Sample Senior Design Project Descriptions

Software

Cameron
**BOP Control Fluid Multi-sensor**
Devise a solution to monitoring (at the topside and subsea) the properties of the control fluid used in a BOP control system.

Cameron
**Improved electronic multiplexer used in ultrasonic flowmeters**
*Project: investigation into an improved electronic multiplexer used in ultrasonic flowmeters.*

**Background:** Many ultrasonic flow meters use multiple ultrasonic transducers arranged in pairs. Ultrasonic pulses are transmitted back and forth between the transducers of each pair and the travel time of the pulses is measured. The difference between the travel time of the pulses going upstream and those going downstream is proportional to the fluid velocity. Typically, the electronic transmitters contain a multiplexer to direct pulses from a transmitter circuit to the transmitting ultrasonic transducers. Likewise the multiplexer directs ultrasonic signals from receiving ultrasonic transducers to an electronic receiver circuit. The isolation between pairs of ultrasonic transducers is an important design parameter. Typically the isolation between an active pair of transducers and an inactive pair is 30 to 40 db. Therefore, when transmitting/receiving there are two ways that a signal can get corrupted - first during transmitting the receive transducer gets stimulated and during reception the transmitting transducer can leak back. A simplified schematic diagram of the multiplexing is attached.

**Objective 1:** The objective of this effort is to increase multiplexer isolation while keeping the multiplexer’s on-resistance low. Currently the on-resistance of multichannel multiplexers is approximately 20 ohms. There are various tricks that can be used (such as shunt paths). Multiple stages improve total isolation - with the cost of additional series resistance. The goal is to keep the "on" series resistance low. While mechanical switches have a much higher isolation and low on-resistance, the high pulse repetition rate of 100 cycles per second and the desired 20 year life preclude the use of mechanical switches.

**Objective 2:** The transmit signal is frequently chosen to be a “full” on (positive supply voltage) or “full” off signal (zero volts or negative supply). The goal is to be able to use the full amplitude supply - but construct an arbitrary transmit signal. Supply voltages are desired to be +/- 100 volts.

Cisco
**Document Sharing Application and Server Technology for Cius Tablet**
*Project Background:*
The corporate enterprise offers many unique opportunities when compared with the consumer market. In the consumer space information is often casual in nature and while security and privacy are important to consumers, protecting business critical information is rarely the primary concern.

A common use case in the enterprise is the need for users to share documents, images, videos, contacts and other information with other devices and with other users. This need has been extended to mobile devices like the Cisco Cius.
Services like “DropBox” exist today but are not always acceptable in the corporate world because the documents are stored off premises and cannot be easily managed by the end customer. On premise information sharing and storage is critical to many enterprise customers who desire the ability to share critical information between desktop and mobile devices in a secure and controlled way.

Project Description:
The goal of this project is to create a Cisco Cius targeted Android application that allows a user to share documents, images, videos and other sharable content in a secure and controlled way. The Android application should:

- Be written for the Cisco Cius using APIs compatible with Android 2.2 (froyo)
- Allow user to share content with
  - Self
  - Specific users
  - All users
- Secure user management, data transmission and storage should be a key consideration
- Application should not require root privileges, shared user IDs or platform key signatures
- Use of Open Source libraries is permitted, however, GPL 3.0 or LGPL 3.0 should not be used.

While the primary goal is to create an Android application as described above, obvious secondary requirements are:

- Identification or Creation of a server side technology used for storage and user authentication. If possible a standard, open, widely available technology should be used.
- Identification or Creation of a cross platform (Windows, Linux, MacOS) client that can be used to share information, via the server, with the Android application described above.

Deliverables:
- Detailed functional description of the requirements
- Functional design document of the proposed solution
- Prototype development and test
- Demonstration of the completed project

CSID
Network Analysis of P2P Based Malware
Analyze a P2P variant, reverse engineer its protocol, and create a spider application to allow for the identification of compromised hosts. Acquire relevant malware samples utilizing P2P protocol. Reverse engineer the samples using binary code analysis identifying external nodes. Investigate P2P network and capture details about each node in the network.

Cura Oceanus
Riverbot Ground Station Software
Cura Oceanus is designing an AUV, called RiverBot, to operate in shallow and congested inland and near coastal waterways. The overall system includes a Ground Control and Communication Subsystem. The Ground Control and Communication Subsystem is the focus of this design project.

The Ground Control and Communication Subsystem performs three key functions:

- It communicates with the submersible at a range of 10-15 meters, and up to 1 meter below the surface
- It displays telemetry and submersible information, received over the communication mechanism, and displays it for the human operators
- It provides human operators an interface to command the submersible over the communication mechanism
Intel

Cognitive Device Configurator

The approach would be to create an application capable of learning how a user interacts with his device (phone, tablet) and then know how to optimize for a specific location based on past behavior. It would understand what applications are used most often and where, and then after an initial learning period auto-configure itself for various uses such as home, classroom, Campus, movie theatre, bar etc.

The device would identify the correct location and apply the correct behavior. Configurations could include visual changes on the device such as rearranging the home screen icons, or auto-silencing, or turning off/disabling photo assist in camera, or populating most used features by others (crowd sourced). We could focus on getting the devices more personalized through learning, sensing and awareness. It could be cloud connecting or stand-alone. It also could predict or provide a more cognitive service to the user.

Qualcomm

Augmented Reality Application, Minerva

Examples of earlier projects in progress are:

1. An app that can photograph pieces of a disassembled item and provide assembly help, i.e. the next step or what to do in the assembly process.
2. An app that can photograph a checkers board and play the role of a strong opponent with the user by indicating its next move on the screen image.

Qualcomm

Augmented Reality Application for Physical Training and Exercise for Persons with Disabilities

Create an avatar-based augmented reality training coach for persons with disabilities. The coach can give guidance, instruction, and encouragement in exercise programs for a handicapped person (tailored to their specific needs and abilities). It can also record performance (say as a video) and either analyze the conformity to a standard or previous session, or send the video to an off-site coach.

