Novel Aninath Computation Detection algorithm for 5G Networks

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Abstract: Cognitive Radio (CR) Network is a backbone for the 5G cellular Networks and User identification at low power levels is a biggest task CR. In the available literature various authors proposed their research with single detection algorithms low power levels as well as concatenation of two or three detection methods. To estimate the user presence the existing detection methods proposed with covariance based approach at static or predefined threshold power levels. In this paper, the authors proposed a novel Aninath computation detection algorithm to estimate the threshold dynamically with inverse covariance approach to improve the Probability of Detection (P_D) and mitigate the Probability of false alarm (P_{fa}) and Probability of miss detection (P_{md}) at low power levels.

Keywords: Hybrid Filter Detection, Cyclostationary Feature Detection, Cognitive Radio, Spectrum Sensing, Dynamic Threshold

1. Introduction:

CR is an emerging technology in 5G cellular Networks. Similarly, spectrum sensing is the backbone for the CR networks for user detection accurately. If not detect the user accurately the spectrum slot is wasted and like that, if not detect user presence in the spectrum which causes the interference in the channel. In the available literature, various authors proposed their research to detect the user presence by Non cooperative detection methods. Some of the authors proposed their research with concatenation of two or three detection methods and made as hybrid filter detections. Various authors are proposed their research is mentioned as [1], explores on user identification by using hybrid energy detection in CR. The Energy Detection (ED) method is implemented on two hypotheses of N samples is corrupted by noise and N samples are corrupted by noise-only samples. The threshold is estimated by using the two hypotheses values for N samples. The hybrid energy detection of 32 sample combination detector is implemented with a 16 sample detectors by mixed signal-noise cases. To achieve the maximum detection the threshold value is e set as optimal. The detection method performance is estimated by using the parameter P_D. [2], describes hybrid coherent spectrum sensing scheme for estimation of user identification in the spectrum. They proposed hybrid spectrum sensing method to achieve the pilot and the data symbols transmitted by PU. The performance is analyzed with the data symbols with PU to achieve good performance by using hybrid spectrum sensing with a parameters of P_D, P_{fa} and ROC. The parameter P_{fa} is analyzed for the various detection methods like ED, Coherent Detection and hybrid energy detection. The smoothing factor is estimated for the number of samples varying with the parameter P_{fa}. [3], explores hybrid detection method to identify the user presence in CR networks. The Roy Largest Root Test (RLRT) and Hybrid RLRT test is implemented with eigen value bases known noise. The performance parametric Pr (detection) is used to analyze the performance. The threshold is computed for the ED, RLRT, HRLRT, Hybrid energy detector and hybrid cyclostationary test. The performance is analyzed between the all detection methods and the performance is analyzed the parameter Pr at various SNR values. The hybrid cyclostationary test provides better detection performance than remaining methods at low SNR values. [4], describes Hybrid algorithm for user identification in CR network. The concatenation of ED and Cyclostationary Feature Detection (CFD) methods framed as Hybrid algorithm has been suggested in the work. Threshold is computed by using Generalized Likelihood Ratio Test (GLRT) in static mode only. To estimate the performance of the detection parameter P_D is used. The P_D has been analyzed with change of input Signal to Noise Ratio (SNR) for various modulation techniques. The performance of ED, CFD and Hybrid algorithm with the performance factor has been analyzed. Finally it has been concluded that Hybrid algorithm contributes better performance than existing two.

[5], explores Hybrid spectrum sensing method by using static or fixed threshold. The performance has been analyzed between the hybrid spectrum sensing method, ED and Covariance Absolute Variance (CAV) methods with the performance metrics of P_D and P_{fa}. The fixed threshold value is computed by using the Generalized Likelihood Ratio Test (GLRT) condition. The parameter P_D with different number of samples has been analyzed and correlation coefficient factor has been estimated for various SNR's. From the results, it has been concluded that the ED works efficiently but it has highly affected to uncertainty in noise. If the received signal has been uncorrelated, the CAV

is fails to perform well. Hybrid spectrum sensing method performs well at low SNR cases, if the noise signal has uncertainty.

[6], has proposed overloaded hybrid system to improve spectral efficiency. To estimate the presence of user in the spectrum for underlay and overlay cases, a static threshold value has been calculated. The Code Division Multiple Access (CDMA) technique has been used for transmission of signals and the results are compared between the hybrid system and overlay system by using the parameter of bit error rate. The results has been analyzed at various SNR and identified that the Hybrid system provides better results than the overlay method. [7], a hybrid CR system is proposed to combine underlay and overlay models. The static threshold for estimation of PU's and Secondary User (SU's) to transmit signals without interference has been computed. The model has been designed for underlay mode where the number of users does not exceed with a limited range. If another SU enters into the region, the underlay has to equal the maximum number of users and switches to overlay mode by using canal method. The number of PU's with the SU's in underlay and overlay model by using hybrid threshold has been mentioned in the results. To estimate the PU and SU occupancy in the underlay and overlay regions, a static threshold level has been calculated.

The research on Hybrid filter detection by combining of any two detection methods has been proposed. Few research works has been done for Hybrid Filter Detection (HFD) in non cooperative detection methods. The existing authors computed the threshold using static mode with GLRT has been computed and the performance parameters P_D and P_{fa} has been analyzed. Few authors proposed the performance factor $P_{md.}$ If the fixed threshold is considered as high, then the P_D becomes low and miss detection error may arise in the detection. Otherwise the threshold is considered as low, then the P_D becomes as high and false alarms error may arise in the detection. Threshold has been considered as a key parameter to identify the user presence accurately. The existing research focuses to measure the threshold by using GLRT only.

The gap identified from the available literature is that, the fixed threshold has been measured by uniform Additive White Gaussian Noise (AWGN) with GLRT, with that the P_D is accomplished as low. In the proposed research paper, the authors estimate the optimal threshold by using non-uniform AWGN with GLRT and additionally to compute threshold with NP observer detection criteria. Few authors are proposed their research on estimation of P_{md}. The authors mainly focus to measure P_{md} along with P_D and P_{fa} in this paper. Previously, the hybrid algorithm has been proposed by combining of ED with Matched Filter Detection (MFD) or ED with CFD only. In the proposed ANINATH detection, the authors have done to concatenation of MFD and CFD with non-uniform AWGN.

