2005

SURF-IT

Summer Undergraduate Research Fellowship in Information Technology

Poster Session

UCI
University of California, Irvine

A Welcome from Calit2

Thursday, September 1, 2005

Dear SURF-IT Fellows, Mentors, Family and Friends,

As SURF-IT's inaugural summer draws to a close, I'd like you to know how pleased I am with the Program's success and with the accomplishments of all the participants.

SURF-IT, which was developed in cooperation with UCI's Undergraduate Research Opportunities Program, offered undergraduate students a unique opportunity to work with faculty mentors in state-of-the-art facilities on IT-related research and applications. Our current group of 14 students was selected from nearly 40 applicants; all have proven their enthusiasm for learning and their skill at gleaning significant information from their research. In addition, I believe everyone benefited from semi-monthly lunch 'n learn seminars that introduced them to research conducted by other SURF-IT Fellows.

Calit2 believes that students are essential to the future of research. I'm delighted that the Institute could play a role in encouraging the collaboration between hardworking, forward-thinking students and the faculty members who were willing to mentor them. The students who have completed this Program have gained first-hand experience that will prove invaluable as they continue on to graduate school or industry.

All of you should be very proud of what you have accomplished. Good luck to you in your future endeavors.

Sincerely,

Albert Yee

Calit2 Irvine Division Director

SURF-IT Poster Presentations

Posters will be displayed in the Atrium of the Calit2 Building from 3:00 to 6:00 p.m.
They will be arranged alphabetically by student last name.

SURF-IT Fellow	Project Title	Faculty Mentor(s)
Fatima Alim *Biomedical Engineering*	Nanoelectronic Circuits for Chemical and Bio-sensors	**Philip Collins** *Physics & Astronomy*
Michael Brown *Earth System Science, Philosophy*	Distributed Data Reduction Techniques Applied to California Climate Change	**Charles Zender** *Earth System Science*
Robert Carpenter *Criminology, Law & Society*	Fingerprint Data Collection and Analysis	**Simon Cole** *Criminology, Law & Society*
Kelvin Cheung *Materials Science Engineering*	Analyzing the Properties of Iridium Oxide(IrOx)-Derived Electrochemical Sensors	**Marc Madou** *Mechanical & Aerospace Engineering*
Vahe Gabuchian *Chemistry*	Biomimetic Modular Design for Advanced Biomaterials	**Zhibin Guan** *Chemistry*
Dirk Groeneveld *Information & Computer Science*	VizION: Evolving Ubiquitous Computing Middlewares	**Falko Kuester** *Electrical Engineering & Computer Science*
Lei Huang *Electrical Engineering*	Vertically Aligned ZnO Nanowires as Potential Building Blocks for Nanoscale Devices	**Jia "Grace" Lu** *Chemical Engineering & Materials Science*
Madelyn Luttgen *Earth System Science*	Axon Guidance Using Microfluidic Devices	**Noo Li Jeon** *Biomedical Engineering*
Uel McMahan *Information & Computer Science*	The EcoRaft Project	**Bill Tomlinson** *Informatics*
Pooya Monajemi *Electrical Engineering*	Implementation of Jakes Channel Simulator for Multiple-Input-Multiple-Output Wireless Systems	**Hamid Jafarkhani** *Electrical Engineering & Computer Science*
Bobak Mosadegh *Biomedical Engineering*	Cell Migration in Microfluidic Devices	**Noo Li Jeon** *Biomedical Engineering*
Cathryn O'Neill *Biological Sciences*	The Use of Computer Games as a Conduit to Invoke Ethical and Moral Behavior	**Kristen Monroe** *Political Science*
Alan Paradiso *Mechanical Engineering*	Dielectrophoretic Separation Systems	**Marc Madou** *Mechanical & Aerospace Engineering*
Daniel Repasky *Studio Art*	VirtualCalit2	**Falko Kuester** *Electrical Engineering & Computer Science*

Fatima Alim

Major: Biomedical Engineering

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Project Title: Nanoelectronic Circuits for Chemical and Bio-sensors

Faculty Mentor: Philip Collins

Abstract:
My project goal is to use carbon nanotubes in electronic devices for chemical and bio-sensing. Single walled carbon nanotubes are grown by chemical vapor deposition using an iron/molybdenum catalyst, and then devices are formed using electrodes laid down by photolithography. Each device is electrically probed for connections and the current vs. gate voltage (I-Vg) dependence is measured to determine whether the nanotube is semiconducting or metallic. Carbon nanotubes can also contain defects—points within the tube where a single carbon atom is missing or has been replaced by another atom, such as oxygen—and these will significantly change the measured I-Vg curve. My project involved finding devices with anomalous I-Vg curves and, through the use of scanning gate microscopy, visibly locating point defects on the nanotube. The gate dependence of a point defect can then be studied and even altered as a function of its chemistry. For example, the presence of different gases affects defects and may impact the use of nanotube devices as chemical sensors. Alternately, the defects can be covalently modified, such as by binding an amine to a carboxyl defect. The ultimate goal of the project is to attach the amine groups of bioreceptors to nanotube point defects and observe the electrical changes when a ligand binds to a receptor. This will allow us to understand protein binding in greater detail and use nanotube devices as biosensors.

