Breadth of Opportunities in Electrical and Systems Engineering

Arye Nehorai
Chair, The Eugene and Martha Lohman Professor of Electrical Engineering

www.ese.wustl.edu
Outline

• ESE areas and applications
• Our faculty
• Changes we made since 2006
• Flexible curricula and double degrees
• Undergraduate research projects
• Study abroad program
• Career opportunities
Preston M. Green Dept. of Electrical & Systems Engineering

Research Areas

- Applied Physics
  - Advanced Materials
  - Integrated Photonics
  - Nano-fabrication
  - Devices

- Information
  - Imaging
  - Signal Processing
  - Information Theory
  - Communications

- Systems
  - Applied Math & Stat
  - Computational Math
  - Optimization
  - Control

Washington University in St. Louis
Research Areas & Applications

Energy
- Storage, Photovoltaic Cells
- Sensor Networks
- Smart Grid, Renewable Energy, Efficiency
- Power Electronics

Applied Physics
- Advanced Materials
- Integrated Photonics
- Nano-fabrication
- Devices

Information
- Imaging
- Signal Processing
- Information Theory
- Communications

Systems
- Applied Math & Stat
- Computational Math
- Optimization
- Control

Medicine
- Sensors
- Imaging
- Genomics

Robotics
- Control, Mechatronics
- Surgery

Security & Defense
- Radar, Sonar
- Sensors, Networks
- Information Analysis
- Environment Monitoring

Systems Applications
- Biology, Medicine
- Operations Research
- Management
- Finances
1. Systems Engineer

Top 50 rank: 1
Sector: Information Technology

What they do: They’re the "big think" managers on large, complex projects, from major transportation networks to military defense programs. They figure out the technical specifications required and coordinate the efforts of lower-level engineers working on specific aspects of the project.

Why it’s great: Demand is soaring for systems engineers, as what was once a niche job in the aerospace and defense industries becomes commonplace among a diverse and expanding universe of employers, from medical device makers to corporations like Xerox and BMW.

Pay can easily hit six figures for top performers, and there’s ample opportunity for advancement. But many systems engineers say they most enjoy the creative aspects of the job and seeing projects come to life. "The transit system I work on really makes a tangible difference to people," says Anne O’Neil, chief systems engineer for the New York City Transit Authority.


“I feel like I have a positive impact on people's lives because I'm helping them get where they need to go. It's exciting, hands-on work.”
Electrical Engineering Examples

Global Positioning System (GPS)  
Magnetic Resonance Imaging (MRI)  
Video Cameras  
Devices: iPads and iPhones  
Smart Grid  
Robots

Degrees We Offer

• **BS**
  – Electrical Engineering
  – Systems Science & Engineering
  – Applied Science Major in EE
  – Applied Science Major in SSE

• **Minors**
  – Electrical Engineering
  – Robotics
  – Mechatronics
  – Energy Engineering
What Makes ESE Unique

- Structure: combination of Electrical & Systems Engineering
- Education and research are well grounded in: math, physics, statistics; as well as classical EE and control systems
- Providing in-depth, broad, and flexible education
- Preparing for adaptation to changes and global awareness
- Applications to solving societal problems in health, security, defense, energy and environment
Meet the Faculty

Applied Physics

Daniel L. Rode
Jung-Tsung Shen
Barry E. Spielman
Lan Yang

Information Processing

R. Martin Arthur
Paul S. Min
Robert E. Morley
Arye Nehorai
Joseph A. O'Sullivan

Systems Science and Applied Mathematics

ShiNung Ching
Humberto Gonzalez
Jr-Shin Li
Hiro Mukai
Heinz M. Schaettler
Professor of Practice and Lectures

Professor of Practice

Dennis Mell

Lecturers

Vladimir Kurenok  Jason Trobaugh  Martha Hasting  Randall Brown
Faculty Awards (2006 - 2011)

New Faculty

- **Dr. Jr-Shin Li** received the NSF CAREER Award in 2007 and the AFOSR Young Investigator Award in 2010
- **Dr. Lan Yang** received the NSF CAREER Award in 2010 and the Presidential Early Career Award for Scientists and Engineers in 2011
- **Dr. Arye Nehorai** received the 2006 Technical Achievement Award and the 2009 Meritorious Service Award from the IEEE Signal Processing Society

