

2011 High School Research Program Projects

Department of Computer Science

1) Kenji Yoshigoe

a) **Scientific Programming on High Performance Computing Systems - Parallel Simulator:**

Supercomputer is a powerful cyberinfrastructure researchers use to discover unknowns in various disciplines. This project will first familiarize you with various types of scientific applications which can be executed on a supercomputer. Depending on the type of applications, you can take advantage of different levels of parallelisms including instruction-level, shared-memory, and distributed parallelisms. You will have opportunities to learn and develop parallel simulation programs using one or more of these parallelisms. At the end of the project, you will be able to evaluate and optimize the performance of your program to fully take advantage of various supercomputer architectures.

b) **Scientific Programming on High Performance Computing Systems - Parallel Data Mining:**

Supercomputer is a powerful cyberinfrastructure researchers use to discover unknowns in various disciplines. This project will first familiarize you with various types of scientific applications which can be executed on a supercomputer. Depending on the type of applications, you can take advantage of different levels of parallelisms including instruction-level, shared-memory, and distributed parallelisms. You will have opportunities to learn and develop parallel data mining programs using one or more of these parallelisms. At the end of the project, you will be able to evaluate and optimize the performance of your program to fully take advantage of various supercomputer architectures.

c) **Sensitivity-Aware Secure Communications in Wireless Sensor Networks (WSNs):**

WSNs have been considered as one of the most important technologies that will change the world. A wireless sensor node consists of limited energy, processing power, and storage. Thus, communication in WSNs is less secure than that in traditional networks. In this project, tradeoff between resource consumption and achievable security will be evaluated. Sensitivity-aware encryption technique will be investigated where more sensitive data will be encrypted with more sophisticated encryption technique. Sensitivity-aware routing will also be proposed and evaluated for providing more secure and resilient path for sensitive information. With a relatively small increase in resource consumption, hypothesis is that, sensitive data can enjoy significantly higher level of security than non-sensitivity data.

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Department of Computer Science (cont.)

2) Steve Minsker

Data Structures and Algorithms:

The study of data structures and algorithms is a happy marriage of computer science and mathematics. It involves the application of mathematical methods to computer programs and software development to analyze their efficiency and correctness. I am interested in algorithms in general and recursive algorithms in particular. I have authored seven research papers on variations of the classical Towers of Hanoi problem, and am currently working on an eighth problem (“the cyclic Towers of Antwerpen problem”) involving color and rotation restrictions on the ring movement. Hanoi problems are very easy to understand, and generally easy to program by computer, but their mathematical analysis can range from the very simple to the extremely difficult.

Students who find recursion fascinating and fun would be welcome to work on implementing computer solutions (either symbolically or graphically) to a few of the many amusing variants of the Towers of Hanoi, and, for the mathematically inclined, there is the additional challenge of analyzing and optimizing the algorithms.

3) Mariofanna Milanova

a. Model of Facial Parameter Extraction and Animation

Recent advances in multimedia-related technologies and new applications such as virtual agents, video conferencing, visual effects in movies, and virtual players in computer games are motivating much research in digital character and face animation. In this project we will develop a system for the implementation of photo realistic avatar using video captured from the user. This is achieved by constructing a dynamic video map of facial expressions and mapping them to a 2D model. The dynamic video map reflects user’s facial expressions with constant updates directly from the input video. The goal of this project is to provide a vivid representation of participants with the use of dynamic video map in perceptually important facial regions, notably eyes and mouth as compared to all of the facial parameters defined by MPEG4. We implemented an automated system that performs face detection, face tracking and facial feature extraction.

b. Step by Step introducing Scratch Programming

The students will create interactive stories, games and animations with Scratch.

The student will have experience implementing Scratch for

- Interactive games
- Storytelling
- Interactive projects
- Music projects
- Animations
- Programming concepts
- Basic introduction to Electronics and Techniques

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Department of Systems Engineering

4) Guoliang Huang

Fabrication of MEMS-Based Piezoelectric Sensors:

The concept of using Micro-Electromechanical Systems (MEMS)-based piezoelectric materials as actuators/sensors for the Structural Health Monitoring (SHM) application is now regarded as one of the most promising techniques since they are usually small, lightweight, unobtrusive, and low-cost. The objective of the research is to develop a MEMS fabrication technique of the MEMS-based piezoelectric sensors that will enable this system to reach its specified performance. A RF sputtering method will be used to fabricate the piezoelectric thin films to work as sensors. Attention will be paid how to control microstructure grain sizes of the piezoelectric thin films under different temperature conditions.