School of Nursing Consultant: Janet Morrison, RN, MSN, MSCN; jmorrison@mail.nur.utexas.edu

Qualcomm

Augmented Reality Application for Persons with Disabilities or Chronic Conditions

Self-location app for people with onset of dementia or episodic orientation/location lapses. Aid for persons who suddenly realize they don’t know where they are or how they got there. Link to their family and/or care-giver or emergency response in a tiered system.

School of Nursing Consultant: Janet Morrison, RN, MSN, MSCN; jmorrison@mail.nur.utexas.edu

Qualcomm

Augmented Reality Application for Android Phone

Develop an augmented reality application for the Snapdragon MDP development platform (provided by Qualcomm to ECE). A suggested area for emphasis is school or classroom use (K-12 or university), but other apps could be acceptable.

The specific topic is left up to the student team in negotiation with their Faculty Mentor and the Qualcomm representative.
Examples of earlier projects in progress are:

1. An app that can photograph pieces of a disassembled item and provide assembly help, i.e. the next step or what to do in the assembly process.
2. An app that can photograph a checkers board and play the role of a strong opponent with the user by indicating its next move on the screen image.

**Qualcomm**

**Assembly Guide Android App using Snapdragon MDP**

Using the Snapdragon MDP (provided by Qualcomm to ECE) develop an Android phone app that can photograph pieces of a disassembled item and provide assembly help, i.e. the next step or what to do in the assembly process.

**Quorum Business Solutions**

**Mobile App to Improve Time & Expense Tracking**

The goal of this project is to build a mobile application to assist with time and expense tracking for Quorum employees. This app should provide a portable solution to efficiently capture time or expenses incurred while working on different jobs by doing the following:

1) Tracking & submitting time on a simple user interface (UI)
2) Providing a digital means of documenting expenses.

Background: Quorum Business Solutions offers software solutions and consulting services for the oil & natural gas industry. Projects range from internally funded efforts, such as major Product Releases, Quorum funded enhancements, and Sales/Marketing work, to client sponsored efforts, such as Client Product Version Upgrades, New Client software implementations, Systems Integration between Quorum Products and other 3rd party systems, Product Support Services, and Business Consulting Services.

Quorum employees often work on multiple projects and tasks while doing extensive travel. Quorum currently has an internally developed system to capture and submit billable (a.k.a. chargeable to a client) time and expenses incurred. This time and expense data is critical to accounting, billing, and overall project management activities. The current time and expense tracking system (called QASTE – Quorum Accounting System Time & Expenses) is a Microsoft Windows-based, thick client application that is used by each employee on their Windows machine both to capture time and expenses and to electronically submit those at least 2 times a month. This system needs improvement in the following two areas:

1) The manual, paper-driven effort required to support expenses submitted for that period.
2) For employees that work on many different projects/tasks, it is challenging to determine how their time was spent across multiple efforts.

**Schlumberger**

**Message Oriented Middleware (MOM)**

The process of building an Oil and Gas well site is implemented on geographically-dispersed distributed systems. These systems are interconnected via a wide range of communication links, from high-latency low-bandwidth satellite links to low-latency high-bandwidth fiber networks. Communication patterns between subsystems vary from one-to-one to one-to-many, crossing multiple security domains and mixing near real-time and bulk data transfer.

Oil and Gas drilling application developers have traditionally taken on the burden of adapting their transport protocols to the specific needs of the data they are transmitting.
MOM technologies are showing growing acceptance across a wide range of industries for solving such complex and demanding communication needs. The project looks at Message-Oriented Middleware (MOM) technologies as a fit-for-purpose solution, while promoting decoupled software architecture and asynchronous communications.

In a first phase, the project is to gather requirements based on an existing well site construction software platform. The project will then propose principles of software architecture, a standard MOM protocol and point at a specific MOM implementation.

In a third phase, the project will implement a prototype of communication system based on the chosen MOM implementation.

**Software/Hardware**

**ARM**

**ARM Processor Application (team can choose one of 6 possible)**

**Cortex-M3 vs. Cortex-M4 vs. NEON comparisons:**

This project would involve putting together a demonstration ‘package’ for highlighting the performance differences between running DSP-centric algorithms and code on Cortex-M4 vs. Cortex-M3, and maybe a comparison of similar code running on NEON. Ideally, students would generate some real-time graphics and sound in a demonstration of executing code presumably showing faster performance or less % of CPU usage, on the Cortex-M4 taking advantage of the extra DSP instruction-enabling hardware than one could expect from the Cortex-M3 without these extra instructions/hardware.

**Windowing systems of the future:**

Windowing systems of the future will be changing significantly, making use of 3D, physics, and 2D acceleration (example). We want to understand how to develop processors that perform better on such windowing systems. The goal of this project is to create a portion of a windowing system of the future, port it to an Android device, and analyze the resultant application on the Android device. This involves a good amount of high level software (i.e. OpenGL, physics algorithms, C/C++) and board level work (an ARM powered Android device, analysis tools, etc.).

**Low-power sensor nodes:**

This project investigates low-cost low-power sensor nodes based on ARM’s M-line of processors. The end goal is to come up with a plug-and-play, interchangeable system of sensors (temperature, fire/flame, gas, PIR, weight/FSR, etc.) that can be powered for a very long time with a single AA battery (or 50mAh micro li-po cells if necessary).

**Garage door indicator:**

This project is an AC-powered device that detects the status of a residential garage door – open/closed/stopped between open and closed – and transmits this to a remote battery powered display device inside the house.

**Remote control of sprinkler system using a USB wireless device:**

Most sprinkler systems have a remote control port used by the installers to test the system. Access to this port by the homeowner is limited to buying the same device the installers use. No reasonable purchasable system exists to enable the homeowner to program, initiate, and get status on the system from a remote computer. This one would be more complicated – involving interfacing to the controller (but controllers are in the $50 range) and USB wireless dongles are inexpensive as well.