Other Faculty

- The late **Dr. Chris Byrnes** received the 2008 Hendrik W. Bode Lecture Prize from the IEEE Control Systems Society
- **Dr. T. J. Tarn** received the 2009 George Saridis Leadership Award in Robotics and Automation from the IEEE Robotics and Automation Society, the 2010 Einstein Chair Professorship Award from the Chinese Academy of Sciences, and the 2010 John R. Ragazzini Award from the American Automatic Control Council
Selected Recent Publications


Faculty Research and Leadership
MURI: Adaptive Waveform Design for Full Spectral Dominance

Arye Nehorai

- **Leading** multiuniversity research initiative (MURI), team from WUSTL, ASU, Harvard U, U of Maryland, Melbourne U*, Princeton U, Purdue U, UIC, and Raytheon*

- **Goal:** Adaptive optimal design waveforms for radar and communications

- **Approach:**
  - Electromagnetic modeling
  - Waveform mathematics
  - Statistical signal processing
  - Optimization

- **DoD/AFOSR funding:** $5.5m, 2005 to 2010

* Externally funded
Changes We Made (2006-2011)

• Hired new faculty
• Improved the instruction
• Renovated our electronics lab
• Introduced new minors in Mechatronics and Energy
• Introduced and revised courses and labs
• Made EE senior design more flexible
• Expanded undergraduate research projects
• Collaborated with industry on projects
• Created study abroad programs
• Revitalized the IEEE student chapter
ESE Undergraduate Enrollments

TOTAL: considers FR, SO, JR, SR, and GRAD students; GRAD: fifth-year students in BSMS programs.
TOTAL: considers FR, SO, JR, SR, and GRAD students; GRAD: fifth-year students in BSMS programs.
Percentage of Female ESE Undergraduates

FL02 FL03 FL04 FL05 FL06 FL07 FL08 FL09 FL10 FL11

SSE
ESE
EE
New Courses

We introduced:

• ESE 101 Intro to Engineering Tools: Matlab and Simulink, Spring 2010
• ESE 103 Introduction to Electrical Engineering, Fall 2009
• ESE 251 Introduction to Systems Science and Engineering, Fall 2010
• ESE 297 Introduction to Undergraduate Research Projects
• ESE 437 Sustainable Energy Systems, Spring 2010
• ESE 497 Undergraduate Research, Fall 2007
ESE297 Introduction to Undergraduate Research Projects

• 2 Credits – open to students at all levels – CSE131 is the only prerequisite

• Hands on experience robots, computers, acoustic sensors, EEG sensors and 3D cameras
ESE297 Introduction to Undergraduate Research Projects (Cont.)

- Implement real-time signal proc. algorithms, with data acquisition on computers and robots
- Learn to use LabVIEW, LabVIEW Real-Time, Matlab and BCI2000
- Design, build and verify an acoustic source location project and a Brain Computer Interface project
- Good design experience for subsequent semesters
Revised Courses

We revised:

- ESE 230 Intro to Electrical & Electronic Circuits (added lab), Fall 2008
- ESE 331 Electronics Laboratory, Fall 2010
- ESE 435 Electrical Energy Laboratory, Spring 2011
Electronics Lab Renovation (2008)

Bryan 306:

• Renovated 16 stations

• Purchased oscilloscopes, function generators, spectrum analyzers, power supplies, computers, and digital multimeters
Electronics Lab Renovation (2008) (Cont.)

Bryan 316:

- Purchased state-of-the-art National Instruments NI-Elvis II teaching platform and a dual-channel USB-based oscilloscope
- This enables students to master the concepts instead of dealing with the complexity of traditional equipment operation

We spent $275k on the renovation ($114k for equipment)
Goals: Hands-on lab experience in the applications of electromagnetic principles, design challenges

Cost: We spent $60K on purchasing new commercial vector analyzers
ESE 331 Revitalization (2010) (Cont.)

