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Performance Analysis of Cognitive Radio for Wi-Fi Signals Using Cyclostationary Spectrum Sensing

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ABSTRACT
The need for radio spectrum usage is increasing day by day with recent advancements in wireless system. But there is limited amount of spectrum available. So that for solving this problem Cognitive Radio (CR) is used for purpose of the spectrum utilization properly. Basically the Licensed users use the licensed bands but the unlicensed users should always check spectrum with the help of CR technology. The main aim of cognitive radio is to sense the spectrum continuously. In this paper, we have provided the proposal that how the capacity of the system can be increased by reuse the unused licensed band by simulating a Cognitive radio system. The secondary users can occupy free space (spectrum holes) and also licensed bands by continuously monitoring the spectrum. The requirements of cognitive radio systems will be investigated by considering spectrum sensing techniques. To achieve this, a Cyclostationary Spectrum Sensing technique is studied and applied to detect OFDM signals in a noisy environment. The results are obtained for the applications employed in high frequency, such as, Wi-Fi.

Keywords-Cognitive Radio,Cyclostationary Spectrum Sensing, Spectrum Sensing,SpectrumHoles,Wi-Fi.

I. INTRODUCTION

There are so many users in the wireless system and they are using the limited Radio spectrum band continuously. The radio spectrum can be represented by two kinds of bands, i.e. licensed band and unlicensed band. The Primary users (PU) use the licensed band and Secondary users (SU) are using the remaining band called unlicensed band. The licensed band is allocated to those users which are buying the license so that they can use radio spectrum easily. When the licensed band is idle, i.e., none of primary user is using the allocated spectrum, then this band is commonly said to be idle band or spectrum holes. This idle band can be used by secondary users (unlicensed users)[8].There are inflexible spectrum sensing tasks i.e. it is not fixed that at which time the primary user is using the licensed band, or not using licensed band[9].

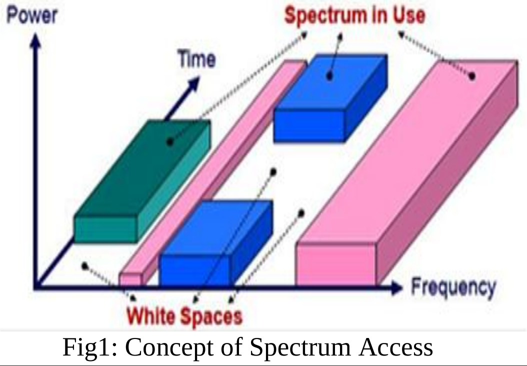

Fig1: Concept of Spectrum Access

Figure 1 shows the physical geometry of spectrum in which the idea about spectrum holes (white spaces) and used spectrum band has been clearly described. The used spectrum is occupied by primary users and white spaces can be used by secondary users. The vital role of cognitive radio is to sense these white spaces and gives the information to secondary users that they can use idle band for transmission purpose.

II. SPECTRUM SENSING

In the spectrum sensing the cognitive radio continuously monitors the activities of the primary or licensed user band and intimates the detection of the presence of secondary users that the specific band is available to use. If there having spectral holes then those spectral holes can be used by the secondary user. The secondary users can only use those spectrum holes without any interference with primary users. If there is an empty spot in frequency spectrum so there will be an opportunity for the secondary user to allocate a new communication link. So there will be detection of an incoming primary user and this action will requires also checking the blank spectrum spots and faster allocating to the secondary users.

III. WI-FI:

Wi-Fi, or Wireless Fidelity, is a term that is used generically to refer to any product or service using any type of 802.11 technology. Wi-Fi networks operate in the unlicensed 2.4 and 5 GHz radio bands, with an 11 Mbps (802.11b) or 54 Mbps (802.11a) data rate, respectively.

Wi-Fi enabled devices (laptops or PDAs) can send and receive data wirelessly from any location equipped with Wi-Fi access.Access points, installed within a Wi-Fi location, transmit an RF signal to Wi-Fi enabled devices that are within range of the access point, which is about 300 feet. The speed of the transmission is governed by the speed of the pipeline fed into the access point. T-Mobile Hotspot service is unique in that every T-Mobile Hotspot service location is equipped with a full T-1 connection running to the access points.

With T-Mobile Hotspot service, a customer, once associated with the access point, can connect to the Internet and enjoy near T-1 speeds in the comfort of American Airlines Admirals Clubs, Starbucks coffeehouses, Borders Books & Music stores and numerous airports.

IV. LITERATURE SURVEY

Joseph Mitolaet. al. (1999), presumed the software radios are growing as stands for multiband multimode weirdo communications schemes. Telecast lip-service is the traditional of RF bands, connected interfaces, protocols, and spatial and worldly designs focus amalgam the conformably of the show block. Theoretical telecast spreads the software telecast approximately telecast -domain shape based symbolic concerning such etiquettes. Outlook Scatter enhances the pliancy of distinct professional care look over a transmission Understanding Proclamation Creole.