Michael Brown

Majors: Earth System Science, Philosophy

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Project Title: Distributed Data Reduction Techniques Applied to California Climate Change

Faculty Mentor: Charles Zender

Abstract:

We apply Distributed Data Reduction and Analysis (DDRA) techniques to climate model data to characterize the envelope of predicted twenty-first century California climate change. Our advanced DDRA techniques reduce bottlenecks and let us evaluate the complete range of climate scenarios considered by the Intergovernmental Panel on Climate Change (IPCC). We use the DDRA-enabled netCDF operators (NCO) to analyze and inter-compare all seventeen IPCC A1B climate projections, which stabilize at 720 ppm CO2. This NCO-based inter-comparison distills meaningful scientific results from over 30 TB of raw model data per scenario. In addition to numerical DDRA, we are using HIPerWall to visually inter-compare all seventeen model predictions simultaneously in a prototype environment for Terascale Data Visualization and Analysis. The IPCC ensemble mean twenty-first century predicted surface temperature and precipitation change are 0.247 K/decade and 0.011 mm/day/decade (globally), and 0.333 K/decade and no significant change in precipitation (California). The National Center for Atmospheric Research (NCAR) Community Climate System Model (CCSM) predicts a decrease in strataform precipitation and an increase in convective precipitation, globally. In California, the CCSM predicts a precipitation increase along the central coast and decreases in the north and south portions of the state. The CCSM also predicts the strongest warming inland with the least warming along the coast of California. In our future work we plan to apply the information gained from the IPCC model predictions to assess the future energy needs of California and characterize inter-model consistencies and discrepancies.

Robert Carpenter

Major: Criminology, Law & Society

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Project Title: Fingerprint Data Collection and Analysis

Faculty Mentor: Simon Cole

Abstract:

Fingerprint analysis is important when interpreting evidence discovered at a crime scene. Recent research has suggested that fingerprint identification may not be as reliable as previously believed. The SURF-IT project involved several tasks. The first task was to continue an ongoing project of searching prints against a database provided by the National Institute of Standards and Technology (NIST). This project involved a database containing 27,000 mated pairs of fingerprints. The initial search of approximately 6,000 fingerprints took about four months, requiring supervision of the automated searching process. It was also necessary to conduct data analysis of the initial search project previously described. Additionally, we had to analyze a set of data containing fingerprints that were collected from Human Subject volunteers during Winter quarter 2005. Fingerprints from nearly 600 individuals were sampled. With fingerprint matching software, we measured the computer's ability to make correct matches by searching latent prints derived from the volunteers against this database. We found that in 28% of the cases the software was unable to identify the correct donor of the subject print properly. In some cases, as many as eight other candidates were selected before the actual donor was matched as the best candidate associated with the latent fingerprint. In some of these cases the mismatched prints look nearly identical and had as many as sixteen points of identification. This could have catastrophic outcomes knowing that point matches above eight could easily result in a conviction during a criminal trial.

Kelvin Cheung

Major: Materials Science Engineering

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Project Title: Analyzing the Properties of Iridium Oxide(IrOx)-Derived Electrochemical Sensors

Faculty Mentor: Marc Madou

Abstract:
The IrOx pH sensor is an inexpensive, miniaturized, and versatile electrochemical sensor that poses great economical and biological potential. The standard glass pH electrodes used today are expensive, fragile, and difficult to miniaturize based on current manufacturing technologies. Due to these limitations, glass pH electrodes cannot be used for many applications, such as implantable devices, patient blood testing, and foods. In recent years, melt-oxidized iridium wires have shown considerable promise in overcoming these limitations. These IrOx sensors require baking small iridium wires in a furnace at high temperatures in a Li_2CO_3 melt. These wires are claimed to produce excellent mechanical stability, very fast response times, and stability in a wide pH range and variety of mediums. Recently however SensIrOx, a company producing these sensors, has made progress in manufacturing them. IrOx sensors obtained from SensIrOx were tested and supported many of the initial claims regarding the sensors produced this way. Fast response times, stability in a variety of pH buffers and in the presence of ferricyanide, and fairly good mechanical stability were all observed. The sensors require a break-in period of being fully soaked in a pH buffer for several days and must maintain hydration to obtain good readings with quick response times. This is contradictory to the initial claims of having equally effective readings with dry sensors. It is presently uncertain why this discrepancy exists; however, the general progress thus far seems to support the initial claims made regarding the creation of IrOx in a lithium carbonate melt bath.

