 have 4 time slots. similarly  $A_2$ ,  $A_3$ ,  $A_4$  are precoders for user 2, user 3, user 4 each with 4 time slots therefore we have 16 precoder matrices.

$$A_1^l = [a_1^l(i,j)]_{4 \times 4}, \quad A_2^l = [a_2^l(i,j)]_{4 \times 4}$$

$$A_3^l = [a_3^l(i,j)]_{4 \times 4}, \quad A_4^l = [a_4^l(i,j)]_{4 \times 4}$$

## D) CHANNEL

$H_1$  is the channel matrix for user 1 and simultaneously  $H_2$ ,  $H_3$ ,  $H_4$  are the channel matrices for user 2, user 3, user 4.

$$H_1 = [h_1(i,j)]_{4 \times 4}, \quad H_2 = [h_2(i,j)]_{4 \times 4}$$

$$H_3 = [h_3(i,j)]_{4 \times 4}, \quad H_4 = [h_4(i,j)]_{4 \times 4}$$

## E) Input output equation

$l$  – Denotes the time slot,  $E_s$  – signal strength, this equation combines the channel matrix, user matrix and noise.

$$Y^l = \sqrt{E_s} (H_1 A_1^l r^l(i) + H_2 A_2^l r^l(i) + H_3 A_3^l r^l(i) + H_4 A_4^l r^l(i)) + N^l$$

$$Y^l = \sqrt{E_s} (H_1^l r^l(i) + H_2^l r^l(i) + H_3^l r^l(i) + H_4^l r^l(i)) + N^l$$

## F) ORTHOGONAL STRUCTURE

The design of precoders to make the transmit directions of signals orthogonal to each other. However, we design the precoders for Users 3 and 4 first, such that each element of the equivalent channel matrices for Users 3 and 4 is Gaussian. Then we design the precoders for Users 1 and 2 to obtain the orthogonal structure. As a result, elements of the equivalent channel matrices for Users 1 and 2 will not be Gaussian at the second 2 time slots.

We design the precoders for users 3 and 4 first, such that each element of the equivalent channel matrices for users 3 and 4 is Gaussian. then we design the precoders for users 1 and 2 to obtain the orthogonal structure. for users 1 and 2 will not be Gaussian at the second 2 time slots. Later we will prove that by using such precoders, we can achieve interference cancellation and full diversity for each user. In what follows, we will describe the details of our precoder designs.

## G) ADVANTAGES OF PROPOSED SYSTEM:

- i. Full diversity achieved
- ii. High interference cancellation
- iii. It is applied to four no of users

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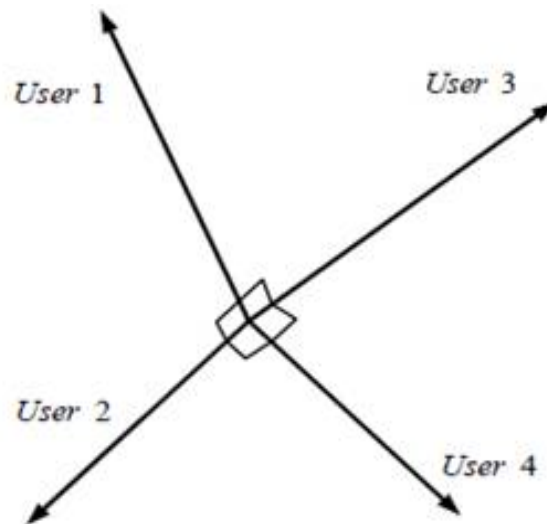


Fig 3.Orthogonal structure of signal vectors in 4 – dimensional space

## IV. SIMULATION RESULTS

In this section, I will provide simulation results that confirm our analysis in the previous sections. The performance of our proposed scheme is shown in Figures, we consider 4 users each equipped with 4 transmit antennas and a receiver with 4 receive antennas. We compare my scheme using QPSK with the scheme proposed in for the same configuration without channel information at the transmitter. With 4 receive antennas, the multi-user detection (MUD) method offered in cancels the interference and provides a diversity of 4. My scheme also cancels the interference completely but provides a diversity of 16 by utilizing the channel information at the transmitter. We also compare our scheme with two other schemes that can

realize interference cancellation and full diversity as well. In both of these two schemes, we assume there are 4 users each with 4 transmit antennas and one receiver with 4 receive antennas. The first scheme is to let only one user transmit using single beamforming at each time slot In order to have the same bit-rate, 256-QAM is used. The second scheme is to let the first 2 users transmit using the scheme for 2 users in at the first 4 time slots and the second 2 users transmit at the second 4 time slots. Similarly, in order to have the same bit-rate, 16-QAM is used. The results, in Figure 3, show that our scheme outperforms both of these two schemes, by 13 dB and 8 dB, respectively.

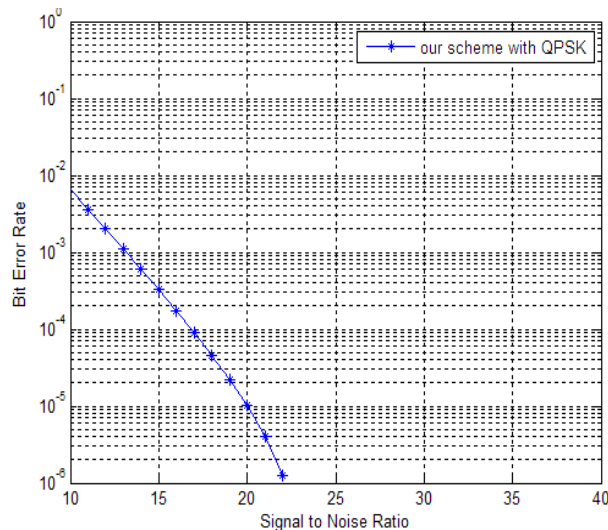
Finally, we compare my scheme with the following TDMA multiple beamforming scheme. At each time slot, only one user transmits using multiple beamforming, i.e., sends 4 symbols along the 4 eigenvectors of the channel matrix. QPSK is used to match the rate. From the simulation, our scheme outperforms this scheme whose diversity is only 1. We compare my scheme with all mentioned schemes when the rate is changed to adapt with the received SNR. In the simulation, the single beamforming scheme switches between 16-QAM and 256-QAM. The multiple beamformingscheme, the MUD scheme in and my scheme all switch between BPSK and QPSK.

The interference cancellation scheme in switches between QPSK and 16-QAM. The threshold to switch between the two rates is properly chosen such that the two constellations are used with the same probability in each scheme. So the rate of all these schemes is 1.5 bits/sec/Hz. We have also provided a “fixed rate” set of simulation results. In all cases, for 1.5 bits/sec/Hz, what we mean by “fixed rate” is the average between the performance of two fixed-rate systems using BPSK and QPSK. we can see that adapting the rate can improve the performance compared with using a fixed rate. Also we can see that even with variable rate, my scheme provides the best performance.

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## V. CONCLUSION

I have considered interference cancellation for a system with more than two users when users know each other's channels. I have proposed a system to achieve the maximum possible diversity of 16 with low complexity for 4 users each with 4 transmit antennas and one receiver with 4 receive antennas. Besides diversity, My proposed scheme also provides the best performance among all existing schemes with simple array processing decoding. My main idea is to design precoders, using the channel information, to make it possible for different users to transmit over orthogonal directions.

In future work, we extend the results to any number of users with any number of transmit and receive antennas. precoders, are designed to make it possible for different users to transmit over orthogonal directions. Then, using the orthogonality of the transmitted signals, the receiver can separate them and decode the signals independently.

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