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Joint Beam Forming, Power and Channel Allocation in Multi-User and Multi-Channel Underlay MISO Cognitive Radio Networks

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ABSTRACT *:*In this paper, we consider a joint beam forming, power and channel allocation in a multi-user and multi-channel underlay multiple input single output (MISO) cognitive radio network (CRN). In this system, primary users (PU's) spectrum can be reused by the secondary user transmitters(SUTXs) to maximize the spectrum utilization while the intra-user interference is minimized by implementing bean forming at each SU-TX. After formulating the joint optimization problem as a non-convex, mixed integer nonlinear programming(MINLP) problem, we propose a solution which consists of two stages. In the first stage, A feasible solution for power allocation and beam forming vectors is derived under a given channel allocation by converting the original problem into a convex form with an introduced optimal auxiliary variable and semi definite relaxation (SDR) approach. After that, In the second stage two explicit searching algorithms, i.e., genetic algorithm (GA) and simplified annealing (SA)-based algorithm, are proposed to determine suboptimal channel allocations. Simulation results show that the beam forming, power and channel allocation with SA (BPCA- SA) algorithm can achieve close-to-optimal sum-rate while having a lower computational complexity compared with beam forming, power and channel allocation with GA (BPCA_GA) algorithm.

I.INTRODUCTION

Orthogonal frequency- division multiplexing (OFDM) is a very popular multi-carrier modulation technique for transmission of signals over wireless channels. OFDM divides the high-rate data stream into parallel lower rate data and hence prolongs the symbol duration, thus eliminating Inter Symbol Interference (ISI). A large number of closely spaced orthogonal sub-carrier signals are used to carry data on several parallel data streams or channels. Each sub-carrier is modulated with a conventional modulation scheme (such as quadrature amplitude modulation) at low symbol rate, maintaining total data rates similar to conventional single-carrier modulation schemes in the same bandwidth.

Power and Channel Allocation: In the cooperative relay in a three-node Cognitive radio network , cognitive radio relay channel can be divided into three categories : Direct, Dual-hop and relay channels which provide three types of parallel end-to-end transmission. Spectrum band available at all the three nodes may either perform relay diversity transmission or assist the transmission in direct or dual-hop channels. In this paper, we develop power and channel allocation approaches for cooperative relay in cognitive radio networks that can significantly improve the overall end-to-end throughput. We furtherdevelop a low complexity approach that can obtain most of the benefits from power and channel allocation with minor performance loss. Multi user power and channel allocation problem in cognitive radio is considered in this paper. Based on game theory, we modelled the problem into non-cooperative game and proved that this problem is a super modular game with the purpose to maximize the total system capacity of the network in which the secondary users choose their payoff function which consider both the capacity gain of themselves and the loss of the others .Simulation results indicate that our algorithm can achieve greater performance improvement.

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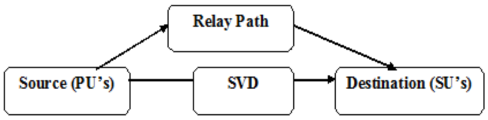
II.SYSTEM MODEL AND ASSUMPTIONS

- Joint Bam Forming based Achievable rate improvement on GENETIC Algorithm using Single relay path for Power and Channel Allocation on Cognitive Radio Network.
- SVD using relay path analysis on MISO system Using Beam forming on Channel Allocation in CR networks.
- Semi Definite Relaxation(SDR) Approach
- Singular Value Decomposition(SVD)

BLOCK DIAGRAM

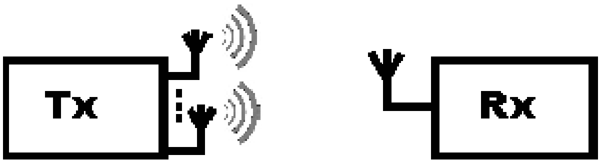


MIMO Formats – SISO, SIMO, MISO, MU-MIMO

There are number of different MIMO configurations or formats that can be used. These are termed as SISO, SIMO, MISO, MIMO. These different MIMO formats have different advantages and disadvantages – these can be balanced to provide the optimum solution for any given application.
These different MIMO formats require different number of antennas as well as having different levels of complexity. Also depend upon the format, processing , may be needed at one end of the link or the other – this can have an impact on any decision made.
Different forms of antenna technology refer to single or multiple inputs and outputs. These are related to radio link. In this way the input is the transmitter as it transmits into the link or signal path, and the output is the receiver. It is at the output of the receiver. It is at the output of the wireless link. In our project we consider MIMO- MISO format.

