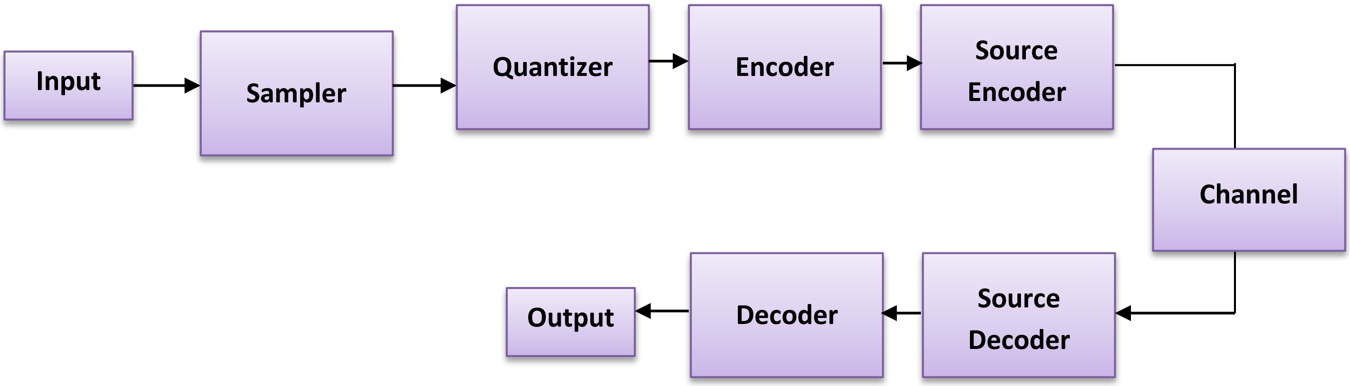
COMM502- Communication Theory

Final Lab Project 2024

Task

You are required to simulate the following communication block.



Given:

The input is a sinusoidal signal $x(t) = a\sin(0.5\, b\, \pi\, t)$, with $t = 0{:}30$ sec. Where **a is the smallest non-zero number of the group members IDs and b is the largest number of the group members IDs,** i.e. if the two IDs are 49-2380 and 49-5694 → a = 2 & b=9

Requirements:

1. Create a function that samples $x(t)$ by taking **1 sample for every N_s samples**, where you can simulate your code with $N_s = 2$.

2. Design a uniform quantizer that takes as an input the vector of sampled values and the number of required levels L and returns a vector of quantized values. **Simulate your quantizer three times, with $L = 2, 4$ and 8.**

Note: **The code written should be adaptable to any number of levels L and any N_s**

3. Calculate the mean absolute quantization error for your designed uniform quantizer for $L = 2, 4$ and 8, respectively. **Then, plot the mean absolute quantization error vs. the number of Levels.** (Comment on the output figure).

4. Calculate the variance of the quantization error for your designed uniform quantizer for $L = 2, 4$ and 8, respectively. **Then, plot the variance of the quantization error vs. the number of levels and also Plot the theoretical variance of the quantization error vs. the number of levels on the same figure.** (Comment on the output figure).

5. Find the SQNR of the designed uniform quantizer with $L = 2, 4$ and 8, respectively. **Then, plot the SQNR vs. the number of levels and plot the theoretical SQNR vs. the number of levels on the same figure.** (Comment on the output figure).

6. For simplicity in your code, **assume that the encoder encodes each level with the level number instead of the binary format**. For example: instead of giving the first level a code of 0000, encode it as 0. Same goes for the second level, instead of encoding it as 0001 encode it as just 1. For the third level, instead of encoding it as 0010 encode it as just 2 and so on.

7. Use a **Huffman Source encoder**.

8. Simulate a **noiseless** channel.

9. For the decoder use the **reverse of the scheme shown above in the encoder**.

10. Use **Huffman Source decoder**.

11. **Plot the input and output signals** on the same figure.

12. List multiple ways that can enhance the approximation of the output figure. **State why there is difference between the input and the output signals.**

13. Calculate the **efficiency** of your compression code.

14. Calculate the **compression rate**.

Useful Matlab functions:

huffmandict, huffmanenco, huffmandeco

Deliverables:

1. The m-files uploaded to the drive (the link will be sent to you later through email).
2. A printed report including your m-files, all the output figures, values and the comments requested above.

Submission:

- Submission will be in the office C3.206 (back side)
- The Assignment will be groups of two-three students
- **The deadline will be on Tuesday 03/12/2024**

- **Needless to say, any copied reports/codes will be graded as ZERO.**