IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Performance, analysis and comparison of modulation techniques for 5G technology

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Abstract: Spectrum sensing is to provide access opportunities to CR users with out interference to the primary network since cognitive radio networks are responsible for detecting the transmission of primary network and avoiding interference to them, CR network should intelligently sense the primary band to avoid missing the transmission of primary users. The basic idea is to let people use licensed frequencies, they can guarantee interference perceived by the primary license holders will be minimal. After the conversion of an Analog signal to digital by sampling different type of digital modulation schemes can be achieved by the variation of different parameter of the carrier signal for example bpsk,dpsf,fsk,psk.

***Index Terms* –Modulation, spectrum sensing, bpsk, dpsf,fsk,psk.**

I. INTRODUCTION

The 5G network continue to be major topic in a network communication industry. There are still many question around how 5G will be achieved. all point to need for faster and more converged networks but there is still uncertainty around how this network will actually be achieved. of the primary ways 5G network technology will be accomplished through cognitive radio with spectrum sensing by energy detection using matched filter in 5G Communication[1]. Cognitive radio (CR) is a form of wireless communication in which a transceiver can intelligently detect which communication channels are in use and which are not, and instantly move into vacant channels while avoiding occupied ones. This optimizes the use of available radio-frequency (RF) spectrum while minimizing interference to other users.[1]. In its most basic form, CR is a hybrid technology involving software defined radio (SDR) as applied to spread spectrum communications. Possible functions of cognitive radio include the ability of a transceiver to determine its geographic location, identify and authorize its user, encrypt or decrypt signals, sense neighboring wireless devices in operation, and adjust output power and modulation characteristics.

There are two main types of cognitive radio, full cognitive radio and spectrum-sensing cognitive radio. Full cognitive radio takes into account all parameters that a wireless node or network can be aware of. Spectrum- sensing cognitive radio is used to detect channels in the radio frequency spectrum.[1].

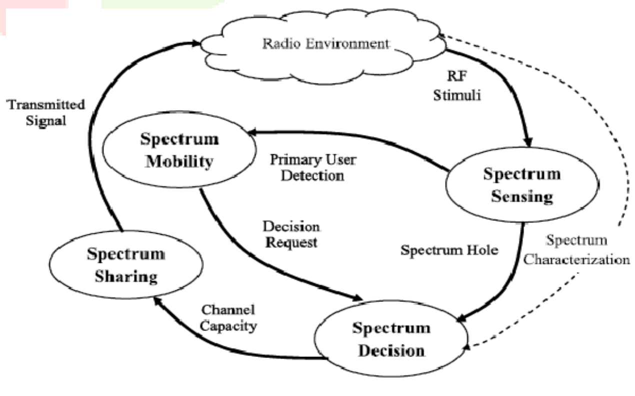

Fig no 1: Cognitive radio

Spectrum Sensing The principal step of spectrum sensing is that it decides the presence of primary user on a band. The cognitive radio has the capacity to impart the result of its detection with other cognitive radios in the wake of sensing the spectrum. The main objective of spectrum sensing is to discover the spectrum status and activity by periodically sensing the target frequency band. Spectrum Management Provides the reasonable spectrum scheduling technique among coexisting users. The available white space or channel is quickly chosen by cognitive radio if once found. This property of cognitive radio is described as spectrum management. Spectrum Sharing in Cognitive Radio find out the unused (spectrum hole) to the secondary user (SU) as long as primary user (PU) does not utilize it. This property of cognitive radio is described as spectrum sharing. Spectrum Mobility

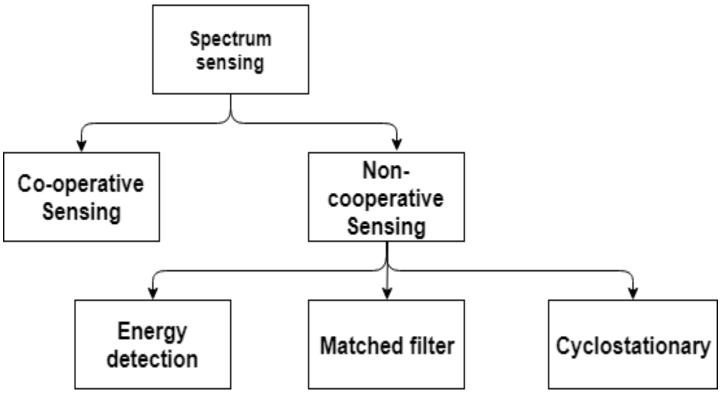

Fig no 2: Types of spectrum sensing

is an authorized (Primary) user is detected, the Cognitive Radio (CR) empties the channel. This property of cognitive radio is depicted as the spectrum mobility, also called handoff.

