Simulation Study of Double Threshold Energy Detection Method for Cognitive Radios.

INTRODUCTION

Wireless spectrum is one of the most important resources required for radio communications. Cognitive radio is a generic term used to describe a radio that is aware of the environment around it and can adapt its transmissions according to the interference it sees. Cognitive Radio is a new paradigm in wireless communication to tackle the problem of spectrum underutilization. Cognitive radio is an agile radio offering dynamic spectrum access. Cognitive radio is identified as a technique which may be used to solve the problem of spectrum underutilization. Spectrum sensing plays an important role for allocating spectrum for any device for communication. The goal of spectrum sensing is to determine the status of the spectrum. Radio spectrum allocation policy is divided into two types static spectrum allocation policy and dynamic spectrum allocation policy. Due to increase number of wireless devices and static spectrum allocation increased the spectrum scaricity. To use the idea of cognitive radio spectrum sensing is very important. They are many spectrum sensing algorithms such as energy detector, matched filter etc.. In radio systems, Secondary Users (SUs) or unlicensed clients named as CRs can utilize authorized band given PU isn't utilizing that specific band. To use the spectrum , SUs need to detect the Pu if Pu is not using that particular band SUs have to sense the spectrum to make a decision about the presence or absence of PUs and then SUs can use that frequency band to transmit its own data.

Double threshold CSS (Cooperative Spectrum Sensing) was introduced to increase the reliability of decision but at the cost of some sensing information lost. In this paper, we are discussing a method of double threshold CSS in which each CR (Cognitive Radio) sends local decision or observed energy to the FC (Fusion Center) depending on the region in which the observed energy lies. FC then makes a final decision by combining local decisions and observed energy values

BACK GROUND

To go into topic, we should know about the energy detector and double threshold and cooperative spectrum sensing

First coming to the conventional energy detector . the conventional uses one threshold to verify the pu is sending signal or not according to conventional detector Two hypothesis of the received signal are considered in the literature, one is hypothesis Ho when PU is absent and another is H1 when PU is present as follows:

H1: Y(N) = S(N) + U(N)

H0: Y(N) = U(N)

$$X = \sum_{n=1}^{N} |y(n)|^2$$

Where, X is the energy of the received signal and N is the number of samples. Expressions for probability of detection and probability of false alarm can be given as [9].

$$P_{fa} = P(X < \lambda) = Q\left(\frac{\lambda - N\sigma_w^2}{\sqrt{2N(\sigma_w)^4}}\right)$$

$$P_d = P(X > \lambda) = Q\left(\frac{\lambda - N(\sigma_s^2 + \sigma_w^2)}{\sqrt{2N(\sigma_s^2 + \sigma_w^2)^2}}\right)$$

Probability of miss detection will be given by

$$P_{md} = 1 - P_d$$

And probability of decision error will be given by

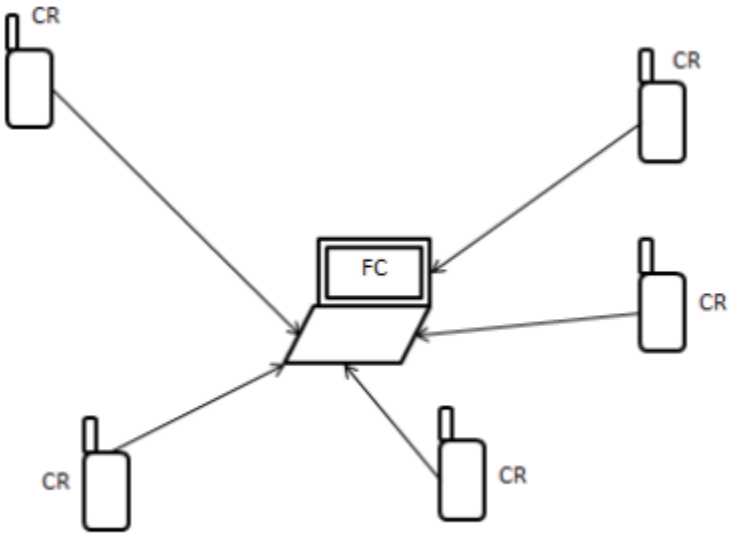
The energy is compared with the threshold lamdaa

