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PERFORMANCE EVALUATION OF ENHANCING THE CAPACITY OF SPECTRUM SHARING COGNITIVE RADIO NETWORKS

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ABSTRACT

In spectrum-sharing cognitive radio systems, the transmit power of secondary users (SU) has to be very low due to the limitations on the interference power dictated by primary users (PU). In order to enlarge the coverage area of secondary transmission and reduce the corresponding interference region, multi-hop amplify-and-forward (AF) relaying can be implement for the communication between secondary transmitters and receivers. Monte Carlo simulation is a method proposed in this project for iteratively evaluating a deterministic model using sets of random numbers as inputs. The optimal power allocation is employed to allocate the transmit power of secondary users(SU) to avoid the interference at the primary user(PU). The performance can be calculated for different number of hops in terms of probability and interference power at the primary user with the signal to noise ratio using an amplify and forward (AF) relay protocol.

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INTRODUCTION

Lately, the field of remote correspondence frameworks has demonstrated a huge measure of improvement concerning research and practice. Applications range from the day by day needs like mobiles, Wi-Fi, to business utilizes like satellite correspondences. With the guide of current innovation, it is conceivable to correspond with any side of the world. These innovations require a dependable and web framework for better execution. Right now clients are being locked in by the administrations of various accessible remote access frameworks. Especially, a number of new systems are capable of using not only the 800 MHZ to 6000 MHz band which is suitable for broadband wireless access systems and for cellular communications but also the frequency bands such as the very high frequency (VHF) and ultra high frequency (UHF) bands. It seems that after around ten years, the majority of frequency bands, suitable for mobile communication systems, are entirely engaged and new solutions are compulsory. One of the possible solutions is to use the "Cognitive Radio" technology which is a radio or system, that is able to sense and that is fully aware of its functioning situation and can regulate its radio operating parameters autonomously according to collaborating wireless and wired networks. In order to more efficiently use the available spectrum on the frequency band, this technology is expected as a key technology.

Cognitive radio (CR) is a promising remote innovation to determine the developing lack of the essential electromagnetic range assets. By utilization of CR, secondary users (SUs) without expressly alloted range assets can exist together with primary users (PUs) authorized with specific range. By and by, some real correspondences controllers like the Federal Communications Committee (FCC) in U.S. what's more, the Office of Communications (OFCOM) in U.K. have permitted secondary access for unlicensed gadgets to the physical TV telecast groups.

Among different types of CR usage, range sharing CR is particularly engaging for down to earth arrangement since it doesn't include complex range detecting instruments. All the more particularly, range sharing CR restricts just the transmit force of SUs such that their hurtful obstruction onto PUs stays beneath recommended mediocre levels. As a result of the obstruction power limitation directed by PUs, the transmit force of SUs in range sharing frameworks must be low, which constrains the scope territory of secondary transmission. To amplify the scope range of secondary transmission and certification solid correspondence, helpful transferring procedures can be abused.

Utilizing handing-off strategies, a solitary or different unmoving users can be included in sending messages between a secondary source and its destination.

MATERIALS AND METHODS

SYSTEM MODEL

The last decade has witnessed the increasing popularity of wireless services. In fact, recent measurements by Federal Communications Commission (FCC) have shown that 70% of the allocated spectrum in US is not utilized. CR is a kind of intelligent wireless device, which is able to adjust its transmission parameters, such as transmit power and transmission frequency band, based on the environment. In a CR network, ordinary wireless devices are referred to as primary users (PUs), and CRs are referred to as secondary users (SUs). CR is defined as an intelligent wireless communication system that provides more efficient communication by allowing secondary users to utilize the unused spectrum segments.

A K-hop cooperative relaying system operating in a spectrum sharing cognitive radio (CR) environment is considered. The secondary users and primary users exchange data with some consecutive Amplify and Forward (AF) relay. All nodes are equipped with a single half duplex omni directional antenna. For the secondary multihop AF relaying link, all SUs work in a time division multiple access (TDMA) fashion. Only one SU transmits to its next node along the multiple path during each time slot. The **[Figure - 1]** describes the system model for spectrum sharing with the distance and the fading coefficient for the desired link and the interference link where(dk,fk) – Distance and the channel fast fading between SUk-1 and SUk (desired link) (lk,hk) – Distance and the channel coefficient between SUk-1 and PU1(interference link)

Fig: 1. System model

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For the secondary multi-hop AF relaying link, all SUs work in a time division multiple access (TDMA) fashion. Only one SU transmits to its next node along the multiple path during each time slot. The received signal to noise ratio (SNR) at the Kth secondary node is defined as:

$$\gamma_k = (P_{k-1}/\sigma_k^2)d_k^{-1}f_k^2 \qquad (1)$$

where γ_k is the received SNR, P_{k-1} is the transmit power o secondary users ,σ_k^2 is the additive white Gaussian noise(AWGN) variance, d_k is the distance, f_k is the channel fast fading coefficient. The received SNR for the secondary users are calculated based on the different parameters. The interference coming from the primary transmitter is treated as noise.

