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Development of optimization model of the M-QAM and MPSK Modulation in AWGN channel

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ABSTRACT

M-QAM and MPSK are important modulation techniques. They are used to modulate systems. M-QAM is a popular scheme in high rate and high bandwidth efficiency systems while QAM is a combination of amplitude and phase modulation. Mathematically the M-QAM is described by the combined amplitude and phase modulation results. MPSK stands for Mary Phase Shift Keying and is a digital modulation process which conveys data by changing the modulating phase of the constant frequency. AWGN or Additive White Gaussian Noise is a basic noise model used to Mimic random processes that occur in nature. This research creates an optimization model for the M-QAM and MPSK Modulation in the AWGN Channel using MATLAB Simulink. Comparison of the two techniques was also performed.

Key words: M-QAM, MPSK, optimization, Simulink, modulation, MATLAB.

1. INTRODUCTION

This research created a system for comparing the bit errors of different M-ary modulation techniques, namely PSK and QAM transmission methods [1,2,3,4]. Both PSK and QAM modulation techniques are somewhat similar to each other [4,5]. These techniques can also be used to improve spatial imaging [7]. These modulation methods are useful for these digital systems [8].

But for these to be done its data should be in a compatible database configuration like [9,10].

The difference is that in QAM modulation techniques, phases would be the same only having different amplitudes to lessen the error in the receiver side of the communications system [11,12]. These systems are extremely useful file transfer communications [13].

In a PSK system as the M-ary number increases, the phases would also tend to increase, and theoretically, the errors would increase as the M-ary number increases because the phases would tend to become close to each other with each increasing input, and the system might confuse a signal with that of another phase [14,15]. For optimizing the system Neural Network [16,17]and Fuzzy Logic [18, 19] can be used.

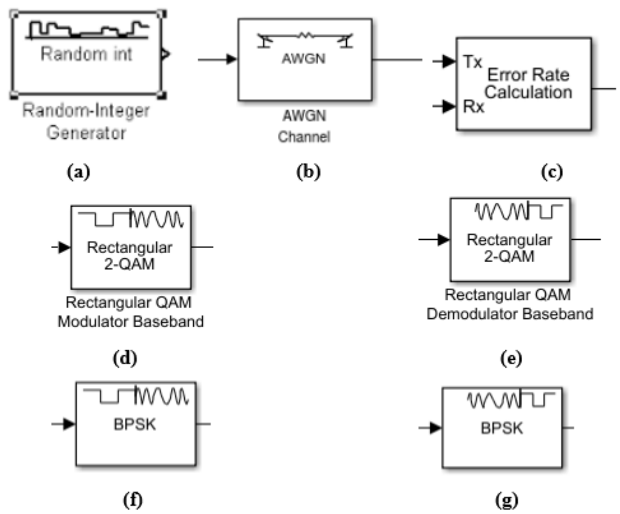


Figure 1: Simulink Blocks

To perform the simulation MATLAB Simulink was used [20,21]. The Simulink software should have a communication blockset [22].The blocks above represent above are the main blocks that will be used for the project. Block (a) is the random integer generator, which will be used as the input of the system. This was chosen as the input so that the simulation will be similar to actual systems. Block (b) is the white Gaussian noise. It is used to simulate the noise for the system. Block (c) is the error rate calculator. This is used to calculate the bit error rate at the output of the system. Blocks (d) and (e) are the Rectangular QAM Modulator and Demodulator, respectively. Blocks (f) and (g) are the PSK Modulator and Demodulator respectively. Blocks (d) to (g) will be used to simulate the modulation techniques for the project. Furthermore, there will be additional blocks used for the project which are used to take the graphs of specific parameters. To optimize the values of the blocks Logic Scoring of Preference (LSP) can be used [23].

