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A novel algorithm for sensing the digital signal in cognitive radio: Maximizing the spectrum utilization using the Bayesian approach

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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. We derive the optimal detector structure for MPSK modulated primary signals with known order over AWGN channels and give its corresponding suboptimal detectors in both low and high SNR (Signal-to-Noise Ratio) regimes. Through approximations, it is found that, in low SNR regime, for MPSK (M>2) signals, the suboptimal detector is the energy detector, while for BPSK signals the suboptimal detector is the energy detection on the real part. 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.

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 80 rate to 5850 MHz) square measure heavily under-utilized 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.

BAYESIAN DETECTOR FOR MPSK MODULATED PRIMARY SIGNALS

In spectrum sensing, there are a unit two hypotheses: H0 for the hypothesis that the atomic number 94 is absent and H1 for the hypothesis that the atomic number 94 is gift. There are a unit two necessary design parameters for spectrum sensing: likelihood of detection (PD), that is the likelihood that SU accurately detects the presence of active primary signals, and likelihood of warning (PF), that is the likelihood that SU falsely detects primary signals once atomic number 94 is in truth absent. We tend to define spectrum utilization as

$$P(\mathcal{H}_0)(1-P_F)+P(\mathcal{H}_1)P_D \quad (1)$$

And normalized SU throughput as

$$P(\mathcal{H}_0)(1-P_F) \quad (2)$$

$$P_F = P(T_D > \in | = \mathcal{H}_0 \quad (3)$$

Probability of detection P_D is the probability that the test correctly decides H_1 when it is H_1

$$P_F = P(T_D > \in | = \mathcal{H}_1 \quad (4)$$

A. Channel Model and Detection Statistics

Following the signal model in [9], we tend to contemplate time-slotted primary signals wherever N primary signal samples area unit accustomed discover the existence of atomic number 94 signals. The atomic number 94 symbol length is T that is thought to the SU and therefore the received signal r(t) is sampled at a rate of 1/T at the secondary receiver. For MPSK modulated primary signals, the received signal of k-th symbol at the metal detector, r(k), is:

$$r(k) = \begin{cases} n(k) & \mathcal{H}_0 \\ he^{j\emptyset_n(k)} + n(k) & \mathcal{H}_1 \end{cases} \quad (5)$$

where $n(k) = n_c(k)+j\ n_s(k)$ is a complex AWGN signal with variance N_0, $n_c(k)$ and $n_s(k)$ are severally the real and pure imaginary number of n(k), $\varphi_n(k) = 2n\pi$,n = 0,1,… ,M − one with equiprobability, h is that the propagation channel that's assumed to be constant at intervals the sensing amount. Denote r = [r(0) r(1) ….r(N − 1)]. Assume that the SU receiver has no data with regards to the transmitted signals by the pu and $\varphi_n(k)$,k = 0,1,….,N − one are freelance and identically distributed (i.i.d.) and freelance of the Gaussian noise. The detection statistics of energy detector (ED) may be defined because the average energy of ascertained samples as

$$T_{ED} = \frac{1}{N}\sum_{k=1}^{N}|r(k)|^2 \quad (6)$$

Although energy detector does not need the knowledge of the image rate, we assume that the sample rate is similar to the image rate. It is well-known that the optimal detector for binary hypothesis testing supported bayesian rule or Neyman-Pearson theorem is to figure the likelihood quantitative relation so create its call by comparing the quantitative relation with the threshold [22]. The likelihood quantitative relation take a look at (LRT) of the hypotheses H1 and H0 may be defined as:

$$T_{LRT}(r) = \frac{p(r|\mathcal{H}_1)}{p(r|\mathcal{H}_0)} \qquad (7)$$

Denote $C_{i,j}$ because the price related to the choice that accepts Hi if the state is Hj, for i,j = 0,1. Supported Bayesian call rule [21] to reduce the expected posterior price

$$\sum_{i=0}^{1}\sum_{j=0}^{1} C_{ij}p(\mathcal{H}_j)p(\mathcal{H}_i|\mathcal{H}_j) \qquad (8)$$

it is convenient to derive the optimal detector (BD):

$$T_{LRT}(r)\sum_{\mathcal{H}_0}^{\mathcal{H}_1}\epsilon \qquad (9)$$

Where,

$$\epsilon = \frac{p(\mathcal{H}_0)(C_{10}-C_{00})}{p(\mathcal{H}_1)(C_{01}-C_{11})} \qquad (10)$$