II. LITERATURE REVIEW

Spectrum sensing is fundamental for the successful deployment of CRs. The main focus of current spectrum sensing schemes for CRs is divided into two main streams: the first is to improve local sensing performance, and the second is to improve performance by having cooperation between SUs. In local sensing, each SU performs spectrum sensing on the received signal and makes a decision about the presence or absence of a PU. In cooperative spectrum sensing,

In SUs perform local sensing and send their sensed information to the fusion center, and a final cooperative decision is taken at the fusion center. Therefore, in order to improve cooperative performance, it is necessary to improve local sensing. Many two-stage spectrum sensing schemes are proposed in literature to improve local spectrum sensing. a two-stage fuzzy logic-based detection (FLD) scheme is proposed. In the first stage, each CR performs existing spectrum sensing techniques, i.e., energy detection, matched filter detection, and cyclostationary detection. While in the second stage, the output from each technique employed in the first stage is combined using fuzzy logic to ultimately decide about the presence or absence of a PU. From A GHASEMI, ES SOUSA, proposed a system titled "Spectrum Sensing In Cognitive Radio Networks: Requirements, Challenges And Design Trade- Offs."[5]

A low power discrete Fourier transform (DFT) filter bankbased two-stage spectrum sensing is proposed in. Energy detector is used for the first stage course sensing and then in the second stage fine sensing it is complemented by the cyclostationary detection. Authors exploited the fact that power of sensing operation depends on the sampling rate. Therefore, polyphase DFT filter bank is used to choose appropriate sampling rate.From W EJAZ, NU HASAN, MA AZAM, HS KIM, proposed a system titled " Improved Local Spectrum Sensing For Cognitive Radio Networks".[6]

SNR-based two-stage adaptive spectrum sensing is proposed in. In the first stage, the SNR is estimated in advance for available channels. The SU then performs either energy detection or cyclostationary detection based on the SNR estimated in the first stage of PU detection. From [3] KG SMITHA, AP VINOD, PR NAIR, proposed a system titled" Low Power Dft Filter Bank Based Two-Stage Spectrum Sensing"[7].

A novel high-speed two-stage detector is proposed in that effectively decreased the sensing time by satisfying the required detection capabilities. Energy detector is used in the coarse sensing stage and if the measured energy is greater than threshold then it declares PU present, else it computes the SNR of device. If the computed SNR is greater than theoretical SNR, then the result of energy detector is reliable. If computed SNR is less than theoretical SNR then second stage for fine sensing is performed in which covariance absolute value is used. W EJAZ, NU HASAN, HS KIM, proposed a system titled" Snr- Based Adaptive Spectrum Sensing For Cognitive Radio Networks"[8]

In another two-stage sensing scheme is proposed in which, at the first stage, the energy detector is used, and if required, cyclostationary detection is used at the second stage. The second stage will run only if a channel is declared unoccupied in the first stage. In this case, the second stage will give a final decision about the presence or absence of a PU. If a channel is declared occupied, the first stage will provide the final decision. S GEETHU, GL NARAYANAN, proposed a system titled " A Novel High Speed Two Stage Detector For Spectrum Sensing".[9]

An improved version of in terms of mean detection time is proposed It achieves the same probability of detection and false alarm with much less mean detection time. The first stage will run in the same way as previously discussed, but before the second stage, it estimates the SNR of the received signal and determines the credibility of the energy detector. If the energy detector is credible, it declares the absence of a PU at the first stage, otherwise it will run the second stage in order to get an accurate decision about the presence or absence of a PU. From S MALEKI, A PANDHARIPANDE, G LEUS, proposed a system titled" Two-Stage Spectrum Sensing For Cognitive Radios".[10]