2. DATA AND RESULTS

2.1. 32 -QAM and 32 – PSK

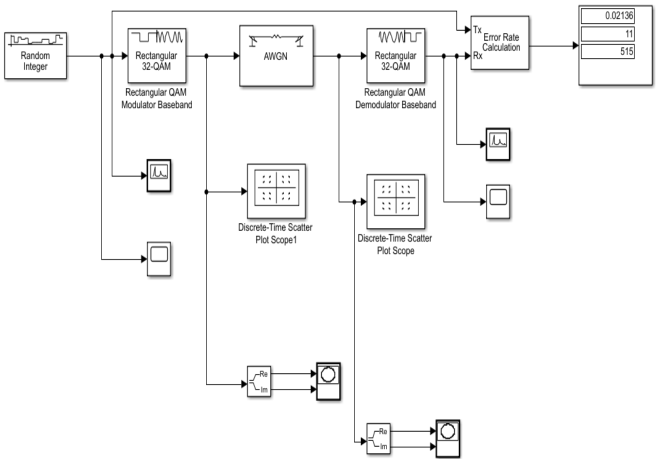


Figure 2: 32-QAM Block Diagram

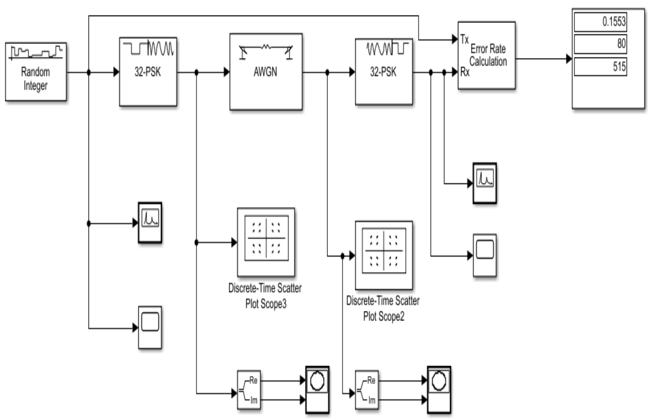
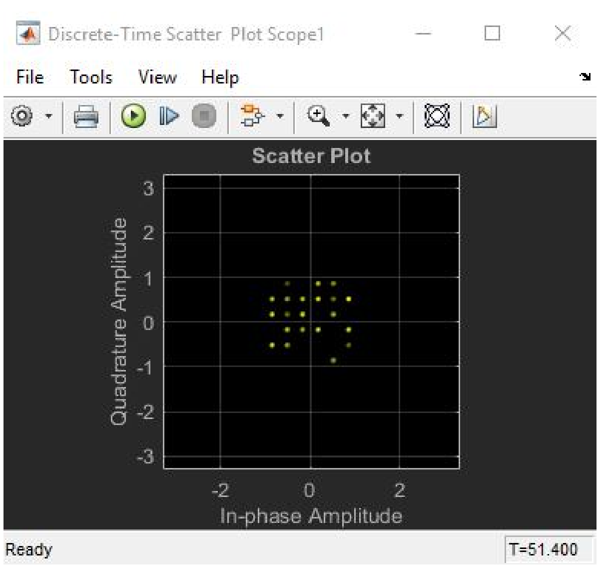
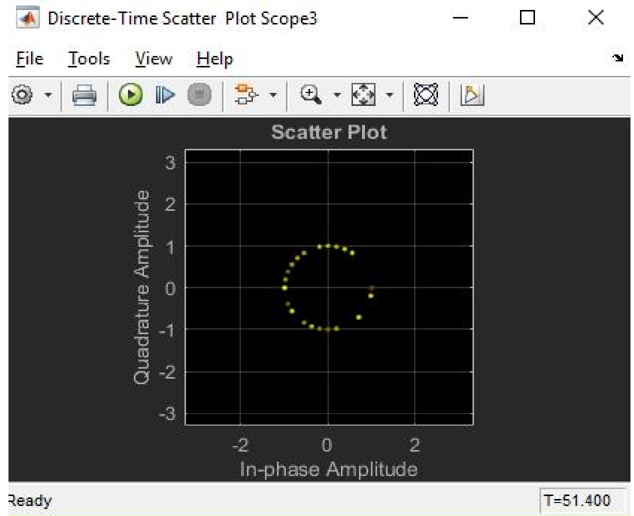


Figure 3: 32-PSK Block Diagram

Figures 2 and 3 shows the 32 QAM and PSK Block Diagrams. Simulink was used to simulate these models.

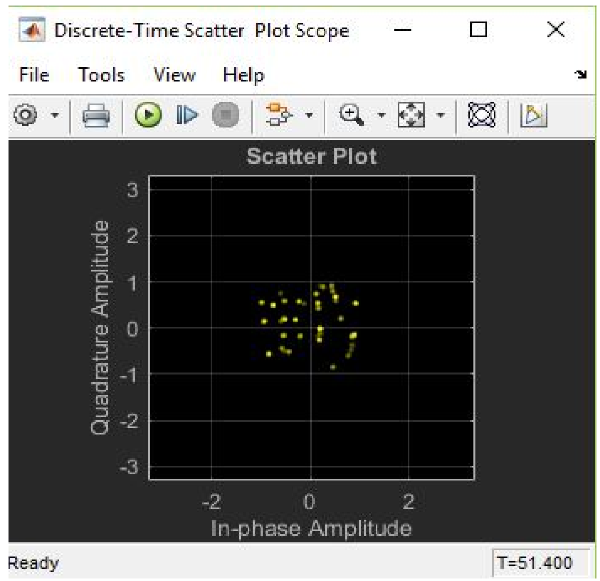


(a)

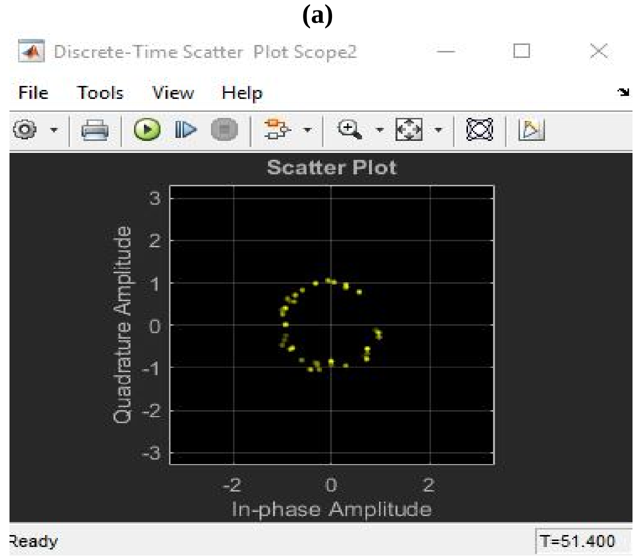


(b)