Now coming to cooperative spectrum sensing to overcome the node failure problem the cooperative spectrum sensing. In this su sends its value to FC . FUSION CENTRE . In fusion cen there are combined by " or rule " or "and rule" or "majority rule " based on the decision from fusion centre report the secondary user to to send data and says that the band is free and it can transmit. Here we are using OR RULE

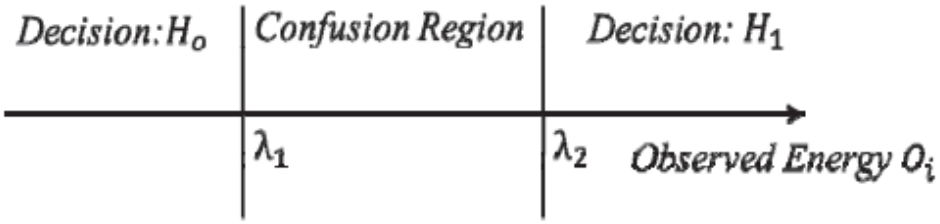
$$Q_d = 1 - \prod_{i=1}^{M} (1 - P_{di})$$

$$Q_f = 1 - \prod_{i=1}^{M} (1 - P_{fi})$$

Where P_{di} and P_{fi} are the probability of detection and probability of false alarm of i_{th} SU respectively and M is the number of CRs participating in CSS.



Now going to the double threshold in the double threshold the su has to two thresholds .based on it they are two hypothesis Here hypothesis H1 is true if X is more than threshold 1 and hypothesis Ho is true when X is less than threshold 2 and incase observed energy X lies in between the two thresholds i.e. in between the two thresholds then no decision is taken and CR will go for the sensing again.



Threshold λ can be calculated from equation 4 as:

$$\lambda = Q^{-1}(P_{fa})\sqrt{2N\sigma_w^4} + N\sigma_w^2$$

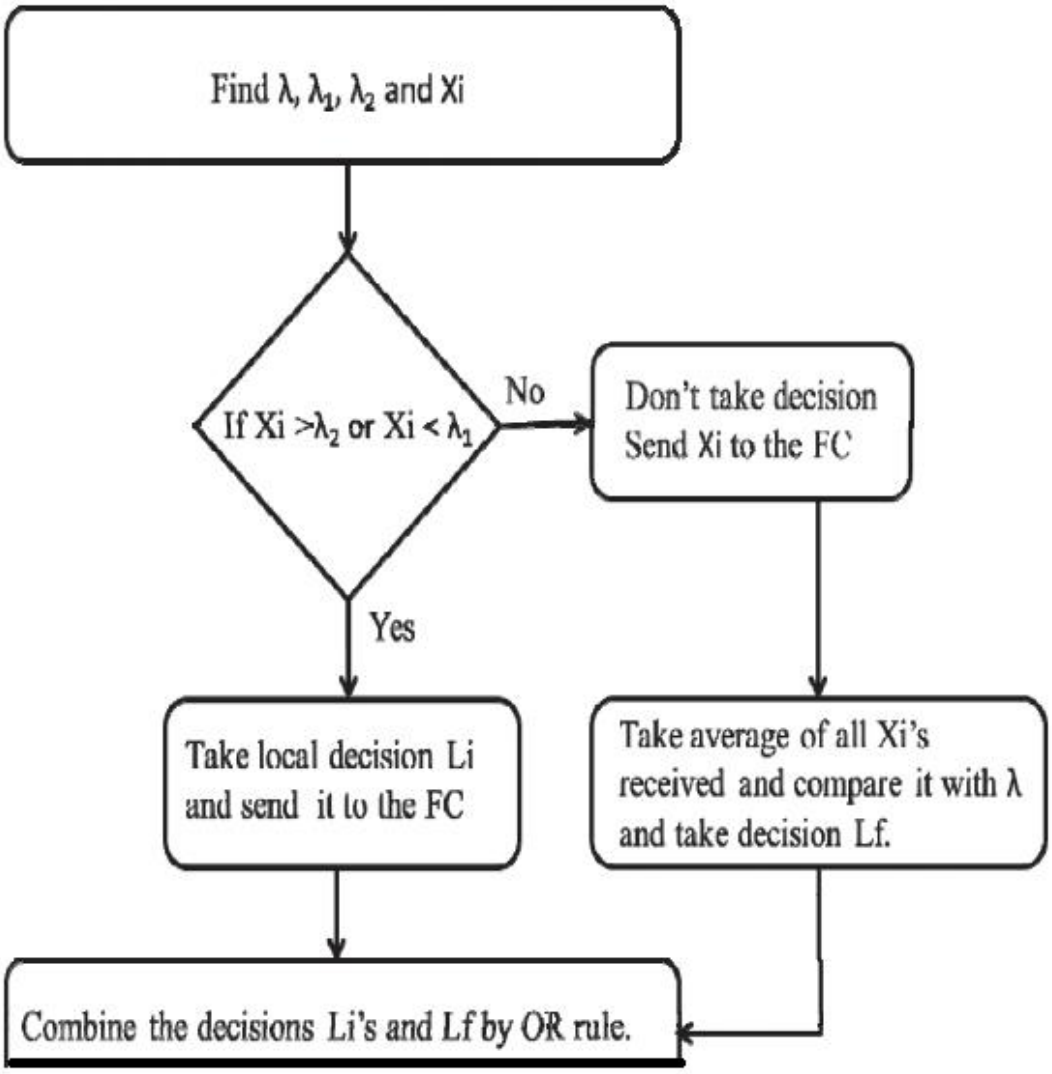
And thresholds $\lambda_1$and λ_2 can be found as:

$$\lambda_1 = (1-\rho)\lambda$$

$$\lambda_2 = (1+\rho)\lambda$$

Here ρ is the uncertainty parameter.

PROPOSED DOUBLE THRESHOLD ENERGY DETECTION IN COOPERATIVE SPECTRUM SENSING



Coming to proposed spectrum sensing

(i)first the thresholds and energy of the signal is calculate

(ii) second it will check whether the value lies between the second threshold 1and threshold 2 if so the it is send the energy to fusion centre. If the values are not present in between the thresholds then each su will have ts own decision value and send it to fusion center because the fusion center cannot decide by the values lying in between the threshold and come to a conclusion that pu is transmitting or not.

(iii) if the fusion center receive the energy values it will average all the energy values and compare with the first threshold and make the decision .now we have k decision from the users and one decision from the fusion centre