A two-stage spectrum sensing scheme is also proposed in which the energy detector is used at the first stage to sort channels in ascending order based on the power of each channel. The one-order cyclo stationary detector is used on the channel with the lowest power to detect weak signals in the second stage. From PR NAIR, AP VINOD, KG SMITHA, AK KRISHNA, propose a system titled" Fast Two- Stage Spectrum Detector For Cognitive Radios In Uncertain Noise Channel".[11]

A two-stage dynamic spectrum access approach, which consists of preliminary coarse resolution sensing (CRS) followed by fine resolution sensing (FRS), is proposed in. In CRS, the whole spectrum is divided into equal-sized coarse sensing blocks (CSB) of equal bandwidth, and an energy detector of bandwidth equal to that of the CSB is applied on randomly selected CSB and checked for at least one idle channel. FRS is then applied on the same CSB, using the energy detector equal to the bandwidth of the channel to determine its unused channel. From W YUE, B ZHENG, Q MENG, W YUE "Combined Energy Detection One-Order Cyclostationary Feature Detection Techniques In Cognitive Radio Systems".[12]

In our proposed scheme, based on the power and band of interest, we first determine information about the PU waveform. The distinction of the proposed scheme is that it deals with multiple types of primary systems, i.e., for primary systems with known and unknown waveforms. Whereas all the existing two-stage detection schemes in the literature only considered single type of primary system. Most of the useful spectrum is allocated to licensed users (eg. mobile carriers, TV broadcasting companies) that do not transmit at all the geographical locations all the time.

If this spectrum is opened for unlicensed use (eg. private users, short range networks, ...) it is highly likely that a vast array of new services will appear. One example of this is for example the huge innovation that has occurred in Wi Fi and Bluetooth operating in unlicensed bands, even though these two standards share just scraps of undesirable spectrum with many other technologies.

III. MOTIVATIONAL BACKGROUND

The cognitive radio offers a very rewarding area of research field. Need of more spectrum due to the under utilization of the available spectrum is the main motivation behind cognitive radio and implementing it leads to lessening of spectrum scarcity and hence the optimal use of spectrum resources. Spectrum sensing which basically checks for the vacant or unused spectrum band forms the main part of the cognitive radio. There are different schemes based on which spectrum sensing is done like energy detector, matched filter detector, Cyclostationary detector, Eigen value based sensing, etc. Energy detector works very well in high SNR environments, matched filter detector needs much more information about the signal which is called priori information and the complexity of other two is high. These constraints led to search for an optimal detector which performs well under low SNR conditions as well and with a complexity not so high. This thesis discusses all these performance metrics in details with exclusive mathematical proof.

IV. PROPOSED METHOD

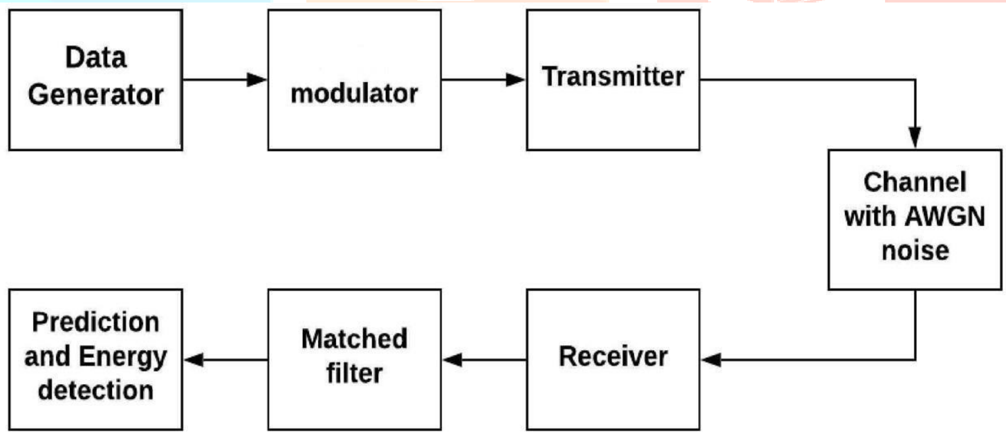

Fig no. 3: Block diagram

This block diagram simulates the complete end-to-end digital communication system. The above row is a Transmitter and below row is receiver section.
Functioning of each blocks:

DATA GENERATOR

Data generator generates bits of digital information signal which needs to be transmitted

BPSK MODULATOR

Modulator changes the form of information signal so that it is suitable and efficient for transmission. BPSK is a modulation technique which stands for Binary Phase Shift Keying is a technique in which the information to be transmitted is converted into NRZ form which stands for non-return to-zero which means the bit '0' present in the information signal is transferred to level '-1' which makes it comfortable to transmit.

