The International Journal of Engineering and Information Technology

journal homepage:www.ijeit.misuratau.edu.ly

Performance Optimization for 5GWireless Network

Fathi Masoud
CommunicationsEngineeringDepartment, College of Electronic Technology
Bani-walid, Libya

Abdelbary Mostafa Algamel
Communications Engineering Department, College of Electronic Technology
Bani-walid, Libya

Abstract— **Fifth Generation (5th G) wireless network is a challengeable research area. As it is intended to serve growing number of subscribers, and to handle various types of data. Therefore, the need for more number of channels and higher performance is increasing. In this paper, we focus on the adopted modulation scheme by 5th G (256 QAM), where the signals set have been arranged among the constellation diagram in order to reach minimum Bit Error Rate (BER) using Gradient Search Method [1]. The novelty of this study comes from adding permutation loop, which is applied on the resulting signals set of Gradient Algorithm, in order to achieve better performance (lower BER).**

The results show that acceptable BER under given Signal to Noise Ratio (SNR) could be reached with the relatively large amount of data that is required by this digital modulation scheme.

Index Terms: **BER, QAM, SNR, AWGN, PERFORMANCE, Gradient, 5th G, WIRELESS.**

I. INTRODUCTION

Digital Modulation is the process of changing one of the characteristics of an analog signal based on the information in digital data. Figure 1 shows the relationship between the digital information, the digital-to-analog modulating process, and the resultant analog signal.[2]

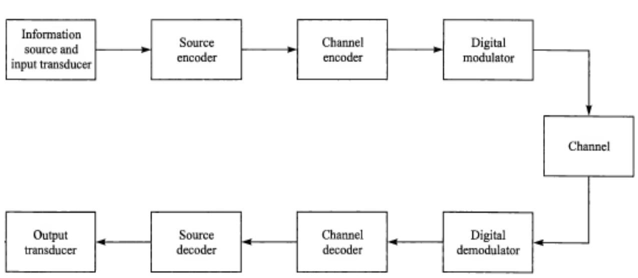


Figure 1. General block diagram

In phase shift keying (PSK), the phase of the carrier is varied to represent two or more different signal elements. Both peak amplitude and frequency remain constant as the phase changes. Today, PSK is more common than ASK or FSK. However, Quadrature Amplitude Modulation QAM, which combines ASK and PSK, is the dominant method of digital to analog modulation.**[2].**

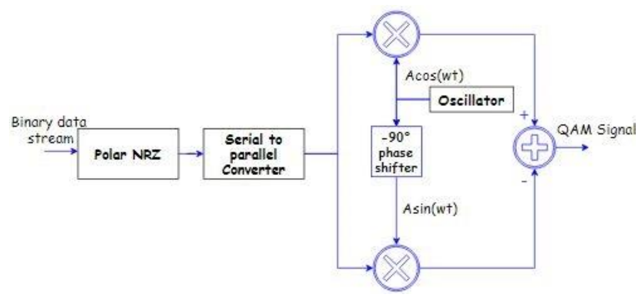


Figure 2. QAM

II. CONSTELLATION DIAGRAM

A constellation diagram is a sketch representation for the digital modulation scheme.

It represents the signal as an n-dimensional plane scatter diagram in the complex plane at symbol sampling instants [4]

Constellation diagram displays the signal place according to each dimension as well as the related neighbor space, due to noise, the signal shifts from its point toward any direction, if the noise is strong enough, the signal enters another signal's space and demodulated mistakenly, which causes error, therefore, if the points are too close to each other, high Bit Error Rate (BER) can be resulted, on the other hand, if the points are too far from each other, low BER is achieved, but this means that high power will be consumed.
Hence, Signal to Noise Ratio (SNR) is used as a reference versus BER in order to measure the performance of any digital modulation scheme.

Received 17 July , 2021; revised 26 Aug, 2021; accepted 15 Oct, 2021.

Available online 26 Oct, 2021.

