FIRST ANNUAL GRADUATE RESEARCH SYMPOSIUM

Wednesday, July 22, 2009
Rochester Institute of Technology
Rochester, NY
Welcome

Dear Graduate Research Symposium Participant,

Welcome to our first ever Graduate Research Symposium! You, our graduate students, have asked the Office of Graduate Studies to sponsor this event, and we are delighted to respond to your request. The Symposium will provide you with an opportunity to discuss your current research project with fellow graduate students, to explore its significance, and to receive feedback from them that will help you refine your ideas.

Through education at the graduate level you gain new knowledge, insights and experience that will enable you to succeed at the highest level in business, industry, government, and other fields of employment. As you are already aware, graduate education is intense, focused, very hard work, and yet exhilarating and fulfilling. This is because it enables you to explore in great depth subjects that engage you deeply, and to which you are wholly committed. Through your efforts you are creating new understandings and generating new ideas. The Symposium is designed to give you an opportunity to present these to a wider audience.

Graduate education is central to the future of RIT. The research that graduate students and faculty conduct together generates ideas and insights that are shaping the direction of the Institute and building its reputation. In the years ahead, graduate education and research will increasingly drive innovation here and contribute importantly to RIT’s success.

Your participation will make this a special day for graduate students. I look forward to meeting you.

Sincerely Yours,

Andrew Moore
Dean of Graduate Studies
Words cannot adequately express how pleased I am to see this symposium finally come to life. This began as a ‘good idea’ that someone threw against the wall and it stuck. A wonderful and focused group of people came together to plan and were fearless in its undertaking. We knew it was important, because strong graduate research is the backbone of a vibrant research agenda for any university. At RIT, we have taken on the challenges that come with becoming an innovation institution. Our doctoral and Master’s students have risen to this challenge and have taken this, our first Graduate Research Symposium, as the forum to showcase their work to the community.

We in the Office of Graduate Studies, are pleased to bring this to you, with the help of so many here on campus as well as the support of our sponsors. Most importantly, we are proud of the students who so eagerly stepped forward to put the fruits of their labors on display. I encourage each of you to enjoy the day and revel in the brilliance of our students.

Chance M. Glenn, Sr.
Professor and Associate Dean

The response to the First Annual Graduate Research Symposium has been outstanding! This is a testament to the commitment that RIT graduate students have towards their work and their willingness to share it with the community at large. As chair of this symposium, I would like to extend my thanks to all those who participate in this event and to those who helped bring it together.

Robert Manley
Graduate Research Symposium Chair

Thank You

We would like to thank the Graduate Research Symposium Committee and our sponsors. Without their support this event would not be possible.
Program Agenda

Wednesday, July 22, 2009

8:00 AM  REGISTRATION  
          CIMS  
          Bldg 78, 2nd Level Balcony

9:00 AM  INTRODUCTION  
          CIMS Seminar Area  
          Bldg 78, 2210/2220

9:10 AM  ORAL PRESENTATIONS  
          Morning Session 1  
          CIMS Seminar Area  
          2120/2130/2140/2150/2170

10:10 AM MORNING BREAK  
          CIMS  
          2210/2220

10:25 AM ORAL PRESENTATIONS  
          Morning Session 2  
          CIMS Seminar Area  
          2120/2130/2140/2150/2170

11:30 AM LUNCH  
          CIMS  
          2210/2220/2230/2240

12:00 PM WELCOME ADDRESS  
          CIMS  
          2210/2220/2230/2240

12:15 PM KEYNOTE ADDRESS  
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          2210/2220/2230/2240

1:00 PM  ORAL PRESENTATIONS  
          Afternoon Session 1  
          CIMS Seminar Area  
          2120/2130/2140/2150/2170

2:00 PM  AFTERNOON BREAK  
          CIMS  
          2210/2220

2:15 PM  ORAL PRESENTATIONS  
          Afternoon Session 2  
          CIMS Seminar Area  
          2120/2130/2140/2150/2170

3:35 PM  POSTER SESSION  
          CIMS  
          2210/2220/2230/2240

4:00 PM  AWARDS AND CLOSING  
          CIMS  
          2210/2220/2230/2240
Session Map

078 - LOUISE SLAUGHTER CENTER FOR INTEGRATED STUDIES (CIMS)
## Oral Presentations

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<td>Stephen Viggiano</td>
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# Oral Presentations

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<td>Characterization Of The Human Body As A Channel For Communication With Implanted Sensors</td>
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<td>Feature-Driven Configuration Management</td>
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<td>Anomaly Detection And Classification Algorithm For Space Weather Alert System</td>
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<td>Modeling And Simulation Of Performance-Driven Multimodal Optical Sensors</td>
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<td>Design And Development Of A Sustainability Toolkit For Simulation Modeling And Analysis</td>
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9:30 AM   Uxml - Universal Intermediate Language
          Kunal Pathak

9:50 AM   Ontolog Based Data Integration
          Vishal Goradia

10:25 AM  Laboratory Computing Sustainability & Utilization
          Kristian Stokes

10:45 AM  A New Covert Channel Over Rtp
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1:20 PM   An Overview Of Covert Channels Within Voice Over IP
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<td>Numerical Relativity, Supermassive Black Holes, Gravitational Waves and Matter</td>
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<td>Astrophysical computing on GPU’s, prospects and progress</td>
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Christopher Barrett

9:50 AM  A Multi-Sensor MEMS Chip for Humidity, Temperature, Pressure, and Light
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10:25 AM  Scalability Study for Robotic Hand Platform
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10:45 AM  Proteomic Analysis of Nitric Oxide Signaling in Bacillus subtilis
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11:05 AM  Studies Towards the Total Synthesis of Eletefine
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1:00 PM  Fabrication of Germanium-on-Nothing Nanowire Arrays via Selective Epitaxy and Wet Chemical Etching
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1:20 PM  Thermal Oxidation Enhancement using a Fluorine Ambient
Ryan Rettmann

1:40 PM  Electrical Characterization of SiO2 films deposited via Chemical Vapor Deposition (CVD)
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2:15 PM  Deriving the Characteristics of a Semiconductor Defect with the Full Width at Half Maximum of a Deep Level Transient Spectroscopy Signal
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2:35 PM  High field induced stress for suppression of GIDL effects in TFTs
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2:55 PM  Free-standing Semiconductor Carbon Nanotube Electrodes for Lithium Ion Batteries
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3:15 PM  A New Technique for Localized Formation of SOI Active Regions
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Posters Presentations

CIMS 2210/2220/2230/2240

Simpond - Interactive Simulation On The Effect Of Acid Rain On Pond/Lake Ecosystem
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Effect Of Barrier Thickness On Interband Transition Energies Of Inas Qd / Gaas Solar Cells
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Quantitative Assessment Of Hydraulic Artificial Muscles For Underwater Robotics
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Synthesis Of Polyfunctionalized Cyclopropene and Cyclopropane Analogs
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MaryEd Kenney

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Jagadeesh Patchala

Indium Gallium Arsenide On Silicon Interband Tunnel Diodes For Ndr-Based Memory And Steep Subthreshold Slope Transistor Applications
David Pawlik

Astrophysical Computing On Gpu'S, Prospects And Progress
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Spatial Analysis Of Macroinvertebrates And Their Effects On Eutrophication In A Shallow Estuary
Chris Scheiner

Synthesis And Characterization Of Ionic Liquid Polymers Derived From 1-Methyl-5-Vinylimidazoles
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Fabrication And Characterization Of Organic Light Emitting Diodes For Display Applications
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Synthesis Of Formyloxy Styrene Copolymers For Sub 32Nm Photolithography
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Implementation Of Real-Time System For Spiking Neural Networks
Dmitri Yudanov

Print-Based High Dynamic Range Display
Dan Zhang
Keynote Speaker

CIMS 2210/2220/2230/2240

Austars Schnore

Austars Schnore has 20 years experience in semiconductors, power electronics, embedded systems and advanced computing. He is a technology strategy leader in the Advanced Computing Laboratory at GE Global Research (GEGR) and has lead/managed High Performance Computing efforts for GE Healthcare and GE Aviation. He is currently leading a Shared Vision project for Lockheed Martin within GEGR related to advanced computing architectures, runs the LM/GE Non-Conventional Computing Conference and is a founder of the LM Non-Conventional Computing Technology Focus Group. He holds 13 patents in the areas of realtime and embedded controls. He is on the Board of Directors of the www.OpenFGPA.org and member of the IBM Cell Advisory Council, and the High Performance Computing-Application Software Consortium.
Talks in Room
78-2120
Surfing Negative Political Television Ads

Joshua Jedidiah Myers

Communication & Media Technology, Rochester Institute of Technology, Rochester, NY

This paper attempts to demarcate a line between major trends in the use of negative political television advertising. Study findings report that negative political television ads are effective among voters because they can enhance public office candidate image. Contrary findings report that there are several drawbacks for its use. Specifically, viewers of these ads develop censorious feelings toward the ad sponsor and subject. Overall, the line between the benefits and drawbacks of negative political television advertising is merely inexisten.
Model Marketing Practices for Universities in Social Networks

A. Hennigan

Department of Communication, Rochester Institute of Technology, Rochester, NY

Social network research is not a new topic for discussion, but its application to modern business models is a relatively new area and has become an important element those working in higher education. This research takes from communication and marketing theory as it applies to social networking and the buyer behavior process. In particular, this paper explores both the relevance of marketing in online social networks and the uses traditional marketing activities, and proposes a marketing model. The model presented through this research is adapted for colleges and universities. These segments of marketing professionals face particularly unique marketing challenges and thus require a unique marketing model. The research process for capturing the best marketing model is explained and supported by a number of relevant examples. The research also provides an extended exploration of a variety of opportunities for the model’s application. Finally, a means of measure is recommended for the assurance of the model’s effectiveness within social networks.

Figure 1. Network Behavior Model. © Ashley Hennigan 2009
Range Voting and the Difficulty of Manipulation

C. Menton

Department of Computer Science, Rochester Institute of Technology, Rochester, NY

The field of computational social choice is concerned with, among other things, the computational properties of voting systems. Key results related to voting have shown that all reasonable election systems are subject to manipulation and strategic voting. That is, it is possible for participants to vote in a way other than their true preferences in order to achieve a more favorable outcome. Furthermore, it may be possible for a central authority to force the outcome of an election through several methods of procedural control. However, even in cases where such manipulation is possible, it may not be possible for a manipulator to efficiently find a good solution. In the terms of complexity theory, the associated decision problems may be NP-complete. Thus it is of interest to analyze what cases of manipulation and control are possible in a given voting system and to determine the computational complexity of any methods to which the system is not immune.

Range voting has gained attention and proponents due to its expressiveness and good performance according to a number of voting system criteria. Voters rate each candidate independently by scoring them in a range from 0 to $k$ and the candidate with the highest aggregate score wins. It can be viewed as an extension of the simpler approval voting system. Range voting has performs well under a variety of methods of manipulation and control, inheriting resistances from approval voting and adding several more. Furthermore, a simple technical variant I call normalized range voting is competitive in its resistance to control with other systems designed for that purpose. This work has been pursued as part of my master's thesis.
Coosentinoworks

D. Cosentino, W. Osterman, P. Ambrogi, A. Miokavic

College of Imaging Arts & Sciences, MFA Photography, Office of Graduate Studies, Rochester Institute of Technology, Rochester, NY

My MFA thesis show, Cosentinoworks, depicts my inquiry into self and object through conceptual explorations in the mediums of video, performance and sculptural installation. I use the title of the exhibition as a cue to explore the double meanings and multiple interpretations at play. I explore identity through relationships and narratives employed in the use of recorded performance and exhibition display. I discuss how symbols and symbolism operate in creating a tapestry of meaning and interpretation through associations to historic form, particularly Minimalism and Romanticism. I explore the role of the observer in finding and understanding double meanings through my exhibition display choices and historic associations. Throughout this exploration I refer to personal stories and biographical reference in my artwork.

Finally, I describe the dangers and rewards of this approach to art making in contemporary art practice.

Figure 2. Cosentino, Daniel. 12 Hour Portrait.
HRD Domain in the Service Science Discipline
Developing Interdisciplinary Professionals

D. Dickson, I. Noveski, and H. Hamidi

Human Resource Development Department, College of Applied Science and Technology, Rochester Institute of Technology, Rochester, NY

The purpose of this paper is to examine the need for HRD-focused content in service science curricula. As growth in the service economy outpaces improvements in productivity, quality, and innovation in service sector enterprises, universities are examining ways to better equip students to be effective in service-related businesses. The research question that served as the basis for the paper is:

• Is an interdisciplinary approach to service science-related education valuable in today’s service economy?

The unique challenges of the global economy, the predicted dominance of service-related enterprises for the foreseeable future, and the need for increased innovation in U.S. businesses are providing impetus for a fresh look at higher education offerings in service education. Because these challenges defy single-discipline solutions, emerging curricula need to be interdisciplinary (Bitner & Brown, 2006, p. 77).

![Figure 1](image.png)

**Figure 1**: Interrelated and interdependent facets of service curriculum content (Street, 2007) The framework in figure 1 is based on the leading research into the requirements for service education, led by IBM (Street, 2007):

• **Service Core**: Content for service sector professionals including service-related concepts, modelling, design, measurement, delivery, management, governance, and innovation

• **People**: Service professionals must recognize that human capital is of unique importance because a growing number of enterprises rely on their employees’ knowledge-related capabilities versus their physical labor to achieve business goals. These professionals must be adept at defining competencies required to drive business strategy, attracting “right fit” candidates, and engaging employees to drive innovation and productivity.

• **Business**: Business content from financial acumen and market analysis to global integration and return on investment are key curriculum subjects.

• **Technology**: Curriculum content areas must include principles of IT infrastructure and architecture, physical architecture and logistics, principles of engineering, and Web 2.0 implications.