CHANNEL

A channel is used to convey an information signal, for example a digital bit stream, from one or several senders to one or several receivers .communicating data from location to another requires some of pathway called medium. These pathways are called communication systems. A channel refers to a theoretical channel model with certain error characteristics. Additive white Gaussian noise is a basic noise model used to mimic the effect of many random processes that occur in nature.

- **Additive** because it is added to any noise that might be intrinsic to the digital communication system.
- **White** refers to the idea that it has uniform power across the frequency band for the digital communication system.
- **Gaussian** because it has a normal distribution in the time domain with an average time domain value of zero.

MATCHED FILTER

A matched filter is obtained by correlating the known delayed signal(template) with an unknown signal to detect the presence of the template in the unknown signal. This is equivalent to convolving the unknown signal with a conjugated time reversed version of the template. The matched filter is the optimal linear filter for maximizing the signal-to- noise ratio (SNR) in the presence of additive white Gaussian noise

PREDICTION AND ENERGY DETECTION

Energy detection is a suboptimal and simple method that can be applied to any signal type without requiring any information about the received signal. Prediction is done based on the results of output from the energy detector and matched filter. If the prediction is right then it is called Probability of detection, if prediction is wrong then it is called probability of miss detection.

V. FLOWCHART

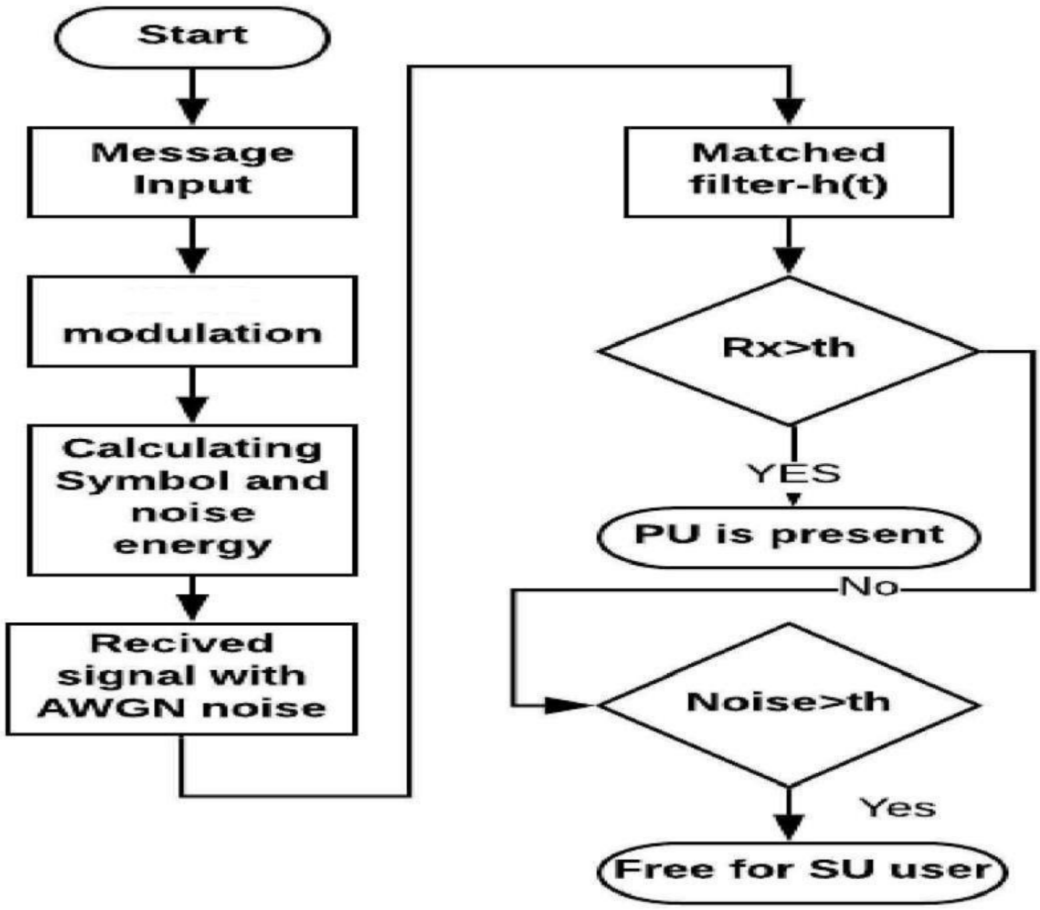

Fig no 4. Flow chart

VI. RESULTS AND DISCUSSION

6.1 GRAPHICAL SIGNAL REPRESENTATION

BPSK

1. The upcoming 9 graphs are visual representations of a message signal in its 1.Binary Phase shift keying modulated form
2. The received signal which contains required amount of noise for respective signal to noise ratios as mentioned in the respective graphs.
3. The output of the matched filter for the received signal. You can observe that output of matched filter is more smooth and resembles the message signal for higher values of SNR.
4. The output of a rational IR filter for respective signal to noise ratios. Although IR filter out is also smooth and it resembles the message signal, it fails to do so accurately.