Highlights:

• Familiarization with a commercial Vector Network Analyzer
  − calibration procedures
  − measurements of commercial components in 2-4 GHz

• Design, fabrication and testing of a microstrip 20 dB directional coupler for use on PCBs
  − microstrip 20dB directional coupler for use on PCBs
  − branch line microstrip quadrature hybrid

• Design, use, and testing of cell-phone band antennas
ESE 435 Revitalization (2011) (Cont.)

Renewable Energy and the Smart Grid

- Photovoltaics (PV) – characterization of single cells and operation in PV arrays
- Energy storage (batteries) – characterization and charging/discharging algorithms
- DC-AC Inverters – inverter algorithms, including pulse-width modulation (PWM)
- DC-DC converters – algorithms and implementation, adaptations for DC-AC

Source: Western USA interconnection (pacific Intertie); ABB, http://www.abb.com
Flexible Curricula and Double Degrees
BS EE Curriculum: Flexible

Courses

<table>
<thead>
<tr>
<th>Courses</th>
<th>Credits</th>
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<tr>
<td>Pre-Req/General:</td>
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<tr>
<td>Required CS Course:</td>
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<tr>
<td>CSE 131 or 126</td>
<td>4 or 3</td>
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<tr>
<td>EE Breadth:</td>
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<tr>
<td>Chosen from engineering or sciences outside EE</td>
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<tr>
<td>Required EE Courses:</td>
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<tr>
<td>ESE 230, 232, 260, ESE 317, 326, 330, 351, ESE 498.</td>
<td>26</td>
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<td>Upper-level EE Laboratories:</td>
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<tr>
<td>Two chosen from: ESE 331, ESE 435, 447, 448, 465, 488</td>
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<tr>
<td>Elective EE Courses:</td>
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<tr>
<td>Chosen from: ESE 330-399, ESE 400, 402, 405, 407, 409, 425, 430-499, ESE 503-589</td>
<td>15</td>
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<tr>
<td>Non-ESE Engineering Elective:</td>
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<tr>
<td>ESE 141 Intro. Robotics:</td>
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<tr>
<td>Humanities and Social sciences:</td>
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<td>18</td>
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<tr>
<td>Free Electives:</td>
<td>11 or 12</td>
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<td>Total</td>
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Students must complete a selection of courses for which the accumulated engineering topics is 45 units. Also certain restrictions apply about the total number of credits of ESE 400 (independent study) and ESE 497 (undergraduate research.)
### BS SSE Curriculum: Flexible

#### Bachelor of Science in Systems Science and Engineering (Sample Program)

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 1</th>
<th>Year 2</th>
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<th>Year 3</th>
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<td><strong>Fall</strong></td>
<td><strong>Spring</strong></td>
<td><strong>Fall</strong></td>
<td><strong>Spring</strong></td>
<td><strong>Fall</strong></td>
<td><strong>Spring</strong></td>
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<td>(3 Credits)</td>
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<td>(3 Credits)</td>
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<td>(3 Credits)</td>
<td>(1 Credit)</td>
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<tr>
<td><strong>Pre-Req/General:</strong></td>
<td><strong>Required CS Courses:</strong></td>
<td><strong>Outside focus:</strong></td>
<td><strong>Required SSE Courses:</strong></td>
<td><strong>Upper-level SSE Laboratory:</strong></td>
<td><strong>Elective SSE Courses:</strong></td>
<td><strong>Non-ESE Engineering Elective:</strong></td>
<td><strong>Humanities and Social sciences:</strong></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
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</tbody>
</table>

Students must complete a selection of courses for which the accumulated engineering topics is 45 units. Also certain restrictions apply about the total number of credits of ESE 400 (independent study) and ESE 497 (undergraduate research.)
Double Degrees or Majors

- Due to the ESE curricula flexibilities, students can complete **double degrees** in 4 years with, e.g.:
  - **Biomedical Engineering**
    * BS in EE or SSE and BS in BME
  - **Computer Engineering & Computer Science**
    * BS in EE and BS in CoE or CSE
  - **Chemical Engineering**
    * BS SSE and BS ChemE

- Students can also complete **double majors** in 4 years, e.g.:
  - BS (in any other program) with second major in Systems Science
  - BS in SSE with second major in Finance