If $C_{00} = C_{11} = 0$ and $C_{01} = C_{10}$, which is a uniform cost assignment (UCA),

$$\varepsilon = \frac{p(\mathcal{H}_0)}{p(\mathcal{H}_1)} \qquad (11)$$

We can consider $C_{01} = C_{10}$ for a more general case. In CR networks, it is likely that $p(H_0) > p(H_1)$ because of spectrum under-utilization. Thus, by (1) and (8), the Bayesian decision rule for an optimal Bayesian detector to minimize the Bayesian risk can be easily reduced to:

$$\max\ p(\mathcal{H}_0)(1-P_F) + P(\mathcal{H}_1)\,P_D \qquad (12)$$

This is equivalent to maximizing the spectrum utilization.

The Neyman-Pearson decision rule is

$$\max P_D(\in) \quad s.t\ P_F(\in) \leq \overline{P_F} \qquad (13)$$

Where P_F is the highest bound of P_F . in keeping with Neyman-Pearson theorem, the structure of the optimal detector (NPD) to maximize the detection chance for a given false alarm chance is the same as the theorem detector, where 9 ought to be thought to be the detection threshold for a given false alarm chance [24]. it's shown that the difference between NPD and BD is a way to determine the detection threshold.

To decide whether or not primary signals square measure gift, we'd like to line a threshold 9 for each take a look at data point, such that bound objective may be achieved. If we tend to do not have prior information on the signals, it's difficult to line the brink supported atomic number 46. a traditional observe is to decide on the brink supported PF underneath hypothesis H_0. For the detector maximizing the spectrum utilization, it's easy to work out the detection threshold through (10) or (11).

$$p(r|\mathcal{H}_0) = \prod_{k=0}^{N-1}\frac{e^{-|r(k)|^2/N_0}}{\pi N_0} \qquad (14)$$

Since the noise signals n(k),k = 0,…. ,N − 1 are independent. The PDF of received signals over N symbol duration under hypothesis H_1 is denoted as $p(r|H_1)$. With equiprobability of $\varphi_n(k) = 2n\pi$,n = 0,1,...,M − 1, and the independence of $\varphi_n(k)$, we can obtain:

$$p(r|\mathcal{H}_1)$$

$$\prod_{k=0}^{N-1}\sum_{\emptyset_n(k)} p(r(k)|\mathcal{H}_1, \emptyset_n(k)p(\emptyset_n(k))$$

$$= \prod_{k=0}^{N-1}\sum_{\emptyset_n(k)}\left(\frac{e^{-\left|r(k)-he^{j\emptyset_n(k)}\right|^2/N_0}}{\pi N_0}\,p(\emptyset_n(k))\right)$$

$$= \prod_{k=0}^{N-1}\sum_{n=0}^{M-1}\frac{e^{-\frac{|r(k)|^2+|h|^2}{N_0}}}{M\pi N_0}\ e^{\frac{2}{N_0}R\left[r(k)h^*e^{-j\emptyset_n(k)}\right]}$$

(15)

Hence, the log-likelihood ratio (LLR), in TLRT (r), is

$$\sum_{k=0}^{N-1} ln \left(\sum_{n=0}^{M-1} e^{\frac{2}{N_0}R\left[r(k)h^{*}e^{-j\emptyset_n(k)}\right]}\right) - \gamma - \ln M$$

(16)

where γ is the SNR of the received signal sample, i.e., γ = |h|2/N_0 .

