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Interference Mitigation and Spectrum Sensing in Cognitive Radio Spectrum

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Abstract: Spectral efficiency gain of an uplink Cognitive Radio (CR) Multi-Input-Multi-Output system in which the Secondary User (SU) is allowed to share the spectrum with the Primary User (PU) using a specific precoding scheme to communicate with a common receiver. They adopt a Successive Interference Cancellation (SIC) technique to eliminate the effect of the detected primary signal transmitted through the exploited eigen modes. We extend this process to achieve high data rate compare to existing , we modified the channel into frequency selective fading channel and applying relay based protocol (ARP) , by this mentioned modification we can achieve high SNR communication. In a cognitive radio network, the secondary users are allowed to utilize the frequency bands of primary users when these bands are not currently being used. To support this spectrum reuse functionality, the secondary users are required to sense the radio frequency environment, and once the primary users are found to be active, the secondary users are required to vacate the channel within a certain amount of time. Therefore, spectrum sensing is of significant importance in cognitive radio networks.

Keywords: Multi-Input-Multi-Output system, Secondary User (SU), Successive Interference Cancellation (SIC) technique

INTRODUCTION

Due to the spread of the current wireless services and wireless communication evolution, more bandwidth is needed to offer more high data rate services. Consequently, the accessible radio spectrum is becoming critically scarce as describes the Federal Communications Commission (FCC).To overcome this shortage, current spectrum allocation policy, relatively inefficient, should be substituted by an optimized spectrum management concept that avoids unused spectrum holes. In this vision, the Cognitive Radio (CR) concept was introduced by Mitola in order to optimize the use of the spectrum within multiple users. The main idea is to allow secondary (non-licensed/cognitive) users, noted “SU”, to share the spectrum with the primary (licensed/non cognitive) users, noted “PU”, without affecting the primary communication.

DEFINITION

A cognitive radio(CR) is an intelligent radio that can be programmed and configured dynamically. Its transceiver is designed to use the best wireless channels in its vicinity. This cognitive radio automatically detects available channels in the wireless spectrum, then accordingly changes its transmission or the reception parameters to allow more concurrent wireless communications in a given spectrum band at one location. This process is a form of dynamic spectrum management.

DESCRIPTION

In response to the operator’s commands the cognitive engine is capable of configuring radio-system parameters. These parameters include “waveform, protocol, operating frequency and networking”. This function as an autonomous unit in the communication environment, exchanging information about the environment with the networks it accesses and other cognitive radios(CRs).

A CR “monitors its own performance continuously”, in addition to “reading the radio’s outputs”, it then uses the information for the determination of RF environment, channel conditions, link performance, etc., Some “smart radio” proposals combine wireless mesh network which dynamically changing the path messages take between two given nodes using cooperative diversity.

Cognitive radio is dynamically changing the frequency band used by messages between two consecutive nodes on the path. Software-defined radio (SDR) is dynamically changing the protocol used by message between the two consecutive nodes.

COGNITIVE RADIO ARCHITECTURE

The system design for model evaluations involves two different networks coexist together as primary and secondary systems.

This generates a wireless environment of dynamic spectrum access that is similar to the anticipated proposals for future heterogeneous networks. Cognitive radio network uses the spectrum management and decision which uses the triggering process first to learn the signal. Then analyses the channel whether it is free or not, if it is free it directly sends data otherwise it waits for the channel to get free in the spectrum.

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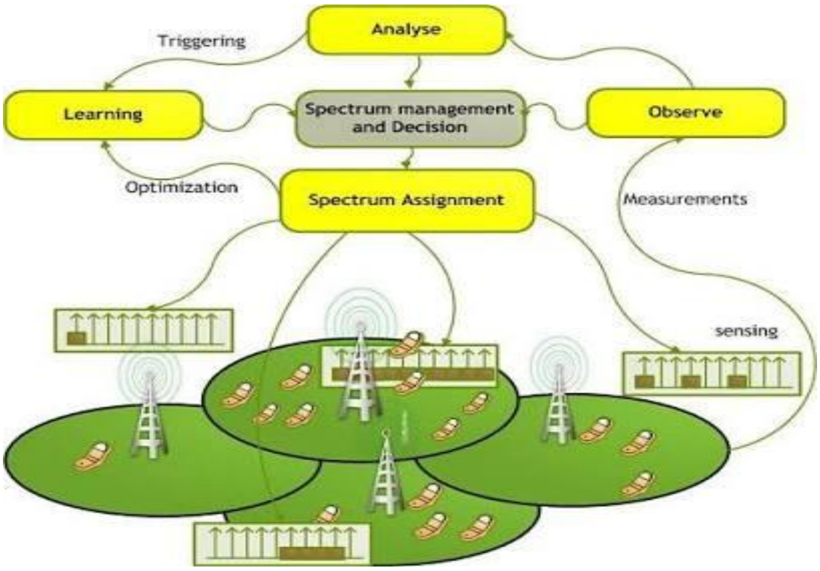

