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PERFORMANCE ANALYSIS OF SPECTRUM SENSING USING UNDER SAMPLING FOR COGNITIVE RADIO

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ABSTRACT

The deficiency of the spectrum range is major issue in communication technology to augment the new standard of communication. The reuse of spectrum is become a way to effectively use the spectrum. To perform this, spectrum sensing is required for reuse of spectral hole. There are several techniques to perform spectral sensing. This paper is explained the spectrum sensing using under sampling method. The spectrum hole detection accuracy is key parameter to evaluate the performance of this method. The results have been given in different noisy environment.

KEYWORDS: Spectrum sensing, Cognirive radio, Energy Detection, etc.

INTRODUCTION

The radio Spectrum which is very essential for wireless communication process is basically a naturally limited recourse. In the fixed spectrum access policy has traditionally been adopted by spectrum regulators to support various wireless techniques. According to fixed spectrum access (FSA) each part of spectrum with definite bandwidth will be hand over to one or more dedicated users also known as licensed users. Thus only these user's have right to use the allotted spectrum and other users are not allowed to use it.

As the demand of users for high speed and low error is increasing with time, the new standards are in process to development. The availble spectrum range is limited. The use of spectrum by any allotted wireless standard is varies with location of use. In rural area, most of the spectrum is unutilized. This spectrum may be used by another standard by knowing the availability of the unused spectrum, this is also called spectrum hole. The spectrum hole detection is a key part of the reutilization of spectrum hole. The interference should not disturb to allotted users (called primary user).

SPECTRUM SENSING:

A major challenge in cognitive radio (CR) is that the secondary users need to detect the presence of primary users in a licensed spectrum and quit the frequency band as quickly as possible if the corresponding primary radio emerges in order to avoid interference to primary users. In this technique is called spectrum sensing. Spectrum sensing and estimation is the first step to implement Cognitive Radio system. We can categorize spectrum sensing techniques into direct method, which is considered as frequency domain, where the estimation is carried out directly from signal and indirect method, in which is known as time domain approach, where the estimation is performed using autocorrelation of the signal. Another way of categorizing the spectrum sensing and estimation methods is through making group into model based parametric method and periodogram based nonparametric technique. Another way of classification depends on the need of spectrum sensing as stated below:

Spectrum Sensing for Interference Detection

Interference temperature detection:

CR system works as in the ultra wide band technology where the secondary users coexist with primary users and are allowed to transmit with low power and are restricted through the interference temperature level so as not to cause harmful interference to primary users.

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In this method, the interference and/or spectrum opportunities are detected based on primary receiver's local oscillator leakage power.

CLASSIFICATION OF SPECTRUM SENSING TECHNIQUES

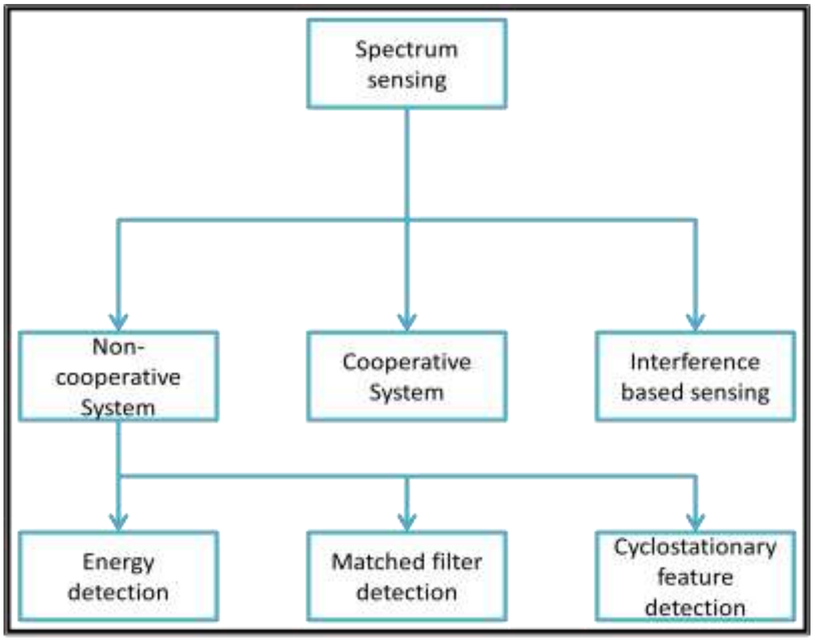

Figure: 1 Classification of spectrum sensing techniques

Figure 1 shows the detailed classification of spectrum Sensing techniques. In broadly classified into three main types, transmitter detection or non cooperative sensing, and cooperative sensing and interference based sensing. In the transmitter detection technique is further classified into energy detection (ED), matched filter detection and cyclostationary feature detection.

