Introduction to Analog and Digital Communications

Final Project

Introduction

The purpose of this project is for you to exercise the material you learnt in the digital communications portion of this class in a physical system, and to learn aspects of constructing a real digital communications system which are not covered in the regular classroom setting. Successful completion of this project will demonstrate your ability to design a communication system.

It is recommended that you use the universal software radio peripheral (USRP), which is a software defined radio platform to implement your system. The USRP is a box that can transmit and receive wireless signals but the processing of the transmitted and received signals are all done on host computers. There are several software tools to interface with the USRP, including an in-house tool that enables you to transmit and receive signals directly from MATLAB. However, you may choose to implement your system with discrete components (i.e. ICs).

The final deliverables for the project are a report and a demonstration of your working system.

System Requirements

At the minimum your project needs to have the following features

1. Communicate digital data across a wireless channel of at least 24 inches. An exception to this rule can be accommodated if you wish to use an appropriate wired channel. You are free to choose any type of data you want.
2. A bit-error rate of 10^{-4} or lower.
3. A net data rate of at least 64 kb/s – this is the net data rate of each packet taking into account any overhead. In other words, if you transmit a packet that is 0.01 seconds in duration which carries 640 payload data bits your data rate would be 64 kb/s.
4. You are not allowed to share any clock signal across your system. Hence, your system must either be robust to frequency and phase offsets between the transmitters and receivers, or compensate for these offsets.
5. An additional enhancement over the basic digital communication system. Some possible ideas include[1]
    a. Error control coding. This refers to coding techniques used to carefully add redundancy to the transmitted data to enable up to a certain number of bit errors to be corrected at the receiver.

[1] This will not be required if you implement the system using discrete components instead of the USRP

b. Source coding. This refers to compression of the source data so that it can be communicated more efficiently across the channel. Huffman coding is a good example of a source coding algorithm that would be suitable in terms of scope and complexity for this project.
c. Medium access control. This refers to protocols that are designed to reduce the probability of multiple users transmitting in the same frequency band at the same time. This will require multiple groups to work with each other, or some form of interaction with existing systems.
d. Orthogonal-Frequency-Division-Multiplexing. This is the modulation scheme used in WIFI systems.

Note that although there are plenty of libraries and code examples that accomplish the above (e.g. Huffman coding), but for the purposes of this class, you will need to implement it yourselves. This requirement is to ensure that you get a full understanding of the system. Your report should have a detailed description of your implementation.

6. Comply with the frequency restrictions assigned to your team.

Teams and Schedule

This project is intended to be done by a team of three to four students.

A short proposal is due on April 16. Please discuss your project ideas with Siddhartan before then.

The final report for this project is due electronically by **5 p.m. on May 9.**

Final demos will be in the allotted time during the final assessment period.

***** Note that you must return the USRP hardware by May 10 or your final report will not be graded.**

Frequency restrictions

The USRP system as issued to you operates in the 2.4 GHz band which is also the band used by wifi networks. Thus, in order to not disrupt existing wifi networks and to not interfere with other teams' communications, we ask that you select a frequency range to operate in on the course wiki and **only transmit in that range of frequencies.**