- Students can also complete a **pre-medicine program** while pursuing a degree in 4 years: BS in EE or SSE with pre-medicine

For details visit the ESE website
Preston M. Green Dept. of Electrical & Systems Engineering

Double Degrees: BS EE and BS BME
Preston M. Green Dept. of Electrical & Systems Engineering

Double Degrees: BS SSE and BS BME

Bachelor of Science in Systems Science & Engineering and Bachelor of Science in Biomedical Engineering (Sample Program)
Double Degree: BS in EE and BS in SSE

<table>
<thead>
<tr>
<th>Year 1</th>
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<th>Year 2</th>
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<th>Year 3</th>
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<tbody>
<tr>
<td>Fall</td>
<td>Spring</td>
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<td>Spring</td>
<td>Fall</td>
<td>Spring</td>
<td>Fall</td>
<td>Spring</td>
</tr>
<tr>
<td>Math 132 Calculus II (3 Credits)</td>
<td>Math 233 Calculus III (4 Credits)</td>
<td>Math 217 Differential Equations (4 Credits)</td>
<td>ESE 317 Engineering Mathematics (4 Credits)</td>
<td>ESE 330 Engineering Electromagnetics Principles (3 Credits)</td>
<td>Laboratory EE (3 Credits)</td>
<td>ESE 448 Systems Engineering Lab (3 Credits)</td>
<td>ESE 498 Senior Design Laboratory (3 Credits)</td>
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<tr>
<td>Physics 117A General Physics I (4 Credits)</td>
<td>Physics 118A General Physics II (4 Credits)</td>
<td>ESE 230 Intro to Electric Circuits (4 Credits)</td>
<td>ESE 232 Intro to Electronic Circuits (4 Credits)</td>
<td>ESE 260 Intro to Digital Design (3 Credits)</td>
<td>Engr 310 Technical Writing (3 Credits)</td>
<td>ESE 499 Systems Engineering Design Project (3 Credits)</td>
<td>Elective EE and SSE (3 Credits)</td>
</tr>
<tr>
<td>CSE 131 Computer Science I (3 Credits)</td>
<td>Intro Engineering Course (3 Credits)</td>
<td>Chem 111A General Chemistry I (3 Credits)</td>
<td>ESE 326 Probability and Statistics (3 Credits)</td>
<td>ESE 403 Operations Research (3 Credits)</td>
<td>ESE 441 Control Systems (3 Credits)</td>
<td>Undergraduate Research EE/SSE (2 Credits)</td>
<td>Elective Free (3 Credits)</td>
</tr>
<tr>
<td>Intro Engineering Course (3 Credits)</td>
<td>ESE 309 Matrix Algebra (3 Credits)</td>
<td>Chem 151 General Chemistry Laboratory (2 Credits)</td>
<td>CSE 241 Algorithms and Data Structures (3 Credits)</td>
<td>Undergraduate Research EE/SSE (2 Credits)</td>
<td>Undergraduate Research EE/SSE (2 Credits)</td>
<td>Elective EE and SSE (3 Credits)</td>
<td>Elective Free (2 Credits)</td>
</tr>
<tr>
<td>Elective Social Science or Humanities (3 Credits)</td>
<td>ESE 251 Intro to Systems Science and Engineering (3 Credits)</td>
<td>Elective Social Science or Humanities (3 Credits)</td>
<td>ESE 351 Signals and Systems (3 Credits)</td>
<td>Elective Free (3 Credits)</td>
<td>Elective Free (3 Credits)</td>
<td>Engr 4501 Engineering Ethics and Sustainability (1 Credit)</td>
<td>Elective Social Science or Humanities (3 Credits)</td>
</tr>
<tr>
<td>EE Requirements</td>
<td>SSE Requirements</td>
<td>EE/SSE Electives</td>
<td>EE/SSE Research</td>
<td>EE/SSE Requirements</td>
<td>EE/SSE Research</td>
<td>EE/SSE Requirements</td>
<td>EE/SSE Requirements</td>
</tr>
</tbody>
</table>

Update to Fall 2011 requirements.
Advantages of Double Degrees

Graduates with double degrees benefit from the following advantages compared with their single-major peers.

