International Journal of Electronics, Communications, and Measurement Engineering
Volume 11 • Issue 1

Enhanced Detectability Using Multi-Cycle Cyclostationary Detector in Cognitive Radio

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ABSTRACT

RF spectrum decision is very crucial in cognitive radio. With the concept of interconnecting society by IoT, the spectrum demand has further raised exponentially, and now it has become very important to meet the problem of spectrum scarcity. Radio spectrum is a scarce commodity, and due to the shortage of the radio spectrum, IoT networking has become very challenging in its implementation. Cyclostationary detection scheme, able to sense RF spectrum and accordingly make decisions to achieve good QoS and interference free communication, is drawing the interest of researchers. In this paper, the authors propose embedding pilot subcarrier in OFDM signal to build the cyclic pattern in the signal of interest. This periodicity pattern is harnessed at the receiver end. Evaluation of this periodicity pattern forms the base regarding RF spectrum availability. The aim of this paper is to show how cyclostationary detector performance can be improved. Pilot subcarriers are mainly used in this paper as a channel estimation parameter using different techniques to increase the detectability of detector.

KEYWORDS

5G, Cyclic Autocorrelation, Cyclic Frequency, Cyclostationarity, Internet of Things (IoT), MIMO, Multi-Cycle Cyclostationary, OFDM, Pilot Subcarrier, Spectral Correlation Function

1.INTRODUCTION

In the present scenario where RF spectrum is fully occupied by various wireless operators and applications. To meet the futuristic demand of 5G wireless networking, 8K video, unmanned driving etc. the requirement of high data rate, low latency are required. Spectrum sensing scheme focuses to resolve the problem of increasing data rate demand. Different types of spectrum sensing methods are being proposed and implemented in a move to choose the most optimal detector in terms of simplicity and detector performance (Cabric, 2004; Kamil et al., 2009; Subhedar & Birajdar, 2011). In this paper Cyclostationary feature detector performance is evaluated and an approach is made to improve its detectability by boosting the pilot subcarriers, by averaging over several symbols and by applying Multi-cycle cyclostationary algorithm. The performance is evaluated in terms of performance metric curve. For reference analysis Energy detector is considered (Abdulsattar & Hussein, 2012; Digham, 2003; Qingchun & Qilian, 2007) to make the base for comaparison, to denote the percentage improve in detection performance of detector under different schemes.

DOI: 10.4018/IJECME.297082 *Corresponding Author

Cyclostationary detection scheme is capable of detecting and identifying analog and digital modulated communication signals (Aparna & Jayasheela, 2012; Aparna & Jayasheela, 2013; Verma et al., n.d.). The basic characteristic of modulated signal is periodicity of its statistical parameters like mean and autocorrelation because its spectral pattern repeats after certain period. The key feature of this scheme highlights its feature of outperforming other schemes in condition of extreme SNR scenario and it possesses a realistic model for distinguishing differently modulated signals by method of spectral analysis. Spectral correlation density function (SCD) is the tool used for signal analysis in cyclostationary detector. The found autocorrelation pattern is used to find SCD of the signal by applying cyclic Wiener-Khinchin relation (Song, 2011). Time-smoothed and frequency-smoothed cyclic periodogram is used to estimate the presence of signal. In the literature this work has been investigated for finding appropriate detectibility (Sohn et al., 2009) where the cyclostationary detection for the OFDM signal has been made by boosting and averaging over symbols, this is an enhancement work to explore and improve the detectibility by using concept of multicycle cyclostationary detection. The motivation of this research work has been taken for comprising these schemes for finding the best of all these schemes. In this paper the signal sensing is made in the frequency domain by doing the periodogram analysis.

This paper, highlights on the pattern detection of modulated signal, wherein OFDM signal has been considered for reference. By exploiting the characteristic of inbuilt property of pilot subcarriers of OFDM based signals, the detectability performance can be enhanced. Thus identification can be made by analyzing the received signal pattern for its pattern, in the band of interest. Further we would boost the pilot subcarriers, average it over several symbols and evaluating the parameter over multiple cyclic frequencies and analyze the detector performance. This could be a method to enhance the detectability of OFDM systems by cyclostationary detector. In the presented work spectral correlation of OFDM signal is implemented. The results are evaluated for pedestrian-A and B and Vehicle-A and B using Multi-cycle cyclostationary algorithm to improve the detectability. Probability of detection Pd for different SNR values are plotted and discussed. The presented work shows how this scheme provides the enhanced results and improves the detectability. This enhanced detectability is useful to combat the requirement of scarce spectrum resource, which is the main concern for future cellular communication for the upcoming 5G technology (Saravanan & Suresh, n.d.). Hence, this sensing method manages spectrum resource efficiently and provides the room for building higher data rate demand of user. This sensing scheme which is very robust in performance finds its application in MIMO technology. Where multiple replicas of original signal is sent for superior performance of received signal. This work is mainly motivated to solve the issue of spectrum sensing so to make an efficient cognitive system. Signal studied for sensing scheme is taken to be OFDM signal which offers several future scope due to its special feature to combat interference and thus forms backbone of future cellular communication and used in collaboration with OFDM-MIMO leading to various upcoming technologies like WBAN, WPCN, IoT, 5G.

In section II, the cyclostationary detector performance is compared to energy detector. In section III, we analyze the Time-smoothed cyclic periodogram for the cyclostationarity detection of signal. In section IV the cyclic autocorrelation function (CAC) and spectral correlation density function (SCF) of OFDM signal is plotted. Section V deals with boosting and averaging over pilot subcarriers to optimize the detection probability of receiver. In section VI results are presented and the inference is drawn from the obtained results for determining the suitability of cyclostationary feature detector (CFD) method for advanced applications like MIMO and IoT.

2.DETECTOR PERFORMANCE COMPARISON AND EVALUATION

In this section we have shown how Cyclostationary detector is better than energy detector scheme, we have also found the degree of improvement achieved in sensing the signal in different environmental conditions and verified by the simulated results. The motive for considering energy detector for