# *Vahe Gabuchian*

Major: Chemistry

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Project Title: Biomimetic Modular Design for Advanced Biomaterials

Faculty Mentor: Zhibin Guan

Abstract:

The protein *titin* is a true elastomer that is crucial for the advanced mechanical performance of mammalian muscle. *Titin* achieves this feat by incorporating sacrificially unfolding domains into the load-bearing fiber. Applying nature's design of the muscle protein *titin* to modern synthetic polymers, we can potentially improve their mechanical properties. My project with the Guan group is to make synthetic modules that can be incorporated as sacrificial domains into today's materials. We hypothesize that module incorporation will lead to improved material performance. The modules, mimicking the IgIII domains of *titin*, have internal sacrificial hydrogen bonds that can rupture under applied stress, absorbing energy and unfolding the domain without breaking any covalent bonds. Once the stress is relieved, the hydrogen bonds reform, ready to absorb more energy. Recently we have synthesized the module in three different loop sizes. These modules were characterized by ES (Electro-Spray) mass spectrometry experiments to confirm that the loop was indeed closed and that our synthesis succeeded. One synthetic hurdle was that the elegant Ring Closing Methathesis closure of the module loop arms failed to go to completion, posing potential purification issues. After discussion with fellow scientists, we solved the problem by thoughtfully altering reaction conditions, as confirmed by NMR (Nuclear Magnetic Resonance) spectroscopy. To see how effective our module is we have incorporated it into polyurethane polymers for bulk studies. The next step is to prepare a special amine terminated module suitable for attachment to a flat Silicon surface. Once attached, these modules will be characterized by single molecule AFM (Atomic Force Microscopy) studies.

Dirk Groeneveld

Major: Information & Computer Science

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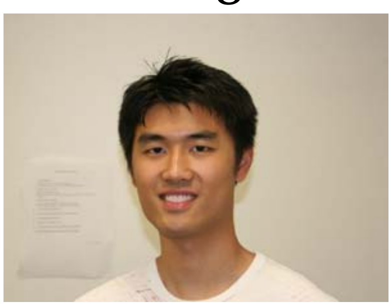
Project Title: VizION: Evolving Ubiquitous Computing Middlewares

Faculty Mentor: Falko Kuester

Abstract:
The rise of ubiquitous computing environments in which computing systems merge into the surroundings has created the need for a software framework that takes away the intricacies of these systems and makes it easy to develop software for them. The challenges of scalability and reliability have been attacked in the past by splitting the complex software system into many small components, the so-called nodes. Traditional systems solve the discovery problem, the problem of how nodes find one another to form a greater system, using a centralized approach in which a single entity serves as a hub between the individual nodes. This approach limits reliability, because a faulty central entity can bring down the entire system, and it limits scalability, because the load on the central entity increases proportionally with the size of the network. The presented new approach eliminates these shortcomings by arranging the nodes in a mesh structure, without a central entity. Each node only carries a constant amount of knowledge. That way, the structure of the single node does not impose a limit on the growth of the system as a whole. Further, failure of a single node does not affect the rest of the system, thus enhancing reliability. The implementation, a continuation of the ongoing VizION project, is being tested in VizClass, UCI's own ubiquitous computing environment in the Engineering Gateway.

Lei Huang



Major: Electrical Engineering

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Project Title: Vertically Aligned ZnO Nanowires as Potential Building Blocks for Nanoscale Devices

Faculty Mentor: Jia "Grace" Lu

Abstract:
Several studies have been performed on the potential usage of quasi-one-dimensional nanostructures for nanoscale devices. To further explore the advantages of these quasi-one-dimensional nanostructures, vertically aligned ZnO nanowires were grown in anodic alumina membranes, which are used as highly ordered templates. The template is a hexagonally arrayed anodic aluminum layer with an average pore size of 80 nm. Gold was evaporated on one side of the template to serve as a working electrode in a standard three electrode cell, and Zn was deposited, using the pulsed electrodeposition method. XRD spectra of increasing oxidation time show that the as-grown Zn was completely converted to ZnO. Electrical properties of a single nanowire were also obtained, using an atomic force microscope in contact mode with a conductive probe. These nanowires will now be used to fabricate transistors, which will serve as building blocks for nanoscale devices.

