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Spectrum Sharing Scheme using Cognitive Radio Networks Based on Channel Information

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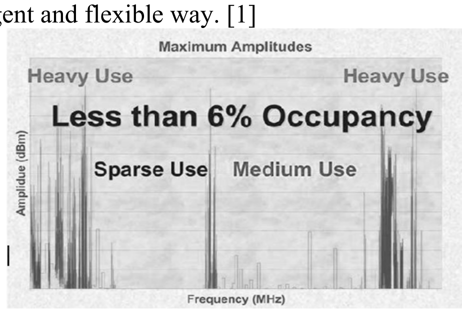
Abstract - **An opportunistic spectrum sharing scheme for the secondary users co-existing with the primary users is proposed in this paper. This scheme is proposed to the secondary user in which the secondary user receives the signal from the primary user and then decomposes it to find the required transmission power for it to transmit. Using neural network Classifier the input samples are trained to find the transmission rate to transmit. The SINR optimizer is used to avoid the interference to the primary user. Based on this power and rate the secondary can access the channel effectively and also producing the maximum throughput. The main aim is to maximize the throughput of the secondary user without causing interference to the primary user, thus utilizing the band effectively.**

Index Terms: Cognitive radio, rate loss constraint, spectrum sharing, and Channel quality information

I INTRODUCTION

A cognitive network (CN) is a new type of data network that makes use of cutting edge technology from several research areas to solve some problems current networks are faced with. Cognitive radio is a promising technology that allows secondary (unlicensed) users to access and share the frequency band that are unutilized by the primary (licensed) users. One of the important problems in spectrum sharing is to manage the interference caused by the secondary users due to opportunistic access. With the rapid deployment of new wireless devices and applications, the last decade has witnessed a growing demand for wireless radio spectrum. However, the fixed spectrum assignment policy becomes a bottleneck for more efficient spectrum utilization, under which a great portion of the licensed spectrum is severely under-utilized. The inefficient usage of the limited spectrum resources urges the spectrum regulatory bodies to review their policy and start to seek for innovative communication technology that can exploit the wireless spectrum in a more intelligent and flexible way. [1]



[1]

Fig 1.1 Spectrum Utilization

1. Cognitive Radio Network

The concept of cognitive radio is has been receiving an increasing attention in recent years, since it equips wireless users the capability to optimally adapt their operating parameters according to the interactions with the surrounding radio environment. Cognitive radio network is a new emerging research area recently. It enhances the existing software-defined radio [2], whose physical layer behavior is largely defined in software. The first definition of the cognitive network was provided by Theo Kantor in his doctoral research at KTH, The Royal Institute of Technology, Stockholm, including a presentation in June 1998 of the cognitive network as the network with memory. In communication networks, cognitive network (CN) is a new type of data network that makes use of cutting edge technology from several research areas (i.e. machine learning, knowledge representation, computer network, network management) to solve some problems current networks are faced with. In [3] CN is seen as a communication network augmented by a knowledge plane that can span vertically over layers (making use of cross-layer design) and/or horizontally across technologies and nodes. The knowledge plane needs at least two elements: 1) a representation of relevant knowledge about the scope (device, homogeneous network, heterogeneous network, etc.); 2) a cognition loop which uses artificial intelligence techniques inside its states (learning techniques, decision making techniques, etc.). Cognitive radio gains popularity in the research area because it enables the current fixed spectrum channel assigned by FCC to be utilized by the new users. For example, most of the spectrums assigned to TV channels are idle most of the time, while wireless network users share a small range of spectrum, 2.4 G Hz and 5G Hz. When there are many wireless users at a time, the network is congested because of the limited channel. With the spectrum opportunities [4] provided by the cognitive radio network, the wireless network users are able to share the idle spectrum for TV channel, on the condition that it does not interfere with the normal TV channel.

2. Cognitive Radio (CR)

A cognitive radio is a transceiver which automatically detects available channels in wireless spectrum and accordingly changes its parameters so more wireless communications may run concurrently in a given spectrum band at a place. This process is also known as dynamic spectrum management.

Cognitive radio in very simple terms is very smart radio that can

1. Observe from environment,
2. Learn from environment, and
3. Adjust to changing environment conditions.

Most fundamental roles of a CR is to discover spectrum opportunities and detecting existence/return of PUs in the channel.

Three fundamental tasks of CR:

1. Radio-scene analysis,
2. Channel identification

Major CR Functions are

Spectrum Sensing: detecting the unused spectrum and sharing it with-out harmful interference with other users. Spectrum Management: capturing the best available spectrum to meet the user communication requirements. Spectrum Allocation Sharing: providing the fair spectrum scheduling method.

II RELATED WORK

One of the important problems in spectrum sharing is to manage the interference among secondary users, or avoid harmful interference to primary users due to secondary spectrum usage. In order to manage and control the interference under the tolerance level of the primary system, many techniques and ways of spectrum sharing were proposed. Generally a fundamental problem is that the cognitive radio is ignorant of the amount of interference it inflicts on the primary license holder. Policies that attempt to limit interference without the active participation of the primary are thus difficult to implement. However, many wireless systems use flow control feedback such as ARQs. By listening to these control signals, a cognitive radio can obtain indirect information about the interference it generates. In particular, a simple generic strategy is proposed where the cognitive radio monitors the primary's effective packet rate and only transmits when that rate is above a threshold. It has an important properties with respect to unknown time-varying interference characteristics as well as favorable delay properties. A distributed power control algorithm to achieve non-intrusive secondary system access without a central coordinator the link control feedback information inherent in two way primary systems can be used as important reference signal to improve the performance of secondary users. It exploits bidirectional interaction of most primary communication links. By controlling access parameters based on inference from observed link control signals of primary user communications, cognitive secondary user achieve high spectrum efficiency limiting interference to primary user. This algorithm was not proven for smaller values of T which led to bur sty convergence procedure when tested. In the existing system, the primary user is oblivious to the existence of the secondary, and that the secondary user serves as a passive listener. Channel Quality Information of the primary channel is estimated, quantized at the primary receiver and then fed back to the primary transmitter. This Quantized information is listened by the secondary user, which then uses this parameter l, and compares it with the parameters stored in the available