Figure 4: Constellations before AWGN (a) 32-QAM (b) 32PSK



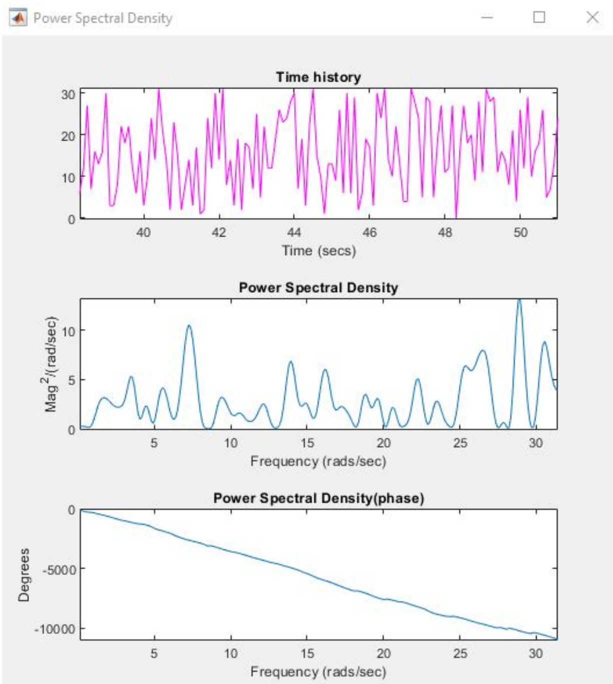
(a)



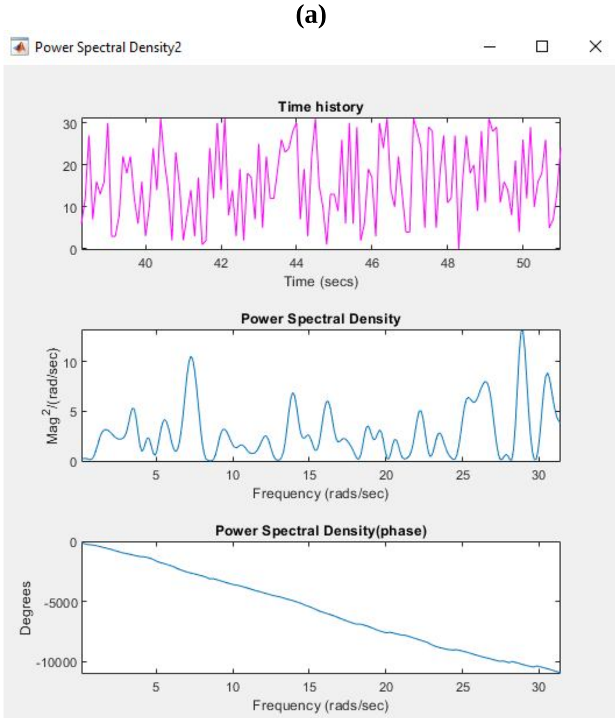
(b)

Figure 5: Constellations After AWGN (a) 32-QAM (b) 32PSK

Figures 4 and 5 shows the constellation diagrams of the AWGN before and after the 32 QAM and PSK. The constellation diagram is a representation of a signal modulated by a digital modulation scheme [24,25,26].

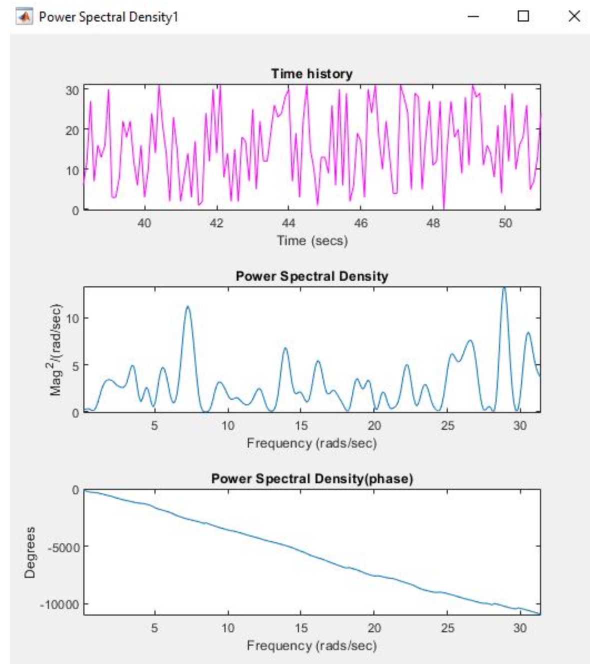


(a)