**Motor controller:**

This project would prototype a new type of motor using the Cortex-M family of parts. Information at this point is confidential; however, we might be able to find a way to work within a non-disclosure framework so that students can develop the project with ARM directly.
Dell

Self-Mapping Data Center
A method is needed to track and locate the physical location of these assets. Solving this problem is a key foundational component to enabling portions of Dell’s long term data center vision.

Dell would like to develop a data center mapping solution that can be easily integrated into all Dell Enterprise products (Servers, Storage Solutions, and Networking Devices) at a minimal cost. In addition, the solution needs to span to non-Dell products so that all assets in a data center can be tracked via a single user interface.

Dell

Utilization of Phones & Tablets to interface with a Server
Dell has introduced the ability to tether a notebook to a server’s management controller (BMC) with our latest generation of servers. The BMC is a slave USB device and the notebook is a master. The BMC enumerates as a USB network device to the notebook. One can then point a browser towards the BMC’s IP address and view/modify all of the server’s configuration information.

We would like to enable the ability to tether to the BMC with phones and tablets. This becomes complicated when connecting to tablets and phones. These devices tend to enumerate as a slave device (storage for photos). There are opportunities to reverse tether slave devices. There is a tremendous amount of Android, iPhone, and USB on the go type of collateral that demonstrates several opportunities to enable the ability to be host from tablets and phones. Much of this collateral requires cracked phones. Dell obviously needs methods that are approved by the cellular carriers.

Dell

Check-In/Build Time Coding Standards Enforcement
Check in/build time coding standards enforcement. Integrate a tool into the various build and check-in systems to scan for violations of the coding guidelines and prevent a user from checking in non-compliant code.

Implement custom Lint or other static source scanning system to enforce our coding standards. That way we do not depend on manual code reviews to catch the best practice/style errors.

DigiClaim

Vehicle Surface Damage Detection
Design and prototype an optical method of detecting surface (hail and collision) damage to a motor vehicle. The output of this system will be passed to another system to determine the extent of the damage on the vehicle. These results will then be used to automate the insurance damage claims and underwriting process.

Design goals:
1. Determine preferred optical technology.
2. Develop an array of sensors that provide a 360° 3D view of the vehicle.
3. Output from said array to be in the stereo lithography (STL) file format with zero redundant data.

Desired performance:
1. Solution should have the ability to detect surface variations created by hail & collision damage, and whose output, described in project #2 [3D Vehicle Surface Image Processing] will ultimately be correlated to a matrix of repair costs.
2. Capable of detecting dents visible to the human eye.
3. Capable of obtaining results on all color surfaces, including white and black, as well as chrome.
Further Features:

4. Determine effects of adverse conditions such as wet (snow) or dirty environments.
5. Capable of operating in both indoor and outdoor environments.
6. Capable of static and dynamic sensing. I.e., fixed scanners & slow moving vehicle/fixed vehicle & slow sensors.
7. Capable of completing full car scan in no more than 5 minutes.

Dun & Bradstreet
D&B Influencer Map
"D&B Influencer Map" enables salespeople to create a graphic depiction of a company’s organizational chart. Designed primarily for tablet use, users can add people, descriptive notes, relationships in the sales cycle, and other critical information. Then, users can literally draw connections between those people, creating a highly visual map of a company.

Environmental Sentry Protection, LLC
I-LIDS Phase 2 – Remote Video Sensor
One of the applications of the I-LIDS system is to stop the spread of Aquatic Invasive Species through automated video inspection and education of boaters launching into a body of water. The current system integrates a web server/wireless MPEG4 video camera that is enclosed in hardened stainless steel housing with solar power. This transmits videos to a backend server where they are put onto a website. In some implementations a magnetic sensor detects the presence of a vehicle and powers on the camera. Field tests have proven the system changes boater behavior and provides an effective deterrent to the spread of AIS.

Limitations with this Phase 1 design include: required installation of a local Wireless Access Point vs. leveraging 3G networks in place; platform size is too large/expensive (10” diameter vs. 5” diameter desired); video camera cannot be put in sleep mode for fast wakeup from GPIO sensor; no local USB storage of video; no object recognition; no local user interface without a laptop. Some of these constraints have already been de-risked (i.e. Microprocessor video capture, storage, compression, isolation of sensor, and connectivity to 3G networks).

The goals of this project are as follows:

1. Confirm target platform will address requirements and adequate support exists
2. Object recognition within video frame including basic movement to trigger capture
3. Confirm video to MPEG-4 for efficient transmission (e.g. FFMPEG)
4. Complete magnetic sensor design using programmable microprocessor and GPIO
5. Implement a configurable sleep mode (low ma draw) 5 sec. wakeup by sensor or timer
6. Configuration of wireless radio on/off based on volume of stored data or schedule
7. Implement Webserver interface for remote management of network / camera
8. Programmable U/I w/ touch screen for configuring camera focus, network settings, etc.
9. Solar/controller/battery interface for 4 hours of inspection over 48 hours without sun
10. Record audio message that can be played back when video event is triggered

When shipped to a user with a 3G contract:

1. Customer will at site find network and run a test to confirm it will upload a video
2. Customer will confirm focus and camera settings using on screen display
3. Customer will assemble housing, external antenna, drive into ground, and install device
In operation, it will operate as follows when a boat approaches:

- Magnetic sensor triggers system to come out of sleep mode in 5 seconds
- Detected motion will tell the camera to record up to 20 seconds at megapixel resolution
- Audio message will be played
- System will store MPEG-4 captured video as file with date/location name
- System will shut down the camera and begins 3G communications with remote server
- System will send the image data from memory via FTP to a remote server
- System will close the wireless connection and sleep until triggered again
- Solar panel/controller will continually charge batteries for availability

Intel
Smart Home Assistant using LEAP Gesture Control
Traditionally, humans have utilized homes as a place of rest, shelter, and physical needs. However, with the advent of technology such as household robots, smart TVs/watches, and WiFi-enabled kitchen appliances, there has been a need for convenience of access, localized control, and automatic control [1]. We propose a "smart home assistant" using gesture control that will allow the inhabitants to not only treat their home as a place of rest, but also as a place of natural interaction [2].