2 PROPOSED WORK

In CFD with Inverse covariance approach [8]-[9], the received signal has been apllied directly to the N-point FFT without initial filtering [10]. Due to the direct input signal, P_D might be low at detection level. The principle of Matched Filter (MF) is suppresses the noise amplitude at some instant of time and increase the signal component at the same time [11]. In this research work, authors have done to concatinate two detection algorithms of MFD, CFD with inverse covariance approach and form as novel detection method named as "ANINATH". The proposed aninath detection method block diagarm is shown in Figure 1.

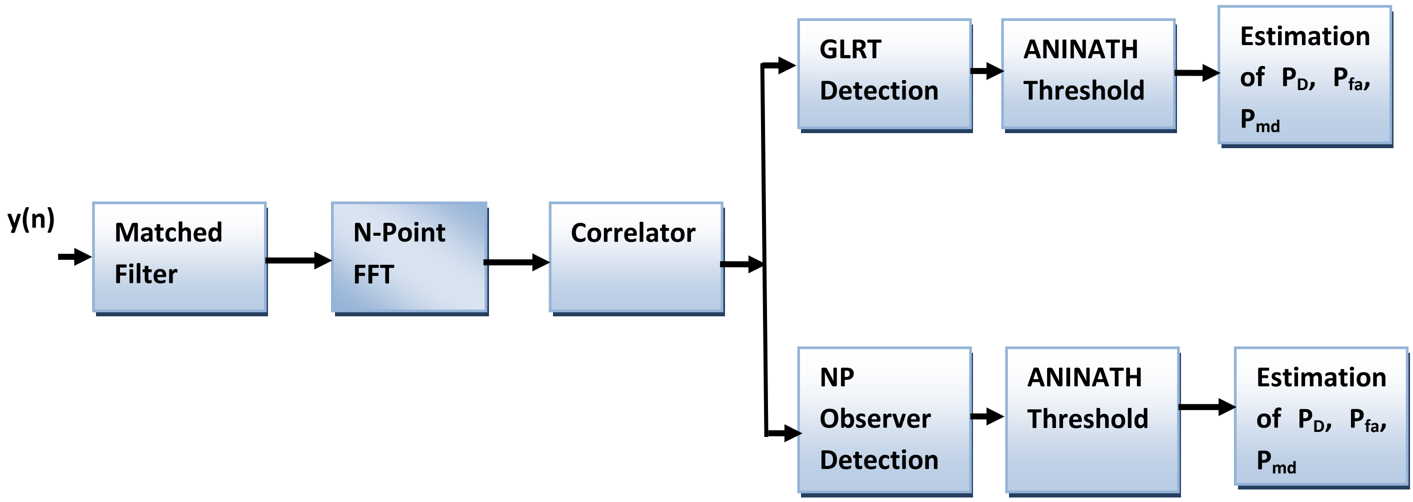

Figure 1: Block diagram of Aninath detection method

The received samples are applied to MF as y(n) as shown in figure 1. From the principle of the MF, the signal component is increased at some instant of time and noise amplitude is suppressed. The output of the MF has been fed to input for N-point Fast Fourier Transform (FFT). The frequency domain signal is getting as output of FFT and it has been applied to a correlator further. The correlator performs auto correlation operation with the obtained from samples from N point FFT. If present samples are correlated with the previous samples, then the past decision would be considered for present sample also. If the present samples are not correlated, then the uncorrelated samples are fed to a ANINATH threshold detector for threshold comparison. The dynamic threshold has been computed for the proposed ANINATH by using GLRT and NP observer detection criteria's. The dynamic threshold computed for the GLRT are as follows.

To measure the threshold for the received signal y(n) is considered as statistical hypothesis H_0 and H_1. Where H_1 has been considered as both signal and noise and H_0 has been considered as only noise [12]-[13]. The output y(n) is

$$H_0 = y(n) = w(n)$$
$$H_1 = y(n) = s(n) + w(n) \quad (1)$$

Here, "w(n) has the noise signal with unit variance, zero mean and s(n) is the original signal. The received signal y(n) is applied to input of the MF for suppressing the noise signal". Then the output of the MF [14] is

$$T(Y) = \frac{(H_1 - H_0)}{\sigma^2} \tag{2}$$

Where "σ^2 is the variance of the channel and T(Y) is the output of the MF". In this proposed research work it has been assumed that each channel has random different noise levels. Therefore, it requires threshold estimation for all the SNR levels and the threshold has been changed dynamically based on the received different SNR. To compute the threshold values for each channel n jointly Gaussian random variable [15] is given as

$$P(y;H_i) = \frac{1}{(2\pi\sigma^2)^{N/2}\det(C)^{1/2}}\exp[-\frac{1}{2}(y-H_i)^T C^{-1}(y-H_i)] \tag{3}$$

Where "C^{-1} is inverse covariance approach, T is transpose of the signal and $H_i = H_0$ and H_1".To estimate the threshold value firstly applies to GLRT detection criteria. The GLRT threshold condition [16] is

$$L(Y) = \frac{P(y;H_1)}{P(y;H_0)} = \gamma \tag{4}$$

Where "γ is initial threshold, L(Y) is equivalent to GLRT threshold value". The ratio of probability of H_1 to H_0 has been substituted from equation (3) in equation (4) and therefore, we get

$$R^{\alpha}_{yy*} = \frac{\exp[-1/2(y-H_1)^T C^{-1}(y-H_1)]}{\exp[-1/2(y-H_0)^T C^{-1}(y-H_0)]} \mathop{\lessgtr}_{H_0}^{H_1} \gamma \tag{5}$$

Where "R^{α}_{yy} auto correlation is function and α is the cyclic frequency for the input samples".

$$L(Y) = R^{\alpha}_{yy*} \tag{6}$$

"The new samples are correlated with previous samples of same series for decision making and this type of correlation is called as the Autocorrelation Function (AF) and it is represented as R_{yy}". The combination of AF with cyclic frequency is represented as R^{α}_{yy} and it is equivalent to the threshold of L(Y).After simplifying the above equation (5), we will get

$$\Rightarrow -\frac{1}{2}(y-H_1)^T C^{-1}(y-H_1) + \frac{1}{2}(y-H_0)^T C^{-1}(y-H_0) \mathop{\lessgtr} \ln(\gamma) \tag{7}$$