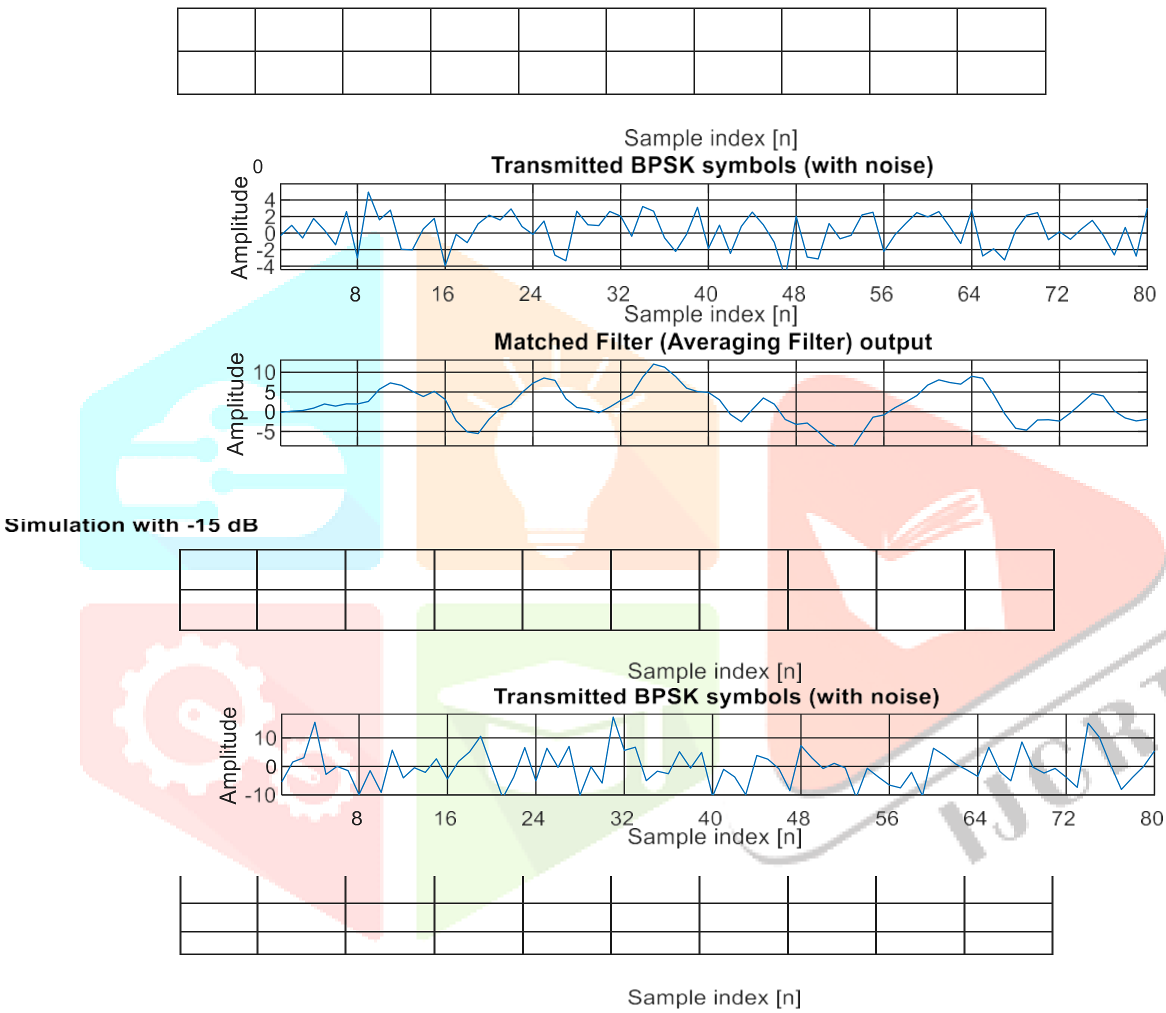

Fig no 5: Simulation at SNR=-15dB

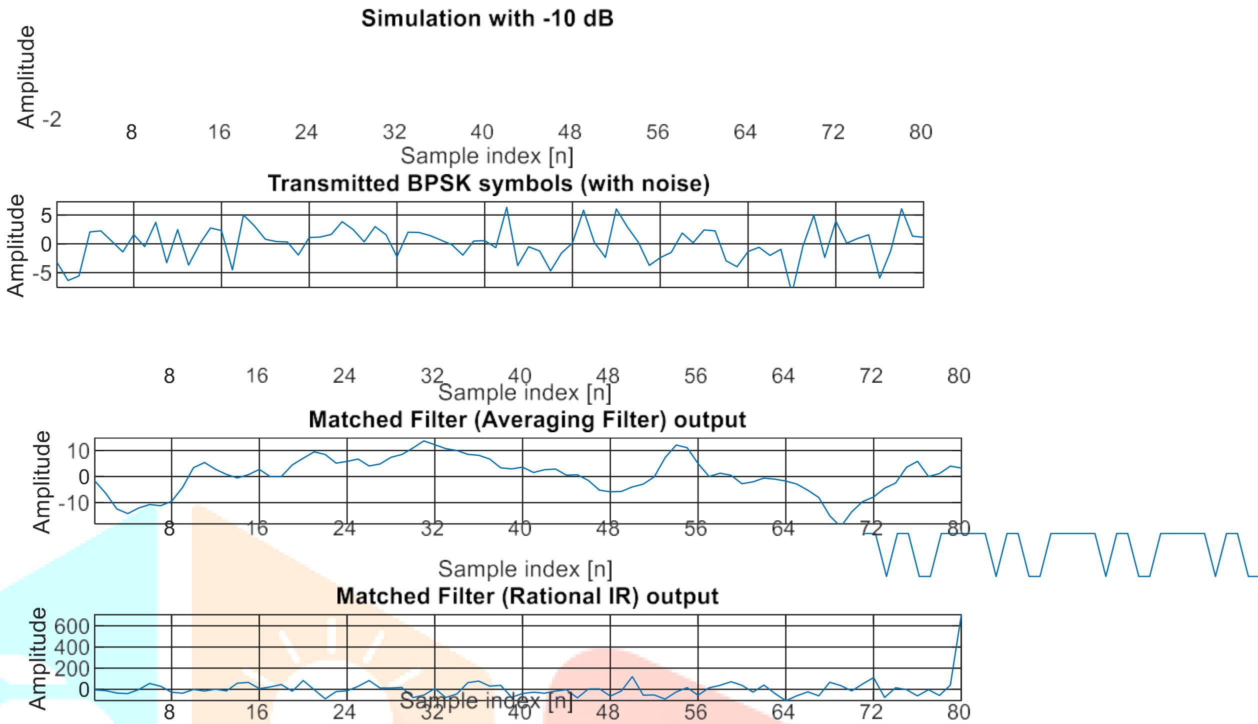

Fig no 3: Simulation at SNR=-10dB

6.2THRESHOLD

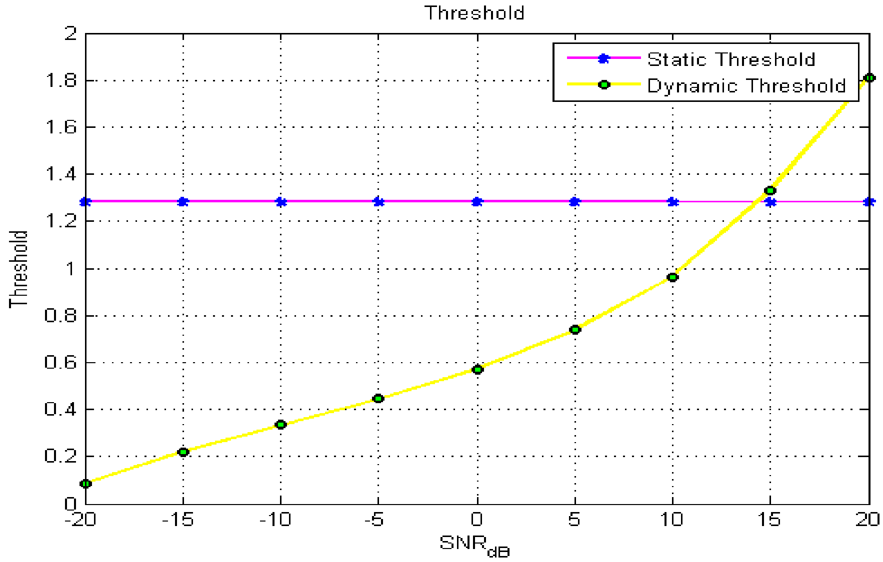

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Fig no 6: This graph shows change in threshold with respect to signal to noise ratio(SNR)

Threshold: It is the reference voltage/level used at the receiver side to predict the