MIMO-MISO

MISO is also termed transmit diversity. In this case, the same data is transmitted redundantly from the two transmitter antennas. The receiver is then able to receive the optimum signal which it can then use to receive extract the required data



MISO – Multiple Input Single Output

The advantage of using MISO is that the multiple antennas and the redundancy coding/ processing is moved from the receiver to the transmitter. In instances such as cell phone , this can be a significant advantage in terms of space for the antennas and reducing the level of processing required in the receiver for the redundancy coding. This has impact on size, cost and battery life as the lower level processing requires less battery consumption.

BEAM FORMING

Beam forming is a general signal processing technique used to control the directionality of reception or transmission of the signal on a transducer array. Using beamforming we can direct the majority of signal energy, we transmit from a group of transducers (like audio speakers or radio antennas) in a chosen angular direction.

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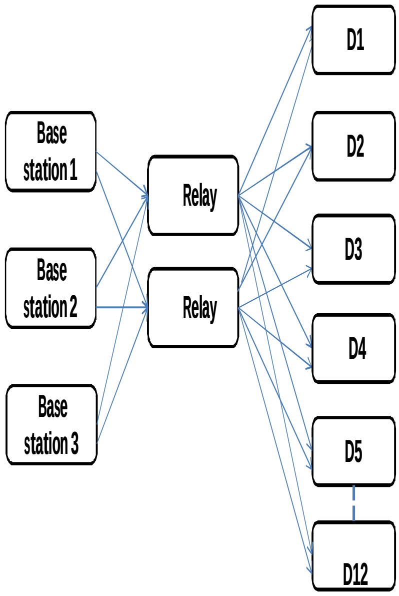
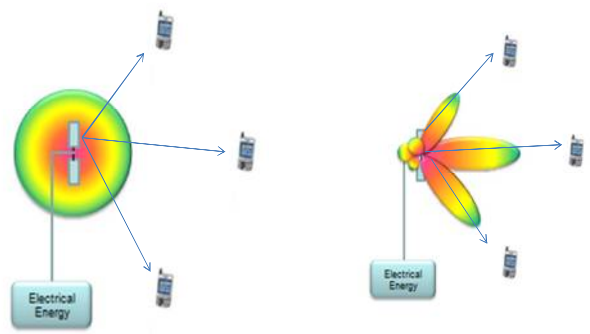
MODIFICATION:

Within multiple relay beamforming should be improved:



Comparison Between Beam forming and Without Beam forming

Without Beam forming **Using Beam forming**



OPTIMAL beam forming algorithm (proposed)

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The basic point in beamforming is, when you set multiple transducers next to each other sending out signals, you're going to get some kind of interference pattern, just like you see in a pond when you throw several stones in at once and create interfering ripples. If you select the spacing between your transducers and the delay in the transducer's signals just right, you can create an interference pattern that's to your benefit, in particular one in which the majority of the signal energy all goes out in one angular direction.

In our project we consider the joint source-relay beamforming design for the three-node MIMO DF relay network with source-destination direct link.We assume that both the source and relay nodes are equipped with multiple antennas while the destination node is only deployed with single antenna. Such a transmission scenario is readily applicable to the downlink transmission of a relay-enhanced cellular system. Unlike existing work with MIMO DF relay channels, which relies an complex numerical solutions , we try to derive the explicit expressions for the optimal beamforming design for our concerned model . Specifically we identify several unique properties of the optimal solutions through mathematical derivation, based on which we develop a systematic approach to arrive at the optimal beam forming vectors for the source and relay nodes for different system configurations. This is because the MIMO channel between source and the relay nodes and the multiple-input multiple-output (MISO)channel between the source and the destination nodes have to be jointly considered and balanced.