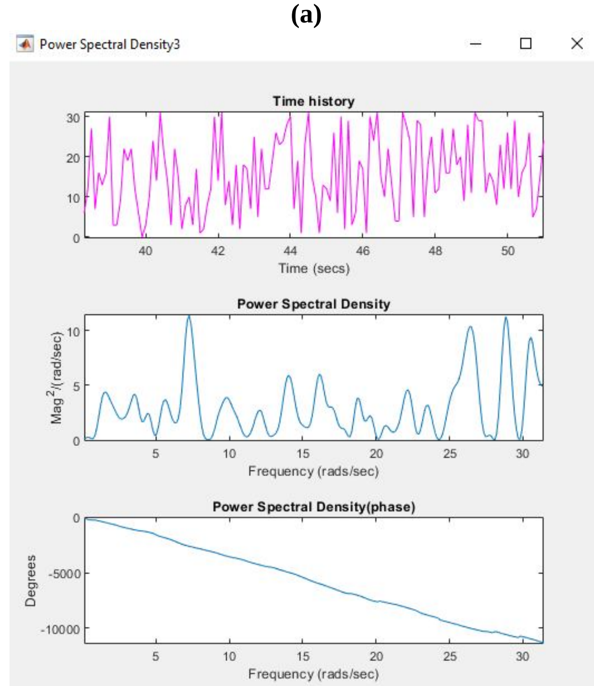


(b)

Figure 6: Power Spectral Density Before AWGN (a) 32-QAM (b) 32PSK



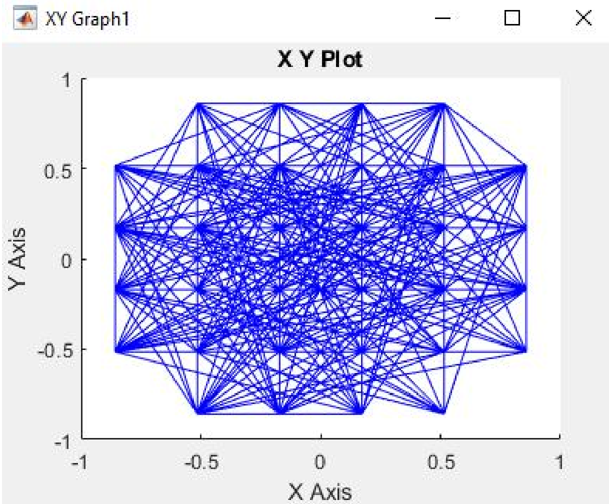
(a)



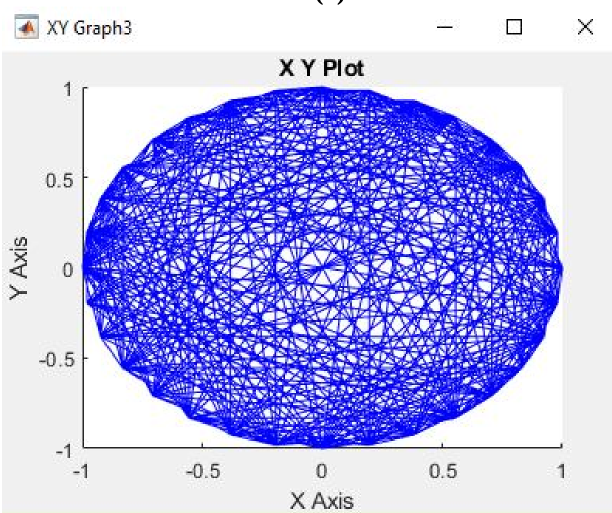
(b)

Figure 7: Power Spectral Density After AWGN (a) 32-QAM (b) 32PSK

Figures 6 and 7 shows the Power density before and after the AWGN 32 QAM and PSK.

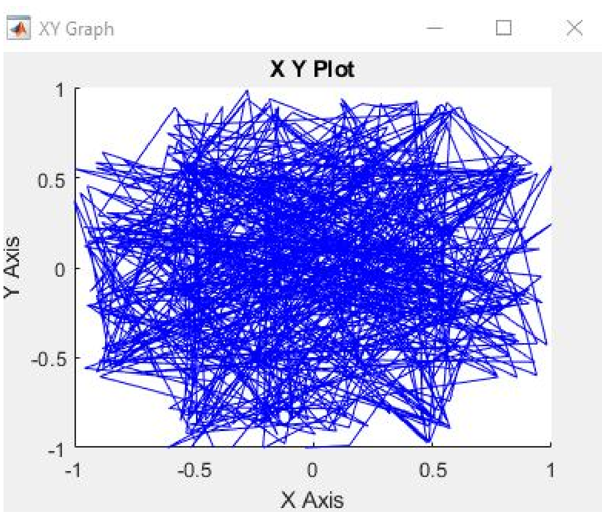


(a)

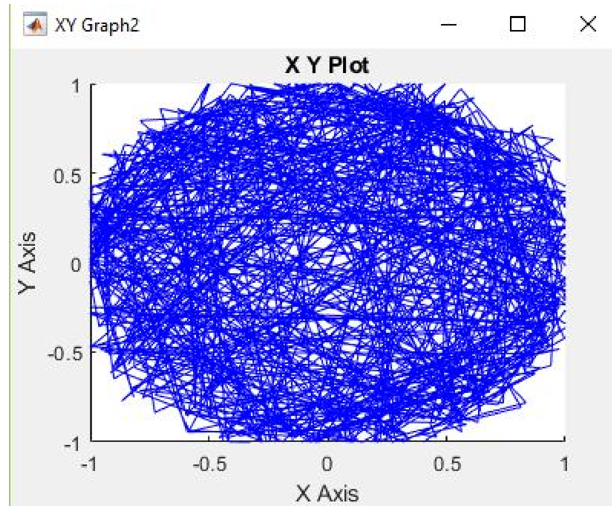


(b)

