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Spectrum Sensing based on Average Information for a Cognitive Radio Network

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ABSTRACT:-

In communications due to presence of bandwidth there is need of using power resources spectrum. so, In this are paper we proposed a spectrum sensing technique which is based on the QAM/PSK. Here we determine the threshold to calculate whether the user is present or absent. So when the primary user is not present threshold is calculated for H0. And when the user is present the entropy for H1 is less than the threshold. For spectrum sensing here we considered probability detection method.

Keywords—Spectrum,QAM,Threshold,Entropy

Introduction

Wireless communications technology has a rapid growth in the past few years .so, that leads to a fastest growth in various wireless systems.Anyway, this speed growth in wireless communications and applications had only limited by bandwidth .In olden days , there is fixed spectrum,where frequency bands are assigned only to the licensed users.While going through the research the task Force reported that radio channels occupied 15% of the time. As we already said that there is limitation in spectrum band the limitation occurs due to the insufficient allocation of bandwidth techniques.Considering all these points spectrum resources has led reg the development, called cognitive radio (CR) networks where we can allocate sufficient space.

The cognitive radio senses/identify the vacant spectrum and also uses the available resource.space.Not only that but also in CR technology,secondary users are allowed to share their with spectrum primary users. so, the frequency bands which are legally assigned to primary users take an advantage by secondary users when primary users do nothing. But primary users can occupy their assigned bands whenever needed because they have that right. As a result, secondary users have to be aware of some variations and also it must adjust to some operating parameters to make a fruitful utilization of the spectrum.

Controlling of secondary users in CR networks is done by the condition of providing enough protection to primary users in CR network.For this reason , we need to recruit efficient spectrum sensing techniques for secondary users then make sure the quality of utility for primary users and use all dynamic spectrum sharing chances.In order to make ease of dynamic spectrum entrance in licensed bands, constructive spectrum sensing algorithum are needed to be developed where the high solidity along with the efficient utilization of the spectrum is achieved.

The approaches that we commonly considered in CR applications for spectrum sensing are energy detection, cyclostationarity feature detection, and coherent detection. These approaches are used based on the prior knowledge and also the parameters we want to know ,for different methods different parameters can be known .For example, if the theoretical information of the primary user signal is known to the secondary users the coherent detection is used. In coherent detection uses attributes such as synchronization messages, pilots, prelude, and spectrum spreading order. After knowing these designs at the CR network, then the sensing operation is performed by correlating the arriving signal with the familiar patterns.When we use pilot detection it was implemented experimentally for coherent detection. Yet energy detection approach is used when the CRs network contain limited information..Low complexity is involved in energy detection approach ,this another reason using energy detection in spectrum sensing applications. Still, the production of energy detection in terms of the ability to detect primary signals is degraded, especially in low signal-to- noise ratio (SNR) conditions.

To detect the primary user there exist a wide range of detection techniques. Some of them are Energy Detection(ED) which we discussed above ,Cyclostationary Feature Detection (CFD)on exploiting its features on the received signal on can find the presence or absence of primary user , the Matched Filter it is acquired by correlating the signal which is delayed , Detection Based on Eigenvalues (EBD) and Covariance Based Detection (CBD) .Where as in Cyclostationary feature is strong to noise riskness ,even It show better performance than the Energy Detection(ED),because in cyclostationary process it deals with the features of the received signal. In these we can find spectral correlation and spectral statistics ,basically the cannot be found in any other interference signals. By make use of precision in the received signal of primary user primary user is identified by the CFD. In low Signal to noise ratio it works better, but it is has more computational difficulty and prolonged sensing time makes it not much common than ED. After that the Matched filter it is used in SNR given input signal to maximize . This approach is mainly applicable when the prior knowledge is known by the secondary user knowledge means characteristics like data rate, carrier frequency signal. It is almost similar to correlation. Just like thein correlation the detector requires the prior knowledge of primary signal, Matched filter performs poorly if the information presented is not accurate . This detector involves demodulation of the received signal in order to obtained the prior knowledge of the signal.One more approach is Eigenvalue detection in this approach it identifies the presence or absence of users by comparing.Comparision is done between the ratio of maximum to minimum eigenvalue of the covariance matrix with the threshold value. When compared to other detectors its advantage is ,prior knowledge of primary user is not required in this approach. But it is a very difficult process that is the disadvantage for this .As we observed from above approaches theres atleast one drawback foe each so,to get the better of from above problems a new sensing method called Spectrum Sensing based on average information is proposed.

