Location – Aware Relay Based Spectrum Accessing for Primary Users in Cognitive Radio OFDM Based Networks System with Power Equalization

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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 multi outputs (MIMO) cognitive radio network (CRN). In this system, primary users' (PUs') spectrum can be reused by the secondary user transmitters (SUTXs) to maximize the spectrum utilization while the intra-user interference is minimized by implementing beam forming at each SU-TX. After Formulate process on CR Network We implement beam forming structure on particular user based particular distance analysis on SVD using receiver part of analysis. In our modification we implement on multi channel on multiple user analysis of relay path based through put rate analysis on CR network using MISO system on SVD with Comparison of semi definite relaxation approach analysis.

I. INTRODUCTION

COGNITIVE radio (CR), built on software-defined radio, has been proposed as a means to improve the utilization of wireless spectrum resources. Spectrum sensing is a core technology upon which the entire operation of cognitive radio rests. It enables unlicensed users (also referred to as secondary users or cognitive users) to communicate with each other over licensed bands by detecting spectrum holes. In spectrum sensing, there are three broad categories of signal processing approaches: energy detection, matched filter detection, and feature detection. As has been discussed in , the energy detection cannot differentiate signal types, which, however, has the advantage of simple implementation. Although the matched filter is an optimal detector in stationary Gaussian noise scenarios, it requires prior information of the primary user signal. As an alternative, the feature detector can differentiate the modulated signal from the interference and additive noise, which, however, comes at the expense of high computational complexities since it requires an extra training process to extract significant features. In current OFDM systems, only a single user can transmit on all of the subcarriers at any given time, and time division or frequency division multiple access is employed to support multiple users. The major setback to this static multiple access scheme is the fact that the different users see the wireless channel differently is not being utilized. OFDMA, on the other hand, allows multiple users to transmit simultaneously on the different subcarriers per OFDM symbol. Since the probability that all users experience a deep fade in a particular subcarrier is very low, it can be assured that subcarriers are assigned to the users who see good channel gains on them. Recently using fixed relays in cellular systems has received significant interest. Fixed relays are low cost and low transmit power elements that receive and forward data from the base station to the users via wireless channels, and vice versa.

Using fixed relays boosts coverage in cellular networks when carefully placed at the cell edge or in regions with significant shadowing. Because they implement a subset of base station functions, fixed relays are a low cost and low complexity solution to meet the requirement of high data rate communication far from the base station at the cell edge The general relay channel, where relays are used to help send data from a source to a destination, has been studied in [4]–[9]. Though the information theoretic capacity of the relay channel remains unknown, several results on capacity bounds are available [5]–[10]. Practical aspects of relaying strategies are addressed [11]–[13]. Prior work mainly focuses on point-to-point transmission via relays, often considering the mobile relay. Unfortunately, it is likely that only a few fixed relays will be available in each cell.

Consequently, each fixed relay will need to support multiple users. This motivates developing point-to-multipoint relaying solutions, where the relay forwards data to and from multiple users. The main challenge in the point-to-multipoint fixed relay is providing a high capacity link between the base station and relay, while at the same time providing multiple data links to multiple users. A natural solution to this problem is to exploit the advantages of multiple-input multiple-output (MIMO) communication. It is well known that MIMO communication uses multiple antennas to enhance system capacity and improve resilience against fading [14]–[16]. Initial work on MIMO relay channels [8] [17], however, deals only with the point-to-point MIMO relay channel. The point-to-multipoint case has received less attention. In this paper we assume that the base station and fixed relay each have multiple antennas but that the mobile users have only a single receive antenna (the latter assumption is primarily for simplicity). Used in this way a high-throughput MIMO link can be employed between the base station and fixed relay, then the MIMO broadcast channel/MAC channel can be used to deliver the data to/from multiple users.

II. SYSTEM MODEL

In this section, we elaborate on the system model of the multiuser fixed relay system. First we describe the system block diagram and main assumptions of the system, and then we present the downlink signal model.

SISO System - The simplest form of radio link can be defined in MIMO terms as SISO - Single Input Single Output. This is effectively a standard radio channel - this transmitter operates with one antenna as does the receiver. There is no diversity and no additional processing required.

Csiso (M) = Csiso (M) + log2 (1 + SNR*abs (hsiso) ^2);

SIMO System - The SIMO or Single Input Multiple Output version of MIMO occurs where the transmitter has a single antenna and the receiver has multiple antennas. This is also known as receive diversity. It is often used to enable a receiver system that receives signals from a number of independent sources to combat the effects of fading. It has been used for many years with short wave listening / receiving stations to combat the effects of ionosphere fading and interference.