Environmental Enrichment Effects on a Stereotyped Swimming Pattern for a North American River Otter (Lontra canadensis)

Kenneth O. Nelson

Environmental Science Department, Rochester Institute of Technology, Rochester NY

In captive animals, knowledge of behavior is essential to understanding environmental stress responses and causes of stereotypic behaviors. A stereotypic behavior is a behavior pattern that is repetitive, invariant and has no obvious goal or function and is linked to stress. Stimuli can be introduced to the environment of a captive animal to increase behavioral choice in the form of environment enrichment, with the overall goal of increasing the animals' welfare by providing physical and mental stimulation. Environmental enrichment has been shown to reduce stereotypic behaviors in cats, bears and walrus. I provided four enrichment items, two food and two non-food items, to a North American river otter (Lontra canadensis) in a random schedule of placement and presentation. It was predicted that the random schedule would reduce the occurrence of the behavior by providing stimulus, not allowing the otter to form a search image, and that each items would elicit unique behavioral responses. Results showed that afternoon enrichment had more influence on the behavior than morning trials. Food enrichment proved effective at reducing the behavior, where as non-food items did not. Placement of all enrichment items combined showed no significance in reducing the behaviors occurrence, but food item placement in the lower level showed a significant decrease in the behavior. Effectiveness in deterring stereotyped behaviors was restricted to the time the otter was able to interact with the item, there was no carry over effect after item removal or consumption. A regression correlation showed that the stereotyped swimming behavior is highly correlated to another behavior, which may be important in deciding management practices to deter the occurrence of the behavior. Results are discussed in relation to a behavioral model in which the behavior occurs to fulfill the desire to forage.
What Color Is Your Beer? Spectrophotometric Analysis of Beer and Wort Color

J. A. Stephen Viggiano

Chester F Carlson Center for Imaging Science

The color of beer ranges from pale straw to black, and includes yellow, orange, and ruby hues. Nevertheless, beer color is customarily expressed as a single number, proportional to the absorbance at 430 nanometers. So that all three dimensions (hue, chroma, and lightness) of a beer may be specified, the American Society of Brewing Chemists (ASBC) recently adopted an alternative procedure that expresses beer color in CIELAB, an internationally recognized three-dimensional color coordinate system. It will be shown that the CIELAB coordinate hue shifts dramatically as the pathlength is varied, limiting the utility of this measurement. A single beer may partake of several hues, depending on how it is viewed in the glass.

Over 40 beers and worts (unfermented beers) were spectrophotometrically analyzed. It was discovered that the log absorbance spectra tended to be linear in wavelength. The spectra (transmittance, absorbance, and log absorbance) were subjected to Principal Component Analysis (PCA) to establish the dimensionality of beer spectra and to determine orthogonal bases. It was found that the combination of absorbance at 430 nanometers (the customary measurement) and the Linner Hue Index (scaled slope of the log absorbance spectrum) can predict the color of a beer under a specified set of viewing conditions (including observer, illuminant, and pathlength) with reasonable accuracy. It was also demonstrated that the linearity of the log absorbance spectrum is not preserved for mixtures of absorbing species with different Linner hue indices. This may necessitate a third coordinate to quantify the curvature.
Virtual World Interoperability of Avatar Information

A. M. Kane

Department of Information Technology

With the growth of online communities and authenticated systems, users of these communities have begun to accumulate immense quantities of authentication tokens, typically consisting of a username and password sequence. Authentication and access control services have arisen in an attempt to assist users in countering this plethora of tokens, such as the XMPP communication protocol [2], OpenID [5] and other various solutions. Sharing of information across the various communities has also become very popular, launching such social development frameworks as Facebook Applications [1].

Similarly, virtual worlds have recently emerged, creating the paradigm of numerous tokens to access numerous virtual worlds. Authentication services have slowly begun to transpire, contrary to the fast pace of virtual world development, such as NCsoft's \PlayNC™ service [3] and Nexon's \Nexon Passport" service [4]. However, sharing of information between these virtual worlds has not gone beyond the existing authentication services or bare statistics, except within experiments [6]. My goal is to develop a more robust and extensible methodology of communicating and transferring avatar information between virtual worlds to assist with this current need for interoperability of virtual environments.

According to the theory of Natural Funativity there are three main types of fun: physical fun, social fun and mental fun. The main areas of the physical fun in our days are sports and dances. Physical fun can also be abstract: watching horror movies or shooting enemies in video games also brings the feeling of physical fun. The area of social fun is all kinds of communication between people. Last, mental fun happens when solving puzzles, playing games like Tetris and so forth.

Most of the existing video games mainly provide mental and social fun. The physical fun in the games is abstract – the player only presses the button on the keyboard or gamepad to control the game.

However, some games cause real physical fun for the player. Physical fun can be brought by using the player’s moves to control the game. Probably the most known and successful example is the Wii, which uses accelerometer to detect the orientation and acceleration of the controller, thus detecting player’s moves and infrared sensor to detect where the controller is pointing. Another way to detect the player’s move is to use a webcam. Webcams are used in Eye Toy and in several small PC games like OvO Games or Cam-Trax. Also, the GameTrak Freedom controller detects the position of the controller using ultrasound technology. There are many other types of motion sensing game controllers, like the dance pad of the Dance Dance Revolution game or the Wii Balance Board, but these controllers are usually designed for very specific types of games. The recent presentation of the Microsoft Natal Project and Sony Motion Controller during the E3 expo showed that the motion based game controller is one of the most emerging themes in game design.

The goal of the project is to create a game controller combining two webcams with brightly colored active markers and accelerometers. Using two webcams will allow the detection of the position of the controller in 3-D space. The active markers will allow the system to work, regardless of lighting conditions. Accelerometers will increase the accuracy of the marker detection and will allow handling fast motion, as well as the situation when the marker goes out of the camera view or is overlapped.
Effects of Blade Geometry Variations on Aerodynamic Forcing of Mistuned Jet Engine Rotors

Dan Segar

GP Technologies, Pittsford, NY
Mechanical Engineering Dept., Rochester Institute of Technology, Rochester, NY

Local geometric differences that occur between sectors of a bladed disk create a phenomenon that is commonly referred to as mistuning. Mistuning implies that a bladed disk can no longer be assumed to be cyclically symmetric. This condition exists in all manufactured bladed disks, simply due to the fact that no set blades can be manufactured to be identical. As a result of this loss of cyclic symmetry, the complex interaction between different blades needs to be considered. The bulk of the research in the area has analyzed this problem strictly from the structural point of view. While some studies have been conducted involving aeroelasticity, they tend to require some simplifications, such as linearized and reduced order models, to be computationally affordable. Generally theses studies are focused on determining the structural response and not the changes in fluid dynamics associated with these geometric variations. The primary goal of this study is to determine the effects of geometric variations on the flow over a single blade, as well as for blade passages. In this study, the fluid dynamics will be examined at a more fundamental level to determine the effects the fluid will have on the structure, mainly the stresses and high cycle fatigue (HCF) life. This work will be a parametric study examining the influence of variations in blade geometry, as well as their associated vibration induced blade displacements on the aerodynamic forcing, and associated stresses, of the blade using two-dimensional CFD simulations for various geometric configurations.
Visualization of Through-Plane Water Transport Across the Anode and Cathode Gas Diffusion Layers of a PEM Fuel Cell

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Water management in proton exchange membrane (PEM) fuel cells is critical in efficient operation of fuel cells during normal operation as well as purge and start-up conditions. Insufficient membrane hydration impedes the flow of protons and an overabundance of water obstructs the flow of reactants in the gas diffusion layer (GDL) and in gas distribution channels. These two extremes of water content in PEMFCs significantly reduce performance and efficiency, causing material degradation and potential failure. To better understand the water balance between the anode and cathode, a visible and infrared transparent PEM fuel cell has been developed to visualize water transport across the anode and cathode GDLs. This unique visualization PEM fuel cell enables simultaneous observation of water transport through the cathode and anode GDLs as well as the cross-section of the gas distribution channels. High resolution visible and infrared imaging systems were used to capture videos of water transport on the ≈230μm cross-sections of the GDLs. Droplet removal mechanisms, water accumulation, and condensation layer as functions of operating conditions have been analyzed. To aid in visualization of the water transport through the GDL, a video processing algorithm has been developed to identify and spatially locate the presence of water. The algorithm allowed for the measurement of the distance from the catalyst layer to the condensation layer as a function of cell operating condition and GDL material. Water balance between the cathode and anode and intrinsic information has been determined from visible and infrared imaging of this transparent PEM fuel cell. The experimental setup, video processing algorithm, results, and direction for future work will be presented.
Effects of Image Dynamic Range on Apparent Surface Gloss

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* Eastman Kodak Company, Rochester, NY, USA

In this paper we present some preliminary results from experiments designed to investigate the effects of image dynamic range on apparent surface gloss. In the experiments we present high dynamic range (HDR) and standard dynamic range (tone mapped, SDR) renderings of glossy objects in pairs and ask observers to judge how glossy the objects are. We analyze the results of the experiments using Thurstonian scaling, and derive common scales of perceived gloss for the objects depicted in both the HDR and SDR images. To investigate the effects of geometric complexity we use both simple and complex objects. To investigate the effects of environmental illumination we use both a simple area light source and a captured real-world illumination map. Our preliminary findings are 1) that limiting image dynamic range does change the apparent gloss of surfaces depicted in the images, and that objects shown in SDR images are perceived to have lower gloss than objects shown in HDR images; 2) that gloss differences are less discriminable in SDR images than in HDR images; and 3) that surface geometry and environmental illumination modulate these effects. Our overall goal is to understand how, and how well, images serve as visual representations of object properties.

Figure 3. High dynamic range (HDR) and standard dynamic range (SDR) image examples of a bunny object pair. The images on the left look similar in limited dynamic range prints, but appear different on our high dynamic range display that reproduces the full luminance range in the HDR image (see the false color images on the right for displayed luminance levels).
The Backyard Experience

Sandra Turner

MFA Industrial Design Candidate, School of Design, Rochester Institute of Technology, Rochester, NY

Thesis Problem Statement:
Finding alternative methods to medication for depression, mental health disorders and ADHD is a high need in today’s society. More than 121 million people are affected by depression and mental health disorders worldwide which is causing increased violence, financial difficulties and a rise in health care costs.

People who live in urban areas are surrounded by brick, cement, metal and plastic. Although they have “nearby nature” all around; the noise, distractions, commotion, violence, mistrust and perceptions are like a fog hanging over their eyes making nature turn a shade of grey.

The key ingredients of “The Backyard Experience” are the fundamental design elements of creating a positive experience for the user by increasing natural connections with “nearby nature” within an urban environment.

Key Ingredients:
• nature
• making a mark
• therapeutic
• exercise
• life
• energy
• people
• spirituality
• family

The De-natured Self
leading to increased depression and mental health related disorders

71% of people with mental health disorders reported decreased levels of depression after a green walk
Department of Health, UK
TALKS IN ROOM
78-2130
Bio-Compatible Implantable Micro-LC Sensor for Tissue Characterization

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Wireless bio-telemetry links using implanted sensors and antennas are promising for a continuous monitoring of physiological data and for analyzing tissues. Previous work by our research group has established the ability to characterize tissue through a bio-telemetry link. Capitalizing on the fact that the sensor’s resonant frequency will be affected by the electrical properties of the tissue in which it is embedded, the input admittance and the resonant frequency at the antenna terminals is measured, from which the permittivity and conductivity of the tissue is determined. The present work is based on this technique. A large amount of information is already known about the electrical properties of various types of tissue. However the sensors used in are not biocompatible. In the present work, a bio-compatible implantable micro-LC sensor is designed and the design is simulated for realistic tissue characterization.

The micro-LC sensor developed for this work is shown in figure 1. It consists of a micro-inductor and an inter-digital capacitor. The tissue layer of interest (sensing layer) is located directly on top of the inter-digital capacitor, shown in figure 1b. The sensor requires the use of a dielectric material. Polyimide was chosen for a variety of reasons. It has been proven as a non-toxic material for use in biomedicine, and it has been used previously for neural implants. The particular polyimide used was Kapton (DuPont).

The extraction of the sensing layer relative permittivity $\varepsilon_2$ and conductivity $\sigma_2$ can be accomplished through measurement of the resonant frequency at the external antenna terminals. Once the free space resonant frequency of the sensor is known, the real and imaginary components of the admittance are used to calculate the electrical properties. There are two frequencies of interest when a sensing layer is present, the frequency of maximum real admittance and the frequency of the imaginary admittance zero-crossing.

A sensor was used to measure and extract values for $\varepsilon_2$ and $\sigma_2$ for a fat and muscle phantom tissue. An Agilent 85070E dielectric probe was used to verify the measurements. It can be seen in table that the measured values agree with those expected.

<table>
<thead>
<tr>
<th>Tissue</th>
<th>Extracted Values (Measured)</th>
<th>Direct Measurement with dielectric probe</th>
<th>Expected Values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$r$ (S/m)</td>
<td>$r$ (S/m)</td>
<td>$r$ (S/m)</td>
</tr>
<tr>
<td>Fat</td>
<td>5.24</td>
<td>0.286</td>
<td>5.32</td>
</tr>
<tr>
<td>Muscle</td>
<td>55.77</td>
<td>0.789</td>
<td>56.05</td>
</tr>
</tbody>
</table>
Novel Transaortic Double Barrel Ventricular Cannula

James D. Cezo and Steven W. Day

Rochester Institute of Technology, Mechanical Engineering Department, Rochester, NY

A novel transaortic ventricular cannula, known as the 'double barrel' cannula (DBC), is designed to minimize the invasiveness of Ventricular Assist Device (VAD) implantation by combining the inlet and outlet cannulae into a single dual lumen cannula. Both flows will pass through a single opening in the apex of the Left Ventricle with the outflow then continuing past the aortic valve, into the aortic arch (Figure 1). This design offers several potential advantages over the current state-of-the art. These include less invasive surgery and providing mechanical support to the septum. By routing the outflow through the aortic valve, the need to access the external structure of the ascending aorta is eliminated thereby eliminating the need for open heart surgery.

In determining the DBC’s design, close attention has been paid to the outflow portion of the cannula, which passes through the aortic valve. It was anticipated that this portion of the DBC could have the largest impact on the device’s usability in practice. The object of this study was to test the performance of the valve with the cannula passing through it. Experiments measuring both the level of shear induced during the systolic phase and amount of aortic insufficiency during the diastolic phase were conducted.

The experiment was designed to analyze the several geometries passing through an aortic valve under two flow conditions. All experiment used a simple flow loop with a section made of optically clear materials (Acrylic and Silicone based polymers) surrounding the valve, which was a natural porcine aortic valve. For the peak systolic flow, a pump and adjustable valves were used to generate a flow rate of 5 liters per minute and an aortic pressure of 120-150mmHg. Particle Image Velocimetry was used to quantify the flow field and shear stress of the flow during systole. For the diastolic flow, a pneumatic ventricular simulator was used to mimic the transient pressure differential across the aortic valve. During this test, High Speed Cinematography and flow rate measurement were used to quantify valve sealing and leakage.

All data was collected and analyzed for the four cross-sectional geometries during both systole and diastole. The performance of the four geometries was compared using the following metrics: aortic insufficiency (AI), shear stress, and hemolysis. The results of these measurements along with an overall recommendation of shape are presented in this study.
Characterization of the Human Body as a Channel for Communication with Implanted Sensors

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In 1999 the FCC allocated the 402-405MHz frequencies to a new Medical Implant Communication Service (MICS) band for the use by medical implants that continuously monitor physiological data. Since then aggressive research has focused on improvements for more robust communication systems that have increased data rates and allow for better patient comfort, mobility and safety.