• They have more job options and they stand out.

• They are in greater demand as new technologies require multi-disciplinary knowledge.

• With broader knowledge, they will be more creative.

• They will be able to adapt more easily to changes in the market.
Undergraduate Research Projects
Undergraduate Research Projects

Recent changes:

• We expanded the number and scope of undergraduate research projects

• Created collaborations with industry (Boeing, Brasch Manufacturing, LS Power, TranSwitch Corporation)

• Created multi-team Robotic Sensing projects

Awards:

• Joshua York (BSEE 2009) received the First Place Award in the Saint Louis Area Undergraduate Research Research Symposium, April 2009
ESE Laboratories

State of the art facilities:

(a), (b) Renovated electronics laboratory

(c) Robotics laboratory

(d) Micro/nano photonics laboratory
Acoustic Source Localization
Joshua York, Patricio S. La Rosa, and Arye Nehorai

Goal: Build an experimental setup for estimating the acoustic-source position using a microphone array

Applications: Teleconferencing, assisted navigation

Diagram of experimental setup and graphical user interface (GUI)

First Place Award, St. Louis Area Undergraduate Research Symposium, April 2009
ESE Launching Multi-team Robotic Sensing Project

- We created a new multi-team undergraduate project entitled Robotic Sensing
- Students will take leadership roles in multi-semester projects
- Students will implement sensor systems for mobile robots that make autonomous decisions based on the sensed environment
- These systems include acoustic, chemical, RF electromagnetic, infra-red, and visual sensors
- The project is multidisciplinary, involving hardware, signal processing, imaging, control, communications, and computer interfaces
- It is led by the department chair, Dr. Arye Nehorai, with the help of our engineer Ed Richter and PhD students
Robotic Sensing – Multi-Team Project

Hardware Design

- Physical/Chemical/Biological Background
- Transducer/Sensor Selection
- Signal Conditioning (analog filter, signal amplifier)
- Data Acquisition System (sampling rate and resolution)
- Microcontroller
- Actuators (motors)

Robotic Platform

Central Processing

- Software/Interface Design
- Algorithm Design
- Graphical display of variables of interest
- Graphical User Interface (GUI) Design
- User-defined System and Algorithms parameters
- Real-time Data Processing Arquitectures
- Preprocessing Algorithms (Digital filters: FIR, IIR)
- Statistical Signal Processing Algorithms
Robotic Sensing – Multi-Team Project (Cont.)

- Microphones
- Chemical Sensors
- Ultrasound Sensors
- Infrared Sensors
- Camera Sensors
- Acoustic Vector Sensors
- Servo Motor
- Processor and Data Acquisition Board
Robotic Sensing: Current Projects

Advisor: Dr. Arye Nehorai

Microphones
Adaptive Source Position Estimation
Raphael Schwartz and Zachary Knudsen
Guide: Phani Chavali

Ultrasound Sensors
Real-time Tracking
Andrew Weins
Guide: Sandeep Gogineni

Chemical Sensors
Chemical Source Position Estimation
Anisha Rastogi and Jessi Mischel
Guide: Vanessa Tidwell

Robotic Platform
Processor and Data Acquisition Board
Servo Motor

Camera Sensors
Visual Navigation
Evan Nixon and Alex Benjamin
Guides: Sandeep Gogineni

Engineer: Ed Richter
Robotic Microphone Sensing: Robotic Platform Design and Adaptive Control Algorithms

Chase LaFont and Arye Nehorai

Goal: Design robotic platform for the microphone array and develop controller algorithms to optimize source estimation position.

Applications: Acoustic surveillance and video conferencing

Closed-loop adaptive estimation of source position
Robotic Microphone Sensing (Cont.)

Demonstration at the WUSTL Undergraduate Research Symposium, October 24th, 2009
**Ultrasonic Robot Tracking**

**Andrew Wiens and Arye Nehorai**

**Goal:** Develop an algorithm for mobile robot tracking using ultrasonic transducers

**Applications:** Autonomous robotics, defense

Andrew Wiens  
EE and CoE Class of 2013

Robot with mono-pulse tracking algorithm and implementation in Labview
Ultrasonic Robot Tracking (Cont.)