SudhirSrinivasaet. al. (2007),defined that cognitive radios are promising solutions to the problem of overcrowded spectrum. In this paper they explored the throughput potential of cognitive communication. Different interpretations of cognitive radio that underlay, overlay, and interweave the transmissions of the cognitive user with those of licensed users are described. Considering opportunistic communication as a baseline, we investigate the throughput improvements offered by the overlay methods. Channel selection techniques for opportunistic access such as frequency hopping, frequency tracking, and frequency coding are presented.

Ozgur B. Akan et. al. (2009), defined that dynamic spectrum access stands as a promising and spectrum-efficient communication approach for resource-constrained multihop wireless sensor networks due to their event-driven communication nature, which generally yields bursty traffic depending on the event characteristics.

Abbas Taherpour and MasoumehNasiri-Kenari(2010),analytically computed the missed detection and false alarm probabilities for the proposed GLR detectors. The simulation results provide the available traded-off in using multiple antenna techniques for spectrum sensing and illustrates the robustness of the proposed GLR detectors compared to the traditional energy detector when there is some uncertainty in the given noise variance.

Ying-Chang Liang et. al. (2011), described that cognitive radio (CR) is the enabling technology for supporting dynamic spectrum access: the policy that addresses the spectrum scarcity problem that is encountered in many countries. In this paper, they provided a systematic overview on CR networking and communications by looking at the key functions of the physical (PHY), medium access control (MAC), and network layers involved in a CR design and how these layers were crossly related.

Eeru R. Lavudiya, Dr. K. D. Kulat and Jagdish D. Kene (2013), have described how to enhance the detection probability by using the different spectrum detection techniques in the cognitive radio system.

Won Mee Jang et. al. (2014),have proposed a blind spectrum sensing method using signal cyclostationary. Often, signal characteristics of the primary user (PU), such as carrier frequency, data rate, modulation and coding may not be known to cognitive users. This uncertainty introduced difficulties in searching for spectrum holes in cognitive radios.

V. Proposed work:

Initially we define the autocorrelation function as cognitive sensing node. This idea originates from the instance of having a pulse modulation of single magnitude like $+/-1$ that after square hide any phantom line but the dc one. Then the transformation $y(t) = x(t).x(t-\tau)$ promises spectral lines for $m.f_0$where m is an numeral. Defining $\alpha = mf_0$we declare

$$M_y^{\alpha} = \langle y(t)e^{-j2\pi\alpha t}\rangle = \langle x(t).x(t-\tau)e^{-j2\pi\alpha t}\rangle \neq 0$$

The Spectral Correlation purpose definition comes from the basic idea of discovery the middling power in the frequency domain as $R\_x\ (0) = |\ x(t)|\text{^}2$. If the correlation in the frequency domain among the shifted forms $v(t)$ and $u(t)$ has to be found then the appearance becomes

$$R_x^0(\tau) = \langle u(t)v*(t)\rangle = \langle |x(t)|^2 e^{-j2\pi\alpha t}\rangle$$

The Power Spectral Density PSD could be imagined as passing the signal $x(t)$ by a narrowband pass filter and scheming the average power, where the filter is simulated all over the band. In the limit where the bandwidths (B) of the filter methods zero:

$$S_x(f) = \lim_{B\to 0}\frac{1}{B}\langle |h_B(t)\otimes x(t)|^2\rangle^n$$

$$S(f) = \int_{-\propto}^{\propto} R_x(\tau)\, e^{-j2\pi ft}\, d\tau$$

Fourier Transform of autocorrelation

$$S_x^{\alpha}(f) = \int_{-\propto}^{\propto} R_x^{\alpha}(\tau)\, e^{-j2\pi ft}\, d\tau$$

Fourier Transform of cyclic autocorrelation.

The Strip Spectral Correlation Analyzer (SSCA) and FFT accumulation (FAM) are both under the time-smoothing organization. The SCD function of $x[n]$is definite as $S_x(f) = \sum_{k=\propto}^{-\propto} R_x^{\alpha}(k)\, e^{-j2\pi fk}$ by means of the discrete Fourier transform, where

$$R_x^{\alpha}(k) = \lim_{n\to\infty} \frac{1}{2N+1} \sum_{n=-N}^{N} [x(n + k)e^{-j2\pi\alpha(n+k)}]\, [x(n)e^{-j2\pi\alpha n}]$$

This way:

$$S_x^{\alpha}(n,f)_{\Delta t} = \frac{1}{T} \langle x_T\left(n, f + \frac{\alpha}{2}\right) x_T^{*}\left(n, f - \frac{\alpha}{2}\right)\rangle$$

Where $x_T\left(n, f \pm \frac{\alpha}{2}\right)$ are the multifaceted demodulators that the meanings are band pass signals shifted to DC.

