NSF Highlights

Search terms: 2006, ENG/EEC, Directorate approved,

35 records found.

2.5 Million American Children on an Engineering Career Path

Highlight ID: 11831

The President's Council of Advisors on Science and Technology

RET Teachers at work in the CMU Robotics Academy

Permission Granted
Credit: CMU/Robin Shoop

CMU Robotics Academy-Robotics Engineering

Permission Granted
Credit: CMU/Robin Shoop

Workforce/Education subcommittee (PCAST) recently released a report that helped crystallize what will happen to the nation's economic innovation engine if we do not inspire a larger number of American children to pursue advanced degrees in science and technology. While U.S. students' interest in science, technology, engineering, and mathematics (STEM) careers is declining, foreign countries are significantly increasing the number of STEM graduates coming out of their universities. The number of STEM graduates enables these countries to attract venture capital that has led to a large number of

technology based jobs. Asian countries are graduating eight times the number of engineers than the United States is graduating. In the future, as in the past, our nation's ability to compete economically will be determined by its ability to innovate and commercialize ideas. Louis Pasteur implied that creativity and innovation happen when opportunity meets a prepared mind.

The Carnegie Mellon University (CMU) National Science Foundation funded Research Experience for Teachers (RET) is helping to place millions of American children in research and engineering experiences designed to prepare their minds for innovation. CMU is using robotics to inspire a larger percentage of children to pursue STEM careers. The CMU Robotics Academy curriculum developed in this project is currently being used in over 4000 schools nationally.

Over the past three years, CMU has offered an RET that places teachers in the position of researchers. Teachers spend five weeks at the National Robotic Engineering Consortium where they interact with CMU research faculty and staff involved in solving today's robotic problems. Teachers learn how robots work, and are then guided to develop lessons that they can take back to their classrooms. The RET experience has lead to the development of curriculum materials that use robotics as the organizer to explicitly teach STEM. The CMU developed curriculum places students in the role of researchers where they are required to prove concepts using fundamental mathematics and do science rather than study it. After the students participate in the guided research experiences, they are challenged to solve engineering design problems. Scaffolding for student learning is supplied through a sequence of guided activities on a multimedia CD-ROM, which provides suggestions, background information, and reference material to students. A separate CD guides the instructor, providing templated lesson plans, assessment guides, answer keys to interim quizzes, and support material on both inquiry-based instruction and domain-specific information about robots.

CMU is building on other NSF funded research. It is working with the University of Pittsburgh's Learning Research and Development Center (LRDC), which has been funded through the Math and Science Partnership Program (MSP). The LRDC MSP is named "System-wide Change for All Learners and Educators" (SCALE). The SCALE program forms teams consisting of cognitive scientists, educators, content specialists, curriculum experts, and administrators working together to develop Immersion Units in which students learn academic content by working like scientists: making observations, asking questions, doing further investigations to explore and explain natural phenomena, and communicating their results based on evidence. CMU is using the LRDC model and receiving LRDC feedback during its development cycle. CMU has developed instructional modules for both LEGO® and RadioShack", and will release a CMU/LEGO co-branded curriculum that will support the next generation LEGO Mindstorm robot. The end goal of the CMU research is to develop our nation's intellectual capital; enabling American students to compete in the global innovation ecosystem where thinking and problem-solving are the "new basics" of the 21st century.

Primary Goal Indicators:
Greater diversity (AC/GPA selected)

Secondary Goal Indicators:
Public understanding of science

This work is notable because
The work being done by NSF and Carnegie Mellon is notable because of the impact it has on American education. CMU Robotics Academy curriculum is currently being used in over 4000 schools nationally. The LEGO Mindstorm Robotic System has been purchased by over 550 universities. Pictured at the right is the new CMU/LEGO co-branded "Robotics Engineering" curriculum will be released in August 2006 with LEGO's next-generation controller.

Other Indicators (Is this work transformative or multidisciplinary?):

No other indicators apply.

ENG/EEC 2006

Program Officer: Mary Poats

NSF Award Numbers:

0338760
Award Title: Pittsburgh's What is Engineering RET

PI Name: John Bares

Institution Name: Carnegie-Mellon University

PE Code: 1360

NSF Contract Numbers:

Submitted on 02/14/2006 by Mary F. Poats
EEC: Approved 02/14/2006 by Gary A. Gabriele
ENG: Approved 02/21/2006 by Joanne D. Culbertson

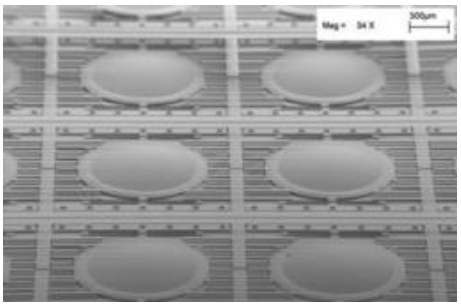
Addressable MEMS-Microlens Array to Improve the Performance of Ophthalmic Sensor

Highlight ID: 11455

Shack-Hartmann sensing employs an array of identical lenses through which an optical beam is passed. The focus points for all the lenses produce an uniform array of bright spots when a plane wave passes through the system. The new SH system is built with micromachined lenses held in a uniform array by micromachined polycrystalline silicon lens holders. We have built an SH system in which the focal-point image for each lens can be made to vibrate and specifically to be identified by a pre-assigned vibrational frequency. The individual identifications of focal points for the lenses greatly improves the performance of the SH wavefront sensor; our work has demonstrated orders-of-magnitude improvement in the ability of the system to measure distortion of the incoming light beams. This innovation extends the useful range for lens-array SH sensors to formerly inaccessible applications and it does so using manufacturing technologies that can be more economical and precise than those used in present commercial practice.

This image shows the fabrication/integration of high-quality microlenses on MEMS structures using polymer-printing technology.

Permission Granted
Credit: Richard Muller



This image shows the core component of our advanced Shack-Hartmann system addressable microlens array.

Permission Granted
Credit: Richard Muller

Primary Goal Indicators:
Contributions

Secondary Goal Indicators:
Global S&E workforce

This work is notable because
This research enables people who work at the forefront of discovery to make important and significant contributions to science and engineering knowledge. These results represent an advance in optical-microsystem technology that makes it possible to build improved and more-economical wavefront sensors. Wavefront sensors provide information and control signals that can be used in adaptive-optics systems to correct distorted optical signals. The wavefront sensors that we have worked on are known as Shack-Hartmann (or simply SH) sensors. SH sensors are widely used in optics, astronomy, and ophthalmology, but their application range that can grow substantially using our results. The new wavefront sensor will not only advance the fields of optics and astronomy but also help to enable the diagnosis, analysis, and potentially the treatment of certain ophthalmic disorders such as keratoconus (a conical protrusion of the center of the cornea) and other vision anomalies.

Other Indicators (Is this work transformative or multidisciplinary?):

No other indicators apply.

ENG/EEC 2006

Program Officer: Alex Schwarzkopf

NSF Award Numbers:

0318642
Award Title: Microsensor and Actuator I/UCRC

PI Name: Richard Muller

Institution Name: University of California-Berkeley

PE Code: 5761

NSF Contract Numbers:

Submitted on 02/22/2006 by Glenn H. Larsen
EEC: Approved 02/28/2006 by Gary A. Gabriele
ENG: Approved 03/01/2006 by Joanne D. Culbertson

Artificial Retina Is in Sight, Winning Acclaim

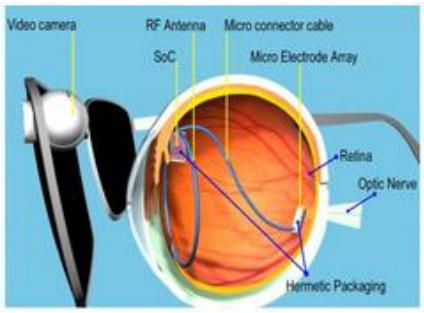
Highlight ID: 11804

Millions of people who have lost their sight due to degenerative eye diseases such as macular degeneration may one day see again, thanks to recent advances toward engineering an artificial retina. Although some treatment to slow the progression of macular degeneration is available, no treatment exists that can replace the function of lost photoreceptors in the eye. Dr. Mark Humayun, Director of the Engineering Research Center for Biomimetic MicroElectronic Systems (BMES), and his research group have developed a prosthetic device that enables previously blind people to perceive light and patterns. Humayuns group discovered that, in many cases, the neural pathways that carry information to the brain are still healthy, even though other parts of the eye are not. Their retinal prosthesis simulates the most complex part of the eye. It receives the optical image information coming in from the world and translates that information to electrical signals that the brain is able to interpret as imagery.

Dr. Mark Humayun displays a model of the prosthetic retina (see below for detailed view)

Permission Granted
Credit: Center for Biomimetic MicroElectronic Systems

In its current form, the retinal prosthesis has several components, some inside and some outside the eye. External components include a small camera, image processing unit, and a sending unit. Implanted components include a bi-directional antenna, hermetically packaged electronics including a novel mixed-signal system on a chip (SoC), and a multi-channel electrode array. The implanted electronics handle power management; receive, process, and transmit data; and send the output signals to the optic nerve. Thus far, six patients have had limited sight restored using this prosthesis. The ultimate goal is to design a fully implantable system, with patients enjoying full restoration of sight.



Cutaway view of the prosthetic retina

Permission Granted
Credit: Center for Biomimetic MicroElectronic Systems

NSFs Directorate for Engineering has supported Humayun and his collaborators in this research and development effort through three of its Divisions. Beginning in 1995, the Bioengineering and Environmental Systems (BES) Division directly sponsored the work on development of the intraocular camera and the hermetic packaging for the implantable system. The Electrical and Communication Systems (ECS) Division funded work on the electrical interconnections between components. Beginning in 2003, the Engineering Education and Centers (EEC) Division has supported a full-court press on realization of the retinal prosthesis through the BMES ERC. As evidence of the importance of this work and the success it is achieving, Dr. Humayun was named the 2005 Innovator of the Year by R&D Magazine. He hopes that a clinically approved version will be available for widespread use within five years.

This is a prime example of the impact that long-term, coordinated funding by NSF can have in a high-risk, multidisciplinary area where the potential payoff in terms of meeting human needs is enormous.

Primary Goal Indicators:
Contributions

Secondary Goal Indicators:
Collaborations

Connections

Identifying new opportunities (AC/GPA selected)

Cross-disciplinary (AC/GPA selected)

This work is notable because
Contributions of individuals in different research fields from different institutions, over more than a decade, have culminated in a prototype of the first-ever retinal prosthesis. Results of this research show promise of providing a true breakthrough in the treatment of blindnessallowing the blind to actually see. This is a prime example of the impact that long-term, coordinated funding by NSF can have in a high-risk, multidisciplinary area where the potential payoff in terms of meeting human needs is enormous.

Other Indicators (Is this work transformative or multidisciplinary?):

This work involves multidisciplinary research.
Contributions of researchers in fields ranging from biomedical engineering to electrical engineering to computer science to medicine were crucial to the success of this effort. This research could not have been conducted without the integrated, multidisciplinary team approach that an Engineering Research Center requires.

This work involves transformative research.
Results of this research show promise of providing a true breakthrough in the treatment of blindnessallowing the blind to actually see. The use of an implantable prosthetic device to send visual imagery information through the optic nerve to the brain is a new paradigm in the treatment of this disability. It is a prime example of the impact that long-term, coordinated funding by NSF can have in a high-risk, multidisciplinary area where the potential payoff in terms of meeting human needs is enormous.

ENG/EEC 2006

Program Officer: Lynn Preston

NSF Award Numbers:

0310723
Award Title: An Engineering Research Center for Biomimetic Microelectronic Systems

PI Name: Mark Humayun

Institution Name: University of Southern California

PE Code: 1480

NSF Contract Numbers:

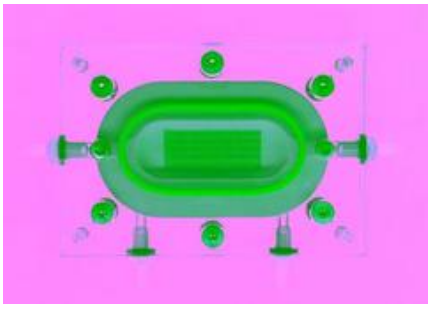
Submitted on 01/30/2006 by Courtland S. Lewis
EEC: Approved 02/01/2006 by Gary A. Gabriele
ENG: Approved 02/08/2006 by Joanne D. Culbertson

Breakthrough Liverchip Mimics Living Organ

Highlight ID: 11800

The liver performs crucial functions that range from the metabolism of drugs and toxins to the production of proteins and other essential molecules. Numerous diseases can affect the liver, so laboratory study of liver cells is crucial to our understanding of the liver and treatments for its diseases.

Liver cell cultures created with current methods only survive for relatively short periods of time, making reliable data relevant to the function of an intact liver difficult to obtain. Enter the liverchipa living model of the liver that allows researchers to grow what is essentially a small liver and perform tests on it without risking a persons life or health.



BPECs new liverchip produces an artificial liver on a small scale that is suitable for research and testing.

Permission Granted
Credit: Biotechnology Process Engineering Center

The liverchip is a three-dimensional cell culture system that fosters the growth of liver cells and facilitates the study of liver function. It is the brainchild of Linda Griffith, Director of the Biotechnology Process Engineering Center (BPEC), an ERC at the Massachusetts Institute of Technology. The chip consists of two flow chambers with a tissue scaffold between them, which creates a bioreactor set-up. The chip is seeded with liver cells. A pump creates an ideal flow of nutrients over the chips scaffolding, subjecting cells to the mechanical stresses, fluid flow rates, and nutrients required by liver cells in the body. Cells expand and grow over the walls of the chip, forming tissue nodules that behave like an in vivo liver.

This system facilitates experiments that investigate the livers interaction with other cell types, its metabolism of drugs and toxins, our understanding of liver regeneration and stem cell differentiation, and the efficacy of new therapeutics. The liverchip will substantially improve the study of disease pathogenesis, tissue engineering, pharmacology and toxicology, leading to the development of better screening systems for new therapies.

Ultimately, this idea could revolutionize biomedicine by providing a vehicle to grow models of various bodily organs from the cells of individual donors. The new models could bypass the use of lab animals, and could allow drug testing and other experiments on mini-organs that have been custom-grown from specific patients with those patients unique characteristics, thus offering greater assurance about therapeutic outcomes.

Primary Goal Indicators:
Cross-disciplinary (AC/GPA selected)

Secondary Goal Indicators:
Contributions

Next generation facilities and platforms

This work is notable because
This highly innovative development has the potential to revolutionize biomedicine by allowing small-scale simulations of various bodily organs to be grown from the cells of individual donors, eliminating the use of lab animals and permitting more individually tailored therapies. This new type of cell culture system required contributions from biochemistry, bioengineering, and biomedicine.

Other Indicators (Is this work transformative or multidisciplinary?):

This work involves multidisciplinary research.
This new type of cell culture system required contributions from biochemistry, bioengineering, and biomedicine. The research effort could not have been conducted without the integrated, multidisciplinary team approach that an Engineering Research Center requires.

This work involves transformative research.
This highly innovative development has the potential to revolutionize biomedicine by allowing small-scale simulations of various bodily organs to be grown from the cells of individual donors, eliminating the use of lab animals and permitting more individually tailored therapies.