Let

$$\vartheta_n(k) = \frac{2}{N_0}R\left[r(k)h^{*}e^{-j\emptyset_n(k)}\right] \qquad (17)$$

It is convenient to verify that $v_{n+M/2}(k)$ = $-v_n(k)$ so $\sum_{n=0}^{M-1} e^{\vartheta_n(k)} = 2\sum_{n=0}^{M/2-1}\cosh(\vartheta_n(k))$. From (16), it is easy to derive the structure of the optimal detector (BD) for MPSK signals as:

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

$$\gtrless_{\mathcal{H}_0}^{\mathcal{H}_1} \gamma + \ln\frac{M}{2} + \frac{\ln \in}{N}$$

Although the detector is optimal, it is too complicated to use in practice. In the following, we will simplify the detector when the SNR is very low or very high.

SUBOPTIMAL DETECTOR AND THEORETICAL ANALYSIS

A. Approximation in the Low SNR Regime.

We study the approximation of our proposed detector for MPSK modulated primary signals in the low SNR regime. When x → 0, cosh(x) ≈ 1 + x2 and ln(1 + x) ≈ x, we can obtain:

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

$$\approx \sum_{k=0}^{N-1}\ln\left(\sum_{n=0}^{M/2-1}(1+\frac{1}{2}\vartheta_n^2(k)\right)$$

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

$$\approx \frac{1}{M}\sum_{k=0}^{N-1}\sum_{n=0}^{M/2-1}\vartheta_n^2(k) + N\ln(M/2) \qquad (19)$$

Through approximation, the detector structure becomes:

$$\frac{1}{N}\sum_{k=0}^{N-1}\sum_{n=0}^{\frac{M}{2}-1}\left(R\left[r(k)h^{*}e^{-j\emptyset_n(k)}\right]\right)^2$$

$$\gtrless_{\mathcal{H}_0}^{\mathcal{H}_1} \frac{MN_0^2}{4}\left(\gamma + \frac{\ln\in}{N}\right) \quad (20)$$

Since

$$R\left[r(k)h^{*}e^{-j\emptyset_n(k)}\right] = R[r(k)h^{*}]cos\ \emptyset_n(k)$$

$$-\beth[r(k)h^{*}]\sin\phi_n(k)$$

And

$$\sum_{n=0}^{M/2-1} cos^2\left(\left(\phi_n(k)\right)\right) = \begin{cases}1 & M=2\\ M/4 & M>2\end{cases}$$

$$\sum_{n=0}^{M/2-1} sin^2\left(\left(\phi_n(k)\right)\right) = \begin{cases}1 & M=2\\ M/4 & M>2\end{cases}$$

$$\sum_{n=0}^{M/2-1} sin^2\left(\left(\phi_n(k)\right)\right) = 0$$

We obtain

$$\sum_{n=0}^{M/2-1}\left(R\left[r(k)h^{*}e^{-j\emptyset_n(k)}\right]\right)^2$$

$$= \begin{cases}[R[r(k)]h^{*}]^2 & M=2\\ \frac{M}{4}|r(k)]h^{*}|^2 & M>2\end{cases}$$

Obviously, the proposed detector (20)

(L-ABD-1) is an energy detector in the low SNR regime for MPSK sigals ($M > 2$). The detector can be normalized to

$$T_{L-ABD-1} = \frac{1}{N}\sum_{k=0}^{N-1}|r(k)|^2 \gtrless_{\mathcal{H}_0}^{\mathcal{H}_1} \frac{N_0}{\gamma}(\gamma + \frac{\ln\epsilon}{N}) \quad (21)$$

When the signal is BPSK, the detector (20) is equivalent to

$$T_{L-ABD-1} = \frac{1}{N|h|^2}\sum_{k=0}^{N-1}(R[r(k)h^*])^2 \gtrless_{\mathcal{H}_0}^{\mathcal{H}_1} \frac{N_0}{\gamma}(\gamma + \frac{\ln\epsilon}{N}) \quad (22)$$

