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Reliable Communication Strategies to Overcome Narrowband Interference in Low Frequency CDMA-DSSS Systems Using MATLAB

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Abstract: This study presents an efficient communication method for single-user direct spread spectrum (DSSS) systems that mitigates band-limited interference in code division multiple access (CDMA) systems. Advanced narrowband communications are in high demand in the security industry. This study presents an experimental and analytical comparison of CDMA power spectral density (PSD) at narrowband frequencies with and without interference. By varying the signal power and Barker code, the optimal system is presented based on the bit error rate (BER) and signal-to-noise ratio (Eb/N) curves. By experimentally varying the signal power, both interference-free PSD and narrowband low interference can be achieved. The spreading factor changes supported by the Barker code demonstrate the benefits of the optimized system model in the case of narrowband interference. The coding-based MATLAB® platform is used to implement the aforementioned novel approach for the CDMA-DSSS system design, modelling, and performance analysis.

Keywords: CDMA, DSSS, PSD, BER, MATLAB

I. INTRODUCTION

Modern DS-CDMA communication systems require optimal transmitter and receiver performance. In fact, the advantages of this system in real-world real-time applications lead to an expansion of the system's application fields. The purpose of the simulation is to improve the performance of the DSSS-CDMA communication system in a narrow-band interference environment. This work clearly demonstrated that varying the signal power can significantly improve the performance of a DSSS-CDMA receiving system against narrow-band interference [1-3]. The optimization approach shows how the expansion factor changes depending on a particular security code or Barker code.

A. Related Work

In DS-CDMA systems, minimizing interference in extremely low frequency ranges is a very difficult task. Starting around 2000, the first project in the related field was CDMA anti-interference authorization [1]. The implementation of a specific model of subspace connectivity has made it possible to increase employment in the material domain [2]. According to the arsenal of specific unfixed ranges [5]. Most near-field kabbalistic work uses the DS-CDMA detection approach [6-8].

II. SYSTEM DESIGN AND MODELLING

Therefore, we presented a modelling methodology based on MATLAB programming and interference cancellation. To compound the problem, we consider a specific value of the propagation coefficient. Generate Barker code based on the diffusivity model. To generate Barker code, utilize the following algorithm and formula. Component analysis [4] [11-16], this research project is important in the CDMA field. On the other hand, FM technology came up with the idea of jamming in order to relinquish power.

$$(C_v)^n = \sum N - v + 1_{aj} + v^n \, a_{jn} \qquad (1)$$

Here $(c_v)_n \leq 1$ for all $1 \leq v \leq N+1$.