Figure 8: XY Plot Before AWGN (a) 32-QAM (b) 32PSK



(a)



(b)

Figure 9: XY Plot After AWGN (a) 32-QAM (b) 32PSK

Figures 8 and 9 shows the XY plot before and after the AWGN 32 QAM and PSK

2.2 64-QAM and 64PSK

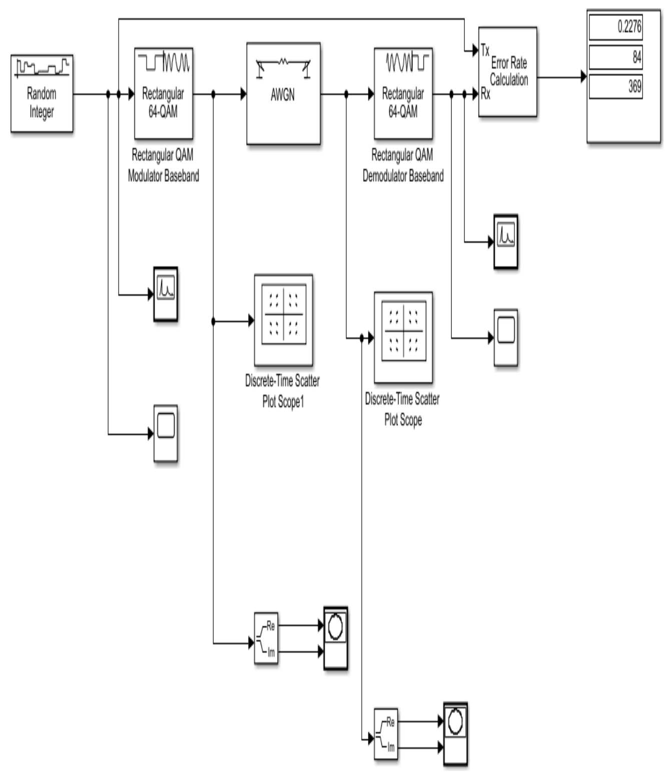


Figure 10: 64-QAM

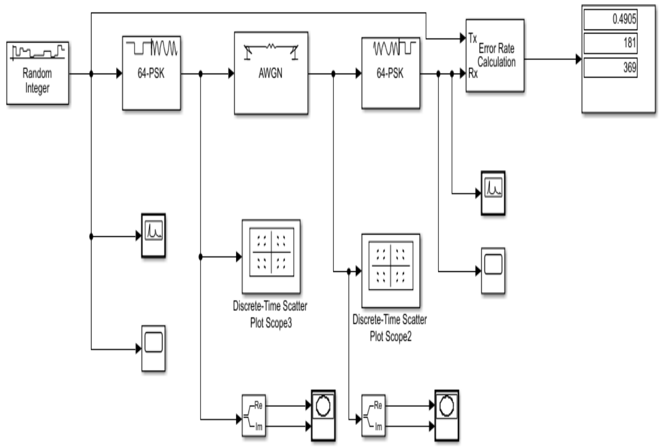
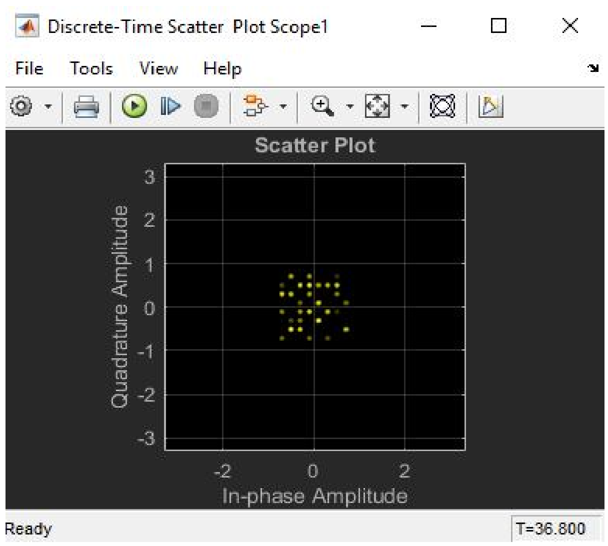
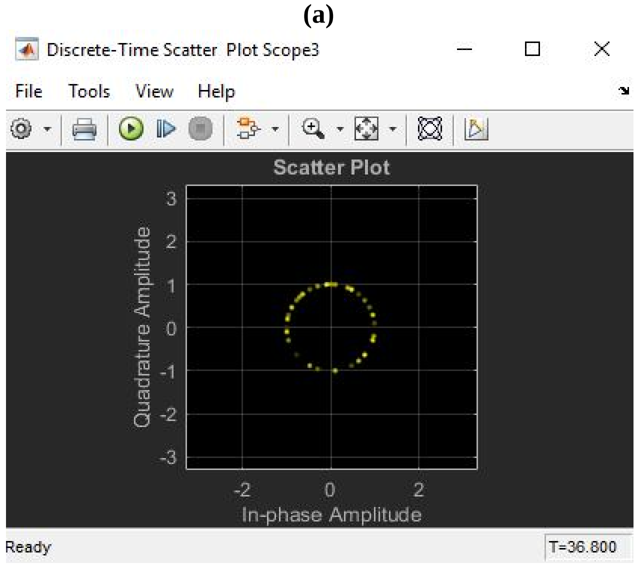


Figure 11: 64-PSK

Figures 10 and 11 shows the 64 QAM and PSK Block Diagrams. Simulink was used to simulate these models.

