Resource allocation and energy analysis for cognitive two way relay network

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***Abstract-* Cognitive enable secondary radio strategies users to access the certified bands while making sure that the satisfactory of service of licensed users' transmission is not affected. We proposed an adaptive two manner relay cooperation scheme for a two way relay cognitive radio networks, which improve the overall performance of unlicensed user transmissions. The strength allocation and relay choice schemes are derived to limit the secondary outage where in best statistical channel records is needed. Precise closed form expressions for secondary outage probability are derived below a constraint at the quality of service of licensed user transmissions in terms of the desired licensed user outage probability. To higher recognize the impact of consumer interference on unlicensed user transmission, we further look at the asymptotic behaviors of the secondary network together with resource allocation and outage probability. And also observe energy level aggregate method to enhance the overall strength of the unlicensed or secondary network. Simulation results are also provided to illustrate the overall performance of the proposed schemes.**

Index Terms- Cognitive radio networks; two way relay; power allocation; relay selection; outage probability

I. INTRODUCTION

Nowadays radio systems are not aware of their radio spectrum environment. And they are are function in a selected frequency band using a specific spectrum access system. Investigations of spectrum utilization indicate that not all the spectrum is under fully utilized condition. Most of the spectrums come on the category of underutilized condition. consequently, a radio that could experience the spectrum and recognize its neighborhood radiospectrum environment, to perceive temporarily vacant spectrum and use it. The manner gives higher bandwidth provider, growth spectrum performance and decrease the need for centralized spectrum control. This could be achieved by a radio that can make autonomous and immediate decisions about how it access spectrum. Cognitive radios have the ability to perform this. Radio in which communications system are privy to their environment and internal state, and can make choices about their radio operating conduct based totally on that information and predefined objectives, is known as cognitive radio(CR) techniques.

CR strategies permit secondary or unlicensed users (SUs) to get admission to the frequency bands at first licensed to primary or licensed users (PUs) while making sure that the QoS of primary transmissions isn't always affected, that may improve spectral performance drastically. But, theSUs regularly perform with limited transmit power to guarantee the QoS of PUs in phrases of interference temperature, accordingly proscribing the throughput and coverage of the unlicensed system.

Cooperative diversity structures involving scattering relay networks have lately been researched to take advantage of the spatial diversity gain and to decorate the secondary channel overall performance. The conventional one-way relay scheme suffers from a loss in spectral efficiency because of 1/2-duplex transmission. To bypass this disadvantage, an adaptive two way relay was proposed. When you consider that there are two distinctive relaying paths, the entire spectral efficiency of a two-manner relay device can be doubled in comparison with a conventional one-way relay system. In cognitive two-way relay networks we here investigate an adaptive cooperative diversity scheme using the DF protocol, where mutual interference between primary users and secondary users are considered. Via the direct link for the duration of the first phase, the secondary transmitters broadcast their signals to the relays and to every different. At some point of the second one phase, if the relays can decode the alerts acquired at some point of the primary segment, the best relay is two chosen to forward the alerts to the STs; in any other case, the STs adaptively repeat the same transmission to every other via the direct hyperlink as during the first phase. Then, the STs combine the two copies of the received alerts after the two transmission phases. Then allocate the available resources to the selected relays.We combine each the energy or power degree of secondary transceivers to enhance the performance ofsecondary device. Finally we look into the outage overall performance of secondary device.

II. LITERATURE REVIEW

The study of the outage performance as well as resource allocation in cognitive two-way relaying networks with CCI is relatively scarce so far. Yang Han,2009 [2] verify that two-way relaying can significantly recover the spectrum efficiency loss of one-way relaying. The SUs regularly perform with restrained transmit power to guarantee the QoS of PUs in terms of interference temperature, as a result restricting the throughput of the secondary machine. To combat this problem, cooperative variety systems concerning scattering relay networks have currently been researched to take advantage of the spatial diversity gain and to enhance the the secondary channel performance [1], [2]. YulongZou,2010 [3] offers an adaptive cooperation variety scheme having excellent-relay choice used for multiple-relay cognitive radio networks. It is to improve the overall performance of secondary transmissions even as making sure the excellent or quality of service(QoS) of licensed user transmissions. Cooperative diversity principle provides an effective method to enhance the transmission performance of the secondary user while ensuring the QoS of the primary user. J. Nicholas Laneman,2004 [4] developed and analyze the low-complexity cooperative diversity protocols with one way relay, which reduce the spectral efficiency. To overcome this problem Armin Wittneben, 2007 [5] proposed a two-hop communication protocols. Here one or several relay terminals help within the conversation between two or more terminals. The two way relay model with DF protocol increase spectral efficiency and also reduced the amount of noise reached at the receiver.

