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Analysis of M-QAM Signals Using Adaptive Detection Approach for Maximum Spectrum Sensing

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ABSTRACT:

The proposed literature presents the novel framework to maximize the utilization of spectrum in cognitive radio networks. In order to achieve the higher spectrum utilization we propose an optical Bayesian detector for spectrum sensing to achieve higher spectrum utilization in cognitive radio networks. This frame work detects a wideband M-ary quadrature amplitude modulation (M-QAM) primary signal over multiple non over lapping narrowband Gaussian channels, using the energy detection technique so as to maximize the throughput in CR networks while limiting interference with the primary network. The signal detection problem is formulated as an optimization problem to maximize the aggregate achievable secondary throughput capacity by jointly optimizing the sensing duration and individual detection thresholds under the overall inter fervencies posed on the primary network. It is shown that the detection problems can be solved as convex optimization problems if certain practical constraints are applied. Simulation results show that the framework under consideration achieves much better performance for M-QAM than for binary phase-shift keying or any real modulation scheme. The performance analysis of proposed framework is expressed in terms of probabilities of detection and false alarm, and selection of detection threshold and number of samples. The simulations have shown that Bayesian detector has a performance similar to the energy detector in low SNR regime, but has better performance in high SNR regime in terms of spectrum utilization and secondary users' throughput.

Key Words: Cognitive radio; Bayesian Detector; Signal to noise ratio; Throughput

INTRODUCTION

It is generally understood that sure forms of spectrum users have significant variability in their spectrum use and far of their allocated spectrum is under-utilized throughout non-peak periods [1]. In [2], it reports that the temporal and geographical variations in the utilization of the appointed spectrum vary from 15 august 1945 to 85th. The activity ends up in [3] suggest that most of the allocated frequencies (ranging from 80MHz to 5850 MHz) square measure heavily underutilized except for the frequency bands allocated for broadcasting and cell phones. The similar observation in [4] also shows that there's a high likelihood that the first users square measure doubtless idle for most of the time. Using psychological feature radios (CRs), the secondary users (SUs) square measure allowed to use the spectrum originally allocated to primary users (PUs) as long as the primary users don't seem to be Victimization it temporarily [5,6]. This operation is called timeserving spectrum access (OSA). We tend to develop the analysis to figure detection and warning chances and give the expressions for the detection threshold and the variety of samples needed for sensing. In our earlier work [24], as a special case, we've got proposed associate degree optimum detector for digital primary signals (BPSK modulated signals) over AWGN channels, and given the analytic results for each low and high SNR regimes. we tend to found that for BPSK signals, the optimum notice or is associate degree energy detector in low SNR regime however employs add of received signal amplitude to detect primary signals rather than associate degree energy detector in high SNR regime. The simulation shows that the proposed Bayesian detector contains a higher performance in terms of spectrum utilization and secondary users' throughput Many detection methods, for example, energy detector[7–9], covariance based detector [11, 12], cyclo stationarity based detector [15–17], matched filter based detector [20] and wavelet-based sensing method [13], have been proposed and studied extensively [14, 18]. Energy detector and covariance based detector assume that the primary signals are random. Cyclo stationarity based detection exploits the cyclostationarity features of the primary signals, however, it does not make full use of the characteristics of the modulated signals. Matched filter based detection requires the complete knowledge of the primary signals, which makes it infeasible for practical applications. In this paper, we propose a Bayesian detector (BD) for digitally modulated primary signals to maximize the spectrum utilization, without the prior information on the transmitted sequence of the primary signals. The proposed method makes use of the prior statistics of PU activity and the signaling information of the PU such as symbol rate and modulation order to improve the SU throughput and the overall spectrum utilization of both PUs and SUs. It is shown that the Bayesian detector has the exact same structure as Ney man-Pearson detector [19], but the design principle of Ney man-Pearson detector is to maximize the detection probability for a given maximal false alarm probability, which results in the difference in detection threshold selection for the two schemes.