LITERATURE SURVEY

[1].R. Tandra and A. Sahai: From this source we gathered th basic idea is to determine whether the frequency band is available or not. And also derived the fundamental leaps on detecting the performance in low SNR in the presence of noise unpredictability-here the noise is supposed to be AWGN. For better examination, we put the centre of attention on various modulations like BPSK- modulated random data without any pilot tones or training sequences. As long as no settled variable is present, the results ae generalized.Precisely, we prove there is a specific value of SNR below which probability of detection is not possible.

[2].Prieto, Angel G. Andrade, Daniela M. Martinez, and Guillermo Gavaviz : : In this paper, the evaluation of a spectrum sensing strategy based on the frequency domain entropy applied to cognitive radio networks is presented. Entropy estimation is performed using Bartlett periodogram. A tradeoff between variance and the spectral resolution for Bartlett periodogram is presented. This tradeoff affects the probability of detection and false alarm of the spectrum sensing strategy in environments with low signal- to-noise ratio and noise uncertainty. The Entropy detector is optimal when the product of the number of segments and the number of points used is equal to the number of available samples of the received signal[4].

[3]Y. L. Zhang, Q. Y. Zhang, and T. Melodia: Sensitivity to noise uncertainty is a fundamental limitation of current spectrum sensing strategies in cognitive radio networks (CRN). Because of noise uncertainty, the performance of traditional detectors such as matched filters,energy detectors, and even cyclostationarity detectors deteriorates rapidly at low Signal-to-Noise Ratios (SNR).
To counteract noise uncertainty, a new entropy-based spectrum sensing scheme is introduced in this letter. The entropy of the sensed signal is estimated in the frequency domain with a probability space partitioned into fixed dimensions.It is proven that the proposed scheme is robust against noise uncertainity.simulation results confirm the robustness of the propsed scheme and show 6 dB and 5 Db improvement compared with energy detectors and cyclostationary detectors,respectively. in addition,the sample size is significantly reduced compared to an energy detectors[4].

N. Zhao: Spectrum sensing is a key problem in cognitive radio. However, traditional detectors become ineffective when noise uncertainty is severe. It is shown that the entropy of Gauss white noise is constant in the frequency domain, and a robust detector based on the entropy of spectrum amplitude was proposed. In this paper a novel detector is proposed based on the entropy of spectrum power density, and its performance is better than the previous scheme with less computational complexity. Furthermore, to improve the reliability of the detection, a two stage entropy-based cooperative spectrum sensing scheme using two-bit decision is proposed, and simulation results show its superior performance with relatively low computational complexity[4].

B.Suseela, Dr.D.Sivakumar: The limited available spectrum and the inefficiency in the spectrum usage necessitate a new communication technology, referred to as cognitive radio (CR) networks. The important functionality of Cognitive Radio (CR) is spectrum sensing in which accuracy and speed of estimation prove to be the key indicators to select the appropriate spectrum sensing technique. Spectrum sensing helps to detect the spectrum holes providing high spectral resolution capability. It is one of the most challenging issues in cognitive radio systems. In this paper, a survey of spectrum sensing methodologies for cognitive radio is presented. Various aspects of spectrum sensing problem are studied from a cognitive radio perspective. The Wavelet Edge Detection is one of the most widely used Spectrum Sensing techniques. This technique observes the spatial distribution of spectral data at multiple resolutions [3].

EXISTING MODEL

Spectrum sensing can be given in terms of a binary hypothesis test equations. The hypotheses whichundergoes the test are:

$H0 : x(n) = \omega(n)$ (1)from[1]

$H1 : x(n) = s(n) + \omega(n)$ (2)from[1]

n = 0, 1…. N-1.

H0 and H1 is for inactive and busy frequency band respectively. In (1) and (2),x(n) denotes the received signal, s(n) denotes the modulated signal, and

ω (n) denotes the noise samples respectively.