Current methods of implementing “smart homes” revolve around voice commands and smartphone applications. However, loud environments can nullify the effectiveness of voice commands, and inaccessibility to smartphones, in situations such as preparing food in the kitchen, limits the use of smartphone applications. On the other hand, gestures (i.e. hand movements or signals), can conveniently work across multiple users in loud environments, and does not require physical interaction with devices such as smart phones.

Here are a couple of use cases for gesture control:

1. Simple Case: Gestures allows the user to complete several tasks regardless of time. When a person wakes up in the morning, he or she can gesture for the coffee machine to start brewing in the kitchen from their bedroom. In addition, they can gesture to start the water running in the shower, and gesture to open the door to the bathroom.
2. Broad Case/Context Awareness: Assume there are strategically placed displays and gesture control devices connected throughout the room. In the morning, the alarm rings and the person gestures to turn it off or hit snooze. To encourage the person to wake up, the gesture prompts news and weather data to pop up on the display.

Below is the equipment necessary to implement a gesture-controlled “smart home:”

1. Gesture Control Device (small enough to integrate into several places) [3] [4]
2. Microcomputer to process data from gesture control device
3. Wireless Adapter for Microcomputer
4. Appliances/Devices to be interfaced (e.g., lights, coffee machine, A/C, fridge, etc.)

Intel
Multi-Modal Speech and Emotion Recognition
It is apparent that speech has become an increasingly popular means of interacting with mobile devices. One key research area is enabling speech recognition under natural yet adverse acoustic conditions; another research topic is improving the naturalness of the interaction between the user and his/her device. This project proposal combines multiple recognition modes to improve the user experience by enhancing the accuracy of speech recognition and enabling emotion recognition.
In one scenario, speech recognition based purely on the acoustic signal becomes problematic under high noise conditions such as a moving vehicle or crowded shopping mall. It may be possible to develop a device that incorporates a microphone and acoustic speech recognizer with a camera aimed at the user that combines recognition of facial features based on images of the speaker’s vocal tract, including the lips, teeth etc. to provide hints to the speech recognition system and improve its accuracy.

In another scenario, an interactive personal assistant should attempt to recognize the emotional state of the user and tailor its responses accordingly. For example, if the user is becoming frustrated at the device, the device should detect this and provide additional help menus, soothing tone, etc. Emotion detection can be based on the manner in which the user is speaking: volume, pitch etc. It may be possible to improve the system’s accuracy by combining facial feature recognition (is the user frowning or smiling etc.) along with emotion detection based on characteristics of the acoustic signal.

**Equipment**
The required equipment for this project includes a computer, a webcam and a microphone. The students will be developing new algorithms and developing software to develop a prototype multi-modal recognition system. In some cases it may be possible to modify existing open source software such as the Sphinx speech recognition system developed at Carnegie Mellon University to incorporate additional image features.

**Student Background**
It is suggested that the students have a basic understand of signal processing of acoustic, speech and images. Some knowledge of Matlab or C might also be required.

---

**Intel**

**Board Games on TV**

**Description**
New displays dramatically change the way we interact computing devices and each other. In this project we’ll explore a new model for board games in the context of new computing devices such as smart phones, Ipads, and internet enabled large screen TVs. The goal of this project will develop a board game with a radical new user interface and to explore the new concepts in collaborative games.

**Equipment**
Android/Iphone programming environment, Android/Ipod touch devices, web-programming

**Student Background**
Object-oriented C programming (Objective C, C++), mobile programming (Android/Iphone).

---

**Intel**

**Mobile Augmented Reality (MAR) Manipulation**

We want to manipulate virtual images using gestures much like what was shown in the film Minority Report. The effort would require the development of a MAR application, combined with gesture software allowing for the ability to manipulate a virtual object. The hardware required could be as simple as a netbook, webcam, and gesture hardware along with the open source MAR software as the starting point.

**Goal:** Build and demonstrate a MAR application that shows a novel method for users to create and edit video using only visual data and gestures.
Lockheed Martin
Miniature Semi-autonomous Unmanned Aerial Vehicle (UAV) with "tight" human-in-the-loop control and sensor interface
Design and prototype a human-in-the-loop miniature flying/hovering platform and control system. Human pilot uses some form of body control input other than a joystick.

Capabilities of interest include but may not be limited to the following:
1. real-time guidance to a point (or point above at a designated altitude).
2. real-time sensing video display for the operator as well as overlaid flight information.
3. semi-autonomous operation within established constraints when human input is unavailable.
4. provisions for future growth capabilities, such as: (1) head/eye steered sensors, (2) pre-planned or on-demand designation of stationary or moving ground-based points of interest, (3) assisted or unassisted surveillance and tracking of those points.

Designing with COTS (consumer off-the-shelf) components and systems:
Explore the tradeoffs involved in applying commercial off-the-shelf (COTS) technologies to custom products. Develop the control system(s), user interface, and custom software to integrate commercial off-the-shelf (COTS) into a system supporting a joystick-less system for flying and visual situational awareness.

Develop Performance Metrics:
Develop an understanding of the use of metrics and primary figures of merit in driving technology innovation. Examples of suggested targets for metrics development include but may not be limited to the following:

- Flying/hovering control
- Stability
- Operational range
- System complexity
- Power consumption
- Mission duration limits
- System reliability
- Autonomous capabilities
- Human-vehicle interfaces
- and others of interest that are uncovered by those performing the tasks

Future Expandability and Applications:
The platform may be the subject of further development and research. Therefore, rather than providing a point design, an engineering framework that would enable rapid construction and integration of human-in-the-loop guided sensing systems like this would be more desirable. Such a framework might include the following items:

- reusable software libraries
- reusable physical components,
- flexible integration/testing environments,

A framework might be demonstrated by showing that it is possible to rapidly assemble and assess design variants and other similar systems.