ENG/EEC 2006

Program Officer: Lynn Preston

NSF Award Numbers:

9843342
Award Title: Biotechnology Process Engineering Research Center

PI Name: Linda Griffith

Institution Name: Massachusetts Institute of Technology

PE Code: 1480

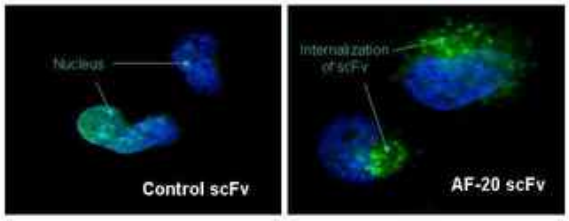
NSF Contract Numbers:

Submitted on 01/30/2006 by Courtland S. Lewis
EEC: Approved 02/01/2006 by Gary A. Gabriele
ENG: Approved 02/08/2006 by Joanne D. Culbertson

Creation of a Screenable Library of Human Antibodies

Highlight ID: 11799

Antibodies are produced by the bodys immune system as a disease-fighting mechanism. In many medical treatments, antibodies are injected into the human body to seek out specific proteins on, for example, cancerous cells and target treatment to those cells. Researchers at MITs Biotechnology Process Engineering Center (BPEC), an ERC, have captured a broad sample of the myriad types of antibodies present in adult humans and have grown those antibodies on the surface of yeast cells in a format suitable for systematic screening by researchers. The resulting antibody library is based on their genetic makeup, using an existing cDNA library as a reference. A user selects antibodies by how they interact with other molecules, and then sequences the ones of interest and names them according to the selection protocol employed.



An antibody (scFv) from the library recognizes a specific molecule on tumor cells (left) and is then internalized by the tumor cells (right). In this way the antibody can be used as a targeting molecule in chemotherapy to take toxins (or suicide genes) directly to tumor cells.

Permission Granted
Credit: Biotechnology Process Engineering Center

This work will speed the search for new antibodiesproteins that are effective tools for recognizing specific molecules. The technology provides a powerful and direct route to the isolation of useful antibodies outside a living body. As a result, it could replace the need to produce antibodies within animals, such as mice.

Primary Goal Indicators:
Cross-disciplinary

Secondary Goal Indicators:
Contributions

Next generation facilities and platforms

This work is notable because
Making antibodies available for quantitative screening in a library that can be accessed as a tool for exploring disease treatments is a novel and powerful idea that could not be realized without a cross-disciplinary systems approach.

Other Indicators (Is this work transformative or multidisciplinary?):

This work involves multidisciplinary research.
This research effort could not have been conducted without the integrated, multidisciplinary team approach that an Engineering Research Center requires. The work involved contributions from biochemists, bioengineers, and biomedical engineers.

ENG/EEC 2006

Program Officer: Lynn Preston

NSF Award Numbers:

9843342
Award Title: Biotechnology Process Engineering Research Center

PI Name: Linda Griffith

Institution Name: Massachusetts Institute of Technology

PE Code: 1480

NSF Contract Numbers:

Submitted on 02/22/2006 by Courtland S. Lewis
EEC: Approved 02/24/2006 by Gary A. Gabriele
ENG: Approved 03/01/2006 by Joanne D. Culbertson

Design and Construction of a Bridge Deck Using Internal Mats and Post-tensioned FRP Reinforcement

Highlight ID: 11434

According to the Federal Highway Administration, 78,000 bridges are in need of structural rehabilitation and, in the worst cases, replacement. Corrosion of metallic structural members, as well as of steel reinforcement within concrete decks and safety appurtenances, is by far the major instrument of degradation, accruing from the routine use of deicing salts on roads and exposure to harsh environments. The development of efficient, rapidly installed and durable bridge deck systems is critical to tackle the impact of economic and social costs associated with bridge replacement and maintenance.

An Industry / University Cooperative Research Center for Repair of Bridge and Building with Composites Project utilizing glass fiber reinforced polymer pre-fabricated panels and rebar cages developed by the center was used in re-building a bridge in Greene County, Mo. The bridge costs were reduced by approximately 15%, with increased material costs offset by over two weeks savings in labor costs. The new bridge was put to use faster than normal. This new process, developed by the center, is an economically viable design giving a potentially longer life span to the bridge. This design is being recognized and adopted by industry.

Primary Goal Indicators:
Connections

Secondary Goal Indicators:
Public understanding of science

This work is notable because

Reinforced and prestressed concrete (RC and PC) structures are facing a worldwide problem, which is the corrosion of the steel as a result of aging and aggressive environments. Steel corrosion leads to member degradation, endangers structural integrity and may even cause catastrophic failures. Research has been carried out in an effort to find the solution for this problem. Fiber Reinforced Polymers (FRP), have been proposed for use in lieu of steel for reinforcement and prestressing tendons in concrete structures. The promise of FRP materials lies in their high-strength, lightweight and non-corrosive, non-conducting, and non-magnetic properties.
The interest in the use of FRP composites in prestressed concrete is mainly based on durability issues. Corrosion of prestressing steel tendons can cause serious deterioration of infrastructure. Properties like high tensile strength and high resistance to corrosion make FRP composites good candidates for prestressed and post-tensioned tendons. Moreover, unlike steel reinforced concrete sections, members reinforced with FRP bars have relatively small stiffness after cracking. Therefore, serviceability requirements have also to be examined.
The type of structure selected for this project is a four-span continuous concrete slab having GFRP bars for top and bottom mats and CFRP reinforcement for internal post-tensioning. The bridge is located in Rolla, Missouri (Southview Drive on Carter Creek). One lane of the bridge was already built using a conventional four-cell steel reinforced concrete box culvert. One lane and sidewalk needed to be added and were constructed using FRP bars.
This study includes design of the FRP portion of the bridge using existing codes, validation of the FRP technology through a pre-construction investigation conducted on two specimens representing a deck strip, and construction of the bridge; the results showed how FRP, in the form of GFRP as passive and CFRP bars as active internal reinforcement, could be a feasible solution replacing the steel reinforcement of concrete slab bridges, and specifically the enhanced shear capacity of the slab due to the CFRP post-tensioning.
The project showcases the successful transition of a new technology from the laboratory to the field, serving the society by providing a safe and long-lasting structure in a fraction of the normal construction time, along with significant cost savings due to the reduced traffic disruption during installation and minimal maintenance needs. The insight gained from the field implementation also provides the researchers with valuable information to move from a prototype system towards an economical and competitive solution.

Other Indicators (Is this work transformative or multidisciplinary?):

This work involves transformative research.
This research might changes the way in which bridges can be quickly built reducing costs for infrastructure development.

ENG/EEC 2006

Program Officer: Alex Schwarzkopf

NSF Award Numbers:

0435733

Fig. 1: View of the Existing Bridge Located on Southview Drive on Carter Creek, Rolla, Missouri.

Permission Granted
Credit: Raffaello Fico, University of Naples - Italy

Figure 2 Placement of the GFRP Rebars into the Central Wall.

Permission Granted
Credit: Raffaello Fico, University of Naples - Italy

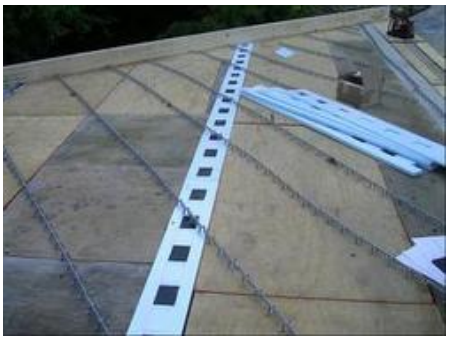


Figure 3 Neoprene Pads and GFRP Mild Reinforcement Details.

Permission Granted
Credit: Raffaello Fico, University of Naples - Italy

Figure 4 Wooden Board

Permission Granted
Credit: Raffaello Fico, University of Naples - Italy

Award Title: I/U CRC for Repair of Buildings and Bridges with Composites - RB2C: Continuing Grant
PI Name: Antonio Nanni
Institution Name: University of Missouri-Rolla
PE Code: 5761

NSF Contract Numbers:

Figure 5 Poured FRP Bridge Deck.

Permission Granted
Credit: Raffaello Fico, University of Naples - Italy

Figure 6 Pulling Machine Ready for the Use.

Permission Granted
Credit: Raffaello Fico, University of Naples - Italy

Figure 7 Bridge after Completion during Load Testing to Assess Performances.

Permission Granted
Credit: Raffaello Fico, University of Naples - Italy

Submitted on 02/02/2006 by Glenn H. Larsen
EEC: Approved 02/13/2006 by Gary A. Gabriele
ENG: Approved 02/21/2006 by Joanne D. Culbertson

Electrical Conductivity Distinguishes Subsurface Features

Highlight ID: 11803

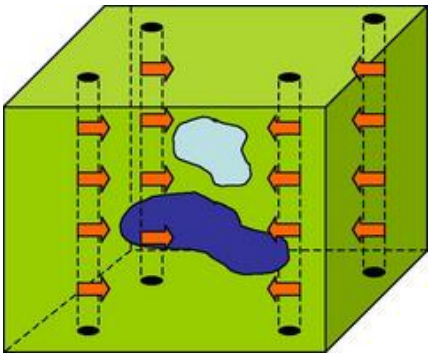
What does a breast tumor have in common with radioactive waste leaking from an underground tank? They are both serious subsurface problems that are not well imaged by conventional means. Conventional mammography is difficult to interpret because tumors and breast tissue differ by less than 15% in x-ray attenuation and are therefore hard to distinguish.

In contrast, the electrical conductivity of tumors is seven times greater than that of normal tissue. Researchers at the Center for Subsurface Sensing and Imaging Systems (CenSSIS), an ERC headquartered at Northeastern University, have pioneered the use of a fast, high-resolution electrical conductivity measurement system called Electrical Impedance Tomography (EIT) to locate areas of high conductivity in breast tissue. The ACT-4 instrument they developed is being clinically tested at Massachusetts General Hospital. Results to date indicate that it will be able to image tumors as small as 3 mm from electrical measurements at the surface of the skin.

The same mathematical inversion techniques are being applied by CenSSIS collaborators at Lawrence Livermore National Laboratory to image radioactive pollution plumes by measuring the electrical resistance between bore holes many meters apart. This EIT technique has been shown to detect and locate leaking contaminants that are invisible to conventional seismic measurements, allowing appropriate remediation measures to be applied.

The ACT-4 electrical conductivity measurement system

Permission Granted
Credit: Center for Subsurface Sensing and Imaging Systems



Detecting radioactive pollution plumes by measuring electrical resistance

Permission Granted
Credit: Center for Subsurface Sensing and Imaging Systems

Primary Goal Indicators:
Contributions

Secondary Goal Indicators:
Collaborations

Connections

Cross-disciplinary

This work is notable because
Using variations in electrical conductivity as an imaging technique offers a powerful alternative to mammography for detecting breast tumors as well as to seismography for detecting radioactive waste in groundwater. The application of similar solutions to diverse problems is the hallmark of this centers research strategy. Innovative mathematical inversion techniques are the key to both of these solutions.

Other Indicators (Is this work transformative or multidisciplinary?):

This work involves multidisciplinary research.
This research effort involved collaboration among electrical and mechanical engineers, mathematicians and computer scientists, and physicians (in the case of the ACT-4 device) and chemists and environmental engineers in the case of the pollution work. It could not have been conducted without the integrated, multidisciplinary team approach that an Engineering Research Center requires.

This work involves transformative research.
Using differences in electrical conductivity to distinguish tumors from healthy tissueor to differentiate other multiphase media such as pollutant plumes in groundwateris a new approach to subsurface measurement that opens up new avenues of research, diagnosis, and detection in areas as diverse as medicine, national security, and environmental protection. The mathematical inversion techniques pioneered by CenSSIS researchers constitute a breakthrough that enables this new technique.

ENG/EEC 2006

Program Officer: Lynn Preston

NSF Award Numbers:

9986821
Award Title: An Engineering Research Center for Subsurface Sensing and Imaging Systems - CenSSIS

PI Name: Michael Silevitch

Institution Name: Northeastern University

PE Code: 1480

NSF Contract Numbers:

Submitted on 02/22/2006 by Courtland S. Lewis
EEC: Approved 02/24/2006 by Gary A. Gabriele
ENG: Approved 03/01/2006 by Joanne D. Culbertson

Encouraging Interest in Engineering through Embedded System Design
Highlight ID: 11881

RET Teachers Work on Their Embedded System Design Projects

Permission Granted
Credit: Kansas St. U/Mitchell L. Neilsen

It is critical to attract a more diverse pool of students to design and implement all types of engineered systems, including real-time embedded systems. To encourage students to seriously consider a career in engineering, we believe that it is important to engage students in the engineering process at an early age, even before high school. In addition, recent advances in embedded systems present significant opportunities for fundamental change at all levels of education, with a greater focus on active, collaborative learning. These advances can be exploited by integrating them into the elementary and middle school curriculums and by having students work in teams to develop innovative new solutions to embedded design problems. To be effective, the teachers must be empowered to thoroughly understand the technology and its potential for application in the classroom. Then, teachers can assign students challenging design problems with many possible solutions and guide them as they work in a team using an iterative design process to derive an innovative solution. For example, the robot shown above was designed by a student team using two custom-built proximity sensors to detect walls on either side of a maze and efficiently traverse the maze. This program focuses on educating upper elementary and middle school teachers who then pass on their knowledge to their students and fellow teachers. Each year, ten upper elementary and middle school teachers from urban and rural schools in Kansas and nearby metropolitan areas are selected to participate in this four-week summer research program focusing on real-time embedded system design. The primary goal of this program is to increase the engineering content of elementary and middle school classes by involving teachers in on-going engineering research. In addition to professional development, this program strives to develop stronger partnerships between Kansas State University and local school districts through ongoing interaction between faculty, graduate students, teachers, and students during the academic year. Teachers work on lab research projects, develop specialized sensors and actuators, and program Lego MINDSTORMS(TM) robots using the Java programming language. They also work on their own individual research projects and develop new curriculum to be used in their own classrooms. In the five years since the project began, the number of schools participating in the Kansas Robotics League has grown from 4 to over 100 schools last year. The number of students directly impacted by this project has also grown exponentially, to over 1,200 last year.

Primary Goal Indicators:
Continuous learning (AC/GPA selected)

Secondary Goal Indicators:
Greater diversity (AC/GPA selected)

This work is notable because
Since the projects inception, the number of schools participating in the Kansas Robotics League has grown exponentially from only 4 schools just five years ago, to over 100 schools last year. The number of students directly impacted by this project has also grown exponentially to over 1,200 last year.

Other Indicators (Is this work transformative or multidisciplinary?):

No other indicators apply.