Figure 1: CR Architecture

Cognitive radio network uses the spectrum management and decision which uses the triggering process first to learn the signal. Then analyses the channel whether it is free or not, if it is free it directly sends the data otherwise it waits for the channel to get free in the spectrum. After getting free, the spectrum assignment assigns the spectrum for the data sharing from the source to the destination.

This block diagram has two major blocks, they are decision making and spectrum sensing. All the four base stations are connected to the spectrum assignment where it is interconnected with the decision maker and the spectrum sensing unit. The spectrum is sensed and the data is shared from one base station to the other base station. This is the architecture of CRN.

INTERFERENCE MITIGATION

Generation
In any radio transmission, the channel spectral response is not flat. It has dips or fades in the response due to reflections causing cancellation of certain frequencies at the receiver. Reflections off near-by objects (e.g. ground, buildings, trees, etc) can lead to multipath signals of similar signal power as the direct signal.

This can result in deep nulls in the received signal power due to destructive interference. For narrow bandwidth transmissions if the null in the frequency response occurs at the transmission frequency then the entire signal can be lost. This can be partly overcome in two ways.

OFDM-MIMO
By transmitting a wide bandwidth signal or spread spectrum as CDMA, any dips in the spectrum only result in a small loss of signal power, rather than a complete loss. Another method is to split the transmission up into many small bandwidth carriers, as is done in a COFDM/OFDM transmission.
The original signal is spread over a wide bandwidth thus, any nulls in the spectrum are unlikely to occur at all of the carrier frequencies. This will result in only some of the carriers being lost, rather than the entire signal. The information in the lost carriers can be recovered provided enough forward error corrections is sent.

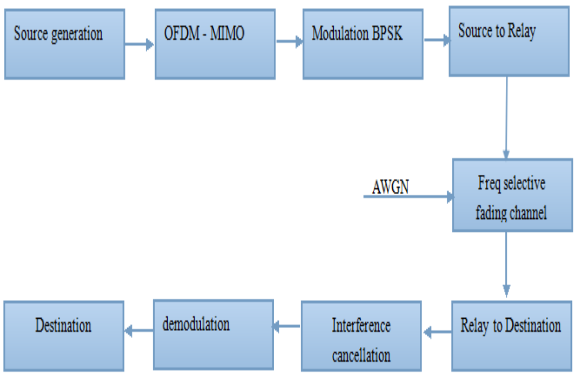

Figure 2: Block Diagram

FREQUENCY SELECTIVE FADING CHANNEL

The current scarcity of spectrum for many types of services can be alleviated by dynamically sharing spectrum across a multitude of services. That possibility motivates the consideration of “wideband” systems in which each user can choose from among a large number of coherence bands. A primary challenge when the users are non-cooperative is the mitigation and control of interference.

This information is all the more important given a wideband fading channel, which offers many degrees of freedom for diversity. Hence there is a fundamental tradeoff in allocating available resources between learning CSI and data transmission. Interference is cancelled and the data rate is increased with high SNR communication.

Demodulation
The demodulation is done in the receiver side. It is the reverse process of the modulation. The output is at the destination.

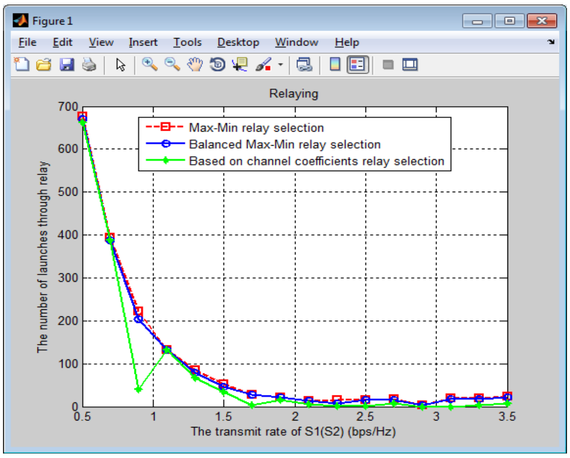

Figure 3: OUTPUT

SPECTRUM-SHARING WITH RELAY SELECTION

Relays that have weak interference links but strong secondary links are useful for spectrum sharing, while relays that produce a strong interference on the primary may do more harm than good. Therefore we use relay selection. In spectrum sharing, relay selection and allocation of transmit powers are coupled through the interference constraint, an issue that is not encountered in conventional (non-spectrum sharing) relaying. To make the problem tractable, we propose a two-step approach: first the allowable interference per relay is bounded, leading to the creation of an eligible relay set. Then the secondary rate is maximized by selecting appropriate relays from among the eligible set and coordinating their transmissions in a manner shown in the sequel.

