Journal of Information Systems Engineering and Management
2024,9(4)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Image Quality and BER Trade-Offs in M-Ary Modulation Techniques for CW-Based Communication Systems

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ARTICLE INFO

Received: 23 Sep 2024

Accepted: 22 Dec 2024

ABSTRACT

In this research, digital carrier wave (CW) modulation schemes are investigated for enhancing the reliability and efficiency of image transmission over communication systems. The focus is on evaluating the performance of various digital modulation techniques—such as PSK, QAM, and FSK—by analyzing their Bit Error Rate (BER) in relation to the energy per bit to noise power spectral density ratio (Eb/No). The goal is to determine the most suitable modulation strategy under additive white Gaussian noise (AWGN) conditions.The image transmission system is modeled using MATLAB/SIMULINK to simulate and analyze real-time transmission scenarios. The image is modulated using different CW techniques, transmitted through an AWGN channel, and subsequently demodulated at the receiver. The effectiveness of each modulation technique is assessed through key performance indicators including BER, Peak Signal-to-Noise Ratio (PSNR), Mean Squared Error (MSE), Standard Deviation, and Variance.Simulation results show that modulation schemes with lower M-values exhibit lower BER at lower Eb/No values, making them suitable for long-distance and low-SNR conditions.[2][4][7]

Conversely, higher-order modulation schemes demonstrate better spectral efficiency and data throughput but at the cost of increased error rates at lower Eb/No values. Thus, for high data rate applications, higher-level modulation is recommended when sufficient signal strength is available.Graphical analysis of Eb/No versus BER confirms the trade-off between modulation complexity and performance reliability. Additionally, the reconstructed images after demodulation are evaluated to ensure acceptable image quality. The findings from this study aid in selecting optimal modulation techniques based on communication requirements, distance, and desired image fidelity.This work highlights the practical relevance of digital CW modulation schemes in modern wireless image communication systems and provides a foundational comparison for system designers.[11][13]

Keyword: Carrier Wave Modulation, Image Transmission, Digital Modulation Techniques, Bit Error Rate (BER), Eb/No, AWGN Channel, MATLAB/SIMULINK, PSNR, MSE, Modulation Order, Signal Quality, Communication System Performance

1. INTRODUCTION

In recent years, digital communication has become one of the most dominant and transformative areas within the field of telecommunications. This paradigm shift is largely due to the increasing demand for high-speed, reliable, and efficient transmission of data across various media. Digital communication systems work by encoding information into binary form—sequences of bits (0s and 1s)—which are then transmitted over different types of channels. Among the core techniques used in digital communication are modulation schemes that help in adapting the binary data to suit the physical medium of transmission.Some of the widely adopted digital modulation techniques include Binary Phase Shift Keying (BPSK), Quadrature Phase Shift Keying (QPSK), M-ary Phase Shift Keying (M-PSK), Quadrature Amplitude Modulation (QAM), and Gaussian Minimum Shift Keying (GMSK). Each technique offers a trade-off between factors like bandwidth efficiency, signal robustness, and power consumption. The selection of a particular modulation scheme is often governed by the nature of the application and the channel conditions.Image transmission, in particular,

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poses unique challenges due to its requirement for both high data rates and the preservation of image quality. Unlike textual data, images are sensitive to distortions, and even minor errors during transmission can significantly degrade visual quality. [3][8]

Therefore, performance metrics such as Bit Error Rate (BER) and Peak Signal-to-Noise Ratio (PSNR) become critical when evaluating the effectiveness of different modulation schemes in transmitting image data.This research focuses on Carrier Wave (CW) modulation techniques for the purpose of efficient and high-quality image transmission. CW modulation serves as the backbone for carrying digital signals, particularly in environments that demand high throughput. The core idea is to convert the image into a digital data stream and then transmit it using digital modulation schemes such as M-ary PSK, M-ary FSK, and M-ary QAM. These techniques are known for their ability to support multiple data levels, thereby increasing the data rate without requiring additional bandwidth.The proposed system aims to optimize the key performance indicators in communication systems—BER, Energy per Bit to Noise Power Spectral Density Ratio (Eb/No), and bandwidth. Using MATLAB/SIMULINK, a simulation-based environment, we have implemented a model-based design approach to assess and compare the performance of different modulation schemes under Additive White Gaussian Noise (AWGN) channel conditions.Furthermore, the research does not solely focus on transmission accuracy but also evaluates image quality after reception. Metrics such as Mean Squared Error (MSE), Standard Deviation, and Variance are computed to analyze the distortion introduced during the modulation-demodulation process. The simulation results demonstrate how modulation order and scheme selection directly influence both transmission reliability and image quality.In summary, this study provides a comprehensive analysis of various CW modulation techniques for image transmission and highlights their impact on error rates and image quality parameters, aiming to find an optimal balance between performance and efficiency.[1][6]