ENG/EEC 2006

Program Officer: Mary Poats

NSF Award Numbers:

0227709
Award Title: RET SITE: Collaborative Learning Through Real-Time Embedded System Design

PI Name: Mitchell Neilsen

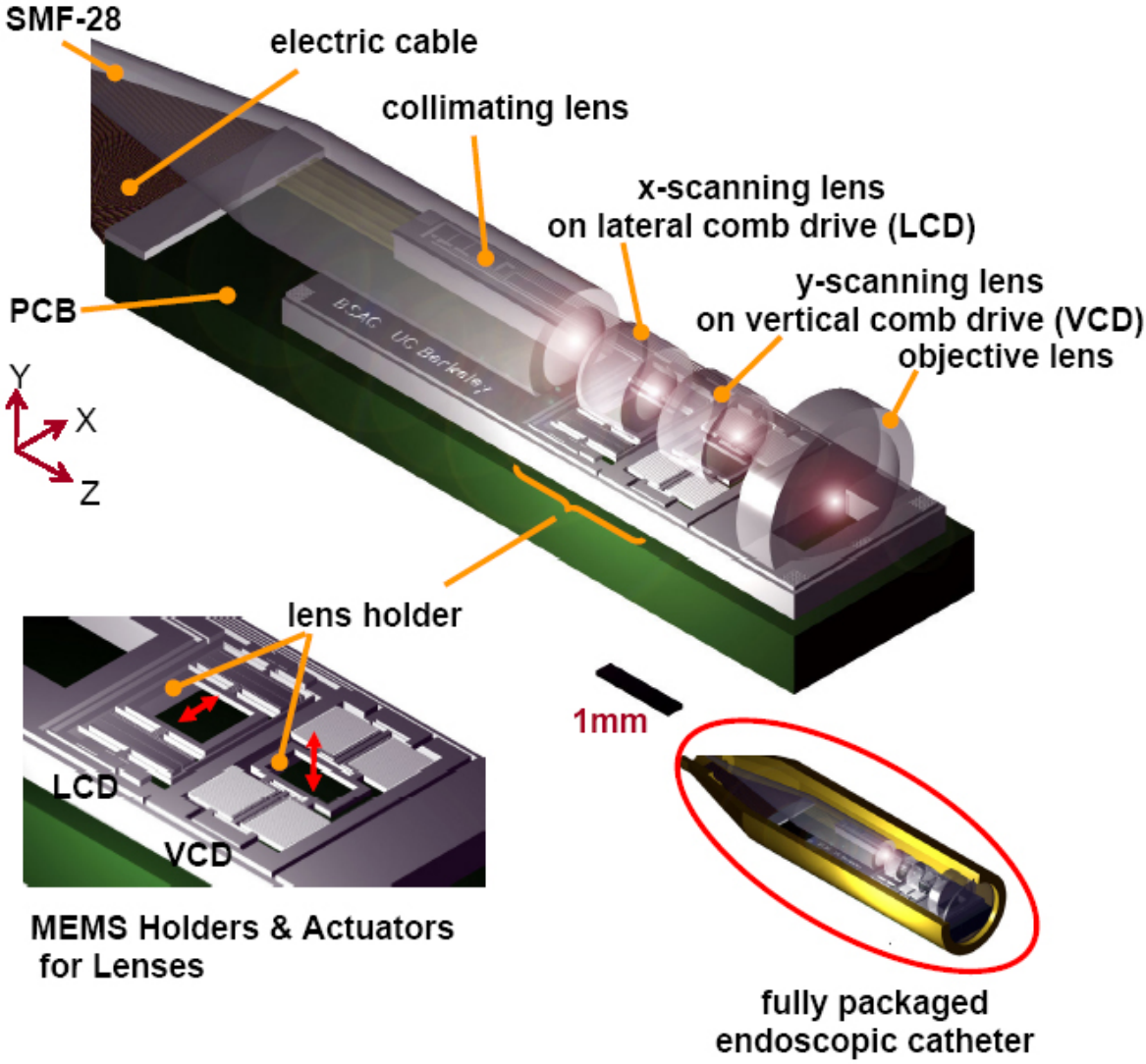
Institution Name: Kansas State University

PE Code: 1360

NSF Contract Numbers:

Submitted on 02/03/2006 by Mary F. Poats
EEC: Approved 02/13/2006 by Gary A. Gabriele
ENG: Approved 02/21/2006 by Joanne D. Culbertson

Endoscopic Optical Coherence Tomography Using Two-Axis MEMS Scanners
Highlight ID: 11441



Design Illustration of two-axis MEMS-Actuated Endoscopic OCT ©2005, U.C. Regents

Permission Granted
Credit: Permission for NSF re-Publication by University of California

Optical coherence tomography and microscopy (OCT/OCM) are emerging medical imaging technologies which enable optical biopsy, at the micron scale, by performing cross-sectional imaging of tissue microstructure. OCT/OCM enables in situ and in real time imaging with resolutions approaching standard histopathology that requires removal and external processing of specimens. Histopathology is the science concerned with the cytrologic and histologic structure of abnormal or diseased tissued. OCT and OCM are analogous to ultrasound imaging, except that light is used instead of sound. Images of internal microstructure in tissue are generated by scanning an optical beam on the tissue and measuring the echo time delay and magnitude of backscattered or back-reflected light. Advances in MEMS can make it possible to develop miniaturized probes which enable in vivo OCT/OCM applications. It allows true integration of XY scanning as well as rapid scan speeds. In particular, it is very critical for new hand-held devices such as imaging probes or needles as well as endoscopes. An endoscope is an instrument for examining visually the interior of a bodily canel or a hollow organ such as the colon, bladder, or stomach.

This work presents a new approach for endoscopic forward OCT (optical coherence tomography) imaging using two axis MEMS lens scanning system with large beam diameter (~1mm). Feasibility studies and analytical design of the system has been completed and fabrication and integration of the system multi-components has begun.

A more detailed look at the system shows that it includes the massive integration of four commercially available aspheric lenses, i.e. a collimating lens, two scanning lenses, and an objective lens, and each lens is integrated on a silicon lens holder. Herein the two-axis lens scanning is achieved by MEMS scanners comprising a lateral comb drive for x-axis scanning and a vertical comb drive for y-axis scanning, perpendicular to the optical axis. This scanning system is targeted for a form factor of 7mm x 2mm and the collimating lens will be coupled with SMF-28 optical fiber in an endoscopic catheter package.The design specification includes a scanning angle of ~±9° at a lens scanning displacement of ±100¼m.

Primary Goal Indicators:
Collaborations

Secondary Goal Indicators:
Connections

This work is notable because
The research is strongly multi-disciplinary, involving clinical diagnostic imaging, mechanical engineering, optics, and microelectronics. Such an interdisciplinary effort, requiring integrative solutions at extremes of all these disciplines, might only be achieved within a large mulit-disciplinary institution with world-class facilities and interdisciplinary researchers and clinicians. The University of California is such an institution and the Berkeley Sensor & Actuator Center has dedicated and affiliated faculty and graduate student researchers from more than ten campus departments to inspire and critique if not direct such an effort.

Other Indicators (Is this work transformative or multidisciplinary?):

This work involves multidisciplinary research.
This research is multi-disciplinary, involving clinical diagnostic imaging, mechanical engineering, optics, and other science and engineering fields of application.

ENG/EEC 2006

Program Officer: Alex Schwarzkopf

NSF Award Numbers:

0318642
Award Title: Microsensor and Actuator I/UCRC

PI Name: Richard Muller

Institution Name: University of California-Berkeley

PE Code: 5761

NSF Contract Numbers:

Submitted on 02/22/2006 by Glenn H. Larsen
EEC: Approved 02/28/2006 by Gary A. Gabriele
ENG: Approved 03/03/2006 by Joanne D. Culbertson

ENGINEERING GRADUATES IN 2004 BETTER PREPARED

Highlight ID: 11786

Students who earned undergraduate engineering degrees in 2004 are better prepared to enter their profession than were similar students who finished their degrees in 1994, according to a study recently completed by the Penn State Center for the Study of Higher Education (CSHE). In all nine engineering knowledge and skill areas emphasized by the new accreditation (ABET)standards, the 2004 graduates in the aggregate have significantly, and often substantially, higher skill levels than did their counterparts from a decade earlier. The skills examined include basic math and science, design and problem solving, experimental skills, engineering science applications, technical and interpersonal communications, as well as working in teams and life-long learning. The 2004 graduates also have greater knowledge of societal and global issues, as well as ethics and professional standards. These results were announced recently at the ABET annual meeting and the final report will be issued in March 2006.

Primary Goal Indicators:
Global S&E workforce

Secondary Goal Indicators:

This work is notable because
These survey results show that students are being better prepared for the global practice of engineering.

Other Indicators (Is this work transformative or multidisciplinary?):

This work involves multidisciplinary research.
Teams of social scientist and engineers worked together to collect and analyze the data.

ENG/EEC 2006

Program Officer: Susan Kemnitzer

NSF Award Numbers:

9812888
Award Title: Regional Faculty Workshops

PI Name: George Peterson

Institution Name: Accreditation Board for Engineering and Technology Inc (ABET)

PE Code: 1340

NSF Contract Numbers:

Submitted on 01/29/2006 by Susan C. Kemnitzer
EEC: Approved 02/01/2006 by Gary A. Gabriele
ENG: Approved 02/08/2006 by Joanne D. Culbertson

ERC Spinoff Company Redirects Biomaterials Discovery to Hydrogen Production
Highlight ID: 11811

Although hydrogen used as fuel offers a strong potential alternative to petroleum-based fuels, the present technology for using hydrogen has serious drawbacks, especially in the transportation arena. Devices and methods that are inexpensive, but also efficient, lightweight, and practical for use onboard hydrogen-powered vehicles have not yet been discovered. There is a need for practical ways to store hydrogen efficiently, that will allow on-demand hydrogen production for energy generation onboard hydrogen-powered vehicles.

Asemblons infrastructure for processing and delivering the hydrogen-rich product used for fuel.

Permission Granted
Credit: Asemblon, Inc.

A few years ago, the University of Washington Engineered Biomaterials (UWEB) Engineering Research Center spun off a company, Asemblon, to produce and market a biomaterials-related invention, novel self-assembled monolayers. The principals in the company afterwards discovered serendipitously that certain of these hydrocarbon materials had important potential applications for hydrogen fuel storage and delivery. Essentially, the compounds are useful for chemically storing hydrogen and releasing the hydrogen on demand, upon reaction with a specific metal substrate, in quantities sufficient for use in generating energy. Further, the spent compound can be regenerated to a hydrogen-rich form that is suitable for re-use in hydrogen production. This recyclable energy source has such a large potential impact in the hydrogen fuel industry that the company changed its direction and patented its discovery.

Asemblon now has two operating units, one manufacturing the molecules (mostly n-alkyl thiols) that researchers need for self assembly--the companys original focus--and the other focusing on hydrogen storage and delivery. The molecular self-assembly operating unit addresses needs in the biotechnology arena, but also has potential for molecular electronics, lubrication, and corrosion protection. Asemblon is now selling a variety of bio-related products through this operating unit. The companys hydrogen storage operating unit continues to work on optimizing storage capacity and release of hydrogen through its patented process using self-assembled monolayers.

Primary Goal Indicators:
Connections

Secondary Goal Indicators:
Contributions

Cross-disciplinary

This work is notable because
This spinoff company from a biomaterials research center was developing specialized materials for use in biotechnology and other applications areas when they realized that the materials had potentially high-impact application in the arena of hydrogen fuel for transportation. The implications for energy self-sufficiency are enormous.

Other Indicators (Is this work transformative or multidisciplinary?):

This work involves multidisciplinary research.
This work derived originally from the integrated, multidisciplinary team approach to research at an Engineering Research Center, and involved materials scientists, chemists, and bioengineers.

ENG/EEC 2006

Program Officer: Lynn Preston

NSF Award Numbers:

9529161
Award Title: University of Washington Engineered Biomaterials (UWEB) Engineering Research Center

PI Name: Buddy Ratner

Institution Name: University of Washington

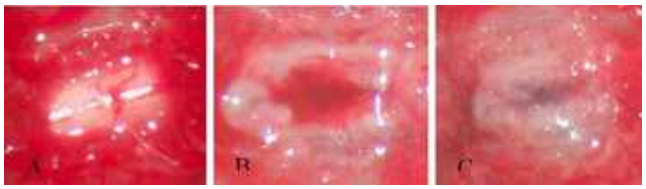
PE Code: 1480

NSF Contract Numbers:

Submitted on 02/22/2006 by Courtland S. Lewis
EEC: Approved 02/24/2006 by Gary A. Gabriele
ENG: Approved 03/01/2006 by Joanne D. Culbertson

Gelling Polymer Repairs Tissue Defects in Vivo

Highlight ID: 11789



(left) Intact spinal cord; (center) Spinal cord with a cavity in dorsal spinal cord; (right) Injury cavity filled with in situ gelling polymer.

Permission Granted
Credit: Georgia Tech/Emory Center for the Engineering of Living Tissues

At the Georgia Tech/Emory Center for the Engineering of Living Tissues (GTEC), an Engineering Research Center, researchers in the centers Neural Tissue Engineering thrust area have developed *in situ* gelling polymer technology to fill irregular soft tissue gaps in a variety of tissues. This includes spinal cord injuries, where these gels will be injected in their liquid state and gelling will occur within seconds at body temperature. This technology has several advantages. First, there is no need for pre-fabricating or pre-measuring exact shapes of defects. Second, bioactive agents such as proteins can be coupled to the backbone to give the materials the functional ability to facilitate growth or differentiation of cells. And third, cells or slow-release vehicles can be embedded into the gels at the time of injection to facilitate controlled differentiation and migration of cells in vivo. GTEC scientists and engineers are currently pursuing two applications for this technology: bridging spinal cord injuries and bridging non-healing bone defects.

Primary Goal Indicators:
Connections

Secondary Goal Indicators:
Collaborations

Cross-disciplinary

This work is notable because
This innovative approach to treating serious medical problems such as spinal cord injuries and bone defects is nearly non-invasive and provides a vehicle for additional therapeutic benefits in addition to the primary repair of tissue defects. Recovery from spinal cord injuries is difficult and uncertain. This approach offers an exciting new avenue of treatment.

Other Indicators (Is this work transformative or multidisciplinary?):

This work involves multidisciplinary research.
This research effort, involving contributions from biology, bioengineering, biochemistry, and medicine, could not have been conducted without the integrated, multidisciplinary team approach that an Engineering Research Center requires.

ENG/EEC 2006

Program Officer: Lynn Preston

NSF Award Numbers:

9731643
Award Title: ERC: Research Center for the Engineering of Living Tissues

PI Name: Robert Nerem

Institution Name: GA Tech Research Corporation - GA Institute of Technology

PE Code: 1480

NSF Contract Numbers:

Submitted on 02/21/2006 by Courtland S. Lewis
EEC: Approved 02/24/2006 by Gary A. Gabriele
ENG: Approved 03/01/2006 by Joanne D. Culbertson

Introducing K-12 Students to Green Engineering

Highlight ID: 11798

Current research on science education confirms the adage that students learn best and are most engaged when they are actively involved in scientific research that is directly related to their everyday lives. Guided by this knowledge, education researchers at the Center for Environmentally Beneficial Catalysis (CEBC), an Engineering Research Center headquartered at the University of Kansas, have developed the first online collaborative research unit, hosted by Pathfinder Science (http://pathfinderscience.net), to address how green engineering impacts students. The research unit, with components targeting both elementary and secondary students, introduces students to the concepts of *environmental assessment* and *green solvents* by investigating the environmental impact of various technologies used by dry cleaners in their own communities.

The environmental impacts of dry cleaning are the basis for a research unit aimed at precollege students and teachers.

Permission Granted
Credit: Center for Environmentally Beneficial Catalysis

The data and results of this research are available to anyone through the Pathfinder website, and can be further evaluated by comparing data generated by students worldwide with existing information on air and water quality. CEBC research is integrated into the background information for the student projects to reinforce the principles of green engineering and chemistry. Teachers and business owners also benefit from this research experience by learning about how environmentally responsible practices improve the quality of life in the community.

Primary Goal Indicators:
Public understanding of science

Secondary Goal Indicators:
Continuous learning

Collaborations

Research on learning and teaching

This work is notable because
This project developed the first collaborative online research unit that exposes precollege students as early as the elementary level to the ways that green engineering impacts their lives and their communities. Teachers and business owners can also benefit from using this research unit by seeing how CEBC research relates to the effects of environmentally responsible practices on quality of life.

Other Indicators (Is this work transformative or multidisciplinary?):

This work involves multidisciplinary research.
This research effort, involving educators along with chemists and chemical engineers, could not have been conducted without the integrated, multidisciplinary team approach that an Engineering Research Center requires.