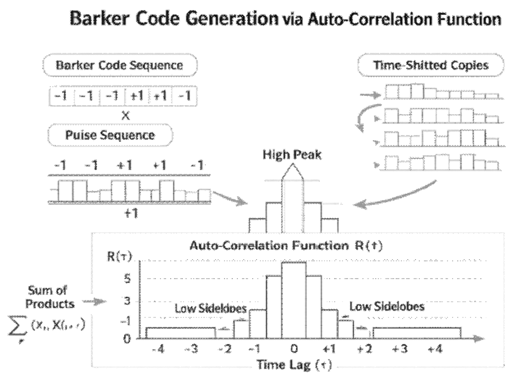

Fig. 1 Barker Code Generation

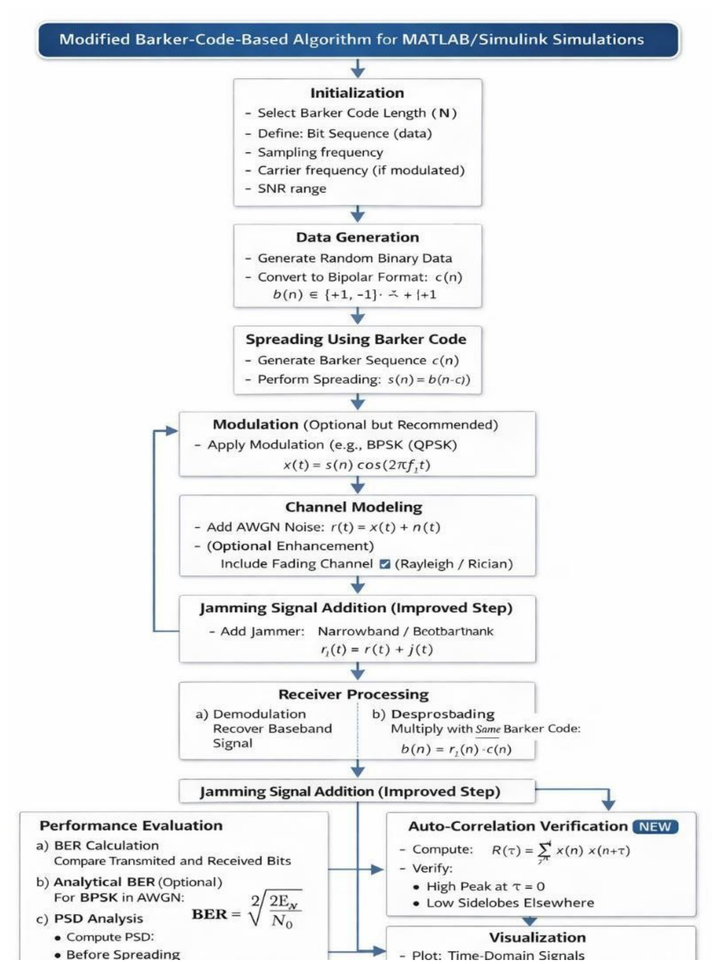

Fig. 2 Algorithm for the Suggested Model

After constructing the Barker code, a modulation technique like QPSK is selected. We then generate data jamming and the channel. The data is disseminated using the spreading code. The proposed system effectively eliminated noise, and the introduction of an Additive White Gaussian Noise (AWGN) channel significantly improved the system's noise performance. During detection, the signal is dispersed with the same chip. We measure the Power Spectral Density (PSD) at the receiver to quantify the jamming level. Our system is built using the proposed Barker Code algorithm. To achieve our goals, we calculate the bit error rate and power spectral density as demonstrated below. The formula we used for Power Spectral Density is as follows.

^{2}]

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$$S_x(f) = \lim_{T\to\infty} \left(mean[x(f)]^2 \right) \quad (2)$$

T represents the time period. To program this in MATLAB, we need to adjust equation (2) as follows.

$$S_x(f) = \lim_{T\to\infty} 1/T \left(\iint_{-T/2}^{T/2} C(t_1)C(t_2)\, mean(n(t_1)n(t_2))\, e^{-j2\pi f(t_1-t_2)}\, dt_1\, dt_2 \right) \quad (3)$$

The mean product of n(t) and C(t) is considered to be noise in (3). As a result, the intermediate power spectral density becomes noise in both systems, enhancing their security. The deterministic function C(t) and the Gaussian noise n(t) with zero mean are expressed in the formula above.

Elucidation of Bit Error Rate:

$$P_b = Q\left(\frac{\beta max}{2}\right) \quad (4)$$

$$\beta_{max} = \sqrt{[2/N \int_0^{Tb} [p(t) - q(t)]dt]} \quad (5)$$

P_b denotes Bit Error Rate. The difference between p(t) and q(t) is indicative of a matched pulse filter.

The time period is designated by T_b.

The use of the Barker code is unique in relation to the near-far problem, whereas solutions to the problem using changes in SNR are well known.

III. RESULTS AND DISCUSSION

Four various types of experimental data modification have been considered in order to reduce the interference effect. The value 13 is used as the spreading factor in all stages of experiments. For the first stage, we utilize the value of 5 dB SIR. It can be seen in Fig. 3 that there is no jamming data in the PSD. From the analysis of Fig. 4, it can be seen that the jamming reflection occurs within the range of 0 to 2.5 Hz of the frequency scale.