The environment presented to an antenna when implanted in human tissue is very hostile. The high water content of human tissue causes attenuation of electromagnetic waves to occur at a much faster rate than would occur in free space. Further complicating this problem is the loss that is both frequency and tissue dependent. In the present work, EM wave propagation is analyzed using heterogeneous body models that are created from anatomical data. The results from these simulations are used to characterize the channel that is presented by the human body.

Physical communication channels such as radio channels which result in time-variant multipath propagation of the transmitted signal may be characterized mathematically as time-variant linear filters. Such linear filters are characterized by time-variant channel impulse response and time varying frequency response. By transmitting wideband time domain electromagnetic pulses from one implant sensor to another inside the human body, we could use the exciting time-domain and frequency-domain system identifications techniques to model the communication path between the two implanted sensors. We will explore the three categories of models available: the linear filter model, the linear time-variant filter model and a multipath signal propagation type model.

Figure 4. Two antennas implanted in a simplified body model composed of 1.6cm of skin and the subsequent time domain and frequency domain data of the input and output signals.
Facial Pose Estimation Using A Symmetrical Feature Model

Raymond Ptucha and Andreas Savakis

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This paper presents a robust approach to performing facial pose estimation by examining the behavior of key facial features over a wide range of poses. Such methods are useful in intelligent vision systems for entertainment, human computer interaction, and security. In our approach, faces of varying pose are automatically detected, eyes and mouth are located and an active shape model is superimposed. A facial pose estimator is developed using predictor models based on the position, size, and symmetry of facial features. By modeling these predictors over pose positions with varying yaw and pitch, excellent results are obtained without the need for complex computationally intensive methods.
Feature-Driven Configuration Management

Melvin Pérez-Cedano

Ph.D. student, Golisano College of Computing & Information Sciences, Rochester Institute of Technology, Rochester, NY

Software Product Lines (SPLs) provide large-scale reuse by strategically exploiting commonalities and managing variations among a set of related systems. These commonalities and variations are usually specified in terms of features – i.e. logical units of behavior that are specified by a set of functional and quality requirements. Systems members of the SPL are defined as consistent configurations of features, but assembled from a set of reusable components. However, features does not map nicely into software components. This mismatch between features and components is problematic for ensuring the feature-wise consistency of individual systems in the SPL. Traditionally, such components are kept under software configuration management for establishing and maintaining its integrity throughout the software lifecycle. Thus the configuration management repository keeps track of relations between artifacts both in space (branches) as in time (revisions). This fact makes the configuration management repository a rich source of information for improving product derivation and evolution processes. This talk introduces a tool-supported Feature-Driven Configuration Management approach for variability management in software product lines with a particular focus on product derivation and evolution. The proposed approach provides a comprehensive traceability strategy which integrates the feature model and configuration management information models in a novel and efficient manner.
Anomaly Detection and Classification Algorithm for Space Weather Alert System

aDr. Chance Glenn, b Dr. Roger Dube and c Santosh Suresh

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bResearch Professor, Chester E. Carlson Center for Imaging Science, Rochester Institute of Technology, Rochester, NY

cDepartment of Electrical Engineering, Rochester Institute of Technology, Rochester, NY

Colonies on the Moon and Mars do not have the protection against interplanetary particles and radiation that is offered by the Earth’s strong magnetic field and thick atmosphere. As a result, potentially lethal doses of radiation and particle flux from solar events such as flares and coronal mass ejections could threaten the basic viability of such colonies. In order to allow colonists to seek safety and protect their equipment before the arrival of such events, an Early Warning System needs to be developed, tested, and deployed.

Looking at precursors within various sources of data so that high reliability broadcasts of early warnings can be made available. Total Electron Content is one such useful indicator that is used in predicting space weather because it varies according to the sun’s activities. Building the profile of historical events using the Anomaly Detection and Classification Algorithm, then using the live generated profile to detect anomalies.

Sample Classification Profile of Total Electron Content

Figure 5. Classification Profile of the Total Electron Content using the Anomaly Detection and Classification Algorithm
Modeling and Simulation of Performance-Driven Multimodal Optical Sensors

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\(^{a}\)Center for Imaging Science, Rochester Institute of Technology, Rochester, NY
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\(^{c}\)Numerica Corporation, Beavercreek, OH

Research Sponsor: Air Force Office of Scientific Research

Research and development of performance-driven multimodal optical sensors is underway through a collaborative effort between RIT and Numerica Corporation. Performance-driven remote sensing is the intelligent selection of an optimum subset of sensors and settings that adaptively minimizes data processing requirements. Available sensor modalities include coregistered panchromatic spatial imagery, polarimetric imagery, and hyperspectral target signatures that are fed to a target tracker through a video stream. Potential applications include finding and tracking moving vehicles within urban areas, as well as detecting improvised explosive device placement. This project is merging the technologies from a micromirror array-based multi-object spectrometer and a tunable spectral polarimeter to demonstrate multimodal remote sensing. Supporting technologies feeding the adaptive sensor model include dynamic input video generation using RIT's DIRSIG software and modality control using Numerica's feature-aided target tracker.

At the heart of the adaptive sensor is an array of micromirrors that enables on-the-fly light switching for expedited selection of sensor channels. The Texas Instruments Digital Micromirror Device and other novel micromirrors designed at RIT are undergoing optical testing to produce scattering models that will improve contrast and increase precision of hyperspectral target signatures. These micromirrors are being mixed with linear polarizers on the same focal plane to achieve coregistered panchromatic and polarimetric imagery through a superpixel detector approach. Further enhancements to RIT's novel micromirror designs include partially transmissive mirror surfaces that can act as tunable Fabry-Perot spectral bandpass filters.

This presentation will introduce the overall multimodal sensor model designs, as well as the expected micromirror performance enhancements due to the use of novel micromirrors and the determination of their scattering properties.

Figure 1: Performance-Driven Sensor Model
Figure 2: RIT's Novel Micromirror Model
Design and Development of a Sustainability Toolkit for Simulation Modeling and Analysis

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As sustainability related issues are becoming increasingly important in business decision making, simulation modeling and analysis tools are needed to analyze these complex systems and their performance not only using traditional performance measures such as productivity and efficiency, but also taking into account environmental impact measures. In this research, a simulation-based sustainability toolkit is introduced. The general design framework and modeling methodology for the toolkit involves identifying environmental measures of interest, developing simulation constructs for modeling dynamic system behavior and resulting performance measures, and implementing the simulation toolkit using modules that can be easily integrated into simulation models. Based on this methodology, a prototype emission toolkit is developed to capture the sustainability aspects in logistics and transportation systems. The toolkit is implemented using the ARENA simulation software. The toolkit contains a flexible framework which enables the simulation of environmental performance measures as easily and readily as traditional system performance measures for transportation systems. A detailed example is presented to illustrate the design and development of the methods as well as the usefulness of the toolkit in practice.

Figure 6. Diagram of a sample instance of truck routings in a centralized logistics and transportation system
Reduction of Power Loss Mechanisms in InAs/GaAs QD Concentrator Solar Cell Grid Design

S. J. Polly, C. G. Bailey, M. L. Harris, D. V. Forbes, R. P. Raffaelle, S. M. Hubbard

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Increasing the performance of III-V solar cells has a significant importance for the concentrator photovoltaics community. Efficiency can be increased by spectral tuning with quantum wells or quantum dots (QD), to more effectively match the material bandgap to the efficiency peak of a detailed balance calculation. In order for these effects to be seen, however, other device parameters must be optimized to reduce power loss mechanisms. Current density increases with concentration, and as power loss increases as the square of current, resistive elements in the cell rapidly become major sources of loss. Reduction of power loss mechanisms can be accomplished in the design of both the cell itself and how it is fabricated. The design of the front contact grid is critical to optimal performance. Proper design allows the resistance encountered within the emitter as current travels laterally before being collected by a grid finger, and the resistance of the grid fingers themselves, to be mitigated. A balance must exist between the thickness of the grid, the resistivity of the metallization used, and the grid design itself so that no one element acts as a bottleneck to the rest of the device. As grid fingers are brought closer together, series resistance in the emitter is reduced, but shadowing loss is increased, reducing power output. In this study, various grid designs were created based on a mathematical compensation between lateral emitter resistance loss and shadowing loss. These findings were then used to apply to fabricated GaAs cells. Additionally, cells were grown with and without multiple stacked layers of strain compensated QDs. Devices were characterized with a large area pulsed solar simulator, using geometrical factors to calculate concentration values. Additional characterization includes spectral responsivity showing the response and contribution of the QDs, as well as $I_{SC}-V_{OC}$ measurements to determine lumped series resistance.

Figure 7. Efficiency versus concentration for cells designed to run at various concentration levels, including the NPRL design currently in use.
Low Resistance, Economical Grid Layer for GaAs Concentrator Solar Cells

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NanoPower Research Labs, Rochester Institute of Technology, Rochester, NY

This paper presents a process for electroplating thick gold grid fingers for use as part of the contact layer on GaAs concentrator solar cells. This process is more economical than evaporation and is shown to produce grid fingers with low resistivity and contact resistance. Cell results show low overall series resistance values and peak efficiencies at much higher concentrations than attained with a thinner evaporated grid.

Figure 8. Cell fill factor and efficiencies under concentrated sunlight, with 6 μm thick electroplated grid. Peak efficiency occurs at near 400 suns. Previously used evaporated 2 μm grid produced efficiency peak at only 100 to 150 suns.
Estimation of Woody and Herbaceous Biomass Using Small-footprint Waveform LiDAR Data: A Signal and Image Processing Approach

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Information regarding global carbon sources (e.g., emissions) and sinks (e.g., carbon sequestration) is essential to our understanding of global energy flows and general carbon stock fluctuations. Such information also plays an important role in fine-scale dynamics, specifically those related to vegetation biomass and its link to land degradation, i.e., the loss of an ecosystem’s capability to provide services to communities. However, measurement and management of ecosystem biomass (carbon) accumulation typically involves extensive field data collection, which includes parameters such as foliar area, stem diameter, crown volume, and vegetation height. Acquisition of these data can be expensive and time consuming, while leaving the user with relatively crude inputs to intricate models, such as those required for biomass estimation. Light detection and ranging (LiDAR) remote sensing, which provides extensive height measurements of terrain and vegetation, has become an effective approach to characterization of vegetation structure. A LiDAR sensor typically emits a laser pulse and registers the return trip distance between the sensor and a reflective target, thereby enabling range measurements. In this study, we propose to develop signal and image processing approaches for woody and herbaceous estimation using a new generation of airborne laser scanners, namely full-waveform LiDAR systems. Structural and statistic-based metrics are directly derived from LiDAR waveforms at the pixel level and related to field-measured data. Initial results show a high correlation between the waveform-derived metrics and field structural data, e.g., tree height and foliar-, woody-, and herbaceous biomass. An overview of the research, its implications, and initial results will be presented at the conference.

Figure 1. Visualization of waveform LiDAR data in 3D space: The lidar intensity is color-coded. The transparency is linear such that low values are more transparent. Voxel size: $0.56m \times 0.56m \times 0.15m$. 

A statistical phonon transport model is developed to solve the phonon Boltzmann transport equation from nanoscale to macroscale for predicting thermal transport in Silicon. The statistical model incorporates a unique state-based phonon transport methodology. Directionally-dependent dispersion curves are utilized to capture the anisotropy of the first Brillouin zone. Both elastic and inelastic scattering processes are included with special attention given to the conservation of energy, pseudo-momentum and the selection rules for three-phonon scattering. The model has several advantages over other techniques that have been used to predict thermal transport from the diffuse to ballistic regimes.
Vibrational Control of Chaos in Artificial Neural Networks

Ralph Bean

Department of Computer Science, Rochester Institute of Technology, Rochester, NY
Talks in Room
78-2140
Mobile web resource tracking during an Emergency Situation

P. Douangboupha

RIT Center for the Handheld Web, Department of Information Technology, Rochester Institute of Technology, Rochester, NY

This project proposes a prototype solution for a mobile web resource tracking system using mobile devices to be used during an emergency situation. The system provides real time data to a decision maker so that he/she can effectively and efficiently monitor resources and access the situation accordingly. Mobile devices, smart phones, support the ease of use for any location and at anytime. The Internet technology is selected to enable multiple or cross platform technology solutions for different mobile devices.

Resources in the scope of this project are human resources and list of hazard items in a room of a building.

Transferring data between system databases and the mobile devices is one of the important areas to address in this project. Since location data of a user is a sensitive data, data has to be encrypted. In addition, by the urgency of any crisis situation it is critical that data from the system databases being retrieved in a reasonable time frame. The investigation includes the exploration of database performance and requirements in emergency conditions on mobile devices.

Figure 9: a screen shot of the mobile web resource tracking user interface on a mobile device
uXML – Universal Intermediate Language

Kunal Suresh Pathak

Galisano College of Computing and Information Sciences, Rochester Institute of Technology, Rochester, NY.

Currently, there are many programming languages that exist; each designed using specific paradigm(s). Each programming language has its own separate compiler that compiles and executes the source program. It would have been great if all the programming languages have just one front-end compiler each and one common back-end. That would let us write the source programs once (in any programming language) and run anywhere (without bothering if compiler for that language is present or not). This can be achieved if the front-end compilers convert the source programs in a common intermediate format and then the common back-end simply execute the program that is converted in a universal intermediate format.

uXML is an experiment to analyze the structure and syntax of popular programming paradigms viz. functional, object-oriented and imperative languages and design a universal language which can represent as much possible, the semantics of programming languages that are written in these paradigms. Due to the gamut of parsing tools available to process XML files, the intermediate language is in XML format. Thus the uXML format will be more readable than the bytecode format that .NET framework uses in common intermediate language.

Software metrics are used in industry to measure important properties of software like lines of code, Cyclomatic complexity, Function point analysis, etc. Due to the disparate syntax of various programming languages, no one tool can perform software metrics of different programming languages. However if all the languages are converted in a common intermediate format like uXML, tools can be easily written to perform the code analysis of uXML. Moreover, since uXML is simply an XML file, writing such tools would not be intricate. uXML can be useful for education purpose as well. A common intermediate language specification will help students write front-end compilers that convert their source code into uXML format. They can also tweak the back-end to incorporate various code optimization algorithms, register allocations or generating a machine code from uXML. Thus this work attempts to design a universal intermediate language that could be useful in various ways.
Ontology based Data Integration

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Multiple source Data integration is the process of combining data residing at different sources and providing the user with a unified view of these data. Most common problems faced with combining multiple data sources are; Schematic heterogeneity, which is the result of differences in the models or structure of the combining data stores. Ontology has explicitly defined concepts and named relationships which are used to address the problem of schematic heterogeneity. Thus, when integrated data is combined from different sources for consumer modeling, it goes through different data processing tasks such as implementing ontology, schematic data integration, data preparation and finally mining of data.