III. WAVE FORM REPRESENTATION

The waveforms are expressed according to *Gram Schmidtprocedure* [3]:

$$S_m(t) = \sum_{n=1}^{N} S_{mn}\phi_n(t) \qquad (1)$$

Where N is the number of dimensions, $\phi_n(t)$ is a set of orthogonal signals[3].S_{mn} is the coefficient that represents the vector projection on $\phi_n(t)$.

Actually each dimension here is dedicated as a carrier for QAM.
$\phi_1(t)$ is simply $S_1(t)$ normalized to unit energy. By subtracting the projection of $S_2(t)$ on $\phi_1(t)$ from $S_2(t)$and normalizing the result to the unit energy we get $\phi_2(t)$, this procedure is repeated until the whole carriers are determined [3]. Generally, The formula for PSK is:

$$S_m(t) = \begin{cases} \sqrt{\frac{2\varepsilon_s}{T}}\cos\left(w_0 t - \frac{2\pi m}{M}\right), 0 \le t \le T \\ 0 \qquad\qquad , elsewhere \end{cases} \qquad (2)$$

Where, m=1,2,…..,M [3]

IV. GRADIENT SEARCH METHOD

The purpose of Gradient Search method is to find the constellation set that has the minimum Bit Error Rate (BER). From [1] BER can be approximated by the following equation:

$$P_e \sim \exp(-\frac{1}{8N_0} min_{i\neq j}(\|s_i - s_j\|^2) \qquad (3)$$

The algorithm is described by:

$$S_{m+1}{}^{*} = S_m - \alpha_m \nabla P_e(S_m) \qquad (4)$$

Where $\alpha_m$is positive step size, and $\nabla P_e(S_m)$ is the gradient of $P_e$with respect to S_m [1]

$$S_{m+1} = \frac{S_{m+1}{}^{*}}{\|S_{m+1}{}^{*}\|} \qquad (5)$$

Equations 4,and 5 are repeated until P_e converges at a given tolerance. Figure 3 illustrates flowchart for the iterations.

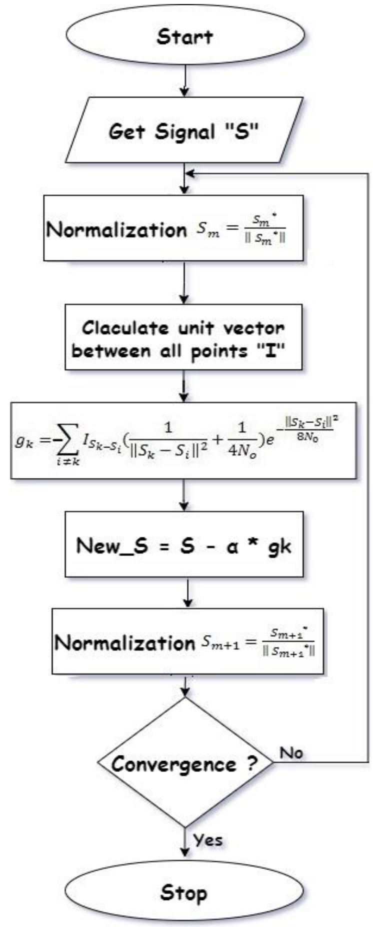
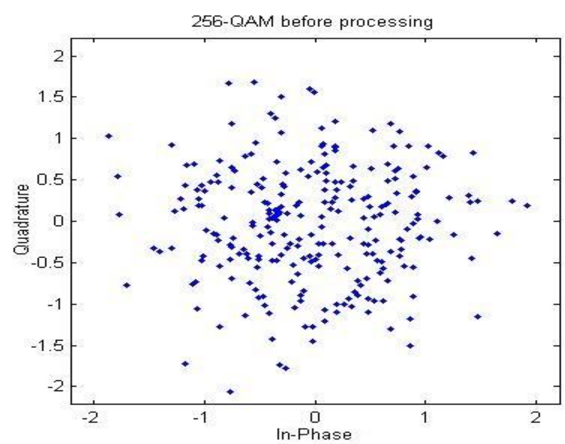


Figure 3. Gradient Search Algorithm

V. RESULTS AND DISCUSSION



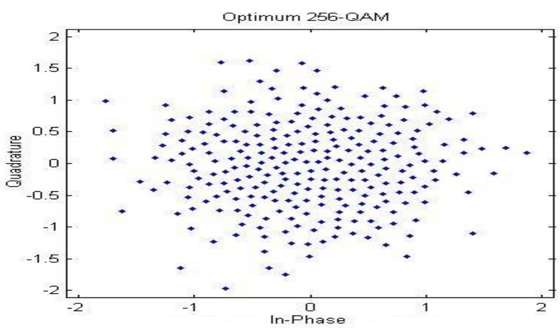
a . 256 QAM before processing.