The Approach implemented to detect M-QAM signals (e.g. DVB-T signals). Taking into consideration the fact that spectrum utilization of allocated spectrum could be very low, we determine the detection threshold based on the unequal probabilities of the two hypotheses. This detector is a likelihood ratio test (LRT) detector which can be approximated.

IMPLIMENTATION

In this paper we have referred the mathematical model of Shoukang Zheng. In spectrum sensing, there are two hypotheses: H_0 for the hypothesis that the PU is absent and H_1 for the hypothesis that the PU is present. There are two important design parameters for spectrum sensing: probability of detection (P_D), which is the probability that SU accurately detects the presence of active primary signals, and probability of false alarm (P_F), which is the probability that SU falsely detects primary signals when PU is in fact absent. We define spectrum utilization as

$P(H_0)(1 – P_F)+P(H_1)P_D$

And normalized SU throughput as

$P(H_0)(1 – P_F)$ Respectively.

Note that $P(H_1)P_D$ is PU throughput when there are primary signals and the SUs detect the presence of the of the primary signals. To determine whether the spectrum is being used by the primary user, the detection statistic TD is compared with a predetermined threshold ϵ. Probability of false alarm PF is the probability that the hypothesis test chooses H_1 while it is in fact H_0: $P_F = P(TD > \epsilon| H_0)$. Probability of detection P_D is the probability that the rest correctly decides H_0 when it is H_1: $P_F = P(TD > \epsilon| H_1)$. To determine whether the spectrum is being used by the primary user, the detection statistic TD is compared with a predetermined threshold ϵ. Probability of false alarm PF is the probability that the hypothesis test chooses H_1 while it is in fact H_0: $P_F = P(TD > \epsilon| H_0)$. Probability of detection P_D is the probability that the rest correctly decides H_0 when it is H_1: $P_F = P(TD > \epsilon| H_1)$.

For M-QAM modulated primary signals, the received signal of k-th symbolat the CR detector, $r(k)$, is:

$$r(k) = \begin{cases} n(k) & , H_0 \\ P_{\frac{c}{i}}\, px(i) + n(k), & H_1 \end{cases}$$

where $n(k) = n_c(k)+jn_s(k)$ is a complex AWGN signal with variance $N0$, $n_c(k)$ and $n_s(k)$ are respectively the real and imaginary part of $n(k)$, i= 0, 1, $\cdot\ \cdot\ \cdot, M - 1$

BAYESIAN DETECTOR (ABD) STRUCTURE THROUGH THE APPROXIMATIONS IN THE LOW AND HIGH SNR REGIMES:

We give the theoretical analysis (detection performance and threshold) for the suboptimal detector to detect complex M--QAM (M = 4 and M > 4) in low SNR regime and compare with the results for real MPSK primary signals.

A .APPROXIMATION IN THE LOW SNR REGIME:

We study the approximation of our proposed detector for M-QAM modulated primary signals in the low SNR regime

$$\sum_{k=0}^{N-1} ln\left(\sum_{n=0}^{\frac{M}{2}-1} \cosh\left(v_n(k)\right)\right)$$

Through approximation, the detector structure becomes:

$$T_{L-ABD-1} = \frac{1}{N}\sum_{k=0}^{N-1}|r(k)|^2 \gtrless \frac{N_0}{\gamma}\left(\gamma + \frac{\ln \epsilon}{N}\right)$$

Above detector uses the real part of the received signal as input and has the same structure as the suboptimal detector for MPSK signals.

