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Energy Detection Spectrum Sensing in Cognitive Radio for Real Time Video Transmission

Dhanuja R¹, Farhana F², Keerthana B³, Savitha G⁴

^{1, 2, 3, 4}ECE Department, Jeppiaar SRR Engineering College

Abstract: In present day, wireless video communication has turned into the most mainstream communication. Because of this developing demand on wireless video communication applications has put a great deal of limitations on the accessible radio spectrum which is restricted and valuable. The cognitive radio demonstrates unique features are supporting video transmission, taking advantage of multiple spectrum bands, dynamic cognitive radio waveform adaptation according to the primary user transmissions, maintaining the security features of wireless video communication. The main novelty of the paper is an effective implementation of CR using energy based spectrum sensing method which is done on cognitive radio for real time transmission of video as a primary user. It is best suited for detection of white spaces using spectrum sensing method during the transmission of video as a primary user on SDR platform. The SDR modulation-based video transmission in cognitive radio systems with perfect spectrum sensing results under constraints on both transmit and interference. The video/frames are modulated using Hierarchical quadrature amplitude modulation (HQAM). In this project, closed-form bit error probability expressions for high priority (HP) data and low priority (LP) data are derived over Nakagami-m fading channels in the presence of sensing errors.

Keywords: Transmission, Cognitive Radio, Modulation, Spectrum band, Radio Spectrum.

I. INTRODUCTION

Efficient utilization of radio spectrum has received an explosive growth in the number of wireless applications and services and the death of available spectrum for licensed allocation. Recent spectrum measurements have shown that large portions of licensed spectrum, notably in the VHF-UHF bands are under-utilized. This means that there is a spatial region and time with no signal occupancy. Such empty spectrum are available for secondary users by means of cognitive radios. Cognitive radio is an advanced software-defined radio that automatically detects its surrounding and intelligently adapts its operating parameters while meeting user demands. Since cognitive radios are considered as secondary users for using the licensed spectrum, an important requirement of cognitive radio networks is that they must effectively exploit under-utilized spectrum without causing harmful interference to the PUs (Primary Users). Hence, cognitive radios should be independently detect spectral opportunities without any assistance from primary users, this is called spectrum sensing. Cognitive radios employ spectrum sensing to determine frequency bands which have the vacancy of licensed transmissions and restrict their secondary transmissions to meet the regularity of limiting harmful interference to licensed systems. The motivation and techniques for spectrum agile Cognitive Radios (CR) is to efficiently utilize unoccupied licensed spectrum like narrowband sensing techniques, such as matched-filtering, energy detection, cyclostationary detection, etc.

II. BLOCK DIAGRAM

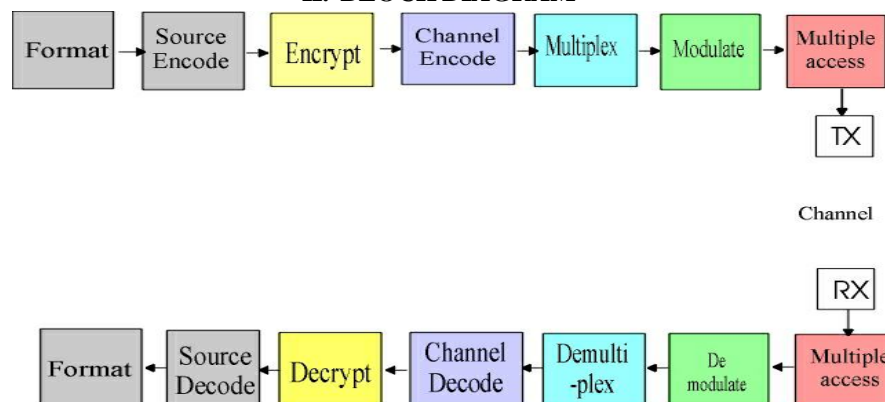


Fig 1: Proposed system of transmitting video for Cognitive Radio Network

III.METHODOLOGY

Orthogonal Frequency Division Multiplexing (OFDM) is seems to be the most popular modulation technique that has widely used recently. By applying this modulation technique, a wideband signal can be converted into multiple serial independent narrowband signals. The main aim of OFDM is to provide a multiple number of n parallel data stream by translating an outgoing data into OFDM symbols. There are several fundamental terms in OFDM symbols that need to be identified such as subcarriers, occupied bandwidth, pilot carrier, cyclic prefix and etc. In OFDM modulation, the allocated bandwidth is occupied by the total number of subcarrier determine at the transmitter.

