California State University, Long Beach

Department of Electrical Engineering

EE482: Communication Systems II

Lab1: Huffman Coding and Capacity

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Objective

The objective of this lab is to help students understand concepts like Entropy, Huffman coding and capacity. MATLAB could be used for simulating results and comparing them with theory. The first segment of the lab is focused on Huffman coding and the final section is about capacity in a bandlimited AWGN channel.

Huffman Coding

A discrete memoryless output is created from the alphabet $\mathcal{X} = \{x_1, x_2, \dots, x_6\}$ with the probabilities $p = \{0.1, 0.3, 0.05, 0.09, 0.21, 0.25\}$.

a) Determine the entropy of the source using MATLAB.
b) Design a Huffman code and sketch the code tree.
c) Specify the codewords for all the symbols in the alphabet.
d) Determine the efficiency of the code designed.
e) Design a Huffman code for a source with sequences of length two: $[x_i, x_j]\ \forall\ i, j = 1, \dots 6$.
    i. Find the probability of each codeword.
    ii. Repeat parts *c* and *d* to find Huffman code and its efficiency.

Capacity of a Bandlimited AWGN channel

Capacity of a Bandlimited AWGN channel is given by formula

$$C = B \log_2 \left(1 + \frac{S}{N_0 B}\right)$$

Where B is the bandwidth of the channel, S is the average transmitted power and $N_0/2$ is the PSD of the AWGN.

a) Plot the capacity with $B = 5KHz$ as a function of S/N_0 for values between -20 and 30 dB.
b) Plot the capacity with $\frac{S}{N_0} = 25dB$ as a function of B up to 100 KHz.
c) Find the limiting value of capacity as B goes to infinity and compare the result with part b.
d) Rewrite the capacity formula as a function of E_b/N_0 and plot the normalized capacity (C/B) as a function of $10 \log_{10} E_b/N_0$.