2. METHODOLOGY & DESIGN

In this study, a comprehensive methodology has been employed to analyze and evaluate the effectiveness of various Carrier Wave (CW) modulation schemes in the context of image transmission. The primary objective is to explore how different digital modulation techniques affect the Bit Error Rate (BER) and the Peak Signal-to-Noise Ratio (PSNR)—two critical parameters that influence the quality and reliability of transmitted images. This section outlines the design architecture, technical approach, simulation tools used, and the criteria for performance evaluation.[22][25]

To begin with, the mathematical expressions for calculating the BER for various digital modulation techniques such as M-ary Phase Shift Keying (M-PSK), M-ary Frequency Shift Keying (M-FSK), and M-ary Quadrature Amplitude Modulation (M-QAM) were considered. These mathematical models serve as the basis for evaluating the theoretical performance of each scheme. By comparing these expressions across different modulation orders (M-values), a deeper understanding of how each technique behaves under varying conditions of signal-to-noise ratio (SNR) can be developed.

In the proposed system, a MATLAB/SIMULINK platform is used to model and simulate the image transmission process. The overall system architecture includes several core components: an image encoder, a digital modulator, a transmission channel (AWGN), a demodulator, and an image decoder. First, the input image is converted into a digital bitstream. This data is then modulated using a selected CW modulation scheme and transmitted over a simulated AWGN channel, which mimics the effect of noise during real-world communication. Upon reception, the signal is demodulated, and the image is reconstructed. The quality of the reconstructed image is evaluated using PSNR, Mean Squared Error (MSE), Standard Deviation, and Variance metrics.[5][10]

One of the distinctive features of this methodology is the integration of a bit-shifting encryption technique to enhance the security of transmitted data. This lightweight encryption method ensures that even if the data is intercepted during transmission, it cannot be easily deciphered without the correct decryption key. The integration of encryption does not significantly affect the transmission speed or image quality, making it suitable for real-time applications.[21][24]

The modulation schemes are evaluated by altering the modulation order (M) for each technique. As the value of M increases, the system can transmit more bits per symbol, which improves the data rate. However, this

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e-ISSN: 2468-4376
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comes at the cost of increased susceptibility to noise, leading to higher BER and reduced image clarity. Conversely, a lower M-value results in better error resilience but reduces the overall data rate. Thus, selecting the optimal modulation order becomes crucial to strike a balance between transmission speed and image quality. The simulation results confirm that careful tuning of M-values allows for optimized system performance based on the application requirements.[9][23]

The proposed methodology also highlights the adaptability of the system to different image types and sizes. The prototype is capable of transmitting grayscale as well as colored images with minimal loss, depending on the channel conditions and modulation strategy. The application, once fully developed, can be extended for broader use in areas such as telemedicine, satellite imaging, and military communications where both image fidelity and secure transmission are paramount.[4][19]

In conclusion, the design and implementation of this image transmission system demonstrate that CW modulation techniques, when appropriately selected and configured, can provide an efficient, secure, and high-quality solution for image communication. The combination of digital modulation, lightweight encryption, and performance evaluation metrics ensures that the proposed system is robust and practical for real-world deployment. Future enhancements could include adaptive modulation techniques and channel coding to further improve reliability under harsh transmission conditions.[12][17]

