A Brief Survey on Cooperative Spectrum Sharing With Relay

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Abstract-Recently, Due of the expanding enthusiasm for the new wireless administrations, the interest for radio spectrum has expanded drastically. Be that as it may, in the present spectrum the executives arrangement, it is exceptionally hard to discover a spectrum for another wireless administration in light of the fact that a large portion of the spectrum has just been allotted. In this manner, there is a spectrum shortage specifically spectrum groups. Despite what might be expected, a huge segment of the allocated spectrum is utilized sporadically, prompting under-usage of a lot of spectrum. Expanding interest for fast wireless systems has roused the improvement of wire-less cell and specially appointed systems. So as to completely misuse the mechanical improvement in radio equipment and coordinated circuits, which take into consideration execution of increasingly confused communication conspires, the central execution points of confinement of wireless systems ought to be reconsidered.

Keyword- Amplify-and-Forward (AF), Decode-and Forward (DF), Adaptive Hybrid Relay , Best Relay Selection.

I. INTRODUCTION

The broadcast property entailed by wireless networks is an important characteristic affecting the optimal communication design for these networks. In a point-to-point communication model different messages received by single users are usually considered to be harmful and treated as interference. However, when multiple nodes re-transmit the same message, broadcasting may become beneficial for network throughput. To fully appreciate the broadcast property of wireless channel and exploit these "beneficial" retransmissions, a model different from simple point-to-point communication should be considered. In a cooperative communication setting the notion of a link is considered as a set of users, encoding and transmitting messages in coordination. In contrast to traditional network flooding, where each link is treated individually and the goal is to avoid .

The idea of cooperative diversity is further developed in, where space time cooperative diversity algorithms have been considered. In particular, the source initiates its transmission to the destination and many relays are involved in this transmission. In, the same relaying schemes as amplify-and-forward and decode-and-forward have been considered. However, in this case the relaying operation can be done by a subset of all terminals except the source and the destination. This comes at the expense of bandwidth loss, since each of the relays is using repetition based cooperative diversity and have to reserve a specific frequency band orthogonal to other relays' band to send the packet to destination. This problem can be solved with the alternative approach of using space time block codes. The price however, is the increase in complexity of the terminals, but the relays are able to transmit at the same time and the same frequency band by exploiting orthogonal space time codes.

Under the proposed scheme, the nodes are divided to three groups in terms of their operation. The first group are the potential source nodes, which are the nodes that have detected activity at the beginning of a slot. The actual set of permissible sources will be chosen among these nodes by the scheduling algorithm, which is explained in detail in the next section. The second group, chosen among the remaining nodes, comprise the set of potential relays, which try to cooperate with the sources.

Fig. 1.1 A Simple Cooperative Relay Network

These potential relays try to implement a decode and forward scheme. The main goal of our work is to find the optimal set of the potential relays and permissible sources. We further quantify the relay nodes, a sub-set of the potential relays, which are indeed successful in the decoding of their intended message. The last set of the nodes comprise the ones not chosen among the potential sources and relays. These nodes should not try to relay and have to remain silent during the communication.

Cooperative communication is another new communication technology in which a group of distributed terminals are used to improve spectral efficiency. In cooperative communication system, each wireless user act as a cooperative relay for another user as well as able to transmit its own data. As a, the wireless user may increase their effective quality of service (throughput, BER, SER, spectral efficiency and outage probability etc.) via cooperation. Cooperative relying offers transmit diversity among single antenna systems. Thus, reduces transmit power or extends the transmission range for a given quality of service. In interference-limited CR systems, cooperative diversity can be used to

- Reduce the interference temperature for a given data rate or
- Increase the data rate with a given interference temperature.

Various types of relaying strategies have been reported and can be classified as follows:

In decode-and-forward (DF) relay strategy, the relay node decodes the source message first and then retransmits to the destination node. The DF strategy can be further classified as: a) fixed decode-forward (FDF) and b) adaptive decode-forward (ADF).

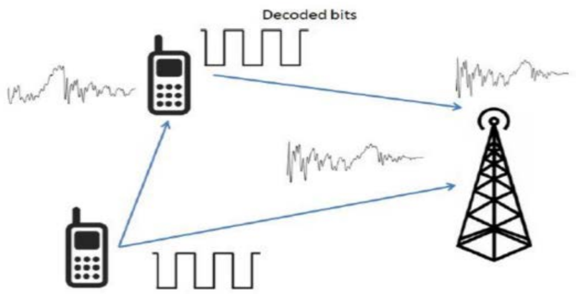

Fig. 2.1 Decode and Forward Relay.