Shannon's entropy, denoted by H, is a measure of the uncertainty present in the random variable. It can bequantified by the following equation[1]:

$$H(X) = -\sum_{i=1}^{L} \frac{n_i}{N} \log ni/N \qquad (3)\text{from}^{[5]}$$

$$\lambda = H_L + Q\text{-}1\ (1 - P_{fa})\ \sigma_n \qquad (4)\text{from}^{[5]}$$

Here ,

$$H_L = \ln(2^{-1/2} L) + 2^{-1}\gamma + 1 \qquad (5)\text{from}^{[5]}$$

λ – Threshold[5]

P_{fa} - Probability of false alarm[5]

γ - Euler-Mascheroni constant[1]

Q-1 - Inverse Q function[1]

σn - Standard deviation[1]

L

For H0 and H1 the entropy is calculated individually.from eq(4) from [5] we can calculate the threshold and the probability of detection is plotted against different values oof SNR.For EnBd,the detection plan isas:

H0-User is absent H1- User is present

In old spectrum sensing techniques the presentation , from the amplitude spectrum the entropy is calculated and the result is powerful to noise uncertainty. In addition using histogram the entropy is calculated.So here the threshold is calculated using the equation (4) from [5] and then comparing H1and H0 with threshold ,after that the graph of probability of detection is plotted

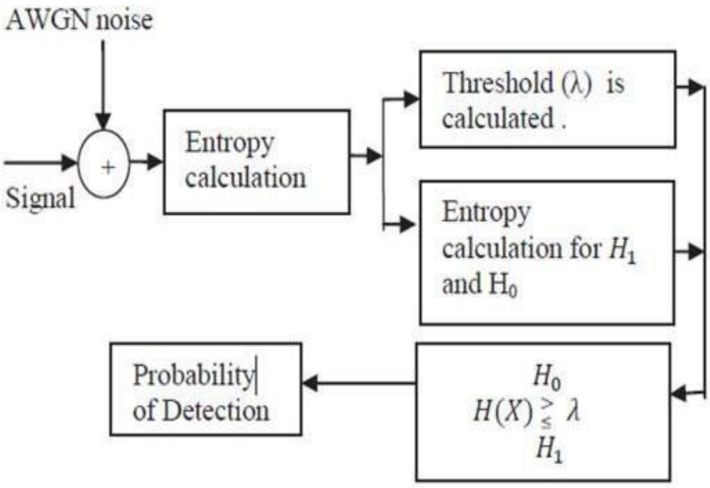


Fig1: Block diagram of the existing method.

Initially, a discrete signal of length 32 is generated in a random manner for H1 and all 32 zeros for H0 hypotheses. This discrete signal is mapped to BPSK and passed through an additive white Gaussian noise channel.entropy is calculated for this discrete signal by using eq(3) from [10]The presence or absence of the user can be obtained by comparing the threshold.and at last we can plot the detection probability curve[1].

- Random discrete data of length/load N=32 is generated.
- The data is mapped to Binary Phase Shift Keying(BPSK).
- The no. of samples in each bin using histogram function in MATLAB is calculated.The average information of 32 bit is calculated using the equation below:

$$H(X) = -\sum_{i=1}^{L} \frac{n_i}{N} \log_2 ni/N$$

Where L=16

- Entropy for H0 and H1 is obtained using equation (3) from [10].
- A threshold is evaluated from eq (6)from [10].
- Detection probability is obtained by differentiating/comparing threshold λ with the entropy of H1and H0.
- If the entropy of H1 is less than the threshold value λ,then the presence of primary user is identified'
- If the entropy of H0 is greater than the threshold value λ,then the absence of primary user isidentified.
- By this way, probability of detection is calculated and the same above procedure is repeated forvarious loads and values.
- Detection probability plot is simulated for different values of SNR.
- Resolution and variance is calculated in the below eq (7) and (8) from [10].
- Resolution =0.89 (k*2π)/N (7) from [1]
- Variance = $\frac{1}{k} P^2_{XX}(f)$ (8) from [1]

  Where P^2_{XX} is a periodogram

- Ratio of variance and resolution (RVR) is determined and the graph is plotted for the ratioand entropy values of H0 and H1 using the eq(3) from [10]

DISADVANTAGES

- For this, the expectation/probability of detection is very low.
- High complexity.
- Low Precision/accuracy**.**

PROPOSED MODEL

In proposed method, by using the modulation techniques like QAM/PSK the entropy is calculated. The probability of detection can be measured by comparing the entropy's H0 and H1 with the calculated threshold. The absence or presence of primary user can be obtained by this threshold. By spectrum sensing we can calculate the probability of detection.the proposed method can be illustrated bythe block diagram below.