National Instruments
Lightning Strike Tracker
Goal: A semi-portable device with antennas, and battery plus laptop powered system to give tracking information (direction and approximate distance) for lightning strikes at a distance greater than 10 mi and less than 1000 mi. To be used in open area, field, or building rooftop (or in a residence but not in ENS). Processing by laptop plus NI MyDAQ (2 boxes supplied) and LabVIEW.

Part A: Front end: direction finding at ELF or VLF (extremely or very low RF frequencies), NI USB DAC, and PC. The goal is to collect waveforms and correlate their features with arrival direction and distance. Visualization and analysis tools (strike data bases for comparison) are needed.

Part B: Based on collected waveforms and statistics from storms and strike clusters, design a distance and direction algorithms that can be implemented in the stand-alone system. By comparison with the National Lightning Strike database, the system can be trained through the use of learning or adaptive software.
Aside: Monitoring of these frequencies may also record various "whistlers" and other magneto-ionospheric phenomenon (some initiated by lightning strikes).

**National Instruments**

**Business and Technical Consulting for Discrete-Event Software Product**

National Instruments has developed the LabVIEW Statechart Module internally (www.ni.com/statechart) but would like to have UT students examine the technical and business aspects of the product. The product is designed to work with both real-time and FPGA hardware targets. We are interested in a market and competitive analysis along with product feedback and strategy. The students will have the chance to interview NI R&D engineers regarding the product development process. The students should evaluate the project along several key vectors of differentiation including ease-of-use, run-time performance, and memory footprint. A final presentation and report will be given to National Instruments R&D engineers, management, and marketing.

**Nuvoton Technology Corporation**

**Fitness Band System**

The objective of this project is to provide a proof of concept for a smart band fitness monitor SOC. The system can provide sense inputs for heart rate, temperature, etc. The project will involve all aspects of prototyping, PCB design, circuit design, software and firmware.

**Nuvoton Technology Corporation**

**Advanced Lighting Panel**

The objective of this project is to provide advanced lighting panels for use in a household environment. This project will be based on Nuvoton’s Nu-micro series of Cortex M0 micro-controllers, for which development boards will be provided.

Each panel should control lighting in response to touch input or to a selected set of voice commands. The response could be extended to include the execution of a pre-programmed sequence.

The panel should interface to a sensor to detect motion and presence of room occupants.

The panel should be capable of driving a RGB LED while controlling the brightness and the color using PWM control (or other means) using the device provided.

Other ideas on making the lighting panels more user-friendly and interactive are open to the student’s imagination. A few ideas that we could suggest are listed below:

- The ability to use the lighting panel as a Voice memo functions. The user can record a message into the light panel. The panel can have an indicator for the number of messages recorded and the ability to play the messages back.
- The ability for two or more much such lighting panels to communicate with each other or to a central control system (possibly through a mesh network) that could be used for security purposes
- Include the ability to control the lighting circuit by a remote application, such as a smart phone.

Nuvoton will provide…

1) Evaluation board with the voice activation algorithm along with a tuning tool to recognize commands
2) Examples of a capacitive touch sensor PCB, software including sample code
3) Off the shelf components that the students require for project completion

The project will involve all aspects of prototyping, PCB layout, circuit design, software and firmware.
Plantronics
Relaying Stress in Speech to a Headset Wearer
Use one of the existing (or add to the existing) microphones on the headset to listen to a person who is speaking to the wearer. Analyze the speech for patterns of increased or decreased stress levels and relay this information to the wearer of the headset via a voice prompt.

Pecan Street, Inc.
Plug-In Electric Vehicle (PEV) Load Demand Response
Objective: Design a system that detects if a home central HVAC system is operating and shut off PEV vehicle charging.

Purpose: During peak electric utility usage the combined electric load of HVAC and PEV charging would exceed the capabilities of the distribution system. The successful completion of this project would yield a system that would detect HVAC operation and shut off the vehicle charging.

Requirements:
1. Must work with all major types/brands of residential HVAC systems.
2. Must work with Level 2 PEV (240VAC) charging. Level 1 PEV (120VAC) demand response is not a requirement.

Pecan Street, Inc.
Residential Power Factor Correction and Harmonic Current Filtering
Objective: Design a system that would correct a residential structure power factor and minimize impact of 3, 5, 7, and 9'th order harmonic currents drawn by modern electronic loads.

Purpose: Modern switching power supplies, compact fluorescent lightbulbs, and LED lighting draw high amounts of harmonic currents when compared to traditional residential appliances. The lighting can cause up to 4-5ARMS of distortion current to be drawn from the utility grid for each house. The overall impact is that during the spring, winter and fall months when HVAC load is low a residential structure can oscillate between leading and lagging power factor, and overall noisy current drawn from the grid. The successful completion of this project would yield a system that would correct for these issues.

Requirements:
1. Must work for a residential 200A, 240VAC split phase supply.
2. Must correct for up to 2kW of load from a range of .7 leading or lagging to .9 or better.
3. Must be able to correct a dynamic home load that may change from leading to lagging at any time.

Qualcomm
SnapSat
SnapSat will be a proof-of-concept CubeSat (small, cubic satellite). It will travel into near-space on a weather balloon, paving the way for engineers to build Qualcomm-powered CubeSat's traveling into earth orbit on rockets.

Qualcomm
Biometric sensor module (fingerprint, IRIS) on IFC6410
Bring up off the shelf Biometric sensor module (fingerprint, IRIS) on IFC6410 and create an app for security use case.
Qualcomm
Robot Brain
Use Snapdragon SOM to design a robot brain including the software and hardware components:

- **HW** – design a new carrier board specialized for a robot. Motor drivers, encoder interfaces, sensors etc.
- **SW** – motor control, planning and motion computation, navigation, etc.