In amplify-and-forward (AF) relay strategy, the relay node amplifies the received message signal from the source node in the first time slot and retransmits it to the destination node in the following time slot without decoding.

In compress-and-forward (CF) relay strategy, the relay node compress the received message signal from the source node in the first time slot and retransmits it to the destination node in the following time slot without decoding. In this relaying scheme.

Hybrid decode-amplify-forward (HDAF) relay strategy combines the advantage of both ADF and AF with hard decision. In ADF, the relay remains silent if the signal received from the source is corrupted. On the contrary, instead of remaining silent in the second transmission phase due to the corrupted signal, the HDAF scheme can increase the performance by having the relay performs in the AF mode.

II. MULTI-ANTENNA COOPERATIVE RELAY NETWORKS

The multiple antennas techniques are well studied; a number of promises in these schemes are documented. The application of these techniques to mobile systems often encounter numerous practical implementation problems. For example, an element spacing of half the wavelength is required to ensure uncorrelated signals for optimal performance. The future wireless terminals are expected to be small and light. The small size feature limits the spatial separation needed by multiple antennas systems for their optimal performance.

Therefore, efficient power utilization becomes a great priority in wireless terminals; the lightweight feature limits the power capability and signal processing that the terminals can support. These factors make the deployment of a large number of antennas not feasible in practice. Therefore, novel techniques for exploiting network resources through nodes cooperation, known as cooperative diversity or antenna sharing, are considered. Most of the early work in the literature on relaying deals with coverage extension or network capacity distribution. These multi-hop relaying approaches are usually used because of their economic advantages over cell splitting methods which are used in conventional cellular networks to increase system capacity and spectral efficiency.

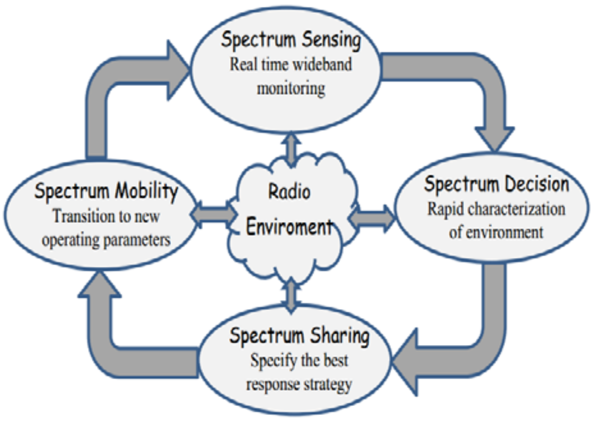

Fig. 2.2 Cooperative Cycle

The range detecting capacity empowers the CR to screen the accessible range groups, catches their data, and afterward distinguishes the range gaps. There are, for the most part, three distinct parts of range detecting, the impedance temperature demonstrate, transmitter detection model and cooperative detection show. The outline in Fig. 2.2 summarized the spectrum sensing strategies.

Transmitter Detection

The sensing, in this plan, is performed over the powerless signal got at the CR terminal from the essential transmitter. The expanding out yonder between the CR terminal and the essential transmitter and also the shadowing debases the performance of this sort of detecting.

Energy Detection

Energy detection is the most widely recognized kind of spectrum detecting due to its straightforward usage and the way that no earlier learning about the PU signal is required.

Finally, the output of the integrator is compared with a threshold, to decide whether a licensed user is present or not.

Let be the likelihood of detection and the likelihood of false caution, at that point if Pd is low then the likelihood of missing the nearness of the PU is high which expands the obstruction to the PU while a high would bring about low spectrum utilization since false alerts increment the quantity of missed openings (white spaces).

The fundamental downsides of the energy detector are the failure to separate signal composes as it can only decide the nearness of the signal, its inclined to the false detection activated by the unintended signals and the need to longer detecting time than the coordinated channel method.

Primary Receive Detection

In this technique, the benefit of the way that all RF recipients neighborhood oscillator (LO) discharge spillage control is abused to enable CRs to find these beneficiaries so the CR clients recognize the LO spillage control for the detection of Discharge rather than the transmitted signals.

The LO spillage power can be identified after similar techniques acquainted with the transmitter detection, i.e., coordinated channel detection, energy detection or cycle stationary detection. As of now, the LO technique is only practical in the detection of the Television inputs.

The principle favorable position of the essential beneficiary detection is the capacity to take care of the collector vulnerability issue acquired in the transmitter detection system however the LO spillage signal shortcoming make the execution of a solid locator isn't paltry.