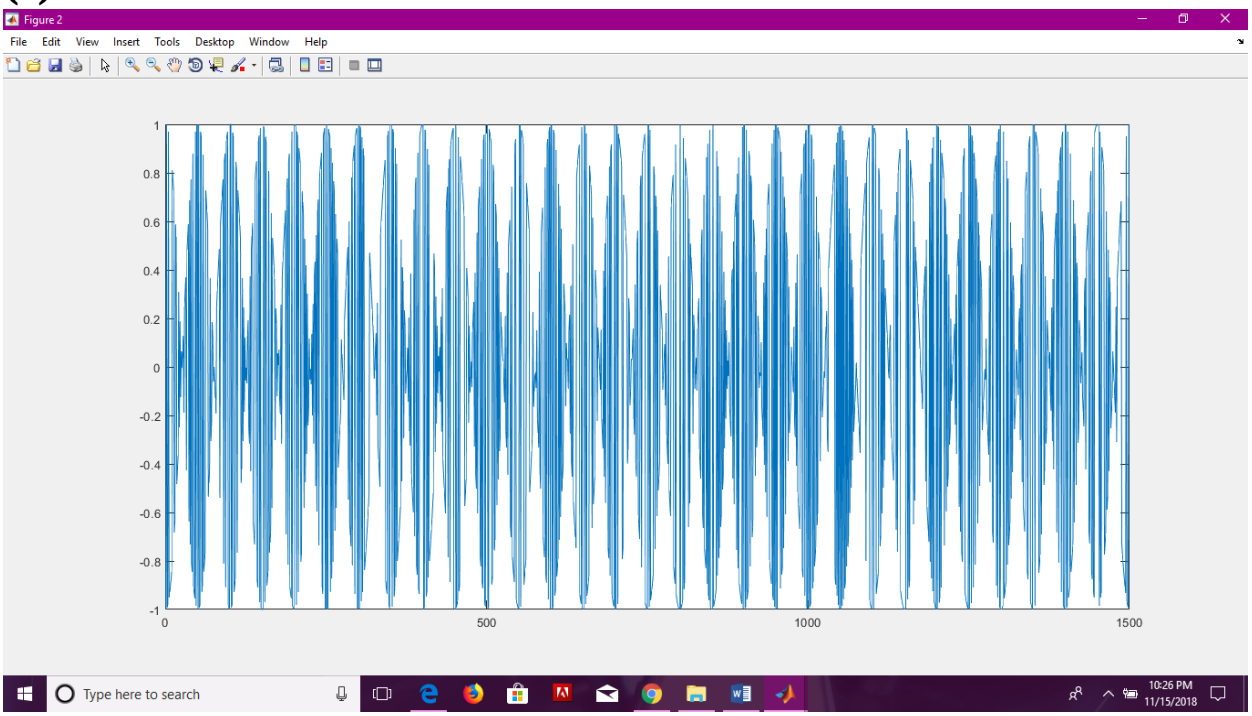
$$X_{avg} = \frac{1}{M-K}\sum_{i=1}^{M-K} X_i$$

$$L_f = \begin{cases} 0 & X_{avg} < \lambda \\ 1 & X_{avg} > \lambda \end{cases}$$

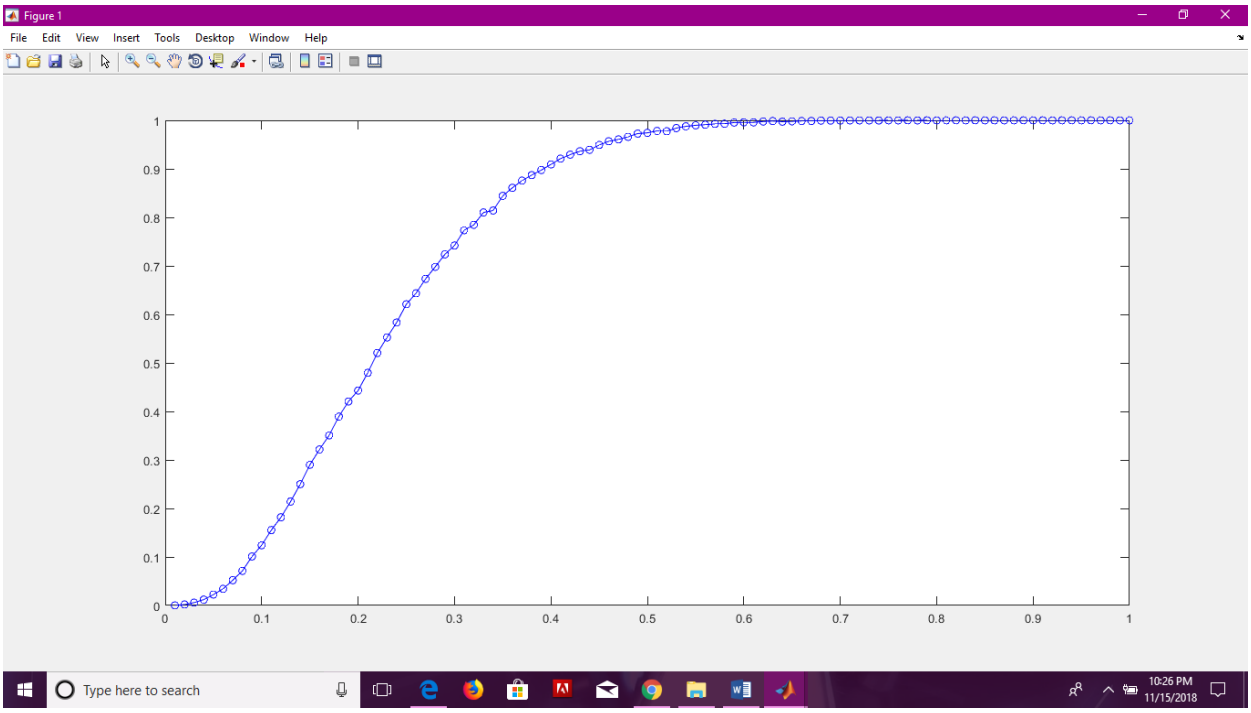
(iv)now we the css rules now we combine decision by using or rule. By we these we come to a conclusion if the spectrum is vacant or not or used .this is one the technique used for spectrum sensing