Flow Diagram

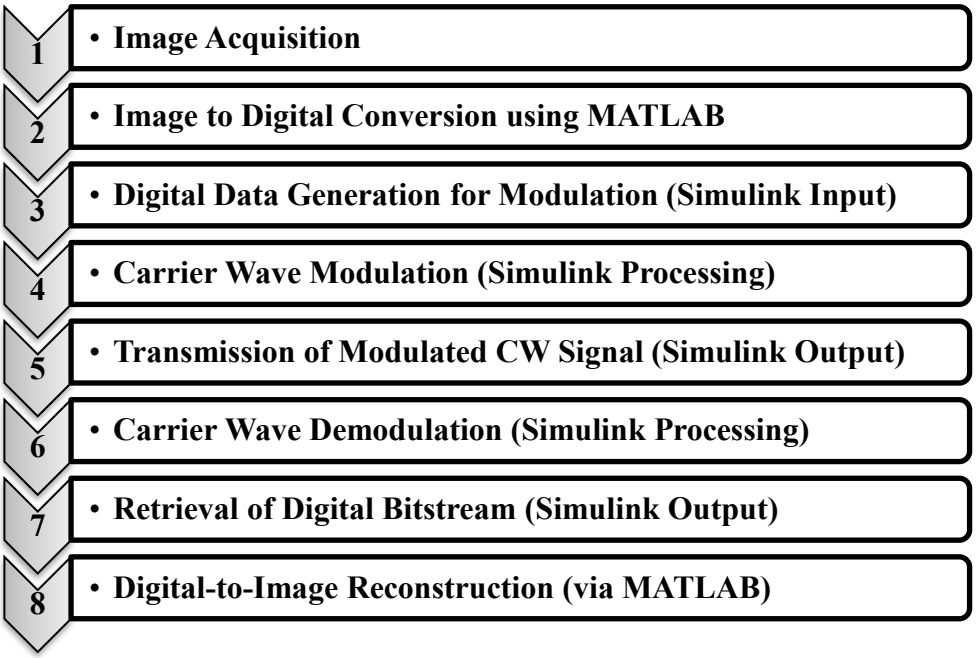


Fig. 1: System-Level Flow Diagram for Image Transmission using Digital Carrier Wave Modulation Techniques

Proposed Methodology and Image Flowchart Description

In the proposed system, the primary input is a digital image which undergoes a series of transformations for transmission through various Carrier Wave (CW) modulation schemes. The image is first processed using MATLAB, where it is converted from its standard visual representation into a digital format. This conversion is essential because transmission systems based on CW modulation require digital data as input. The image is thus transformed into a stream of hexadecimal or binary values—representing the image in digital signal form.[2][16][18]

Following the conversion, the digital signal is passed into a selected digital modulator. In this study, we particularly focus on Gaussian Minimum Shift Keying (GMSK) as one of the modulation schemes, which is

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e-ISSN: 2468-4376
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known for its spectral efficiency and constant envelope characteristics, making it ideal for image transmission in bandwidth-constrained environments.
Once modulation is completed, the data is sent over a simulated channel. On the receiver side, the signal undergoes demodulation using the corresponding demodulator, and the recovered digital stream is re-converted into an image. This completes the process of image transmission and reception using CW modulation.[4][6][14]

A critical part of this research involves assessing the quality of the received image after transmission. Various image quality parameters, including Peak Signal-to-Noise Ratio (PSNR), Mean Squared Error (MSE), and other statistical metrics, are evaluated. These parameters help determine the efficiency of different CW modulation techniques in preserving image fidelity. Each modulation scheme used in this study is tested to analyze its impact on image quality during transmission and reception. This approach enables a comparative analysis to determine the most suitable CW modulation method for digital image communication applications. [3][15][20]

3. DESIGN STEPS

1. Design Step for BPSK

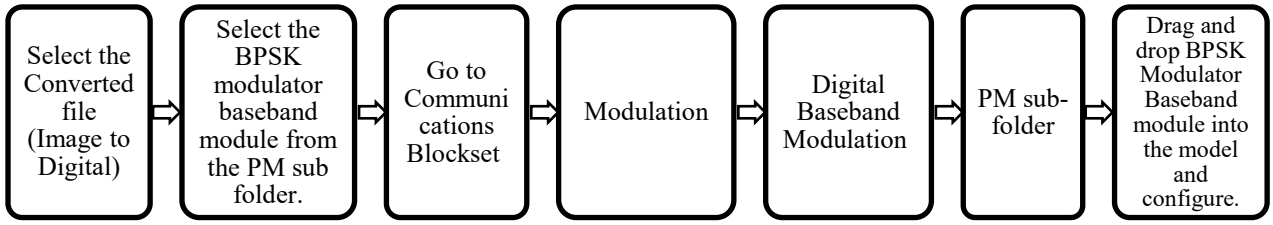


Fig. 2: Simulink-Based Model of Image Transmission Using Binary Phase Shift Keying (BPSK)

"Figure 2 illustrates the workflow of image transmission using BPSK, where the input is a digital signal obtained from the prior conversion of an image into digital format."

2. Design steps for QPSK

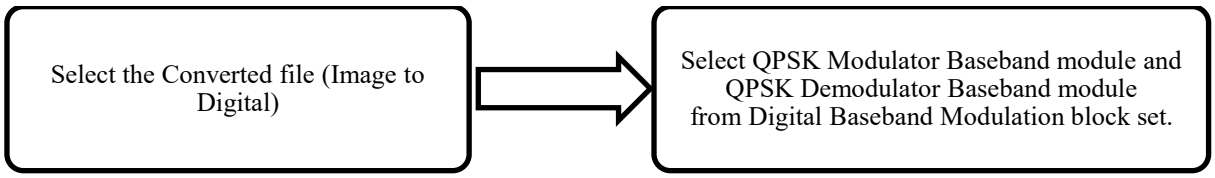


Fig. 3: Simulink-Based Model of Image Transmission Using Quadrature Phase Shift Keying (QPSK)

"Figure 3 illustrates the workflow of image transmission using QPSK, where the input is a digital signal derived from the earlier conversion of the image into digital format."Design steps for M-PSK