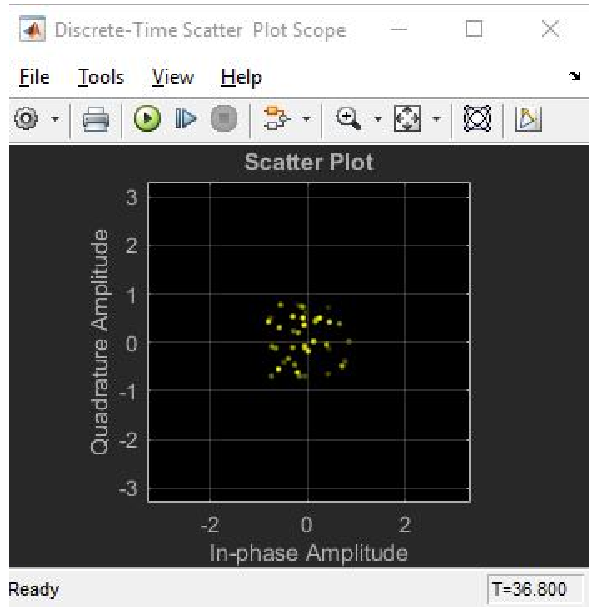


(a)

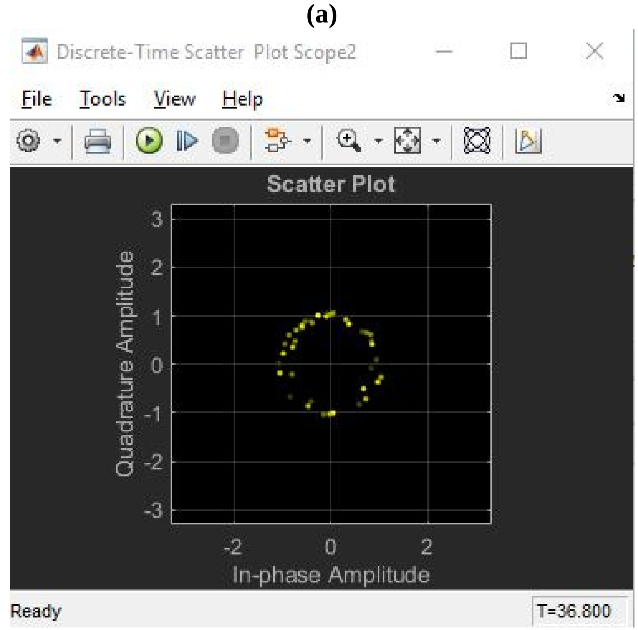


(b)

Figure 12: Constellations before AWGN (a) 64-QAM (b) 64PSK



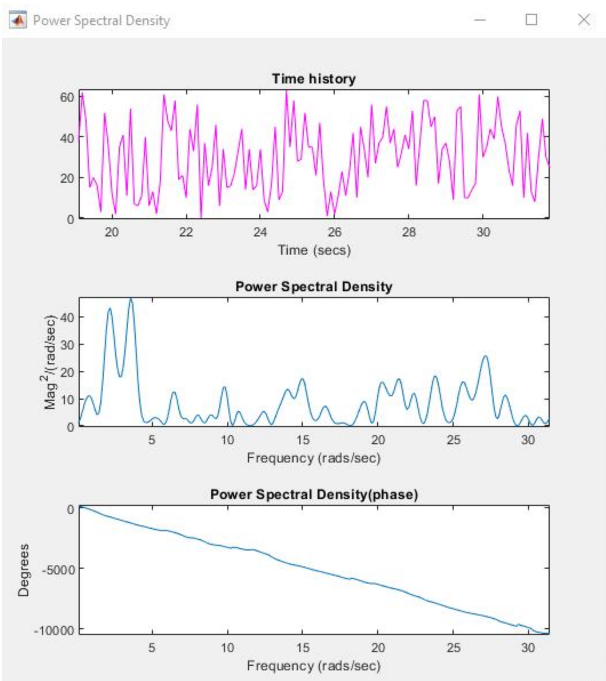
(a)



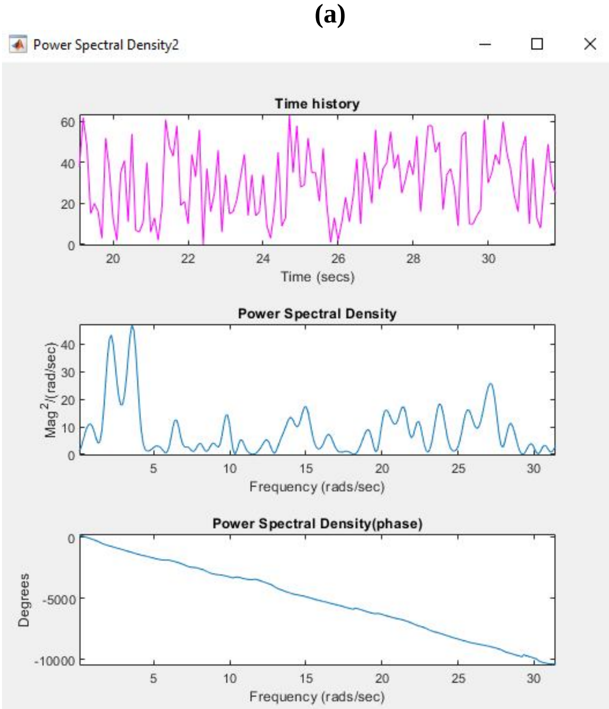
(b)

Figure 13: Constellations After AWGN (a) 64-QAM (b) 64PSK

Figures 12 and 13 shows the constellation diagrams of the AWGN before and after the 64 QAM and PSK.