ENG/EEC 2006

Program Officer: Lynn Preston

NSF Award Numbers:

0310689
Award Title: Center for Environmentally Beneficial Catalysis

PI Name: Bala Subramaniam

Institution Name: University of Kansas Center for Research Inc

PE Code: 1480

NSF Contract Numbers:

Submitted on 01/30/2006 by Courtland S. Lewis
EEC: Approved 02/01/2006 by Gary A. Gabriele
ENG: Approved 02/08/2006 by Joanne D. Culbertson

Introducing Nanotechnology into the Curriculum at a Predominantly Undergraduate Institution
Highlight ID: 11878

Technology is entering a new age of

The Nanoscale Science, Engineering and Technology (NSET) Program

Permission Granted
Credit: JSU/Tigran Shahbazyan

advancement that will be heavily influenced by the ability to alter, characterize, and assemble matter at the nanoscale. All U.S, institutions of higher education including predominantly undergraduate and minority collegesmust be prepared to educate future scientists and engineers for the age of nanoscale science, engineering, and technology.

The Nanoscale Science, Engineering and Technology (NSET) program at Jackson State University, a historically black university, started in the fall of 2003 and has had success in introducing and training undergraduate students predominantly from underrepresented groups in interdisciplinary nanotechnology-related areas. The program supports on average 10-15 students per semester. Activities include nanotechnology courses and research experiences. The nanotechnology program at JSU is focused on training in nanotechnology-related materials science applications using an array of nanocharacterization tools appropriate for hands-on undergraduate education. Specific goals of the program include: 1) increasing student awareness of advanced technologies such as nanotechnology as early as freshman year; 2) developing student research skills; and 3) developing professional skills (written/oral presentation and communication skills) through mentoring.

These goals are achieved by means of an introductory nanoscale science and engineering lecture course and a complementary introductory laboratory course. There is a nanotechnology seminar series and a range of student research projects. Mentoring and successful development and recruitment of minority students for the undergraduate program is an

Primary Goal Indicators:
Greater diversity

Secondary Goal Indicators:
Global S&E workforce

This work is notable because
Since 2003 this program has averaged 10-15 students per semester, most of them from underrepresented groups, who are involved in nanotechnology-related coursework and undergraduate research. The program has been instrumental in introducing nanotechnology systematically into the undergraduate curriculum at this historically black institution and has provided funding for students as well as research infrastructure (laboratories and instrumentation).

Other Indicators (Is this work transformative or multidisciplinary?):

No other indicators apply.

ENG/EEC 2006

Program Officer: Mary Poats

NSF Award Numbers:

0532468
Award Title: NUE: Integrating Nanoscale Science Education and Student Research at Jackson State University

PI Name: Tigran Shahbazyan

Institution Name: Jackson State University

PE Code: 7219

NSF Contract Numbers:

Submitted on 02/03/2006 by Mary F. Poats
EEC: Approved 02/13/2006 by Gary A. Gabriele
ENG: Approved 02/21/2006 by Joanne D. Culbertson

Learning Factory Receives NAE Gordon Prize

Highlight ID: 11785

students working in the learning factory.

Permission Granted
Credit: OLPA Library

The Learning Factory was developed to produce engineering graduates who could easily translate engineering theory into practice and manage projects independently. In this innovative undergraduate program, students tackle real problems from industry, such as designing a collapsible crutch, turning coal ash into a pavement, and making the mechanism that adjusts the position of car seatbacks safer. Multidisciplinary teams of students define and characterize the problem, build a solution prototype, write a business proposal, and make presentations about their idea. The Learning Factory originated from a coalition between three universities, Sandia National Laboratories, and 36 industrial partners that shared a desire to give students firsthand experience in design, manufacturing, and business. A 1994 National Science Foundation/Advanced Research Projects Agency grant funded the creation of the Learning Factory as a Manufacturing Engineering Education Partnership (MEEP). Within three years, the university partners -- Pennsylvania State University, the University of Puerto Rico-Mayagüez (UPRM), and the University of Washington (UW) -- successfully integrated the Learning Factory into their institutions and curricula. Since then, Learning Factory concepts and course materials have spread to other departments within these institutions, and to other universities in the U.S. and Latin America. More than 10,000 students have created over 1,200 Learning Factory design projects involving more than 200 industry partners. On February 21, 2006 the originators of the Learning Factory received the prestigeous Gordon Prize, a $500,000 award presented by the National Academy of Engineering.

Primary Goal Indicators:
Collaborations

Secondary Goal Indicators:

This work is notable because
The Learning Factory challenges teams of engineering students to confront actual technology needs facing industry and society today.

Other Indicators (Is this work transformative or multidisciplinary?):

This work involves multidisciplinary research.
Multidisciplinary teams of engineering students tackle real world technolgy problems.

ENG/EEC 2006

Program Officer: Susan Kemnitzer

NSF Award Numbers:

9413880
Award Title: TRP: The Manufacturing Engineering Education Partnership

PI Name: John Lamancusa

Institution Name: Pennsylvania State Univ University Park

PE Code: 1467

9812928
Award Title: The Learning Factory: Implementing ABET 2000 A Hands-On Workshop

PI Name: Lueny Morell

Institution Name: University of Puerto Rico Mayaguez

PE Code: 1340

NSF Contract Numbers:

Submitted on 02/01/2006 by Susan C. Kemnitzer
EEC: Approved 02/01/2006 by Gary A. Gabriele
ENG: Approved 02/06/2006 by Joanne D. Culbertson

LEGO Tutorials for Precollege Outreach
Highlight ID: 11810

To increase participation in science, technology, engineering, and math programs by precollege students in rural southwestern Virginia, the Center for Power Electronics Systems (CPES), an Engineering Research Center headquartered at the Virginia Institute of Technology and State University, has developed programs focusing on outreach to elementary and middle school students and teachers. One such program, based on the FIRST LEGO League (FLL) robotics challenge program, is intended to engage precollege students in an ongoing project related to power controls and design. The CPES initiative provides participating teachers and students with on-site demonstrations, workshops, and mentorship by engineering undergraduate and graduate students.

Each CPES tutorial module consists of a beginner or Basic cluster and an Advanced cluster

Permission Granted
Credit: Center for Power Electronics Systems

In 2005, the CPES team completed development of five computer-based tutorials for use in the classroom. Each module consists of a beginner or Basic cluster and an Advanced cluster. Each tutorial unit consists of a homepage, an introduction, linked lessons, and a glossary targeting the second grade reading level. The modulesProblem Solving, Gears, Power, Sensors, and Programmingwere created using FLASH software. In order to facilitate the integration of robotics into the classroom, the FLL contents have been aligned with the Virginia Standards of Learning. Teachers may access these standards and benchmarks for each grade, 4-8, for the justification of using the FLL program as a co-curricular activity. In Spring 2005, CPES conducted an in-school usability study, designed to solicit and incorporate teacher and student feedback on the modules. The tutorials will soon be available through the CPES website and the Virginia FIRST Lego League organization.

Primary Goal Indicators:
Continuous learning (AC/GPA selected)

Secondary Goal Indicators:
Greater diversity

This work is notable because
The development of these tutorials for use in elementary and middle school classrooms provides precollege teachers with powerful classroom tools, aligned with the States formal educational standards, for increasing the engineering and science literacy and interests of young students.

Other Indicators (Is this work transformative or multidisciplinary?):

No other indicators apply.

ENG/EEC 2006

Program Officer: Lynn Preston

NSF Award Numbers:

9731677
Award Title: ERC: Center for Power Electronics Systems

PI Name: Fred Lee

Institution Name: Virginia Polytechnic Institute and State University

PE Code: 1480

NSF Contract Numbers:

Submitted on 01/31/2006 by Courtland S. Lewis
EEC: Approved 02/01/2006 by Gary A. Gabriele
ENG: Approved 02/16/2006 by Joanne D. Culbertson

Light and Optics Workshop for High School Teachers

Highlight ID: 11788

The ERC for Extreme Ultraviolet Science and Technology (EUV ERC), headquartered at Colorado State University, considers highly interactive workshops for teachers to be one of the most effective ways to raise the science and engineering literacy of a large number of students. When teachers are educated in engineering design and in the inquiry-based scientific process, they can pass on the excitement and power of science and engineering to their students. The EUV ERC presented a highly successful workshop to 23 middle school teachers from Pueblo, Colorado, in 2004. The Pueblo School District serves a large minority population. In January 2005 the Center ran a second workshop aimed at 16 high school teachers. It featured 13 challenging experiments involving basic concepts in lasers and optics designed to be performed using only equipment and materials commonly found in a public high school classroom.

The workshop encouraged a constructivist approach where a physical phenomenon related to light was demonstrated and participants were asked to explain the fundamental concept through experimentation and discussion. Alternatively, predictions were solicited and then verified or disproved with experiments. These were highly effective and popular approaches that elicited participant discovery. Gaps in knowledge were quickly exposed and filled. Ultimately, we provided teachers with sequences of questions and discussion points, which, in combination with experiments, can successfully lead students to discover the nature of physical phenomena in light/optics.

High school teachers work on concepts related to lasers and light.

Permission Granted
Credit: ERC for Extreme Ultraviolet Science and Technology

Quotes from 2005 High School Teacher Workshop: · The workshop was very useful. It provided a way for me to use hands-on activities to teach light and optics within a limited budget. This type of information is extremely useful to me as a teacher. · I was forced to come up with hypotheses just as my students are. · These activities make me think in ways I want my students to think. · The workshop gave me a better way to explain concepts to my students. · I leave with a clearer understanding of concepts that I only poorly knew of before. · The demos were within our budget capabilities and time limitations. · The best part of the workshop was the hands-on approach.

Primary Goal Indicators:
Greater diversity

Secondary Goal Indicators:
Continuous learning

This work is notable because
This annual workshop is aimed at middle and high school teachers from a district where a high percentage of students are Hispanic or Native Americans. The impact of the project is highly leveraged in that teachers acquire new knowledge and powerful teaching tools that can stimulate the interest of hundreds of students in science and technology and potentially affect the career choices of many students from underrepresented groups.

Other Indicators (Is this work transformative or multidisciplinary?):

No other indicators apply.

ENG/EEC 2006

Program Officer: Lynn Preston

NSF Award Numbers:

0310717
Award Title: Engineering Research Center for Extreme Ultraviolet Science and Technology

PI Name: Jorge Rocca

Institution Name: Colorado State University

PE Code: 1480

NSF Contract Numbers:

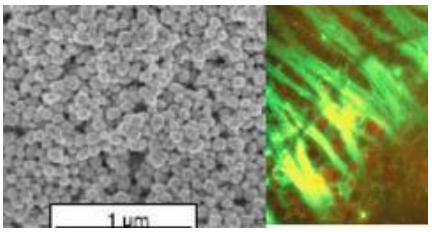
Submitted on 01/30/2006 by Courtland S. Lewis
EEC: Approved 02/01/2006 by Gary A. Gabriele
ENG: Approved 02/08/2006 by Joanne D. Culbertson

Nanobiolistics: Delivering Biological Markers Into Tissue

Highlight ID: 11809

One of the subtler tenets of scientific research is that "the necessity for an observer makes perfect observation impossible." The challenge is to minimize the effect of the observers and their observational tools. For example, investigations into the neurophysiology of the retina often require that "functional indicators" of parameters such as ion concentrations and protein locations be loaded into living retinal neurons, so that the parameters can be measured in real-time.

Until now, the technique for "biolistic loading" of indicators has been to inject fluorescent particles into the neurons. The particles were relatively large and often caused significant damage to the living cells during the loading process. To solve this problem, researchers at the Engineering Research Center for Biomimetic MicroElectronic Systems (BMES ERC), headquartered at the University of Southern California (USC), developed a "gene gun" to propel tiny silver nano-particles coated with fluorescent indicators into the retinal neurons. The particles are less than one-tenth the size of the standard particles and cause only about 10% as much cell damage--making more accurate observation possible.



(left) Silver nanoparticles (80 nm in diameter) under electron microscopy. Courtesy of Nanodynamics Inc. (right) Eight-week-old live mice retinas imaged using multiphoton microscopy. Under 60x microscopy and 6.6 digital zoom, images of the nerve fiber cell layer of the mouse retina are shown.

Permission Granted

Credit: Center for Bioimetic MicroElectronic Systems

Primary Goal Indicators:
Cross-disciplinary

Secondary Goal Indicators:
Collaborations

Connections

This work is notable because
Developing a novel technology to improve the way that biochemical markers are loaded into living neurons has made the research easier to conduct and the results more reliable. Based on contributions from engineers, biologists, materials scientists, and medical doctors, the "gene gun" is a powerful tool with many other potential applications.

Other Indicators (Is this work transformative or multidisciplinary?):

This work involves multidisciplinary research.
Based on contributions from engineers, biologists, materials scientists, and medical doctors, this research effort could not have been conducted without the integrated, multidisciplinary team approach that an Engineering Research Center requires.

ENG/EEC 2006

Program Officer: Lynn Preston

NSF Award Numbers:

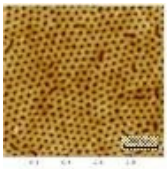
0310723

Award Title:	An Engineering Research Center for Biomimetic Microelectronic Systems
PI Name:	Mark Humayun
Institution Name:	University of Southern California
PE Code:	1480

NSF Contract Numbers:

Submitted on 01/31/2006 by Courtland S. Lewis
EEC: Approved 02/01/2006 by Gary A. Gabriele
ENG: Approved 02/06/2006 by Joanne D. Culbertson

Nanoporous Templates for Immobilization of Biomolecules
Highlight ID: 11365



Advances in nanotechnology will enable us to manipulate and control objects on a scale much smaller than ever before imagined. The power of miniaturization became tangible for Lin Ho, an undergraduate chemical engineering student who participated in the REU program at Keck Graduate Institute of Applied Life Science (KGI) in Claremont, California, during the summer of 2004. In her research project she fabricated the worlds smallest honeycomb structures which can fit one billion holes into an area equivalent to the head of a pin, each hole measuring approximately 25 nanometers in diameter. The goal of her work is to use these structures in the ordering of biomolecules such as proteins or DNA as a way of creating nanoscopically structured biosensors.

XXXXXXXXX

Permission Granted
Credit: XX

To fabricate these nanoarrays, Ho deposited an ultra-thin polymer layer on top of silicon wafers. She then used techniques of self-assembly and surface processing developed by professor Thomas Russell to form the nanoscale honeycomb structures. Working closely with her advisor and KGI professor Angelika Niemz as well as Harvey Mudd College professor Shenda Baker, Ho was able to quickly master the necessary techniques and the use of advanced instruments such as the Atomic Force Microscope. Prior to participating in this REU program, her only research experience involved computer simulations of self-assembly processes. Lin is an extraordinarily talented researcher, said Niemz. She is inquisitive, hard working and has two golden thumbs in the lab.

In March, Ho presented her work at the American Chemical Societys national meeting in San Diego and is working on a paper to describe the capabilities of these templates in the self-assembly ordering of DNA nanospheres. Making something that matters is the coolest thing! said Ho. Having hands-on experience, using lab equipment that youd find in industry or at a graduate university, was great. It certainly has made me more interested in becoming involved in applied research. I want to work in the bioscience and biotechnology fields as a result of this REU experience at KGI.

Primary Goal Indicators:
Instrument technology

Secondary Goal Indicators:

This work is notable because
The goal of her work is to use these structures in the ordering of biomolecules such as proteins or DNA as a way of creating nanoscopically structured biosensors.

Other Indicators (Is this work transformative or multidisciplinary?):

No other indicators apply.