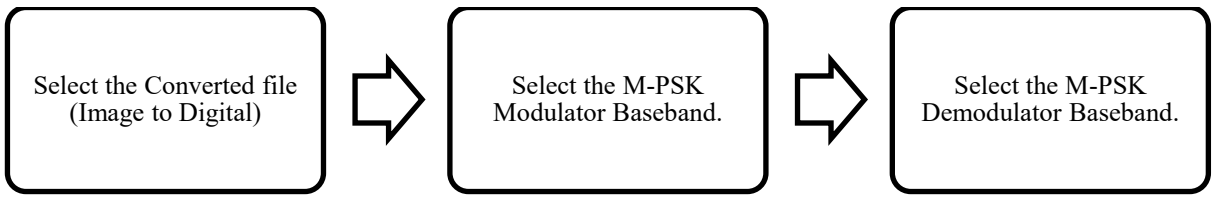


Fig. 4: Simulink Model for Image Transmission Using M-ary Phase Shift Keying (M-PSK)

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In Fig. 4 we have elaborated the working flow of image transmission using M-PSK. Here we are selecting input file as Digital signal which we have already got from Image to digital Conversion. Simulate again after changing value of M (4, 8, 16, 32 and 64). [20-22]

3. Design steps for Mary-QAM

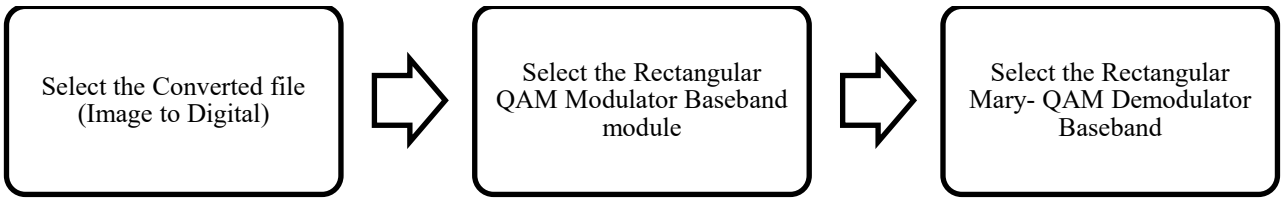


Fig. 5: Simulink Model for Image Transmission Using M-ary Quadrature Amplitude Modulation (M-QAM)

"Figure 5 depicts the workflow of image transmission using M-ary QAM, where the input digital signal is obtained from the prior conversion of the image into digital format."

RESULTS AND DISCUSSION

3.1 Results of Image Transmission & Reception

In this study, a total of eight different images were selected as test samples to evaluate the effectiveness of various carrier wave (CW) modulation schemes for image transmission and reception. Each image underwent a series of processes including conversion from image format to digital data, modulation using CW techniques, transmission through a simulated communication channel, and subsequent demodulation and reconstruction at the receiver's end.

MATLAB was used as the simulation platform to model and implement the entire process. The results indicated that CW modulation techniques—especially when implemented with optimized parameters—help significantly in preserving the quality of the transmitted images. Among the various performance metrics analyzed, the Peak Signal-to-Noise Ratio (PSNR) emerged as a key indicator of image quality. Higher PSNR values across all test images confirmed that the distortion during transmission was minimal and the images retained a high degree of visual fidelity.

Additionally, parameters such as Mean Squared Error (MSE), standard deviation, and variance were calculated for each image after transmission and reception. Interestingly, all eight images showed consistent results, indicating the reliability and repeatability of the CW modulation method. These results validate the proposed methodology as an efficient solution for secure and high-quality image transmission over digital communication systems.

1) BER values of M-ary PSK

Table 3.1: Bit Error Rate (BER) Values for M-ary Phase Shift Keying (M-PSK) Modulation Schemes at Various Eb/No Levels

M	Eb/No = 2dB	Eb/No = 3dB	Eb/No = 4 dB	Eb/No = 5dB	Eb/No = 10dB	Eb/No = 15dB	Eb/No = 20dB	Eb/No = 25dB	Eb/No = 30dB
	BER								
2(BPSK)	0.1495	0.0812	0.08044	0.08027	0	0	0	0	0
4(QPSK)	0.2188	0.0822	0.0807	0.0804	0	0	0	0	0
8-Ary PSK	0.2639	0.1753	0.1401	0.1233	0.0958	0.0887	0.0860	0.0843	0.0834
16-Ary PSK	0.5597	0.4764	0.4164	0.3821	0.2988	0.2593	0.2375	0.2256	0.2141
32-Ary PSK	0.8145	0.8145	0.7108	0.6810	0.6139	0.5774	0.5597	0.5423	0.5338
64-Ary	0.7933	0.7515	0.9774	0.9887	0.6139	1.0689	1.0689	0.9887	1.0689