First, we formulate an optimization problem on the joint source and relay beam forming design for MIMO DF relay channel, which actually is a max-min fairness optimization problem. For a better understanding of the optimal beam forming design, we effectively separate the phase angle design and normal design problems for the optimal vectors. We also prove that the signal to noise ratio (SNR) of the MISO relay to destination channel can be regarded as a concave function of the SNR of the MIMO source to relay channel.

III.GENETIC ALGORITHM STEPS

Step: 1

Set that parameter based multiple base station (3 Base stations) 1 relay path and 6 destinations.

Step: 2

Each channel path e need to process on random variable of signals (channels)[rand (3,64)]

Step: 3

Each channel path we need to analysis on one by one loop on chromosome set

3 base station to 1 relay

<u>[3X1] matrix size for base station to relay</u>

Base station 1 to relay [1 0 0]

Basestation 2 to relay [0 1 0]

Base station 3 to relay[0 0 1]

Step: 4

Depend upon corresponding rate we need to choose best path, worst path using descending order condition.

$$[\mathcal{R}^{(g)}_{sorted}, \mathcal{G}^{(g)}_{sorted}] \leftarrow \text{sort}(\mathcal{R}^{(g)}, \mathcal{G}^{(g)}, \text{'Descending'})$$

$$[\mathcal{R}^{(g)}_{best}, \mathcal{G}^{(g)}_{best}] \leftarrow \text{select}(\mathcal{R}^{(g)}_{sorted}, \mathcal{G}^{(g)}_{sorted},, \text{'Best'})$$

$$[\mathcal{R}^{(g)}_{worst}, \mathcal{G}^{(g)}_{worst}] \leftarrow \text{select}(\mathcal{R}^{(g)}_{sorted}, \mathcal{G}^{(g)}_{sorted},, \text{'Worst'})$$

$$[\mathcal{R}^{(g)}_{luckies}] \leftarrow (\mathcal{R}^{(g)}_{best} - \mathcal{R}^{(g)}_{worst})$$

$$[\mathcal{G}^{(g)}_{luckies}] \leftarrow (\mathcal{G}^{(g)}_{best} - \mathcal{G}^{(g)}_{worst})$$

Step: 5

Found that path then we need to transmit maximum throughput rate Crossover condition

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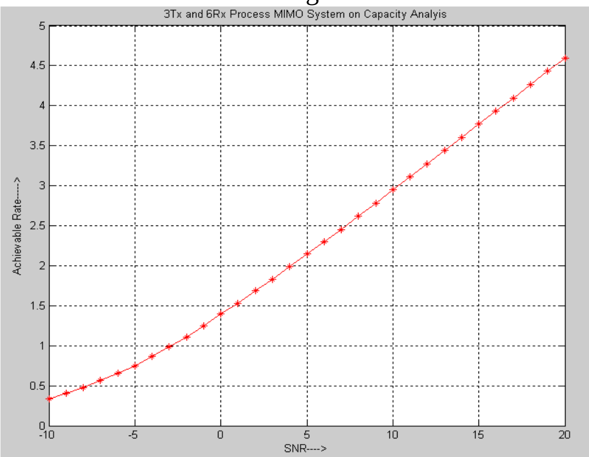
$$P1 \leftarrow \text{select}(\mathcal{G}^{(g)}_{best}, 1, \text{'Random'})$$
$$P2 \leftarrow \text{select}(\mathcal{G}^{(g)}_{luckies}, 1, \text{'Random'})$$
$$[TempCH1, TempCH2] \leftarrow \text{Crossover}(P1, P2)$$
$$[CH1, CH2] \leftarrow \text{Mutation}(TempCH1, TempCH2)$$