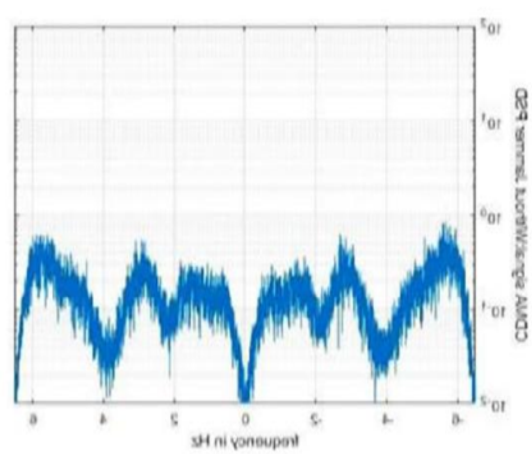

Fig.3:DS-CDMAPSDwith no jamming

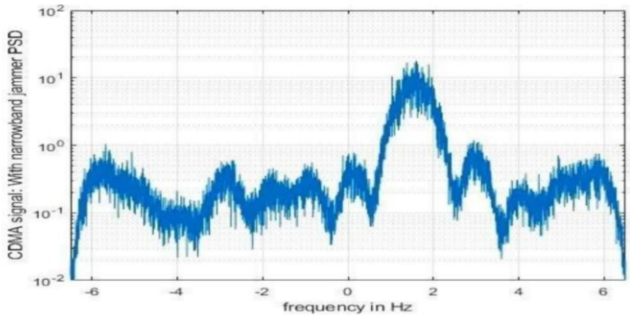

Fig. 4: Jamming PSD in DS-CDMA

It is evident from Fig. 5 that the 13-spreading factor and 5 dB SIR values are inadequate to suppress narrowband jamming. The analytical BER curve is shown as a smooth curve in Fig. 5, while the jamming curve is illustrated with a bubble line.
Fig. 5 depicts the inadequacy of 13 spreading factor and 5 dB SNR in suppressing narrowband jamming. In Fig. 5, the jamming curve has been drawn as a bubble line and the analytical curve as a smooth one.

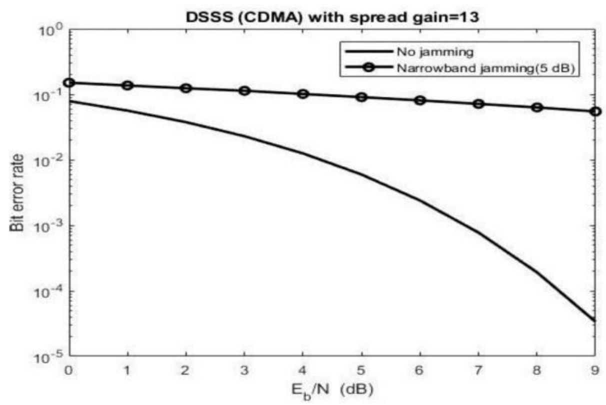

Fig. 5 Bit Error Rate with and without Jamming

In the second phase, the Signal-to-Interference Ratio (SIR) is 8 dB. These results are presented in Figs. 6, 7, and 8. Fig. 6 depicts the definition of jamming without any PSD. However, Fig. 7 depicts the definition of jamming with PSD. In accordance with the BER graph, the value of jamming has been reduced in Fig. 8. In contrast to Fig. 5, the bit error rate is somewhat minimized.