By expanding the above equation (7) and moving the terms to right hand side, then the resultant equation is

$$\Rightarrow (H_1 - H_0)^T C^{-1}[y - \frac{1}{2}(H_0 + H_1)] \gtrless \ln(\gamma) \quad (8)$$

The basic threshold condition for the GLRT is

$$R^{\alpha}_{yy*} = (H_1 - H_0)^T C^{-1} y \gtrless [\ln(\gamma) + \frac{1}{2}((H_1 - H_0)^T C^{-1}(H_0 + H_1))] \quad (9)$$

The FFT condition is applied to the basic threshold equation (9) and the resultant equation obtained as

$$R^{\alpha}_{yy*} = [\ln(\gamma) + (\frac{1}{2}(H_1 - H_0)^T C^{-1}(H_1 + H_0))\exp(-j2\pi\alpha n f_s)] \quad (10)$$

Where f_s is the sampling frequency and n is the number of samples. As of the ANINATH condition, the combination of MFD and CFD detection methods are framed as Aninath detection method. According to the condition, equation (2) and equation (10) are combined, then the final threshold condition for the ANINATH-G has been obtained as

$$L(Y) = \frac{(H_1 - H_0)}{\sigma^2} * [\ln(\gamma) + (\frac{1}{2}(H_1 - H_0)^T C^{-1}(H_1 + H_0))\exp(-j2\pi\alpha n f_s)] \quad (11)$$

In the proposed ANINATH detection method, the authors have made calculation the threshold by using the NP observer detection criteria. The NP observer threshold (Tucker, J. D., 2010) condition has been given as

$$L(Y) = \frac{\left(P(y;H_1)/\sigma^2\right)^2}{\left(P(y;H_0)/\sigma^2\right)^2} = \gamma \quad (12)$$

$P(y;H_1)$ and $P(y;H_0)$ from equation (3) are substitute in the above equation (12) and as from the equation (6) the resultant equation has been obtained as

$$R^{\alpha}_{yy*} = \frac{\left[\exp[-(y - H_1)^T C^{-1}(y - H_1)] / 2\sigma^2\right]^2}{\left[\exp[-(y - H_0)^T C^{-1}(y - H_0)] / 2\sigma^2\right]^2} \mathop{\gtrless}_{H_0}^{H_1} \gamma \quad (13)$$

After simplifying and solving the above equation (13), obtained as

$$\Rightarrow -\frac{1}{2}(y-H_1)^T C^{-1}(y-H_1)+\frac{1}{2}(y-H_0)^T C^{-1}(y-H_0) \gtrless \sigma^2 \ln(\sqrt{\gamma}) \tag{14}$$

Simplifying the above equation (14) and the resultant equation is obtained as

$$\Rightarrow (H_1-H_0)^T C^{-1}[y-\frac{1}{2}(H_0+H_1)] \gtrless \sigma^2 \ln(\sqrt{\gamma}) \tag{15}$$

Simplifying the above equation and by moving the terms to right hand side, then the basic threshold condition for ANINATH-NP method has been obtained as

$$R_{yy^*}^{\alpha}=(H_1-H_0)^T C^{-1} y \gtrless \sigma^2 \ln(\sqrt{\gamma})+\frac{1}{2}((H_1-H_0)^T C^{-1}(H_0+H_1)) \tag{16}$$

The FFT condition has been applied to the basic threshold equation (16) of ANINATH-NP and the simplified equation obtained as

$$R_{yy^*}^{\alpha}=(H_1-H_0)^T C^{-1} y \gtrless [\sigma^2 \ln(\sqrt{\gamma})+\frac{1}{2}((H_1-H_0)^T C^{-1}(H_0+H_1))\exp(-j2\pi\alpha n f_s)] \tag{17}$$

As of ANINATH condition, the combination of MF and CFDI detection methods are framed as hybrid filter detection. According to the condition, equation (2) and equation (17) are combined, then the final threshold condition for the ANINATH-NP is

$$L(Y)=\frac{(H_1-H_0)}{\sigma^2} * [\sigma^2 \ln(\sqrt{\gamma})+(\frac{1}{2}(H_1-H_0)^T C^{-1}(H_1+H_0))\exp(-j2\pi\alpha n f_s)] \tag{18}$$

To analyze the performance of the detection system, the following parameters are considered as; the P_{fa} has been estimated as

$$P_{fa}=Q\left(\frac{\gamma-(H_1-H_0)^T C^{-1} H_0}{\sqrt{(H_1-H_0)^T C^{-1}(H_1-H_0)}}\right) \tag{19}$$

The P_D has been estimated as

$$P_D=Q[Q^{-1}(P_{fa})-\sqrt{(H_1-H_0)^T C^{-1}(H_1-H_0)}] \tag{20}$$

The P_{md} has been measured as

$$P_{md}=Q\left(\frac{\gamma-(H_1-H_0)^T C^{-1} H_1}{\sqrt{(H_1-H_0)^T C^{-1}(H_1-H_0)}}\right) \tag{21}$$

3 METHODOLOGY

The methodology for the proposed ANINATH method is shown in the Figure 2. The process of the ANINATH method has been illustrated as follows:

i. The received signals of the receiver are assumed as H_1 and H_0.

ii. The optimal threshold is estimated for the proposed ANINATH detection method by using GLRT and NP detection criteria's.

iii. The received signal has been correlate with the optimal threshold value and identifies the received sample as either $H1/H0$.

iv. The received samples are above the reference threshold level, the system identifies as the occupied the spectrum by users and P_D is measured.

v. The system identifies as the spectrum is free, when the received samples SNR's are below the threshold level.

vi. Due to weak signal strength at few low SNR ranges, the signal power less than the reference threshold level and it represents that the spectrum is free. Actually user is occupied that channel, so such miss detected samples are estimated by P_{md}.

vii. The received samples are H_0 and then the received signal is correlate with the optimal threshold level.

viii. The samples power is less than the reference threshold value, then the detection system identifies that the spectrum slot is free.

ix. The noise signal is highly dominated at the low SNR cases, such noise dominated samples are higher than the reference threshold level and such wrong detections are estimated by using the parameter of P_{fa}.

x. It is possible to identify the either miss detected or false alarm affected samples for a instant of time. While estimating the probability of errors different P_D values may arise and out of that two P_D values which contains maximum value has been taken as final P_D in the proposed method.

xi. The better detection method is identified by using the estimated parameters of P_D, P_{fa} and P_{md}.

