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RESEARCH ARTICLE

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AF SIMULTANEOUS TWO WAY MIMO RELAYING USING SFBC CODES

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ABSTRACT

Relay transmission plays an important role in future cellular system because, it increases the system capacity. The existing system is a non simultaneous two way relaying. Unlike conventional two-way relaying, the base station in NS-TWR performs two-way relaying with two different users ,a transmit-only user and a receive-only user (RUE). Non simultaneous means either source to relay transmission or relay to destination transmission takes place . The RUE experiences back-propagating interference (BI). The existing design cancels this BI and provide beam forming gain. The precoder and the receiver designs as well as the power allocation program are then extended for a multi-user system with multiple transmit-only and receive-only users. The proposed system uses simultaneous two way relaying which means, at the same time both transmissions takes place .The proposed system uses SFBC codes instead of STBC codes, here the power allocation is on the basis of incoming signal and here use Eigen value precoder to design the precoders ,and it can be used in both transmission and destination sides there is no need for extra precoder .

I. INTRODUCTION

Relay transmission plays an important role in future cellular system because**,** to meet the demand of higher data rates and ubiquitous coverage in wireless systems. The half duplex communication prevents relay station (RS) from concurrently transmitting and receiving on the same spectral resource so this reduces the spectral efficiency of one-way relaying this twice the number of channel uses. Two-way relaying (TWR) exploits simultaneous bi-directional data flow between two nodes to eliminate this spectral loss. In TWR, it is assumed that a node not only wants to send but also has data to receive from its partner node and send this to the relay ,the relay combines these two incoming signals and then broadcast. Since both nodes have their self-data, they can cancel self-interference/back propagating interference (BI) from their received sum-signal. The basic principle thus in TWR is to aggregate two data flows from two nodes to establish two-way data flow via the relay.

The BS can serve both TUE and RUE with one-way relaying .One-way relaying creates two non-interfering links, uplink and downlink, to serve two users. However, one-way relaying will reduce the system spectral efficiency. In the MAC phase of the Non-Simultaneous TWR (NSTWR) protocol (see Fig. 1(a)), both TUE and BS transmit data signals to the relay The relay receives the sum of these two signals. In the BC phase (see Fig. 1(b)), the relay amplifies and forwards this received sumsignal to both BS and RUE. The BS now requires two channel uses to serve both users.

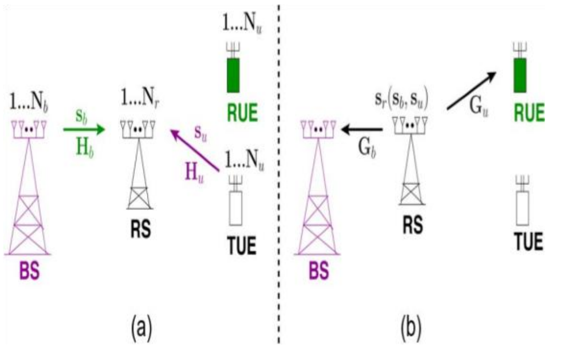


Fig. 1. **Non-Simultaneous TWR protocol**

In the MAC phase, user TUE transmits data meant for the BS while the BS transmits data meant for user RUE. In the BC phase, relay amplifies and forwards the sum-signal received in the MAC phase to both BS and RUE.

The existing relay-precoder has three limitations. First, it does not realize beam forming gain Second, it restricts the number of BS antennas to be equal to the number of TUE/RUE antennas. Third, it fixes the number of transmit streams to be equal to the number of BS/TUE antennas. The existing system joint design overcomes all these limitations.

Here proposed the simultaneous two way relaying .In the existing non simultaneous two way relay is half duplex (either transmitting or receiving),and there used STBC codes, so the transmitting data needs more time to reach the destination and used AF protocol so the errors will also added to the information. If we use simultaneous (proposed) two way relaying have overcome these problems. In proposed we used full duplex communication, so we will get both the transmitted and received data at a time. Here SFBC codes are used instead of STBC codes so here data need only less time to reach the destination. Here use DF protocol instead of AF protocol. It will increase the security.