III. LITERATURE SURVEY

Sr. No.	Title	Author	Year	Approach
1	Cooperative spectrum sharing with multi-antenna based adaptive hybrid relay	S. S. Bhattacherjee, A. Saha, C. K. De and D. De2017	2017	Performance analysis of cooperative spectrum sharing network using multi-antenna based Adaptive Hybrid Relay (AHR) scheme in presence of multiple primary users under non-identical Rayleigh fading channel has been studied in this paper.
2	Cooperative spectrum sharing with space time block coding and non-orthogonal multiple access	F. Kader and Soo Young Shin	2016	In this paper, we have proposed a novel two-phase cooperative spectrum sharing protocol on the basis of Alamouti space time block coded (STBC) non-orthogonal multiple access.
3	Low-complexity air-interface-agnostic cooperative parasitic multi-antenna spectrum sharing system	D. Ntaikos, K. Ntougias, B. Gizas, F. Verdou and C. B. P. Athens	2015	In this paper we propose a SU system that is equipped with a parasitic antenna array and incorporates a low-rate feedback technique in order to accomplish highly efficient spectrum sharing.
4	A Novel Low-Complexity Joint User-Relay Selection and Association for Multi-User Multi-Relay MIMO Uplink	G. O. Okeke, W. A. Krzymień, Y. Jing and J. Melzer	2015	In this work, we study joint user-relay selection and association in multi-user multi-relay cooperative wireless relay uplinks with multi-antenna nodes.
5	Cooperative Spectrum Sharing: A Contract-Based Approach	L. Duan, L. Gao and J. Huang	2014	We study the optimal contract design for both weakly and strongly incomplete information scenarios. In the weakly incomplete information scenario, we show that the PU will optimally hire the most efficient SUs and

				the PU achieves the same maximum utility as in the complete information benchmark.
6	Exploiting opportunistic decode-and-forward cooperation for cognitive radio relay channels in multi-antenna cognitive radio networks	S. Mishra and A. Trivedi,	2013	In this paper, we investigate the performance of an opportunistic decode-and-forward cooperation (ODFC) strategy for cognitive radio relay channels (CRRCs) in multi-antenna cognitive radio network.
7	Outage Performance of Multi-Antenna Relay Cooperation in the Absence of Direct Link	H. Katiyar and R. Bhattacharjee2011	2011	In this letter, we investigate the performance of an infrastructure based multi-antenna relay network in the absence of a direct link.

S. S. Bhattacherjee, A. Saha, C. K. De and D. De [1] Performance analysis of cooperative spectrum sharing network using multi-antenna based Adaptive Hybrid Relay (AHR) scheme in presence of multiple primary users under non-identical Rayleigh fading channel has been studied in this paper. An Adaptive Hybrid Relay equipped with multiple antennas at the input employs selection combining (SC) on the signals received from secondary user source (S) via multiple receiving antenna at the input and forwards the received signal to secondary user destination (D). The outage probability has been evaluated at the secondary destination where Best Relay Selection (BRS) scheme is used. The comparison between outage performances of cooperative spectrum sharing for Amplify-and-Forward (AF), Decode-and-Forward (DF) and Adaptive Hybrid Relay (AHR) scheme is also presented. The effects of number of relay antennas (L), number of relays (K) and number of primary users (PUs) on the system performance have also been studied. It is also seen that the outage performance increases with increse in number of primary users (PUs). A tradeoff between number of relay and number of antenna at each relay is also shown.

F. Kader and Soo Young Shin [2] In this paper, we have proposed a novel two-phase cooperative spectrum sharing protocol on the basis of Alamouti space time block coded (STBC) non-orthogonal multiple access. The network scenario comprising of a primary transmitter-receiver pair and a secondary transmitter-receiver pair. During the first two time slots, the primary transmitter transmits two STBC primary symbols to the cooperative secondary transmitter. The secondary transmitter acting as a decode-and-forward relay for the primary system is allowed to transmit its own secondary signal superposed on the STBC coded primary signal in exchange of cooperation during the next two time slots. Simulation and theoretical results demonstrate the efficacy of the proposed protocol compared to the conventional super positing coding based overlay scheme in terms of the outage probability and the ergodic capacity.

D. Ntaikos, K. Ntougias, B. Gizas, F. Verdou and C. B. P. Athens [3] Responding to the IEEE DySPAN 2015 5G Spectrum Sharing Challenge, in this paper we propose a SU system that is equipped with a parasitic antenna array and incorporates a low-rate feedback technique in order to accomplish highly efficient spectrum sharing. This approach optimizes the performance of both the PU and SU systems, in terms of the achieved throughputs, without the latter system having knowledge of the former system's link features.