Department of Information Science

5) Elizabeth Pierce

Creating a Twitter "Mood Ring"

Twitter is a popular online service that allows people to share and discover what's happening right now anywhere in the world. Sentiment Analysis refers to a collection of techniques for finding and interpreting moods, opinions, and emotional impacts in a body of text. This summer research project will investigate the creation of a Twitter "mood ring" that will analyze a collection of tweets to determine the moods being expressed. (e.g., happy, sad, confused, angry, fearful, etc) and then to display the results in a creative way. Students interested in this project just need to like to "tweet", have some basic computer skills, and be willing to learn some basic text mining, extraction, and presentation strategies alongside a UALR faculty member.

Department of Engineering Technology

6) Hiram Patangia

Photovoltaic Solar Power Systems

This project will give students an overview of the photovoltaic solar power systems, including defining components and their various functions, the basic parameters in designing and improving the performance of the system and the current research to improve system efficiency and performance. Students will set up basic electrical measuring equipment, record and plot data, and write reports on findings.

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Department of Applied Science

7) Cang Ye

a. Dynamic object following by a mobile robot:

This project is to develop an algorithm that enables a mobile robot to follow a moving object (e.g., a person walking around). A laser rangefinder will be used to measure distances between the robot and objects. Students will develop a method to detect an object and its motion based on the range data, and a method to follow the object.

b. Mobile robot position estimation using a laser rangefinder:

Through this project students will get hands-on experience on how to estimate a robot's position and heading direction by a laser rangefinder. They will learn how to obtain range data from the sensor and how to compute the change in position and heading from the range data.

c. 3D imaging sensor for mobile robot navigation:

The objective of this project is to investigate an obstacle detection method based on a 3D imaging sensor. Students will learn how to capture 3D data from the sensor and develop a preliminary method to detect objects that block the robot's path.

Department of Biology

8) Fusheng Tang

Exploring the effect of pH homeostasis on life span extension:

Understanding the mechanisms of aging is of critical importance in preventing the onset of such diseases. In my laboratory, we are exploring how vacuoles, an intracellular organelle, contribute to longevity with genetic approaches. Since the vacuole (equivalent of mammalian lysosome) is the major organelle to adjust the intra-cellular pH homeostasis, we plan to analyze whether mutants with elevated or compromised pH-buffering vacuolar functions affect the life span. This work is part of ongoing efforts in the Tang laboratory to develop anti-aging practices. The conservation of sub-cellular organization between yeast and mammalian cells allows us to test our discoveries in yeast on mammalian cells and organisms in the future.

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Department of Chemistry

9) Wei Zhao

Carbon-based Nanomaterials for Nanophotonics and Optical Biosensing:

The research work in Dr. Zhao's lab focuses on the studies of carbon-based nanomaterials including carbon nanotubes and nanographene for nanophotonics and optical biosensing applications. The work involves preparation of water-soluble single-walled carbon nanotubes and nanographene by using non-covalent surface functionalization with various polymers, including biological molecules enzymes and DNA. The nanomaterials are then purified with uniform sizes by chromatographic separations. These purified samples are measured by powerful two-dimensional infrared laser spectroscopy for novel optical properties including near infrared photoluminescence, nonlinear optical absorption and switching etc. When the samples are immobilized with enzymes and complementary DNA, they are developed as optical sensors for biological molecule detection such as sensing glucose for diabetes diagnoses and probing target DNA for cancer diagnoses.

10) Anindya Ghosh

Synthesis and characterization of amide based iron or manganese complexes for activation of hydrogen peroxide and oxygen:

Students will synthesize few amide based acyclic metal complexes for activation of natural oxidants. We will characterize these metal complexes and use these complexes for oxidation of organic substrates. We will also use these complexes to degrade organic pollutants.