FAM is one of the approaches under time-smoothing organization which has good efficiency, calculation wise. There are parameters complicated that are used to trade-off determination, reliability and of course computation decrease.

FAM contains of capturing in a time length Δ_ta piece of the received signal $x[n]$ which is the outcome of $x(t)$ sampled atf_s. Approximation of $S_x^{\alpha}(n,f)_{\Delta t}$is achieved over this time length.

VI. Results and Discussion:

The simulation results have been performed for the Wi-Fi system. Modulation used in our simulations is QAM with different constellation size or bits-per-symbol. For Wi-Fi system Simulations are taken with 4 symbol sizes of QAM, *viz.*, 2, 4, 16 and 64.

In first case the SNR vs. BER is calculated by using the Rayleigh channel. The Simulation results are shown in fig2: -

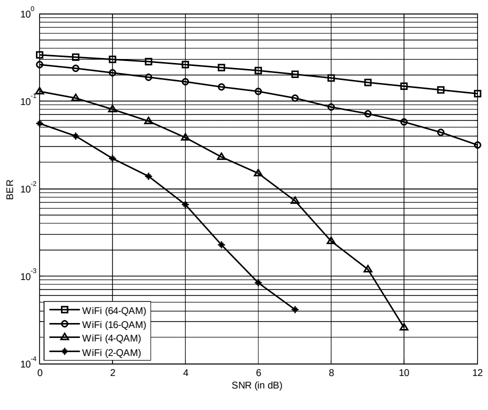

Fig2: SNR vs. BER for Wi-Fi signal using Rayleigh channel

As we seen from above figure that with increase in the size of the constellation of the QAM modulation, BER increases as expected. Also with increase in the SNR, the BER reduces exponentially for every configuration. This proves that the simulated results are in direct correlation with the theoretical results.

In next case SNR vs. BER for Wi-Fi signal is simulated by using Rician channel. The value of the K factor is considered as 5 for this simulation result and the resulting graph is shown in fig3: -

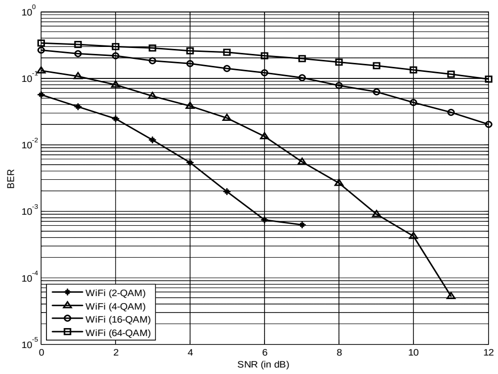

Fig3: SNR vs. BER for Wi-Fi signal using Rician channel with K factor = 5

As seen from above figure, with increase in the size of the constellation of the QAM modulation, BER increases as expected. Also with increase in the SNR, the BER reduces exponentially for every configuration. This proves that the simulated results are in direct correlation with the theoretical results.

After that the value of k factor is changed from 5 to 10 and then taking the SNR vs. BER simulation results for Wi-Fi signal by using the Rician channel with K factor = 10.

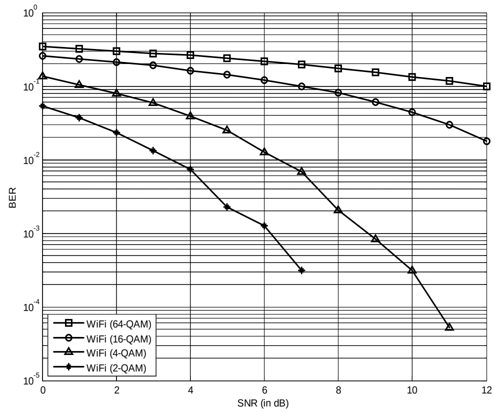

Fig4: SNR vs. BER for Wi-Fi signal using Rician channel with K factor = 10

As seen from fig4, with increase in the size of the constellation of the QAM modulation, BER increases as expected. Also with increase in the SNR, the BER reduces exponentially for every configuration. This proves that the simulated results are in direct correlation with the theoretical results obtained in theory under ideal conditions.

VII. CONCLUSION

A Cyclostationary Spectrum Sensing technique is used to detect OFDM signals in a noisy (AWGN) environment. For very high speed applications, a spectrum sensing technique should require less computation time and should have less complexity. The proposed system has fulfilled all the requirements to get high efficiency for high frequency applications, such as Wi-Fi. The proposed system was compared with existing spectrum sensing techniques in terms of bit error rate performance.By changing the fading channel from Rayleigh to Rician and by selecting some of the parameters better results have been obtained.

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