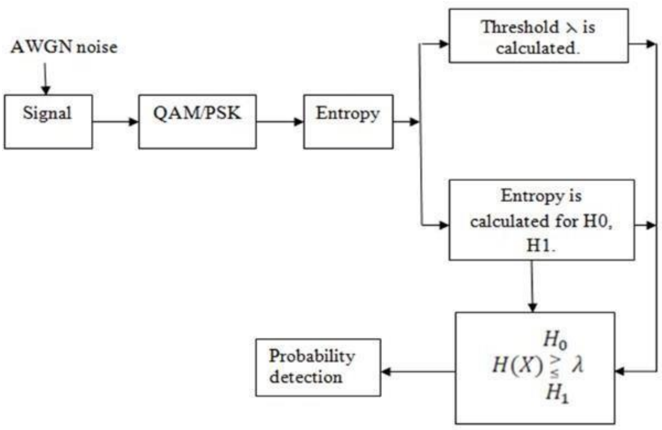


Fig2: Block diagram of the proposed method

Quadrature Amplitude Modulation (QAM):

Quadrature Amplitude Modulation, QAM uses two basic components to provide a modulation that is capable to provide maximum efficiency of spectrum usage . for analog transmissions, QAM is employed for AM stereo transmissions, and is for data applications . Additive White Gaussian Noise blockadds white Gaussian noise to the input signal. QAM Demodulator block demodulates a QAM modulated signal.

For high efficient communication , QAM provide an efficient modulation for data and almost do every single system from digital telephone to WIFI .QAM codes are used for higher spectral efficiency over specific spectrum bandwidths. Quadrature Amplitude Modulation, is a signal in which there are two carriers shifted in phase by 90 degrees i.e.one is sine and the other is cosine undergo modulation. The quadrature nature exists because of phase difference i.e. 90^0 and hence the name. There are 2 signals that are I signal and Q signal,where I signal represent In-phase signal and Q represent Quadrature signal.

Basically,the process of modulation is the thing which the characteristics of the message signal changes according or with the help of the carrier signal. The characteristics that are modified are amplitude
,frequency etc.QAM is vigorously used in various modulation techniques because of the efficient behaviour in bandwidth and frequency. Waves that are modulated were added, and the result is a summation of PSK and ASK.

Various papers and journals studied the a lot of variety of modulation procedures. Information about M-ary
,QAM and the related information of simulation has been obtained. So here we proposed the model which was used to assess the for adaptive modulation in QAM system.

In, a Simulink based simulation system was implemented using Additive White Gaussian Noise channel (AWGN) to study the performance analysis of Bit Error rate (BER) vs. Signal to Noise ratio (SNR). An Orthogonal Frequency Division Multiplexing (OFDM) system design was proposed in simulated using the Simulink. The digital modulation schemes such as M-PSK (M-ary Phase Shift Keying) and M-QAM (M- ary Quadrature Amplitude Modulation), which provide way of parallel transmission, were also compared to analyze the BER performance of designed OFDM system. Different modulation techniques allow transmitting different bits per symbol and thus achieving different throughputs or efficiencies. QAM is a widely used modulation technique as it provides high efficiency in power and bandwidth[2].

Overall output consists of both amplitude and phase differences. By the fact that both I and Q differences exist it can be said that it is the combination of both phase and amplitude modulation schemes.

A motivation for the use of quadrature amplitude modulation comes from the fact that a straight amplitude modulated signal, i.e. double sideband even with a suppressed carrier occupies twice the bandwidth of the modulating signal. This is very wasteful of the available frequency spectrum. QAM restores the balance by placing two independent double sideband suppressed carrier signals in the same spectrum as one ordinary double sideband suppressed carrier signal[7].