Schlumberger
Real-Time Simulation
Automation, smart devices, remote monitoring and control, advanced signal processing and human-machine interfaces - all these are part of modern systems used in oil&gas industry. Due to complexity of hardware, software and uncertainties associated with using it in real environment, the task of effective systems validation and verification is on top of the agenda for all players in the industry. Integration of existing physical models, control algorithms and hardware in a flexible real-time testing environment for complex systems in oil&gas domain can potentially significantly reduce the cost of initial system testing, and more importantly reduce the risks of system failures during real operations.

This project will look in detail at a possible implementation of testing, validation & verification platform, based on National Instruments VeriStand software environment. The resulting system will integrate existing physical models and hardware into a Hardware-in-the-Loop real-time synthetic drilling machine that simulated behavior of real drilling equipment. Project will also include development of prototypes for new HMI and integration with existing commercial supervisory systems.

Schlumberger
Wireless Electromagnetic Communication System
Communications along a coated pipe, by inducing magnetically a current loop on the pipe with return via the ground or water and the sacrificial Aluminum electrodes used to protect the pipe from corrosion. Goal of the project is to simulate, build and test a prototype communication system. Evaluate the robustness in case of a leak due to damage on the pipe’s coating.

Specifications:

- Autonomy: Every 5 years on battery for the remote modem, or energy harvesting
- Transmission of 2 messages per day with remote modem sensor data

Texas Instruments
DLP-based After-market Heads-up Display
Using the DLP Lightcrafter, design and build an after-market Head-Up Display (HUD) for a car. As a minimum requirement, the HUD should be able to display navigation information in a safe manner, and have a safe and easy to use user interface.

Texas Instruments
Brake Pad Sensor
Design a low cost, easily replaced sensor to monitor thickness of brake pads with status notification to a personal electronic device. The system will be installed on the UT solar car.
**Texas Instruments**

**GroBot – Power Controller for Hydroponic Systems**

Building all-in-1 supply that converts 120VAC power from the wall to a CFL light bulb as well as a step-down 12VDC supply for a water pump. Use a MSP430 kit (or something cheaper from the Analog PWR catalog), which is programmable from a USB that will allow periodic switching of the lighting and watering systems. The idea is for different plants (i.e. tomatoes, herbs, etc.) to have a different (preset) cycling scheme, making home growing easier for the average gardener.

**Texas Instruments**

**Directive Advertising**

Develop a highly directional sound-source or speaker that enables an advertiser to deliver a message to a highly localized area at a distance of at 5 to 10 feet from the speaker. The sound beam delivered by the speaker system should be able to track the customer as he or she moves through the store. The speaker system should be small enough to embed in an advertising display.

**Texas Instruments**

**TempSense - Wireless Temp Sensor Network**

Design low power temp sensors that communicate temp data via standard wireless protocols like Wi-Fi or Bluetooth. The temp sensor must be small and low power to operate for extended time on battery power. Design a receiver with microcontroller that receives data from the temperature array and discerns each element in the array. Develop an algorithm to govern cooling devices (i.e. fan/dampers) to optimize cooling as well as handle situations where one or more elements in the array is lost (due to interference or low battery).

**Texas Instruments**

**Autonomous Robot Resilient to Hardware Failures and Cyber Attacks**

This project will involve designing and prototyping a simple autonomous robot, and programming the capability for it to recover from failures in the hardware as well as from external attempts to hijack it. This team will compete with team with the goal of hijacking the other team's robot.

**Texas Instruments**

**Project Peregrine V**

Develop an autonomous airborne vehicle (AAV) whose stability and flight path are controlled by an onboard autopilot system. While in flight, the AAV may also perform various elective tasks.

**Texas Instruments**

**Security and Privacy Abstractions for Intelligent Ground Vehicles**

Develop an autonomous airborne vehicle (AAV) whose stability and flight path are controlled by an onboard autopilot system. While in flight, the AAV may also perform various elective tasks.

We believe that vehicles and their control systems that drive physical components require a careful re-think of security abstractions that an operating system (OS) provides. While a traditional OS relies on access control over files and other objects, cyber-physical systems may require abstractions that factor in time as well as the algorithms and data structures that are used by vehicles' control systems. The goal of this project is to build a prototype smart ground vehicle and concretize security problems in the context of this prototype.
Texas Instruments
Epilepsy Detection/Notification System
Thousands of Americans are affected by grand mal seizures every year. Grand mal seizures are very violent and often result in injuries to the person, especially if they were standing up or worse yet in a vehicle. The goal of this project is two-fold. The first would be a pre-emptive system to predict when a seizure is coming. Currently seizure dogs are used to provide a reasonably accurate indicator. The second would be a post event system that would notify a set list of contacts (through text message, email, etc.) that a person had a seizure, ideally providing location and time. This function would serve both as a log for the seizures (which is very valuable medical information to the doctors treating the patient) as well as a beacon of help, as post seizure it is very common for a person to be highly disoriented or passed out for 30 minutes or more. This project would be pursued without doing original medical research.

Texas Instruments
Solar Powered Intelligent Smoke and Carbon Monoxide Detector
The device should be able to function as a normal smoke and CO detector without any battery or AC power. Also should be able to act as a Wireless Sensor Network (WSN) and be able to transmit the data (temperature, CO status, etc) back to a receiver which can then process it and take appropriate action like call a predefined number (911 or Alarm Monitoring service) with a prerecorded message. The development of the receiver part and calling of predefined number is optional for this project but some system to measure that data was transmitted by WSN properly should be present. Goals should include minimizing cost as well (has to be commercially viable). This project provides a platform for additional WSN projects.