Yindi Jing,2009 [6] proposed a selection of relay(RS) scheme for an adaptive 2-manner networks with more than one amplify or expand-and-forward relays is proposed. The scheme maximizes the more severe get hold of signal -to-noise ratio (SNR) of the two source or end node users. Xuesong Liang , 2013 [7] look at the outage performance of a decode and forward (DF) two-way relay network.P. Ubaidulla,2012 [8] presented an optimal scheme for allocation of power and selection of relay in a cognitive radio network that employs two-way relaying to enhance the transmission rate of the SU transceivers. The CCI from the PUs was modeled as Gaussian noise. Qunwei Li,[10] 2017 proposed, an adaptive two-way relay cooperation scheme is studied for more than one-relay cognitive radio networks to enhance the overall performance of secondary transmissions. The resource allocation and relay selection schemes are derived to reduce the secondary outage probability. But the energy combining method is not introduced.

III. METHODOLOGY AND DESIGN

This chapter reports the methodology adopted for the design of adaptive cooperative diversity scheme in cognitive two-way relay networks using the DF protocol, which includes the system model, selection of relays, outage analysis, power allocation, selection of software, designing procedures.

A. System Model

Consider a general spectrum-sharing cognitive two-way relaying network which is shown in Fig. 3.1. The traces among the nodes denote data transmission or interference. Solid lines represent information transmission that takes place either during the first or the second phase. The dashed strains stand for co-channel interference between licensed and unlicensed user. In the primary or licensed network, a licensed transmitter u sends data to a licensed or main receiver v. Meanwhile, in the secondary relay network, STs s and d exchange information with each other.

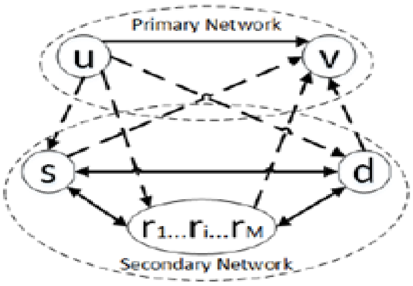

Fig 3.1 System model of a cognitive two-way relaying network [10]

Secondary relays ri, i = 1,2,3,……M, are available to assist secondary data transmissions using the DF protocol. Let the channel link from k to j (k; j Ɛ {u, v, s, r_i, d}) undergoes Rayleigh fading.

During the first section, s and d simultaneously broadcast their signals to the relay ri and to the corresponding receiver, i.e., $s \rightarrow r_i \leftarrow d$, $s \leftrightarrow d$. By employing more than one antennas and self-interference cancelation (SIC), the STs can send and receive simultaneously. After successfully receiving the combined signals, the relay node forwards the signals to the two end nodes during the second phase. Since there are two exclusive relaying paths, the total spectral efficiency of a relay system can be doubled compared with a conventional one-way relay system. During the first phase, some relays may successfully decode the received signals, amongst which the best or first-class relay is chosen to ahead the data to STs. If none of the relay cannot decode the signal completely STs s and d will repeat the transmission of the unique alerts to each different thru the direct link

B. Relay Selection

In this subsection, focus on the adaptive scattering relay scheme with relay selection. During the first phase, some relays may successfully decode the received signals, among which the better relay is select to direct the data to STs.

First of all, the received signal during the first section at r_i is represented as,[10]

$$Y_{r_i} = \sqrt{P_u}h_{u,r_i}x_u + \sqrt{P_s}h_{s,r_i}x_s + \sqrt{P_d}h_{d,r_i}x_d + n_{r_i} \qquad (1)$$

where n_{r_i} is the zero-mean AWGN with variance N_0. For convenience, we denote $D_M = \{r_1, r_2, \ldots\ldots, r_M\}$ to be the collection of all the relays and those relays that are able to successfully decode the received signals constitute a set D. Therefore, D is a dynamic relay set that depends on the decoding status of the relays. Note that the relay set D determines whether a direct transmission between STs is needed or not. If it is not needed, the relay set D determines the feasible relay that can be selected to direct the signal.