Basic Energy Detector

Energy detector does not require prior knowledge about the primary user signal, only the value of white Gaussian noise is to be known. It collects the test statistic and compares it with a threshold to decide whether the PU (Primary user) signal is present or absent. Energy detection is optimal for detecting independent and identically distributed signal in high SNR conditions, but not optimal for detecting correlated signals. The test statistic is given by,

$$X = \frac{1}{N}\sum_{n=1}^{N}|y(n)|^2 \qquad (1)$$

Where, y(n) is received input signal, N is the number of observations, X denotes the energy of received input signal which is compared with threshold to make the final decision. Threshold value is set to meet the target probability of false alarm Pf according to the noise power. The probability of detection Pd can be also identified. The expression for Pf and Pd are given by,

$$P_f = Q\left(\frac{T - N\sigma_w^2}{\sqrt{2N(\sigma_w^4)}}\right) \qquad (2)$$

$$P_d = Q\left(\frac{T - N(\sigma_s^2 + \sigma_w^2)}{\sqrt{2N(\sigma_s^2 + \sigma_w^2)^2}}\right) \qquad (3)$$

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Where, σ2w and σ2s are the noise variance and signal variance, respectively. Q() denotes the Gaussian tail probability Q-function and T denotes the threshold used in the energy detector. Threshold used in energy detector depends upon noise variance. So a small variation in noise variance estimation causes performance degradation. In conventional Energy detector, threshold can be determined as,

$$T = Q^{-1}(P_f)\sqrt{2N(\sigma_w^4)} + N\sigma_w^2 \qquad (4)$$

Where Q-1 denotes the inverse Gaussian tail probability Q function. If the threshold is exceeded, it is decided that signal is present otherwise it is absent. Energy detection can be implemented both in time and frequency domain using Fast Fourier Transform (FFT). Energy Detector simply needs a band-pass filter, square law device and an Integrator. First the input signal's bandwidth is limited to a band of interest.

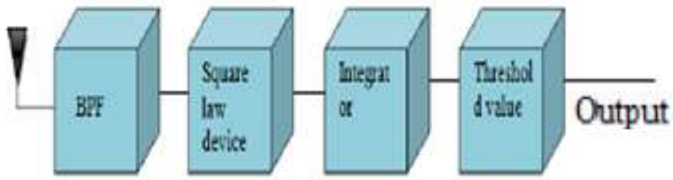

Figure: 2 Energy detector block

Matched Filter

Figure: 3 Block diagram of matched filter

A matched filter is a linear filter designed to maximize the output signal to noise ratio for a given input signal. When secondary user has a priori knowledge of primary user signal, in matched filter detection is applied. Matched filter operation is equivalent to correlation in which the unknown signal is convolved with the filter whose impulse response is the mirror and time shifted version of a reference signal.

Sub-Nyquist Sampling

The sampling rate used was twice the colour sub-carrier frequency of the PAL signal (8.86MHz or 2fsc). In the insufficient to ensure that the sampling does not introduce distortion - a frequency of at least 11MHz is required. That distortion components were present in the frequency range 3.37MHz to 5.5MHz. Because of the nature of the TV signals the energy in the signal tends to be clustered at multiples of the TV line frequency (15.625kHz). By arranging for the alias components to sit in between these wanted components, a comb-filter (a filter with peaks and troughs every 16kHz above 3.37MHz) can be used to minimize the effect of aliases whilst also minimizing the impact on the wanted information. See Figure 3 for a more pictorial description of this process.

In practice, the best results were obtained by initially sampling the signal at four times the sub-carrier frequency, applying comb-filtering to the 4fsc samples to remove components at frequencies which would otherwise form aliases at exact multiples of line frequency, forming the sub-Nyquist sample values and finally comb-filtering the 2fsc samples to remove the aliasing introduced by removing the unwanted samples.