II. SYSTEM MODEL

We consider amplify-and-forward (AF) non-simultaneous two-way multiple-input multiple-output (MIMO) relaying where two users, TUE and RUE, communicate with the BS through a half-duplex relay (see Fig. 1). The BS has N_b antennas, users TUE and RUE have N_u antennas each, and the relay has N_r antennas. We assume that there are no direct links between the BS and the two users.In the MAC phase (BS → RS ← TUE) of NS-TWR, both BS and TUE simultaneously transmit to the relay; the relay receives an $N_r \times 1$ signal given as

$$\mathbf{y}_r = \mathbf{H}_u\mathbf{s}_u + \mathbf{H}_b\mathbf{s}_b + \mathbf{n}_r. \quad (1)$$

Here, $\mathbf{H}_u \in C^{Nr \times Nu}$ and $\mathbf{H}_b \in C^{Nr \times Nb}$ are full-rank MIMO channels of the TUE → RS and BS → RS links, respectively. The data vectors $\mathbf{s}_u \in C^{Nu \times 1}$ and $\mathbf{s}_b \in C^{Nb \times 1}$ are transmitted by the TUE and BS, respectively; they are obtained by linear precoding of the normalized complex source vectors, that is, $\mathbf{s}_u = \mathbf{B}_u\tilde{\mathbf{s}}_u$ and $\mathbf{s}_b = \mathbf{B}_b\tilde{\mathbf{s}}_b$. The precoded data vectors satisfy the total power constraint:

$$\mathrm{Tr}\left(\mathbb{E}\left(\mathbf{s}_i\mathbf{s}_i^H\right)\right) = \mathrm{Tr}\left(\mathbf{B}_i\mathbf{B}^H_i\right) \triangleq \mathrm{Tr}(\Omega_i) \leq P_i. \quad (2)$$

A .BI Cancellation Precoder Design

Our objective is to design relay precoders **Z** and **F** to cancel the BI of RUE alone and not that of the BS, as the BS can itself cancel its BI. To achieve this, we first stack the BC-phase receive signal of both RUE and BS in (4) to form a vector **y** such that

$$y = \mathbf{GWHs} + \tilde{\mathbf{n}}. \quad (3)$$

To cancel RUE's BI, we state the following condition: *The BI is cancelled for the RUE alone, if and only if precoders* **Z** *and* **F** *are designed such that either*

$$\underbrace{\widetilde{\mathbf{G}}_0 = \widetilde{\mathbf{H}}_0 = \mathbf{0}}\ \mathrm{or}\ \underbrace{\widetilde{\mathbf{G}}_u = \widetilde{\mathbf{H}}_u = \mathbf{0}}. \quad (4)$$

The signals received by the RUE and BS (after BI cancellation),

$$\mathbf{y}_u = \widetilde{\mathbf{G}}_u\Xi_u\widetilde{\mathbf{H}}_b\mathbf{s}_b + \tilde{\mathbf{n}}_u = \mathbf{G}_u\mathbf{Z}_u\Xi_u\mathbf{F}_b\mathbf{H}_b\mathbf{s}_b + \tilde{\mathbf{n}}_u,\ \mathbf{y}_b = \widetilde{\mathbf{G}}_b\Xi_b\widetilde{\mathbf{H}}_u\mathbf{s}_u + \tilde{\mathbf{n}}_b = \mathbf{G}_b\mathbf{Z}_b\Xi_b\mathbf{F}_u\mathbf{H}_u\mathbf{s}_u + \tilde{\mathbf{n}}_b. \quad (5)$$

We next design precoder matrices **Z** and **F**.

1) *Design of Precoder Matrix* **Z***:* To ensure $\mathbf{G}_0 = \mathbf{G}_u\mathbf{Z}_b = \mathbf{0}$, precoder $\mathbf{Z}_b$ should lie in the nullspace of $\mathbf{G}_u$

2) *Design of Precoder Matrix* **F***:* To ensure $\mathbf{H}_0 = \mathbf{F}_b\mathbf{H}_u = \mathbf{0}$, precoder $\mathbf{F}_b$ should lie in the left nullspace of $\mathbf{H}_u$,

B. Channel-Diagonalization Design

To diagonalize the end-to-end downlink (BS → RS → RUE) and uplink (TUE → RS → BS) MIMO channels, we note that the RUE and BS linearly combine their respective signals

II JOINT POWER ALLOCATION VIA GEOMETRIC PROGRAMMING

We now maximize the WSR, via joint power allocation at the BS, TUE and relay, by casting it as a geometric program (GP) . A GP can be efficiently solved using off-the-shelf software packages

We first define the WSR of the system as

$$(\delta, \lambda_u, \lambda_b) = \frac{1}{2} \sum_{i \in \{u,b\}} \sum_{n=1} w_{i,n} \log_2 (1 + \mathbf{N})$$

Next maximize the WSR in two steps:

1) Use a high-SNR approximation to cast WSR maximization as a GP,
2) The WSR so obtained is further maximized using an algorithm proposed herein. WSR maximization with its exact expression

Initialization step: Calculate $R^0(\delta,\lambda_b,\lambda_u)$ by solving problem **P1** and set δ, λ_b and λ_u as feasible variables. Fix the maximum number of iterations N_{max} and threshold value ν. **Main step**: **for** p = 1 to N_{max} **do**