signal strength at that particular interval of time. Threshold is chosen carefully by taking the shape and strength of transmitted signal into consideration. This is used to cancel the effect of noise introduced in the received signal

6.3 PROBABILITY OF MISS DETECTION

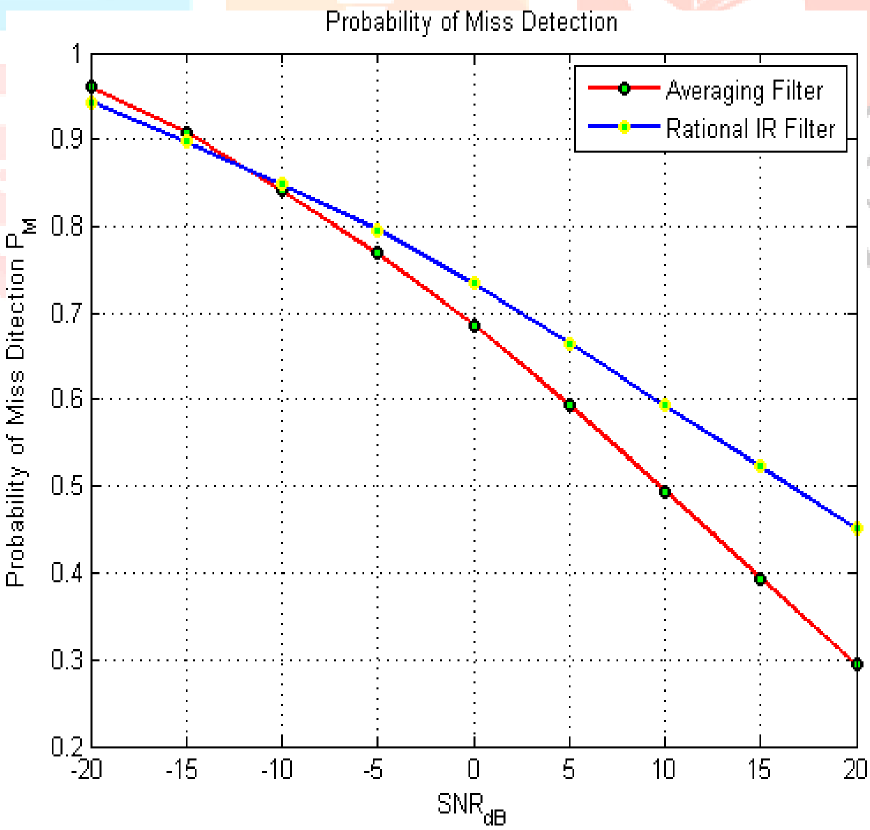

Fig no 7: This graph shows probability of miss detection(practical)

Probability of miss detection: This is the byproduct of the prediction done for detecting the presence of Primary user. Sometimes a model fails to detect a primary user signal due to very low SNR, lesser than SNR threshold. In that case, our system fails to detect the presence of primary user and gives the wrong prediction as the Primary user is absent.
This probability of missing the primary user's signal is termed as Probability of miss detection.

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