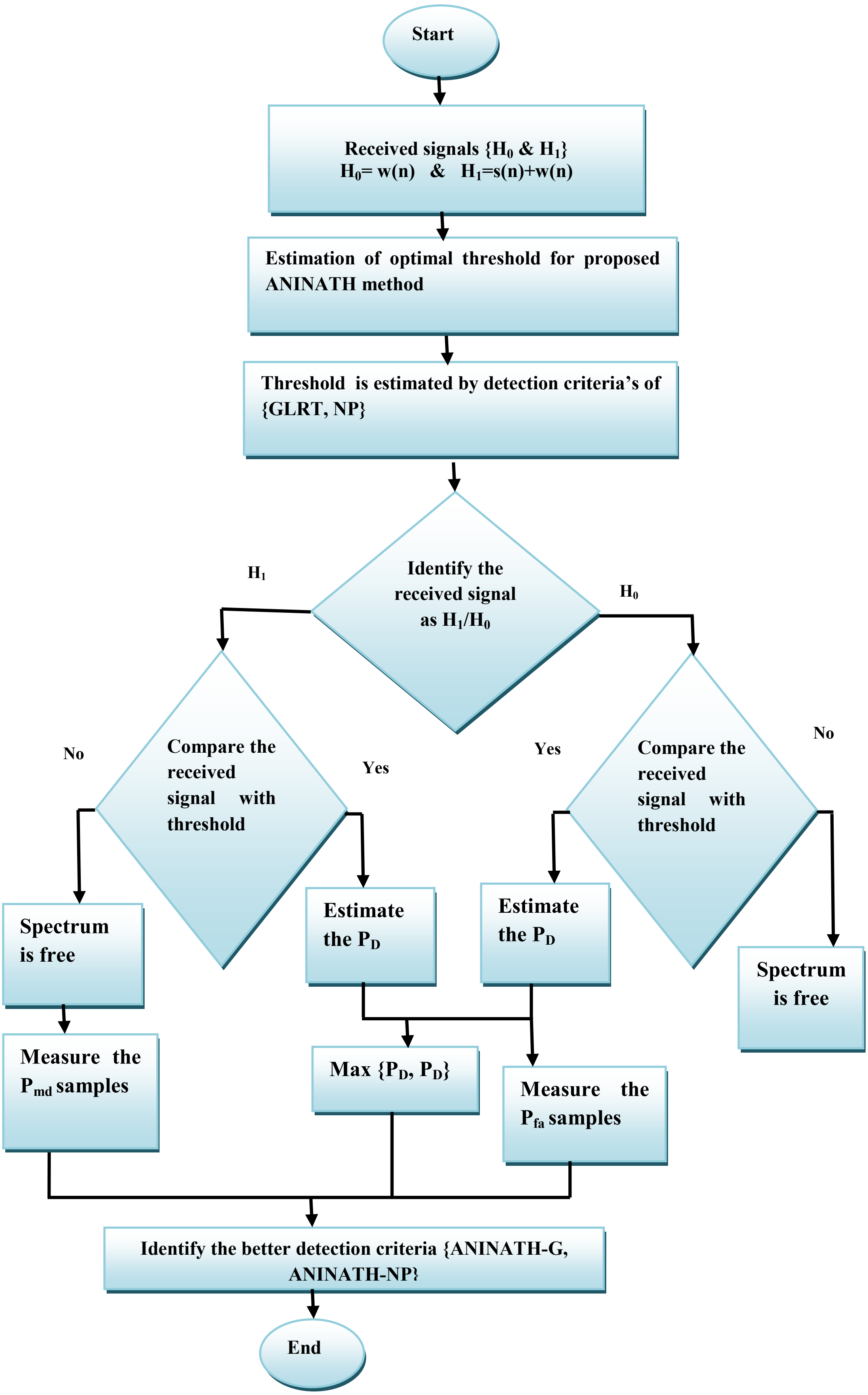

Figure 2: Flow chart of the proposed ANINATH detection

4. RESULTS AND DISCUSSION

In this paper, for simulation the following assumptions have been considered. 100 Monte Carlo samples are generated with equivalent to 100 channels. The free space propagation path loss is assumed as 40 dB/decade (Lee, W. C., 2010), the environment contains Rayleigh fading, the channel bandwidth is assumed as 200 KHz, the power ranges from -10 dB to 0 dB and the rate of periodicity of scanning is assumed as 20 seconds. The range of samples for a period α has been assumed as for every 100 samples.

From figure 3, the parameter of P_D has been analysed in along with the existing HFD method. At -10 dB the HFD method contains the P_D as 0.5, for the same power level ANINATH-NP have P_D as 0.58 and ANINATH-G contains 0.70 as given in Table 1. When the power level is increased from -10 dB to 0 dB the P_D also rises. To compare the ANINATH-G, ANINATH-NP with the HFD method, the P_D is high for the proposed two methods at all input SNR's. The threshold used in existing method is static for all SNR's, due to that the P_D is achieved as low. In the case of proposed two methods, the dynamic threshold value has been estimated and applied to all input SNR's. So, the proposed two methods got high P_D than existing method. In the proposed methods, the ANINATH-G offers more detection probability than ANINATH-NP. By comparing the ANINATHG and ANINATH-NP, the P_D offers 1 from the power level -3 dB onwards, but the ANINATH-NP gives 1 or high from -1 dB onwards. The input SNR -10 dB to -2 dB power level, the ANINATH-G contains more detection probability than ANINATH-NP. Hence, at low SNR ranges the ANINATH-G contributes better detection than existing and ANINATH-NP. The comparison between the proposed dynamic thresholds with the fixed threshold for the case of P_D at different power levels as shown in Figure 3.