**MUSES**: Automotive Greenhouse Gas Policies and Materials Flows is a part of a larger ongoing NSF-funded project whose goal is to build a system that will allow policy analysts to explore the impacts of greenhouse-gas-emission-reduction policies on the automotive industry. It is a multi-disciplinary, multi-university research task, where RIT’s GCCIS will be focusing on the computer aided scenario generation. There are models that address consumer demand: what are the features of vehicles that drive consumer purchase decisions? There are models that address producer decisions: what vehicle technologies will meet consumer demand and provide producer profit? There are models that address the perspective of environmental policy makers: what greenhouse reduction policies will impact producer and consumer behavior in a way that balances environmental sustainability? Thus in the MUSES system, there are multiple models and perspectives of vehicles, multiple model implementation approaches, and multiple existing data sources that describe a “vehicle”.

MUSES requires development of a vehicle ontology and a MUSES Integration framework which will combine these vehicle datasets with other perspectives of vehicles. Also, this data integration comes with the issues of “record matching”, i.e. referring to the same entity with different names, and “data standardization”, i.e. single attribute representing multiple information. Further, this unified view of the datasets will assist in consumer modeling process to better understand impacts of policy proposal on material flows.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure1.png}
\caption{MUSES Integration Framework and Modeling Scenario}
\end{figure}
Laboratory Computing Sustainability & Utilization

K. Stokes

Networking, Security & Systems Administration, Rochester Institute of Technology, Rochester, NY

Environmental, social and economic sustainability has been a recent focus of academia and industry to further invest in the future and lower operating costs. For this presentation, various emerging techniques will be applied in an academic laboratory environment to record, analyze and project Green IT initiatives. Student utilization metrics will be evaluated to observe typical computing operation during a normal academic quarter. Computer and network usage, power consumption, and room temperature will be analyzed. Cooling and virtualization techniques are currently being investigated and will be reported. The findings of this study can be used across an academic environment to further reduce energy usage and meet the objectives of the Institute's goals towards a green and sustainable environment.
A New Covert Channel over RTP

C. Forbes

Department of Networking, Security, and Systems Administration, Rochester Institute of Technology, Rochester, NY

The high packet frequency and large payload of multimedia communications (such as VoIP) make it an attractive carrier for a covert channel. We present a method to covertly communicate using the timestamp of the RTP protocol header. By using the protocol heading, we will bypass issues associated with modifying the payload and provide a broad applicability.

Figure 1. An ASCII “A” is embedded into the timestamp in the first packet RTP packet. The expected value of 160 has been replaced with 225.
Evolving Neural Networks with Genetic Algorithms

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Biologically inspired vision systems have been modeled with artificial neural networks (ANN’s). The evolution of many of these networks has been limited to feed-forward ANN’s or ANN’s with predefined architectures. The purpose of this research is to explore a method for evolving neural networks with no predefined architectures and with temporal behavior to solve various problems. The system to be evolved is passed in data input and expected output as parameters. ANN’s are evolved with genetic algorithms using an encoding that defines a functional network with no restriction on recurrence or the number of nodes that compose the ANN. The structure of each chromosome in a population is defined with a weight matrix which allows for efficient simulation of outputs. Each chromosome is evaluated by a fitness function that scores how well the actual output of an ANN compares to the expected output. Crossovers and mutations are applied between population members with high fitness scores to evolve these networks to come up with an optimal ANN that solves the problem at hand. The approach has proven to be sufficient to solve various problems such as AND gates, OR gates, subtractors, and non-linearly separable problems such as the XOR gate. With this method of evolving ANN’s it may be possible to discover ANN’s that mimic components of the human visual system.
Clean Slate Switched Internet Architecture

Yoshihiro Nozaki, Hasan Tuncer, Arnav Ghosh, Josh Watts, Krishna Thummala, Quan Li

a Rochester Institute of Technology, Rochester, NY

The Internet is a huge mesh connecting different networks around the world into one single cloud. Internet, as we see today was never meant to do the things it is doing presently, it had started as a research project to link the Local Area Networks of various research universities and government agencies. From a small internetwork to the current state the Internet has undergone enormous changes and has become extremely complex to understand and manage. Internet has been patched over and over to make it sustainable which has added to the complexity. Moreover Internet was never built to support wireless networks.

The current internet is based primarily on routing services provided by the various Internet Service Providers. They achieve this by looking up their own routing tables and as and when they find a match they forward it to the next ISP that can best reach the destination. As of today the size of the core routing tables are reaching 300000 which implies that if a packet reaches the core router for a lookup, the router has to go through all those entries.

The other issue with the internet right now is the lack of address space, IPv4 with a 32-bit address length is running out of addresses and IPv6 with 128-bit is not there yet. Moreover IP addresses do not assist in routing, it simply get routed as they do not have a logical structure to it.

A new Internet architecture that has hierarchy built into it and is based on a simple forwarding mechanism rather than routing so that the routers do not have to look up huge routing tables before they forward packets. The address would itself assist the routers to route. Moreover with a structured architecture managing the network becomes relatively easier.

Figure 10. Basic Switched Internet architecture indicating the addressing scheme as well as the built in hierarchy in the architecture.
An Overview of Covert Channels Within Voice Over IP

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Voice over Internet Protocol is becoming an exceedingly popular protocol for businesses and residential areas alike, based on the advantage of being able to send both voice and internet traffic over a single phone or television line. While this is an advantage for those who use the service, there is the disadvantage of the ability for use of covert channels, or messages embedded into the data stream which carries the voice, to be transmitted to other parties, either with or without the sender’s knowledge. This paper attempts to provide an overview of covert channels within the VoIP protocol and propose definitive terminology to be used within the covert channels field. It concludes with a proposed experiment to demonstrate a yet to be seen ability to modify and demonstrate a voice over IP session initiation attack.
A New Framework for an Electrophotographic Printer Model

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Printer models serve to predict the characteristics of actual printed images. Accurate printer models are important because they assist in the development of digital halftone algorithms, resulting in higher quality digital images. The challenge of building an accurate printer model is in precisely accounting for the interactions between the printer characteristics, the printing media, and the input halftoned pattern.

The goal of this research is to build an accurate electrophotographic printer model, based on the premise that a printer is a texture transformation machine. Recent understanding of the perception and modeling of visual textures, using filter banks, has allowed for compact parametric representations of textures. The proposed printer model consists of a bank of neural networks that transform the input texture and topology parameters into the texture parameters of the printed image. An advantage of this model over existing models is that, in addition to accurate tone predictions, the output texture parameters can be used to produce a synthetic image from which noise metrics can be calculated. Other advantages include: that it is computationally fast, is easy to calibrate, and can be incrementally trained. This study reviews the foundation for the development of our model, key design parameters and sensitivities, and typical results.
Managing a Toner Cartridge Supply System for a Fleet of Printers using Operations Research and Simulation

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The goal of this research is to design and develop an optimization method to dynamically determine the minimum cost of managing inventory in a dynamic, discrete time, stochastic inventory system with uncertainty in demand, demand forecast, and supply lead-time while maximizing customer service levels. The research focuses on managing the inventory of toner cartridges for an organization with a fleet of printers. Current methods for inventory management of toner cartridges typically focus on aggregate cartridge demand. Recent advances in printer research have resulted in the development of consumption algorithms which can accurately quantify the amount of toner that has been consumed based on print job characteristics. The inventory management system developed in this research and illustrated in Figure 1 utilizes the consumption algorithm to forecast individual printer demand for toner replenishment. Given the forecasts for all printers in the fleet, the optimization model determines the optimal ordering strategy for a specified time horizon. The current optimization model consists of an integer program. To evaluate the inventory management system, a simulation model is constructed. Using the simulation model, a wide variety of inventory systems can be investigated to evaluate the robustness of the methodology. Future research will involve a simulation-based optimization methodology which will provide a relaxation of assumptions required for the current optimization model.

Figure 1: Printer Fleet Inventory Management System
Explaining Print Media Paper Consumptions Patterns through a System Dynamics Approach

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The writing and printing paper lifecycle exhibits a series of problematic behaviors associated with its highly environmental, social and economic impacts. Printing is also generally characterized for been a resource-intensive manufacturing process, and because the communication industry largely relies on printed-paper, improving sustainability in these systems could be a leverage point to improve Sustainable Development as a whole. Regardless of the importance of the paper as a communication medium in our environment, society and economy, and of the so far frustrated hope of the substitution of paper for digital display technologies, little has been done to understand the dynamics of these sectors (paper, print, communication, and Information technology). These sectors should be viewed as part of one single system to understand how print media consumption patterns might behave in the future and find leverage points where change is necessary and achievable.

This thesis presents the importance of understanding through a system dynamics approach the behavior of print media. A comprehensive system dynamics model to explain current and past consumer behavior with respects to media-behavior was conducted to analyze how pertinent stakeholders of the system interact, understand what has lead to the observed growth on print paper consumption and foresee future trends. The analysis tool chosen to conduct this study is System Dynamics, because system dynamics thinking can help identify the feedback loops that determine the structure of the system and uncovers the places where sustainable change can be guided and promoted.
Print Jobs and Energy Consumption – Design and Initial Approach of a Print Life-cycle Decision Tool

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The software world is awash with programs that try to help its users become more eco friendly by providing all sorts of usage metrics, tips on hardware utilization and general guidelines on how to minimize the impact on the environment. Surprisingly, printing software is an area that has not been fully utilized. Despite the IT industry’s willingness to serve as a conduit for sustainable practices and ideas, a print tool that would at least bring awareness to users on any of the many impacting, quantifiable elements of their printing choices is largely nonexistent for the time being.

This project puts forward a tool to estimate the energy consumption of a given document by analyzing the user’s requirements for the print job, the printer selected and the corresponding life-cycle criteria for these elements.
High-Efficiency, High-Gain Power Amplification Device for Wireless Transmitters based in Syncrodyne Amplification

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The need for efficient amplifiers for wireless devices is clear when we see how the improvement and integration of new features in these devices has also increased the demand for greater bandwidth and, at the same time, the load to the processor, all of this has produced a consequent increase in the demand of energy from the batteries; this joined with the fact that today the tendency of electronic devices is to reduce their size, has created a need to use the power provided by these "smaller" batteries in a more efficient way.

According to Glenn a high-efficiency, high-gain power amplifier device can be constructed taking advantage of chaotic process [1]. In this presentation I am going to demonstrate the simulation of a chaotic amplifier using MATLAB and show how to develop the optimal working point of a chaotic system for synchronization and efficiency. I will also present the process work for the amplification of an information-bearing signal.

Figure 1 - General syncrodyne amplifier block diagram. A syncrodyne amplification device works similar to a regular amplification device with the main different condition that a chaotic oscillator is used. This block diagram shows the chaotic oscillator and an adaptive control/stabilization block that works as a feedback mechanism that senses the error between the input and the output signals and applies perturbations to a circuit element to minimize this error in real-time.

A Digital Communication System using Chaotic Carriers

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The goal of communication engineers has always been using scarce resource available to them i.e. bandwidth in an efficient manner. This research project aims at transmitting more number of bits by using three chaotic waveforms for transmission of data instead of conventional two sinusoidal signals. This is possible as these three chaotic waveforms are orthogonal to each other and data can be extracted at the receiver easily. Bandwidth efficiency is increased by 150% compared to conventional digital transmission techniques when three mutually orthogonal chaotic waveforms are used for baseband multiplexing. Bandwidth efficiency of 225% can be achieved by using chaotic waveforms for carrier transmission also in addition to baseband multiplexing.

The transmission system is presently in the simulation stage using MATLAB. Transmitter and receiver functionalities have been designed and successfully tested. At the transmitter end, a random digital data stream is generated and is converted into three separate baseband signals using three separate chaotic waveforms. Preamble data and end tag are added to these wave forms for retrieving block size and extracting data at receiver end. Waveforms along with overhead data are multiplied with three chaotic carrier waveforms and added together. This is converted to an audio signal and transmitted over a cable.

At receiver end, the audio signal is recorded and stored. This data is multiplied with chaotic carrier waveforms and filtered to extract three separate baseband waveforms containing overhead bits and the data. Block size, i.e. the number of points used for constructing baseband chaotic waveform is calculated. Preamble and end tags are removed and base band multiplexed wave forms are extracted. Data bits are retrieved and added to reconstruct transmitted bit stream. Transmitted and Received data is compared to obtain the bit error rate.

Figure 11. Chaotic wave forms used for base band multiplexing
Multiplexing of Digital Signals Using Mutually Orthogonal Chaotic Waveforms

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The demand to transmit large chunks of data faster by more effective use of bandwidth is growing. The digital modulation techniques like quadrature amplitude modulation (QAM) and quadrature phase shift-keying (QPSK) does not support high data rates transmission individually. The most effective methods of signal transmission that are being used are orthogonal frequency division multiplexing (OFDM) for its optimal bandwidth usage and multiple input and multiple output (MIMO) for its speed. We propose a new multiplexing technique that uses the inherent waveform shape diversity of chaotic oscillations in order to find sets of orthogonal waveforms.

Modulation techniques with multiplexing of orthogonal chaotic waveforms has an added advantage over standard modulation techniques, the amount of data sent using the later is less than the former with in the same bandwidth. The new digital modulation technique called as Multiplexing of Mutually Orthogonal Chaotic Waveforms (MOC) has an added advantage over QAM and QPSK for high data rate, lower error rate and better bandwidth usage. Chaotic waveforms are produced by different mathematical algorithms. These processes can produce diverse waveform shapes. The set of mutually orthogonal chaotic waveforms found are used as basis waveforms for the MOC communication system to create baseband waveforms. The data to be transmitted using MOC is broken accordingly and converted to analog signal. This analog signal is used to modulate the basis waveforms, which are multiplexed to form baseband waveform. The carrier waveforms modulated by baseband waveforms are used to transmit information. The baseband waveforms are extracted from carrier waveforms at the receiver. The data can be extracted from baseband waveform by a standard demultiplexing method. The MOC communication system proposed compared to the equivalent QAM, QPSK, and ultimately OFDM, have lower error rate at higher noise levels and higher data rates for same bandwidth. The figure below is the Power spectral density of MOC communication system.

Fig 1. Power spectral Density of MOC for K= 4.
Gain Enhancement of Microstrip Patch Antenna Using Double Negative Superstrate

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In recent years, several size reduction techniques for microstrip patch antennas have been developed for use in miniaturized circuits. However, size reduction comes at the expense of antenna gain. The present work focuses on a gain enhancement technique using Left Handed Materials (LHMs) that have a negative refractive index. Such materials have negative permittivity and permeability and are referred to as double negative (DNG) material. Of interest is the DNG described in [1] that is a high dielectric material with a triangular lattice of holes.