Step: 6

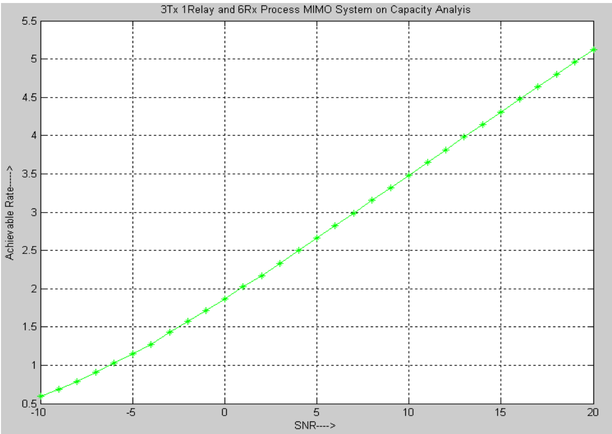
Optimal channel allocation analysis on relay path to destination we need to implement on decode forward relay path process.

IV. SIMULATION RESULTS

Without Beam Forming on 3 Tx and 6Rx :



With relay process on 3 Tx 1 Relay and 6 Rx :



With relay process on 3 Tx 1 Relay and 6 Rx Using Joint Beam Forming :

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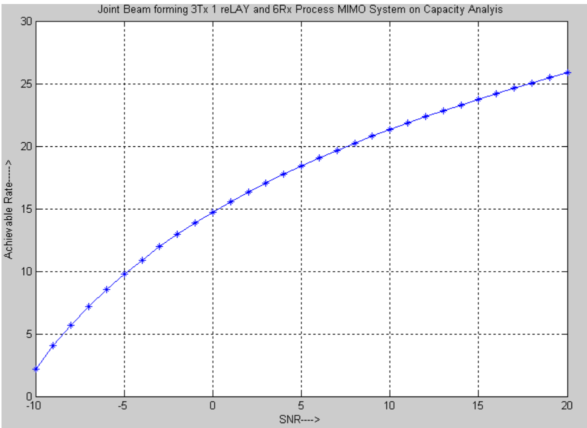
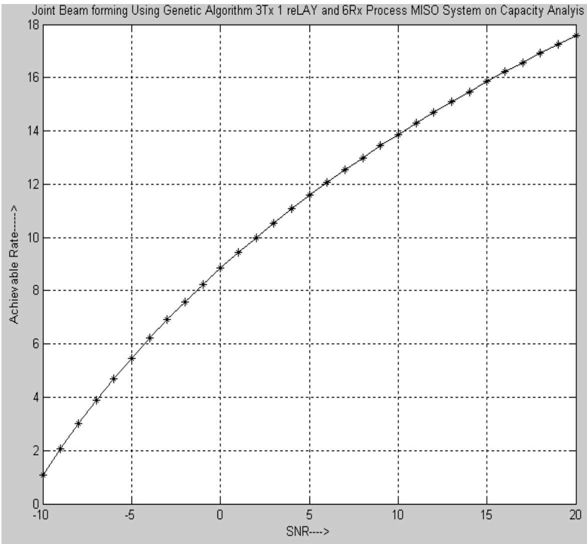


With relay process on 3 Tx 1 Relay and 6 Rx Using Joint Beam Forming on GENETIC Algorithm :



Comparison Results	311	312	313	314	315	316
Without Relay	1.2194	1.5934	1.8231	1.9955	2.1318	2.245
Single Relay	1.5638	1.9908	2.2517	2.4443	2.5947	2.7202
Joint Beam forming	2.7382	5.856	8.8174	14.6014	16.2623	18.62

V.CONCLUSION

We considered a Multi user and Multi channel underlay system with distributed relay nodes and developed an iterative technique to minimize the total transmit power consumed by all source and relay nodes such that a minimum SINR threshold is maintained at each receiver. The proposed algorithm exploits beam forming techniques at the relay nodes and the destination nodes in conjunction with transmit power control. Simulation results demonstrate that the jointly optimal power control and beam forming algorithm outperforms the existing techniques.

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