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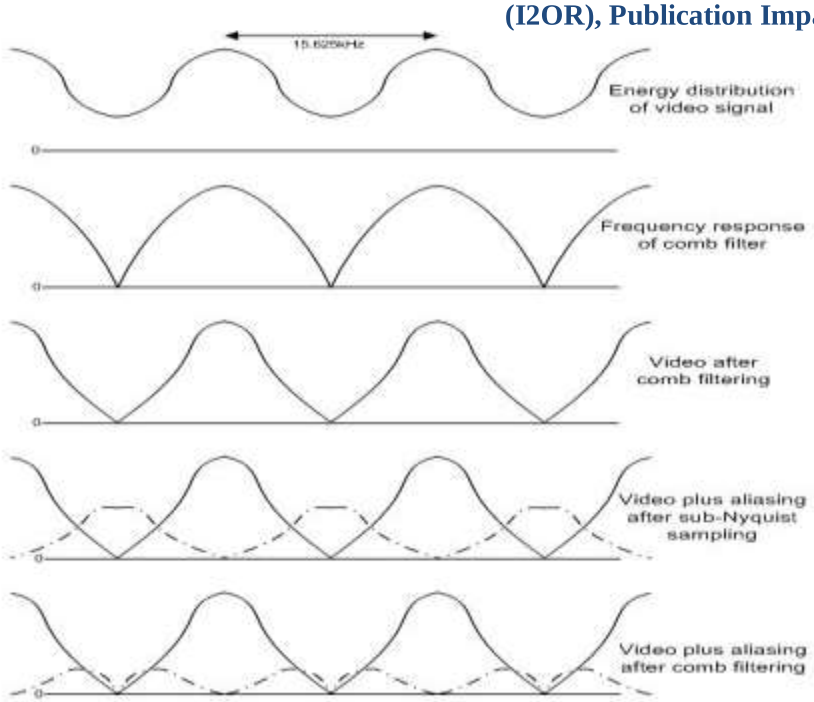

Figure: 4Impact of sub-Nyquist sampling

RESULTS

The simulation system system will be developed the spectrum sensing and cognitive radio using MATLAB. The graphs shown in simulation & result section of the paper clarify the process shown in the system model.