OPTIMAL POWER ALLOCATION

The criterion for optimal power allocation at the secondary nodes is established. The average tolerable interference power at the primary user is W dB. The optimal power is constrained and this tolerable interference power is based on the interference power or average peak power. The power allocation parameter is determined based on the average interference power and it is expressed as

$$E[\lambda_{k-1}(\sigma_k^2/\eta_k)(h_k^2/f_k^2)] = 10^{W/10} \qquad (2)$$

Where λ_{k-1} is the optimal power, σ_k is the variance ,η_k is the path loss ratio ,h_k is the fading coefficient of the interference link, f_k is the fading coefficient of the desired link ,W is the tolerable interference power at the primary user.

CHANNEL ESTIMATION

The channel estimation depends on detecting the primary and secondary users. The quantity of channels are allotted for the transmission of the information outlines. The channel state data is given to every client. The detecting time depends on the discovery likelihood.

The quantity of diverts allotted in this task is 8. The clamor and the force level can be evaluated for every channel.

PERFORMANCE ANALYSIS

Consider the quantity of hops as a significantly number with K=4. The multihop connection is opposite by utilizing an open up and forward transfer convention. In this handing-off plan, the hand-off sends an opened up rendition of the got signal in the last time-space. For helpful correspondence, AF plans give spatial assorted qualities to fight against blurring; for limit estimation of transfer systems, such plans give achievable lower limits that are known not ideal in some correspondence situations and for simple system coding, given the telecast way of the remote medium that permits the blending of the signs noticeable all around, these plans give a correspondence procedure that accomplishes high throughput with low computational unpredictability at interior nodes.The way path loss worth is taken as 10 and it is utilized to ascertain the separation parameters for the coveted connection and the obstruction join. The way path loss is given as

$$\eta = dk^{-\varepsilon}/lk^{-\varepsilon} \qquad (3)$$

 where,dk and lk are the distance parameters ,ε is the path loss exponent and the value is 4
If the multihop link is perpendicular to the interference link then the value is normalized to unity. For K=4 hops the distance between the PU1 and SU2 is normalized to unity.The various distance parameters are calculated using the path loss ratio. The monte carlo simulation method is used in which the gain of the channel is subject to Rayleigh distribution with unit mean and the variance of AWGN at all nodes is set to unity.

A Monte Carlo method is a technique that involves using random numbers and probability to solve problems. Monte Carlo simulation is a method for iteratively evaluating a deterministic model using sets of random numbers as inputs. This method is often used when the model is complex, nonlinear, or involves more than just a couple uncertain parameters. The **[Table -1]** shows the value for different distance parameters and it is calculated based on the path loss ratio.

Table: 1. Distance Parameters

Parameters	Value
d_1	1.6
d_2	0.6
d_3	0.56
d_4	0.04
l_1	2.12
l_2	1.06
l_3	1
l_4	1.14

The SNR of the received PU signal at the sensor depends on the PU transmitted power and the propagation environment. The two error probabilities are linked to each other through sensing time, SNR, and detection threshold. The detection performance improves with an increase in the SNR. After determining the SNR value as 15 dB then the optimal power is allocated to each secondary user under some constraints. The probability is determined based on probability density function.

The tolerable interference power is measured with respect to the optimal power and the distance parameters. The total transmit power at the secondary user is 10 and the interference power is found as W=30 dB. It indicates the increase in tolerable interference power leads to the better performance for different hops in multipath.

RESULTS
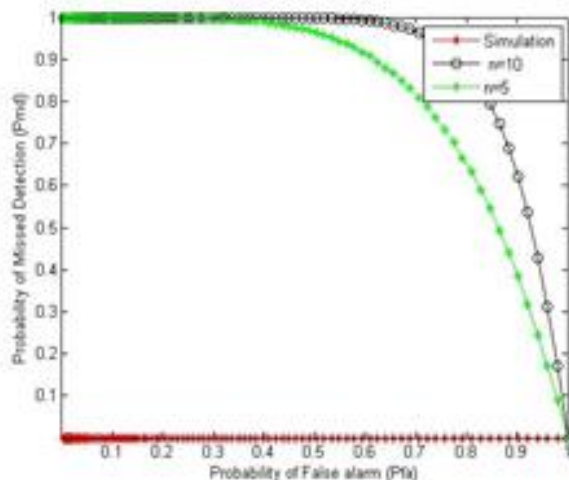
Outputs

In this paper, the performance of cooperative spectrum sharing is evaluated for different number of hops using amplify and forward (AF) relaying protocol.

Fig: 2. Performance of Spectrum sharing

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The **[Figure -2]** indicates the performance of spectrum sharing for the different number of cognitive radio users. From the above graph, it is very clear that the alarm increases with the detection probability and it indicates that the channel can be reused when it is available. The probability of detection is the time during which the PU (licensed) is detected. If the sensing time is increased then PU can make better use of its spectrum and the limit is decided that SU can't interfere during that much of time. More the spectrum sensing more PUs will be detected and lesser will be the interference because PU can make best use of their priority right.