In the second section, if D is empty, i.e., D = Φ, STs s and d will repeat the transmission of the original signals to every other through the direct link. In this case, with SIC and signal combination using maximum ratio combining (MRC) method, the SINR at each ST can be respectively expressed as

$$\mathrm{SINRs}(D = \Phi) = \frac{2P_d|h_{d,s}|^2}{P_u|h_{u,s}|^2+N_0} \qquad (2)$$

$$\mathrm{SINRd}(D = \Phi) = \frac{2P_s|h_{s,d}|^2}{P_u|h_{u,d}|^2+N_0} \qquad (3)$$

Otherwise, if D is not empty, where $D = D_s$, the relay r_i chosen within D_s will transmit its decoded information circulate to the two STs. In the end, STs combine the two copies of the received indicators the usage of SIC and MRC strategies. Therefore, the respective SINR is given as

$$\mathrm{SINRs} = \frac{P_d|h_{d,s}|^2}{P_u|h_{u,s}|^2+N_0} + \frac{\beta_i P_{r_i}|h_{r_i,s}|^2}{P_u|h_{u,s}|^2+N_0} \qquad (4)$$

$$\mathrm{SINRs} = \frac{P_s|h_{s,d}|^2}{P_u|h_{u,d}|^2+N_0} + \frac{\alpha_i P_{r_i}|h_{r_i,d}|^2}{P_u|h_{u,d}|^2+N_0} \qquad (5)$$

where P_{r_i} is the transmit power of r_i, and α_i and β_i are the ratios of total transmit power at r_i for the transmission of original signals from s and d to d and s, respectively.

C. Outage Probability

Outage probability can be defined as the chance that the measured information rate is much less than the specified threshold statistics rate.

The relays that are not in outage can be select to direct the signals to the STs. The outage probability (outage_pp) is calculated by using the following equation[10],

outage_pp=log(1+(energy_y/(energy_r_s+energy_r_d))) (6)

where y is the signal obtained at the main receiver and r_s and r_d are the acquired signal at the secondary transceiver s and d respectively.

$$Y = \sqrt{P_u}h_{u,v}x_{pu}+\sqrt{P_s}h_{s,v}x_s + \sqrt{P_d}h_{d,v}x_d \qquad (7)$$

P_u,P_s and P_d are the power at the primary transmitter, secondary transceiver s and d respectively. Transmitted signal from the primary transmitter and from the secondary transceivers are represented by x_{pu}, x_s and x_d respectively. And $h_{u,v}$ is the channel between primary transceivers and $h_{s,v}$ and $h_{d,v}$ are the channel between secondary transceivers and primary receiver.

energy_y=abs(real((y).^2)) (8)

$r_s=\sqrt{P_s}h_{s,v}x_s$ (9)

energy_r_s=abs(real((r_s).^2)) (10)

$r_d=\sqrt{P_d}h_{d,v}x_d$ (11)

energy_r_d=abs(real((r_d).^2)) (12)

After the determination of energy of the acquired signal we set a threshold value by using the following equation

threshold=energy_y/2 (13)

if the energy of the acquired signal at the output of the relay node is less than the threshold rate or cut off value denote it as outage, otherwise choose that particular relay node for the data transmission.

Now we study the outage behavior of secondary system under the condition that the relay node r_i is chosen and can successfully direct the signals to the STs s and d. Specifically, if r_i forwards the signals as the relay, the secondary system is in outage if at least one of the two STs can not successfully decode the received signal.

D. Power Allocation

Resource/power allocation is the assignment of available resources/power to various uses. In the following, optimize the unlicensed user's outage performance in the relay network to address the problems of power allocation.

In the context of power allocation for the DF relaying network, fist need to determine the powers of STs s and d, represented by Ps and P_d, power of the relay r_i, represented by P_{r_i} , and the power ratio for transmission of different information streams at the relay, represented by α_i and β_i.

Next, determine the power allocation for the STs, i.e., P_s and P_d. First, note that the quality of the direct link between the STs may be severely affected due to long distance. This also partially constitutes the reason to employ relays since the links between the STs and the relays are relatively of much higher quality as well as providing diversity. To effectively make use of the relay channel diversity to enhance system performance, we maximize the minimum probability that the link between the STs and a relay is connected.

