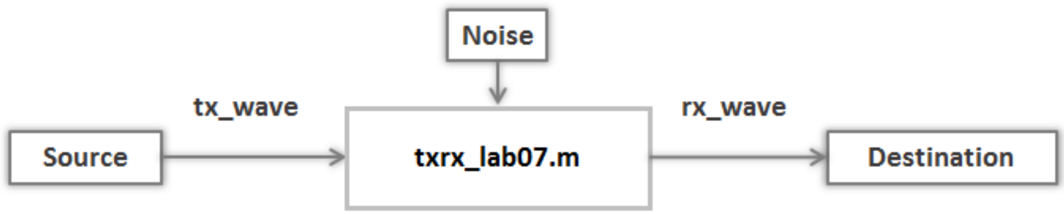
Help

LAB 8 TASK 2 - BER WITH VARYING DECISION THRESHOLD

In this task, you will study the influence of the threshold on BER.

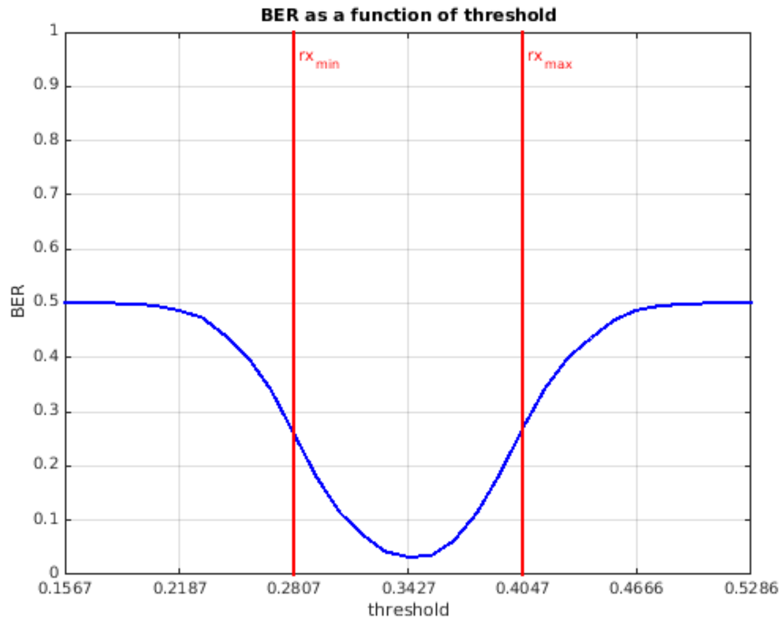



```
distance = 11;  % set the transmission distance
SPB = 50;       % bit time in samples

tx_bs = rand(1,1280) > 0.5;          % generate a random bit sequence
tx_wave = format_bitseq(tx_bs,SPB);  % create waveform following protocol
% transimit and receive over noisy channel
[rx_wave, start_ind, rx_min, rx_max, sigma] = txrx_lab07(tx_wave,distance);
sample_ind = start_ind+2*SPB-1+SPB*[0:1279];

plist = -1:0.1:2; % list of threshold parameters
np = length(plist);
thresh = zeros(1,np);
empirical_BER = zeros(1,np);
for i=1:np,
    p = plist(i); % set threshold control parameter
```

Correct

Figure 1

Help



Check Reset Save *You have used 1 of 10 submissions*

INSTRUCTIONS

In Task 1, you used the decision threshold placed exactly in between **rx_min** and **rx_max**

thresh = rx_min + 0.5*(rx_max-rx_min) = 0.5*(rx_max+rx_min)

for bit detection. This is the optimal threshold *if the input is equally likely to be 0 and 1*. In this task, your job is to study how the decision threshold affects the BER.

The code here is very similar to that used in Task 1. However, In the code window, the available code defines the decision threshold according to

thresh(i) = rx_min+p*(rx_max-rx_min); % set the threshold

according to a threshold control parameter **p**. When **p** = 0, the decision threshold is **rx_min**. When **p** = 0.5, the decision threshold is halfway between **rx_min** and **rx_max**. When **p** = 1, the decision threshold is **rx_max**.

The code uses a **for** loop to sweep the code over all values in **plist = -1:0.1:2**. The for loop will adjust p from p=-1 to p=2 with a step size of 0.1. As a result, the decision threshold increases from a value less than **rx_min** to a value greater than **rx_max**.

After you click on the **Run Code** button, MATLAB will return a graph showing the BER performance at different threshold values, which is very similar to the graph described at the end of Topic 9.4.

This graph was generated assuming that input bits are equally likely to be 0 and 1, i.e. P[IN=0] = P[IN=1] = 0.5. However, what if this were not the case? Would this affect the BER curve and the optimal decision threshold? Try changing the code to alter the probability that the input bit is 1, i.e. P[IN = 1]. Note that this automatically changes the probability that the input is 0, since P[IN=0] + P[IN=1] = 1.

Note that the input bit sequence is defined by the line of code

tx_bs = rand(1,1280) > 0.5; % generate a random bit sequence

Help

The function **rand(1,1280)** returns a random number that is equally likely to be any value between 0 and 1. Since we compare this to 0.5, **tx_bs** is equally likely to be **0** or **1**. How can you change the code to change the probability P[IN=1]?

Re-run the code with different values of P[IN=1]. You do not need to submit your work for this task. Based on your observations, **answer the question below**.

LAB 8 TASK 3 - QUESTION 1 (1/1 point)

In the above lab task, you observed that when bits "1" and "0" are transmitted with equal probability, the decision threshold 0.5*(rx_max+rx_min) is optimal, in that it results in the lowest BER. Suppose the probability of transmitting bit 1 is increased to P[IN=1]=0.75. Which one of the following statements is correct.

Please select the correct answer.

- ( ) The optimal threshold is still equal to 0.5(rx_max+rx_min).
- ( ) The optimal threshold is greater than 0.5(rx_max+rx_min).
- (•) The optimal threshold is less than 0.5(rx_max+rx_min). ✔

EXPLANATION

The bit error rate can be determined by BER = P[IN=0]P[error|IN=0]+P[IN=1]P[error|IN=1]. Given that P[IN=1]>P[IN=0], we can improve the overall perforamnce by decreasing P[error|IN=1]. Thus, the optimal threshold should be moved away from rx_max toward rx_min.

Hide Answer   *You have used 2 of 2 submissions*

LAB 8 TASK 3 - QUESTION 2 (1/1 point)

Consider the limiting case where we increase the decision threshold towards positive infinity. Assume that input bits 0 and 1 are not equally likely, i.e. P[IN=0] $\neq$ P[IN=1]. What will be the limiting value of the BER as the decision threshold is increased?

Please select the correct answer.

- BER = 0.5.
- BER = 1.0.
- BER = P[IN=1], that is the probability bit "1" is transmitted.
- BER = P[IN=0], that is the probability bit "0" is transmitted.

Help

EXPLANATION

The bit error rate can be determined by BER = P[IN=0]P[error|IN=0]+P[IN=1]P[error|IN=1]. If the threshold is increased to positive infinity, then we will have P[error|IN=0]=0 and P[error|IN=1]=1. Thus, BER = P[IN=1].

Final Check Save Hide Answer *You have used 1 of 2 submissions*