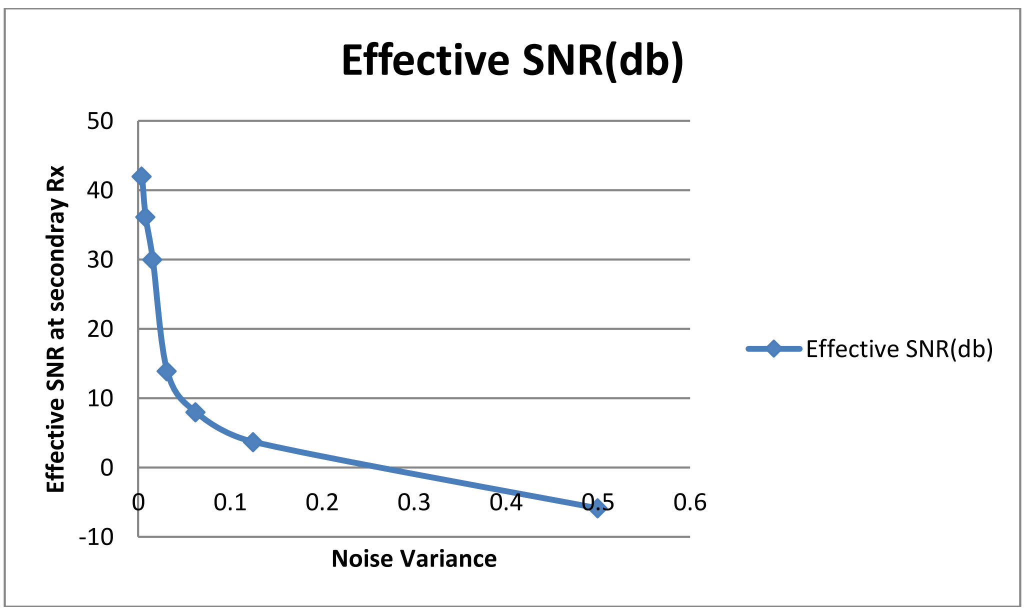

Figure: 5Performance of Noise Vs SNR

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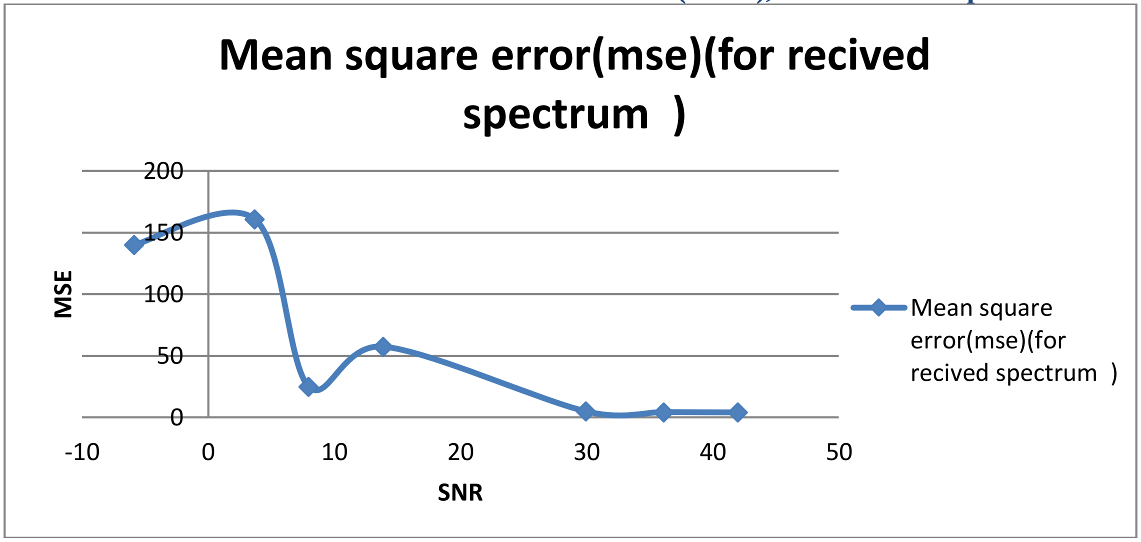

Figure: 6 Performance of Noise

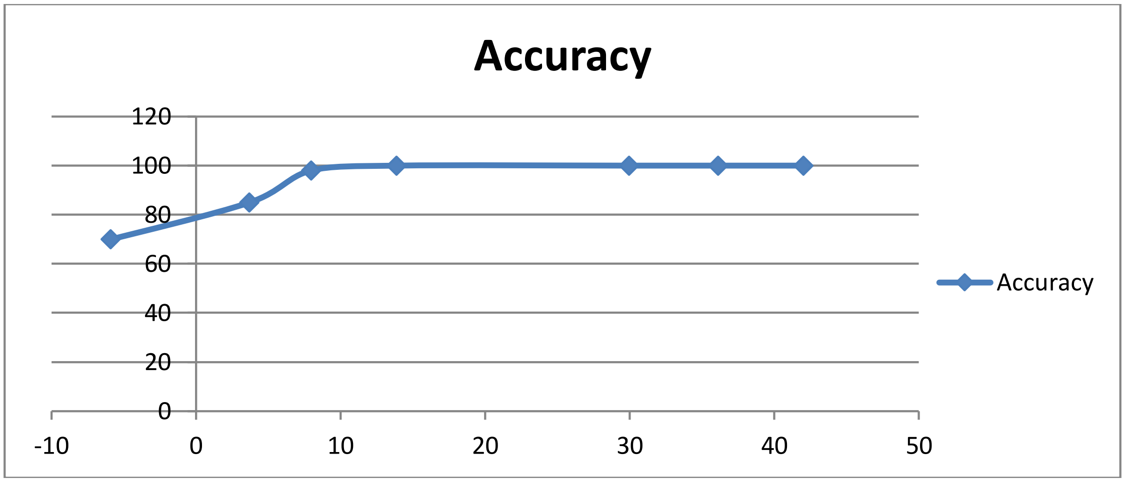

Figure: 7 Performance of Accuracy

Table .1 Performance of parameter and sigma values

S.No	sigma	Snr(db)	Mean square error(MSE)
1	0.0039063	42.0076	3.8
2	0.0078125	36.1026	4.0567
3	0.015625	29.9609	4.5865
4	0.1	13.8829	57.235
5	0.2	7.9648	24.7874
6	0.33	3.7049	160.7300
7	1	-5.8843	139.8703

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CONCLUSION

ThisWideband spectrum sensing approaches for cognitive radio need to address the sampling schemes and the detection algorithms jointly relevant to the specificobjective of system design based upon specific primary system models. The proposed technique utilize a multicast sampling scheme that can use arbitrarily low sampling rates close to the channel occupancy. We evaluate the detection performance of this method for a typical case. In this results show that even in low SNR, and increase accuracy.

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