Video of demonstration at the ESE Undergraduate Research Expo, April 30th, 2010
Chemical Sensing: Odor Identification and Source Localization

Joy Chiang and Arye Nehorai

**Goal:** Identify odors using a chemical sensor array; estimate direction to a chemical source; and guide a robot in seeking out the source

**Applications:** Detecting and locating chemical leaks or chemical weapons, monitoring food freshness

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Joy Chiang
EE and BME Class of 2010

Block diagram of chemical sensor signal acquisition

Diagram showing the flow from odor sample to PC via Labview GUI, Elvis DAQ, and Figaro Sensor and Circuitry.
Source Localization using Chemical Sensing

Jessi Mischel, Anisha Rastogi, Vanessa Tidwell and Arye Nehorai

**Goal:** Develop a mobile platform to localize and pursue chemical source.

**Approach: Biological**
- Mimic shark olfactory system by creating sensor array to localize chemical sources using positional data
- Interface sensor array to mobile platform

Generating Light Sources on a Silicon Chip

Kim Venta and Lan Yang

**Goal:** Achieve ultra-high-quality micro-lasers on a silicon chip.

**Applications:** Communications and biomedicine

High throughput and high sensitivity on-chip sensing based on microlasers

Pulse-echo Methods for Determination of Broadband Ultrasonic Attenuation to Image Temperature in Tissue

Chris Reale and R. Martin Arthur

Goal: Maximize the echo signal bandwidth of a programmable pulser/receiver designed at WUSTL to improve ultrasonic thermometry
Automated Music Generation for Sight Reading
Kevin McKee and Boaz Porat

Goal: Develop a computer program that automatically generates music

Application: Musical education

Kevin Mckee, EE Class of 2008, presenting his project at the Spring UGR Symposium 2008

Graphical user Interface (GUI) illustrating an example of a generated music by the software
Renewable Energy Resources: A Feasibility Study
Naitik Bhatt, Jessica Stigile, Joshua York, and Arye Nehorai

In collaboration with LS Power

Goal: Determine feasible sites for wind/PV solar development considering the availability of resources, current land use, legislation, environmental impacts, load demand, and cost

Experimental Process

NREL Resource Availability Raw Data Maps

NREL Wind Generation Tables
MATLAB: Calculate actual Capacity Factor (CF)
Excel: Calculate CF from actual Irradiance
Database Data and zone by CF
Define/Quantify Obstacles to green energy development
Create Map/Rating System for developers

NREL Solar Irradiance Maps

Naitik Bhatt       Jessica Stigile
CE Class of 2010   SSE Class of 2010
Optimal Policy Design on Carbon-Climate
Jessica Stigile, Alexandra Silva, Lindsay Aronson, Justin Ruths and Jr-Shin Li

**Goal:** Construct an optimal control model to derive optimal emission policies for mitigating climate change

Sample output of the webservice built to perform the optimizations
Autonomous E-Car
Evan Nixon, Alex Benjamin, Sandeep Gogineni and Arye Nehorai

Goals:
• Navigate campus autonomously
  − Obstacle avoidance
  − Road detection
  − Irregular intersections
  − Differing light conditions
• GPS, Compass and Camera integration

Approach:
• Interface car with computer
• Sensors to get car information
• Edge detection algorithms
Brain-computer Interfaces

Goal: Detect signal features of intents from EEG

Applications: Rehabilitation, assistive technology, remote control

Approach:
- Develop statistical protocols to analyze EEG
- Implement and optimize spectral estimation
- Demonstrate performance via mobile robotic platform control

From left: Jenny Liu (EE/BME 2013), Tim Greer (SSE/Applied Math 2014), Charles Holmes (EE 2012), Mark Wronkiewicz (BME 2012), Sam Fok (EE/BME 2011), Thane Somers (ME 2013), Colleen Rhoades (SSE/BME 2013), Amanda Spencer (EE/BME 2013), and Elad Gilboa (EE PhD Student)
Head-computer Interface for Robot Control
Sam Fok, Amanda Spencer, and Yongjia Liu
Eye Tracking to Help ALS Patients with Writing
Sana Naghipour, Saba Naghipour, Phani Chavali and Arye Nehorai

