Simulation of QAM modulation (June 2014)

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I. Introduction

Our task was to prepare an interactive demonstration of the quadrature amplitude modulation. The application must be equipped with a graphical user interface allowing for visualization of important signals within the modulator / demodulator, simulation of transmission through the AWGN channel.

II. Description of the program

To run the program, there are two files. The main.m is the main file, containing every parameter configured in order to correctly observe the behavior of the QAM modulator/ demodulator. The application.m is the Graphical User Interface, of the main.m program.

In the main.m file the parameters of the modulator are given such:

Carrier frequency = 40 Hz,

Energy per bit to noise power spectral density ratio = 20 dB,

Sampling frequency = 500 Hz,

Modulation index = 16,

Number of bits in bitstream = 16.

In the application.m file, user can specify the input bitstream, or generate a random one, also the Modulation index.

In order to generate bitstream, the user must click “Generate bitstream” button.

To observe QAM modulation process, button “Modulate” must be pressed.

To observe QAM demodulation process, button “Demodulate” must be pressed.

The axes are presenting the input bitstream, constellation of the modulation, Inphase signal and Quadrature signal, and after multiplying by the carriers, also the Output signal passed through the AWGN channel. There is also another axes showing the Fast Fourier Transform of the Inphase signal to present the spectrum of the modulated signal and the demodulation process.

III. Goals of the project

Our goals was to create a QAM simulation, properly implement the modulator, and the domodulator, study cases for different modulation index, and the different input bitstream, specified by the user, or generated by the script written inside the program. Observe important signals within the modulator, demodulator, and modulated signal going through the AWGN channel.

IV. Description of the work of the program

First after, defining the bitstream, program plots the bitstream, then it starts the process of the mapping bits in to the constellation. After successful calculations the constellation diagram is being shown. Then it splits the signal into the Inphase and Quadrature signals, plots the signals, multiplies them by the carriers, and plots them. After that adds Inphase and Quadrature signals, into the Output signal, plots it, and pass through the AWGN channel, then plots it again.

For the demodulation process, program multiplies the signal passed through the AWGN channel, with the carriers. Then it filtrates the signals using the Butterworth Low-Pass Filter. After that it starts to compute the recovered constellation to observe if the demodulation process has been working correctly. In order to observe the spectrum of the Inphase signal and how it was changing through the modulation process, and after the demodulation, filtration, and amplitude compensation.

Program also computes comparison errors, to check whether the whole process of modulating and demodulating was done without any errors. In order to observe that it is computing Bit Error Rate.

V. Summary

The program fulfills it role, we managed to successfully implement the features that we declared. Unfortunately the GUI application is instable.

The roles of the team members were:

Piotr Szkotak:

-Verification of simulation results against theoretical error levels

-Ability to observe important signals within the modulator / demodulator

-Implementation of the QAM modulator / demodulator for type III constellation of arbitrary order

Przemysław Dymitrowski:

-Simulation of transmission through the AWGN channel

-Ability to simulate transmission with both a manually specified and a randomly generated bitstream

-Design and implementation of the GUI