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PSK

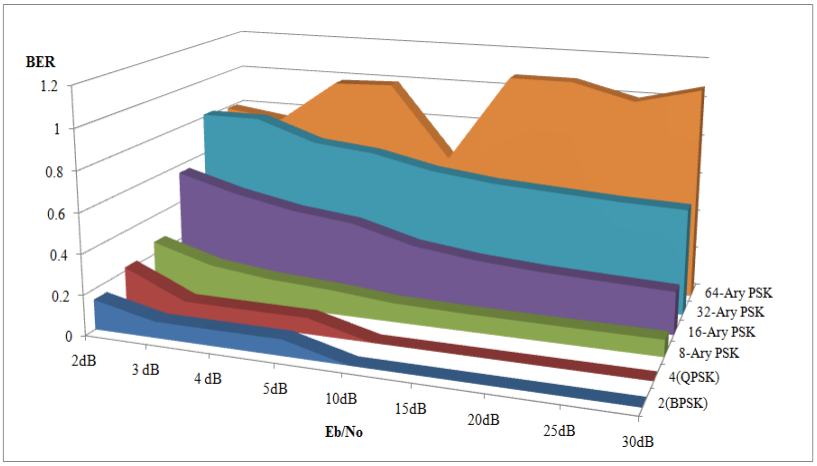


Fig. 6: Graphical Representation of Bit Error Rate (BER) Performance for M-ary PSK Modulation Schemes at Varying Eb/No Levels

Table 3.2: Simulation Results of Image Quality Metrics for M-ary PSK Modulation Schemes

Scheme	PSNR	MSE	Std deviation	Variance
2(BPSK)	51.3521	153.7325	44.5955	1988.7586
4(QPSK)	47.6648	143.2275	44.1289	1947.3598
8-Ary PSK	47.775	118.8069	42.3073	1789.9076
16-Ary PSK	48.1424	123.2526	41.7317	1741.5348
32-Ary PSK	49.0974	111.0237	41.0457	1684.7495
64-Ary PSK	49.5682	131.7159	40.8534	1669.0003

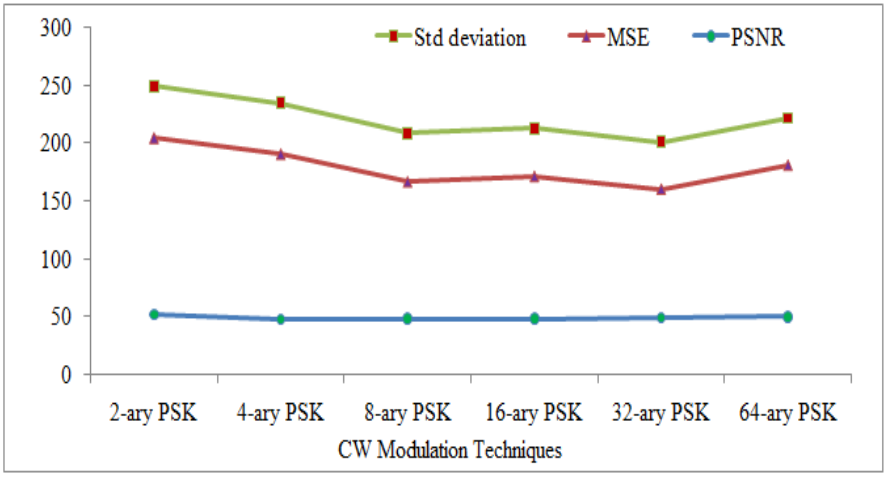


Fig. 7: Comparative Analysis of M-ary PSK Modulation Schemes Based on Image Quality Metrics (PSNR, MSE, and Standard Deviation)

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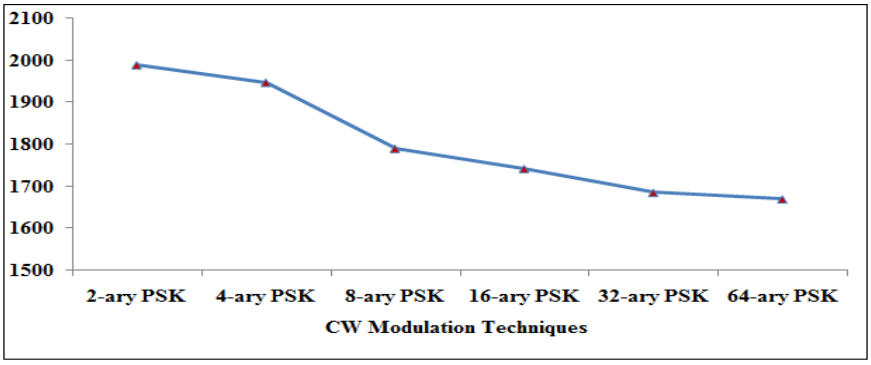