ENG/EEC 2006

Program Officer: Esther Bolding

NSF Award Numbers:

0243910
Award Title: Undergraduate Research in Biotechnology and Bioengineering

PI Name: Angelika Niemz

Institution Name: Keck Graduate Institute

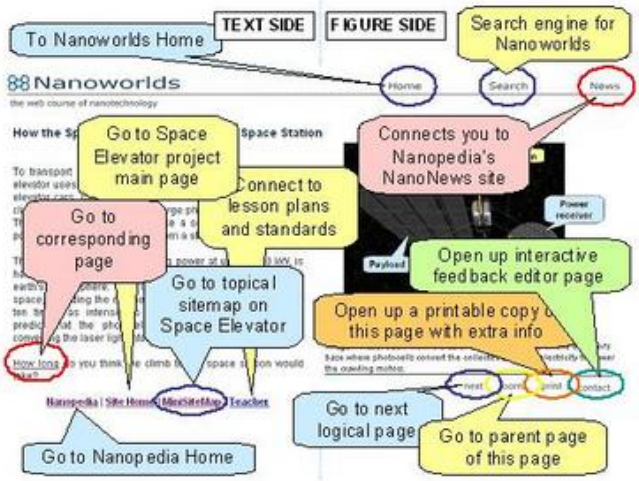
PE Code: 1360

NSF Contract Numbers:

Submitted on 02/01/2006 by Esther M. Bolding
EEC: Approved 02/01/2006 by Gary A. Gabriele
ENG: Approved 02/21/2006 by Joanne D. Culbertson

Nanoworlds: Introduction to Nanotechnology Using a
Highlight ID: 11829

One of the outstanding examples of open-source communal creation of resources on the worldwide web is Wikipedia, an online encyclopedia that is created and updated by users around the world. A Nanotechnology Undergraduate Education project at Case Western Reserve University has adopted the Wikipedia approach to the development of an undergraduate curriculum aimed at non-engineering students, providing these students with a stimulating and engaging introduction to nanotechnology and technology in general.



Sample page from Nanoworlds

Permission Granted
Credit: CWU/Alexis Abramson

Nanoworlds is an innovative technology-literacy program in the form of an undergraduate learning experience and associated web resource in the emerging and very important interdisciplinary field of nanotechnology. This one-semester nanotechnology education program was designed for beginning college students who do not necessarily have a technical background and is now being offered for the second year in a row. A significant portion of the course material, both presented by the lecturer and submitted by the students, is accessible via a web interface (see http://nanopedia.cwru.edu). Aside from conveying the appeal of cutting-edge science, we wanted our students to gain experience in critical thinking about the evolution, applications, and ethics of technology. Moreover, for spring semester 2006, a new approach to learning about nanotechnology is being employed: the undergraduate students will be working with a high school teacher and high school students to develop mini teaching modules on aspects of nanotechnology. The cumulative result of all these efforts is a student-tested, rigorously assessed, web-based resource uniquely developed for the enhancement of undergraduate education in nanotechnology. This scalable technology is also suitable for public dissemination of teachable content on any scale.

Fundamental to the course offering was the building and maintenance of a web portfolio engine allowing teachers and students to build of their own organized knowledge base in the field of nanotechnology and its applications. Professors built content as the class evolved, while students contributed individually and in groups both in content exploration and creative writing. The net result was a portfolio-based Nanopedia, or encyclopedia of nanotechnology at three levels: (1) a student's individual portfolio amounting to a reconstruction of the field of nanotechnology as learned by the student and organized and expressed in his or her own words; (2) at the level of the class as a whole where there was an overall organizational structure, background material written by the professor, assignments, and where individual and group research topics were included; and (3) as edited contributions to an archival web encyclopedia of nanotechnology for general public use, to which many classrooms can contribute.

The Nanoworlds project also involved development of a custom website (the figure shows a sample page). This course was a seminar-based course with 11 students enrolled in Year 1 and 17 students enrolled in Year 2. In addition, one graduate student, one undergraduate student, one high school student and three high school teachers have worked on further development of the Nanopedia, the Nanoworlds course, as well as mini teaching modules that will be made accessible to the public soon.

Primary Goal Indicators:
Public understanding of science

Secondary Goal Indicators:
Continuous learning

This work is notable because
This project familiarizes non-technical undergraduate students with the rapidly emerging field of nanotechnology. But beyond that, it also immerses them in the creation collectively by a group of an online technical resource, an experience that in itself imparts a number of technical skills and a broader interest in science and technology. In addition, the involvement with precollege students broadens the participants' experience on both sides. Finally, the Nanopedia resource is available to the public worldwide as a way to promote public understanding of this important field.

Other Indicators (Is this work transformative or multidisciplinary?):

No other indicators apply.

ENG/EEC 2006

Program Officer: Mary Poats

NSF Award Numbers:

0407208
Award Title: NUE: Nanoworlds: An Innovative Undergraduate Curriculum Using a Scalable Web-Based Encyclopedia of Nanotechnology
PI Name: Alexis Abramson

Institution Name: Case Western Reserve University

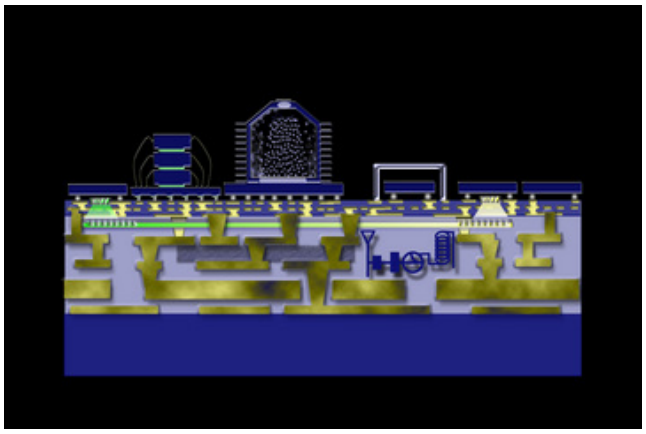
PE Code: 1340

NSF Contract Numbers:

Submitted on 02/14/2006 by Mary F. Poats
EEC: Approved 02/14/2006 by Gary A. Gabriele
ENG: Approved 02/21/2006 by Joanne D. Culbertson

Partnership Catalyzes SOP-based Industry
Highlight ID: 11795

The Georgia Tech Packaging Research Center (PRC), an Engineering Research Center, completed its 10-year term as an ERC in late 2005. A recent study conducted by the Stanford Research Institute determined that between 1994 and 2004, the PRC produced a direct economic benefit (new jobs, licensing fees and royalties, etc.) to the economy of the state of Georgia of nearly $192 million. When indirect benefits are factored in, SRI estimates that the total quantifiable contribution of the PRC to the Georgia economy over the 10 years was $351 million.



System-on-a-Package (SOP) is a new approach to electronic systems integration that will revolutionize the microelectronics industry. Its emergence requires a new generation of engineers skilled in SOP concepts and technology. The PRC and its industrial partners are jointly producing these engineers and moving them into industry.

Permission Granted
Credit: Packaging Research Center

Over the 10 years, the PRC and its industry partners jointly designed and implemented a strategy to cooperatively develop the Centers new System-on-a-Package (SOP) technologies, educate the next generation of packaging engineers, and transfer both technologies and graduates to industry to strengthen its competitiveness. This partnership resulted in hundreds of industrial internships and well over 300 PRC graduates hired by the Centers industrial partners. Industrial practitioners routinely gave lectures in the classroom and participated on thesis committees. The PRC hosted over 60 visiting industry engineers on campus, documented numerous examples of technology transfer, and disclosed nearly 200 inventions. The PRC also impacted local economic development by creating spin-off companies, attracting spin-in companies, and assisting local start-up companies in incubating nascent technologies.

By developing a portfolio of critical SOP technologies, graduating over 500 skilled SOP engineers, and facilitating the creation of new companies in its field, the PRC has enabled an SOP-based industry to emerge in the United States.

Primary Goal Indicators:
Collaborations

Secondary Goal Indicators:
Connections

Identifying new opportunities

Cross-disciplinary

This work is notable because
This university-based research center has collaborated closely with its industrial partners over a ten-year period on both the research and education programs that have culminated in the emergence of a new type of microelectronics packaging industry and a new breed of packaging engineers to make it viable.

Other Indicators (Is this work transformative or multidisciplinary?):

This work involves multidisciplinary research.
This long-term research effort, involving electrical and packaging engineers as well as computer scientists, materials scientists, and computer engineers, could not have been conducted without the integrated, multidisciplinary team approach that an Engineering Research Center requires.

ENG/EEC 2006

Program Officer: Lynn Preston

NSF Award Numbers:

9402723
Award Title: Engineering Research Center for Low Cost Electronic Packaging

PI Name: Rao Tummala

Institution Name: GA Tech Research Corporation - GA Institute of Technology

PE Code: 1480

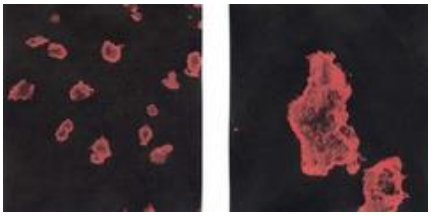
NSF Contract Numbers:

Submitted on 02/22/2006 by Courtland S. Lewis
EEC: Approved 02/24/2006 by Gary A. Gabriele
ENG: Approved 03/01/2006 by Joanne D. Culbertson

Protecting Transplanted Islet Cells Can Improve Treatment of Diabetes

Highlight ID: 11790

A major hurdle in cell transplantation is the high rate of initially nonfunctional cells and early cell destruction. For example, in order to reverse diabetes in a single patient, pancreatic islets from 2 to 4 donor organs are typically required, placing a significant burden on an already limited donor organ supply. Evidence suggests that the problem is exposure to inflammatory injury triggered by the transplantation process that destroys cells or suppresses their function and amplifies subsequent immune reactions.



Porcine islets coated with polymeric shells using a layer-by-layer (LbL) technique.

Permission Granted
Credit: Georgia Tech/Emory Center for the Engineering of Living Tissues

Researchers at the Georgia Tech/Emory Center (GTEC) for the Engineering of Living Tissues, an Engineering Research Center, are working to protect transplanted islet cells by coating their surfaces with a comparatively new generation of polymeric shells or membranes created using the layer-by-layer (LbL) technique. This method involves the assembly of composite layers by alternating adsorption of oppositely charged polymeric species. The membranes exhibit good stability with regard to changes of pH, solvent, and temperature. Other features, such as biocompatibility and permeability, can be tailored by using specific polyelectrolytes as building blocks. An important advantage of layer-by-layer adsorption from solution is that film architectures are completely determined by the deposition sequence and many different materials can be incorporated in individual multilayer films. In addition to ease of assembly of these multicomponent coatings, there is no limit to the size, shape, and composition of the templates.

Recent GTEC investigations confirm that this strategy offers a new approach for the fabrication of *conformal* multicomponent films directly on islet surfaces. The investigators postulate that in this manner the surface of the pancreatic islet can be, at least transiently, re-engineered. Thus, in addition to providing a permeability barrier as a mechanism to limit the adverse effects of the host immune response, they believe that LbL methods also provide a workable approach for adding desired biological functionality to the islet surface. This means that more effective ways to treat diabetes may be in sight, using methods that place less pressure on the available donor organ supply.

Primary Goal Indicators:
Contributions

Secondary Goal Indicators:
Collaborations

Connections

Cross-disciplinary

This work is notable because
This work involves the application of new materials, using innovative techniques, to the reengineering of pancreatic tissues and cells. It opens the prospect of a breakthrough in the treatment of diabetes that requires far fewer donor organs than current transplantation methods demand, with more versatility in treatment possibilities through the addition of specific biological properties to the tissue surface.

Other Indicators (Is this work transformative or multidisciplinary?):

This work involves multidisciplinary research.
This research effort, involving contributions from biology, bioengineering, biochemistry, and medicine, could not have been conducted without the integrated, multidisciplinary team approach that an Engineering Research Center requires.

This work involves transformative research.
Re-engineering the surface of the pancreatic islet to protect the tissue while adding additional functionality to the cells offers the prospect of more effective treatment of diabetes--a nearly epidemic medical condition in the United States today.

ENG/EEC 2006

Program Officer: Lynn Preston

NSF Award Numbers:

9731643
Award Title: ERC: Research Center for the Engineering of Living Tissues

PI Name: Robert Nerem

Institution Name: GA Tech Research Corporation - GA Institute of Technology

PE Code: 1480

NSF Contract Numbers:

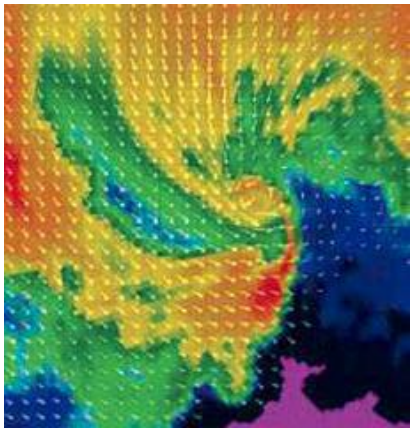
Submitted on 02/22/2006 by Courtland S. Lewis
EEC: Approved 02/24/2006 by Gary A. Gabriele
ENG: Approved 03/01/2006 by Joanne D. Culbertson

Radar Algorithms for Automatically Detecting Tornadoes

Highlight ID: 11802

Using data from networks of low-power Doppler weather radars, researchers have developed the first algorithms for dynamically detecting tornadoes. The Engineering Research Center for Collaborative Adaptive Sensing of the Atmosphere (CASA), headquartered at the University of Massachusetts-Amherst, designed the algorithms to distinguish tornadoes from transient but intense low-altitude shear regions within severe storms. For the first time, CASAs radars can now see close to the ground, enabling operators to locate a tornado and determine its intensity. A notable challenge lies in determining what observable conditions on radar constitute a tornado, since the official definition requires visual confirmation that the vortex is in contact with the ground and since no threshold wind speeds exist that can be used to distinguish tornadoes from other columnar vortices.

The algorithms reconstruct the 3D wind field based upon wind estimates from multiple Doppler radars. Because real data are not yet available from the new CASA radars that are about to be deployed in Oklahoma, extremely high-resolution computer simulations of storms and their associated tornadoes are being used as a proxy. The image shows one such simulated data set processed by the tornado detection algorithm, with the tornado located in the region of swirling flow in the right-center portion of the image.



The image shows a simulated data set processed by the tornado detection algorithm, with the tornado located in the region of swirling flow in the right-center portion of the image.

Permission Granted
Credit: Center for Collaborative Adaptive Sensing of the Atmosphere

Primary Goal Indicators:
Contributions

Secondary Goal Indicators:
Connections

Identifying new opportunities

Cross-disciplinary

This work is notable because
Tornadoes have often evaded detection by radar because they form low to the ground and other short-lived and severe weather events in that region of the atmosphere can mimic tornadoes. These algorithms allow confident detection of tornadoes and thus clear the way to the use of a new type of radar for accurate and timely detection of tornadoes.

Other Indicators (Is this work transformative or multidisciplinary?):

This work involves multidisciplinary research.
Electrical engineers, computer scientists, and meteorologists collaborated on this project. The research effort could not have been conducted without the integrated, multidisciplinary team approach that an Engineering Research Center requires.