This detector has the same structure as the suboptimal detector for BPSK signals and real noise in [24], though here it uses the real part of the received signals as the input. To achieve a better approximation, we can use higher order approximation for the suboptimal detector structure. Since x → 0, cosh(x) ≈ 1+ $x^2/2! + x^4/4!$ and ln(1+x) ≈ x− x/2 + x/3 ,

Let $$u_n(k) = \frac{1}{M}\sum_{n=0}^{M/2-1}\left[u_n^2(k) + \frac{1}{12}u_n^4(k)\right] \quad (23)$$

We obtain

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

$$\approx \sum_{k=0}^{N-1}\left[u_n(k) - \frac{u_n^2(k)}{2} + \frac{u_n^3(k)}{2} + \ln(M/2)\right] \quad (24)$$

Thus, with the above approximation, the detector structure (L-ABD-2) is:

$$T_{L-ABD-2} = \frac{1}{N}\sum_{k=0}^{N-1}\left[u_n(k) - \frac{u_n^2(k)}{2} + \frac{u_n^3(k)}{2}\right]$$

$$\gtrless_{\mathcal{H}_0}^{\mathcal{H}_1} \gamma + \frac{\ln\epsilon}{N} \quad (25)$$

B. Approximation in the High SNR Regime

We consider the high SNR regime in this section. When x ≫ 0, cosh(x) ≈ $e^x/2$, or when x < 0, cosh(x) ≈ $e^{-x}/2$. In other words, when |x| ≫ 0, cosh(x) ≈ e|x| . Therefore,

$$\sum_{k=0}^{N-1}\ln\left(\sum_{n=0}^{M/2-1}\cosh(\vartheta_n(k))\right) \approx \sum_{k=0}^{N-1}\ln\left(\sum_{n=0}^{M/2-1}\frac{e^{|\vartheta_n(k)|}}{2}\right) \quad (26)$$

From (18), through approximation in the high SNR regime, the detector structure (H-ABD) becomes[2]

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

$$\gtrless_{\mathcal{H}_0}^{\mathcal{H}_1} \gamma + \ln M + \frac{\ln\epsilon}{N} \quad (27)$$

In [24], as a special case of MPSK signals, we have a tendency to assume a real signal model for BPSK modulated primary signals. The suboptimal Bachelor of Divinity sight or employs the total of received signal magnitudes to detect the presence of primary signals in the high SNR regime, which indicates that energy detector isn't optimal in this regime. The same as the derivation in [24], supported (27) we are able to derive the suboptimal detector as shown in (28), which additionally uses the total of the important part of the received signal magnitudes to sight primary signals.

The detector H-ABD is as follows: When the signal is BPSK, the detector (20) is admire

$$T_{H-ABD} = \frac{1}{N}\sum_{k=0}^{N-1}|R[r(k)]h^*| \gtrless_{\mathcal{H}_0}^{\mathcal{H}_1} \frac{N_0}{2}(\gamma + \ln 2 + \frac{\ln\epsilon}{N}) \quad (28)$$

C. Detection Performance

We provide the detection performance in terms of metallic element and PF for L-ABD-1 during this section. As we have mentioned above, the detector for complicated MPSK signals (M > 2) is that the energy detection, while the detector for BPSK signals is that the real part energy detection. suppositious analysis for such energy detections may be found in [10,24].

1) complicated MPSK Signals (M > 2): below H0, the mean and variance of $T_{L-ABD-1}$ ar as follows [10]:

$$\mu = N_0, \sigma^2 = \frac{N_0^2}{N} \quad (29)$$

On the other hand, under $H1$, the mean and variance of $T_{L-ABD-1}$ are as follows [10]:

$$\mu = (1+\gamma)N_0, \sigma^2 = \frac{1}{N}(1+2\gamma)N_0^2 \quad (30)$$

Thus, the detection probability is:

$$P_D = P(T_{L-ABD-1} > \frac{N_0}{\gamma}\left(\gamma + \frac{\ln \epsilon}{N}\right)|\mathcal{H}_0|)$$