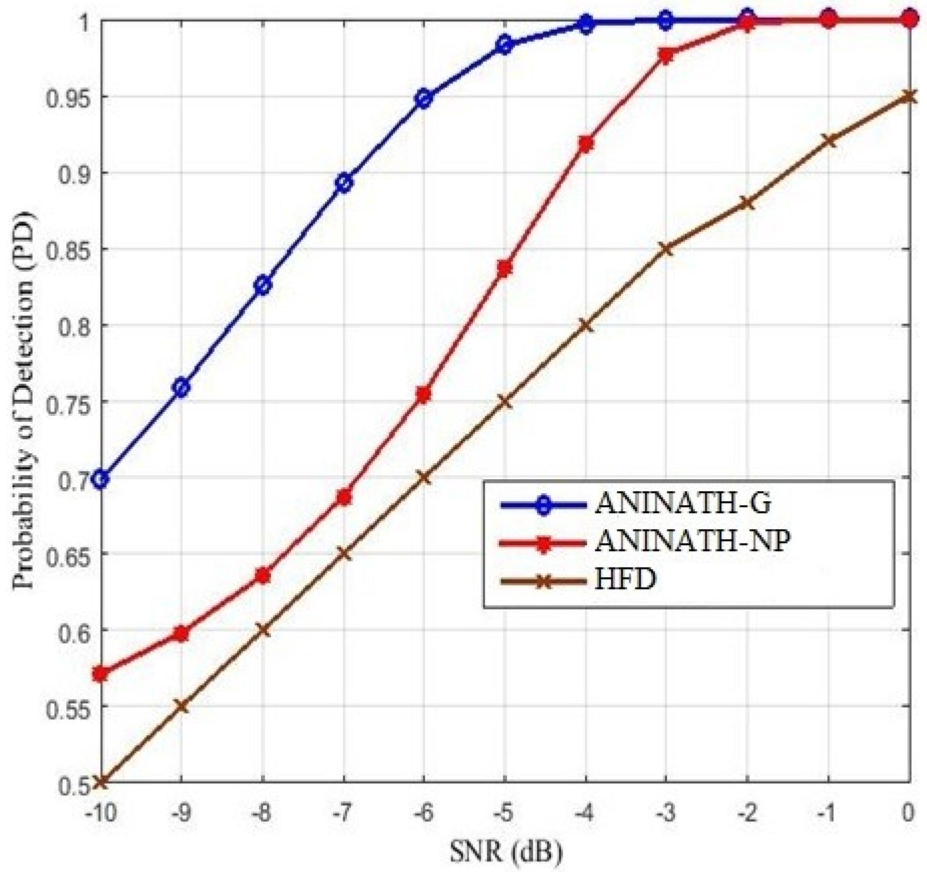

Figure 3: PD vs input SNR for proposed ANINATH

Figure 4: Comparison of P_D with dynamic and fixed thresholds

The comparison of P_D is analyzed between the power levels -10 dB and -5 dB with fixed threshold versus dynamic threshold as shown in Figure 4. In the HFD method, the threshold value is static for all SNR values. The P_D is observed at -10 dB, because of fixed threshold the P_D has been achieved as 0.5 and due to dynamic threshold, the P_D is achieved for ANINATH-G, ANINATH-NP as 0.69 and 0.57 respectively. The probability of detection has been observed at -5 dB, because of fixed threshold the P_D has been achieved as 0.75 and due to dynamic threshold, the P_D is achieved for ANINATH-G, ANINATH-NP as 0.98 and 0.83 respectively. To compare the detection probabilities at fixed threshold value, where as the power level increases from -10 dB to -5 dB the P_D is increased by 0.25 only. In case of dynamic threshold, the power level has been increased from -10 dB to -5 dB, the P_D has increased up to 0.26 for ANINATH-NP and 0.29 for ANINATH-G. The increase in rate of detection probability for proposed methods are higher than existing method and also the level of P_D is higher for the proposed methods than existing method. To compare with the HFD method, the proposed two methods have shown better detection probability. In the proposed detection methods, the ANINATH-G had increased by 0.29 when the power level is changed from -10 dB to -5 dB, but ANINATH-NP is increased by 0.26 when the power level is changed from -10 dB to -5 dB. The rate of increase of P_D and the level of detection probability is higher for ANINATH-G when compared to ANINATH-NP. The proposed methods are compared and the detailed analysis shows that, ANINATH-G provides more detection probability. The dynamic threshold provides better improvement in detection than fixed threshold value at low SNR levels.

The P_{fa} parameter is analyzed with the HFD method in figure 5. At -10 dB the HFD holds the P_{fa} as 0.5, the proposed ANINATH-NP contains the P_{fa} as 0.42 and ANINATH-G contains 0.3 for the same instant of power and also represented in Table 2. When the power level is changing from -10 dB to 0 dB the P_{fa} is reduced. To compare the ANINATH-G, ANINATH-NP with the HFD method, the P_{fa} is less for the proposed two methods for all input SNR's. The fixed low threshold value used for all existing methods of SNR values, the P_{fa} is high.

Table 1: P_D at various SNR levels of ANINATH

S.No.	Input Power (dB)	ANINATHG P_D	ANINATHNP P_D
1	-10	0.69	0.57
2	-9	0.75	0.59
3	-8	0.82	0.63
4	-7	0.89	0.68
5	-6	0.94	0.75
6	-5	0.98	0.83
7	-4	0.99	0.91
8	-3	1	0.97
9	-2	1	0.99
10	-1	1	1
11	0	1	1