Csimo (M) = Csimo (M) + log2 (1 + SNR*norm (hsimo) ^2);

SIMO has the advantage that it is relatively easy to implement although it does have some disadvantages in that the processing is required in the receiver. The use of SIMO may be quite acceptable in many applications, but where the receiver is located in a mobile device such as a cell phone handset, the levels of processing may be limited by size, cost and battery drain.

MISO System - 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.

Cmiso (M) = Cmiso (M) + log2 (1 + SNR/M*norm (hmiso) ^2);

MIMO System - Where there is more than one antenna at either end of the radio link, this is termed MIMO - Multiple Input Multiple Output. MIMO can be used to provide improvements in both channel robustness as well as channel throughput.

Cmimo (M) = Cmimo (M) + log2 (real (det (eye (M) + SNR/M*Hmimo*Hmimo')));

In order to be able to benefit from MIMO fully it is necessary to be able to utilise coding on the channels to separate the data from the different paths. This requires processing, but provides additional channel robustness / data throughput capacity.

MIMO System - A channel may be affected by fading and this will impact the signal to noise ratio. In turn this will impact the error rate, assuming digital data is being transmitted. The principle of diversity is to provide the receiver with multiple versions of the same signal. If these can be made to be affected in different ways by the signal path, the probability that they will all be affected at the same time is considerably reduced. Accordingly, diversity helps to stabilise a link and improves performance, reducing error rate. MIMO is effectively a radio antenna technology as it uses multiple antennas at the transmitter and receiver to enable a variety of signal paths to carry the data, choosing separate paths for each antenna to enable multiple signal paths to be used. One of the core ideas behind MIMO wireless systems space-time signal processing in which time (the natural dimension of digital communication data) is complemented with the spatial dimension inherent in the use of multiple spatially distributed antennas, i.e. the use of multiple antennas located at different points.

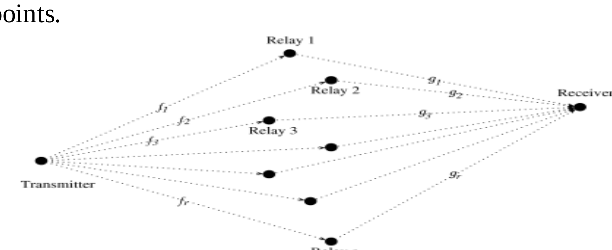


Fig: MIMO-Relay Path Process

Accordingly MIMO wireless systems can be viewed as a logical extension to the smart antennas that have been used for many years to improve wireless. It is found between a transmitter and a receiver; the signal can take many paths. Additionally by moving the antennas even a small distance the paths used will change. The variety of paths available occurs as a result of the number of objects that appear to the side or even in the direct path between the transmitter and receiver. Previously these multiple paths only served to introduce interference. By using MIMO, these additional paths can be used to advantage. They can be used to provide additional robustness to the radio link by improving the signal to noise ratio, or by increasing the link data capacity.

Beam Forming Analysis - In this paper, we also consider the joint source-relay beam forming 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 where the base-station and the relay can accommodate multiple antennas but the mobile user equipment can only afford a single antenna due to size or other constraints. Note that downlink transmission to resource-limited mobile terminals limits the overall performance of cellular systems.

As such, our design aims to fully explore the special diversity advantage of MIMO DF relay channel to enhance system throughput to the destination node. Unlike complex numerical solutions, we strive to derive the explicit expressions for the optimal beam forming 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. We would like to stress that deriving the explicit expressions of the optimal beam forming design for our concerned model with single-antenna destination node is by no means trivial. This is because the MIMO channel between the 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. In addition, our explicit solutions, which cannot be otherwise obtained as the special cases of previous work, offer interesting new insight to the design of MIMO DF beam forming.

III. POWER AND CHANNEL ALLOCATION PROCESS

Joint Beam forming based Achievable rate improvement on GENETIC Algorithm and Simulated annealing using Single relay path for Power and Channel Allocation on Cognitive Radio Network with MIMO-OFDM.