In the present work this slab is used as a superstrate for the microstrip patch (fig, 1 a and b). At first, the DNG structure has been analyzed for its behavior as a lens where results show that an image of the source is formed in the transmission plane (fig, 1c). In addition, there is a phase reversal (fig, 1d) in the image plane to illustrate the left handed behavior of the slab. The DNG structure is implemented as a superstrate on a microstrip patch antenna. An exhaustive analysis for optimizing the superstrate structure and the height between the patch antenna and DNG superstrate shows encouraging results. A gain enhancement of 3.5 dB (fig, 1e) and return loss of -25.82dB have been achieved. Experimental validation is under progress.

Figure 1: (a) Microstrip Patch antenna
(b) Optimized DNG superstrate with a pedestal mount.
(c) Field amplitude illustrating image formation
(d) Phase reversal illustrating DNG behavior
(e) Radiation Pattern: for gain enhancement
   patch with DNG —— patch without DNG ——

Hyperspectral Clustering for the Study of Zapotec State Formation

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This project will create full coverage classification maps of the Oaxaca, Mexico area for use in studying Zapotec civilization. The Zapotecs were the earliest state-level society in Mesoamerica, with passionate debate over whether this was an environmentally deterministic or socioeconomic process. The research team has acquired hyperspectral imagery from NASA's Hyperion sensor. Previous archaeological remote sensing has focused on the difficult tasks of feature detection using low spatial resolution imagery or visual inspection of spectral data. This project will attempt a different method, assessing three different clustering algorithms and their effectiveness: K-means/IsoData, Gaussian Maximum Likelihood and Gradient Flow. Gradient Flow is a novel algorithm that is different from the stochastic and geometric algorithms commonly applied to remote sensing. The clustering process will be automated to efficiently classify the approximately 30,000 km² research area.

Preliminary class maps will designate materials easily found using remote sensing, such as vegetation, soil, and water. Through analysis of algorithm parameters and region of interest selection, it is desired to produce class maps with greater material resolution, further differentiating classes into floral communities, urban expansion, etc. These more detailed class maps and other data in a Geographic Information System that archaeologists can develop theories on topics such as settlement networks, resource availability, trade routes, and environmental impact; which provide insight into how the Zapotec state-level society formed. Along with providing data for future archaeological studies, this project will serve as the foundation for future imaging projects, such as sub-pixel unmixing of the dataset.
Use of remote sensing data to enhance the performance of hydrodynamic simulation of a partially frozen power plant cooling lake

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The effectiveness of a power generation site’s cooling pond has a significant impact on the overall efficiency of a power plant. The ability to monitor a cooling pond using thermal remote sensing, coupled with hydrodynamic models, is a valuable tool for determining the driving characteristics of a cooling system. However, the thermodynamic analysis of a cooling lake can become significantly more complex when a power generation site is located in a northern climate. The heat effluent from a power plant entering a cooling lake is often not enough to keep a lake from freezing during winter months. Once the lake is partially or fully frozen, the predictive capabilities of the hydrodynamic model are weakened due to an insulating surface layer of ice and snow. Thermal imagery of a cooling pond was collected over a period of approximately 16 weeks in tandem with high-density thermal measurements both in open water and imbedded in ice, meteorological data, and snow layer characterization data. The proposed research presents a method to employ thermal imagery to improve the performance of a 3-D hydrodynamic model of a power plant cooling pond in the presence of ice and snow.
GeoSynth: Geographic Scene Synthesis from Images

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Automated synthetic terrain and architecture generation is now becoming feasible with calibrated camera remote sensing. This project implements computer vision techniques that have recently become popular to extract “structure from motion” (SfM) of a calibrated camera with respect to a target. This process will build off of Microsoft’s popular “PhotoSynth” technique and apply it to geographic scenes imaged from an airborne platform. Additionally, it will be augmented with new features to increase the fidelity of the 3D structure for realistic scene modeling. This includes the generation of both sparse and dense point clouds useful for synthetic macro/micro-scene reconstruction.

Although, the quest for computer vision has been an active area of research for decades, it has recently experienced a renaissance due to a few significant breakthroughs. This presentation will review the developments in mathematical formalism, robust automated point extraction, and efficient sparse matrix algorithm implementation that have fomented the capability to retrieve 3D structure from multiple images of the same target and apply it to geographical scene modeling.

The seeds of computer vision were actually planted by photogrammetrists over 40 years ago, through the development of “space resectioning” and “bundle adjustment” techniques. But it is only the parallel breakthroughs, in the previously mentioned areas that have finally allowed the dream of rudimentary computer vision to be fulfilled in an efficient and robust fashion. Both areas will benefit from the application of these advancements to geographical synthetic scene modeling. This presentation will explore this application in a process the authors refer to as Geographic Synthesis (GeoSynth).

Figure 12. Geographically registered sparse 3D point cloud with a facetized dense point cloud model of a vat generated using the GeoSynth process. Data was taken from 5 images from a flight over the Van Lare Wastewater Treatment Plant.
Radiometric Modeling of Mechanical Draft Cooling Towers to Assist in the Extraction of their Absolute Temperature from Remote Thermal Imagery

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Determining the internal temperature of a mechanical draft cooling tower (MDCT) from remotely-sensed thermal imagery is important for many applications that provide input to energy-related process models. The problem of determining the temperature of an MDCT is unique due to the geometry of the tower and due to the exhausted water vapor plume. The radiance leaving the tower is dependent on the optical and thermal properties of the tower materials (i.e., emissivity, BRDF, temperature, etc.) and also the internal geometry of the tower. The tower radiance is then propagated through the exhaust plume and through the atmosphere to arrive at the sensor. The expelled effluent from the tower consists of a warm plume with a higher water vapor concentration than the ambient atmosphere. Given that a thermal image has been atmospherically compensated, the remaining sources of error in extracted tower temperature due to the exhausted plume and the tower geometry must be accounted for. A temperature correction factor due to these error sources will be derived through the use of three-dimensional radiometric modeling. A range of values for each important parameter are modeled to create a target space (i.e., look-up table) that predicts the internal MDCT temperature for every combination of parameter values. The look-up table will provide data for the creation of a fast-running parameterized model. This model, along with user knowledge of the scene, provides a means to convert the image-derived apparent temperature into the estimated absolute temperature of an MDCT.
Advanced Analyst Exploitation Environment

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The present state of intelligence data collection systems flood analysts with data. This overabundance of data makes it difficult if not impossible for every piece of information to be properly examined and related to sites of interest. Our team is developing an environment in which an analyst may immerse himself in the data. Through the use of fundamental analytical photogrammetric techniques and modern computing power we are now able to automatically generate three-dimensional models of sites of interest. These models are then inserted into a virtual world where new image data may be projected onto them. An analyst may then interact with the data by looking at one image at a time or many at once. Process models can be integrated into the system to provide the analyst with key data which enables the determination of the main processes taking place at the site. Image data can also be tagged to draw attention to various anomalies or patterns. This data can then be extracted for use in more advanced forms of analysis. The ultimate goal of the project is to provide the intelligence community with a tool that will lead to more thorough and thus more accurate forms of analysis.

From left to right: A wireframe mesh of the site, a highlighted building with its known information floating in a text box, and an infrared image projected onto the model.
Simulations of different Astrophysical scenarios with a Smoothed-Particle Hydrodynamics code

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Employing a smoothed-particle hydrodynamics (SPH) code, we setup different kinds of simulations in order to model the interaction between a main sequence star and a black hole, and between two stars. The SPH method works by dividing the fluid into a set of discrete elements, referred to as particles.

These particles have a spatial distance (known as the “smoothing length”), over which their properties are “smoothed” by a kernel function; i.e. any physical quantity of any particle can be obtained by summing the relevant properties of all the particles which lie within the range of the kernel. We use a code adapted from starcrash(http://www.astro.northwestern.edu/StarCrash/), including modifications for make it able to deal with the situations described below.

In the first case, we propose the study of a system composed by a black hole and a main sequence star in order to understand how the interaction between them affects the stellar structure. These interactions are likely to occur at the center of our Galaxy where, due to the local high stellar density, Sun-like stars can approach the central black hole at very short distances.

In the second situation, we are particularly interested in looking for an explanation of the episode occurred by a very well known star V838 Monocerotis (Fig. 1). In the 2002 this star suddenly showed an outburst producing a luminous echo in the surrounding matter. Tylenda and Soker (2007) showed that all the basic characteristics of the V838 mon eruption can be reproduced by a merger of two stars. By means of numerical simulations we can generate realistic hydrodynamic models of stellar collisions and follow the merger remnant up to relaxation. The results of our simulations can be used to constrain the nature of the V838mon outburst.

Finally, we want to address the capability of SPH codes in order to model different situations and scenarios combining simplicity and precision.

Figure 13: Light Echo from V838 Monocerotis
Numerical Relativity, Supermassive Black Holes, Gravitational Waves and Matter

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Recently, different mechanisms have been proposed where Gravitational Waves are able to imprint electromagnetic signals in matter. This possibility opens an incredible window for detection and observation of Gravitational Waves through electromagnetism waves (i.e. conventional observation -telescopes-).

One of the most interesting scenarios where such mechanism could be present is an accretion disk surrounding a supermassive black hole merger. Gravitational Waves emitted by the merger of two supermassive black holes could interact with an accretion disk, in such a way that through viscous dissipation the matter will be enable to radiate electromagnetic waves.

As Gravitational Waves propagate away from their source, they may interact with matter in several ways. They can induce shear in surrounding gas which can be dissipated through viscosity, they could also drive transverse and longitudinal density waves, excite resonant vibration modes, boost the frequency of photons, lead to graviton–photon conversion, and couple to magnetohydrodynamic waves in strongly magnetized plasmas. But in general, these interactions are so weak that Gravitational Waves are expected to escape from the densest environments like the cores of supernova explosions, gamma–ray bursts, or the early universe, and travel across cosmological distances without any noticeable attenuation.

However, in the vicinity of coalescing supermassive black hole binaries, even a minuscule coupling with matter could lead to a bright electromagnetic signal.

If the imprinting of the electromagnetism counterpart from the Gravitational Waves is possible, it could be a very important element to take into account for test and correlate other kind of observational surveys of Gravitational Waves.

For the previous reasons, numerical simulations tackling these kinds of situations are fundamental to understand and predict what information should be expected to get from such interactions.
Astrophysical computing on GPU's, prospects and progress

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Graphics co-processor chips (GPU's) found in all laptop and desktop computers provide an exciting opportunity to the scientific community. GPU's are computationally strong, ten to a hundred times stronger than the central processor chips (CPU's) in the same laptop and desktop computers. Scientific problems like black hole encounters and gravity waves which are naturally parallel fully utilize the massive parallelism of the GPU architectures. Clusters of PC's each with several GPU cards further the parallelism. Some problems previously requiring supercomputers are migrating to GPU's.

Figure 14. The collision of two black holes generates gravitational waves moving forward at the speed of light across the galaxy. Gravity waves, illustrated here, are warps in space-time and might provide clues to the origin of the universe. CCRG simulation by Manuela Campanelli, Carlos Lousto and Yosef Zlochower. CCRG visualization by Hans-Peter Bischof. Work is in progress mapping simulations like this to GPU’s.
The Study of the Planetary Nebula, BD+30 3639

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Planetary nebulae (PNs) are dying stars, representing the last stages of evolution of Sun-like stars. The central star in a PN forms into a carbon/oxygen core surrounded by hydrogen and helium shells through nuclear fusion, and as the star evolves it puffs off these ambient outer layers. Although the temperatures of the central stars are too low to emit X-rays, X-ray emission has nonetheless been detected from PNs. The origin and nature of X-ray emitting gas in PNs is far from understood so far, although the X-rays are believed to arise from a superheated plasma region within PNs generated by violent collisions between a fast stellar wind originated from the central star and the slowly expanding (hydrogen/helium) ambient layers.

To improve our insight into these processes, we observed the X-ray emission region of the PN BD+30 3639 with a high resolution spectrometer aboard the orbiting Chandra X-ray Observatory (like the Hubble Space Telescope, a NASA "Great Observatory"). We detected the signature of very high carbon abundances in the X-ray spectrum, and determined other elemental abundances with tightly-constrained uncertainties. From these results, we conclude that the superheated plasma within this PN originated from deep inside the current central star. We also measured a range of temperatures within the X-ray-emitting plasma, a result that provides new input into specific theories concerning the origin of X-rays from stellar wind collisions.
Talks in Room 78-2170
A non-cantilever-beam micro-electro-mechanical (MEMS) based viscosity sensor is proposed. Some of the current MEMS-based viscosity sensors utilize changes in resonant frequencies of cantilever beams to correlate viscosity changes. These devices are considered vibration viscometers in which the damping of an oscillating electromechanical resonator immersed in the test liquid is measured. Complex actuation and sensing methods, which are usually non-CMOS compatible, make these devices quite challenging to fabricate and integrate.

The proposed vibration viscometer device utilizes thermal actuation and piezoresistive sensing, both of which are integrated in standard CMOS fabrication. The actuation is accomplished via the application of a high-energy short pulse that sets the membrane to vibrate at its mechanical natural resonance. Viscosity changes can be correlated to changes in the oscillation frequency and amplitude. The selection of this pulse is not trivial as it has to provide enough energy to achieve mechanical resonance but it has to be short enough in duration so that it does not interact with the surrounding fluid. Preliminary data shows the resonant frequency of a 15 µm Silicon membrane device in air to be 15.85 kHz. When this device is immersed in oils with kinematic viscosity values at 20°C of 125 cSt, 263 cSt and 849 cSt the resonant frequencies change to 12.20 kHz, 11.90 kHz and 11.55 kHz respectively, as shown in Figure 1. The resulting sensitivity is 0.81 Hz / cSt. The proposed MEMS viscometer is CMOS compatible, inexpensive and reliable and it could provide and option that is easy to integrate for in-situ viscosity measurements in the auto and manufacturing industries.

![Figure 15. Vibration frequencies of a thermally actuated Silicon membrane immersed in fluids of different viscosities. The frequency of vibration is reduced as the viscosity of the fluid is increased.](image)
Fabrication and use of Microchannels to Study Cellular Adhesion in the Inflammatory Response

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Understanding the adhesive processes associated with inflammation is an important step in understanding numerous disease states such as heart disease, asthma, or cancer associated with inflammatory disorders. Increasing our understanding of these processes could lead to the development of novel devices and therapeutic methods. In fact, there has already been some success using adhesion driven technologies to develop hemotopoetic stem cell enriching devices, targeted drug delivery systems, and microfluidic cell separation systems.