**Goal:** Develop a device for tracking pupil position

**Applications:** Help a patient write or draw using his/her eye movements

**Approach: Color Intensity Based**
- Divide each frame into several blocks of smaller sizes
- Compute the average intensity of each block
- Compute the centroid of the block with smallest intensity and declare that as the location of pupil

August 2011: Preliminary results obtained using a 15sec video recorded using an infrared camera.
Autonomous Quadrocopter

Eitan Babcock and Arye Nehorai

Goal:
• Design and build an autonomous four-rotor helicopter (quadrocopter)

Approach:
• Use inputs from gyroscope and accelerometer sensors to stabilize flight

Additional Sensors:
• Add other sensors such as cameras and ultrasound transducers to the mobile platform
Measuring Localized CO$_2$ in Microgravity

Christie Powers, Andrew Wiens, Alex Mentch, Katie Burlingame, John Menze, Hans Runge, and Ricky Marcus

**Goal:** To determine the persistence of exhaled CO$_2$ in the oral/nasal region in microgravity

**Applications:** Environmental and astronaut health monitoring onboard the International Space Station

**Approach:**
- Develop system to measure CO$_2$ cloud in 1-g and microgravity environments
- Collect data from both environments
- Analyze to determine persistence relative to ambient conditions
Undergraduate Research Projects (Cont.)

Total number of enrollments in ESE 400 and ESE 497
“Your dreams, our reality” has become the club’s new motto. With all of the participating students contributing program ideas and getting involved in the planning process, so far Feiereisen and his team have turned several dreams into realities.

IEEE makes a comeback, Student Life
IEEE Student Branch
Vertigo Dance Floor Project

**Goal:** Design, build, and market an interactive LED dance floor that is sensitive to pressure as well as beats in music

**Approach:**

- **Electrical Engineering:** Switching power supply design and schematic/PCB layout design
- **Computer Engineering:** Designed hardware communications module in VHDL
- **Computer Science:** High-level programming in Java to enable GUI control, custom animations, and detection of beats
- **Mechanical Engineering:** Designed plastic and wood structure in AutoCAD and manufactured parts on a homebuilt CNC machine
Demonstration at Vertigo, the Annual All-school Dance party hosted by WUSTL Engineering Council
IEEE Student Branch Awards

- The WUSTL branch was named the IEEE Outstanding Student Branch by:
  - EEE St. Louis Section, 2009
  - IEEE Region 5, 2010
- The WUSTL branch placed second in the IEEE Region 5 Ethics Competition, April 2010
- Jeffrey Feiereisen (BSEE 2010) received the Outstanding Student Member Award from:
  - IEEE St. Louis Section, 2009
  - IEEE Region 5, 2010
- Andrew Wiens and Aaron Mosher received First Place at the annual IEEE St. Louis Section Black Box Competition, December 2010
International Experiences
Undergraduates at Micro-Robot Contest in Japan


- **Goal:** Design and build several micro-robots, 1 cubic cm, fitting specified challenges

- **ESE Advisor:** Professor Tzyh-Jong Tarn

- **Host:** Professor Toshio Fukuda, Nagoya University
Undergraduates at Micro-Robot Contest in Japan (Cont.)

Left: Kate Stambaugh (SSE 09), Professor Toshio Fukuda, and Joshua York (EE 09), Nov. 2008

Top right: Schematic of micro-robot.
Bottom right: Final prototype

Left to right: Erik Brinkman, Kara Sikorski and Austin Jones, Nov. 2009
ESE Study Abroad Programs
Summer 2009: Tubingen, Germany

- We created a study abroad program in summer 2009
- Six ESE undergraduate students participated
- **Topic:** Introduction to multimodal imaging
- **Host:** University of Tübingen MEG-Center, and the Max Planck Institute for Biological Cybernetics, Germany
Summer 2009: Tubingen, Germany (Cont.)