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

$$= Q(\frac{\ln \epsilon - N\gamma^2}{\gamma\sqrt{N(1+2\gamma)}}) \quad (31)$$

Where

$$Q(t) = \frac{1}{\sqrt{2\pi}}\int_t^{\propto} e^{-\frac{u^2}{2}} du$$

and the false alarm probability is:

$$P_D = P(T_{L-ABD-1} > \frac{N_0}{\gamma}\left(\gamma + \frac{\ln \epsilon}{N}\right)|\mathcal{H}_1|)$$

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

$$= Q(\frac{\ln \epsilon}{\gamma\sqrt{N}}) \quad (32)$$

2) BPSK Signals: Under H_0, $\frac{\Re[r(k)h*]}{|h|} = \frac{\Re[n(k)h*]}{|h|}$. It is easy to verify that $\frac{\Re[n(k)h*]}{|h|}$ is Gaussian distributed with mean 0 and variance $N_0/2$. Thus the mean and variance of $T_{L-ABD-1}$ are as follows [10]:

$$\mu = {N_0}/{2}, \sigma^2 = \frac{N_0^2}{2N} \quad (33)$$

On the other hand, Under H_1, $\frac{\Re[r(k)h*]}{|h|} = \frac{\Re[n(k)h*]}{|h|}$. It is easy to verify that $|h|e^{j\emptyset_n(k)} + \frac{\Re[n(k)h*]}{|h|}$ is Gaussian distributed with mean 0 and variance $N_0/2$. Thus the mean and variance of $T_{L-ABD-1}$ are as follows [10]:

$$\mu = \left({1}/{2} + \gamma\right)N_0, \sigma^2 = \frac{1}{2N}(1+4\gamma)N_0^2 \quad (34)$$

Thus, the detection probability is

$$P_D = P(T_{L-ABD-1} > \frac{N_0}{2\gamma}\left(\gamma + \frac{\ln \epsilon}{N}\right)|\mathcal{H}_1|)$$

$$= Q(\frac{\frac{N_0}{2\gamma}\left(\gamma + \frac{\ln \epsilon}{N}\right) - \mu}{\sigma})$$

$$= Q(\frac{\ln \epsilon - 2N\gamma^2}{\gamma\sqrt{N(2+8\gamma)}}) \quad (35)$$

And the false alarm probability is

$$P_D = P(T_{L-ABD-1} > \frac{N_0}{2\gamma}\left(\gamma + \frac{\ln \epsilon}{N}\right)|\mathcal{H}_0|)$$

$$= Q(\frac{\frac{N_0}{2\gamma}\left(\gamma + \frac{\ln \epsilon}{N}\right) - \mu}{\sigma}) = Q(\frac{\ln \epsilon}{\gamma\sqrt{2N}}) \quad (36)$$

3) Real BPSK Signals and Real Noises: If the signal is BPSK and the noise is real, according to [9, Eq. (4)], we can compute probability of false alarm as:

$$P_F = \frac{\Gamma({N}/{2}, \frac{N\gamma + \ln \epsilon}{2\gamma})}{\Gamma({N}/{2})} \quad (37)$$

$$P_D = Q_{N/2}(\sqrt{2N\gamma}, \sqrt{\frac{N\gamma + \ln \epsilon}{\gamma}}) \quad (38)$$

Where $Q_{N/2}(\bullet, \bullet)$ is the generalized Marcum Q-function and can be computed with the geometric approach [23]. An alternative form for PD is also shown in [24, Eq. (23)], which is the same as (35).

D. Detection Threshold and Number of Samples

In our proposed Bayesian detector for MPSK modulated primary signals over AWGN channels in the low SNR regime, using (29)-(30), we have

$$\epsilon = \begin{cases} \exp\left(\gamma\sqrt{N}\ Q^{-1}(P_F)\right), & M > 2 \\ \exp\left(\gamma\sqrt{2N}\ Q^{-1}(P_F)\right) & M = 2 \end{cases} \quad (39)$$