MATLAB is used to perform both Gradient Search and the permutation loops. Where a specific code has been built to produce random 256-QAM signals (figure 4-a), and then all the formulas that are illustrated in figure 3 are built and carried out sequentially until the algorithm converges, separate code is designed for the permutation loops in order to reach the optimum distribution (figure 4-b).

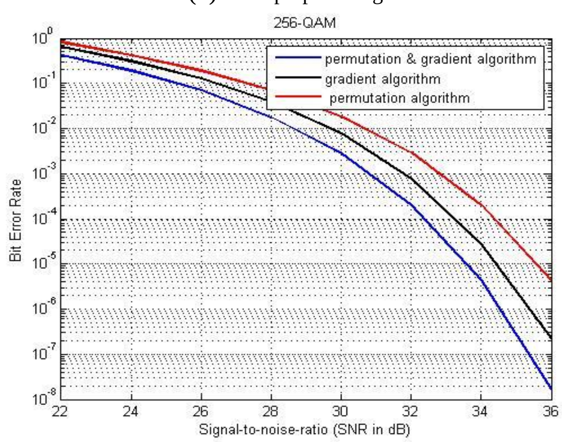
Figure 4-c shows that BER is lowered to 10^{-5} at about 36dB by using only the permutation method. While the same BER could be achieved nearby 35 dB by using Gradient Search, as proposed by Foschini [1] , which is obviously better. By combining both ways, 10^{-5} can be reached around 33 dB. Which means that the results in [1] could be enhanced by using permutation.

Figure 4 (a) Random Constellation (b) Optimum Constellation (c) SNR vs BER.

By considering the results in [5], it can be noted that BER of 10^{-5} is achieved at about 40 dB, without channel coding and under Gaussian noise. The documented results of Gradient search/permutation loop show better performance.



(a) The proposed signal set.



(b) Upper curve: permutation, middle curve: Gradient, lowest curve: both algorithms.

VI. CONCLUSION

Gradient search method has been applied to reach the optimum distribution of QAM 256 signals over the constellation diagram. The above results show that the method could be used to get relatively good outcomes, and also can be further enhanced by using a number of permutation loops.

The results show that although Gradient search is very effective method, but it does not give the perfect distribution at all the cases, and should be enhanced by extra procedures such as permutation.

ACKNOWLEDGMENTS

The authors wish to thank CETB staff for their valuable help and support.

REFERENCES

[1] Optimization of Two-Dimensional SignalConstellations in the Presence of Gaussian Noise by GERARD J FOSCHINI, RICHARD D.GITLIN, STEPHEN B.WEINSTEIN.
[2] Data Communications and Networking By Behrouz A.Forouzan
[3] Digital Communications By JoahnG.Proakis, MasoudSalehi
[4] Computer Networks By Andrew S. Tanenbaum , David J. Wetherall
[5] Significant reduction of Bit Error Rate in 5G-GFDM system using Concatenated Turbo Code with low density parity check code in fading channels by Hocine Merah, Khalid Tahkoubit, Moukhtaria Mesri Merad.

BIOGRAPHY

FATHI.M.MASOUD received his Master in systems and signals area from West Virginia University in 2012. He joined CETB as lecturer and Head of Training Department in 2013. Then as the General Registrar in 2017 Also worked as Telecom Specialist for ENI GAS Company from 2003 to 2009 and attended enhancing intensive courses in ALCATEL company/Italy in 2003.

Abdelbary Mostafa Algamel student inCollege of Electronic Technology,Bani-walid, in Communications Engineering Department, Also Researcher at (UNDP).