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4G/VoLTE- Spectrum Sensing using Cyclostationary Detection (CS-SS) Method: A Review

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Abstract: The primary and most significant method by which Cognitive Radio (CR) locates unoccupied bandwidth is Spectrum Sensing (SS). This paper provides a comprehensive explanation of cognitive radio's operation and discusses its advantages and potential. Numerous advantages make cyclostatinary detection-based spectrum sensing (CD-SS) popular. A characteristic of a transmission channel, a characteristic of a transmission signal, or even the method of modulation. A simulation overview of CD-SS is provided in these articles. The probability of detection (Pd), the probability of a false alarm (Pfa), and the BER of time-dominant cyclostationary detection are the most significant variables that are examined and simulated.

Keywords: Cognitive radio, Cyclostationary, Spectrum, BER.

Review Paper

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1. INTRODUCTION

The most fundamental human need is currently wireless communication. The utilization of data transmission develops in light of the fact that radio recurrence range is required for correspondence among transmitter and collector. The bandwidth frequency, on the other hand, does not rise [1]. The cutting-edge technology of cognitive radio makes it simple to distinguish between used and unused channels. There are also a lot of ways to sense the spectrum in cognitive radio, including energy detection, matched filter detection, cyclostationary detection (CD), and using more spectrum. Because it is a common signal, we are employing an energy detection strategy here [2-4]. Due to its extremely simple implementation, the spectrum sensing methods. We can use the spectrum of major users to improve its efficiency when secondary users prefer it. The decision variable is the output of the device for integrating and squaring, which is used to locate energy. The threshold is then compared to the decision variable [5-7]. The detector's output is sent to a primary user if the decision variable is greater than the threshold. Energy detection is an important part of the spectrum because it requires less information to detect the signal.

To determine whether the channel is open or not, the detector compares the energy to a threshold value. For example, the matching filter is the best choice because it shortens the amount of time it takes to detect and increases SNR [8-10]. Secondary (cognitive) users can discover free spectrum bands without the assistance of primary systems thanks to spectrum sensing. Range detecting has been taken a gander at according to various perspectives before. Matching filters, for instance, are appropriate because they maximize SNR [11, 12]. Cyclostationary detection provides the ability to distinguish between primary signals and background noise, but it comes at the expense of significant computational costs and the need for the right primary signal parameters to determine cycle frequency [13-15]. The use of models that combine two or more detection methods has recently improved the spectrum sensing capabilities of cognitive radio networks. To evaluate whether essential clients are available or missing in a cognitiveness of network, a artificial neural network (ANN) is utilized for learning [16]. The OFDM system uses a number of low-rate subcarriers to send data. This means that the licensed frequency band will be used more often. Although MIMO-OFDM systems are simpler to set up, they do not offer the advantages of the CD-SS process that come from a variety of broadcasts with multiple branches (antennas) [17-19].The spectrum sensing function has a significant impact on cognitive radio network performance. A new threshold determination method based on an online learning algorithm is proposed in this study to reduce the overall error probability and improve the performance of spectrum sensing methods [20].

2. Cyclostationary Detection - Spectrum Sensing (CD-SS)

The value of the received signal's autocorrelation coefficient serves as the foundation for the autocorrelation- based sensing method. It makes use of the autocorrelation features that are already present in the transmitted signal rather than the noise. The definition of the autocorrelation function for a given signal, s(t):

$R_{ss}(\tau) = \int_{-\infty}^{+\infty} s(t)s^*(t-\tau).d\tau$………. (1)

Where s* is the signal's complex conjugate, t is the time, and τ is the time lag. The level of noise affects the sensing quality in the context of spectrum sensing, making it challenging to interpret the affected signals by the Gaussian noise. In point of fact, there is no correlation between white noise and its autocorrelation function, which shows a sharp spike at the zero lag while the other lags are all close to zero. The signal's autocorrelation is correlated, whereas the noise's is uncorrelated. The signal's strength increases when the degree of correlation is higher. As a result, as depicted in Figure 1, spectrum sensing is carried out by utilizing the autocorrelation function to identify the presence of PU signals amid noise.