B. APPROXIMATION IN THE HIGH SNR REGIME

We consider the high SNR regime in this section.

$$\text{When } x \gg 0, cosh(x) \approx \frac{e^{x}}{2} \text{ or when } x \ll 0, cosh(x) \approx \frac{e^{-x}}{2}$$

The detector structure becomes

$$T_{H-ABD} = \sum_{k=0}^{N-1} \left(ln \left(\sum_{n=0}^{M/2-1} e^{\frac{2}{N_0}\Re[r(k)h^* e^{-j\varphi n(k)}]} \right) \right)$$

$$\gtrless \gamma + lnM$$

A special case of M-QAM signals, we assume a real signal model for MPSK modulated primary signals. The suboptimal BD detector employs the sum of received signal magnitudes to detect the presence of primary signals in the high SNR regime, which indicates that energy detector is not optimal in this regime.

1. FALSE ALARM PROBABILITY

The false alarm probability, is

$$P_F = P(T_{L-ABD-1} > \frac{N_0}{2}(\gamma + \frac{\ln\epsilon}{N})|\mathcal{H}0)$$

$$= Q\left(\frac{\frac{N_0}{\gamma}\left(\gamma + \frac{\ln\epsilon}{N}\right) - \mu}{\sigma}\right)$$

$$= Q\left(\frac{\ln\epsilon}{r\sqrt{N}}\right)$$

2. DETECTION PROBABILITY

The detection probability is

$$P_D = P(T_{L-ABD-1} > \frac{N_0}{2}(\gamma + \frac{\ln\epsilon}{N})|\mathcal{H}1)$$

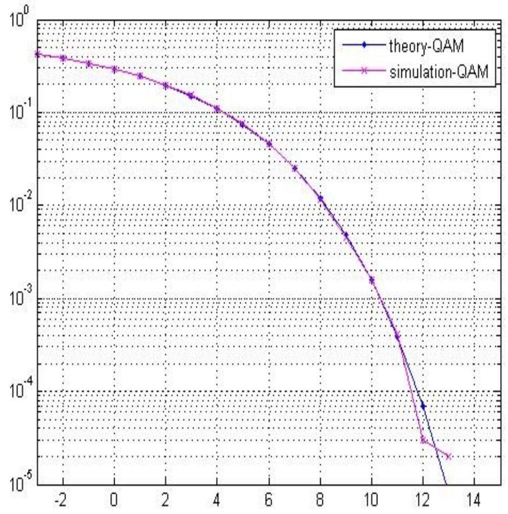
$$= Q\left(\frac{\frac{N_0}{\gamma}\left(\gamma + \frac{\ln\epsilon}{N}\right) - \mu}{\sigma}\right)$$

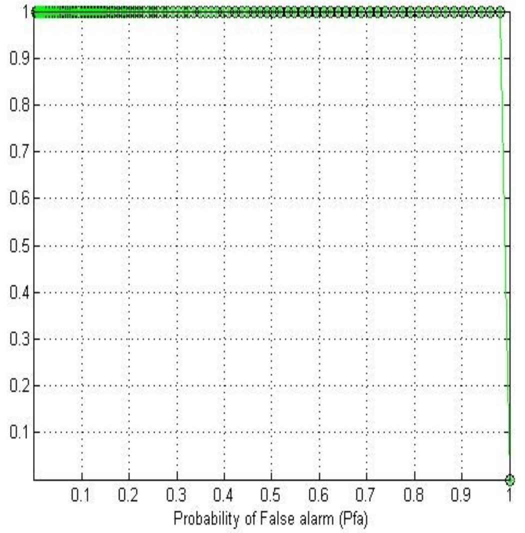
$$= Q\left(\frac{\ln\epsilon - N\gamma^2}{r\sqrt{N(1+2\gamma)}}\right)$$