The QAM is one of the adaptive modulation techniques that are commonly used for wireless communications. Different order modulations allow sending more bits per symbol and thus achieving higher throughputs or better spectral efficiencies. However, it must also be noted that when using a modulation technique such as 64-QAM, better signal-to-noise ratios (SNRs) are needed to overcome any interference and maintain a certain bit error ratio (BER) [6]. Generally, as the transmission range increases, a step down to lower modulations would be required (e.g. Binary Phase Shift Keying "BPSK"). But, for closer distances higher order modulations like the QAM could be utilized for higher throughput. Additionally, the adaptive modulation techniques allow the communication systems to overcome fading andother interferences[2].

Phase Shift Keying (PSK):

It is the digital modulation technique in which the phase of the carrier signal is changed by varying the sine and cosine inputs at a particular time. PSK technique is widely used for wireless LANs, bio-metric, contactless operations, along with RFID and Bluetooth communications[8].

The term is widely used in a radio network system. Phase shift keying scheme is widely adaptable for data communications.For best results, it is important to gain knowledge of how to use PSK scheme. PSK comes under digital modulation.Carrier signal which is also called as reference signal changes the phase by using this scheme.

The digital data can be represented with any kind of digital modulation method by using a limited number of separate signals. This kind of modulation method uses a limited number of phases where each phase can be assigned with binary digits. Generally, every phase encodes an equivalent number of bits Every bits pattern forms the symbol that is denoted by the exact phase.

PSK, is mostly being used nowadays in radio communications systems,and is apt to the growing area of data communications.Compared to other modulation techniques like frequency shift keying, the phase shift keying enables the data to be carried in a most efficient manner over radio communications[9].

The PSK method can be represented by a convenient method namely constellations diagram. In this kind of communication, the points of the constellation can be selected are generally placed by uniform angular spacing in the region of circle. So that utmost phase separation can be offered among nearby points & therefore the best protection to corruption. These are arranged in a circle so that they can all be transmitted by similar energy[9].

Despite transferring data from analog formats to digital formats, data communications is growing in importance and along with the numerous forms of modulation that can be used to carry data.

4 . PROCEDURE

- So from the model that has been proposed by us we can calculate the entropy using QAM/ PSKtechniques.
- For the hypothesis that we had considered as H0 and H1the entropy is calculated .
- So different as we discussed already in the beginning when the entropy of hypothesis H1 is lessthan the threshold value λ we can identify the primary user.
- As well as if the hypothesis of H0 is greater than the threshold value λ we can identify the absenceof primary user.
- The reason to calculate the threshold is to know the presence or absence of user by comparing itwith H0 and h .

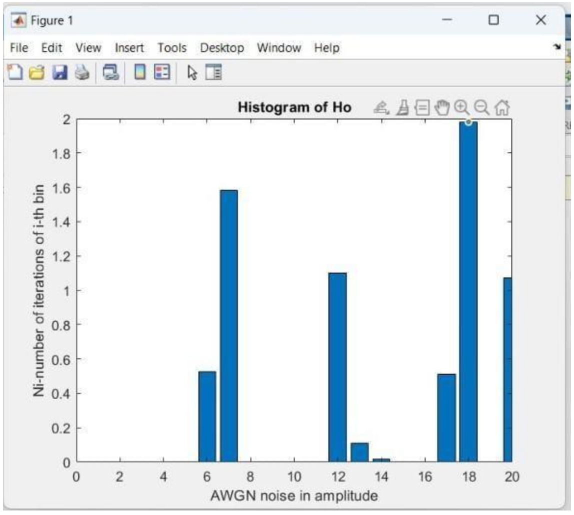
We also calculated the probability of detection just by comparing threshold value λ with theentropies of hypothesis H1 and H0.