Adhesion during inflammation is influenced by the interplay of 3 major factors, geometric features of the localized vasculature (effects hydrodynamics), particle physiochemical properties and ligand-receptor biochemical interactions at the target site. Initially most of the research performed on cellular adhesion involved the use of parallel plate flow chambers. However, recently there has been a trend toward using photolithography and soft lithography techniques to create novel flow chambers for the study of these adhesive phenomena. These microfabricated lab on chip devices represent a significant improvement over the parallel plate flow chambers used in earlier studies. These microchannels allow researchers to work at the proper scale while also being able to better represent the true geometry of the microvasculature, by replicating the branched configuration and the pseudo circular cross sections of post capillary venules. These devices are also a step forward from parallel plates because they are smaller which reduces the amount of reagents needed for coating which can be expensive. These novel flow chambers promise to improve in vitro experiments which, especially when coupled with CFD and in vivo data, have proven to be powerful tools in further elucidating exactly how the previously mentioned factors interact. The understanding of these interactions will be vital in the characterization and prediction of adhesion in vascular networks and the improvement of our understanding of inflammation.

Figure 16: Magnified view of a junction in a synthetic vascular network created in PDMS using soft lithography. This picture shows the successful fabrication of 30 micron diameter channels with a semi circular cross section for the study of particle adhesion. (Prabhakarpandian 2008)

A Multi-Sensor MEMS Chip for Humidity, Temperature, Pressure, and Light

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A microchip composed of multiple MEMS (Micro-Electro-Mechanical Systems) based sensors was designed, fabricated, and tested in a single quarter at Rochester Institute of Technology. The 4-mm x 4-mm chip included sensing capabilities for humidity, temperature, pressure, and light. The respective MEMS structures were interdigitated finger capacitors, a p-n junction diode, a Wheatstone bridge resistor network on a thin diaphragm, and a p-n junction photocell. A resistive heater was also included on the chip.

The capacitive humidity sensor measured 9.6 pF without the polyimide coating. The capacitance measurement increased by about 10% when the sensor was introduced to a more humid environment. The temperature diode responded with a change of -1.8 mV/°C. The Wheatstone bridge was measured at atmospheric pressure and under vacuum. The maximum difference in output voltage was 24.5 mV, which corresponds to a strain in the diaphragm of 0.49%. The photocell was tested using a linear amplifier, a logarithmic amplifier, and different colored light sources. The current generated in the photocell varied by orders of magnitude, so the logarithmic amplifier was useful to prevent the signal from saturating. Infrared light was observed to be the most effective light source from the low intensity LEDs. The photocell generated up to 2.78 μA of current for the infrared LED, and up to 2 mA for high intensity white light. The p+ diffusion heater was measured to be 315 Ω. A maximum voltage of 15 V was applied across the heater, which resulted in a temperature of 151°C. The thermal resistance of the heater-to-ambient was observed to be 188°C/W.
Scalability Study for Robotic Hand Platform

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The problem of scalability aims to bridge the gap between the complex life-size robotic hand and the less adept yet smaller-scale micro-manipulators available today. Taking some functionality of the larger hand and scaling down will result in a more sophisticated and precise tool for applications such as micro-surgeries. Currently, micro-manipulators are used in the laboratory for cell manipulation, which covers a broad range of applications. Also, robot assisted surgery is a developing field, marked by the need for precision. The combination of these tools while promising, presents many developmental challenges for researchers today.

The current life-sized RIT robotic hand is used to validate a Finite Element Model created for scalability. Actuation of the fingers is done with air muscles, and the corresponding contact force of the fingers is measured. The foam rubber that adheres to each finger acts similar to a tendon or return spring. These inputs are modeled so that a smaller version of the geometry can be evaluated without building multiple hands. Finding the limitations of the current design in terms of scalability is the objective of this work.
Proteomic Analysis of Nitric Oxide Signaling in Bacillus subtilis

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Our work focuses on identifying the role of nitric oxide (NO) production by bacterial nitric oxide synthase (bNOS) in the model bacterium *Bacillus subtilis* 168 (*B. sub 168*). Previous work (Gusarov, et al.) identifies this function as a component of a system intended for detecting and responding to external oxidative stress. However, given the design of *Bacillus subtilis*’ bNOS enzyme it is unlikely that native NO production can provide concentrations that would be of any significance during an oxidative attack or similar stress, during which NO concentrations can often climb to millimolar levels. It is the intention of this work to determine if bNOS is in fact producing NO for use in a nitric oxide signaling pathway. This will be tested by exposing early-log phase *B. subtilis* to 8mM concentrations of the bNOS inhibitor aminoguanidine in order to silence native NO production, then using two-dimensional electrophoresis SDS-PAGE to statistically identify differences in proteome for the condition. Further confirmation will be sought using a genetic knockout of the bNOS enzyme to inhibit NO production without a chemical inhibitor, thus removing the possibility that observations are due to the inhibitor’s influence on other pathways. Proteins identified as unique to a given treatment via statistical analysis will be isolated and submitted to the Ohio State University Chemistry Instrumentation Center protein database in order to identify protein type and function.
Studies Towards the Total Synthesis of Eletefine

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Natural products are targets for synthetic research due to their challenging structures and possible biological applications. Eletefine is a natural product belonging to a family of alkaloids isolated from plants of the *Menispermaceae* family. These plants have been used in the traditional medicine of both Brazil and China to treat fever, asthma, and urinary tract infections. A convergent total synthesis of eletefine employing a lithium-halogen exchange and the Sonogashira coupling reaction will be proposed.

![Molecular structure of Eletefine](image)

Figure 18. The molecular structure of the natural product, eletefine. The structure was determined through various NMR, IR and UV-Vis experiments.
Fabrication of Germanium-on-Nothing Nanowire Arrays via Selective Epitaxy and Wet Chemical Etching

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Advances in material growth techniques are enabling novel devices and circuit designs to scale CMOS below the present technology node. Nanowires (NW) are among the promising structures that may be the future of the industry as the very nature of these structures lend themselves to gate-all-around devices which, similar to double gate structures, have significantly greater control of the channel and are largely resistant to short channel effects[1,2]. However, to the author’s knowledge, few of the previously developed fabrication techniques would be compatible with the demands of the IC industry. Materials used for growth of NWs, poor control of growth direction, and difficult integration have all plagued the utilization of NW devices for today’s applications [3-6]. In this study the authors present a method by which arrays of Germanium-on-Nothing (GON) NWs may be fabricated in a CMOS and integration compatible process flow.

NW growth techniques commonly require the use of an Au catalyst in solution, or on a substrate, and a second processing step to secure the wires to the source and drain contact regions on a second substrate. The aforementioned processes tend to produce random crystal orientations in the NWs as well as random placement on the substrate/contact surface [3-6]. Additional techniques have utilized reactive ion etching (RIE) of a film stack of Si/Si$_x$Ge$_{1-x}$ combined with wet etching to produce NWs on a substrate [7]. However, few studies have thoroughly investigated Si/Ge film stacks, nor have there been extensive investigations into selective wet chemical etchants for creating NW systems from film stacks of Si and Ge.

GON NW arrays have been fabricated on a Si substrate with a thermal oxide layer with trenches exposing the Si below. Reduced pressure metalorganic chemical vapor deposition (RPMOCVD) was utilized for selective epitaxial growth of Ge on (001) Si in the SiO$_2$ trenches, in a process known as aspect ratio trapping (ART) (Fig. 1) [8, 9]. Following lithography a series of selective wet chemical etches is performed and GON NW arrays are suspended between oxide supports and are ready for ALD or other conformal film techniques (Fig.2) [10-12].

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Thermal Oxidation Enhancement using a Fluorine Ambient

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Thermal Oxidation of silicon using different fluorine ambient gas was investigated at low temperature regimes for use in the Thin Film Transistor (TFT) market. TFT process technologies employ Silicon on Glass (SiOG) substrates, which restricts the thermal budget for these technologies significantly. This effectively removes thermal oxides from a viable option for gate oxides, as the process time necessary is higher than prohibitive. Introduction of a viable thermal oxide process step could remedy several current challenges facing the TFT market. Studies have shown potential for enhanced oxide growth and potential for electrical state reduction using both NF3 and F2 ambients. [1], [2]. This research combines the elements of previous studies for use specifically in TFT process parameters.

The test setup was constructed as follows; a horizontal hot-walled furnace with an 800°C torch was outfitted with a direct injection fluorine inlet. Two different fluorine gas sources, NF3 and an 5% F2 in Ar mixture were explored. Thickness measurements were performed using a Wollam VASE ellipsometer, a Rudolph ellipsometer, and a Tencor SM300 SpectraMap. Oxide quality was investigated using C-V measurements, taking by using an MDC mercury probing station, in addition to fabricated Al capacitors. Process parameters including torch temperature, tube temperature, gas flows, and soak times were varied.

C-V Measurements from the Hg probe station showed good interface levels with fluorine as compared to pure dry oxidation runs. This suggests a shift in dielectric properties, or perhaps a porous oxide. Figure 1 shows the relationship between fluorine concentration and oxide void space, a metric of oxide quality. A parabolic relationship between oxide thickness and fluorine concentration was also identified. One explanation could be a competing reaction of fluorine etching the oxide, occurring at increased concentrations. This has been replicated by Kazor et al. [3] as well.

Work continues to optimize the technique for a complete TFT CMOS (complimentary metal-oxide-semiconductor) process flow.

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Electrical Characterization of SiO₂ films deposited via Chemical Vapor Deposition (CVD)

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The motivation for this study is to improve the gate dielectric in a low temperature fabrication process used to form thin-film transistors (TFT) on Corning Silicon on Glass (SiOG™) substrates [1]. Silicon dioxide is the most commonly used gate dielectric in the semiconductor industry for the formation of metal-oxide-semiconductor field-effect transistors (MOSFET). The typical method for creating an oxide layer is to heat a silicon wafer to \( T \geq 900 \, ^\circ C \) in oxygen, though this can be undesirable due to thermal constraints of some substrates. The SiOG substrates motivating this study have a strain point of 665 \(^\circ C\), so methods of depositing oxide at lower temperatures were required.

The standard oxide for the RIT SiOG TFT fabrication process is a low temperature oxide (LTO) deposited using Low Pressure CVD (LPCVD) in the Advanced Semiconductor Materials (ASM) 6” LPCVD using a silane oxidation process. Oxides with chemical precursors of silane (SiH₄) and tetraethylorthosilicate (TEOS) were deposited in the Applied Materials P5000 using Plasma Enhanced CVD (PECVD). Also for silane based PEVCD oxides, nitrogen (N₂) and nitrous oxide (N₂O) were introduced in small amounts in an attempt to reduce leakage currents and increase oxide breakdown voltage. The LTO exhibits near ideal characteristics, and will serve as a baseline for comparison to the PECVD films.

The various oxide films were characterized using capacitance-voltage (C-V) and current-voltage (I-V) measurements to characterize the dielectric properties of the film, including electrical oxide thickness (EOT), fixed oxide charge, current leakage, and field breakdown strength. A C-V plotting spreadsheet [2] was used to match simulated curves to experimental data by adjusting desired parameters.

Initial results showed the introduction of both nitrogen and nitrous oxide did reduce leakage and increase the breakdown strength of the oxide, though the effect was much more profound and reproducible with the nitrous oxide. The TEOS based oxide and the oxide with nitrous showed the lowest levels of fixed charge. Despite higher levels of charge, transistors fabricated using silane & oxygen only provided the highest drive current, and had the greatest subthreshold slope.

![C-V Overlay](image1)

![D3 NFET Lin/Sat Chart](image2)

Fig. 1. Overlay of C-V curves measured from each of the different types of Oxide on the HP4284B

Fig. 2. Measured I-V curve of transistor fabricated with SiH₄ + O₂ PECVD Oxide


Deriving the Characteristics of a Semiconductor Defect with the Half Width at Half Maximum of a Deep Level Transient Spectroscopy Peak

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Deep Level Transient Spectroscopy (DLTS) is a transient charge measurement technique developed by D.V. Lang to detect the presence of defects within a semiconductor crystal [1]. DLTS utilizes a box-car correlation technique in order to measure the transient characteristics of the defect states within the semiconductor crystal when they react to an applied bias in the form of a square wave. As the capacitance due to charged defect states changes immediately after the transient bias is applied, it is measured at two times, \( t_1 \) and \( t_2 \), which are defined by a single time setting, \( t_D \). These two capacitance measurements are subtracted to yield a pseudo-differential with respect to time. This measurement is made over a temperature range stretching from 100K or less to at least 300K and a spectrum is generated. The characteristics of these defect states are traditionally derived from the position of peak maxima when the time values, \( t_1 \) and \( t_2 \) are changed. By mapping the temperature corresponding to the peak maximum with the time settings, an Arrhenius Plot may be generated which yields the Capture Cross Section and Activation Energy of the defect which has been detected.

This method, while accurate, is time-consuming. It can take days to collect the spectra necessary for analysis of a single sample. An alternative does exist, however. The Activation Energy and Capture Cross-Section of a semiconductor defect may be calculated from a single spectrum if the width of the peak is utilized in addition to the position of the peak maximum. An expression for the Activation Energy associated with a semiconductor defect may be approximated with reasonably high precision from the differential of the transient capacitance with respect to time. By relating the rate of decay at the peak maximum to the rate of decay at an arbitrary position on the same peak with an amplitude ratio of \( n \) with respect to the peak maximum, the following expression may be defined.

\[
\Delta E = \frac{k \ln \left[ k_o \left( \frac{T_H^2}{T_M^2} \right) \right]}{1/T_M - 1/T_H}
\]

In this expression, \( T_M \) is the position of the peak maximum while \( T_H \) this the position of the arbitrary point on this same peak. Boltzmann’s Constant is represented by \( k \) while \( k_o \) represents a scaling constant which may be derived from the ratio of the emission rate associated with the peak maximum to the emission rate associated with the arbitrary position.

\[
k_o/\exp(k_o - 1) = n
\]

An expression for the capture cross-section may be derived from the position of the peak maximum once the Activation Energy has been calculated. This derivation relies on the definition of the decay rate, which is given by Shockley-Read-Hall statistics, and is as follows, where \( \sigma \) is the value of the Capture Cross Section and \( \gamma T^2 \) is the product of the thermal carrier velocity and the density of states.

\[
\sigma = \frac{t}{\gamma T^2 \exp \left(-\Delta E/kT_M \right)}
\]

High field induced stress for suppression of GIDL effects in TFTs

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Gate-Induced drain leakage (GIDL) is an unwanted short-channel effect that occurs at higher drain biases in an overdriven off state of a transistor. The GIDL is the result of a depletion region that forms in the drain at high off biases (negative for NFET, positive for PFET). The depletion region causes band bending which in-turn allows conductive band-to-band tunneling creating excess current.