- **Period:** May 11, 2009 – May 15, 2009
- One unit of credit, with the option to continue working on an independent study or undergraduate research course
- Lectures, projects, lab visits, and social programs
- Final report
- Acknowledgment: We are grateful to the donor for his generous support that made this program possible
Exploring Tubingen downtown.

From left to right: Jennifer Sisto, Zeynep Esin, Michael Steinbock, Ian Beil, Patricio S. La Rosa, Jessica Stigile, and Jeffrey Feiereisen

Jeffrey Feiereisen (BSEE 2010) uses magnetoencephalography (MEG) device and Jennifer Sisto (BSSS 2010) tests a transcranial magnetic stimulation device (TMS).
Summer 2010: Haifa, Israel

• We created a new study abroad program at the Technion, Israel, in May 2010. Thanks to the donor

• Eleven students were selected to participate

• They visited the laboratories of Control and Robotics, Signal and Image processing, and Network Biology in the Department of Electrical Engineering

• Also visited Departments of Aerospace Engineering, Biomedical Engineering, Computer Science, and Mechanical Engineering of the Technion
At the Control and Robotics Laboratory of the Technion

Visiting the old city of Acre
Summer 2012: Tel Aviv, Israel

• Nine undergraduate students from the department participated in this international experience on May 23 – May 30, 2012

• Students visited Tel Aviv University to learn about the state-of-the-art research being performed there

• The group also visited three high-tech companies in the region: Verint, PrimeSense, and Motorola Mobility

• Students also toured the country and experienced local culture
Summer 2012: Tel Aviv, Israel (Cont.)

The group at Tel Aviv University

Learning about echolocation research
Career Opportunities
Our graduates are highly sought after and have exciting positions in:

- Academia
- Aerospace
- Computers & communications
- Data storage
- Defense
- Electronics
- Energy and power
- Finances
- Medical imaging
- Physical layer communications
- Semi-conductors & solid-state electronics
Examples of Companies Employing ESE Graduates:

- **Energy**: Exxon
- **Defense**: Northrop Grumman, Raytheon, Boeing
- **SemiGov Lab**: APL, Lincoln Lab, JPL
- **Finance**: Bank of America, Citi Group, NISA Investment Advisors
- **Auto**: Honda of America
- **Consulting**: Accenture, Corporate Executive Board, Deloitte Consulting, CRB Consulting Engineering
- **Food**: Anheuser-Busch, Nestlé (USA & Canada)
- **Health Care**: Cerner, Proctor & Gamble, Computerized Medical Systems
- **Communications**: GeoEye
- **Engineering**: Burns & McDonnell, Jacobs Engineering
- **Government**: U.S. Patent & Trademark Office
Successful Alumni Leaders

• Numerous are founders or CEO's of companies

• Dr. John Sommerer, Head of Space Department, Johns Hopkins University Applied Physics Laboratory

• Mr. Zachary Lemnios, Assistant Secretary of Defense for Research and Engineering of the US Department of Defense

• Dr. T. Alan Hurwitz, President of Gallaudet University

• Three are Deans of Engineering

• One faculty member at Harvard, UIUC, UCLA, Notre Dame, Texas A&M

• Two are faculty members at each of: Stanford, Georgia Tech, and Carnegie Mellon University
Additional Information

• ESE department web site:
  http://www.ese.wustl.edu

• ESE undergraduate program:
  http://ese.wustl.edu/undergraduateprograms/Pages/default.aspx

• ESE undergraduate research:
  http://ese.wustl.edu/Research/Pages/undergraduate-research.aspx

• Hall of Fame:
  http://ese.wustl.edu/people/Pages/AlumniHallofFame.aspx

• Alumni news:
  http://ese.wustl.edu/people/Pages/Alumni.aspx
Preston M. Green Dept. of Electrical & Systems Engineering

The Preston M. Green Hall
The Preston M. Green Hall
Summary

- Unique structure: EE and Systems
- Broad, in-depth, and flexible curricula allowing:
  - Double degrees with BME, CoE, ChemE
  - Double major with CS, Finance
  - Pre-Medicine program
- Growth in electrical and systems technologies and applications
- Graduates are highly sought after
- Department has strong reputation and alumni
Questions?