CURIE Academy 2014
Design Project: Exploring an Internet of Things

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http://www.csl.cornell.edu/curie2014
CURIE Design Project Sponsors

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Laboratory facilities provided by the School of Electrical and Computer Engineering at Cornell University
CURIE Design Project Staff

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- Olivia Gustafson, ECE Senior
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- Laura Johnson, ECE Ph.D.
- Christopher Torng, ECE Ph.D.
- Jon Tse, ECE Ph.D.
ECE is the Study and Application of Electricity, Micro-Electronics, and Electro-Magnetism

Power Systems

- Smart Grid and Smart Buildings
- Atmospheric Science

Telecomm

- Information Theory
- Network Protocols and Optimization

Signal Processing

- Image, Audio, Video Processing

Electrical Devices

- Opto-Electrical Devices
- Micro-Electro-Mechanical Devices

Computer Engineering

- Control Theory
- Robotics
- Computer-Aided Design
- Analog and Digital Circuits

Electrical Circuits

- Bio-Electrical Engineering
- Systems and Synthetic Biology

Fusion and Plasma Physics

- Fusion and Plasma Physics
Cornell was founded because of ECE!

**Samuel Morse** invented the telegraph (a digital communication device), but needed help building the network.

**Ezra Cornell** built the first telegraph line (the beginning of telecommunications), and invested in the Western Union Telegraph Co.

"What hath God wrought?"

Ezra Cornell’s investments created the fortune that eventually enabled the founding of Cornell University.
“Optional Homework”

- Visit the statue of Ezra Cornell on the Arts Quad
- Does something on the back of the statue relate to ECE?
Computer Engineering

- Power Systems
  - Smart Grid and Smart Buildings
  - Atmospheric Science
- Telecom
  - Information Theory
  - Network Protocols and Optimization
- Image, Audio, Video Processing
- Signal Processing
- Electrical Devices
  - Opto-Electrical Devices
  - Micro-Electro-Mechanical Devices
- Fusion and Plasma Physics
- Control Theory
- Robotics
- Computer-Aided Design
- Analog and Digital Circuits
- Electrical Circuits
- Bio-Electrical Engineering
- Systems and Synthetic Biology
In its broadest definition, computer engineering is the development of the abstraction/implementation layers that allow us to execute information processing applications efficiently using available manufacturing technologies.
Monday Lab Session

Computer Engineering – Hardware Perspective

- Application
- Algorithm
- Programming Language
- Operating System
- Instruction Set Architecture
- Microarchitecture
- Register-Transfer Level
- Gate Level
- Circuits
- Devices
- Technology

Boolean logic gates and functions
Combining devices to do useful work
Resistors, LEDs, Transistors
Monday Lab Session

Computer Engineering – Hardware Perspective

How data flows through system, specifically how to do binary addition

Application
Algorithm
Programming Language
Operating System
Instruction Set Architecture
Microarchitecture
Register-Transfer Level
Gate Level
Circuits
Devices
Technology
Tuesday Lab Session
Computer Engineering – Software Perspective

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- Mobile Robot Control Application

Robot starts in this quadrant
12"x12" Target

Robot wanders environment searching for target
Tuesday Lab Session
Computer Engineering – Software Perspective

Finite-state-machine control algorithm

Arduino-code to implement algorithm

```
// Move forward for two seconds

digitalWrite( pin_motor_left_dir, LOW );
digitalWrite( pin_motor_right_dir, LOW );
analogWrite( pin_motor_left_speed, 100 );
analogWrite( pin_motor_right_speed, 100 );
delay(2000);
```
Tuesday Lab Session

Computer Engineering – Software Perspective

Arduino machine instructions

00000100 <loop>:
100: push r28
102: push r29

# load values from memory into registers
104: lds r24, 0x0103
108: lds r25, 0x0102

# do the actual addition
10c: add r24, r25

# store sum from register to memory
10e: sts 0x0104, r24
Lab Sessions on Computer Engineering

Lab 1
Hardware pushing towards software (EE,CE)

Lab 2
Software pushing towards hardware (CS,CE)

Computer Engineering

- Application
- Algorithm
- Programming Language
- Operating System
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The “Traditional” Internet

Human beings must collect, enter, publish, and analyze almost all of the information that is transmitted over the Internet.
Emerging Trend Towards an Internet of Things

Interconnected "things" augmented with inexpensive embedded controllers, sensors, actuators to collect information and interact with the world.
CURIE IoT Design Projects

Internet of Things (IoT) involves connecting various physical objects to the internet, enabling them to communicate and exchange data. IoT consists of two main components:

1. **IoT Input Device**: This is the device that interacts with the physical world through sensors or other input modules. IoT Input Modules (sensors) collect data from the environment.

2. **IoT Output Device**: This is the device that transmits data to the physical world through displays or actuators. IoT Output Modules (displays, actuators) facilitate the interaction between the virtual and physical worlds.

3. **IoT Cloud**: The IoT Cloud acts as the central hub, processing and connecting the data from input devices to output devices. It supports data analysis, decision-making, and control functions.

This diagram illustrates the flow of data from input to output devices, integrated by the IoT Cloud, showcasing the core principles of the Internet of Things.
CURIE Group 1

Private Device
Product ID: ltWzhIAw96x_uUq09j5
Product Secret: f70bfc57a3c5d15797a5e0cc8f4eb3e45204875
Serial Number: 67T24EF4D23Y
Activation Code: 12a26b7d2bba920c03a8aa0323011a1796a83c

Activated at 10-07-2014 10:11:01

Feed ID: 1109083764
Feed URL: https://xively.com/feeds/1109083764
API Endpoint: https://api.xively.com/v2/feeds/1109083764

Channels
Last updated 3 minutes ago

Request Log

<table>
<thead>
<tr>
<th>Status</th>
<th>Method</th>
<th>Endpoint</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>GET</td>
<td>channel test_value</td>
<td>00:23:1-0400</td>
</tr>
<tr>
<td>201</td>
<td>POST</td>
<td>feed</td>
<td>00:23:13-0400</td>
</tr>
<tr>
<td>200</td>
<td>GET</td>
<td>channel counter</td>
<td>00:23:04-0400</td>
</tr>
<tr>
<td>200</td>
<td>PUT</td>
<td>channel counter</td>
<td>00:23:03-0400</td>
</tr>
<tr>
<td>200</td>
<td>GET</td>
<td>channel counter</td>
<td>00:23:01-0400</td>
</tr>
</tbody>
</table>

API Keys

Learn about the Deploy stage
Agenda

- Group 2 : Smart Home
- Group 7 : Wearable Health Monitor
- Group 6 : Wildlife Monitoring System
- Group 4 : Early Disaster Warning System
- Group 3 : Smart Power Distribution Grid
- Group 1 : Smart Home
- Group 8 : Wearable Health Monitor
- Group 5 : Early Disaster Warning System