An Improved Self Cancellation Scheme to Reduce Non-Linearity in OFDM Spectrum

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Abstract-- As the wireless communication system has evolved tremendously, leading to the need for high performance and much higher capacity for the multiuser communication systems but within the constraints of limited spectrum and limited bandwidth. The main function of OFDM is to convert a frequency selective channel into a collection of frequency- Flat sub channels with partially overlapping spectra. The differentiating factor of this scheme is the orthogonality provided to the subcarriers that provided synchronisation and helps in avoiding ISI .An OFDM signal consists of a number of closely spaced modulated carriers.

I. Introduction

Cognitive radio is:" A radio which is capable of sensing its operational environment and can adjust its parameters according to the environment dynamically and behave accordingly."The most significant objectives for which cognitive radio networks were introduced are:

i. To utilise the spectrum efficiently.
ii. To make highly reliable communication networks available wherever and whenever needed

As it is known that there is rapid deployment of wireless devices, as a result the demand of wireless radio spectrum is also increasing rapidly. But fixed spectrum assignment policy is proving a bottleneck in efficient utilisation of spectrum. Cognitive radio networks helps in eliminating inefficient usage of limited spectrum by using various dynamic spectrum access techniques, through which, unlicensed users called *Secondary users*, are allowed to temporarily use the unused portion of licensed spectrum. The licensed users are called *Primary users.* In cognitive radio networks, secondary users dynamically access the spectrum in opportunistic fashion, without interfering with the primary users.

Ii Literature Survey

Technically, Cognitive Radio is a kind of two way radio that can automatically change its transmission or reception parameters in such a way that the entire wireless communication network communicates efficiently, while avoiding interference between licensed or unlicensed users.
The definition of Cognitive radio can be "a cognitive radio is a software radio whose control processes leverage situational knowledge and intelligent processing to work for achieving the goals related to the needs of the user, Application, and/or network". The concept of Cognitive emerges from Software defined Radios as Cognitive radio is a "step ahead" of SDR technology. Cognitive radio can be summarized through following definitions:

Definition 1: A radio or system that senses its operational electromagnetic environment and can dynamically and autonomously adjust its radio operating parameters to modify system operation, such as maximize throughput, mitigate interference, facilitate interoperability, access secondary markets.

Definition 2: A cognitive radio is an adaptive, multi-dimensionally aware, autonomous radio system that learns from its experiences to reason, plan, and decide future actions to meet user needs.

Depending upon the type of parameters taken into consideration while transmission or reception, there can be various types of cognitive radios:

- **Full Cognitive Radio**: In this CR, each and every parameter which is observable by a wireless network is taken into account.
- **Spectrum Sensing Cognitive Radio**: In this CR, only Radio Frequency spectrum is taken into account.
- **Licensed Band Cognitive Radio**: In this, along with unlicensed bands, CR can use bands assigned to licensed users.
- **Unlicensed Band Cognitive Radio:** In this, CR can use only unlicensed bands of radio frequency spectrum.

III Problem Defination

The main aim of this paper is to optimize the Parallel Cooperative sensing technique and to simulate efficient results for better spectrum utilization .For this scheme a spectrum would be generated to analyze the effect of various parameters like noise, throughput etc on the overall efficiency. A parallel scheme would be used for carrying out the signal transmission.

Cognitive Radio System

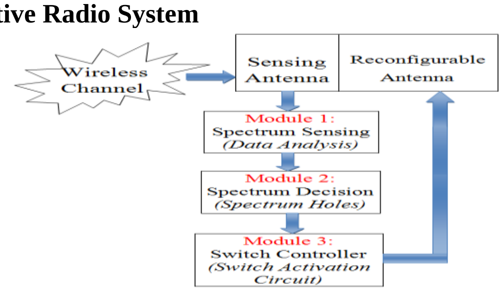

Figure Cognitive Radio System

The RF architecture of a CR system consists of a “sensing antenna” to continuously monitor the wireless channels and to look for unused frequency bands (holes) and a “reconfigurable transmit/receive antenna” to perform the required communication within those unused frequency channels. “Spectrum Sensing” and “Spectrum Decision” modules are required to determine the unused frequency bands and assign the appropriate frequency to the secondary users. Based on the output of these modules the “Switch Controller” will communicate with the switch activation circuit in order to change the physical/electrical structure of the reconfigurable antenna.