Suggested Tools:
• Texas Instruments Battery Charge Management parts like BQ25504 family
• Battery management SPICE models from TI
• TI's Sensor AFE Tool for CO detector

Texas Instruments
Bluetooth Home Automation
Use current and common devices, i.e. smartphones, laptops, and tablets with Bluetooth capability, to control household appliances to increase efficiency and safety in daily tasks. Design and implement a wireless control network in the house using Bluetooth technology.

Example use cases:
• Control lights, garage doors, doors, watering systems
• Monitor room temperature, cooking temp, humidity, etc.
• Use of voice recognition for control

Requirements:
• Use TI dual mode Bluetooth device - CC256x

Texas Instruments
Prevent Texting While Driving
Texting while driving is dangerous. Even though it is outlawed in some states, there are still about 50% of teens admitted to be distracted while driving because of texting. In this project we would like to design a device to detect texting behavior, and sends out a signal to either shut off the phone or issue a warning. One way of detecting texting behavior is to keep track of eye movement through a dashboard mounted camera.

The project involves a mechanism to detect a driver who is texting or not looking at the road/being distracted, and sends out an alarm sound effect.
Texas Instruments
Automated Cabinets
It is easy to lose items in cabinets and drawers, causing frustration and repurchase of items that are not needed. It also can make restocking and shopping more time consuming. The solution: a method for setting last location via smartphone or GPS capable device (say when groceries are put away), and locating items using text search from your phone or GPS, triggering an LED light on a cabinet handle to indicate location of searched item.

Texas Instruments
Home Wireless Temperature Control
Wireless temperature sensor array that communicated to local hub via Zigbee. This could utilize TI’s portfolio of temp sensor ICs and CC1102 type transceiver chip. The application is for a home/office where temperature can be independently monitored in several rooms and the data is fed back wirelessly to a local computer which can manage Heating and AC unit based on a specific programmed profile. For example, at night the temperature of the bedroom is kept cool while the rest of the house is unadjusted to save energy costs.

Texas Instruments
Directional Haptics
Blind people often need assistance from a human or specially trained animal to navigate outside their home. Haptics could be used to help direct those using GPS or other sensors. Develop a belt, shoe, or other clothing that could be worn by a blind person to help navigate a city block or building.

Texas Instruments
Wearable Athletic Haptics
Goal: A semi-portable device with antennas, and battery plus laptop powered system to give tracking information (direction and approximate distance) for lightning strikes at a distance greater than 10 mi and less than 500-1000 mi. To be used in open area, field, or building rooftop (or in a residence but not in ENS). Processing by laptop plus NI MyDAQ (2 boxes supplied) and LabVIEW.

Part A: Front end: direction finding at ELF or VLF (extremely or very low RF frequencies), NI USB DAC, and PC. The goal is to collect waveforms and correlate their features with arrival direction and distance. Visualization and analysis tools (strike data bases for comparison) are needed.

Part B: Based on collected waveforms and statistics from storms and strike clusters, design a distance and direction algorithms that can be implemented in the stand-alone system. By comparison with the National Lightning Strike database, the system can be trained through the use of learning or adaptive software.

Aside: Monitoring of these frequencies may also record various "whistlers" and other magneto-ionospheric phenomenon (some initiated by lightning strikes).

Texas Instruments
Bicycle Collision Avoidance System
Many metropolitan areas have combined bicycle and pedestrian trails. Serious cyclists can travel at average speeds of 20 mph. Joggers and speed walkers travel at 4-5 mph, with casual dog walking speeds of 2-3 mph. Collisions between cyclists and pedestrians are not uncommon, and some result in serious injury and even death to those involved. Cyclists are not always heard because of local environment conditions (e.g. wind), or pedestrian use of entertainment/motivation devices. This project would demonstrate the identification of a pedestrian on a potential collision course and provide audible and/or visual warning to a pedestrian. The system power source would be from the bicycle.
Texas Instruments
Magnetometer Calibration to Enable Indoor Navigation

Accurate indoor navigation is getting closer and closer to a reality for consumer electronics since the quality of available (and inexpensive) MEMS gyroscopes, magnetometers, and accelerometers has improved significantly in the last few years. Comprehensive pedestrian navigation solutions being developed in the industry blend WiFi, GPS, gyroscope, accelerometer, and magnetometer measurements. The sensors are critical for navigation in places without sufficient WiFi or GPS signals. One of the biggest remaining challenges for sensor-based navigation is to compute and maintain magnetometer calibration parameters so that the direction of motion can be computed. The calibration parameters of the magnetometer can be time, temperature, and location dependent. Existing methods require the user to perform a calibration maneuver (a figure of eight) so that the magnetometer can be calibrated. This is cumbersome and sometimes unreliable.

This project explores the possibility of building simple infrastructure to enable more accurate indoor navigation for a pedestrian. The infrastructure involves placing a QR code a wall. The QR code carries data that assists in the calibration of the magnetometer. When a user puts the phone up to scan the QR code they will naturally cause the phone to do a maneuver that along with the correct angle to magnetic north while scanning the QR code (this angle is encoded in the QR code) may be used to compute more accurate magnetometer calibration parameters.

There are different kinds of applications this may enable. For example, it may help visitors in a museum move between exhibits or customers in a store find an advertised product. Imagine a store putting an advertisement in the front of the store that includes a QR code. When the customer scans the QR code, their smartphone calibrates its navigation sensors, then directs them to the advertised product.