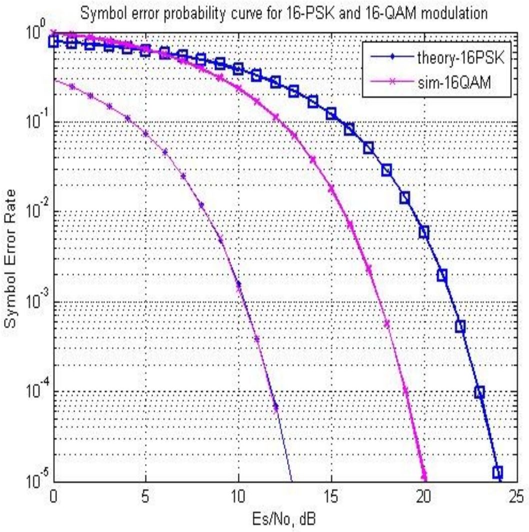
APPLICATIONS

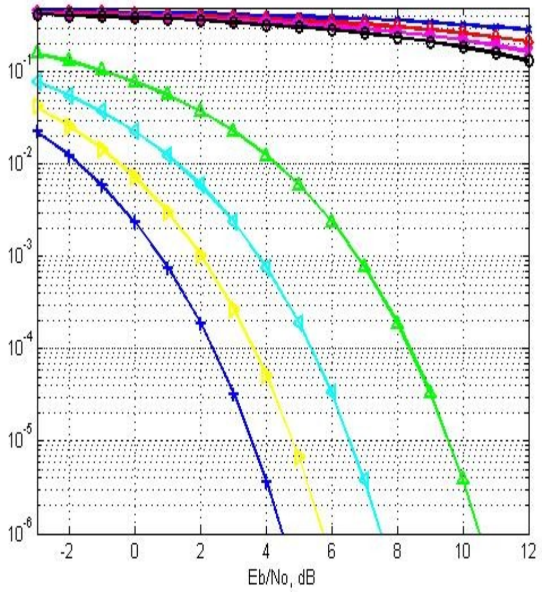
Geo-location and Networking Applications: New capabilities are enabled when a CR knows where it is and where it is going. This information may be obtained through dedicated sensors such as an Inertial Navigation Unit, a GPS receiver, or through relative geo-location techniques built into the waveforms or configuration of an SDR channel to receive and process GPS signals. An inertial navigation unit keeps track of location relative to an initial known location through the use of accelerometers and time. The accuracy of this technique deteriorates in time, but re-synchronization with GPS receivers mitigates this characteristic. Through a combination of Inertial Navigation and GPS, a CR can sense its location with good precision, even indoors. from using the CR. Since a radio is usually used for voice communications, there is a microphone in the system. The captured signal is encoded with a Vo-Coder and transmitted. The source radio can authenticate the user and add the known identity to the data stream.

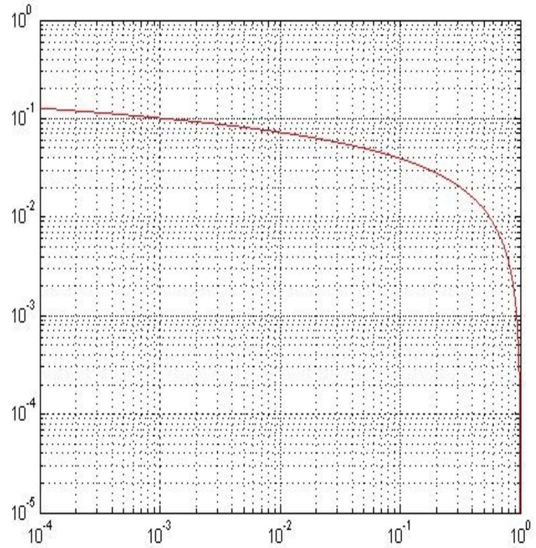
SIMULATION RESULTS:

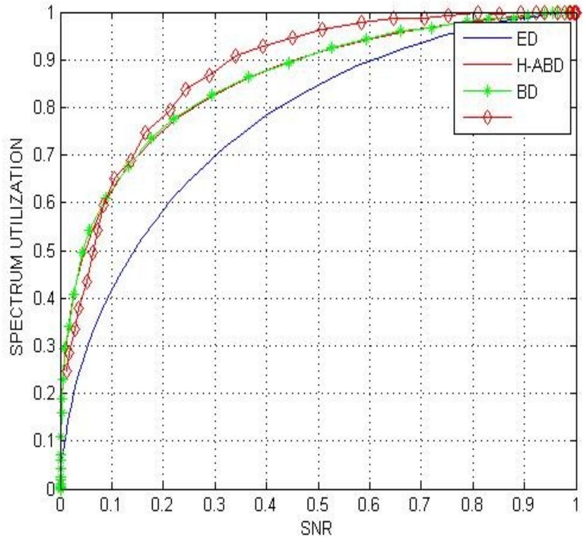


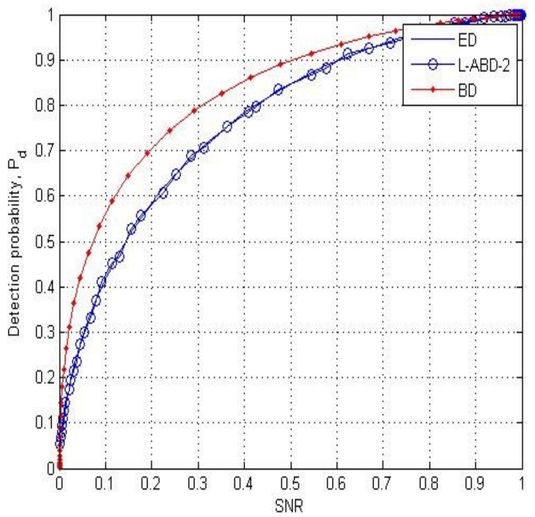


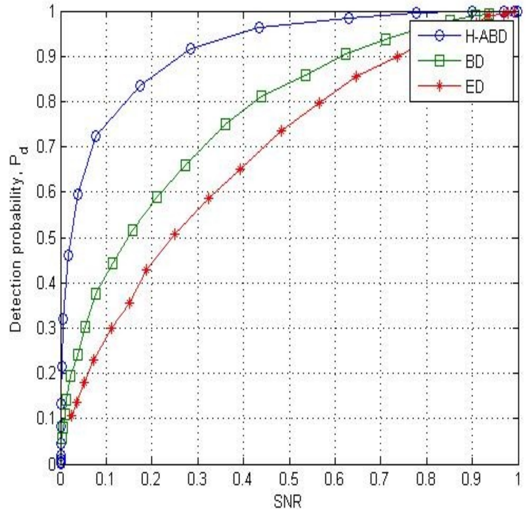


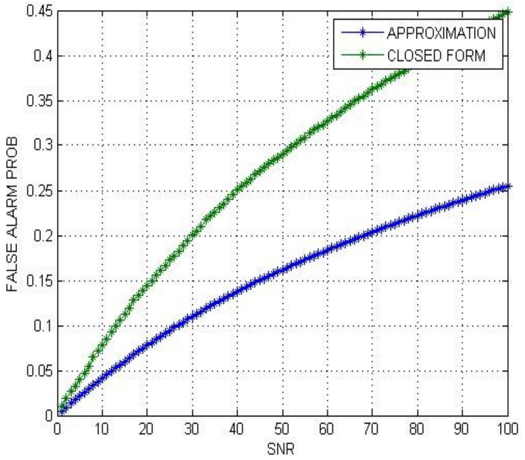












CONCLUSION

The dynamic spectrum access, which is one of the applications of cognitive radio technology, has been observed as a promising solution to the problem of radio spectrum scarcity and underutilization by introducing the opportunistic usage of licensed frequency bands that are not efficiently utilized by licensed owners. Following the general belief that spectrum sensing is the key functionality to enable DSA, this research work focused on issues of spectrum sensing. The thesis discussed merits and demerits of most of the current detection methods or algorithms presented in literature. After a careful, neutral and constructive analysis of most of the current detection methods in literature, it showed that none of the methods can adequately and reliably detect all forms of primary radio signals in a cognitive radio environment.

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BIOGRAPHY

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