By utilizing the effects of high energy, or “hot”, electrons the GIDL current can be suppressed. High energy electrons are a result of the fact that the electric field in the channel region of the transistor increases laterally as a function of distance from the negative electrode. The electrons then have sufficient energy to surmount the silicon-oxide barrier thus charging the oxide in regions close to the positive electrode. The transistors in this experiment were placed under a high field stress condition for a given amount of time and then re-tested. Transistors were fabricated using silicon-on-insulator (SOI) wafers and RIT’s low temperature CMOS process with both a low-temperature oxide (LTO) and a thermal oxide. The stress involved different steady-state biases between the gate and drain while the source was either grounded or left open. Results show that with the correct bias between the gate and drain, the GIDL current can be reduced by approximately 1 order of magnitude. Although this effect has been demonstrated the GIDL suppression is not permanent. More investigations are underway to try to understand the impacts of time on the suppression of GIDL and how the stress affects the longevity of the transistor.

Figure 20. Gate voltage sweep of 12µm x 24µm SOI TFT with LTO gate pre-stress and post-stress. The GIDL current in the curve after stress shows greater than an order of magnitude reduction compared to before stress. The drain bias for both of these devices was +5 volts so they are both in the saturation mode of operation.
Free-standing Semiconductor Carbon Nanotube Electrodes for Lithium Ion Batteries

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The advancements in mobile technology have created a considerable demand for high energy density batteries for many applications including for hybrid electric vehicles. The higher volumetric and specific energy densities of lithium ion batteries make them a compelling solution; however, even the current state-of-the art lithium ion batteries can still be improved through the use of alternative electrode materials. Lithium alloys with semiconductors such as silicon and germanium are known to have high lithium ion capacities up to 4000 mAh/g; but these semiconductor alloys demonstrate limitations in charge rates and cyclability due to crystal lattice expansion. The innovative pairing of nanoparticles and nanoscale coatings with CNT electrodes can significantly improve the battery energy density by eliminating the heavy inactive copper substrate. In addition, this structure can provide efficient electron transport through the CNTs and allow for a potential improvement in the crystal structure changes of the nanoparticles. In the present work, a systematic study of semiconductor deposition techniques correlating material properties with electrochemical performance was completed. A variety of deposition techniques has been used to evaluate the ability to control material properties of semiconductors as they are incorporated into CNT papers. Using a conventional half cell setup, the lithium ion capacity of these composites was measured; values of over 800 mAh/g for the initial testing of Ge-SWNT electrodes were demonstrated. Studies investigating concentration, morphology, annealing treatments, and the oxide/reduced state of the semiconductors have been performed using Raman spectroscopy and scanning electron microscopy to understand more clearly how these material properties influence lithium ion capacity. Differences in crystallinity through have been monitored to demonstrate the influence of crystallinity on the capacity and voltage profile. In addition, studies on lithium ion capacity as a function of c-rate, ranging from C/10 to 1C, indicate the power capabilities of these semiconductor-nanotube electrodes.
A New Technique for Localized Formation of SOI Active Regions

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The oxidation of electrochemically etched porous silicon (PSi) has demonstrated success in the formation of device quality localized SOI for CMOS applications. A primary advantage with a localized SOI formation is the ability to integrate novel device structures and optoelectronics (i.e. optical switches, waveguides) with bulk silicon CMOS. The formation of PSi can be done selectively by controlling the Fermi level in areas to be etched or not etched, which is typically done by adjusting the level of doping. An alternative method is to introduce a reversible donor species such as protons or fluorine (this work) for the selective formation of islands of crystalline silicon surrounded by porous silicon. Implanted fluorine in silicon has demonstrated a donor effect upon annealing at low temperature (600 °C), which is reversible as the fluorine outdiffuses during higher temperature annealing (1000 °C). Crystalline silicon islands that were fabricated with this technique have a thickness of about 300 nm and are completely surrounded by oxidized porous silicon. Further study will investigate the device quality of the localized SOI structures for microelectronic and optoelectronic applications.

Figure 21. SEM images of 300 nm thick crystalline silicon regions surrounded by porous silicon. Top image (a) shows complete isolation of a large area crystalline silicon island. Bottom image (b) shows the resolution of 1 μm crystalline silicon features formed using a mask pitch of 2 μm. Note that the structure in (a) did not have the high-energy boron implant for the p buried layer, and lacks the thickness and uniformity control demonstrated in (b).
SimPond – Interactive simulation on the effect of Acid Rain on pond/lake ecosystem

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Interactive Simulations are increasingly being used as educational tools in the academic environment. They emulate real world phenomena in a short span of time that would in reality take ages. Moreover the outcome observed in a simulation is totally reversible. This makes it an inexpensive tool for observing and predicting trends. An Interactive Simulation allows the user to tweak the model and realize the cause and effect relationships (Marks, 2005) and this helps to understand the underlying concepts of a particular phenomenon. This paper explores some ideas for the design of an interactive simulation to demonstrate the effects of acid rain on a Lake Ecosystem.

SimPond is an interactive simulation on the impact of acid rain on lake chemistry, and in turn its effects on the aquatic ecosystem. The user will be presented a balanced lake, with a pH level of 7. The user can cause an acid rain to occur and observe the changes in acidity of the water and its consequence on the plant life, reproduction and existence of fishes, frogs and crustaceans. The user will also be able to explore ways to reduce air pollution, neutralize an acidified lake and observe the restoration of the ecosystem.

(A healthy lake ecosystem with a balanced pH level)
Effect of Barrier Thickness on Interband Transition Energies of InAs QD / GaAs Solar Cells

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In the last decade, quantum dots (QDs) have gained the attention of the solar cell community for possible device enhancement purposes. Inserting layers of vertically stacked QDs into the i-region of a p-i-n solar cell has the potential benefit of realizing the intermediate band solar cell (IBSC) by facilitating mini-band formation. For this to occur with a reasonable bandwidth and density of states, sufficient QD-QD vertical coupling must be present. To ensure QD coupling, the energy barrier must be thin enough for the wavefunctions of one QD to overlap with those of neighboring QDs. In this study, wavefunction overlap was modeled using the Silvaco ATLAS device simulator program. Because the model is 1D, QDs were modeled as InAs quantum wells within GaAs barriers. This was used to estimate the threshold of significant electron wavefunction overlap.

Epitaxially grown p-i-n devices were fabricated with barrier thicknesses within this threshold and photocurrent and electroluminescence measurements were taken and their results discussed. The Stranski-Krastanow mode of QD growth used here exploits the lattice mismatch and compressive strain (7.2%) inherent in the InAs/GaAs system. Layers of GaP (3.2% tensile strained to GaAs) are inserted between QD layers to compensate for the compressive strain. Layers of high-temperature (HT) and low-temperature (LT) GaAs were used as spacers and capping layers between the InAs and GaP. The HT GaAs was varied resulting in total barrier thicknesses, including GaP, of 14 to 75 ML, respectively. Cells studied have 5 and 10 repeating sets of these layers within the i-region. External quantum efficiency measurements and electroluminescence data were obtained for all samples. An overall red-shift is observed for all QD transitions with decreasing barrier thicknesses. This indicates decreased energy transition values for thinner barrier layers as can be seen in figure 1, possibly due to miniband formation.

![Figure 22. Peak energy values extracted from the Lorentzian fitting of electroluminescence spectra of the 5 layer (top) and 10 layer (bottom) sample sets.](image-url)
The tangiBook: A Tangible Display System for Direct Interaction with Virtual Surfaces

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Advances in computer graphics technology have provided the capability to render realistic images of synthetic objects that are nearly indistinguishable from photographs of real-world objects. However, when presented on standard computer graphics systems, these synthetic objects are rendered to a virtual 3D space and manipulated through indirect means, such as a mouse or keyboard, leaving users a step removed visually and physically from the virtual objects they are interacting with. We have developed a tangible display system, the tangiBook, to remove the barriers between the real and virtual environments and allow users to observe and manipulate virtual surfaces as naturally as real ones. The tangiBook supports direct manipulation of the virtual object’s orientation by rotating the display system and updates the virtual surface’s appearance in response to changes in the user’s physical viewing position (shown in Figure 1). The tangiBook is based on an off-the-shelf laptop computer that contains a triaxial accelerometer and a webcam as standard components. Through custom software that integrates these devices, we are able to actively sense the orientation of the laptop’s display and dynamically track the observer’s viewpoint using camera-based head-tracking. This information is used to drive a physically-based rendering algorithm that renders accurately-oriented and realistically shaded views of surfaces with complex textures and material properties, illuminated by environment-mapped lighting, to the laptop screen at interactive rates. We demonstrate the potential utility of the tangiBook in three application domains: material perception research, computer-aided appearance design and soft proofing, and enhanced access to collections in digital libraries and museums.

Figure 23. Sequence of images showing a model of a painting being displayed on the tangiBook. Custom software allows the orientation of the laptop screen and the position of the observer to be tracked in real-time. Tilting the laptop (top sequence) or moving in front of the screen (bottom sequence) produces realistic changes in surface lighting and material appearance.
Studies Toward the Total Synthesis of Trocheliophorolide A

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Transition metal-mediated carbon-carbon bond forming reactions are among the most synthetically useful chemical transformations in modern organic synthesis. The most expedient routes toward many natural products and compounds of pharmacological interest involve such reactions. Our research focuses on the development of a novel synthetic route towards the total synthesis of Trocheliophorolide A (figure 1) using such transition metal-mediated reactions. This natural product was recently isolated from Red Sea soft corals S. trocheliophorum and L. arboreum and has exhibited significant growth inhibition of bacterial cell lines S. aureus and B. subtilis.

Figure 24. Reported Structure of Trocheliophorolide A
Securing the Application Acquisition Chain: Security Concerns and Human Factors of Application and System Acquisition in the Enterprise

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In recent years, security has become a prime concern within enterprise information technology (IT) infrastructures. This can be attributed to the rise in cyber-crime and increasing government regulation of technology and personal data. As a result, many researchers have attempted to identify the foundational factors that must be addressed to increase security within organizations. Previous research studies have identified end-users as the “weakest-link” in the implementation and execution of IT security-related practices and procedures. This current research study challenges this notion and asserts that failures in successful exercise of enterprise security should be attributed to the IT staff. In consideration of the “weakest-link” analogy, I propose that the members of the IT staff collectively represent a lock; without a strong, fastened lock to hold the chain together, the strength of the individual links is irrelevant.

To explore this problem, this research study will examine the role of security awareness in the software and system acquisition process. Specifically, the study will focus on the members of the IT staff within small- and medium-sized enterprises, which are traditionally understaffed and underfunded. The research aims to discover how IT decision makers research, select, and ultimately decide what software or systems to acquire. Examining the acquisition phase of the system development lifecycle is important for security because careful component selection can greatly reduce security incidents in the future and reduce the amount of time spent “fire fighting” such breaches. Through this research we will gain an understanding of security awareness and security consciousness within enterprise organizations. As a result, strategies and tools can later be developed to help improve decision making by IT practitioners in order to mitigate risk and potential threats to enterprise IT environments.
Quantitative Assessment of Hydraulic Artificial Muscles for Underwater Robotics

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In the modern world robots are key elements to our society. They provide an efficient and safe means to accomplish numerous tasks. In the field of underwater robotics there is a strong drive for development for many fields, especially industrial maintenance. In order to help this drive, this thesis will focus on actuation in an aqueous environment. The Pneumatic Muscle Actuator, also known as a McKibben muscle, will be the specific focus of this investigation. McKibben muscles have been used in for many actuation needs, such as, robotic hands, and robotic joints, i.e. elbows. The dexterity provided by them would be beneficial for underwater robotics. By changing the actuating medium from air to water, this thesis will quantitatively assess the possible benefits of using a McKibben type actuator in underwater maintenance operations, comparing them to the performance of the current means of underwater actuation.

Figure 25. This figure shows the basic movements of the muscle and how an increase of pressure creates an increase of contractile force. The muscle is filled with a fluid causing the inner tube, constrained by a braided sleeve, to expand in the radial direction and contract axially.
Synthesis of Polyfunctionalized Cyclopropene and Cyclopropane Analogs

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Recently, three-membered carbocyclic ring compounds are attracting new interest as versatile building blocks in organic synthesis because of a wide range of biologically activities. At the present time, however, there is no general [2+1] cycloaddition methodology amenable for the straightforward synthesis of diversely functionalized cyclopropene compounds. A careful examination of the synthetic background, broader impact, and the research project’s goal to develop a broadly applicable [2+1] cyclopropenation methodology from 1,2-disubstituted alkynes and diazoacetate compounds will be presented.
Protein Structural Homology Using Small Structural Motifs

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Homology is a term used to describe proteins that are thought to derive from a common ancestor. Homology is commonly evaluated by aligning protein sequences or by aligning the backbones of the proteins. We have developed a plug-in for the PyMOL molecular graphics environment called ProMOL that enables users to explore homology of small structural motifs consisting of 3-5 amino acids. ProMOL contains a tool called Motif Maker; users can build a motif with up to 5 amino acids from a given protein structural file. ProMOL will then compare any protein structural file against this small structural motif to look for structural homology. We began by exploring the catalytic sites of enzymes, as described in the Catalytic Site Atlas (http://www.ebi.ac.uk/thornton-srv/databases/CSA/). Motifs were constructed in Promol for three different proteins: 3-isopropylmalate dehydrogenase (PDB ID 1a05), Thymidylate synthase (PDB ID 1b02), and aromatic amino acid aminotransferase (PDB ID 1ya4), which can be found in the Protein Data Bank (PDB). Five additional motifs were then constructed for each protein in which the distance thresholds between target amino acids were varied using a “precision factor” tool (PF 0.5, 1.0, 1.5, 2.0, 3.0, 4.0). Six additional motifs were then constructed to include all backbone atoms. A total of 12 motifs were made for each protein for systematic analysis. First each motif was tested against the template protein structure. All motifs were then tested against the other two proteins as templates, and analyzed individually to elucidate possible motif matches in locations other than the active site. Two such relationships were found. A repeat appearance was found for the 1a05 motif (high precision factors) in both the 1b02 and 1ya4 proteins. Interestingly, the 1a05 motif was not located in the active site of either 1b02 or 1ya4 proteins. Further systematic study of the 1a05 motif and its possible function will be presented.

Support for this project has been provided by NIGMS 1R15GM078077-01 and 3R15 GM078077-01S1
Surface Oxidation of Single-walled Carbon Nanotubes with Oxygen Atoms

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Liquid-phase oxidizing agents are often used to surface oxidize carbon nanotubes in order to achieve adhesion to the nanotubes. Gas-phase oxidation processes would eliminate liquid waste and may assist with the manufacture of nanoelectronic devices.