RESULTS AND DISCUSSION

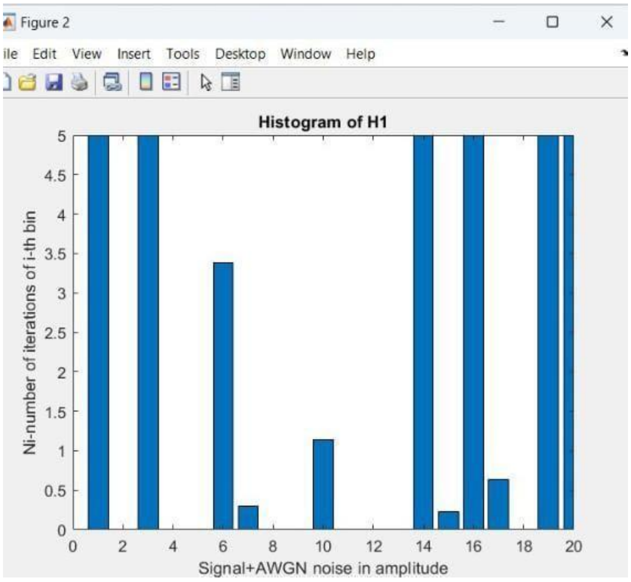
N	SNR indB	Average informationfor h0
16	2	3
	6	2.8
	12	2.6
	14	2.5
	16	2.4
	20	2
32	2	6
	6	5.5
	12	4.6
	14	4.5
	16	4.3
	20	3.5
64	2	10
	6	9.1
	12	8.7
	14	8.5
	16	7.5
	20	5.9

SNR in dB	Probability of Detection
-20	0
0	0
20	1

SIMULATION PLOTS



Histogram is a graphical representation of data points organized into user-specified ran Fig 1 is a Histogram for H0.It is used to summarize discrete or continuous data that are measured on an interval scale. Similarly, the above graph representation is the histogram for H0.This is represented for AWGN noise in terms of amplitude against N(number of iterationsof i-th bin).



Histogram is a graphical representation of data points organized into user-specified ranges.[11]

Fig 2 is a Histogram for H1. It is used to summarize discrete or continuous data that are measured on an interval scale. Similarly, the above graph representation is the histogram for H1 This is represented for AWGN noise along with signal in terms of amplitude against N(number of iterations of ith bin).From the graph we can notice that the graph reached its maximum peak at 5th iterations.

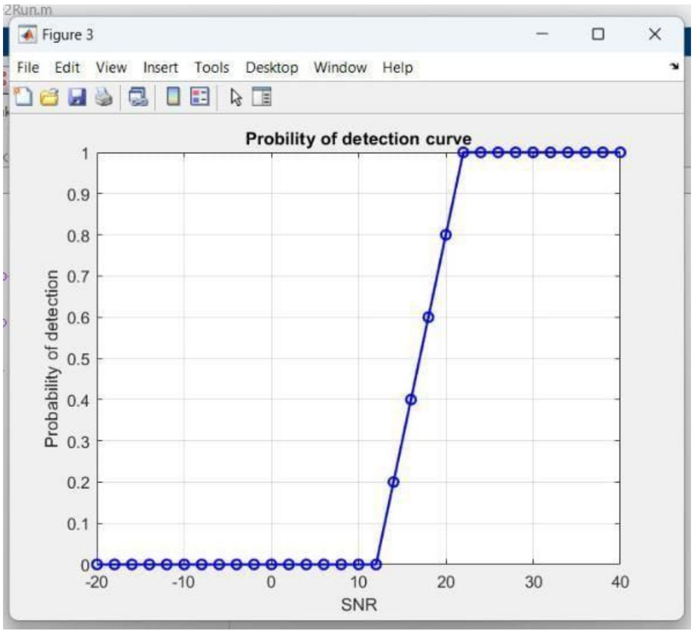
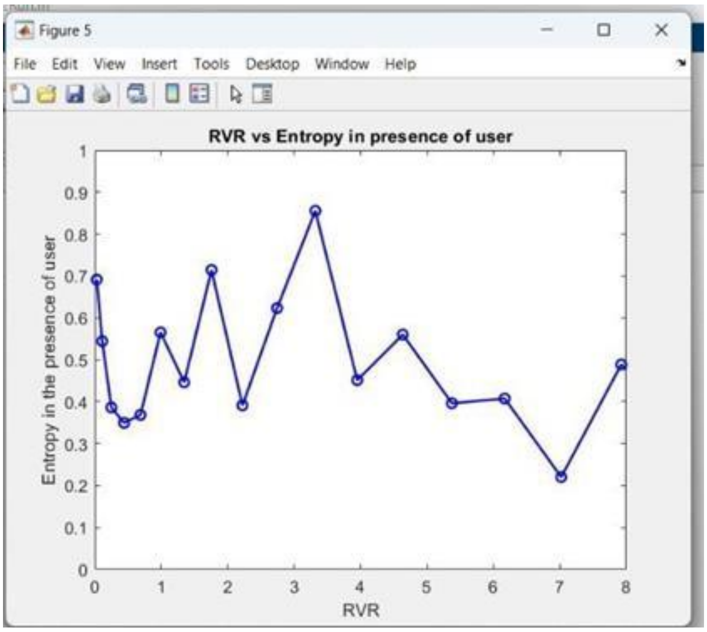
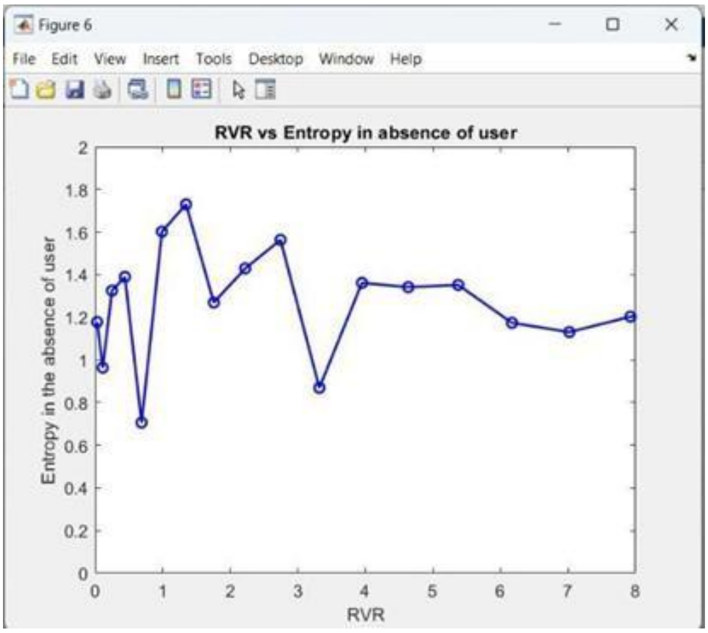