Madelyn Luttgen

Major: Earth System Science

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Project Title: Axon Guidance Using Microfluidic Devices

Faculty Mentor: Noo Li Jeon

Abstract:

In the central nervous system, axons do not regenerate after injury due to several environmental factors, including the release of inhibitory proteins such as myelin associated glycoprotein, oligodendrocyte myelin glycoprotein, and Nogo. Using a microfluidic device designed to separate growing axons from cell bodies and dendrites, this research examines the activity of the Nogo protein. To replicate central nervous system injury, different concentrations of Nogo are added to individual devices after the axons are cut, and single axon regrowth can be directly measured. Preliminary results have shown that, as the concentration of Nogo increases, the length of regenerated axons decreases. Further research will go in depth to find which concentrations of Nogo have the maximum inhibitory effect on axonal outgrowth. Subsequently, the microfluidic device will be applied in rescuing the axons from Nogo, and observing how axons grow after an initial exposure to the inhibitory protein. This microfluidic device is instrumental to the future modeling of the efficacy of drugs that will be used to block Nogo inhibition and further test regeneration of axons.

Uel McMahan

Major: Information & Computer Science

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Project Title: The EcoRaft Project

Faculty Mentor: Bill Tomlinson

Abstract:

The EcoRaft Project is an evolution Tomlinson's Virtual Raft Project, in which stationary computers are treated as islands of virtual space separated by a sea of real space. Tablet PCs serve as virtual rafts, allowing animated characters to move between islands of virtual space. The EcoRaft Project extends the technologies implemented in its predecessor to create a novel approach for teaching 8 to 12 year olds about restoration ecology: tablet PCs are used to convey species of plants and animals from a lush, tropical island to a deforested one in a natural order of succession. To make the project engaging enough to be a powerful educational platform, The EcoRaft Project has uniquely employed several techniques of animation and networking, which include a novel orchestration of sounds, graphics, and interactions with mobile agents. Although much research has already been done on implementing mobile code, especially mobile agents, on heterogeneous platforms, none of it has focused specifically on embodied agents. Our research continues to examine the efficacy of using the virtual raft paradigm for educational purposes, as well as with the possibilities and issues regarding the implementation of embodied mobile agents on heterogeneous platforms.

Pooya Monajemi

Major: Electrical Engineering

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Project Title: Implementation of Jakes Channel Simulator for Multiple-Input-Multiple-Output Wireless Systems

Faculty Mentor: Hamid Jafarkhani

Abstract:

The wireless link between two communication terminals—what is called a channel—is relatively unprotected and vulnerable to factors including noise, attenuation, delay, Doppler effect, reflection, and interference. Thus, the strength of the received signal can be a function of many, or practically infinite, factors. Due to the complexity of the environment of a channel, it is practically impossible to predict the signal strength at any given location and time. Therefore, statistical methods are widely adopted to model the fading channels, one of which is the Jakes' fading model. The goal of the project is to simulate such a channel in an efficient and easy-to-use way. Such a tool would be helpful in the assessment of various schemes and algorithms used in wireless communications. In the first phase of the project, a testing tool was designed to evaluate the performance of the simulation results. In the next phase, various methods were tested. The last method, which included filtering of a Gaussian random process with an ARMA (Auto-Regressive Moving Average) structure, was chosen due to better quality, speed, and manipulability. Initially 4 poles were used for the simulation, but further research includes using more than 4 poles and finding the optimum values for these poles.

Bobak Mosadegh

Major: Biomedical Engineering

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Project Title: Cell Migration in Microfluidic Devices

Faculty Mentor: Noo Li Jeon

Abstract:

The field of microfluidics provides a means to study and have real-time monitoring of cell migration in a controlled environment. Two types of microfluidic devices were used to produce controlled gradients: christmas tree and H-channel design. The christmas tree design enables higher-ordered profile shaped gradients, such as 2^{nd} order polynomial, while the H-channel design only allows for linear gradients. Although the H-channel is limited in the types of profile gradients it can produce, its advantages are that it is more practical to set up and it allows for the isolation of cells that underwent chemotaxis. With a pure population of cells that migrated, more specific tests can be conducted on their inherent properties, such as which receptors were more utilized. Three types of cells were studied: human neural stem cells (hNSC), metastatic rat breast cancer cells (MTLn3), and neutraphils. The hNSC were studied with the christmas tree design that produced gradients of SDF1-✔ at 100 ng/ml and 250 ng/ml. Conditions for the MTLn3 cells and neutraphils were optimized in both the christmas tree design and the H-channel design; however, experimental data has not yet been fully analyzed. We found that the hNSC exhibited chemotaxis in response to a SDF1-✔ gradient; which was characterized by plotting the cells' chemotactic index (directionality) and speed against various concentrations of the gradient. For both 100 ng/ml and 250 ng/ml gradients, the chemotactic index showed a parabolic shape with a maximum at approximately 50ng/ml of SDF1-✔. However, there was no significant change in speed at different location in the gradient. This data leads us to believe that only the direction, not the magnitude of cell migration is controlled by SDF1-✔ for hNSC. This claim however needs further tests to determine its validity. Also tests on other cell types, such as neutraphils and MTLn3 cells can give insight to determining any universal laws to cell migration.

Cathryn O'Neill

Major: Biological Sciences

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Project Title: The Use of Computer Games as a Conduit to Invoke Ethical and Moral Behavior

Faculty Mentor: Kristen Monroe

Abstract:
My SURF-IT project originated this summer as a means to invoke ethical behavior in people via empathic involvement. Professor Monroe's team developed the idea of an experiment, in which subjects play a computer game, with the aim of increasing the player's ethics as a result of empathic participation. The summer began by conducting research on the literature of related experiments, of which there is a minute amount; therefore, the search broadened. Primates and the presence of altruism, human aggression incurred by violent video games, and related social experiments of human obedience and empathy were all explored. The process of creating a computer game is quite lengthy; therefore, this summer, CEM (UCI Interdisciplinary Center for the Scientific Study of Ethics and Morality) interns began with the narrative, background and storyline of the computer game. The team of interns created a people, village and disease analogous to World War II and the Holocaust, and then combined these components to create a storyline the game will follow. In the game, a character will be faced with dilemmas and decisions, similar to those made during the war, and the player will be implicitly encouraged to make the more ethical choice. Our next step is to find funding and persons able to design the game mechanics and eventually, program the game. Many museums and educational centers have expressed interest in this game and its potential possibilities.

Alan Paradiso

Major: Mechanical Engineering

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Project Title: Dielectrophoretic Separation Systems

Faculty Mentor: Marc Madou

Abstract:
In the field of tribology (the science of lubrication), it has been found that much of the wear on an engine occurs even when particles that are greater than a micron are filtered. Typical oil filters used by the automotive industry can only filter particles greater than 10~40 μm. In this work, we present a novel dielectrophoretic filter system in which clumps of nano-sized particles are separated from a fairly large amount of fluid in a short amount of time. The method we are using is called dielectrophoresis, in which we use electric fields to induce dipoles within particles and then attract them to the high electric field regions. The design we use is single wires spaced apart by about 100 μm spacers and connecting every other wire together. After connecting the wires to an alternating current, we ran dirty oil—oil with nanofibrous carbon—over the wires, trying to trap the particles between the wires while the clean oil flowed past. With this we were able to see a visual difference between the experimental and the control setup. By looking at a sample of the oil under a microscope we were able to count the number of particles in a given area to see that the control was dirtier than the experimental.

Daniel Repasky

Major: Studio Art

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Project Title: VirtualCalit2

Faculty Mentor: Falko Kuester

Abstract:

Disaster preparedness is joining the forefront of planning and design for public spaces, but methods of study currently lack realistic simulation of human behavior in these spaces during a disaster. The VirtualCalit2 project is aimed at creating a photorealistic model of the Institute to turn the entire building into a virtualized living laboratory in which this study can take place. This model will serve as the foundation for research targeting areas such as emergency management and response, real-time structural monitoring, augmented reality, and location-based games, to name a few. We first developed the 3D model of the building directly from the building's blueprints, and applied high resolution photographs of the building's textures. Then, the model was given collision geometry and imported into the Torque game engine and scripted into a disaster escape scenario from the first-person point of view. This has been found to be a very good way to study individuals' reactions to a disaster, and even train them in ways to escape more effectively. First-person scenarios like this one can be used in a variety of environmental simulations, not only to help in designing spaces to be more disaster prepared, but to train individuals about the best course of action in an emergency.

☙ Faculty Mentors and Program Contacts ❧

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Philip Collins
Physics & Astronomy

Zhibin Guan
Chemistry

Hamid Jafarkhani
Electrical Engineering & Computer Science

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Jia "Grace" Lu
Chemical Engineering & Materials Science

Marc Madou
Mechanical & Aerospace Engineering

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Political Science

Bill Tomlinson
Informatics

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