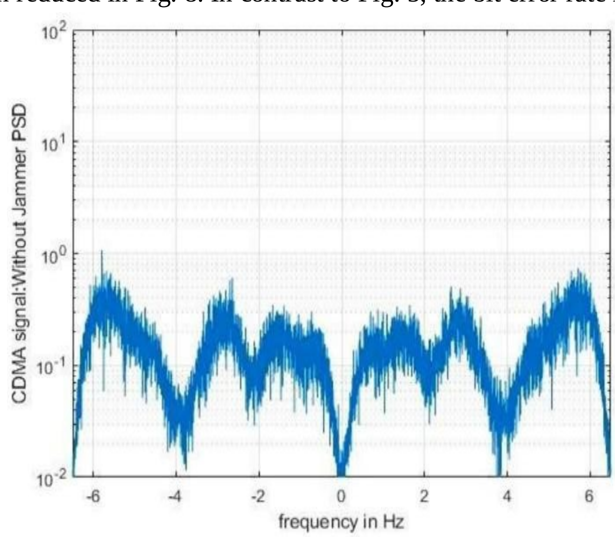

Fig. 6. DS-CDMA PSD without jamming

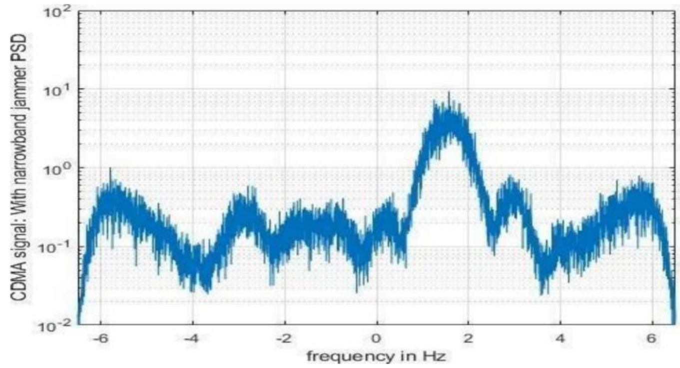

Fig. 7. DS-CDMA PSD with jamming

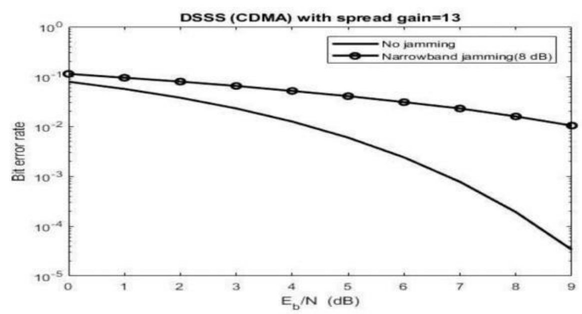

Fig. 8. Bit Error Rate with and without Jamming.

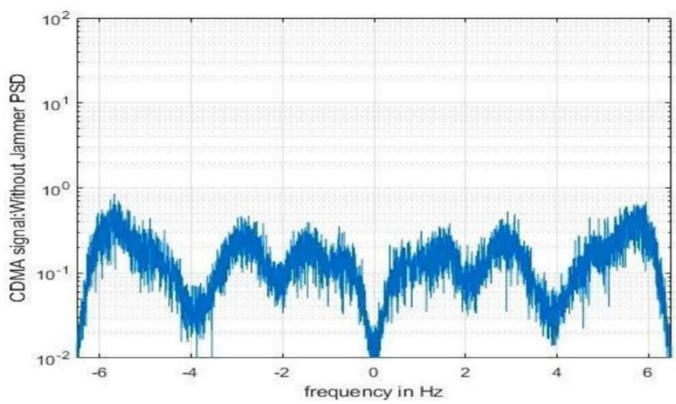

Fig. 9. DS-CDMAPSD without jamming

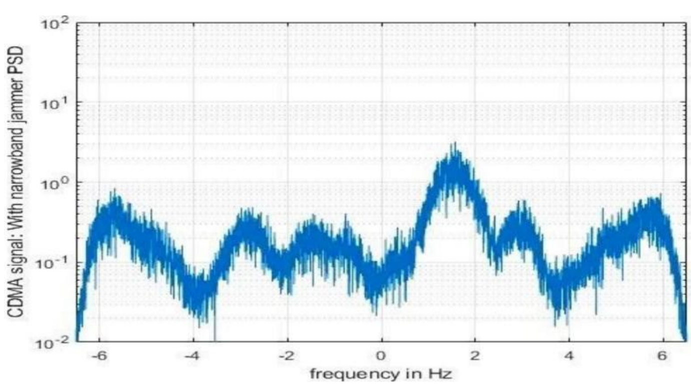

Fig.10 DS-CDMAPSD with jamming

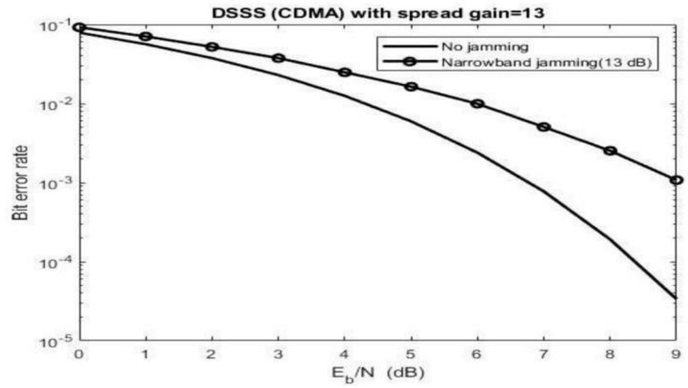

Fig. 11. Bit Error Rate with and without Jamming

Results obtained using SIR value of 13dB can be seen in Figures 9, 10, and 11. It can be seen from Figure 9 that there are no cases of data jamming. It can also be seen from Figure 10 that mitigation for jamming had a positive effect. Another issue is that the distortion is indicated by the swing of the PSD plot from positive to negative side. But in real situation, it depends on resolution.