G. O. Okeke, W. A. Krzymień, Y. Jing and J. Melzer [4] In this work, we study joint user-relay selection and association in multi-user multi-relay cooperative wireless relay uplinks with multi-antenna nodes. For non-regenerative and altruistic relays we propose a low-complexity joint scheme, which simultaneously selects multiple relays and users for cooperation as well as assigns the selected users to different selected relays for service. The proposed scheme is sub-optimal and utilizes only the channel gains between the nodes, which leads to reduced feedback and overhead in comparison to schemes that require full channel knowledge. Furthermore, the complexity of the scheme scales linearly as the product of the total number of relays, the total number of users and the number of selected users. Simulation results demonstrate the superiority of the proposed joint scheme compared to a scheme with neither user-relay selection nor user-relay association and another scheme with user-relay association, but no user-relay selection. The favorable performance and low-complexity of the proposed scheme make it very attractive for possible implementation in emerging broadband wireless relay networks (e.g., LTE-Advanced).

L. Duan, L. Gao and J. Huang [5] Providing economic incentives to all parties involved is essential for the success of dynamic spectrum access. Cooperative spectrum sharing is one effective way to achieve this, where secondary users (SUs) relay traffics for primary users (PUs) in exchange for dedicated spectrum access time for SUs' own communications. In this paper, we study the cooperative spectrum sharing under incomplete information, where SUs' wireless characteristics are private information and not known by a PU. We model the PU-SU interaction as a labor market using contract theory. In contract theory, the employer generally does not completely know employees' private information before the employment and needs to offers employees a contract under incomplete information. In our problem, the PU and SUs are, respectively, the employer and employees, and the contract consists of a set of items representing combinations of spectrum accessing time (i.e., reward) and relaying power (i.e., contribution). We study the optimal contract design for both weakly and strongly incomplete information scenarios. In the weakly incomplete information scenario, we show that the PU will optimally hire the most efficient SUs and the PU achieves the same maximum utility as in the complete information benchmark. In the strongly incomplete information scenario, however, the PU may conservatively hire less efficient SUs as well. We further propose a decompose-and-compare (DC) approximate algorithm that achieves a close-to-optimal contract. We further show that the PU's average utility loss due to the suboptimal DC algorithm and the strongly incomplete information are relatively small (less than 2 and 1.3 percent, respectively, in our numerical results with two SU types).

S. Mishra and A. Trivedi [6] In this paper, we investigate the performance of an opportunistic decode-and-forward cooperation (ODFC) strategy for cognitive radio relay channels (CRRCs) in multi-antenna cognitive radio network. The key feature of the proposed strategy is that, via opportunistically decode-and-forward cooperation strategy, the cognitive users can maximize its end-to-end throughput by utilizing opportunistic cooperation. The proposed ODFC strategy maintains full diversity. Simulation results demonstrate the effectiveness of the proposed approach as compared to no power no channel allocation scheme (NPNCA), power allocation scheme (PA), and channel allocation scheme (CA). Opportunistic cooperation significantly improves the end-to-end throughput of the system and performs very close to channel allocation scheme in single antenna case and increases the end-to-end throughput in multi-antenna case without using additional transmit power or bandwidth requirement.

H. Katiyar and R. Bhattacharjee [7] Cooperation among relays can achieve spatial diversity, which improves the link quality in a wireless network. In this letter, we investigate the performance of an infrastructure based multi-antenna relay network in the absence of a direct link. A closed form expression of outage probability has been derived, when the cooperating relays and destination coherently combine the received signals. The effect of number of relay antennas and relay placement on the system performance have also been studied.

IV. PROBLEM IDENTIFICATION

Cooperation among nodes has its roots in the relay channel problem, an open problem in information theory. This problem has recently gained significant interest in the information theory community. Although the relay problem is unsolved in terms of the optimal communication scheme, significant improvement has been achieved in quantifying the performance gains obtained from cooperation. In order to mitigate these effects, the user has to increase its transmission power or use more sophisticated reception algorithms. Another important limitation of wireless performance caused mainly as a result of communication over a limited bandwidth is the interference from other users, communicating over the same frequency spectrum.

V. CONCLUSION

Wireless Communications has made colossal development in the course of the most recent couple of decades and it is foreseen to push ahead in future. The applications dependent on wireless system have been expanding as per the requests of client. Administrations, for example, versatile sight and sound, live video spilling, on-request benefit requires high information rate, speed and unwavering quality. Then again, transmission of signal from source to goal in wireless condition experiences blurring of signal due to multipath proliferation which in variety in adequacy, stage and postponement of the got signal.

For future presumes Cooperative Communication framework utilizing Amplify and Forward convention can be connected to increasingly practical recurrence particular blurring channel display. Additionally work can be likewise stretched out to other joining methods like ideal consolidating and adaptive consolidating schemes.

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