ENG/EEC 2006

Program Officer: Lynn Preston

NSF Award Numbers:

0313747
Award Title: Center for Collaborative Adaptive Sensing of the Atmosphere (CASA)

PI Name: David McLaughlin

Institution Name: University of Massachusetts Amherst

PE Code: 1480

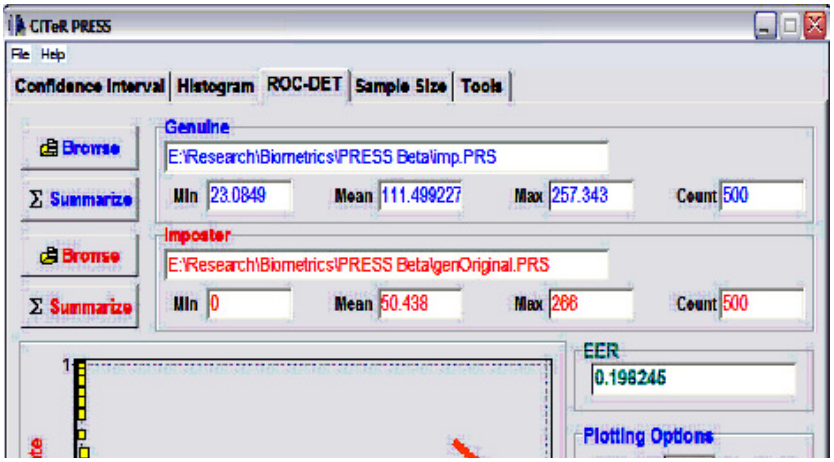
NSF Contract Numbers:

Submitted on 02/22/2006 by Courtland S. Lewis
EEC: Approved 02/24/2006 by Gary A. Gabriele
ENG: Approved 03/01/2006 by Joanne D. Culbertson

Rapid Identity Authentication

Highlight ID: 11388

Researchers at the Center for Identification Technology Research (CITeR), an NSF Industry University Cooperative Research Center based at West Virginia University, are putting tools in the hands of practitioners in government and industry to dramatically improve homeland security. CITeRs focus is on the advancement of the state of the art of biometric systems

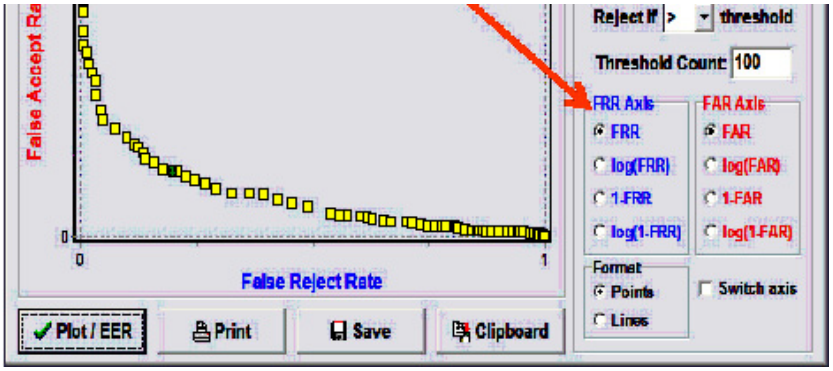


automated systems able to rapidly authenticate visually the identity of an individual. The capability of biometrics to identify a person with their actions is absolutely central to enhance homeland security and defense. CITeRs Multibiometrics (MUBI) Tool and Program for the Rate Estimation and Statistical Summaries (PRESS) are being used by DoD and DHS to rapidly and effectively implement biometric systems.

PRESS is a software system that allows a user to assess how well that systems under test are functioning based on empirical testing. This allows testers of biometric systems to more quickly understand their performance, enabling a more rapid deployment of systems. PRESS was developed by Dr. Michael Schuckers and C. J. Knickerbocker, an undergraduate, at St. Lawrence University, one of CITeRs participating universities. National and international testing organizations as well as DoD and DHS are using the tool.

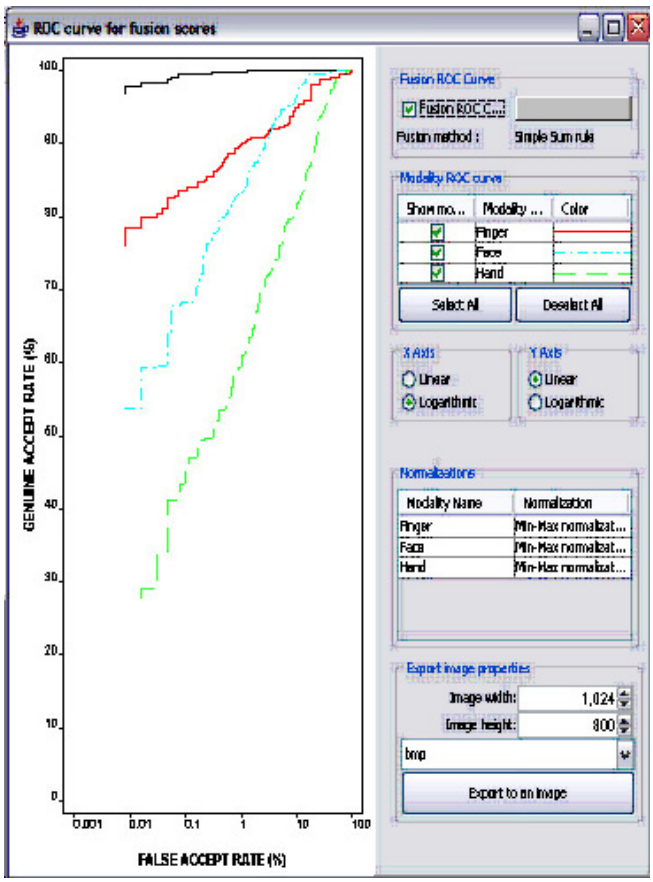
MUBI addresses the growing need to build systems, which use multiple biometrics. It evaluates the most effective combination of biometric indicators, such as face, fingerprint, iris, etc., and determines the parameters for each indicator to meet the desired application specific performance goal. Graduate students under the direction of Dr. Bojan Cukic of West Virginia University developed this tool. MUBI is now being used by DHS in order to establish security systems using biometrics, which are easy to use, yet highly effective.

MUBI and PRESS tools and the accompanying documentation are available free of charge under the open source software license at



Example of analysis from the CITeR-supported PRESS software tool. Credits: Michael Schuckers and C. J. Knickerbocker, St. Lawrence University

Permission Granted
Credit: Credits: Michael Schuckers and C. J. Knickerbocker, St. Lawrence University



MUBI tool results showing improvement in performance (black top curve) from fusion of finger, face, and hand biometrics.

Permission Granted
Credit: Bojan Cukic, West Virginia University

Undergrad and grad student research group explores the use of a multibiometric system with hand geometry and fingerprint capture.

Permission Granted
Credit: CITeR, West Virginia University

www.citer.wvu.edu/downloads/software.php . Both are being continually updated with new modules as a result of ongoing

Primary Goal Indicators:
Expand access

Secondary Goal Indicators:
Data collection/analysis

This work is notable because
CITeRs Multibiometrics (MUBI) Toll and Program for the Rate Estimation and Statistical Summaries (PRESS) are being used by DoD and DHS personnel to enable them to effectively design and evaluate biometric systems.

Other Indicators (Is this work transformative or multidisciplinary?):

This work involves multidisciplinary research.
The tool implements more than a dozen algorithms from research literature and offers an embedded tutorial on multimodal biometric systems and fusion techniques. It supports biometric systems designers, system evaluators, students and all others interested in performance analysis and integration of biometric systems.

ENG/EEC 2006

Program Officer: Alex Schwarzkopf

NSF Award Numbers:

0128402
Award Title: Operating Center Proposal for The Center for Identification Technology Research (CITeR): An I/UCRC in Biometrics
PI Name: Lawrence Hornak

Institution Name: West Virginia University Research Corporation

PE Code: 5761

NSF Contract Numbers:

Submitted on 02/02/2006 by Glenn H. Larsen
EEC: Approved 02/13/2006 by Gary A. Gabriele
ENG: Approved 02/21/2006 by Joanne D. Culbertson

Remote Sensing Saves Lives After Earthquakes
Highlight ID: 11787

Earthquakes can instantaneously destroy property and human life, but a speedy and well-organized response can limit the extent of further losses. An emergency managers most difficult post-disaster task is to quickly and accurately assess damage and the disruption being experienced in efforts to direct available resources to areas of greatest need.

Researchers at the Multidisciplinary Center for Earthquake Engineering Research (MCEER), an Engineering Research Center headquartered at the University at Buffalo, have been investigating how remote sensing technologies such as synthetic aperture radar and high-resolution optical imagery can be used to improve post-disaster damage/situation assessment. For example, MCEER researchers have furthered the integration of such technologies, and expanded their use, in investigations immediately following another type of disasterHurricane Katrina. For the first time, a new remote sensing-based building damage scale was used to rapidly assess residential wind destruction and determine corresponding damage states generated by the HAZUS hurricane damage model. Post-Katrina images also guided and streamlined field reconnaissance in New Orleans and Mississippi, through integration within the GPS-linked VIEWSTM data collection and visualization system. More advances are likely to come from the widening availability of high-resolution images and the use of unmanned airborne vehicles and other means to collect data in near-real-time, and during the weeks and months following the event. Using pre-disaster images of vulnerable areas to establish a baseline, this technology will enable planners to determine the severity and distribution of post-disaster damage, and then monitor progress made in the recovery.

Primary Goal Indicators:
Connections

Secondary Goal Indicators:
Instrument technology

This work is notable because
Using remote sensing technologies to improve post-disaster assessment of damage and the situation on the ground when access is difficult can save time, lives, and property. It can also speed the recovery by providing a clear record of how much damage has occurred where. After Hurricane Katrina, a new remote sensing-based building damage scale was used to rapidly assess residential wind destruction across the region.

Other Indicators (Is this work transformative or multidisciplinary?):

This work involves multidisciplinary research.
This research effort, involving civil engineers, computer scientists, and image processing specialists, could not have been conducted without the integrated, multidisciplinary team approach that an Engineering Research Center requires.

ENG/EEC 2006

Program Officer: Lynn Preston

NSF Award Numbers:

9701471
Award Title: Multidisciplinary Center for Earthquake Engineering Research (MCEER)

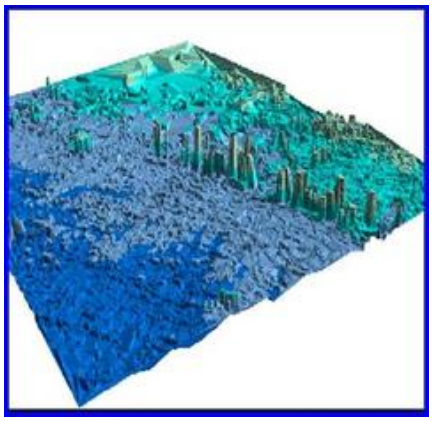
PI Name: Michel Bruneau

Institution Name: SUNY at Buffalo

PE Code: 1483

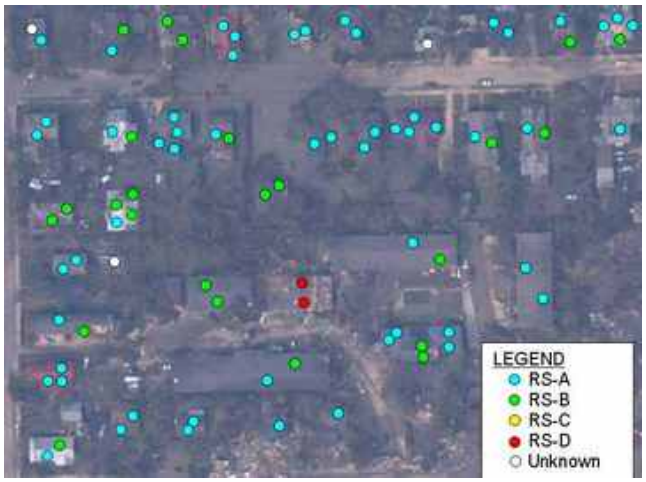
Remote sensing imagery can distinguish the damage state of buildings over a large area.

Permission Granted
Credit: Multidisciplinary Center for Earthquake Engineering Research



Synthetic aperture radar offers a powerful remote sensing tool for earthquake damage assessment.

Permission Granted
Credit: Multidisciplinary Center for Earthquake Engineering Research



Remote sensing technologies were used to rapidly assess wind damage to dwellings after Hurricane Katrina. The legend shows different levels of damage, ranging from no apparent damage (RS-A) to roof and wall collapse (RS-D).

Permission Granted
Credit: ImageCat, Inc.

NSF Contract Numbers:

Submitted on 02/22/2006 by Courtland S. Lewis
EEC: Approved 02/24/2006 by Gary A. Gabriele
ENG: Approved 03/01/2006 by Joanne D. Culbertson

Research Experiences for Undergraduates in Japan in Advanced Technology (REUJAT)
Highlight ID: 11833

Since 2002 the Research Experiences for Undergraduates in Japan in Advanced Technology (REUJAT) program has taken a few of America's top undergraduate students abroad to participate in a summer research appointment at some of Japan's finest universities and research institutions. The REUJAT program creates a unique opportunity for its participants to work closely with renowned Japanese researchers as their mentors in innovative technological research. The topic each participant selects is based on research they have conducted at their respective home institution in the US. The REUJAT program functions in tandem between US and Japanese mentorship with one common research project.

REUJAT Participant working with Japanese advisor, K. Seto, on Structural Control.

Permission Granted
Credit: Shirley J. Dyke and Makola M. Abdullah,Washington University in St. Louis and Florida A&M University

A two pronged primary objective of the program has been to entice student's interest in the study of advanced technology as well as to foster and nurture future Japanese and US cooperation in and sharing of innovative technological research. In order to facilitate these objectives the REUJAT program exposes undergraduates to Japan's advanced technological research activities in mentors' laboratories. Participants receive academic instruction and/or guidance from mentors and fellow Japanese students. Moreover, and often with the greatest impact, participants are exposed to the unique culture of Japan. Participants' US advisors often coordinate directly with the participant's Japanese mentors serving as a bridge between the US and Japan increasing collaboration and information exchange between the scientific communities of the two nations.

Since its inception the primary goals of this program have been achieved. Most of the participants go on to pursue post baccalaureate education in engineering disciplines, of which many of them attribute that decision to their REUJAT experience. Undoubtedly all of them finish the program with a more holistic awareness of the universal impact advance technology has on one's life despite cultural differences. Relationships between US and Japanese researchers have been established and are blossoming by way of joint research publications as well as with continued correspondence establishing future cooperative research projects.

Primary Goal Indicators:
Collaborations (AC/GPA selected)

Secondary Goal Indicators:
Global S&E workforce

Expand access

This work is notable because
A two pronged primary objective of the program has been to entice students interest in the study of advanced technology as well as to foster and nurture future Japanese and US cooperation in and sharing of innovative technological research. In order to facilitate these objectives the REUJAT program exposes undergraduates to Japans advanced technological research activities in mentors laboratories. Participants receive academic instruction and/or guidance from mentors and fellow Japanese students. Moreover, and often with the greatest impact, participants are exposed to the unique culture of Japan.

Other Indicators (Is this work transformative or multidisciplinary?):

No other indicators apply.

ENG/EEC 2006

Program Officer: Esther Bolding

NSF Award Numbers:

0243809
Award Title: REU Program in Japan in Advanced Technology

PI Name: Shirley Dyke

Institution Name: Washington University

PE Code: 1360

NSF Contract Numbers:

Submitted on 02/06/2006 by Esther M. Bolding
EEC: Approved 03/06/2006 by Gary A. Gabriele
ENG: Approved 03/07/2006 by Joanne D. Culbertson

REU Site: Nanoscale Science and Engineering for Materials Processing and Systems
Highlight ID: 11923

Preparing Students for Graduate School by Conducting Research in Nanoscale Materials Science and Engineering at Clarkson University

Permission Granted
Credit: John Moosbrugger, Clarkson University

The REU Site: Nanoscale Science and Engineering for Materials Systems and Materials Processing at Clarkson University provides summer research opportunities and program activities for undergraduate students in science and engineering. Program activities are designed to promote graduate school and research, as a career path for the participating students, and to expose the students to the broader field of nanoscale science and engineering, which has been established as a national priority area for research and development.