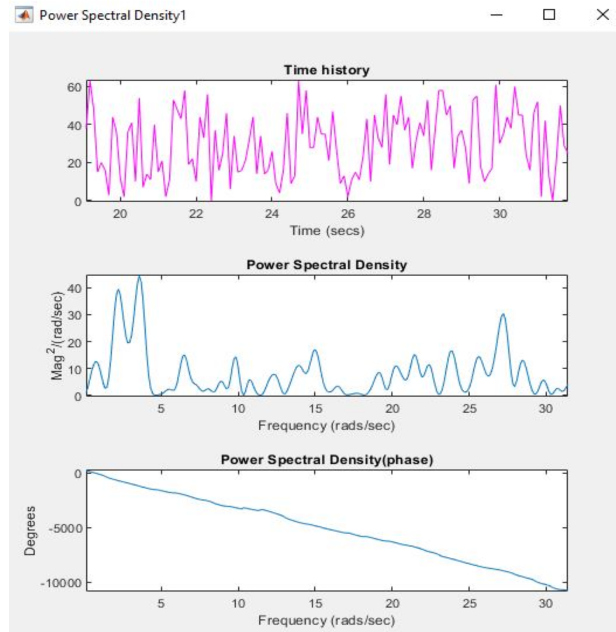


(a)

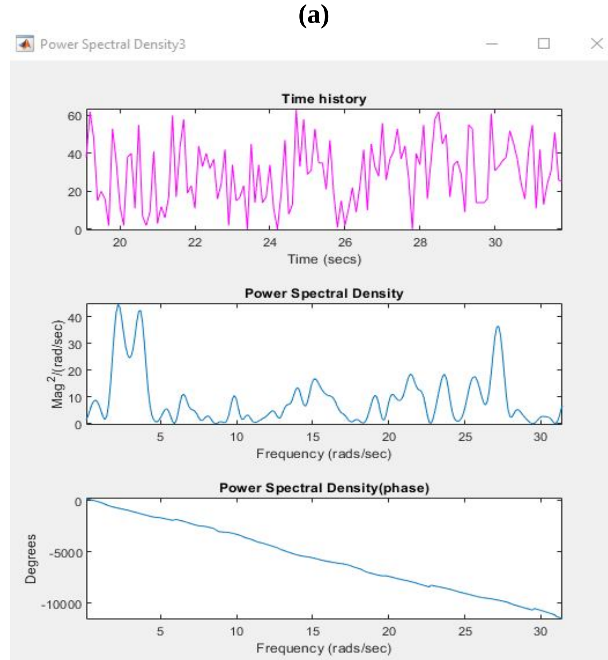


(b)

Figure 14: Power Spectral Density Before AWGN (a) 64-QAM (b) 64PSK



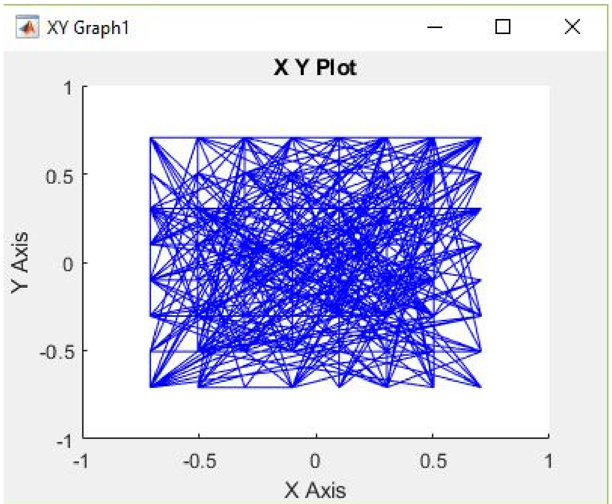
(a)



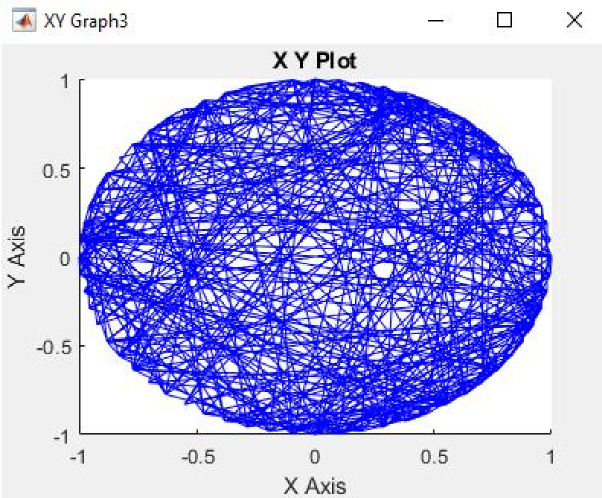
(b)

Figure 15: Power Spectral Density After AWGN (a) 64-QAM (b) 64PSK

Figures 14 and 15 shows the Power density before and after the AWGN 64 QAM and PSK. These power densities may have some unknown values. If this happens the Rough Set Theory can be used [27, 28].

