Simulation of MSK modulation and demodulation (June 2014)

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I. Introduction

THE goal of the project is to develop an interactive demonstration of the MSK modulations. The application must be equipped with a graphical user interface allowing for simulation of transmission through the AWGN channel, observation of important signals within the modulator / demodulator, and comparison of spectral efficiency of both modulations.

II. Program basic settings and functionality

Our repositories consist of many files. Every single function is placed separately. To run the program we should choose the GUI_1.m file. We set the default settings for Tb, Ts and c and they are as follow:

```
Tb=0.07;
Ts=0.0001;
c=Tb/Ts;
```

We made the simulation for MSK modulation for 20 bits.

After run program we can see 3 axes which correspond to “Initial signal”, “Modulated signal” and “Demodulated signal”. The reason to design out GUI in such a way was to show the general flow of signal through the modulation and demodulation.

In first section we can specify if bits should be random generated or we can input our own sequence. In first section we have select list and button “Show”. We can use it to plot some important signals on axes 1 as half sinusoid or eye diagram.

Next section is responsible for modulated signal. We can plot it after clicking on button “Modulate”. Than half of this section is responsible for adding noise in channel. We can specify the amount of SNR and click “Plot with noise” to see how our graph change. Last part is demodulation. We can see there comparison of demodulated signal and initial one after clicking button. Last section also contain BER simulation which is displayed in new figure.

There is also one more important feature below each plot there is a button to open it in bigger figure.

III. DESCRIPTION OF THE WORK OF THE PROGRAM

After defining the input bit stream the signal passes to the NRZ encoder. The stream is then demultiplexed into an even and an odd stream. Then the pulses are shaped to have a number of samples of 2Tb/Ts per symbol. After that the half sinusoids are generated by multiplying the even arm with a cosine and the odd arm with sine with a period of 4Tb. The odd part should be delayed by Tb. Next the 2 streams are multiplied with the cosine and sine carriers with a frequency of 2/Tb and added together to form the modulated signal. To simulate the AWGN channel it is possible to add white Gaussian noise to the signal to reach a specified SNR.

In the demodulator the modulated signal is multiplied by the carriers and by the signals that generate the half sinusoids and again we get two streams one containing the even bits and one the odd bits. Numerical integration is performed on those streams over a period of 2Tb and the results are compared to 0.

In GMSK modulator the input bit stream passes through the NRZ encoder it is shaped to have Tb/Ts samples per bit, integrated and passed through the Gaussian filter. This filtered signal will be the phase of the quadrature components which are then multiplied by the carriers added and ‘transmitted’.
In the demodulator the signal is multiplied by the sine and cosine carriers to get 2 parts which are the filtered through a low pass filter to remove unwanted frequencies. after that arctan of the ratio of the signals is performed and integrated over Tb. The result is compared to 0 to get the demodulated bit stream.

QPSK has the most straightforward modulator between the 3. The bit stream passes the NRZ encoder then it is demultiplexed into 2 streams of even and odd bits. These streams are submitted to pulse shaping and then multiplied by the respective carriers. These quadrature components are added to for the QPSK modulated signal.
In the modulator the received signal is multiplied by the carriers to get 2 parts which are then integrated over Tb and the result compared to 0.

IV. Our goal

We assume that our project will contain implementation of the MSK modulator / demodulator as well as ability to display important signals within it. Another feature we want to

achieve was implementing simulation of transmission through the AWGN channel. Important for us was also ability to simulate transmission with both a manually specified and a randomly generated bit-stream and last thing which is verification of simulation results against theoretical error levels.

V. Responsibilities

Genti Cuka: Responsible for creating the functions involved in the modulators/demodulators, and auxiliary functions like noise addition, BER, constellations and spectral analysis.

Mateusz Wilczyński: Design and creation of GUI. Usage of the modulation/demodulation and other functions in the GUI according to the project requirements

VI. Conclusion

We have met all of assumed requirements. We did not observe any bugs in our program. The GUI is simple and clear for most of the users and what is important it is very intuitive. As we can see on our BER simulation our results are precise and our modulator is very close to the theoretical one.

After finishing all required tasks we developed some functions from higher grades but unfortunately due to the lack of time we did not put them into GUI. We prepared two more modulations QPSK and GMSK as well as suitable script with tabs.