IV. RESULTS AND DISCUSSIONS

In this part, provide simulation results to validate the analysis and to show the improvement brought by the proposed cooperative diversity scheme.

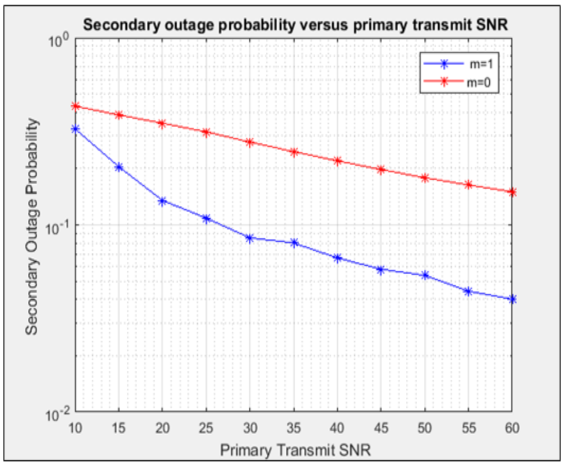

Fig 4.1 Secondary outage probability versus primary transmit SNR

The cognitive or unlicensed system outage probability versus primary transmit SNR plot of the proposed cooperation and non-cooperation schemes is plotted by using MATLAB software demonstrated in fig 4.1. It is observed that the proposed scheme outperforms the noncooperation scheme with lower outage probability. We notice that the two schemes share the same cutoff value, and secondary transmission is forbidden when SNR is smaller than the cutoff value because no extra interference is allowed in order to achieve the pre-defined primary QoS. A higher SNR results in greater secondary transmit power, and then lower secondary outage probability. As is expected, we can also see a performance floor occurs in high u regime, which is due to the fact that the interference from the primary transmitter dominates the secondary outage rather than noise in this case. This also validates the asymptotic outage probability analysis when signal to noise ratio goes to vastness.

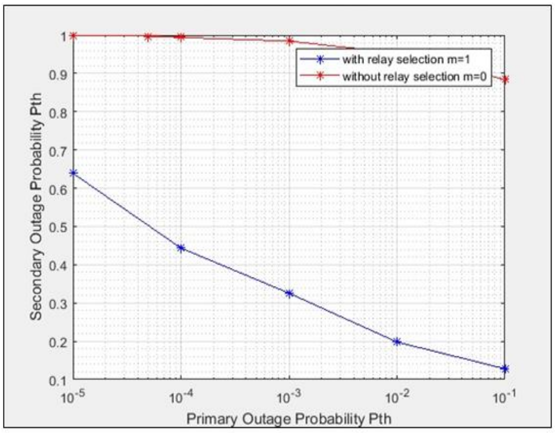

Fig 4.2 Secondary outage probability versus primary QoS constraint Pth.

In Fig. 4.2, the present unlicensed systems outage probability for various values of primary outage probability Pth. When the QoS requirement of the primary system is too stringent, no secondary transmission is allowed. When the QoS requirement loosens, there begins the unlicensed user transmission and the proposed adaptive diversity scheme achieves lower outage probability than the non-cooperation scheme. Higher Pth allows greater unlicensed system transmit power and then the unlicensed system outage probability is consequently reduced.

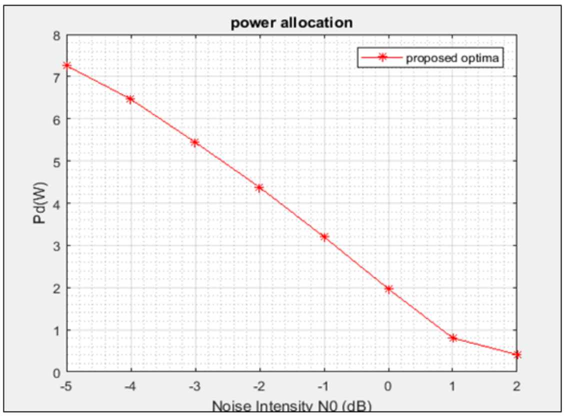

Fig 4.3 Power allocation comparison with various noise intensity N0.