for a given P_F , or

$$\epsilon = \begin{cases} \exp\left(\gamma\sqrt{N(1+2\gamma)}\ Q^{-1}(P_D) + N\gamma^2\right), & M > 2 \\ \exp\left(\gamma\sqrt{N(2+8\gamma)}\ \ Q^{-1}(P_D) + 2N\gamma^2\right) & M = 2 \end{cases}$$
(40)

for a given P_D. For the given design parameters P_F and P_D, we can obtain the number of samples N as follows:

$$N = \begin{cases} \left[\frac{Q^{-1}(P_F) - \sqrt{1+2\gamma}\ Q^{-1}(P_D)}{\gamma}\right]^2 & M > 2 \\ \left[\frac{Q^{-1}(P_F) - \sqrt{1+4\gamma}\ Q^{-1}(P_D)}{\gamma}\right]^2 & M = 2 \end{cases} \qquad (41)$$

Notice that when M = 2, the above is the same as [24, Eq. (36)]. Equation (41) is also the minimum number of samples for NPD. When |x| is large, we can approximate Q(x) function with the following upper and lower bounds

$$\sum_{k=1}^{l+1} a_k\, e^{-b_k x^2} < \ Q(x) < \frac{1}{2} e^{-\frac{1}{2}x^2}, x > 0$$
(42)

where ak and bk are constant coefficients that are independent of x^3. The left inequality is by [25, Eq. (5)], and the right inequality is based on Chernoff bound. Alternatively, the upper and lower bounds of Q(x) can be shown as follows4

$$\frac{x}{1+x^2}\frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}x^2} < Q(x) < \frac{1}{x}\frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}x^2}, x > 0$$
(43)

From (39) and the upper bound of (43), we can obtain

$$P_F \approx \frac{1}{x}\frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}x^2} \qquad (44)$$

Where x>0 and

$$x = \begin{cases} \frac{\ln\epsilon}{\gamma\sqrt{N}} & M > 2 \\ \frac{\ln\epsilon}{\gamma\sqrt{2N}} & M = 2 \end{cases} \qquad (45)$$

Similarly, from (40) and the lower bound of (43), we can obtain

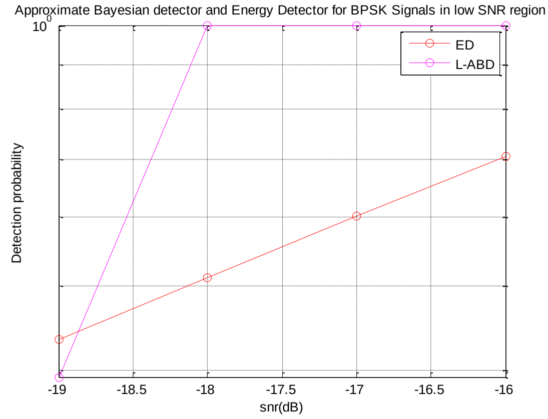
$$P_D \approx 1 + \frac{x}{1+x^2}\frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}x^2} \qquad (46)$$

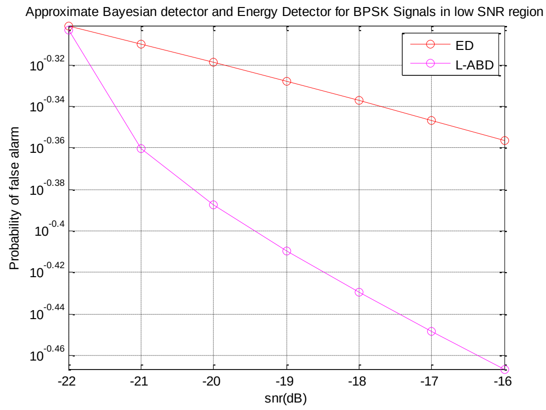
Where x< 0 and

$$x = \begin{cases} \frac{\ln\epsilon - N\gamma^2}{\gamma\sqrt{N(1+2\gamma)}}, & M > 2 \\ \frac{\ln\epsilon - 2N\gamma^2}{\gamma\sqrt{N(2+8\gamma)}} & M = 2 \end{cases} \qquad (47)$$