A. OFDM Transmitter Design

In this work, the PHY layer in the SDR transmission for Cognitive radio network functioned as half duplex communication system. One video transmission has been configured to operate as an OFDM transmitter and the other one as an SDR receiver. At the transmitting side of the video transmission, the video frames that have been generated by the video capture program are passed through to the SDR frame encoding process. The SDR frame encoding as shown in block diagram occurred at the PHY layer where HQAM mapping, multiplexing, OFDM carrier allocation, IFFT and cyclic prefix process are taking place. After the SDR frame encoding part, the modulated video signal is transferred to the SDR.

B. OFDM Receiver Design

At the receiving end, the SDR Cognitive radio received the analogue signal and down converted it into a baseband signal. Then, the baseband signal is converted into digital signal by the analog to digital (ADC) converter in the SDR cognitive radio network primary users. Next, the digital signal is transferred into the receiver host computer and processed under SDR frame detection and decoding. The frame detection part is mainly about the frame synchronization process. While for the frame decoding part, it comprises of demultiplexing, Fast Fourier Transformation (FFT), equalization and payload decoder.

IV.RESULT AND DISCUSSION

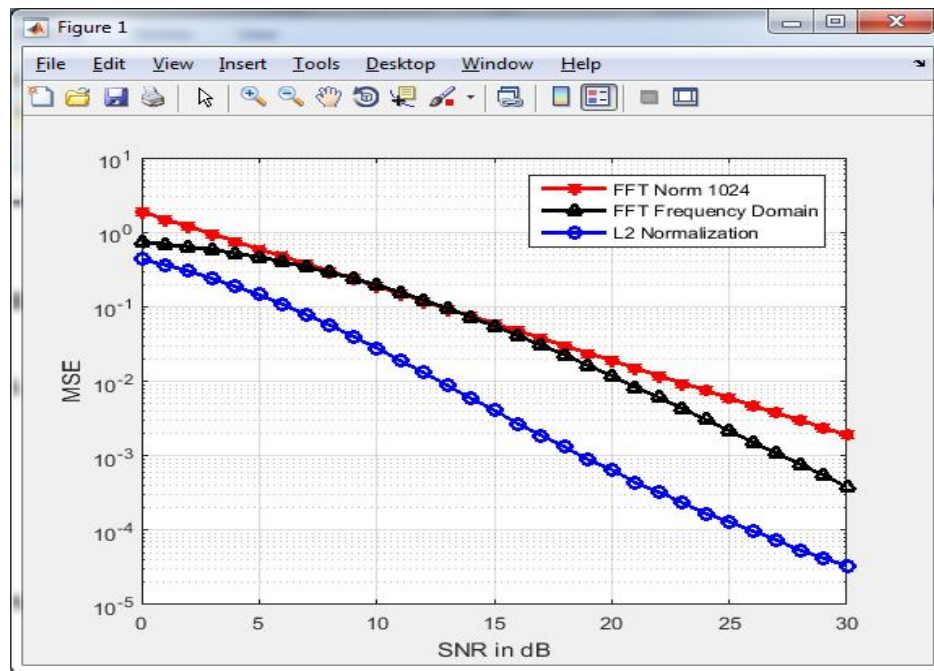


Fig. 2: Spectrum sensing MSE reduction for L2 Norm method is compared with FFT frequency domain

Fig. 2 shows that the spectrum sensing based on MSE reduction using L2 norm. We know that In CR networks, to determine the spectrum availability, CR user need statistical information on the received primary signals, so the minimum SNR is the least signal level needed to decode the received signals. Thirdly, CR users cannot perform the sensing tasks and transmission at the same time. Thus, according to the hardware limitation, a new sensing structure where observation period and transmission period will be separated is necessary for CR users as we mentioned.