Analysis of Inter-Carrier Interference

The main disadvantage of OFDM, however, is its susceptibility to small differences in frequency at the transmitter and receiver, normally referred to as frequency offset. This frequency offset can be caused by Doppler shift due to relative motion between the transmitter and receiver, or by differences between the frequencies of the local oscillators at the transmitter and receiver. In this project, the frequency offset is modeled as a multiplicative factor introduced in the channel, as shown in Figure: shows.

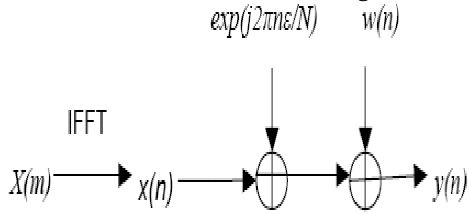

Figure : Frequency Offset Model

The received signal is given by,

$$y(n) = x(n)\ e^{\frac{j2\pi n\varepsilon}{N}} + w(n)$$

Where ε is the normalized frequency offset, and is given by ΔfNT_s. Δf is the frequency difference between the transmitted and received carrier frequencies and T_s is the sub-carrier symbol period. $w(n)$ is the AWGN introduced in the channel. The effect of this frequency offset on the received symbol stream can be understood by considering the received symbol $Y(k)$ on the k^{th} sub-carrier.

$$Y(k) = X(k)S(0) + \sum_{l=0, l\neq k}^{N-1} X(l)S(l-k) + n_k$$

$$k = 0,1..........N-1$$

Where N is the total number of sub-carriers, $X(k)$ is the transmitted symbol (M-ary phase-shift keying (M-PSK), for example) for the k^{th} sub-carrier, is the FFT of $w(n)$, and $S(l-k)$ are the complex coefficients for the ICI components in the received signal. The ICI components are the interfering signals transmitted on sub-carriers other than the k^{th} sub-carrier. The complex coefficients are given by

$$S(l-k) = \frac{\sin(\pi(l+\varepsilon-k))}{N\sin(\pi(l+\varepsilon-k)/N)}\exp(j\pi(1-\frac{1}{N})(l+\varepsilon-k))$$

To analyze the effect of ICI on the received signal, we consider a system with N=16 carriers. The frequency offset values used are 0.2 and 0.4, and l is taken as 0, that is, we are analyzing the signal received at the sub-carrier with index 0. The complex ICI coefficients $S(l-k)$ are plotted for all sub-carrier indices in figure.

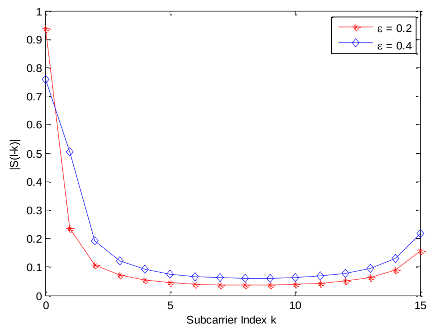

Figure ICI Coefficients for N=16 Carriers

This figure shows that for a larger ε, the weight of the desired signal component, $S(0)$, decreases, while the weights of the ICI components increases. The authors also notice that the adjacent carrier has the maximum contribution to the ICI. This fact is used in the ICI self-cancellation technique described.

IV CONCLUSION

In this project, the performance of OFDM systems in the presence of frequency offset between the transmitter and the receiver has been studied in terms of the Carrier-to-Interference ratio (CIR) and the bit error rate (BER) performance. Inter-carrier interference (ICI), which results from the frequency offset, degrades the performance of the OFDM system.

One method is explored in this project for mitigation of the ICI i.e. ICI self-cancellation (SC). By using this method the BER is improved in comparison to simple OFDM system.

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