Fig. 8: Variation of Image Quality Parameter (Variance) with Different M-ary PSK Modulation Orders

2) BER values of M-ary QAM

Table 3.3: Bit Error Rate (BER) Values for Various M-ary QAM Modulation Orders at Different Eb/No Levels

M	Eb/No = 2dB	Eb/No = 3 dB	Eb/No= 4 dB	Eb/No = 5dB	Eb/No = 10dB	Eb/No = 15dB	Eb/No =20dB	Eb/No =25dB	Eb/No = 30dB
	BER								
2-Ary QAM	0.1257	0.0945	0.1257	0.0818	0	0	0	0	0
4-Ary QAM	0.1484	0.1016	0.1484	0.0825	0	0	0	0	0
8-Ary QAM	0.1598	0.1052	0.1598	0.0829	0	0	0	0	0
16-Ary QAM	0.1655	0.1070	0.1655	0.0831	0	0	0	0	0
32-Ary QAM	0.1683	0.1079	0.1683	0.0832	0	0	0	0	0
64-Ary QAM	0.1698	0.1083	0.1697	0.0833	0	0	0	0	0

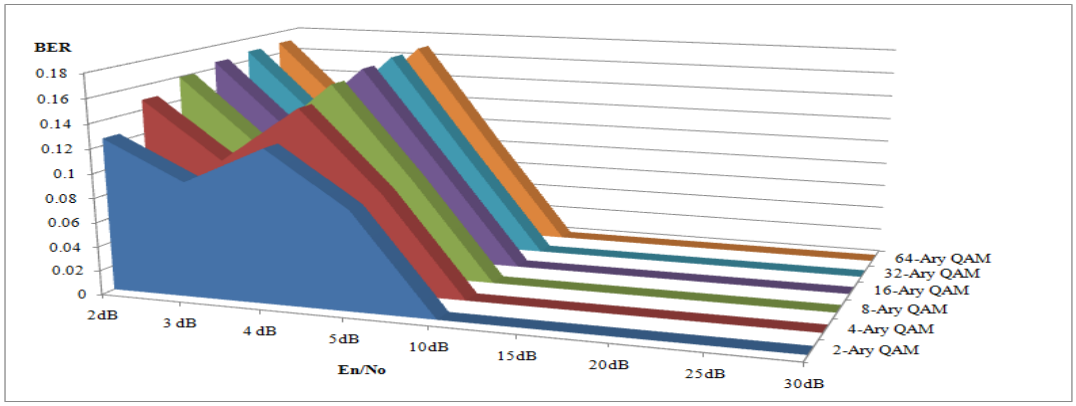


Fig. 9: Graphical Representation of Bit Error Rate (BER) for Different M-ary QAM Modulation Orders Across Varying Eb/No Ratios

Table 3.4: Simulation Results of Image Quality Metrics for Various M-ary PSK Modulation Orders

Scheme	PSNR	MSE	Std deviation	Variance
2-Ary QAM	45.7147	106.8546	44.5588	1985.49
4-Ary QAM	46.0043	99.5266	44.7054	1998.57
8-Ary QAM	46.0974	111.0237	44.0457	1940.02
16-Ary QAM	46.5682	33.7159	44.8534	2011.83
32-Ary QAM	47.8750	119.8069	44.0073	1936.64
64-Ary QAM	48.1424	123.2526	44.7317	2000.92

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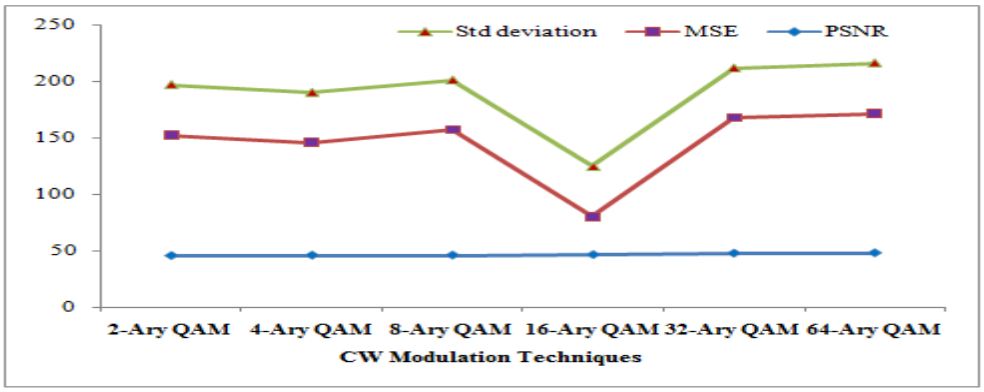