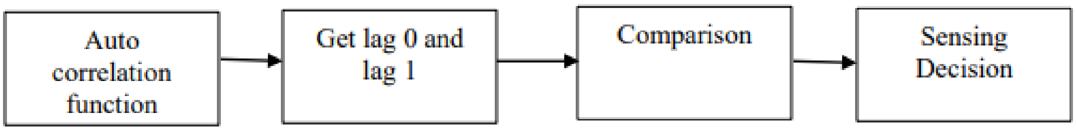

Figure 1: Autocorrelation based sensing model

The statistical distribution of the autocorrelation function is the foundation for the sensing decision. The autocorrelation at the first lag represents a significant value when there is a signal, whereas it is very small or negative for random noise. As a result, comparing lag0 and lag1 of the autocorrelation function of the SU received signal constitutes the sensing method. The decision made by sensing is expressed as:

$if\ lag0 \approx lag1, PU\ signal\ present$ … … (2)

$if\ lag0 \gg lag1, PU\ signal\ absent$ … … (3)

The difference between the two lag values is the autocorrelation threshold. The autocorrelation threshold, for instance, is the value where lag0 is greater than lag1 by a percentage of the total. Because it can distinguish between signals and noise, autocorrelation-based sensing is less sensitive to noise uncertainty. The second-order moment can be represented as a Fourier series for signals produced by the cyclostationary detection method.

$R_x(t,\tau) = \sum_a R_x{}^a(\tau)^{2\pi at}$ … … … (4)

Where α is known as a CF. For all integers k, the sum is greater than α= k/T0, where T0 is the period, if the autocorrelation is periodic. On the off chance that the autocorrelation is practically occasional, it is the amount of at least two intermittent capabilities with disproportionate periods. For this situation, the aggregate over the CFs incorporates all music of every major period. The majority of the time, the sum over CF is left unspecified to accommodate this ambiguity. The cyclic autocorrelation, which is represented by the Fourier coefficient Rxa(τ), is equivalent to the conventional autocorrelation when = 0. The standard Fourier coefficient expression gives it,

$R^{\alpha}{}_x(t) = \lim_{T->\infty} \frac{1}{T}\int_{-T/2}^{+T/2} R_x(t,\tau)e^{j2\pi\alpha t}.dt$ ………. (5)

Where an integration over a single period can take the place of the limit for all other CS signals but is required for a CS signal that is almost periodic. The data themselves can also be used to calculate the cyclic autocorrelation,

$R^{\alpha}{}_x(t) = \lim_{T->\infty} \frac{1}{T}\int_{-T/2}^{+T/2} x(t+\tau/2) * x'(t-\tau/2)e^{j2\pi\alpha t}.dt$……….. (6)

3. SIMULATION RESULTS

The SNR value increases the calculated Pd. Figures 2(a, b) show the results for higher and lower SNR values, respectively. When we contrast the performance of an energy detector with that of a cyclostationary detector, we find that the energy detector provides significantly higher PD values for the same SNR value. Additionally, the lower SNR value results in higher PD values for the energy detector. For instance, cyclostationary detector achieves PD values close to 1 around -5db, whereas energy detector achieves close to 1. Energy detector clearly outperforms cyclostationary detector by a significant margin at lower SNR values.

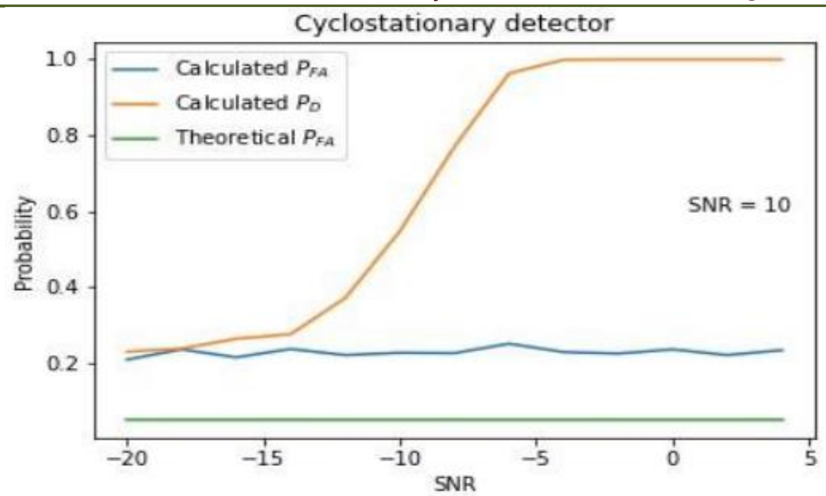

Figure 2(a): For High SNR Value (SNR =10)