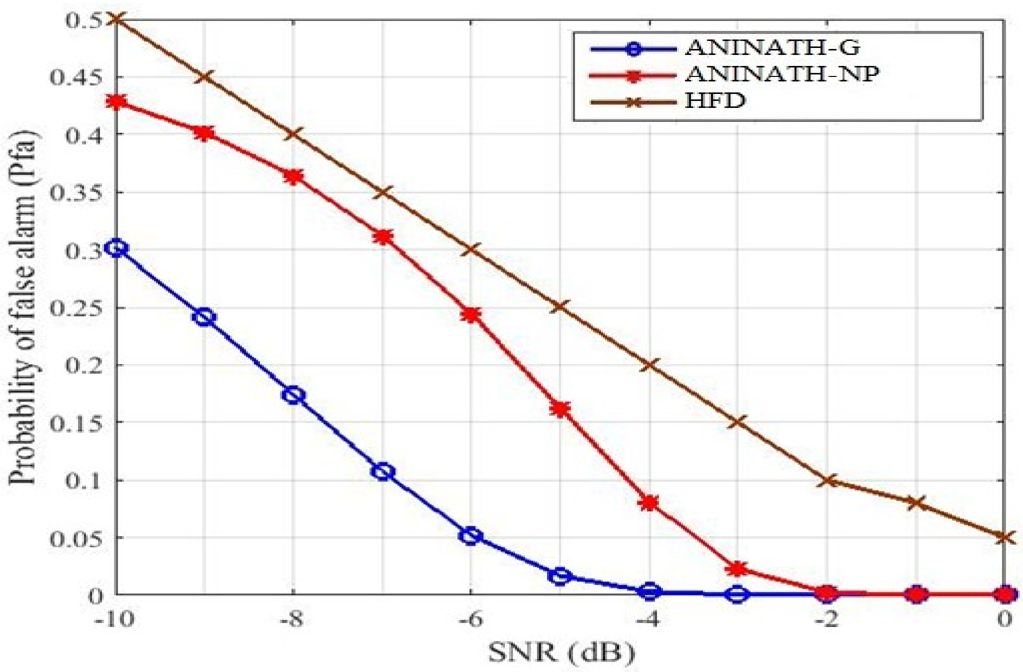

Figure 5: P_{fa} vs input SNR for proposed ANINATH

In the case of proposed methods, the dynamic threshold value is estimated and applied to all input SNR's. The proposed methods offer less P_{fa} than HFD method. In the proposed two methods, the ANINATH-G gives less false alarms than ANINATH-NP. By comparing the two proposed methods of ANINATH-G and ANINATH-NP, the power level from -10 dB to 0 dB, the ANINATH-G contains less P_{fa} than ANINATH-NP. Hence, ANINATH-G provides better improvement than HFD and the proposed ANINATH-NP at low SNR levels. The comparison between the proposed dynamic thresholds with the fixed threshold for the case of P_{fa} at different input power levels are as shown in figure 5.

The comparison of P_{fa} had been analyzed between the power levels -10 dB and -5 dB between fixed threshold and dynamic threshold is as shown in Figure 6. In the existing method, the threshold value is fixed for all SNR values. The P_{fa} is observed at -10 dB, for fixed threshold the P_{fa} is achieved by 0.5 and dynamic threshold the P_{fa} for ANINATH-G, ANINATH-NP is 0.30 and 0.42 respectively. The false alarm probability is observed at -5 dB, for fixed threshold, the P_{fa} is 0.25 and dynamic threshold the P_{fa} for ANINATH-G, ANINATH-NP as 0.02 and 0.16 respectively. To compare the P_{fa}, at fixed threshold value the power level is changing from -10 dB to -5 dB, the P_{fa} mitigates around 0.25. In the case of dynamic threshold, the power level is changing from -10 dB to -5 dB, the P_{fa} got decreased to 0.26 for ANINATH-NP and 0.28 for ANINATH-G. The rate of false alarm probability has mitigated higher for the proposed method than existing method and also the level of false alarms is less for the proposed methods. To compare the existing and proposed methods, proposed method shows better improvement in case of false alarms. In the proposed methods, the ANINATHG has less false alarms of 0.28 when the power level has been increased from -10 dB to -5 dB, but the ANINATH-NP had decreased by 0.26. The rate of decrease of P_{fa} and the level of false alarm probabilities are less for ANINATH-NP when compared to ANINATH-G. By comparing the proposed methods, ANINATH-G provides less probability of false alarms. The dynamic threshold provides better improvement in false alarms identification than fixed threshold value at lower SNR levels.

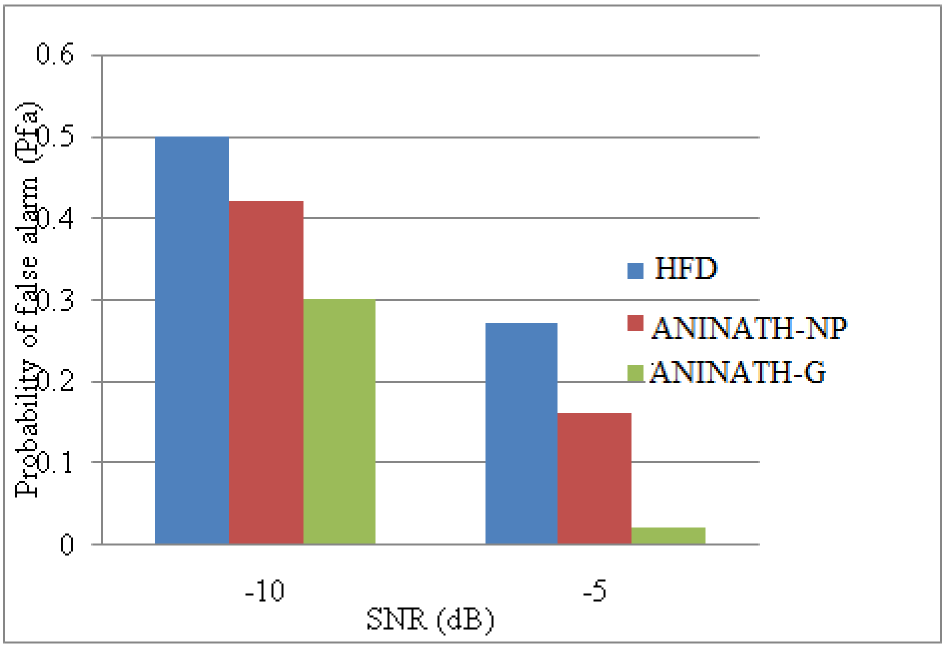

Figure 6: Comparison of P_{fa} with dynamic and fixed thresholds

Table 2: P_{fa} at various SNR levels of ANINATH

S.No.	Input Power (dB)	ANINATHG P_{fa}	ANINATHNP P_{fa}
1	-10	0.30	0.42
2	-9	0.24	0.40
3	-8	0.17	0.36
4	-7	0.10	0.31
5	-6	0.05	0.24
6	-5	0.02	0.16
7	-4	0.01	0.08
8	-3	0	0.02
9	-2	0	0
10	-1	0	0