Fig. 10: Performance Comparison of M-ary QAM Modulation Schemes Based on Quality Metrics (Standard Deviation, Mean Squared Error, and Peak Signal-to-Noise Ratio)

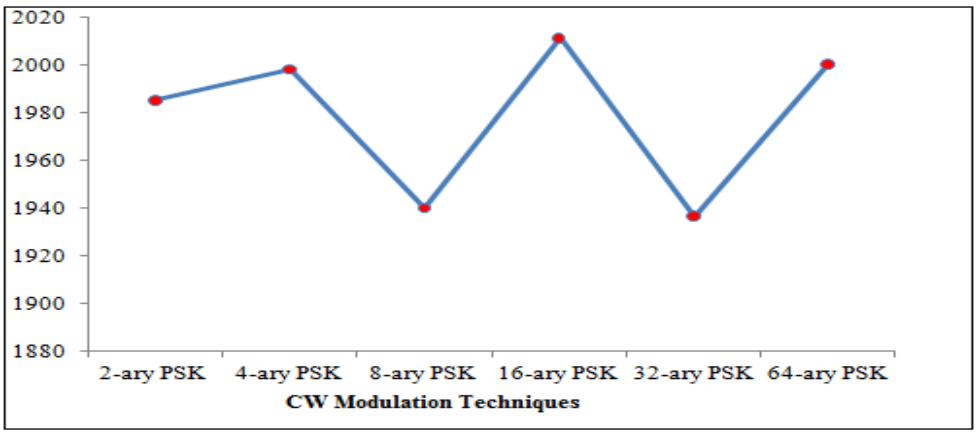


Fig. 11: Analysis of Quality Parameter Variance Across CW Modulation Schemes Using MQAM

CONCLUSIONS

3.2 Analysis of BER and Image Quality Parameters Using CW Modulation Techniques

In this research, we performed a comprehensive analysis of **Bit Error Rate (BER)** for various Carrier Wave (CW) modulation schemes to evaluate their effectiveness in digital image transmission. The primary objective was to determine how different M-ary modulation techniques impact the quality and reliability of image communication over an Additive White Gaussian Noise (AWGN) channel. The analysis involved modulation techniques such as Binary Phase Shift Keying (BPSK), M-ary Phase Shift Keying (M-PSK), M-ary Quadrature Amplitude Modulation (M-QAM), and M-ary Pulse Amplitude Modulation (M-PAM).

To measure the system's performance, we analyzed the relationship between the Energy per bit to Noise power spectral density ratio (Eb/No) and BER. From the results illustrated in Figures 3.2 and 3.5, it was observed that BPSK and M-QAM outperformed other schemes in minimizing BER. Specifically, these techniques exhibited negligible error rates, even under conditions with moderate noise interference, thereby preserving the integrity of the transmitted image.

In addition to BER, we evaluated image quality using key metrics such as Mean Squared Error (MSE), Standard Deviation, Variance, and Peak Signal-to-Noise Ratio (PSNR). The PSNR values for BPSK and M-QAM were found to be 51.3521 dB and 48.1424 dB respectively, indicating high-fidelity image reconstruction with minimal loss of visual quality. These results validate the capability of CW modulation schemes to handle image data effectively in real-time communication environments.

Conclusively, this study demonstrates that employing CW modulation techniques, especially BPSK and M-QAM, enables reliable image transmission with very low BER and excellent image quality. This proves highly beneficial in applications where image integrity is critical, such as in medical imaging, remote sensing, and

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secure image transfer systems. The proposed approach thus combines both signal efficiency and data accuracy, ensuring robust and efficient communication.

REFERENCES

[1] B. O. Omijeh, Ifiokabasi Eyo, " Comparative study of Bit Error Rate of Different M-ary Modulation Techniques in AWGN channel", American Journal of Networks and Communicaions, Vol 5, Issue 5, October 2016, Pp 82-90.

[2] Neda Fatima, Salman Ahmad Siddiqui, Anwar Ahmad , Comparative Performance Analysis of Digital Modulation Schemes with Digital Audio Transmission through AWGN Channel, IEEE Xplore, June 28,2020.

[3] S. R. Udawant and S. S. Magar, "Digital image processing by using GMSK," in *Proc. ICACDOT*, IEEE, 2016, pp. 695-698

[4] Sandip R Udawant, Satyawati S Magar,Modulation and Demodulation of Image Processing by Using GMSK, International Journal of Engineering & Technology, Volume 7, Issue 3.27, Pages 233-235.

[5] Rajesh M N, B K Shrisha, Nishith Rao, H.V.Kumaraswamy, An analysis of BER comparison of various digital modulation schemes used for adaptive modulation, IEEE International Conference On RTEICT, May 20-21, 2016, India, 241-245.