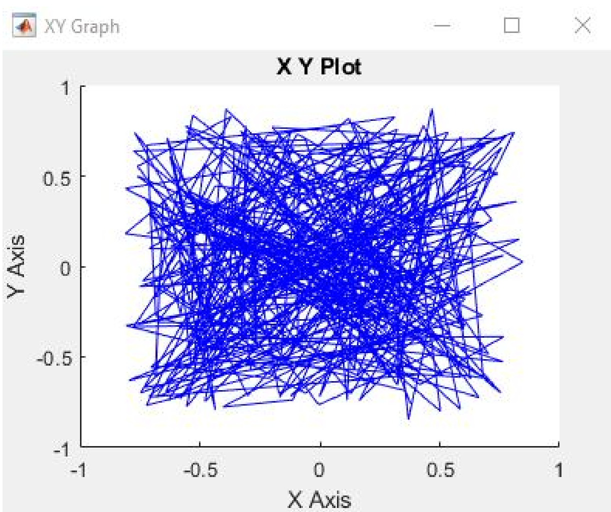


(a)

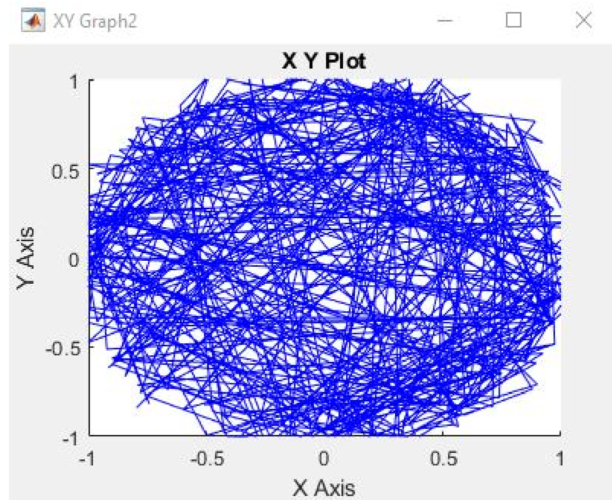


(b)

Figure 16: XY Plot Before AWGN (a) 64-QAM (b) 64PSK



(a)



(b)

Figure 17: XY Plot After AWGN (a) 64-QAM (b) 64PSK

Figures 16 and 17 shows the XY plot before and after the AWGN 64 QAM and PSK.

3. ANALYSIS OF DATA

It can be observed in the making of the project, that in low M-ary encoding, there is little difference or no difference in the bit error rate, specifically from BPSK up to 8PSK and 2-QAM up to 8-QAM modulations [29]. However, as the M-ary number increases, this is where the bit error rate can be seen to also increase. As the time increases, there are more errors that are being detected in the demodulated signal of a MPSK modulation technique, it was also observed that their constellation and xy graphs differed only for M-ary is equal to 4, in 4PSK the constellation would appear as a diamond, wherein the points are found on the axes and in QAM the points were to be found in their respective quadrants and would form like a box [30].

It was noticed that even if theoretically the 2 modulation techniques would somewhat be similar to each other because of how they would transmit data, the simulation seems to show otherwise, in the sense that PSK is not that effective of a transmission technique when the data input would be M-ary 16 and above [31]. We noticed that starting from M-ary 16, this is where the bit error rate started to differ largely between the 2 modulation techniques [32].

The researchers believe that this is so because of the theory that was taught to them wherein it states that a PSK would always add a phase shift whenever M-ary increases, whereas in QAM technique, data would tend to share the same phase, but differ in amplitude. This is to reduce the error that would be received because it would lessen the confusion of the system to interpret one data over the other. These data can be used in large data real world applications [33, 34] and optimized using the Rough Set Theory [35].

4. CONCLUSION

The researchers compare the QAM and PSK modulation techniques as the number of combinations possible increases. The researchers conclude that QAM type of modulation is better because it presented less bit error rates compared to PSK type of modulation. It seems that this would be a more efficient and effective way of transmitting data that have a big number of M-ary inputs, as it would have fewer chances of being misinterpreted by the receiver. The researchers believe this because of the data that was also shown on the output of the system. In the data that was retrieved, it can be seen that as the M-ary increases, in PSK, the phase shift tends to form a circle as the M-ary increases, this is because the phase difference generated every time that M-ary is increased. Wherein in QAM modulation, it can be seen that it somehow forms cubes that tend to have points that have the same phase, which coincides with the theory that was taught that QAM modulation techniques have the same phase with different magnitudes. It was also observed that the xy graphs of the modulation's techniques are also very different. Supporting what was previously stated, the xy graphs of higher M-ary modulations showed a somewhat circular diagram as well, because it just follows the constellation diagrams that were also presented.

To further conclude, the researchers were able to observe the difference in the the performance of the two modulation techniques. The system's design was based on one of the experiments from the course with supplementary knowledge from research.

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