11	0	0	0

The parameter of P_{md} is analyzed with the existing HFD as shown in figure 7. At -10 dB the HFD contains P_{md} as 0.5, the proposed ANINATHNP contains P_{md} as 0.44 and ANINATHG contains 0.37 for the same power level as given in Table 3. When the power level is changing from -10 dB to 0 dB, the P_{md} has been reducing for all methods. To compare the ANINATH-G, ANINATH-NP with the HFD method, the P_{md} is less for the proposed two methods at all input SNR's. The high fixed threshold value is used in existing method for all SNR values, due to that P_{md} became as high.

In the proposed two methods, the dynamic threshold value is estimated and applied to all input SNR's. Hence, the proposed methods offer less P_{md} than HFD. In the proposed two methods, ANINATH-G provides less miss detections than ANINATH-NP. The comparisons between the proposed dynamic thresholds with the static threshold, the P_{md} at different SNR levels are tabulated and the analysis on P_{md} as shown in Figure 8.

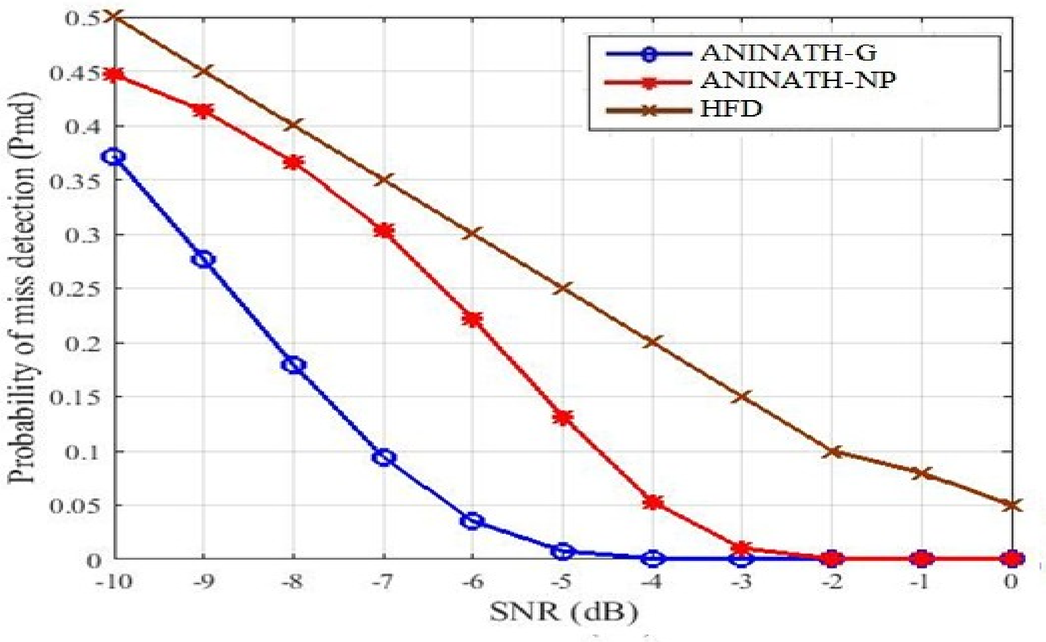

Figure 7: P_{md} vs input SNR for proposed ANINATH

The comparison of P_{md} is analyzed between the power levels -10 dB and -5 dB between fixed threshold and dynamic threshold as shown in Figure: 8. In the existing method, the threshold value is fixed for all SNR values. The P_{md} observed at -10 dB, has been achieved as 0.5 for higher fixed threshold and for dynamic threshold the P_{md} is achieved for ANINATH-G, ANINATH-NP as 0.37 and 0.44 respectively. The probability of miss detection is observed at -5 dB, for fixed threshold the P_{md} is achieved 0.25 and due to dynamic threshold the P_{md} is achieved for ANINATH-G, ANINATH-NP as 0.01 and 0.13 respectively. To compare the miss detection probability, at fixed threshold value the power level had been increased from -10 dB to -5 dB and the P_{md} is decreasing around 0.25.