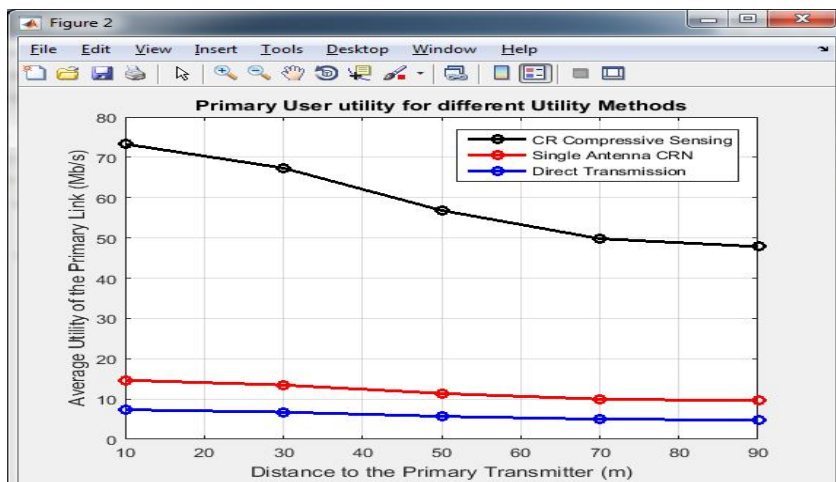


Fig. 3: Primary user utility

Fig. 3 shows the average utility of the primary link, in terms of the throughput under different schemes versus the distance d . We use “Compressive sensing”, to represent the performance of MIMO-CCRN through exhaustive search of the best relay set. To reduce the complexity, we restrict our search to the sets $S(i; j); 0 \leq i; j \leq K$. $S(i; j)$ is the relay set constructed by including the top i SRs and top j STs with best downlink channel gains h_{0rj} into R . The reason is to greedily enhance the downlink capacity, which is the bottleneck of our cooperative communication. The performance given by this heuristic algorithm is denoted as “Heuristic”. In addition, we use “Single-Antenna CCRN” to denote the CCRN scheme proposed, which also aims at maximizing the PU’s throughput. It assumes that each SU is equipped with a single antenna. For fair comparison, both schemes adopts the same settings stated above, and the power budget for SUs are all set to $P_{max} = P_p$. In MIMO-CCRN, we assume the target rate $R(s) = k$ of each secondary pair is 5 Mb/s. The number of secondary pairs is $K = 8$. Finally “Direct Transmission” gives the primary link’s throughput without SU cooperation. From the figure, we can see that by exploiting the SU cooperation with MIMO capability, MIMO-CCRN significantly improves the throughput of the primary link by up to 110% compared with direct transmission. Also, MIMO-CCRN outperforms the Single-Antenna CCRN by up to 75%. This is due to the following two reasons: (i) Secondary relays equipped with multiple antennas achieve a stronger beam-forming in receiving and forwarding the PU’s data; (ii) By exploiting the spatial domain, no dedicated fraction of time is allocated to the SUs, thus the overhead for the PU’s transmission is reduced. Moreover the primary link’s throughput reaches a peak when d is around 30, which is the location that best balances the uplink/downlink capacity. Also our heuristic algorithm gives a fairly acceptable performance, which is about 85% of the optimal PU’s throughput for most of the points.

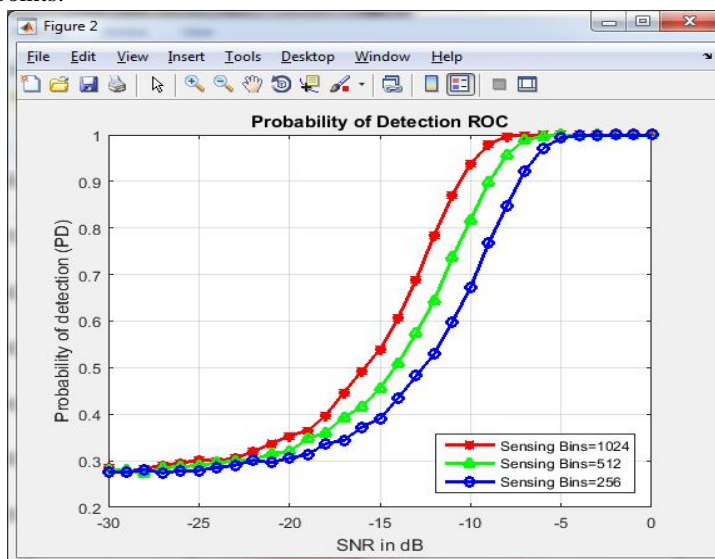


Fig. 4: Probability of Detection ROC

Fig. 4 shows the probability of detection ROC. ROC represents receiver operating characteristics. A Detectors performance is measured by its ability to achieve a certain probability of detection for a given SNR. Examining a detectors ROC curve provide insight in its performance. It indicates the probability of detection between the three sensing bits namely 256,512 and 1024. Normally the probability should be 1. While comparing with these sensing bits,1024 is more efficient because it performs as a less noise ratio.