[6] Satyawati Magar, Bhavani S , "Comparative analysis of biomedical image compression using oscillation concept and existing methods" , Computational Vision and Bio Inspired Computing, Springer, Jan 2018,205-214.

[7] D Buda, "A Comparison of Two Digital Modulation Techniques," IEEE Transaction on Communications, Vol.1, pp 429-335, 1996.

[8] Shadbhawana Jain and Shailendra Yadav, "Image Transmission Using 64-QAM Modulation Technique in Digital Communication System", International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 4 Issue 12, December 2015

[9] Jondral, F., Machauer, R., and Wiesler, A., "Comparison of GMSK and inear approximated GMSK for use in Software Radio." IEEE, 1998. pp. 557-559.

[10] D. H. Morais, K. Feher, "Bandwidth efficiency and Probability of Error performance of MSK and OQPSK Systems", IEEE Transaction on communication, 12 Dec. 1979.

[11] S. Magar and B. Sridharan, "Innovative approach to biomedical image compression using oscillation concept," in *Proc. ICACDOT*, IEEE, 2016, pp. 124–128.

[12] Ali Farzamnia, Ngu War Hlaing, Muralindran Mariappan, Manas Kumar Haldar, "BER Comparison of OFDM with M-QAM Modulation Scheme of AWGN an Rayleigh Fadig Chanels", 9th IEEE Control and System Graduate Research Colloquium (ICSGRC), 3-4 Aug. 2018.

[13] D. S. Chirov, "Application of the decision trees to recognize the types of digital modulation of radio signals in cognitive systems of HF communication" , Systems of Signal Synchronization, Generating and Processing in Telecommunications, pp. 1–6, Belarus, July 2018.

[14] B. Chirag, A. Lohith, and H. S. Prashantha, "Comparative performance analysis of various digital modulation schemes in AWGN channel," 2017 Innov. Power Adv. Comput. Technol. i-PACT 2017, vol. 2017-January, pp. 1–5, 2018.

[15] P. Kumar and A. Kumari, "BER Analysis Of BPSK, QPSK, 16-QAM & 64-QAM Based OFDM System Over Rayleigh Fading Channel," IOSR J. Electron. Commun. Eng., vol. 11, no. 04, pp. 66–74, 2016.

[16] K. D. Rao, "Channel coding techniques for wireless communications," Channel Coding Tech. Wireless Communication, pp. 1–394, 2015.

[17] M. Barnela, "International Journal of Advanced Research in Computer Science and Software Engineering Performance Analysis of OSPF , RIP , IGRP and EIGRP Routing Protocols using OPNET 14 . 5 Simulator," vol. 5, no. 5, pp. 1335–1341, 2015.

[18] K. Thakuria and A. Ghosh, "Analysis of Bit Error Rate of different M-ary PSK Modulation Schemes in AWGN Channel," Int. J. Innov. Res. Electr., vol. 2, no. 5, pp. 2321–5526, 2014.

[19] H. M. Aung, W. Z. Hein, and H. M. Tun, "Performance Evaluation of GSM Transmission over Different Modulation Schemes," Int. J. Sci. Res. Publ., vol. 4, no. 4, pp. 1–5, 2014.

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[20] H. Kaur, B. Jain, and A. Verma, "Comparative Performance Analysis of M-ary PSK Modulation Schemes using Simulink," Iject, vol. 7109, no. 3, pp. 204–209, 2011.
[21] R. Suthar, S. Joshi, and N. Agrawal, "Performance Analysis of Different M-ARY Modulation Techniques in Cellular Mobile Communication," Int. J. Comput. Appl., vol. 1, pp. 25–29, 2011.
[22] Hossain, A. H. Khandokar, G. Rashed, R. Yasmin, and A. F. M. Mirza, "Performance Comparison of M-Ary Modulation Schemes for an Efficient Wireless Communication System with Digital Color Image Transmission Performance Comparison of M-Ary Modulation Schemes for an Efficient Wireless Communication System with Digital Color Image Transmission," no. February, 2009.
[23] Rohan D Jahagirdar and Aditya Narendra Ukey, "Study of Digital Modulation Techniques," IEEE Transactions on Communications, vol. 8, pp. 312-322, 2010.
[24] Mrs.J.A.Desai and Mrs.S.N.Kulkarni, "Effect of Noise on BER of BPSK, QPSK, DPSK, and QAM Modulation Techniques", IJRSI, vol 3, issue 7, pp. 71-74, July 2015.
[25] PratimaManhas and Dr M.K Soni, "Ber Analysis Of BPSK, QPSK & QAM Based OFDM System Using Simulink", IJEEE, vol 7, issue 2, pp. 54- 60, July-Dec 2015.

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