Eligible Relay Selection

The interference on the primary nodes is controlled by activating only the relays with weak interference links. We design the relay selection in a distributed manner that does not require CSI exchange among the relays.

Channel state Estimation:

We briefly discuss CSI uncertainty in the CSI of relay cross-channel gains. Denote the (relay) estimated cross channel gain as |ˆg ℓi|2. For simplicity, consider |ˆg ℓ i|2 has the same exponential distribution as the true channel gain |g ℓi|2. Assume uncertainty can be modeled as an interval, e.g., that the true cross-channel gain is in the interval [0, (1 + €)|ˆg ℓi|2] for some known and fixed €. In this case, if α and Pr satisfy

The interference constraints on the primary will still be ensured. Since f (•) is an increasing and bounded function, the impact of uncertainty € is to reduce the transmit power at the relays.

Spectrum-Sharing With Alternating Relay Protocol

In this section we consider issues raised by the relay half duplex constraint, i.e., limitations that arise because relays cannot listen to the source at the same time as they are transmitting. When a subset of relays are activated for relaying the previously received information, the inactive relays are able to listen and receive information from the source, thus in principle the source can transmit continually and the half duplex loss can be mitigated. This is the basic idea of spectrum sharing with Alternating Relay Protocol, which is the subject of this section.

DESCRIPTION OF SYSTEM MODEL

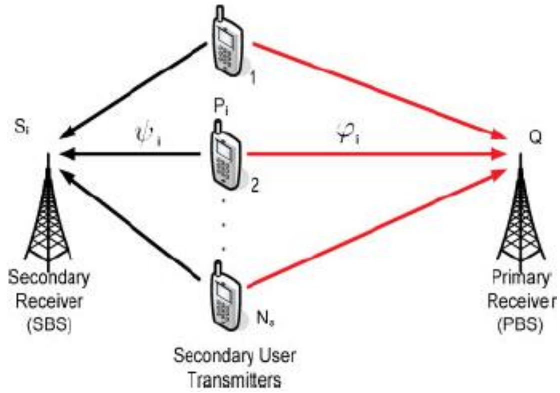

Figure 4: System model for spectrum-sharing systems.

A symmetric fading channel is considered where SU transmitter--PU receiver (interference channel) and SU transmitter--SU receiver (desired channel) channel gains are assumed to be independent and identically distributed exponential random variables (RVs) with unit mean in independent Rayleigh fading channels environments.

Capacity Of Spectrum-Sharing System

In this system, there are two assumptions for the SU transmitter power. When the interference power level P caused by SU-transmitter at the PU-receiver achieves a value larger than Q, an adaptive scheme is used to adjust its value.

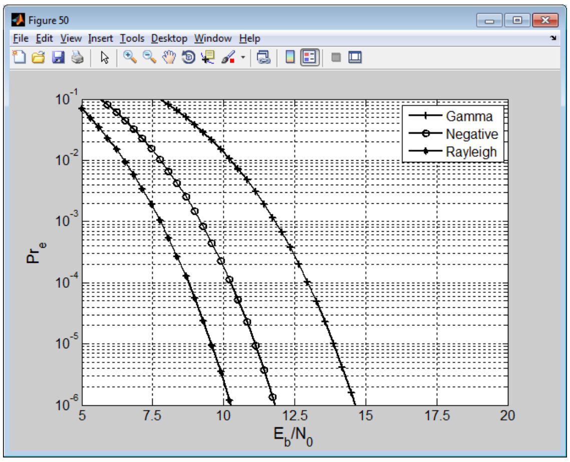

Figure 5: OUTPUT

CONCLUSION

This paper has introduced the wireless energy and information transfer to have a maximum data rate and to have a less interference inside the antenna. Then to sense the spectrum from the cognitive radio spectrum is done successfully by Spatial False Algorithm(SFA). By maximizing the two bounds, we obtained the sensing of systems by algorithm.

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Advantages:
High SNR rate
Power reduction- communication perfection in all time due to modified fading channel
Totally complexity getting very low while doing this process

Application:
Network based communication.
Wireless mobile communication

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