SIMULATION RESULTS

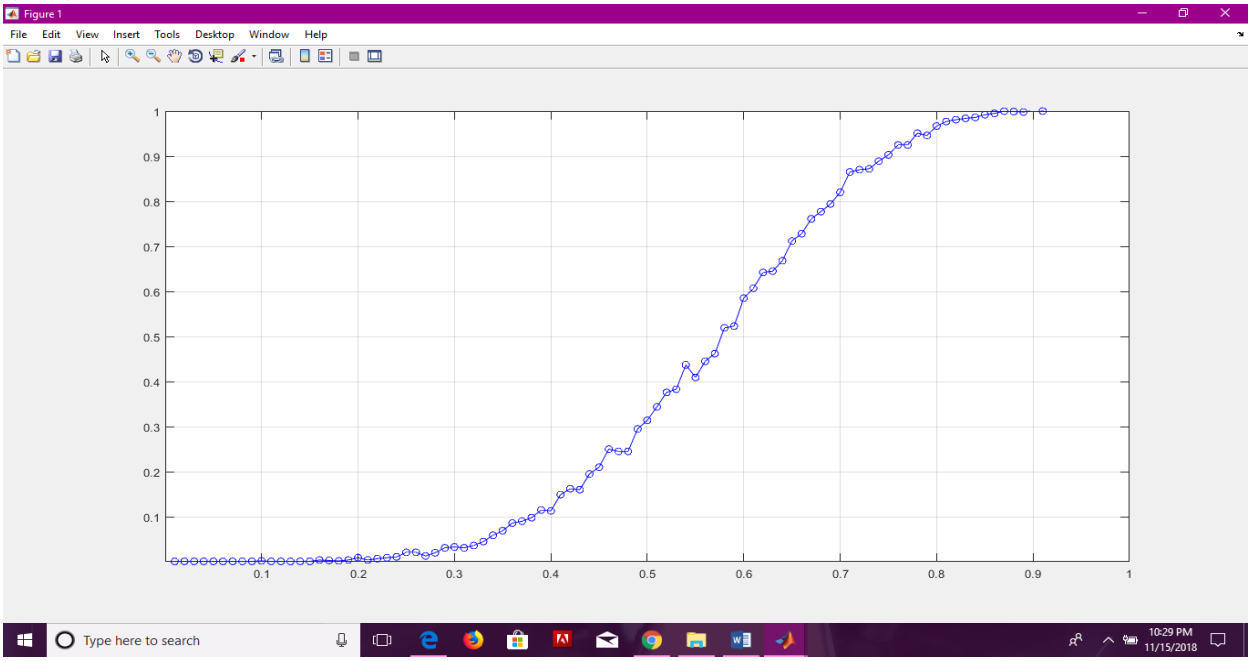
(I)BPSK SIGNAL



(II) **conventional energy detector**

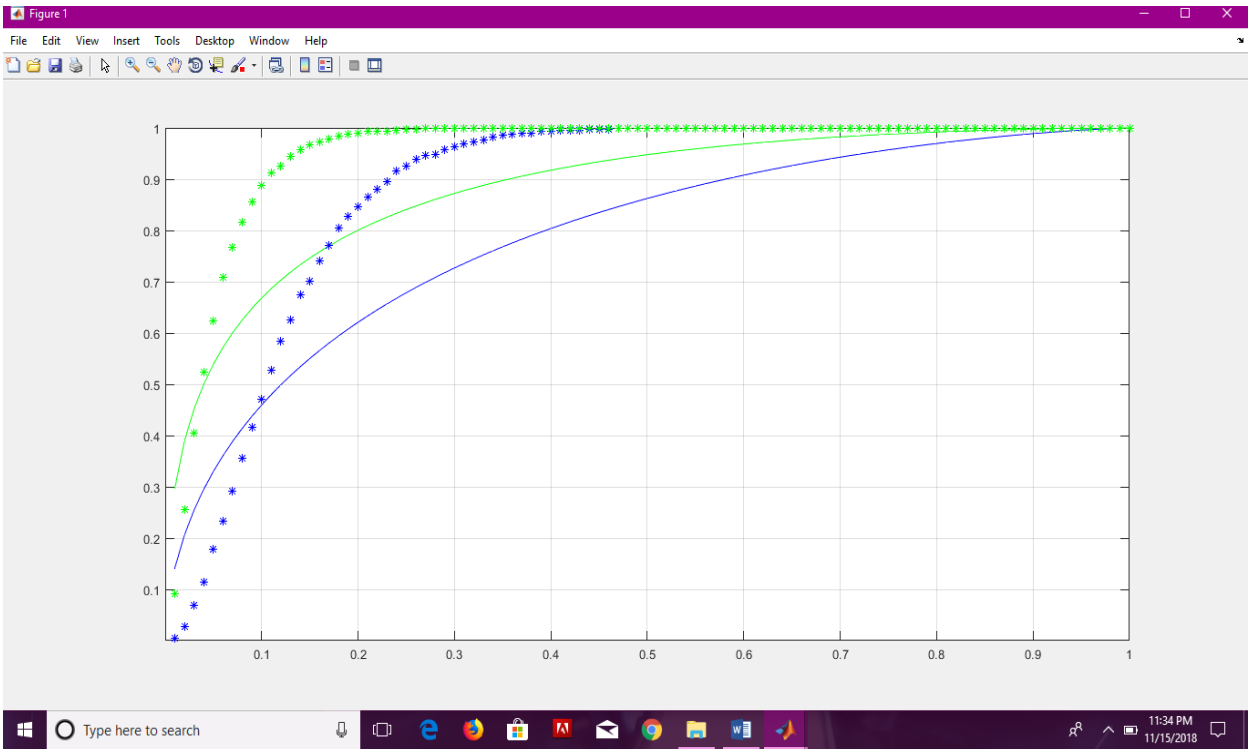


(III)DOUBLE THRESHOLD ENERGY DETECTOR



GREEN CONVENTIONAL ENERGY

BLUE DOUBLE THRESHOLD



Blue – therotical ;; blue** simulated;;

REFERENCES :-

[1]H. Urkowitz, "Energy detection of unknown deterministic signals," IEEE Proceedings, vol. 55, no. 4, pp. 523-531, Apr. 1967.

[2] C. H. Sun, W. Zhang and K. Ben Letaief, ''Cooperative spectrum sensing for cognitive radios under bandwidth constraints,'' IEEE Conf. on Wireless Communications and Networking, vols. 1-9, pp. 1--5, Mar. 2007.

[3] J. Zhu, Z. Xu, F. Wang, B. Huang and B. Zhang, "Double threshold energy detection of cooperative spectrum sensing in cognitive radio," IEEE Int. Conf. on Cognitive radio oriented wireless networks and communication, pp. 1-5, 2008