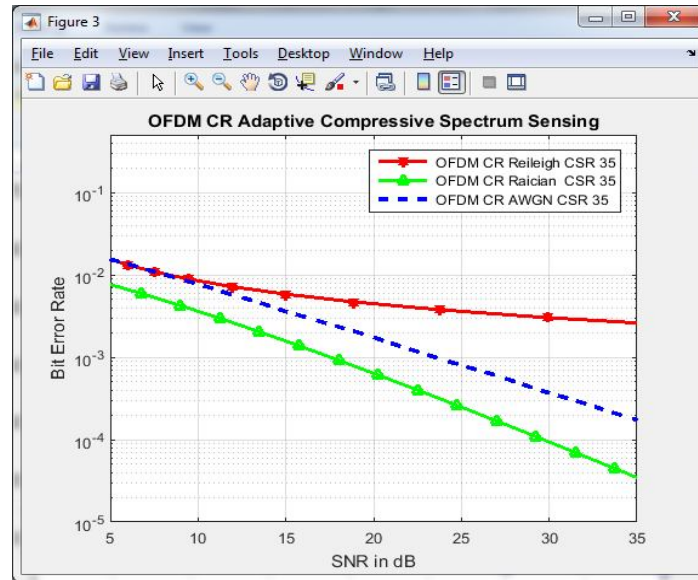


Fig. 5: OFDM CR network for adaptive compressive sensing

OFDM based CR network used to give adaptive compressive sensing as shown in the fig. 5. It compares the recovery error of the recovery methods when the sampling matrix is a Toeplitz matrix as a function of the signal to noise ratio (SNR) from -10 dB to 10 dB. As expected, the recovery error is decreasing with the increase of SNR for all the three techniques. For low SNR, values under 4 dB, the recovery error of the Bayesian method is lower than those of the two other methods. For higher SNR (SNR > 4 dB), the recovery error of the three methods are very low and slightly similar. Thus, when SNR is under 4 dB, the Bayesian recovery is significantly more suitable and efficient than the other two techniques. The error decreases with the increase of the number of samples for the three recovery methods. For a low number of samples, our proposed approach overcomes both recovery methods and minimizes the error. For a high number of samples, the recovery error of the Bayesian method is about 0.02, while it is about 0.2 for the other two recovery methods. Therefore, the Bayesian method presents the lowest recovery error even for a low number of samples.

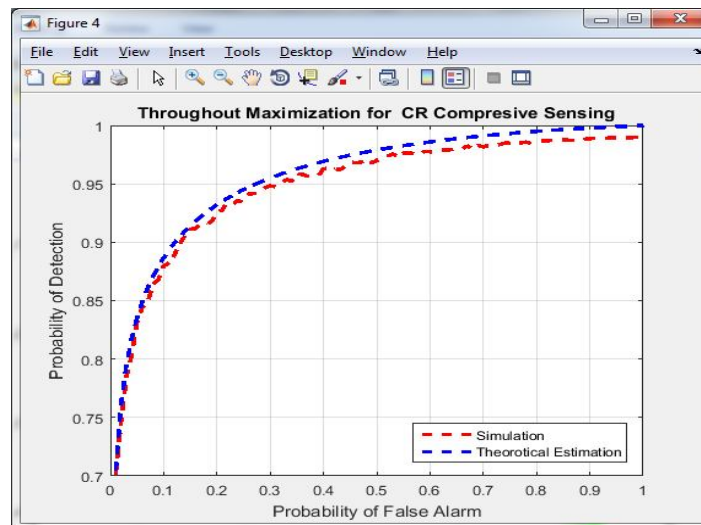


Fig. 6: Throughput maximization for adaptive spectrum sensing

The sensing threshold for energy detector is an important parameter. When a detector does not adjust its threshold properly, it suffers from some performance degradation of the spectrum sensing. Various approaches were suggested for energy detection technique. As the sensing performance is highly affected by the estimation error of the noise power, a dynamic estimation of the noise power. Adaptive threshold control is implemented with linear adaptation on the threshold based on SNR. This approach attains a considerably higher SU throughput than the fixed threshold approach, but maintains unacceptable chances of false alarms.

V. FUTURE WORK

The accurate detection of OFDM based primaries can be provided by an efficient frequency-domain cyclic prefix (CP) autocorrelation based wideband spectrum sensing and sharing method in wideband CR systems. The corresponding threshold, probability of false alarm and probability of detection are occurred from the derivation of Novel analytic expressions in the presence of noise uncertainty (NU) and frequency selectivity.

VI. CONCLUSION

An adaptive spectrum sensing algorithm have been proposed for improving the throughput of wideband CRs using CS technologies. It has been shown that the wideband spectrum can be successfully reconstructed by the proposed algorithm by using a few sub-Nyquist samples. Also the actual spectral recovery error is unknown even if the wideband signal acquisition can be automatically terminated, thanks to the l_2 norm validation approach. And it has been proved that the greater throughput can be provided by the proposed CR system than the CR system using traditional CS technologies.

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