IMPLEMENTATION OF 32-QAM TX-RX SYSTEM USING MATLAB

Final Project Poster on Signals, Spectra, and Signal Processing Laboratory

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ABSTRACT

Quadrature Amplitude Modulation (QAM) is a digital modulation technique. It involves combining the Amplitude and Phase Modulation of the carrier wave. Thus, creating a more efficient use of the bandwidth. In this project, the student creates a 32-bit QAM Transmitter to Receiver System using MATLAB. The transmitted data was mixed with noise so that the system would be closer to real life. The results show successful transmission and recovery of the audio file.

INTRODUCTION

Digital Modulation is an important modulation scheme in modern communication systems as it is more efficient than analog modulation for two major reasons. First, it can transmit large amounts of data over long distances without significant loss of the modulation signal. Second is that by encoding the information signal to the carrier signal, the signal becomes less susceptible to noise and interference [1]. There are several types of Digital Modulation schemes, including Amplitude-Shift Keying (ASK), Frequency-Shift Keying (FSK), Phase-Shift Keying (PSK), and Quadrature Amplitude Modulation (QAM). The ASK varies the carrier wave amplitude, FSK varies the carrier frequency depending on the digital data, PSK modulates the carrier phase, and QAM is the digital modulation scheme that uses two carrier waves. QAM will be the modulation scheme that the proponents will use for the system.

OBJECTIVES

1. To create a Transmitter to Receiver system using Quadrature Amplitude Modulation using MATLAB
2. To base the quality of the QAM Transmitter (Tx) -- Receiver (Rx) system on the Bit Error Rate (BER) of the received signal
3. To test the noise tolerance of the system by implementing several Signal-to-Noise Ratio (SNR)

THEORETICAL CONSIDERATION

- **Quadrature Amplitude Modulation**

This modulation scheme uses two carrier waves; amplitude and phase of each carrier wave represents the Digital Data.

- **Filter**

In the context of QAM system, filters serves multiple purposes such as limiting the bandwidth and noise rejection.

- **Fast Fourier Transform**

This algorithm was used in the project for performing signal analysis and filter design.

METHODOLOGY

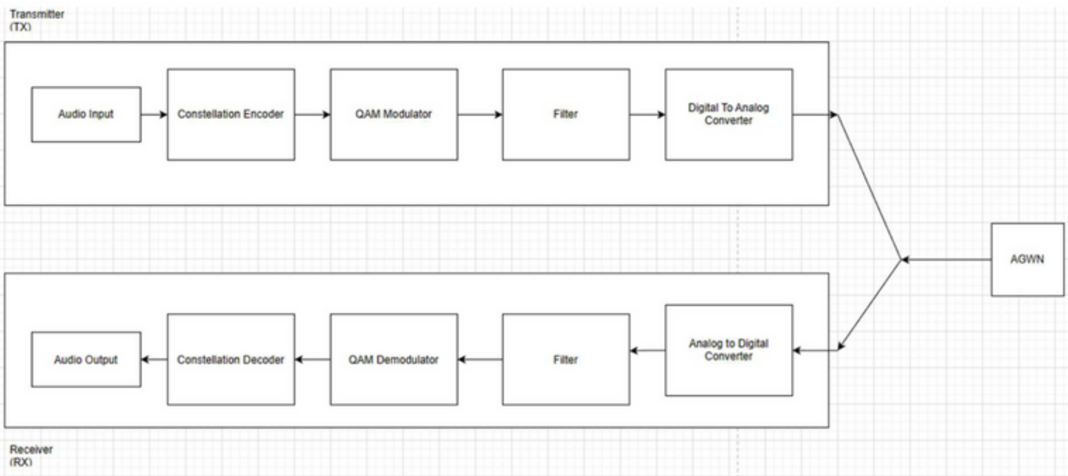
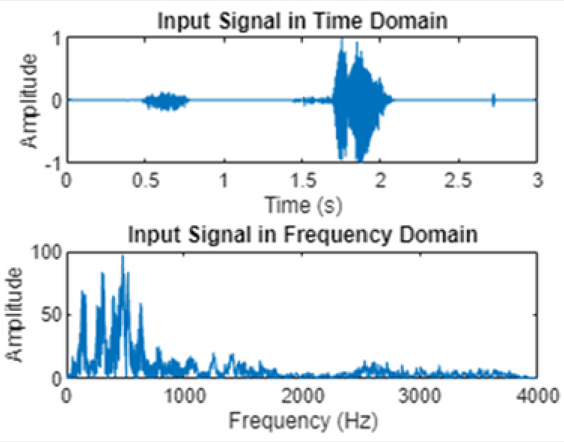
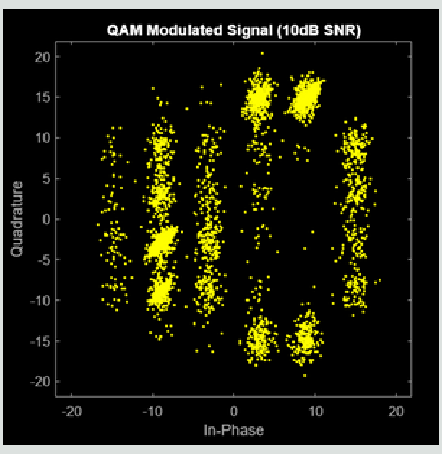