Single-walled carbon nanotube (SWNT) powder was surface oxidized with gaseous oxygen atoms produced by low-pressure (1) plasma-generated vacuum UV (VUV) photo-oxidation (\(\lambda = 104.8\) and 106.7 nm) and (2) microwave plasma discharge of an Ar-O\(_2\) mixture in the absence of photons. X-ray Photoelectron Spectroscopy (XPS) was used to detect the carbon- and oxygen-containing functional groups in the top 2-5 nm of the sample’s surface. The results are compared to our previous experiments with atmospheric pressure, UV photo-oxidation (\(\lambda = 184.9\) and 253.7 nm) where ozone was primarily reacted with SWNT powder [1] and SWNT paper [2].


Opinion Mining of Consumer Preferences in Automobiles

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Green House Gas emissions are the main cause of global warming. To reduce global warming, many industrialized countries, including the United States, are designing Green House Gas (GHG) Reduction policies. With automobiles contributing nearly one third of all GHG emissions, these GHG Reduction policies have a great impact on the design and material flow of automobiles. As a result, the Muses Project started to study the impact of GHG Reduction policies on automobiles. The main goal of this project is to produce analytical tools, models, and methods for analyzing the changes in design and material flow of automobiles due to GHG emission policies. To achieve this goal, a significant number of models must be created, refined, and integrated, including:

1) Producer and Consumer Decision- Making Models to determine market responses to these policies.
2) Models describing how these GHG policies affect vehicle design and material flows.
3) Life Cycle Material Flow Models to capture flows from nature and production supply chain.

One of the main questions in this process is how automobile producers and consumers respond to GHG policies. The Muses Project Team developed a Producer and Consumer Decision- Making Model for identifying producer and consumer preferences. During this process, they applied data mining and statistical techniques on sales data collected from manufacturers and dealers of automobiles to identify consumer preferences for each vehicle characteristics.

Today, people are expressing their opinions in the form of online reviews, expressing their preferences on almost every feature of the product in the course of these reviews. It is therefore ideal to consider the reviews on automobiles while building the Consumer Decision- Making Model. I would like to consider these online reviews on automobiles and refine the Decision Making Model used in the Muses Project. In this process, I would like to apply feature- level opinion analysis techniques, where one can identify each feature mentioned in the reviews and extract the opinion of the user towards each feature of the product.

Problem Statement:
My objectives for this project are:
1) To apply information extraction and sentiment analysis techniques in text mining for a collection of customer reviews regarding automobiles and build a model to identify consumer preferences.
Indium Gallium Arsenide on Silicon Interband Tunnel Diodes for NDR-based memory and Steep Subthreshold Slope Transistor Applications


a Department of Microelectronic Engineering, Rochester Institute of Technology, Rochester, NY, USA, b Department of Electrical Engineering, Pennsylvania State University, State College, PA, USA, c Network for Computational Nanotechnology, Purdue University W. Lafayette, IN, USA, d Amberwave Systems Corporation, Salem, NH USA

Advances in materials growth techniques are enabling new device concepts, circuit approaches, and system architectures to enhance and extend CMOS technology such as tunneling-based static random access memory [1] and steep subthreshold slope III-V tunneling field effect transistors (TFETs) [2], which are gates tunnel diodes. Recently, the authors reported on record III-V tunnel diodes fabricated on Si [3] via a technique known as aspect ratio trapping (ART) [4, 5], Fig. 1a. To the knowledge of the authors, the high PVCR (56) was the fourth highest reported for any tunnel diode structure on any substrate. In this study, the authors report on (i) the formation of virtual Ge and GaAs substrates on Si via aspect ratio trapping (ART) technique, (ii) GaAs based Esaki tunnel diodes fabrication and characterization, (iii) the temperature dependence of these devices, (iv) the insensitivity of tunnel current (forward and Zener) to temperature, and (v) the absence of mid-gap states in the excess current.

The specifics of device fabrication were described in ref. [3]. The structure reported in this abstract is illustrated in Fig. 1b & 2. For temperature characterization, large area devices (radius=31 µm) with PVCR of 27 were measured. Temperature dependent J-V characteristics were then obtained between 77 K and 490 K. Fig. 3 illustrates the typical temperature dependent J-V characteristics. It is observed that the PVCR varies from 10 (480 K) to 27 (room temperature) to 65 (77 K).

Subsequently, ideality factors (n) were calculated from the post-valley J-V characteristics. The ideality factor varies linearly from 2 to 12 (Fig. 4). Above room temperature, the excess current mechanism is dominated by a series of thermal processes (e.g., thermionic hole and electron emission over the respective band offsets) which cannot be uniquely deconvolved from the present data. Furthermore, the data clearly reveals that the ART growth of the III-V diode on Si did not introduce mid-gap states as the data is consistent with prior reports of Si and GaAs Esaki diodes [6].

Astrophysical computing on GPU's, prospects and progress

David Saroff, Carlos Lousto

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Graphics co-processor chips (GPU's) found in all laptop and desktop computers provide an exciting opportunity to the scientific community. GPU's are computationally strong, ten to a hundred times stronger than the central processor chips (CPU's) in the same laptop and desktop computers. Scientific problems like black hole encounters and gravity waves which are naturally parallel fully utilize the massive parallelism of the GPU architectures. Clusters of PC's each with several GPU cards further the parallelism. Some problems previously requiring supercomputers are migrating to GPU's.

Figure 26. The collision of two black holes generates gravitational waves moving forward at the speed of light across the galaxy. Gravity waves, illustrated here, are warps in space-time and might provide clues to the origin of the universe. CCRG simulation by Manuela Campanelli, Carlos Lousto and Yosef Zlochower. CCRG visualization by Hans-Peter Bischof. Work is in progress mapping simulations like this to GPU's.
Spatial analysis of macroinvertebrates and their effects on eutrophication in a shallow estuary: applying small-scale results to a large-scale study

C. Scheiner, C. Tyler, K. Korfmacher

Program in Environmental Science, Rochester Institute of Technology

Shallow coastal estuaries are threatened by numerous factors, including habitat destruction, overharvesting, and especially the detrimental effects caused by the input of excess nitrogen. The community of benthic invertebrates and the physico-chemistry of the sediments are mutually dependent on one another and vary spatially in estuaries. Many benthic macroinvertebrates are known to modify their surroundings and impact the removal of nitrogen and carbon, but our current understanding of the effect of invertebrates is based primarily on small-scale laboratory experiments. Scaling the results from these experiments to the system-level requires consideration of the spatial variation. Using aerial images, two sub-basins of West Falmouth Harbor, a shallow estuary on Cape Cod, MA currently subject to high levels of nitrogen loading, were divided into individual strata representing different habitat types in terms of water depth, vegetation cover and potential sediment type. An unsupervised classification was run in ArcGIS to map the extent of different combinations of these factors. The results were interpreted to define the likely conditions represented by the classification. The interpreted classification was then used to plan a sampling scheme that took into account the variation present as determined from the aerial imagery. Benthic physico-chemical conditions (sediment oxygen consumption, microalgal chlorophyll a, and sediment porewater ammonium) were sampled from at least four locations within all strata in each sub-basin. These data were interpolated in a GIS and compared to macroinvertebrate community assemblage data collected during previous studies. Spatial analysis in the GIS revealed patterns between the physico-chemical conditions, invertebrate species composition and the remotely-defined strata, verifying the use of GIS and remote imagery as a planning tool for a spatial field study. The completed model will demonstrate an increased understanding of the inherent spatial complexity in shallow estuaries.

Figure 1. Map of West Falmouth Harbor showing sampling locations and remotely classified strata.
Synthesis and Characterization of Ionic Liquid Polymers Derived from 1-Methyl-5-Vinylimidazoles

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Ionic liquids are salts that have low melting points and remain liquid over a large temperature range. Other important characteristics are that they are chemically and thermally stable and are both nonvolatile and nonflammable. These materials are being studied for use in chemical and electrochemical devices such as batteries, solar cells, fuel cells, capacitors, and actuators. In devices like batteries for lightweight electronic devices, film-like electrolyte materials that might be obtained with polymer electrolytes would be advantageous. Present research is directed toward the synthesis of ionic liquid monomers, specifically unsymmetrical 1,3-dialkyl-5-vinyl imidazolium salts and their cooperation in polymeric systems. Potential regio-synthetic pathways to these monomers will be discussed along with apparent barriers to their synthesis.
Fabrication and Characterization of Polymer Light Emitting Diodes (PLEDs)

aNikita Surve, bRichard Hailstone

aMaterial science and Engineering Department, Rochester Institute of Technology, Rochester, NY
bImaging Science Department, Rochester Institute of Technology, Rochester, NY

Typically polymer light-emitting diodes consist of emitting layer(s) sandwiched between a cathode and an anode. In our research, indium tin oxide (ITO) is used for anode, the polymer blend as emitting layer and metals such as aluminum, magnesium, silver as cathodes. The devices are fabricated using varying blend ratios of polyfluorene polymers, TFB: 9, 9’-dioctyfluorene-co-N-(4-butylphenyl) diphenylamine and F8BT: poly (9, 9’-dioctyfluorene-co-benzothiadiazole). The effort is made to develop procedure for reproducibly fabricating polymer light emitting diodes. The scope of this research work is fully focused to understand and compare efficiencies of the diodes fabricated by using different cathodes. Further, the optimum efficiency for a combination of cathode and blend ratio will facilitate additional development in the technology.
Fabrication and Characterization of Organic Light Emitting Diodes for Display Applications

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\textsuperscript{a} Center for Materials Science and Engineering, Rochester Institute of Technology, Rochester, NY
\textsuperscript{b} Center for Imaging Science, Rochester Institute of Technology, Rochester, NY

Organic Light Emitting Diodes (OLEDs) constitute a new and an exciting emissive display technology. These electroluminescent devices based on thin films of organic molecules, conjugated polymers, oligomers or molecularly doped polymers have been extensively investigated owing to their potential applications in flat-panel displays and solid-state lighting. OLEDs have the advantages of being self-emitting, consuming low power, having a wide viewing angle, and having a faster switching speed. The multilayered device structure consists of sequentially deposited stacked layers of metal thin films and organic layers by combination of thermal evaporation and spin coating on the ITO coated glass substrate. Improved charge injection, efficient charge recombination, and hole-electron charge balance are the key aspects for fabricating efficient devices. The research work deals with fabrication and characterization of reproducible green OLEDs based on 8-tris-hydroxyquinoline aluminum (Alq3) as an electron transporting and emitting layer, and N,N-diphenyl-N,N bis (3-methyphenyl)-[1-1-biphenyl]-4-4-diamine (TPD) as a hole transporting layer. The research focuses on improving the efficiency by building these devices using different architectures, based on different cathodes (Al, Mg:Ag and Ca) and buffer layers (PEDOT:PSS, LiF, and Bathocuproine). The research work will help in identifying the materials and the efficient device configurations for further development of the technology.
Synthesis of formyloxy styrene copolymers for sub 32nm photolithography

R. Yin, B. Baylav, M. Zhao, P. Xie, T. Smith

College of Science, Department of Chemistry, and Kate Gleason College of Engineering, Microsystems Enge Program, Microelectronics Engineering Department, Rochester Institute of Technology, NY.

In an attempt to increase the resolution and reduce the line roughness of chemically amplified resists, novel copolymers are being prepared wherein solubility of the positive resist material is induced by a direct, non-chemically amplified photochemical reaction. Specifically, the use of the photo-Fries reaction in copolymers containing formyloxy styrene functional groups is being leveraged to create positive photoresists that can be imaged at 193 nm and developed in aqueous base.

Formyloxy styrene copolymers, such as that shown below,

might be prepared by derivatization of polymers containing acetoxy styrene residues, or by direct free radical copolymerization of formyloxy styrene. In this paper, the relative advantages of different synthetic strategies will be presented.
Implementation of Real-Time System for Spiking Neural Networks

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Computer Science Department, Rochester Institute of Technology, Rochester, NY

Real-time simulations of large-scale biological neural networks (BNNs) provide natural platform for applications in robotics, control systems, data recognition. BNNs possess inherently parallel architecture and operate in continuous signal domain. Spiking neural networks (SNNs) are type of BNNs with reduced signal dynamic range: communication between neurons occurs due to time-stamped events (spikes). SNNs allow reduction of algorithmic complexity at a price of little loss in accuracy. Simulation of SNNs using traditional sequential Von Newman architecture results in significant time penalty. This penalty prevents application of SNNs in real-time systems.

Graphical processing units (GPUs) are cost effective devices specifically designed to exploit parallel shared memory-based floating point operations applied to computer graphics. This makes them an attractive solution for SNN simulation comparing to that of FPGA, ASIC and cluster message passing computing solutions. Successful implementations of GPU-based SNN simulations have been already reported.

The purpose of this project is to develop a scalable GPU-based system that can provide real-time application of SNNs with arbitrary topology. This system will offer a BNN designer a framework that can be applied for robotics, control systems, data recognition and other purposes.

Recently introduced in computational neuroscience Parker-Sochacki (PS) numeric integration technique is used as a core computational method. Comparing to the other methods PS method offers high-accurate simulation at reduced computational cost.

Preliminary prototype of the system demonstrated real-time functionality of a small SNN size of 768 neurons. The work is still in progress to achieve further improvements.
Print-based high dynamic range display

Dan Zhang, James Ferwerda

Munsell Color Science Laboratory, Rochester Institute of Technology, Rochester, NY

The idea of print-based high dynamic range display is to use a calibrated projector-camera system to control the appearance of the real image and thus extend the high dynamic range on reflective media (print in this case). It is of great interest for various domains such as radiology, astronomy, optical microscopy and entertainment installations. The display is based on the principle of double modulation of light, which is to present content over several orders of magnitude between minimum and maximum luminance.

The technique is based on a secondary modulation of projected light being surface-reflected, thus allows boosting contrast, perceivable tonal resolution and color saturation beyond the possibility of projectors or the capability of spatially uniform environment light. First, we measure the maximal contrast values that can be achieved locally as well as globally by reflecting projected light on the print. Two high-resolution HDR images (under a full white and under a full black projection) of the print are captured. Next, the HDR representation (Itarget) of the printed image content could be derived. After that, the HDR image has to be split appropriately into the corresponding projected image and printed image, thus the correct appearance of an existing HDR image (IHDR) could be visualized through the modulation of the two images. Finally, a luminance quantization technique, which maximizes the number of perceived tonal values while considering the discrete nature of the applied modulation devices, is proposed.

To conclude, this work has proposed a simple and low-cost method of superimposing high dynamic range visualizations on arbitrary reflective media. And it has great potential to be applied in combination with three-dimensional objects.

This research is supported by NSF award 0811680 to James Ferwerda.

Figure 1. (a) Example of the split HDR image. (b) Reconstructed HDR image
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