Montana State University
REU project descriptions, Summer 2007
Several students will work collaboratively on each project with faculty mentorship

PROJECT 1: Neighbor discovery for an ad-hoc network using smart antennas (Richard S. Wolff)

We are investigating the benefits of using smart antennas for mobile ad hoc networks in sparsely populated areas. Smart antennas can greatly improve the wireless communication range and have been reported to improve throughput. However there are many challenges for introducing smart antennas to an ad hoc network. One key issue is neighbor discovery. For conventional a mobile ad hoc network, each node is equipped with an omni-directional antenna, which will periodically send "hello!" messages to its neighbors to maintain an updated neighbor list. However a smart antenna usually forms a beam in one direction or several distinct directions that makes the current neighbor discovery method invalid. We will study neighbor discovery using beam switching methods. The REU student will use Matlab simulation tools to study a new neighbor discovery methods for a network with N mobile nodes. The locations of each node are obtained by other methods and the terrain in the region is known as well. Other useful assumptions will be considered: the smart antenna in transmission mode will form a beam in a specific direction, while in receiving mode it will listen omni-directionally.

PROJECT 2: Beamforming algorithm implementation (Yikun Huang)

The goal is to develop and implement a beamfoming software package for a compact 8-element array smart antenna system operating at 5.8GHz. We have recently investigated and developed the first commercial technology to consolidate several advanced techniques (i.e. smart antenna and WiMAX radio technology) in one small size, light weight multi-function, low cost communication unit providing users easy access to a communication network where wired transmission is too costly, inconvenient, or unavailable. The student will run a Matlab simulation study for phased array beamforming, spatial signature estimation and mobile target tracking algorithms using the programming skill from the Matlab Mini-course. The student will calibrate an existing 8–channel beamforming board and implement his/her Matlab code with a user friendly control interface developed in the ECE antenna lab to control an existing beamforming board for beamforming, spatial signature estimation and tracking algorithms test. The student will evaluate the algorithms performance and compare the test results with simulated results.

PROJECT 3: PC Instrument control development and implementation (Andy Olsen)

We will have a research project that focuses on modern day instrumentation for research in antenna design and test for wireless communications. We have designed and built an anechoic chamber and the related antenna data acquisition system for the ECE department. However, a better instrument control and data acquisition system refining are very much needed for efficiently performing complex smart antenna tests in the chamber. The REU student will initially work with our staff to become familiar with each instrument, the functions of the existing instrument control system and the basic functions we need to add or to improve in this REU project. The student will learn to use LabView or Matlab and to control the instruments with the computer. In the end of the program, he/she will use his instrument control system to test a smart antenna array. The antenna array will be designed by one of the other REU students

and the array will be automatically controlled by beamforming software developed by another REU student.

PROJECT 4 Mesh Routers and Internet Gateways for Rural Areas (Jian Tang)

The goal of this project is to examine alternative approaches to designing networks for Internet service in rural areas The REU student will help to construct models and carry out simulations to study alternative approaches to providing high-capacity, cost effective Internet connections in sparse areas.

PROJECT 5 Free Space Optical Communications for Rural Areas (Kevin Repasky)

The goal of the effort will be to examine the feasibility of using free space optical paths as an alternative or a supplement to wireless and to assess the trade offs and limitations under typical rural conditions. Montana State has recently initiated a study of the use of free space optical communications and has developed a testbed to evaluate the performance of low-cost optical components in earth-space links. In this REU project, the student will initially use the existing testbed and adapt it to terrestrial applications. He/she will examine propagation impairments such as rain, dust and snow that are typical of rural areas. The result will be a link model comprised of commercially available optical components and an assessment of expected range and throughput.

PROJECT 6 Determining Link Availability for Optical Earth-Space Communications (Joseph Shaw)

Optical remote sensing systems originally developed for ground-based measurement of cloud statistics for climate studies provide the opportunity of measuring link availability statistics for Earth-space optical links through the free atmosphere. This project will use infrared imaging and laser radar (lidar) sensors to measure the spatial and temporal statistics of cloud cover over a potential optical ground station site to explore the suitability of earth-space free space optics for communications in rural areas. The REU student will work on setting up a lidar experiment and designing the data acquisition software to enable simultaneous measurements at multiple sites to investigate site-diversity statistics.

PROJECT 7 Wireless propagation in rural areas (Richard S. Wolff)

The goal of this project is to measure the range and throughput of radio links under varying terrain and distance conditions. We are developing prototype steerable antennas for use with emerging WIMAX radio technologies. The REU student will work on link budget calculations and make field measurements to validate our link models.