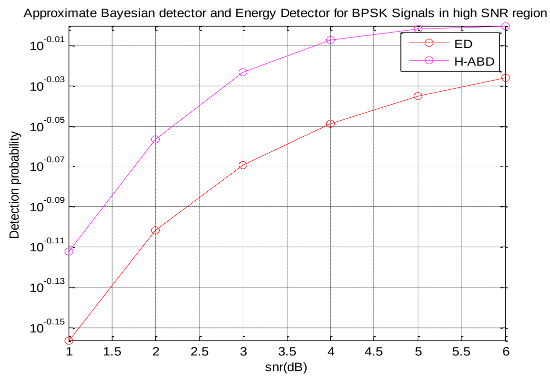
SIMULATION RESULTS:

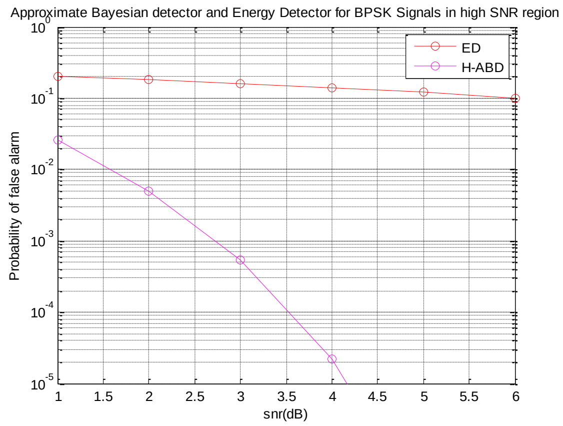
LOW SNR

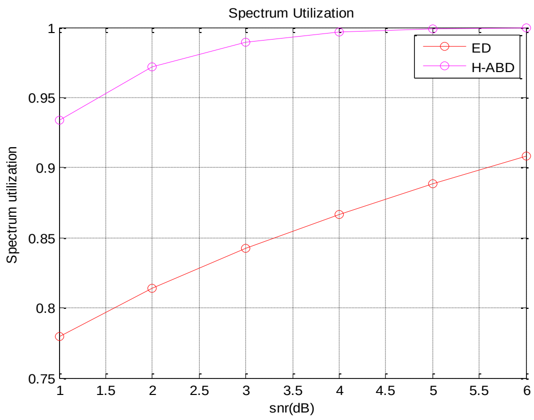


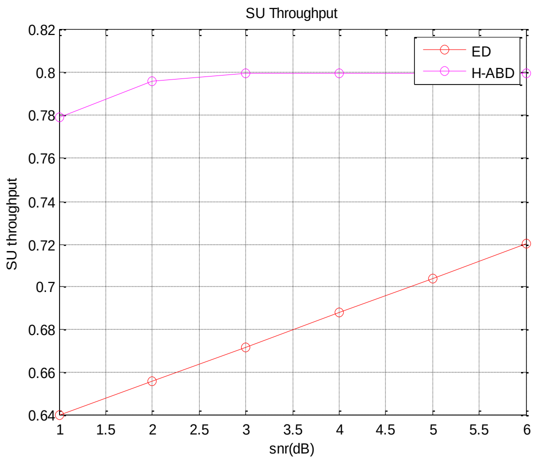


High SNR









CONCLUSION

In our proposed framework to achieve the higher spectrum utilization we propose an optical Bayesian detector for spectrum sensing to achieve higher spectrum utilization in cognitive radio networks. We derive the optimal detector structure for MPSK modulated primary signals with known order over AWGN channels and give its corresponding suboptimal detectors in both low and high SNR (Signal-to-Noise Ratio) regimes.

The proposed paper evaluates the performance which is alike to the energy detector is based on the Bayesian detector.. But they are different in high SNR regime, where Bayesian detector has a better performance in terms of spectrum utilization and secondary users' throughput. The simulation results confirm that energy detector is not optimal in high SNR regime. It is also observed that due to the chosen detection threshold, probability of false alarm. The Bayesian detector is strictly designed to increase the spectrum analysis performance

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