III PROPOSED WORK

A spectrum sharing scheme for the secondary users co-existing with the primary users is proposed in this paper. The listening of the primary Channel Quality Information from the primary user in the existing system without interference to the primary by the secondary user is difficult to implement practically. Hence in the proposed scheme, instead of listening from primary, the secondary user uses the signal strength of the primary and passes into Neural Network Classifier. Then the Wavelet Transform is applied. The trained neuron is constructed and the input is given .The corresponding neuron output whose value is high is chosen and stored in quantization table, to determine the best transmission power and transmission rate. Under primary rate loss constraint, the optimal transmit power and transmission rate for the secondary is obtained to maximize the secondary throughput with limited interference to the primary user.

IV SIGNAL CONSTRUCTION AND DECOMPOSITION BY WAVELET TRANSFORM

The Secondary user receives the signal strength of the primary user. This received signal consists of the signal with the Gaussian noise. The modulations such as the QPSK and BPSK are applied for the signal modulation. The signal is represented as data construction in the experiment. Different representation can be applied for representing the single or multiple channels. The signal is then represented in time vectors to generate data with some sample frequency. The noise added can be the white Gaussian noise. The Spectral estimator known as Power Spectral Density is applied. The period gram is used which returns PSD calculated in power per radians per sample. Finally the power per unit of frequency is measured. This power is used to determine the transmission power that is required to transmit by the secondary user. The signal is then passed to the classifier in which the signal decomposition takes place. The signal is decomposed by applying the Daubechies Wavelet Transform. The Daubechies wavelets are a family of orthogonal wavelets defining a discrete wavelet transform and characterized by a maximal number of vanishing moments for some given support .With this transform the signal is decomposed into signal frequency components .In this ,the ranges of signal with the noise is similar in one component but it varies from component to component .In each frequency component the concern energy is measured. This energy is then passed as input to the neurons in the network.

V NEURAL NETWORK CLASSIFICATION

The neural network is trained and the corresponding bit/symbol is classified. The energy from each component is taken and is given as input to each neuron. Feed forward networks have one-way connections from input to output layers. They are most commonly used for prediction, pattern recognition, and nonlinear function fitting.

The neural network is trained with the back propagation algorithm and the corresponding bit/symbol is classified. The energy from each component is taken and is given as input to each neuron. Consider if sample of 128 bit is taken, the input neuron is taken as 7 and the hidden neurons are given as 4 then the output neurons produced are 10. In these, the highest valued neuron is chosen. This value gives the transmission rate to be that can be used by the secondary user to transmit. This value is checked with the quantization table. With this value in the table, the corresponding transmission power and rate is chosen to transmit. Thus the transmission power and rate to be transmitted by the secondary user with the maximum throughput is obtained. Thus the secondary user can now access the unutilized band effectively.

VI SPECTRUM SHARING SCHEME WITH NO INTERFERENCE

Further the SINR optimization is done. This is done in order to choose the best rate by which the secondary user must transmit so that it does not interfere with the primary user's transmission. Also, when opportunistic access is done and when the primary user comes back to access the channel the secondary user must leave without causing any interference to the primary user, also considering the possibility to reconstruct the signal.

The Quantization table is assumed to be present in the secondary user. Suppose that the quantization codebook of the primary system is available at the secondary transmitter. By determining the information using the above method, the secondary transmitter decides to access the primary channels by judiciously choosing a pair of transmit power s and transmission rate s for itself. In fact, a table *{***P**s*,* **R**s*}* is created once at the secondary transmitter before its transmission and does not vary with the channel fading, where **P**s Δ= [s 0 , . . ., s −1] and **R**s Δ= [s0, . . . , s −1] are vectors of secondary transmit power and transmission rate corresponding to various quantization regions, respectively. Every time when the secondary user overhears the feedback of the primary channel information, i.e., the index , it will look up the table *{***P**s*,* **R**s*}*, and then immediately access the primary channel with transmit power Ps and transmission rate Rs. The table *{***P**s*,* **R**s*}* is designed with an aim of maximizing the average transmission rate s of the secondary system while satisfying the secondary average transmit power constraint s the and the primary rate loss constraint p RL. Mathematically, it is formulated as

max R^S
Ps*,* **Rs**
s.t. $1 - Rp/R \leq r^P$ RL
$ps \leq psth$
Ps*,* **R**s >= **0**

where Rp and Rp denote the average achievable rate of the primary system at the presence and absence of the secondary transmission, respectively. The RLC constraint p RL shows how much the rate loss of the primary user can be tolerated at the presence of the secondary user. In other words, how much interference at maximum from the secondary can be allowed by the primary user. Based on this the values in the quantization table is chosen. With this selected values of power and transmission rate the channel is accessed.

VII CONCLUSION

As a result, unutilized wasted band can now be utilized properly by applying this method. Also this method provides way to reduce the interference caused to the primary user. In future, this method can be extended by providing techniques to reduce the size of quantization table.

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