Digital Communication LAB **3**

Monte Carlo Simulation of Digital Modulation Schemes

Aim

- Understand how to simulate digital modulation schemes on MATLAB using Monte Carlo simulations.
- Plotting constellation diagrams on MATLAB and investigating the noise effects.
- Construction baseband modulators/demodulators of MASK, MPSK, and square MQAM.

Experiment Steps

1. Study carefully the accompanying .m file (Modulation_EEC481.m). This code shows the complete simulation framework for the general square MQAM modulation
2. Based on your understanding, answer the following questions:
    a. In line 13, why we multiply by `log2(ModulationOrder)`?
    b. Explain how `Eb` is calculated for the three modulation schemes?
    c. What is the meaning of the step `SymbolBits=reshape(Bits,log2(ModulationOrder),NumberBitsPerFrame/log2(ModulationOrder))';`
    d. Why the transmitter and the receiver have two branches?
    e. Why do we add 1 to the symbol index in `SymbolIndex_branch1=binaryVectorToDecimal(SymbolBits_branch1)+1`
    f. In the noise generation, why do we multiply by `sqrt(No/2)`?
    g. Explain the functional operation of the loop

```
for threshold=-sqrt(ModulationOrder)+2:2:sqrt(ModulationOrder)-4
            DetectedSymbols_branch1((ReceivedSignal_branch1>threshold)
&(ReceivedSignal_branch1<=threshold+2))=threshold+1;
end
```

    h. Observe the effect of noise level on the constellation diagram. Print the output figures and comment.
    i. Explain the functional significance of the condition

```
if sum(sum_prob_error)==0
        break
    end
```

3. Produce a new version of the code (Modulation_EEC481_MASK.m) for implementing the general MASK modulation scheme.
4. Produce a new version of the code (Modulation_EEC481_MPSK.m) for implementing the general MASK modulation scheme.

Deliverables

1. By running the accompanying .m file, produce the BER curves of QPSK, 16QAM, and 64QAM. These BER curves need to be on the same figure. Find the power efficiency of each modulation scheme at BER=10^{-6}
2. By running the accompanying .m file, produce the received constellation diagrams of the 64QAM for Eb/No range=[0:2:30]dB (i.e., 16 figure). Comment on the figures you got.
3. The .m file Modulation_EEC481_MASK.m
4. The .m file Modulation_EEC481_MPSK.m
5. For the code Modulation_EEC481_MASK.m, produce the BER curves of 4ASK, 8ASK, and 16ASK. These BER curves need to be on the same figure. Find the power efficiency of each modulation scheme at BER=10^{-6}
6. Produce the received constellation diagrams of the 16ASK for Eb/No range=[0:2:30]dB (i.e., 16 figure). Comment on the figures you got.
7. For the code Modulation_EEC481_MPSK.m, produce the BER curves of QPSK, 8PSK, and 16PSK. These BER curves need to be on the same figure. Find the power efficiency of each modulation scheme at BER=10^{-6}
8. Produce the received constellation diagrams of the 16PSK for Eb/No range=[0:2:30]dB (i.e., 16 figure). Comment on the figures you got.

Bonus Marks

1. Implement a simulation framework for the MFSK?
2. What changes should we do in the code in order to simulate the passband modulation and not its baseband equivalent?