During the summer of 2005, the first year of the program, six students conducted research projects mentored by faculty from the Mechanical and Aeronautical and Chemical Engineering departments. Examples of the research projects include: 1) development of processes for large scale production of nano-sized particles, which are used in advanced drugs, printing and imaging technology and many other areas; 2) characterization of magnetic properties of ultra fine grain nickel, which has potential applications in the development of devices for sensing sound and is even being developed for use in high-tech sporting equipment; and 3) development of methods to produce nanoscale aluminum flakes for use in obscurant smokes for military operations. Students also participated in workshops designed to develop their ability to write reports and papers, to deliver effective presentations and increase their understanding of graduate study and the process of applying for graduate school, graduate assistantships and fellowships.

At the end of the program, all students prepared a short conference-style paper and presented their research at Clarkson University's summer annual SURE (Symposium for Undergraduate Research Experiences) conference. One of the students also presented his research findings at Clarksons CAMP (Center for Advanced Materials Processing) meeting of industry and faculty researchers. A second student will be presenting his research at an international chemical engineering conference, and is co-author on a submitted journal paper. Subsequent to the program, four students prepared graduate school applications, and two of these applied to the NSF GRFP.

Primary Goal Indicators:
Greater diversity

Secondary Goal Indicators:
Global S&E workforce

This work is notable because
Of the six students who participated in the first year of the program, three (50%) are from underrepresented groups (two African-American, one Hispanic) and one is female. (A recent study by Susan H. Russell (NSF Pan-REU workshop, 2005) reported that, nationwide, 14% of REU students were Black or Hispanic.) Additionally, four of the six students have definitely decided to attend graduate school in engineering. Among these four, there are two African-Americans and one woman; the fourth student is from a non-research BS-only institution.

Other Indicators (Is this work transformative or multidisciplinary?):

No other indicators apply.

ENG/EEC 2006

Program Officer: Esther Bolding

NSF Award Numbers:

0453404
Award Title: REU Site: Nanoscale Science and Engineering for Materials Processing and Systems

PI Name: John Moosbrugger

Institution Name: Clarkson University

PE Code: 1360

NSF Contract Numbers:

Submitted on 02/08/2006 by Esther M. Bolding
EEC: Approved 03/06/2006 by Gary A. Gabriele
ENG: Approved 03/06/2006 by Joanne D. Culbertson

REU-NSF:Novel Materials and Processing in Chemical and Biomedical Engineering

Highlight ID: 11918

Objectives of this REU-NSF Site include development and enhancement of the students' creativity and ethics in science and engineering, fostering the understanding of the research process and intellectual property, giving the students experience at writing and presenting their work, and uniquely preparing them for interdisciplinary collaborations in their future workplaces. In 2005, the REU program included 15 undergraduates from the U.S. and Puerto Rico with a wide spectrum of scientific backgrounds. It supported research in areas like novel nanomaterial systems, protein and peptide interactions, biological surface modification for implantable medical devices, and micropatterned substrates for controlled growth and neurite extension of retinal neurons http://www.uic.edu/labs/AMReL/NSFREU2005/.

Representative projects with notable findings included: microelectrodes implanted in the brain which were shown to effectively send and record electrical brain signals (left figure, below); also, undifferentiated stem cells were seeded onto nanofiber scaffolds, images were taken every 3-4 days, and the organization of nanofibers was found to have an effect on cell orientation, i.e., aligned scaffolds oriented cells better than random scaffolds (right figure, below).

An important unique aspect of the 2005 REU Program was the continuous and intense cross-fertilization of ideas among undergraduates with very rich and diverse (academic, cultural, socioeconomic) backgrounds. Two thirds of the students were women and underrepresented individuals.

Primary Goal Indicators:
Greater diversity

Secondary Goal Indicators:
Contributions

Instrument technology

This work is notable because
This project is notable because it fostered the continuous and intense cross-fertilization of ideas among undergraduates with very rich and diverse (academic, cultural, socioeconomic) backgrounds. Two thirds of the students were women and underrepresented individuals.

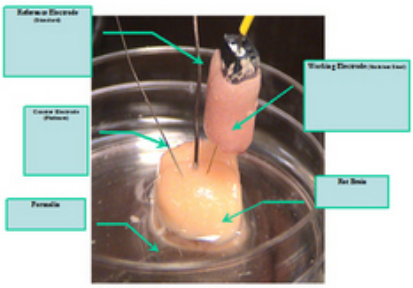
Other Indicators (Is this work transformative or multidisciplinary?):

No other indicators apply.

ENG/EEC 2006

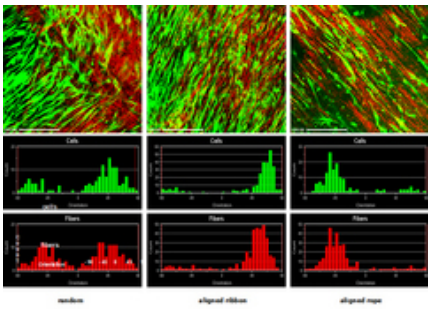
Program Officer: Esther Bolding

NSF Award Numbers:



Microelectrodes for use in neuroprosthetics. Electrochemical setup test is shown on rat brain tissue.

Permission Granted
Credit: Christos G. Takoudis, University of Illinois at Chicago



Day 18 of stem cells on nanofibers. Ribbon and rope scaffolds are aligning stem cells better than random scaffolds. Distribution of nanofiber angles are with respect to the horizontal axis.

Permission Granted
Credit: Christos G. Takoudis, University of Illinois at Chicago

0453432

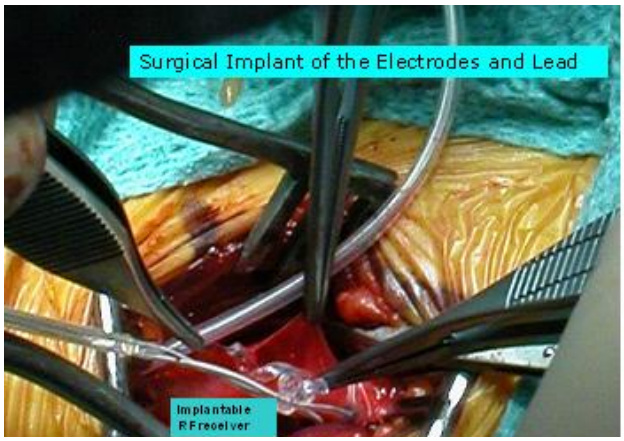
Award Title:	REU: Novel Materials and Processing in Chemical and Biomedical Engineering
PI Name:	Christos Takoudis
Institution Name:	University of Illinois at Chicago
PE Code:	1360

NSF Contract Numbers:

Submitted on 03/01/2006 by Esther M. Bolding
EEC: Approved 03/06/2006 by Gary A. Gabriele
ENG: Approved 03/06/2006 by Joanne D. Culbertson

RF Powered Neural Stimulator

Highlight ID: 11859

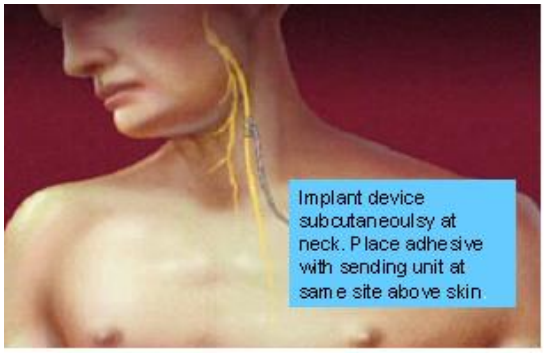


Depression and seizure disorders affect more than 5 percent of the population of the United States. High school teachers at the University of Pittsburgh's RET site have been among the first

researchers in the nation to study whether a small implanted electronic device is a safe and effective treatment for patients that suffer refractory epileptic seizures or have been diagnosed with

Surgical Implant of the Electrodes and Lead

Permission Granted
Credit: UPitt/Michael Lovell



Implant Device

Permission Granted
Credit: UPitt/Michael Lovell

treatment-resistant depression (TRD). An RF device developed by these teachers will dramatically improve the quality of life for millions of people. In their summer research experience, the teachers determined the necessary electrical signal requirements to neurologically stimulate a patient's vagus nerve and created an implantable radio frequency (RF) based system to meet these requirements. Similar to a pacemaker for the brain, the developed RF powered Vagal Nerve Stimulation (VNS) system will help regulate nerve impulses by sending intermittent mild pulses of electricity directly to the vagus nerve. Signals from the VNS device will travel through a lead, up the vagus nerve, and into the brain. Unlike existing VNS devices that must be implanted into the chest and contain leads that are invasively tunneled through a patient's shoulder and neck, the new RF stimulation device is placed directly inside the patient's neck and contains a replaceable external power source. Through the School of Engineering's partnership with the University of Pittsburgh Medical Center (UPMC), the VNS system will be studied in humans. As one of 20 centers in the United States that will conduct a double-blind study, UPMC will implant the device in up to 30 patients, who will be evaluated for approximately 12 weeks. If successful, the new system may become a unique and effective treatment for patients that suffer refractory epileptic seizures or have been diagnosed with TRD. As part of their summer research experience, the Pittsburgh Public School District high school teachers developed design-based learning units for physics, chemistry, and biology. The units, which focus on integrated team design projects, were highly innovative and spanned the topics of artificial arm development to post-hurricane soil analysis. Implemented in the curriculum during the present school year, the design-based learning projects will culminate with a district-wide student design competition that will be hosted by Westinghouse Electric Corporation this April.

Primary Goal Indicators:
Continuous learning

Secondary Goal Indicators:
Underrepresented individuals and institutions

This work is notable because
Depression and seizure disorders affect more than 5 percent of the population of the United States. The economic cost of treating depression alone is more than $40 billion a year. Although numerous antidepressant drugs are available to treat the disease, the estimated 1.5 percent of the general population with severe, recurrent episodes of depression has a form that is resistant to conventional treatment. Outside of electroconvulsive therapy, which costs up to $20,000 per patient per year and carries the risk of short-term and possibly long-term memory deficits, there is almost nothing a physician can do for someone with TRD. If proven to be effective, the RF device developed by the teachers will dramatically improve the quality of life for millions of people. At the conclusion of their research experience, the RET participants submitted an invention disclosure to the University of Pittsburgh's Office of Technology Management. This disclosure is presently being patented by the University and the teachers have been designated contributing inventors and will receive a percentage of any royalties generated. Furthermore, the research results generated by the RET participants have helped serve as a catalyst for a new RFID Center of Excellence (www.engr.pitt.edu/site/rfid) that opened at the University of Pittsburgh this fall.

Other Indicators (Is this work transformative or multidisciplinary?):

No other indicators apply.

ENG/EEC 2006

Program Officer: Mary Poats

NSF Award Numbers:

0502035
Award Title: Bringing Innovative Design into Urban High Schools on a Sustainable Basis: University of Pittsburgh Design Team RET Site
PI Name: Michael Lovell

Institution Name: University of Pittsburgh

PE Code: 1360

NSF Contract Numbers:

Submitted on 02/14/2006 by Mary F. Poats
EEC: Approved 02/14/2006 by Gary A. Gabriele
ENG: Approved 02/21/2006 by Joanne D. Culbertson

Steady Hands for Retinal Surgery

Highlight ID: 11796

The Steady-Hand Robot system facilitates delicate retinal surgery.

Permission Granted
Credit: The Johns Hopkins University

Retinal disorders are one of the leading causes of blindness in people over the age of 60. The delicacy and small size of the retinal structures makes surgery to correct these disorders extremely challenging and, in some cases, impossible to perform by hand. The Engineering Research Center for Computer-Integrated Surgical Systems and Technology (CISST), headquartered at The Johns Hopkins University, has developed a system for eye surgery that combines robotic hand stabilization and guidance with information overlays to create a surgical assistant for these delicate procedures. Video information from the left and right eyes of the surgical microscope is processed to create a three-dimensional model of the retina and the locations of the surgical tools at any given moment during the operation.

With these three-dimensional models, it is possible to define desirable paths in space to perform the procedure and thus guide the surgeons movements using simulated fixed points, or virtual fixtures, to define landmarks or boundaries for movement. This guidance is passive, allowing the surgeon to maintain total control over the execution of a medical procedure; thus, unlike most robotic systems, it functions as an assistant rather than as a direct controller. At the same time, pre-operative information is registered to the view of the microscope and is also displayed to the surgeon. The software control allows the configuration of the virtual fixture (i.e., the desired path for movement) to be modified depending on the specific context of the operation, yielding a very flexible system. The Steady-Hand Robot system thus has the potential to give surgeons the super-human accuracy and precision necessary to develop new treatments for these blinding disorders.

Primary Goal Indicators:
Connections

Secondary Goal Indicators:
Cross-disciplinary

This work is notable because
This innovative robotic system expands the scope of eye surgeries that surgeons can confidently undertake, making possible both new treatments and greater success in operations.

Other Indicators (Is this work transformative or multidisciplinary?):

This work involves multidisciplinary research.
This research effort, involving electrical and mechanical engineers, bioengineers, and medical doctors, could not have been conducted without the integrated, multidisciplinary team approach that an Engineering Research Center requires.

ENG/EEC 2006

Program Officer: Lynn Preston

NSF Award Numbers:

9731748
Award Title: ERC: Engineering Research Center for Computer-Integrated Surgical Systems and Technology

PI Name: Russell Taylor

Institution Name: Johns Hopkins University

PE Code: 1480

NSF Contract Numbers:

Submitted on 02/22/2006 by Courtland S. Lewis
EEC: Approved 02/24/2006 by Gary A. Gabriele
ENG: Approved 03/01/2006 by Joanne D. Culbertson

Students Design Advanced Radar Network

Highlight ID: 11801

An all-student team of 15 graduate and undergraduate students at the ERC for Collaborative Adaptive Sensing of the Atmosphere (CASA) is creating an experimental radar system, to be deployed in Puerto Rico, that will transform our ability to monitor rainfall. Comprised of an array of miniature radar sensors, the system produces accurate rainfall data to be used to predict flooding and support other applications such as crop hydrology that require accurate rainfall estimates. The radar system should be operational by Fall 2006.

The student-run radar network consists of two types of installations: a CASA "rooftop radar" (coverage shown by blue circle) located at the University of Puerto Rico-Mayaguez; and CASA "off the grid" radars (pink circles) that will be deployed at remote locations using solar panels to provide power. This array will fill in a low-level coverage gap that the islands only WSR-88D Doppler radar cannot see.

Permission Granted
Credit: ERC for Collaborative Adaptive Sensing of the Atmosphere

The student-run testbed system offers both a unique research and educational experience. It requires students to work across disciplinary and geographical boundaries and understand all facets of developing and implementing a testbed. When the testbed is up and running it will cover a crucial 1.5 km-high gap in atmospheric weather-monitoring over western Puerto Rico that traditional radar technology cannot sense. The testbed also will explore methods for more accurate measurement of rainfall and wind data than is now possible. And it could be used as a back-up to the current radar system if the Puerto Rican electrical grid blacks out in heavy weather. One of many student design innovations is a system for allocating power-hungry activities (such as computation) to nodes with more reliable access to power, to minimize downtime.

Primary Goal Indicators:
Global S&E workforce

Secondary Goal Indicators:
Greater diversity

Collaborations

Underrepresented individuals and institutions

Cross-disciplinary

This work is notable because
This project is providing students with an opportunity to collaborate in a multicultural team on the design, installation, and operation of an advanced technological system in a region culturally and geographically very different from that of the home research center. Thus, it is a superb educational testbed for developing the skills that a global engineer needs.

Other Indicators (Is this work transformative or multidisciplinary?):

This work involves multidisciplinary research.
This research effort could not have been conducted without the integrated, multidisciplinary team approach that an Engineering Research Center requires. Students studying electrical and mechanical engineering as well as meteorology, computer science, and even social science are involved in the project.

