

Impact of Primary User Duty Cycle on LogDet Covariance Based Spectrum Sensing under Colored Noise

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Radio-frequency (RF) spectrum is a scarce natural resource allocated to the licensed primary users (PUs) in a cognitive radio (CR) communication system. With the rapid growth in wireless services, the demand on the RF spectrum is extremely high. Thus, CR based communication systems are proposed to enable efficient utilization of available spectrum by using dynamic spectrum allocation [1]. In CR based dynamic spectrum access, the secondary users (SUs) can utilize the spectrum opportunistically without interfering with the PUs using three approaches: underlay, overlay, and interweave techniques [1]. In fact, the IEEE 802.22 wireless regional area networks (WRAN) is the first wireless standard to include interweave CR in its specification [1] where PUs are digital television (DTV) and wireless microphone, and SUs are customer premises equipment (CPE). Most spectrum sensing algorithms used in CR, are based on statistical covariance and eigenvalue of the received sample covariance matrix (RSCM) such as covariance absolute value, maximum eigenvalue, maximum to minimum eigenvalue based algorithms etc. The above algorithms are based on the covariance matrix of uncorrelated samples, thus not suitable for correlated or colored noise as found in many practical systems.

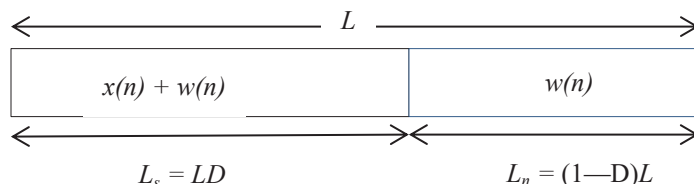
In [2], we proposed LogDet covariance based algorithms which have better performance than existing algorithms in the presence of colored noise at very low signal to noise ratio. However, the system model which is used in [2] is conventional as:

$$\begin{aligned} H_0: y(n) &= w(n) & (1) \\ H_1: y(n) &= x(n) + w(n) & (2) \end{aligned}$$

where, $x(n)$ and $w(n)$ are PU's signal samples and noise samples respectively. From above, the PU signal is absent under null hypothesis H_0 , and present under alternative hypothesis H_1 .

Since, the main PU of IEEE 802.22 is DTV and its ON and OFF state during the sensing interval may change, which leads to the degradation of the existing algorithms including LogDet covariance based algorithm. Thus in this paper, we study the impact propose techniques to improve the LogDet covariance based algorithm in the presence of PU duty cycle.

The structure of received signal in the presence of duty cycle (D ($0 < D < 1$)) is shown in Figure 1.



The received signal in the presence of D is given as:

$$y_D = \begin{cases} x(n) + w(n), & 0 \leq n \leq L_s \\ w(n), & L_s + 1 \leq n \leq L \end{cases} \quad (3)$$

When $D = 0$, PU signal is completely absent and the received signal contains noise only as per H_0 of (1). When $D = 1$, PU signal is completely present similar to H_1 of (2).

1. A. Bishnu and V. Bhatia, "Grassmann Manifold based Spectrum Sensing for TV White Space," *IEEE Transactions on Cognitive Communications and Networking*, vol. 4, no. 3, pp. 62-472, 2018.
2. A. Bishnu and V. Bhatia, "LogDet Covariance based Spectrum Sensing under Colored Noise," *IEEE Transactions on Vehicular Technology*, vol. 67, no. 7, pp. 6716-6720, 2018.