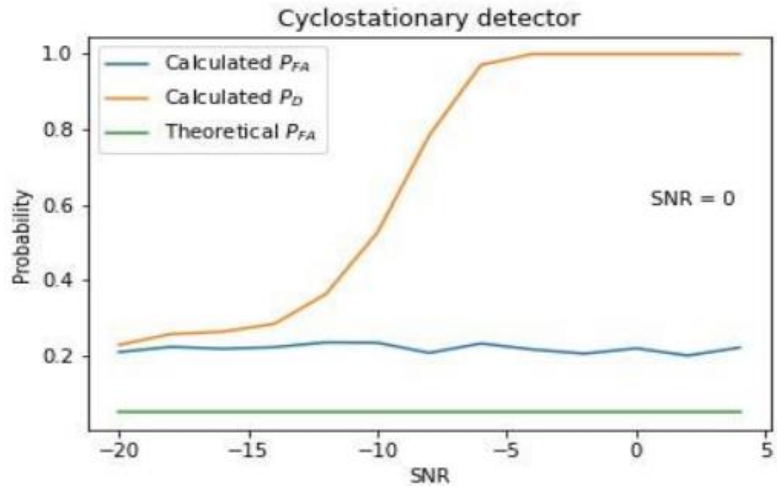

Figure 2(b): For Low SNR Value (SNR =0)

As shown in Figure 3(a, b), the calculated PD has clearly decreased in comparison to the preceding case. Due to the smaller noise component, however, the performance drop at higher SNR values is negligible. Additionally, we can see that the cyclostationary detector has a lower performance drop than the energy detector, making it less susceptible to noisy estimates.

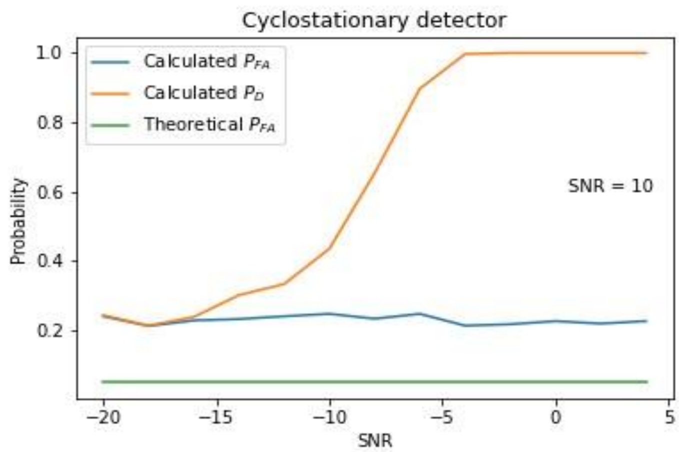

Figure 3(a): For High value of SNR (SNR = 10)

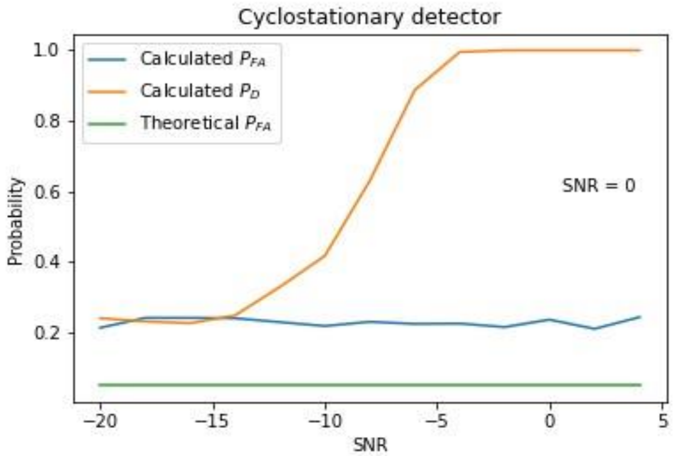

Figure 3(a): For Low value of SNR (SNR = 0)

The performance in case of Probability of Detection (PoD) vs SNR as well known that the higher the SNR, the lower be the corresponding PoD. Cylcostationary detection of ed n=1000 is better compared to Cylcostationary detection of ed n=10000.

4. CONCLUSION

In this study, we present preliminary results regarding the evaluation of cyclostationary detection performance. Future evaluations of cyclostationary detection will be guided by the findings from this phase of our investigation. This analysis may lead us to the conclusion that increasing the sensing duration will increase the likelihood of detection; however, noise uncertainties and estimate errors impose a limit below which detection cannot be extended. Another important finding is that taking into account the current noise levels, dynamically selecting the detection threshold would increase the likelihood of detection in the case of moderate SNR. The cyclostationary detector are reviewed with optimizeed technique, implemented, and evaluated by us. We assess the presentation of the identifiers by plotting Likelihood versus SNR under spotless and boisterous circumstances.

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