Montana State University
REU project list, Summer 2009
Several students will work collaboratively on each project with faculty mentorship

Project 1. WiMAX Mesh Network Relay Node (Richard Wolff)

This project will assemble and test a WiMAX radio relay node as part of a larger mesh network test bed. The student will assemble the node from off the shelf radios and develop and test software to route signals through the node. The student will also conduct testbed and field tests of the radio system.

Project 2. Generation of Communication Signals (Andy Olson)

The student will work with the mentor to develop a Matlab/Simulink program that will generate the complex waveforms used in modern communications systems. The program will output a bit stream to be used by a National Instruments controller to program an Arbitrary Waveform Generator (AWG) to create the physical signal. The goals for the student are:

- To understand several of the signals used in wireless communications systems
- Learn how to analyze and synthesize these signals in the Matlab/Simulink environment.
- To physically program the signals into a computer controlled AWG and utilize them.

Prerequisites: The student should be able to write simple Matlab programs. It is helpful if the student has had an engineering course in Communications but not required.

Project 3: Fabrication and characterization of optical nanostructures (Waturu Nagakawa)

This project involves the use of standard microfabrication materials and processes to produce nanostructured devices with applications in optics and communications. Nanostructures provide unique opportunities to produce devices with novel or engineered optical properties, tailored to their target application. An appropriate device design will be selected, and the participants will use the extensive resources available at MSU to fabricate and characterize the selected device. Students with a background in optics and/or experience in microfabrication strongly preferred.

Project 4: Wireless Network Algorithm Design and Implementation (Brendan Mumey and Jian (Neil) Tang)

This project seeks to improve theoretical and practical performance of various types of wireless networking systems, including MIMO systems (each node has multiple antennas and can decide what to do with them) and cognitive radios (where communications can occur simultaneously on separate channels). Students should have a computer science background with some previous exposure to algorithm and data structure design and programming experience.

Project 5. Cross-layer Optimization for Dynamic Spectrum Access Wireless Mesh Networks (Jian (Neil) Tang)

This project focuses on the emerging Dynamic Spectrum Access (DSA) Wireless Mesh Networks (WMNs). Cross-layer design is strongly needed for such a network due to its two special features: dynamic spectrum availability and spectrum heterogeneity. We are conducting a comprehensive study on cross-layer optimization for DSA WMNs, and designing networking protocols under its guidance. Specifically, we concentrate on the bottom four layers of the network stack and seek joint congestion control, routing, spectrum sharing, and power

control solutions with the objective of maximizing throughput, achieving certain fairness, and providing QoS support.

Project 6. Wimax Signal Pilot Tone Recovery Model (Andy Olson)

The student will work with the mentor to develop a Matlab/Simulink model to process a Wimax signal to recover the phase and amplitude of the pilot tones. The goals for the student are:

- To understand several of the signal profiles used in Wimax wireless communications systems
- Learn about the signal processing algorithms required to analyze the Wimax signal.
- To Develop and Document the Matlab code to analyze Wimax signals and recover the phase and amplitude of the pilot tones
- To Design a user interface for the program.

Prerequisites:

The student should be able to write simple Matlab programs. It is helpful if the student has had an engineering course in Communications but not required.

Project 7. Optical Networking Research (Brendan Mumey and Richard Wolff)

This project looks at designing better strategies to improve performance on large-scale optical only networks by considering how physical impairments affect the real-life performance of communications in the network. We are actively designing new routing and wavelength assignment strategies for improving performance. Students with a background in computer science or electrical/optical engineering preferred.

Project 8. Broadband Array Simulation Study (Yikun Huang)

The student will develop and run simulations to test the performance of a Broadband Array System and determine its ranges of acceptable operation, as well as evaluate the limitations that the antenna hardware will impose on the realized system. This will include Monte Carlo simulations studying the effects of frequency on the array gain and beam pattern, array size vs. antenna mutual coupling, and other frequency dependent algorithms whose usage is desired or of interest. Goals include:

- Understanding the basic operation of a Smart Antenna Array
- Experience in writing and running Matlab simulations of a physical system
- Practice analysis and visualization of collected datasets
- Possibly verification of the simulation results in the laboratory

Prerequisites:

Prior experience in the Matlab environment

Project 9. Antenna Array Self-Calibration (Yikun Huang)

Calibration of smart antenna arrays is very important as the array system performance is usually very sensitive to the phase and magnitude errors. Such errors may significantly affect the smart antenna systems performance. The student will run Matlab simulations to investigate the performance of several calibration algorithms. The student will test the one of the selected calibration algorithms in the antenna lab and makes sure it works. The student will help with the troubleshooting and doing calibration on an adaptive array translation board as well.

Prerequisites:

Prior experience in the Matlab environment.