A. Genetic Algorithm - GA is a searching algorithm, which can be applied to find out near optimal solution to an optimization problem without the knowledge of the objective function's derivatives or any gradient related information. The key idea of GA is to first select a set of feasible values for the decision variables and then design new solutions based on the previous set to improve the objective function [35]. Different from standard GA, in this thesis, we define a K_N matrix as a chromosome instead of a single string chromosome as in [24], where the kth row and nth column entry of the chromosome indicates whether the nth channel is allocated to the kth SUTX or not. In fact, a chromosome describes one realization of channel allocation.

GA-based channel allocation algorithm

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

Step 2 - Each channel path we need to process on random variable of signals (channels)

[Rand (3, 64)]

Step 3 - Each channel path need to analysis on one by one loop on chromosome set

3 base station to 1 relay

[3X1] matrix size for base station to relay

Base station 1 to relay [1 0 0]

Base station 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

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

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

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

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

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

Step 5 - Found that path then we need to transmit maximum through put rate **Crossover condition**

P1 $\leftarrow$ select ($G^{(g)}_{best}$,1,'Random')

P2 $\leftarrow$ select ($G^{(g)}_{luckies}$,1,'Random')

[Temp CH1, Temp CH2] $\leftarrow$ Crossover (P1,P2)

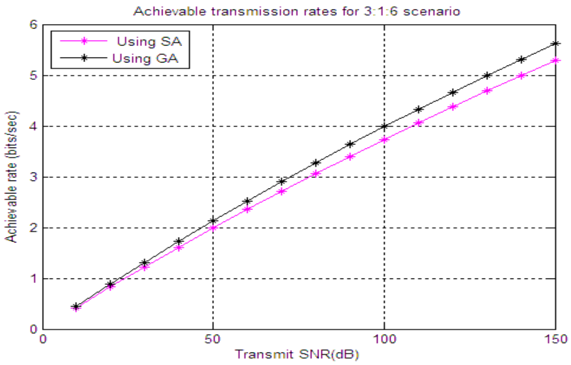
[CH1, CH2] $\leftarrow$ Mutation (TempCH1, TempCH2)

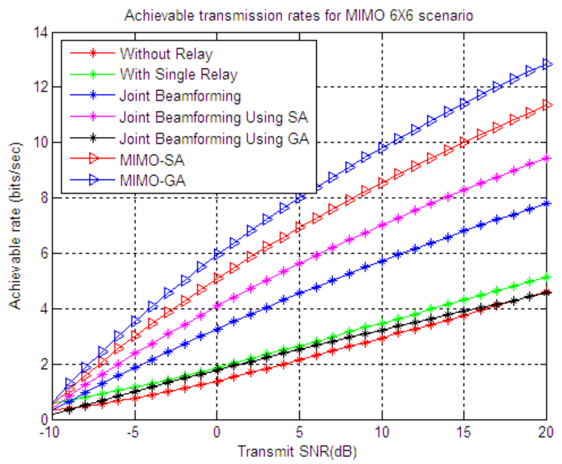
Step 6 - Optimal channel allocation analysis on relay path to destination we need to implement on decode forward relay path process

B. Simulated Annealing (SA)-based algorithm - The SA-based algorithm uses neighborhood searching to determine a suboptimal solution. Specifically, the SA-based algorithm starts with a control parameter and an initial channel allocation that is used to generate new neighbor channel allocation. Then, the new channel allocation is clearly selected if it shows any performance improvement. Otherwise, it may still be accepted with a certain probability, which allows SA based algorithm to escape from local optimal configurations. The cooling schedule manages the control parameter during the optimization process.

IV. RESULT AND EXPLANATIONS

The simulation results have been given in this chapter. 100 channel realizations has been used for simulations in mat lab. Then SNR values from -10 to 20 dB has been used





V. CONCLUSION

In this paper, a problem of joint beamforming, power and channel allocation is considered for multi-user multi-channel underlay cognitive radio networks. The problem is formulated as a non-convex MINLP problem, which is NP-hard. In order to reduce the computational complexity, we decouple the original problem into two sub problems. At first, a feasible solution for beamforming vectors and power allocation is obtained for a known channel allocation by an iterative algorithm, which uses the SDR approach with an auxiliary variable. After that, MIMO-GA and MIMO-SA-based algorithms have been applied to determine suboptimal channel allocations. Simulation results show that BPCA-MIMO-GA can obtain close-to-optimal solution with a price of high computation complexity. Whereas, BPCA-MIMO-SA can significantly reduce the computational complexity with marginal performance degradation compared to BPCA-MIMO-GA. Moreover, beamforming with interference tolerance capability introduced by our system model can achieve better performance than traditional ZFBF.

VI. REFERENCES

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