EEL 4350 – Principles of Communication

Project 4

Due Thursday, April 2, 2015

Description

This project provides a simulation-based introduction to digital communication system techniques and, more specifically, pulse-code modulation. In this project, MATLAB will be used to numerically perform the operations of quantization and encoding for a sampled signal.

Deliverables

Your deliverable will be in the form of a hard-copy report with the following clearly labeled sections:

- Cover sheet including your name, the name and number of the course, and the project number (1).
- Brief Description of Project (1 to 2 paragraphs recommended)
- Complete MATLAB Code with Comments
- Detailed description of your quantization and encoding algorithm, along with the requested figures. Figures should be appropriately labeled ("Figure 1", "Figure 2", etc.). The Figures should be placed at appropriate places within the body of your descriptions.
- Conclusions (likely a 1 paragraph summary)

Failure to adhere to this format will result in deduction of points.

Project Summary:

In this project, pulse-code modulation and encoding is performed on a cosine wave message. An "analog, continuous-time" signal is sampled using supplied MATLAB code. Your task is to complete the PCM to allow digital transmission: you will perform quantization and bit encoding operations on the signal.

Project Description and Assignment

Enter the following MATLAB code into a .m file and save as "project4.m":

```
%Pulse-code modulation
%This code creates a continuous-time function, samples the function at
%discrete instants in time, and quantizes the results, resulting in a
%bitstream representing the sampled data.  The project shows the conversion
%of a signal from a continuous-time, analog signal to a discrete-time,
%digital signal.
t=0:0.00001:0.1;
m = 5*cos(200*pi*t);    %the continuous-time function
figure;
plot(t,m);
%Sample the function; the Nyquist rate is 200 Hz.  Sample at 400 Hz
%instead.  The sample time is 1/400 = 0.0025.
Ts = 0.0025;
nstop = 0.1/0.0025;
n = 1:nstop;
ms = 5 * cos(200*pi*n*Ts);   %the sampled signal -- ms is a vector containing
the sample values
figure;
plot(n,ms);
```

This code provides for the sampling of a continuous-time message signal

$$m(t) = 5\cos(200\pi t)$$

Notice that the sampling begins at $T_s = 0.0025$ and the signal is sampled every $T_s = 0.0025$ seconds. The signal bandwidth is 100 Hz, so the use of the sampling rate $f_s = 1/T_s = 400$ Hz is satisfactory (>2B).

At the end of the code, a sequence ms[n] exists. This is an analog, discrete-time signal (it is merely a sequence of numbers). To complete the pulse-code modulation, this sequence of numbers must be quantized and then represented by bits. You will perform these operations by appropriate MATLAB coding. Your assignment is as follows:

1. Copy the existing code into a .m file. The existing code plots the continuous-time, analog signal as a function of time (Figure 1). It then samples the signal at a rate f_s Hz and plots the sampled signal versus the sample number (Figure 2).
2. Add code to quantize the signal into L = 16 levels covering the range between -5 and 5 (use m_p = 5). It is likely you will want to use a "while" or "for" loop to accomplish this. Plot the quantized signal as a function of sample number (Figure 3). Convert the quantized values to signal level numbers (i.e. 1 through 16 with 1 corresponding to the lowest quantized value and 16 corresponding to the highest quantized value). Plot the quantized signal versus sample number (Figure 4).

3. The quantized values can now be converted into a four-bit representation of the signal because n n = $\log_2$ L = $\log_2$ 16 = 4 bits. Create a bitstream representing this signal. Note that you will now have four bits for each sample. Each bit should be a 1 or a 0. You will likely need to create a "for" or "while" loop to accomplish this. Plot the bit values versus bit number (Figure 5).

As stated in the first page of the assignment, be sure to include a section containing your conclusions as part of this report.