To avoid the interference at the primary user the transmit power of secondary users has to be very low, so that the optimal power allocation algorithm is used to allocate the power optimally under maximum and minimum conditions. The optimal power is constrained and this tolerable interference power is based on the interference power or average peak power. The number of channels allocated is 8. The noise and the power level can be estimated for each channel. The below **[Figure -3]** represents the power allocation using the water filling for 8 channels and the various noise and power levels can be estimated.
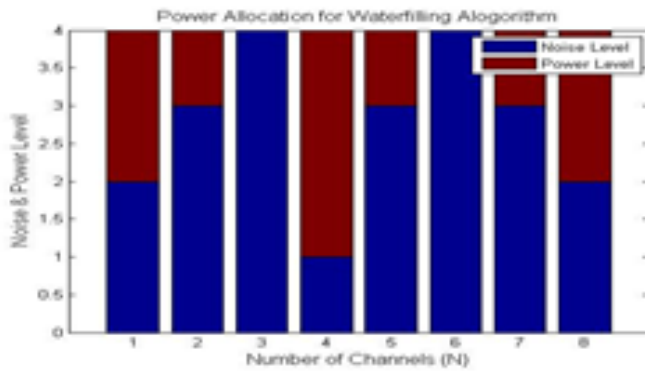

Fig: 3. Optimal power allocation

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After the power assignment is done, the execution can be resolved concerning the likelihood and the normal impedance power. The amplify and forward (AF) transfer convention is utilized for helpful transferring as a part of multihop networks .The SNR worth is measured as 15 dB and it is utilized to gauge the interfernce power or normal top force which is termed as middle of the road impedance power at the primary user.The beneath **[Figure -4]** demonstrates the likelihood debases when there is an expansion in decent obstruction power for various number of jumps as k=2, 4. As the bounces increments in the system, the scope zone for transmission can be amplified.
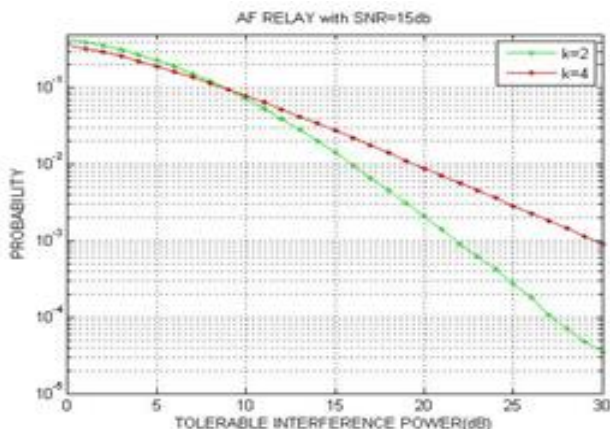
Fig: 4. Performance of interference power with probability

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The below **[Figure -5]** shows the performance of AF relay under different channels with SNR and probability.
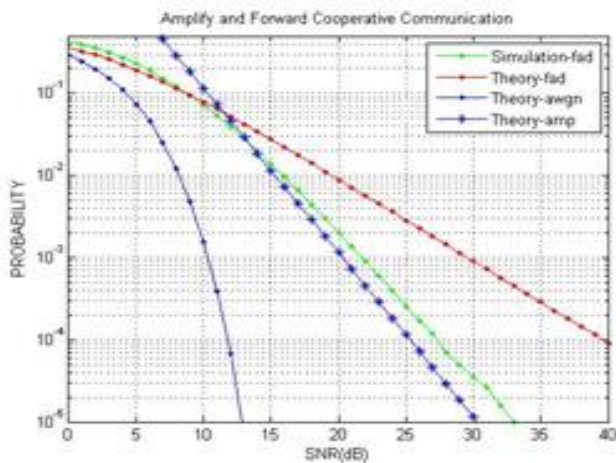
Fig: 5. Performance of Amplify and Forward relay

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CONCLUSION

In this project, the performance of cooperative spectrum sharing in cognitive radio is analyzed using multihop relay networks. The coverage area can be extended using the multihop cooperative relaying. The amplify and forward relaying protocol improves the performance of the multihop network and it is simple when compared with the other techniques. To avoid the interference at the primary user, the transmit power of secondary users has to be low, so optimal power allocation is done at the secondary user. The signal to noise ratio (SNR) value is 15dB, and the results are analyzed for different hops in terms of tolerable interference power and probability.

In future, the analysis of cooperative spectrum sharing in multihop networks can be done for different relaying protocols. The optimal power allocation can be used to limit the transmit power of secondary users for the tolerable interference at the primary user with the different number of hops.

CONFLICT OF INTEREST
The authors declare no conflict of interests.

FINANCIAL DISCLOSURE
The authors report no financial interests or potential conflicts of interest.

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