1. Evaluate the posynomial in denominator of the objective (22a) with the given δ, λ_b and λ_u.
2. Compute for each *i*th term in this posynomial
3. α_i $\dfrac{\text{value of ith term in posynomial}}{\text{value of posynomial}}$
4. weights α_i to reduce this posynomial into a monomial.
5. Solve the resulting GP to calculate $R^p(\delta,\lambda_b,\lambda_u)$.
6. **if** $|R^p(\delta,\lambda_b,\lambda_u) - R^{p-1}(\delta,\lambda_b,\lambda_u)| < \nu$, **then break**. **end if**. **end for**

III . PRECODER DESIGN FOR MULTI-USER SCENARIO

The system model now consists of N_u single-antenna TUEs, TUE-1 to TUE-N_u, that only transmit data to the BS via the relay (see Fig. 2(a)) and N_u single-antenna RUEs, RUE-1 to RUE-N_u, that only receive data from the BS via the relay (see Fig. 2(b)).

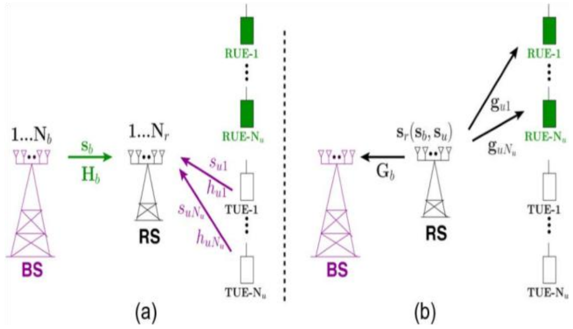


Fig. 2. Illustration of Multi-user NS-TWR protocol. Note that, in the BC phase, $\mathbf{s}_u = [s_{u1},\cdots,s_{uNu}]^T$. (a) MAC phase. (b) BC phase.

Precoder design for multi-user scenario.

Downlink precoder design

1: Design **Z** and **F** to cancel BI experienced by RUEs.

2: Design $\mathbf{B}_b$ and Ξ_u such that the BS employs ZF-DPC to cancel CCI experienced by RUEs.

Uplink precoder design

3: Design Ξ_b and $\mathbf{D}_b$ to triangularize the uplink MIMO channel.

4: Jointly allocate power at the BS and relay to maximize WSR.

A. *Performance Evaluation of Single-User Precoder Design*

We compare the average WSR of the proposed BICD design with that of the ZF and the MMSE precoders designed for conventional TWR, and of the BICT precoder.The ZF precoder cancels BI for both BS and RUE, and can be used for NS-TWR. The ZF and MMSE precoders cancel/mitigate BI for the BS also, which is undesired. The BICT precoder cancels the BI for the RUE alone and is shown to perform better than the ZF/MMSE precoders. The WSR for these designs is maximized using the algorithms relevant for each.

B . Performance Evaluation of the Multi-User Precoder Design

We now evaluate the performance of multiuser BI-cancelling DPC (BIDPC) design .The performance of the BIDPC design is compared with the ZF precoders and two DPC-based precoderse-DPC1 and e-DPC2. The ZF and MMSE precoders are constructed at the relay to cancel both BI and CCI. The e-DPC1 precoder, also constructed at the relay, cancels the BI alone; the CCI is cancelled at the BS by using DPC.

IV PROPOSED SYSTEM

The proposed two way relaying is simultaneous .The two way relay(TWR) means two terminals excghange information over a shared wireless half duplex channel with the help of relay.TWR improves spectral efficiency of cellular system.The simultaneous (proposed) two way relay means both transmission that is source to relay and relay to destination takes place at the same time ie, its a full duplex communication.Here use SFBC codes instead of STBC codes so it increases the security of the system.Here use only one precoder design in both transmission and reception section ie,the eigen value precoder design .

V. SIMULATION RESULTS

A. SNR vs SER

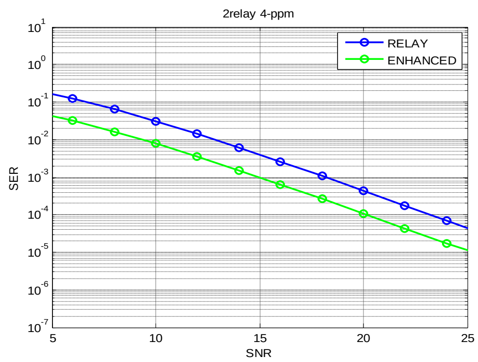


Fig shows SNR increases SER the symbol error rate decreases

B. EETA vs WSR

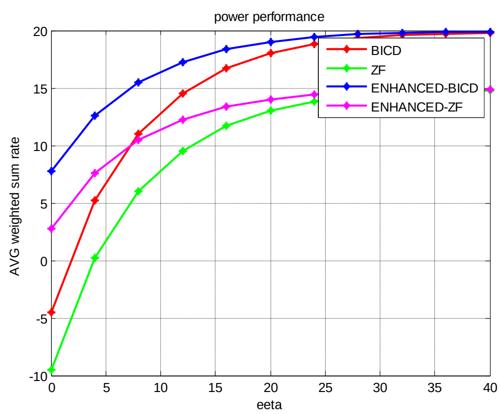


Fig enhanced BICD increases as compared to existing system which means BI the back propaghating interference cancels .