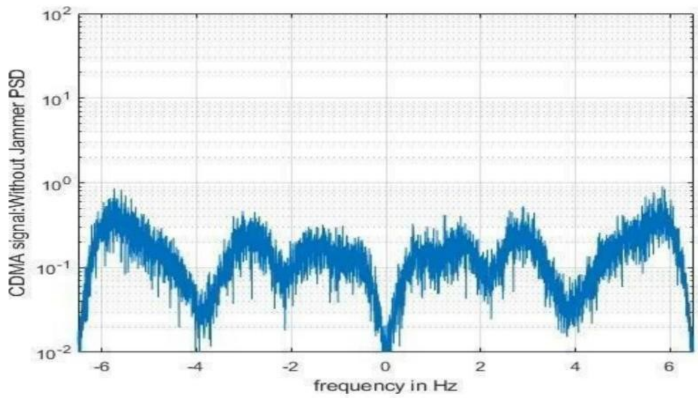

Fig.12. DS-CDMA PSD without jamming

The spreading factor of 13 and SIR of 20 dB can be related to Figs. 12, 13, and 14. Both Figs. 12 and 13 contain identical data indicating the absence of any jamming in this particular data set. The findings clearly indicated no jamming, as depicted in Fig. 14.

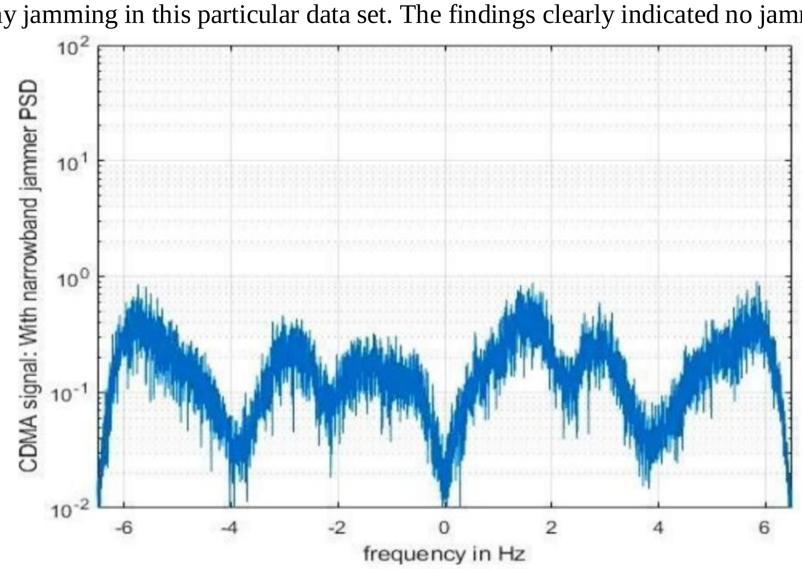

Fig. 13. DS-CDMA PSD with jamming

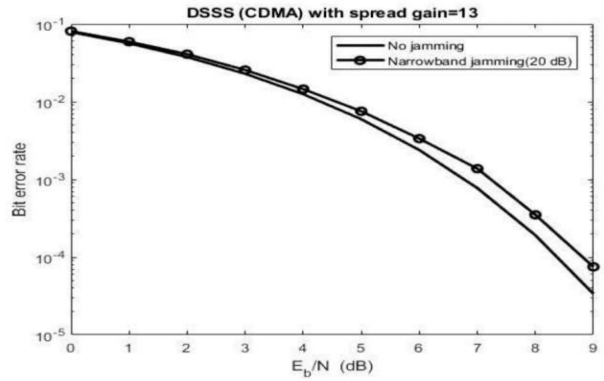

Fig.14 Bit Error Rate with and Without Jamming

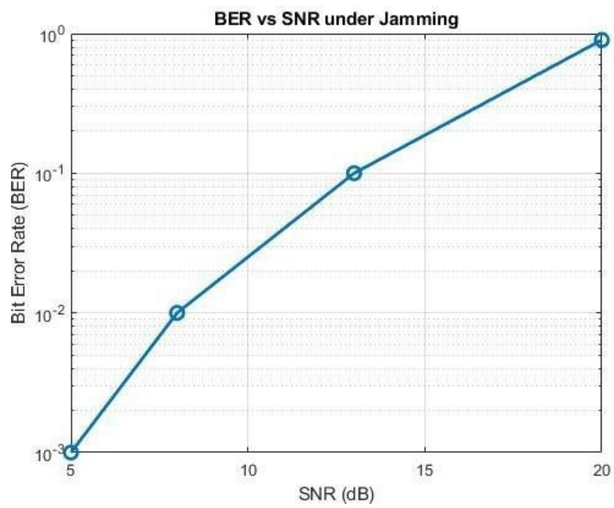

Fig.15 Bit Error Rate & SNR Under Jamming With 5dB to 20dB Variation

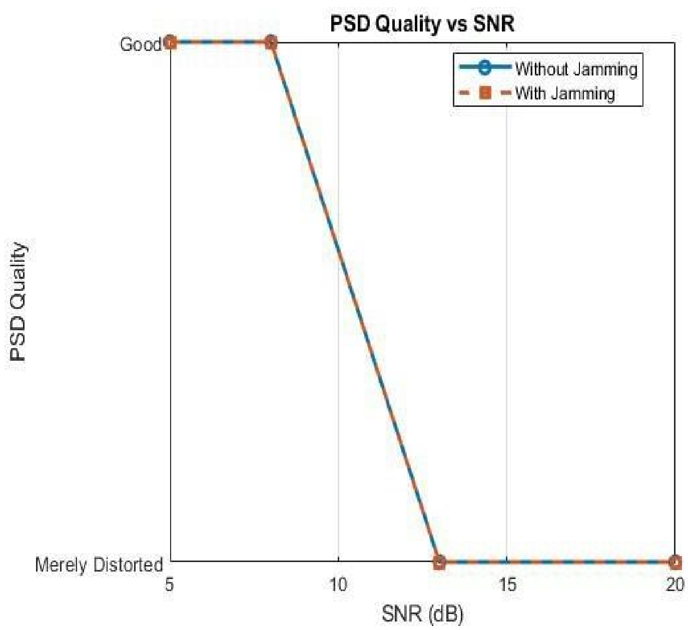

Fig.16:PSD Quality & SNR with & without jamming from 5dB to 20dB range

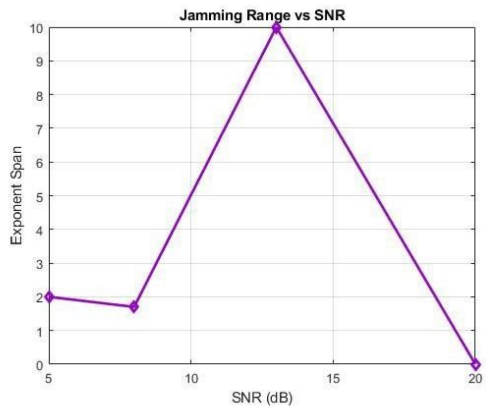

Fig.17: Jamming Range & SNR from 5dB to 20dB range

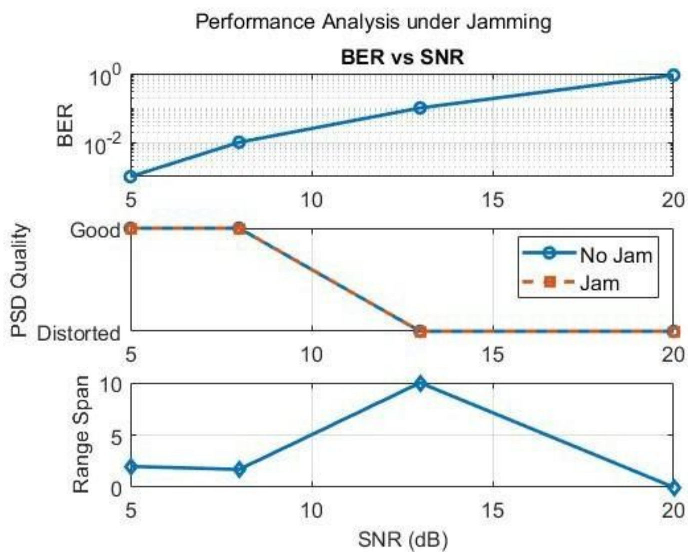

Fig.18: Performance Analysis under 5dB to 20dB Range

IV. CONCLUSION & FUTURE DEVELOPMENT

TABLE I PARAMETER ANALYSIS

Performance Analysis Data					
Spreading Factor	SNR (dB)	g Range of Jamming portion of PSD	PSD without jamming	PSD with jamming	BER
13	5	10^{-1}to10^{1}	good	good	10-3
13	8	10-1to 100.7	good	good	10-2
13	13	10-5to10+5	Merely distorted	Merely distorted	10-1
13	20	Below10^{0}	Merely distorted	Merely distorted	Almost over lapped

All parameters are calculated under SF 13 using Table 1. It can be observed that a higher SIR leads to almost jam- free PSD at the same SF. PSD performance is very good in low SIR; however, it is impacted by narrowband jamming. Distortion in PSD plots has been found to be caused due to resolution and not due to any practical reasons. Figure 1 shows the barker code generation.

Quantum computing may take the place of circuit/block creation in the future.

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