Fig 4 The above plot is for SNR vs Average Information for H0.This graph gives the information about howthe plot changes for different values of load i.e., N. Here N denotes the length of the generated random discrete data. If the N value is 32, we calculate the Average information of 32 bit sample . And then we calculate the Entropy, and plot it against various values of SNR





CONCLUSION

In summary we conclude that a spectrum sensing techniques is proposed using average information. .In this technique we used the modulation techniques i.e., QAM/PSK. Presence of primary users can be detected by this method. Detection of the primary user can be done by calculating the entropy. Primary user is absent if the entropy calculated is lower than the calculated threshold .From this spectrum sensing we can also calculate the probability of detection.

REFRENCES

[1] C. Geetha Priya, S. Sowmiya Sri, M.Renganayagi, T. M. Varsha. "Average Information based Spectrum Sensing for Cognitive Radio", 2019 InternationalConference on Communication and SignalProcessing (ICCSP),2019.

[2] Tamer Youssef, Eman Abdelfattah."Performance evaluationof different QAM techniques usingMatlab/Simulink", 2013 IEEE Long Island Systems, Applications andTechnology Conference (LISAT), 2013

[3] B . Suseela, D. Sivakumar. "Non-cooperative spectrum sensing techniques in cognitive radio-asurvey", 2015 IEEE Technological Innovation in ICT for Agriculture and Rural Development (TIAR), 2015

[4] www.researchgate.net

[5] www.nebula.wsimg.com

[6] R. Tandra and A. Sahai, "Fundamental limits on detection in low SNR under noise uncertainty," inProc. Int. Conf. Wireless Netw., Commun. Mobile Comput. vol. 1, Jun. 2005, pp. 464-469.

[7] Submitted to October University for ModernSciences and Arts (MSA)

[8] www.theburningofrome.com

[9] www.coursehero.com

[10] Prieto, Angel G. Andrade, Daniela M. Martinez, and Guillermo Gavaviz, "On the Evaluation of anEntropy-Based Spectrum Sensing Strategy Applied to Cognitive Radio Networks," IEEE Access,

Vol. 6, pp.64828-64835, Oct. 2018

[11] www.investopedia.com