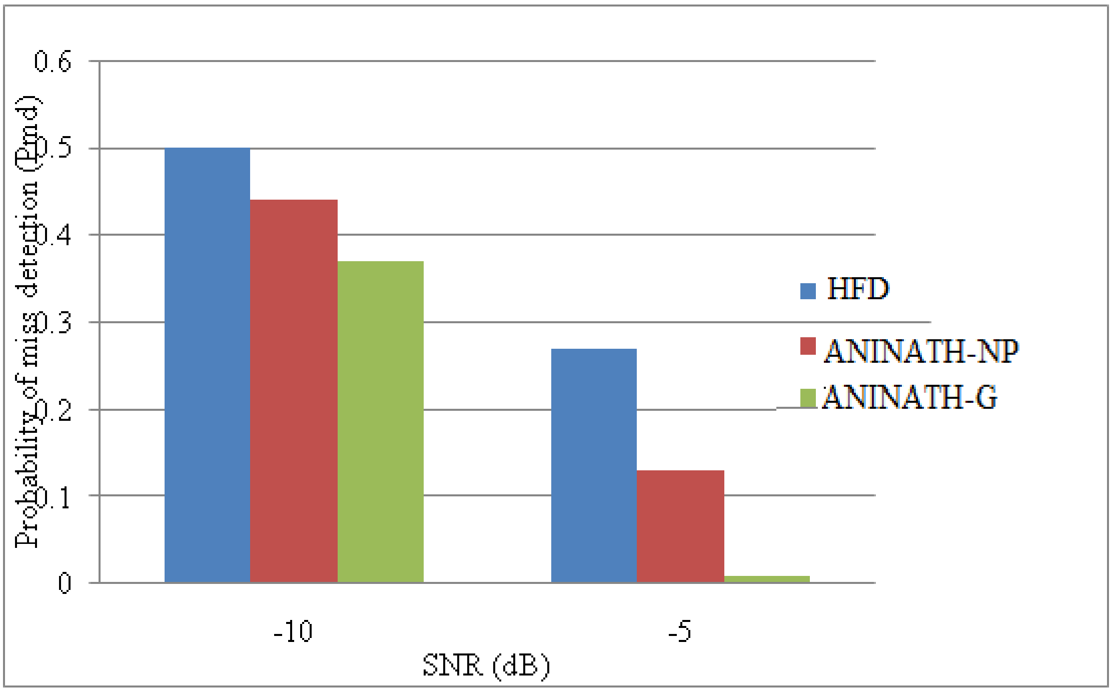

Figure 8: Comparison of P_{md} with dynamic and fixed thresholds

In the case of dynamic threshold, the SNR level increases from -10 dB to -5 dB and the P_{md} mitigates up to 0.31 for ANINATH-NP and 0.36 for ANINATH-G. The rate of miss detection probability had been higher for the proposed two methods than the HFD method and also the level of miss detection is less for the proposed methods. To compare with the HFD method, the proposed two methods show better improvement in case of miss detection. By comparing the rate of miss detection for ANINATH-G is decreased to 0.36 while the power level is changing from -10 dB to -5 dB, but the ANINATH-NP had decreased to 0.31 for the proposed methods. The rate of decrease of P_{md} and the level of miss detection probabilities is less for ANINATH-G when compared to ANINATH-NP. By comparing the proposed methods, ANINATH-G offers less probability of miss detections. The dynamic threshold provides better improvement in miss detection identification samples than fixed threshold value at lower SNR values.

Table 3: P_{md} at various SNR levels of ANINATH

S.No.	Input Power (dB)	ANINATHG P_{md}	ANINATHNP P_{md}
1	-10	0.37	0.44
2	-9	0.27	0.41
3	-8	0.17	0.36
4	-7	0.09	0.30
5	-6	0.03	0.22
6	-5	0.01	0.13
7	-4	0	0.05
8	-3	0	0.01
9	-2	0	0
10	-1	0	0
11	0	0	0

The performance of the parameters P_D, P_{fa} and P_{md} is analyzed individually and from the above results, it can be concluded that the proposed ANINATH-G provides better performance than the HFD and proposed ANINATH-NP method. To compare the test between P_{fa} and P_D, Receiver Operating Characteristic (ROC) curve has been plotted and shown in Figure 9. ROC curve is plotted between the ANINATH-G and HFD method to measure the receiver sensitivity. From figure 9, it is found that, ANINATH-

G has better performance at low SNR values when compared with HFD method. The P_D value has been changed from 0.65 to 0.95 in the existing method, but the ANINATH-G of P_D has been varied from 0.9 to 1 at various levels of P_{fa}. Hence, ANINATH-G provides better sensitivity than the HFD.

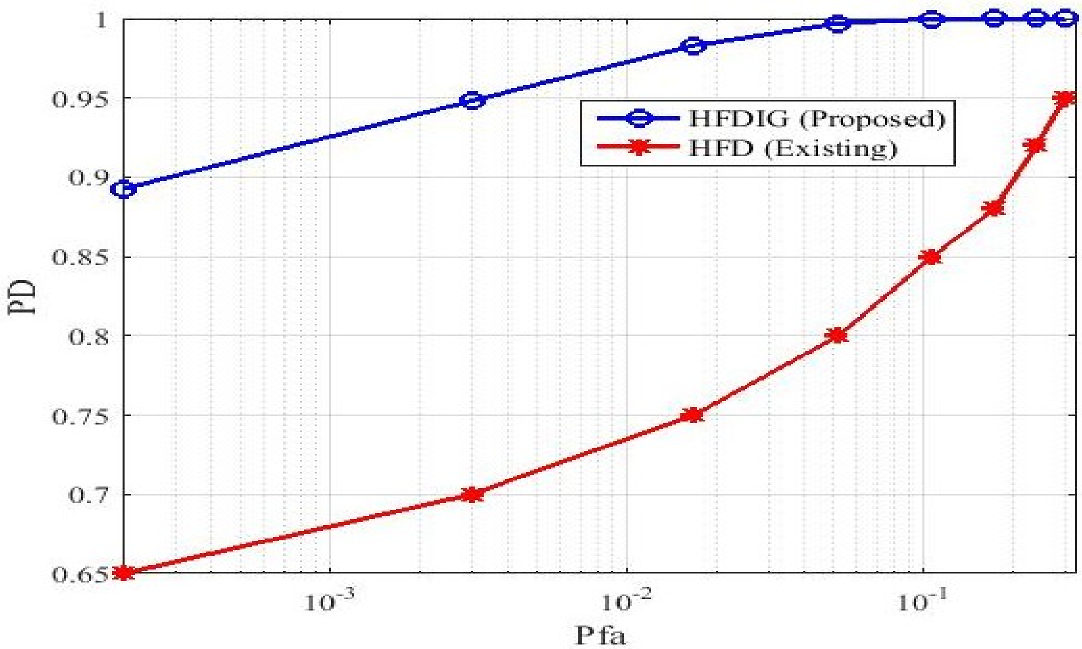

Figure 9: ROC curve of ANINATH

5. Conclusion:

First the hybrid detection system process which has been proposed by various researchers and the gaps is identified and discussed. The dynamic threshold value is computed for the proposed ANINATH-G and ANINATH-NP detection methods. The parameters P_D, P_{fa} and P_{md} are estimated for the proposed two methods. In the results and discussion, each parameter has been measured and plotted for the power levels from -10 dB to 0 dB. The statistical comparison has been proposed between the three parameters at -10 dB and -5 dB power levels and identified that ANINATH-G provides better detection when compared to existing and proposed ANINATH-NP. The ROC curve is plotted and recognizes the receiver is more sensible for which type of detection method. Finally it can be concluded that the ANINATH-G provides more sensitivity and detection method at low SNR values.

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