In Fig.4.3, we plot the power allocation comparison in different noise intensity. In cognitive relaying networks with high noise intensity, it is highly possible that the secondary transmission is turned down to provide protection to the primary transmission. From this graph we can analyze that the power allocation is inversely related to noise intensity, ie when power allocation increases the noise intensity reduces. We can also analyze that at the beginning of the graph the value of noise intensity is very less, that is the quantity of information content or information is very high. To reduce the outage probability allocate maximum amount of power to that particular relay node. When the noise intensity increases we allocate less amount of power.
The scenario N0 > 2 dB is not given is due to the fact that secondary transmission is switched off to prevent interference to primary users in low SNR regime with the given system parameters. In cognitive relaying networks with high noise intensity, it is highly possible that the secondary transmission is turned down to provide protection to the primary transmission.

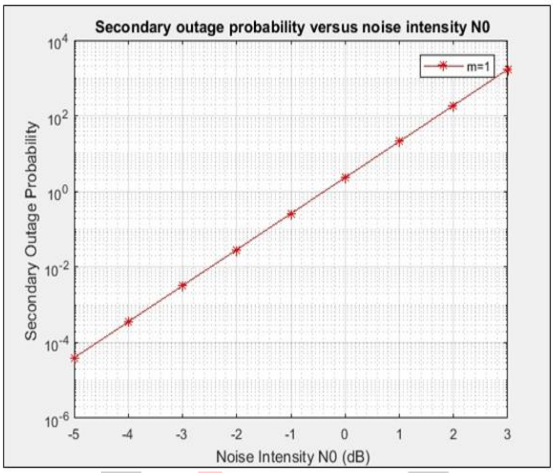

Fig 4.4 Secondary outage probability versus noise intensity N_0.

Fig. 4.4 shows the secondary or unlicensed users outage probability versus noise intensity N_0. It is observed that the outage performance worsens as noise gets more intense. From this graph we can analyze that the secondary or unlicensed user system outage probability is proportional to noise intensity, ie when secondary outage probability increases the noise intensity reduces. We will find that all the powers of the nodes in the unlicensed user network approach 0. This means that the secondary network is transmitting data with extremely low power in a high noise environment and consequently the outage probability approaches 1. We can see that the proposed scheme of power or resource allocation clearly leads to performance improvement compared with the uniform power scheme, even though the power of relay nodes is both maximized in these two schemes. Another interesting finding is that the proposed scheme of power or resource allocation can result in higher relative performance when the secondary network has more relay nodes. Since the suggested idea is designed to optimize the outage performance and power allocation of P_s and P_d considers all the relay channels, more relay nodes enhance the possibility that the given P_s and P_d can result in lower outage probability. Although we employ high SNR with asymptotic analysis as a part of our power allocation scheme, the performance improvement can also be seen in the high noise level regime.

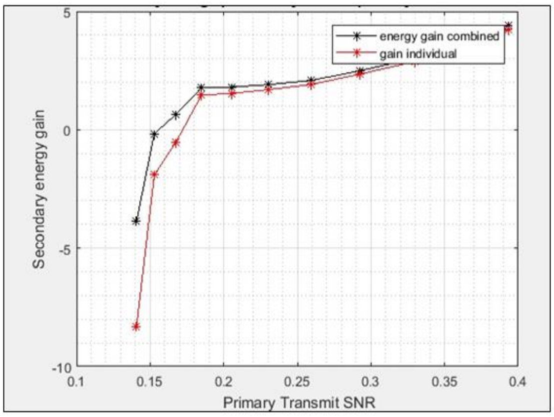

Fig 4.5 secondary energy gain verses primary transmit SNR

Fig 4.5 indicates the plot of secondary energy gain verses primary transmit SNR. When the secondary energy level increases the primary transmit SNR also increases. From the graph we can also found that the combined energy level method improves the performance of unlicensed user system. When the energy level increases, we can also increase the threshold value and thus amount of information transmission can also increase.

V. CONCLUSION

The work introduces an adaptive two way relay method with resource allocation and energy analysis in cognitive networks. The QoS of the licensed network is given by the primary or licensed user outage probability, which is guaranteed during the transmissions between the unlicensed users. To better apprehend the impact of licensed user interference on the secondary transmission, we additionally investigated the asymptotic behaviors of secondary network when the primary signal to noise ratio goes to infinity. The results shows that cooperative diversity systems involving adaptive scattering two way relay networks improve the spectral efficiency gain and enhance the secondary channel performance. The energy level of both the secondary transceivers combined at the secondary output, which improves the energy level of the secondary network.
This have presented various simulation results to show the validation of the proposed cooperation scheme.

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