C. EETA vs WSR

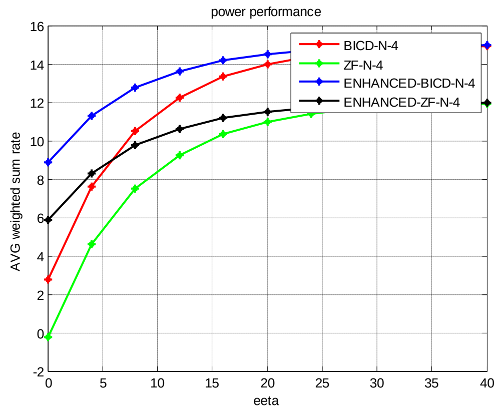


Fig shows as eeta increases the WSR ie,weighted sum rate increases and here the graph is plotted on the basis of antenna configuration 4.

D. EETA vs WSR

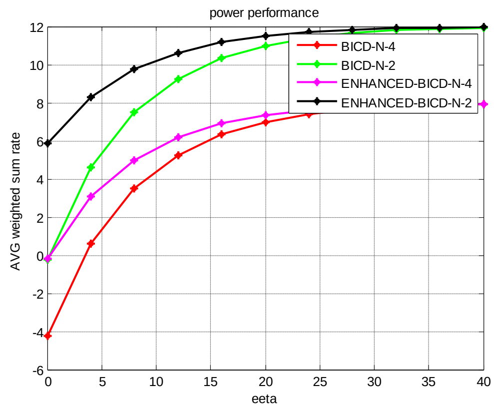


Fig shows as eeta increases the WSR ie, weighted sum rate increases and here the graph is plotted on the basis of antenna configuration 2 and 4.

E. MULTIUSER SCENARIO

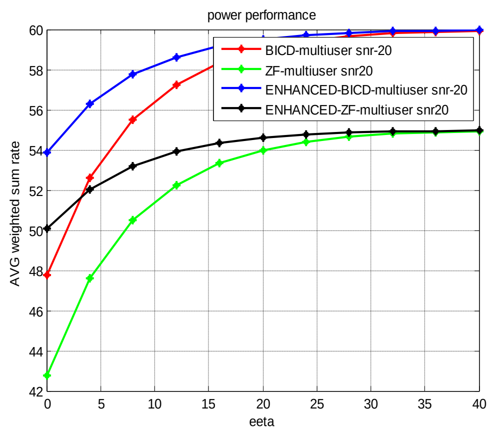
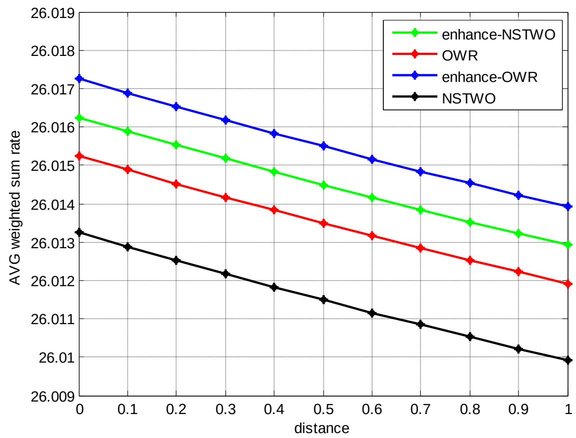


Fig multiuser enhanced BICD increases as compared to existing system which means BI the back propagating interference cancels .

F. DISTANCE vs AWG WSR



As distance increases the AWG WSR decreases .

VI COMPARISON

EXISTING		PROPOSED	
1	Joint precoder design.	1	Eigen based precoder design.
2	Amplify and then forwarding .	2	Decode and then forwarding.
3	SFBC codes .	3	STBC codes .
4	Non simultaneous.	4	Simultaneous.
5	Half duplex.	5	Full duplex.

VII. CONCLUSION

This paper proposes a simultaneous two way relaying. This proposed algorithm can be used in two way ie, full duplex communication. Comparing both (the existing and proposed) proposed has certain advantages over existing .The proposed method increases the security. Here shows as eta increases AWG WSR increases for different antenna configurations. TWR improves spectral efficiency of cellular system. The simultaneous (proposed) two way relay means both transmission that is source to relay and relay to destination takes place at the same time. Here use SFBC codes instead of STBC codes so it increases the security of the system. Here use only one precoder design in both transmission and reception section ie, the Eigen value precoder design .

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