This work involves transformative research.
We believe this research project can be considered transformative in terms of its impact on students and their education. The research and following installation and operation of the radar system was conducted by students, with little faculty involvement. The design, development, and implementation of a major research testbed for the Center by students is unique among the ERCs and perhaps anywhere. It is a high-risk approach with enormous potential benefits for the educational experience of the students involved.

ENG/EEC 2006

Program Officer: Lynn Preston

NSF Award Numbers:

0313747
Award Title: Center for Collaborative Adaptive Sensing of the Atmosphere (CASA)

PI Name: David McLaughlin

Institution Name: University of Massachusetts Amherst

PE Code: 1480

NSF Contract Numbers:

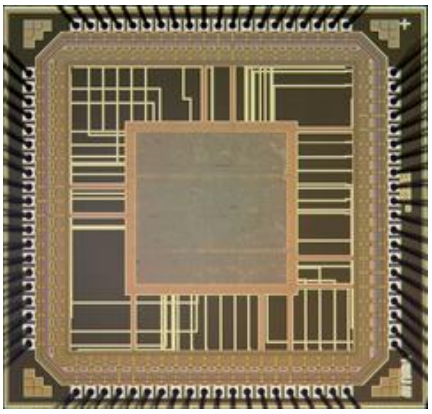
Submitted on 02/22/2006 by Courtland S. Lewis
EEC: Approved 02/24/2006 by Gary A. Gabriele
ENG: Approved 03/01/2006 by Joanne D. Culbertson

Systems-on-a-Chip for Powerful Prostheses

Highlight ID: 11805

The Engineering Research Center for Biomimetic MicroElectronic Systems (BMES ERC), headquartered at the University of Southern California, is developing entire platforms for a range of implantable devices that could one day restore vision to the blind, reanimate paralyzed limbs, and overcome certain cognitive impairments. This new genre of implantable microelectronic systems will seamlessly integrate with the human body and, in so doing, replace missing or damaged neuronal function. The enabling technologies being developed range from wireless power and data to hermetic packaging and bioelectrodes, as well as novel low-power biomimetic mixed-signal very large scale integrated circuits (multifunctional VLSI chips).

As a highlight of development in one of these areas, the BMES ERC has made great strides in state-of-the-art mixed-signal systems on a chip. The device shown serves as a vehicle for developing the technology to implement neural functions in silicon. These new mixed-signal circuits will allow Center researchers to pack more functionality onto each chip, so that the same piece of silicon will hold both digital circuits inspired by neural processing and analog circuits able to communicate with neurons. Such a device has already successfully replaced the CA3 part of the hippocampus in the lab and in the future could also help meet the needs of an implanted retinal prosthesis that allows the blind to read and recognize faces.



A novel mixed-signal system on a chip as a platform for implantable prosthetic devices.

Permission Granted
Credit: Center for Bioimetic MicroElectronic Systems

Primary Goal Indicators:
Cross-disciplinary (AC/GPA selected)

Secondary Goal Indicators:
Collaborations

Connections

This work is notable because
The mixed-signal VLSI chip, combining both digital and analog circuits to mimic biological function, provides a platform for powering and controlling a range of implantable prosthetic devices that could revolutionize the treatment of many serious disabilities. It is a versatile tool that allows a new way of seeing solutions to medical problems ranging from blindness to paralysis.

Other Indicators (Is this work transformative or multidisciplinary?):

This work involves multidisciplinary research.
Based on contributions from engineers, biologists, and materials scientists, this research effort could not have been conducted without the integrated, multidisciplinary team approach that an Engineering Research Center requires.

ENG/EEC 2006

Program Officer: Lynn Preston

NSF Award Numbers:

0310723
Award Title: An Engineering Research Center for Biomimetic Microelectronic Systems

PI Name: Mark Humayun

Institution Name: University of Southern California

PE Code: 1480

NSF Contract Numbers:

Submitted on 02/22/2006 by Courtland S. Lewis
EEC: Approved 02/24/2006 by Gary A. Gabriele
ENG: Approved 03/01/2006 by Joanne D. Culbertson

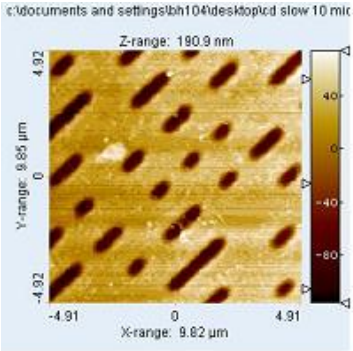
Teaching Nanosystems Engineering to Early College Students with Active Learning Experiences

Highlight ID: 11875

The emerging field of

Nanosystems engineering students working on lab exercises

Permission Granted
Credit: LaTechU/Hisham Hegab



Sample atomic force microscope image from CD-ROM activity

Permission Granted
Credit: LaTechU/Hisham Hegab

Nanosystems Engineering Degree

Permission Granted
Credit: LaTechU/Hisham Hegab

nanotechnology and nanoengineering has enormous potential to significantly influence our daily lives through its impact on biomedical technology, computers, consumer products, electronics, energy, environment, materials, and pharmaceuticals. There is a growing need for engineers who can fill several roles that are required to transform nanotechnology from intriguing science to useful technology. Nanosystems engineers will be needed to educate and support potential nanotechnology end users, transition laboratory work into commercial production, evaluate the commercial viability of products, create new nanotechnology companies, and interface between scientific researchers and investors. This Nanotechnology Undergraduate Education project played a key role in supporting the establishment of the first nanosystems engineering B.S. program to be offered in the U.S. The project provided critical components of the first Bachelor of Science in Nanosystems Engineering program, offered at Louisiana Tech University (more info at http://www.latech.edu/coes/nanosystems-engineering). The project has developed several hands-on lab exercises to support lower division courses in the new program. These active learning exercises include nanoassembly of thin films using electrostatic layer-by-layer assembly, nanoparticle production by chemical synthesis, fabrication of nickel nanowires using electrochemistry, atomic force microscopy of CDs and DVDs, and scanning tunneling microscopy of graphite. These hands-on activities are effective in attracting and retaining students to pursue science and engineering degrees. The project has also supported outreach to area high school students by using some of the active learning exercises at high school visits and at on-campus student recruitment events such as Engineers Day, on which nearly 500 high school seniors visited the campus. The results of this work have been disseminated through proceedings at a national conference, acceptance as a chapter in an upcoming book on nanoscale science and education, and a brochure sent to area math/science teachers, prospective students, industry recruiters, and alumni.

Primary Goal Indicators:
Global S&E workforce

Secondary Goal Indicators:
Greater diversity

Public understanding of science

This work is notable because
Nanoengineering is a major new field that is emerging at a time when engineering research capabilities are expanding rapidly in many nations around the world. Nanoengineers educated in the U.S. will be competing with counterparts across the globe and must be highly qualified in this new field. This project provided critical components of the first nanosystems engineering B.S. program to be offered in the U.S. The precollege outreach components of the project help to ensure a supply of U.S.-born students who are attracted to this exciting new field.

Other Indicators (Is this work transformative or multidisciplinary?):

No other indicators apply.

ENG/EEC 2006

Program Officer: Mary Poats

NSF Award Numbers:

0407097
Award Title: NUE: Teaching Nanosystems Engineering to Early College Students with Active Learning Experiences

PI Name: Hisham Hegab

Institution Name: Louisiana Tech University

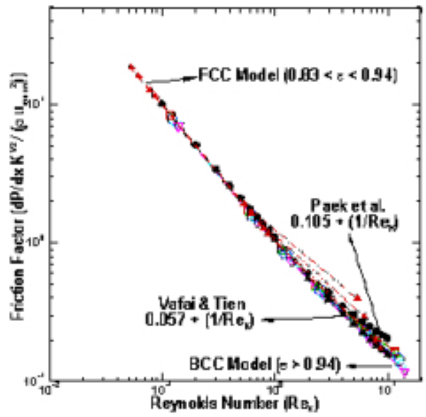
PE Code: 1340

NSF Contract Numbers:

Submitted on 02/03/2006 by Mary F. Poats
EEC: Approved 02/13/2006 by Gary A. Gabriele
ENG: Approved 02/21/2006 by Joanne D. Culbertson

Transport in Porous Structures and Metal Foams
Highlight ID: 12449

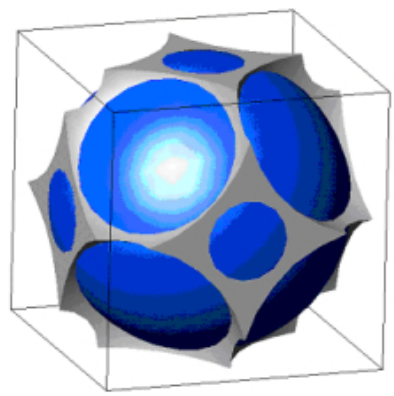
Cellular solids are again attracting increased attention and research interest due to their potential applications to a variety of areas including electronics thermal management. In general, the attractiveness of these light-weight materials lies in the ability to tailor their properties to given requirements of heat transfer enhancement, while providing high surface area-to-volume ratios. Many cooling applications utilize various porous structures and metal foams for heat transfer enhancement. These include porous wick structures in heat pipe applications, thermal conductivity enhancers for transient cooling, as well as heat sinks for air-cooling. It is necessary to characterize the performance of these structures, in terms of their effective thermal conductivity, interfacial heat transfer coefficients, and pressure drop. To obtain a fundamental understanding, it is necessary to develop a basic approach to geometry representation of porous structures and foams, to develop a computational methodology for determining effective conductivity, Nusselt numbers and fRe products, and to validate computations against experiments as well as published theories and correlations. Further, such simulations can provide guidelines for identifying most effective porous structures for minimal pressure drops and maximum heat dissipation.



Predicted friction factor as a function of modified Reynolds number for foams.

Permission Granted
Credit: S Krishan, SV Garimella, and JY Murthy.

A novel computational methodology for direct simulation of open-cell foams and heat pipe wicking structures has been developed in a project conducted by Drs. Jayathi Murthy and Suresh Garimella in the NSF Cooling Technologies Research Center of Purdue University. This comprehensive model predicts the thermal and flow characteristics of foams and particle beds, which are in excellent agreement with published measurements. A distinguishing feature of the geometrical representation of the foams that has been developed is its ability to predict the thermal and flow characteristics without using any arbitrarily varying parameters, and thus eliminating empiricism. Further, the results show the capability of the developed methodology and presents opportunities to explore other problems such as thermal dispersion, particulate fouling and foam structure optimization.



Representative elementary volume for open-cell foam model.

Permission Granted
Credit: S. Krishnan, S.V. Garimella, and J.Y. Murthy

Primary Goal Indicators:
Contributions

Secondary Goal Indicators:
Connections

This work is notable because
A novel computational methodology for direct numerical simulation of open-cell foams and heat pipe wicking structures has been developed in a project conducted by Drs. Jayathi Murthy and Suresh Garimella of Purdue University. This comprehensive model predicts the thermal and flow characteristics of foams and particle beds, which are in excellent agreement with published measurements. The results show the capability of the developed methodology and presents opportunities to explore other problems such as thermal dispersion, particulate fouling, and foam structure optimization.

Other Indicators (Is this work transformative or multidisciplinary?):

This work involves transformative research.
The work predicts the properties of foams and particle beds as they are affected by friction and other conditions.

ENG/EEC 2006

Program Officer: Alex Schwarzkopf

NSF Award Numbers:

0217364
Award Title: Compact High Performance Cooling Technologies Research Center - An Operating Center Proposal for an NSF I/UCRC
PI Name: Suresh Garimella

Institution Name: Purdue University

PE Code: 5761

NSF Contract Numbers:

Submitted on 03/06/2006 by Glenn H. Larsen
EEC: Approved 03/06/2006 by Gary A. Gabriele
ENG: Approved 03/06/2006 by Joanne D. Culbertson

Undergraduate Research On Nanodevices
Highlight ID: 11920

Nanostructural organization can produce colors by coherent scattering alone. Prior experiments in other laboratories have shown nanostructures to be the cause of coloration in different animals, showing that differences in hue between different areas of the skin are achieved by size and spacing of dermal collagen fibers.

In this project the long held belief that iridescent coloration in the male peacock feather is achieved by mere pigmentation was investigated, with an alternative explanation being proposed that this coloration is created instead by nanostructural organization. To understand the color production, incoherent or coherent light scattering techniques were used. Male peacock feathers were examined for coherent light scattering in arrays of fiber and dermal collagen. Scanning Electron Microscopes, Tunneling Electron Microscopes, and spectroscopy was used for the experiments in the search for natural nanostructures.

Male Peacock

Permission Granted
Credit: PI William Brown, Co-PI Greg Salamo, Directors Ron Foster and Ken Vickers

The goal of this study was to determine if it is possible for feather color to be determined by nanostructures and if it is possible then to understand why this effect occurs. Possible societal implications of this work would be the creation of new materials that could be embedded in clothing for reasons as diverse as fashion coloration or military camouflage.

In this study structures were found at the nanoscale level in a male peacock feather that are believed to create the iridescence qualities in that bird. These nanostructures were compared with those found in Blue Jays. Clear differences were observed between the two birds feathers; the peacocks structures were very organized and symmetrical, while the blue jays structures were irregular and not well organized.

Further studies of male peacock feathers from different age birds are planned in the near future to determine if the nanostructures identified in this study are created at the feather surface, or if instead they are formed at the center of the feather and then migrate to the outer surface as the bird ages. Calculations will also be performed to compare the observed color of the feather from different angles with the predicted interference colors resulting from incident angle-caused nanostructure spacing variation.

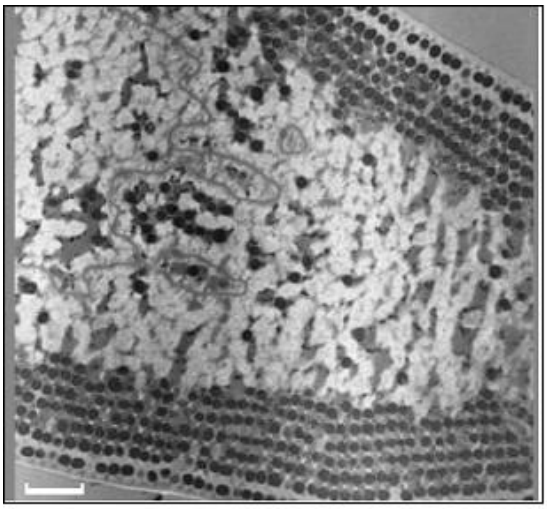


Figure 1: TEM Image of Male Peacock Feather (one micron scale bar)

Figure 1 displays the TEM image of a feather cross section, with the white scale line at the bottom left corner of the picture indicating one micron. The black dots arrayed in about six rows with even spacing at the outside edge of the feather are nanostructures. Non-organized nanostructures can also be observed at the center of the feather.

Permission Granted
Credit: PI William Brown, Co-PI Greg Salamo, Directors Ron Foster and Ken Vickers

Primary Goal Indicators:
Connections

Secondary Goal Indicators:
Global S&E workforce

Expand access

This work is notable because
The goal of this study was to determine if it is possible for feather color to be determined by nanostructures and if it is possible then to understand why this effect occurs. Possible societal implications of this work would be the creation of new materials that could be embedded in clothing for reasons as diverse as fashion coloration or military camouflage.

Other Indicators (Is this work transformative or multidisciplinary?):

No other indicators apply.

ENG/EEC 2006

Program Officer: Esther Bolding

NSF Award Numbers:

0244071
Award Title: Undergraduate Research on Nanodevices REU Site

PI Name: William Brown

Institution Name: University of Arkansas

PE Code: 1360

NSF Contract Numbers:

Submitted on 02/08/2006 by Esther M. Bolding
EEC: Approved 03/06/2006 by Gary A. Gabriele
ENG: Approved 03/06/2006 by Joanne D. Culbertson