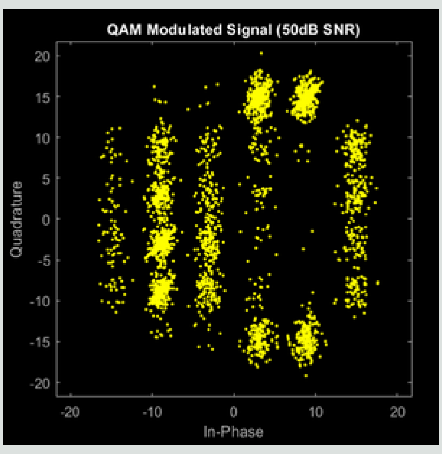
FIGURE 3.1. Input-Process-Output (IPO) Model

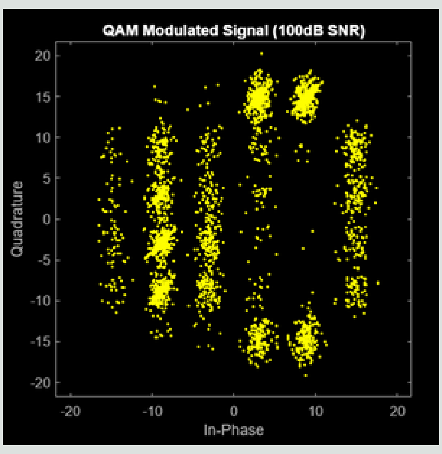
Figure 3.1. shows the general process of the MATLAB code. First, the input was created by recording the signal using MATLAB. Here, the Fast Fourier Transform was used for the conversion so that the the modulation and filter parameters can be obtained. After obtaining the parameters, the author encoded the audio signal into its discrete form. The syntax uencode() was used so that the input is stored in symbols. The next step was designing a QAM modulator block. The modulation was done using qammod(). Before transmitting the signal, a bandpass filter was created to limit the frequency band of the signal. The code for the transmitted block. Then, to test the system with more real-life factors, the author mixed the QAM Signal with additive white gaussian noise (AWGN) after transmitting the signal. The author used three values of SNR: 10, 50, and 100 dB. The author recovered the noisy signals for comparison with the input and output signals. Meanwhile, in the receiving block, the filter used is the same code similarly in the transmitter block. After filtering the signal in Transmitter block, The next step was to demodulate the filtered signal. The author used qamdemod() for the QAM demodulation. The resulting signals were decoded to convert into its numerical value and were plotted in their respective time and frequency domains. The resulting signals were also saved as .wav files for audio comparison it was then amplified to increase the amplitude for some losses in the transmission and filter process.

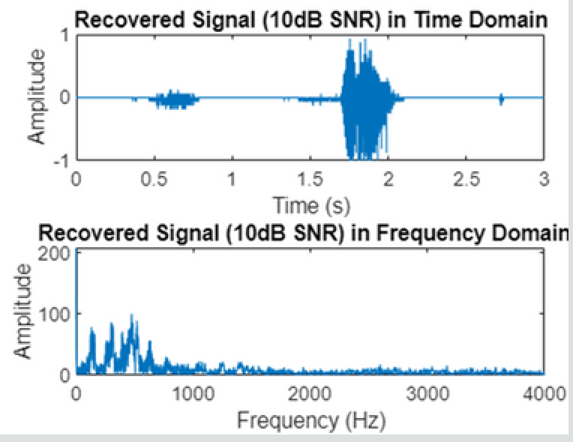
RESULTS

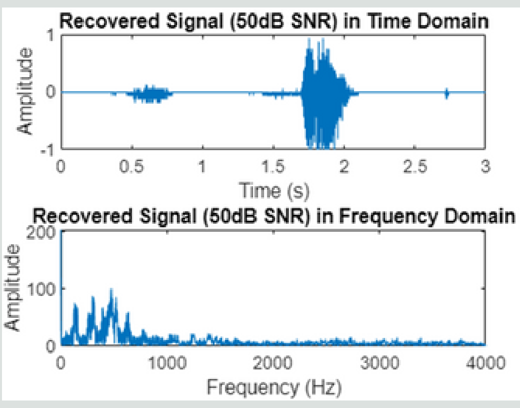


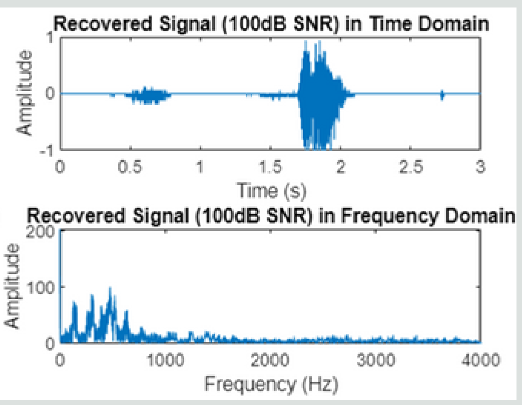












DISCUSSION

The main objective of the project is to create an efficient QAM Tx-Rx System using MATLAB. The results showed that the system was working successfully and there were no major problems that need to be addressed. The audio files show that the input data was not clipped and there were no other signs of data distortion. The BER for the different SNR Values was within the expected range and considered to be good. It also has an inverse relationship with the SNR.

The Chebyshev Type 1 filter was working successfully by minimizing the bandwidth in the transmitter and minimizing the AWGN in the receiver. This was done while having an order of 7. It means that the filter is efficient while having less complexity and cheaper components.

CONCLUSION

In conclusion, the proponent has successfully implemented a QAM Tx-Rx System using MATLAB. The output audio filesshow an audible quality without any major signs of clipping and distortion. The system also the range of a good BER and the results show inverse relationship between the SNR and BER. The project is only limited to creating a QAM Tx-Rx system using MATLAB. It means further studies can be comparative projects between other Digital Modulation Tx-Rx systems. The project is also limited to Chebyshev Type 1 filter, as it is preferred because QAM needs a sharper roll-off in the stop band. This reason behind can be further investigated by using other types of filters.

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