Phase 1: magnetometer calibration, with limitations on the postures the smartphone may be held in while reading QR code and navigating.
- When the smartphone recognizes a QR code it starts buffering data to use for magnetometer calibration.
  - Task #1: make a program that stores raw samples from the magnetometer or find an existing software to do the same.
- The smartphone decodes the angle from magnetic north from the QR code.
  - Task #2: create an encoder to store the angle in the QR code. Or find an existing software to do the same.
  - Task #3: create an application to decode the QR code. Or find an existing software to do the same.
- The buffered data, the angle to magnetic north, the pitch angle, and the roll angle are used to compute calibration parameters for the magnetometer.
  - the pitch and roll angles are known because of the required posture while reading the QR code.
  - Task #4: create a calibration algorithm that takes advantage of the known angle to magnetic north. Existing algorithms that can serve as a starting point can be found in the literature. (See references below)
- The calibrated magnetometer (along with pitch and roll angles) is used to provide accurate direction of motion.
  - Task #5: implement existing algorithms for this computation.
  - the pitch and roll angles while the user walks are known because of the posture limitations.

Phase 2: Storing partial map information in the QR code as well.
- QR code carries other data such as: current location, destination, route between them, etc.
- Including map information requires carefully designing a format that can be stored in a small number of bits since the QR code has a limited storage capacity.

Phase 3: sensor calibration, without posture limitations
- use accelerometer to compute roll and pitch angles. Both while reading QR code and during navigation.
- in this phase a gyroscope may also be used to improve the overall solution.

Phase 4: Use image processing to compute the relative angles of the smartphone and the QR code while the QR code is being scanned. This can be used to improve the overall accuracy of the system.
Components: evaluation kit to store magnetometer data and capture images (a smartphone should be sufficient)

References

3. 

Texas Instruments

Sound Identification and Tagging

The project involves basic feature extraction from audio recordings or live capture and discovery of meaningful patterns for automatic sound classification.

In daily lives, we constantly listen to and process the innumerable sounds that surround us. Automatic recognition and classification of these sounds (including human speech) in diverse environments is a very challenging and yet unsolved problem. Simple identification of selected sound classes in a controlled environment can be a fun exercise providing a glimpse into the complexity of our brain’s processing that we take for granted.

The goal for the project is to learn basic attributes of sound (in the time and frequency domains, e.g. energy variations, periodicity) and to implement a sound capture and extraction of selected audio features on a TI device. A threshold-based decision tree trained on the extracted features can be used as a simple classifier to distinguish between compared audio samples.

The students are free to apply the implemented sound processing to a real-life use-case of their choosing. For example, the application could be to identify in a music library the songs that may be most suitable for a workout or relaxation. Another example could be selecting loudest movie scenes and skipping potentially less interesting quiet movie segments. A more challenging application may include a trigger when a specific audio event occurs (e.g. two consecutive hand claps switching on home stereo or lights).

A system demo and performance analysis (classification success rate, false alarm rate) would be expected.

Components: PandaBoard (http://pandaboard.org/) or BeagleBoard (http://beagleboard.org/)

Reference:

1) Intro to audio features: http://luthuli.cs.uiuc.edu/~daf/courses/CS-498-DAF-PS/Lecture%208%20-%20Audio%20Features2.pdf

Texas Instruments

Food Safety

Build a small, battery run, hocky-puck size device that can be packed in a shipping container to monitor and record temperature, fruit/vegetable ripening gases, and bruising force events.

Texas Instruments

Optical Time Domain Reflectometry

Use of optical networking for delivering entertainment and communications is extensively available in industrial and consumer environments. Dependency on optical communications networks has often become vital to businesses, as is quick identification and resolution of network problems. Using Optical Time Domain
Reflectometry (OTDR), providers can quickly diagnose and determine accurate locations of cable breaks. This project would demonstrate the use of typical reflected signal patterns to diagnose and pinpoint cable problems.

Texas Instruments
Projector Display or White Board Image Capture using a Smartphone

Background
Smartphones are getting more powerful and functional day by day. Most smartphones feature a whole array of sensors including back and/or front facing cameras. App developers are trying to take advantage of these sensors and the available processing power to develop innovative applications.

Camera based apps in various app stores are numerous. A possible use case for a smartphone camera is to replace note taking by capturing a screenshot of the presented information. However, it is not always possible to capture a surface from the optimal perspective. Also, sensor resolution, distance, and other factors can limit the usefulness of a screenshot. Fortunately, image enhancement techniques can be employed to recover the information in the scene.

Project
The first stage of the project would involve a pandaboard [1] (an OMAP 4 development platform) coupled with an image sensor (such as a webcam) comparable to a smartphone camera.

The algorithm steps will be roughly as follows:
• Capture the intended surface (i.e. a presentation slide or handwritten notes on a board) from an angle
• Detect the edges of the surface
• Perform perspective transformation to correct the pose
• Enhance the content (text, symbols, drawings) using deblurring, color correction, denoising etc.

Advanced enhancement techniques such as Super-resolution can be used by capturing several shots of the same scene.

In the second stage, the developed algorithm can be ported to an OMAP based android smartphone and an app can be created to be submitted to the android market.

References

Texas Instruments
Low-Power Birdcall Recorder
Build a low power bird call recorder that tracks and identifies a small number of bird calls. This could be used to locate, identify and count rare species or used by a bird watching hobbyist to locate and identify various species of birds.

Texas Instruments
eRecorder Flute Musical Instrument
The eRecorder Flute is an educational wind controller instrument that simulates a typical recorder flute. Focused on portability and learning features, it is aimed to provide users who wish to learn how to play the recorder flute a flexible alternative to do so at their own convenience. In order to achieve this, the eRecorder Flute combines real time instrument play, through a portable flute device, with virtual instrument simulation, through a computer application, to provide a complementary education. The portable flute device will allow users to play musical notes electronically through a breath pressure sensor and buttons. It will include features such as step-by-step LED guidance, music note identification, song playback and music file sharing with a computer in order to instruct users about musical notes, fingering, timing and sounds, as well as providing users with musical piece
observation and evaluation methods. As part of the music file sharing feature it will allow MIDI files to be played. Also, it will provide volume control and headphone support to allow users to practice anywhere without disturbing their surroundings. The computer application will provide the same learning features but will be more focused on the musical composition aspects. With its innovative approach, the eRecorder Flute’s goal is to allow a wider market to embrace wind instruments in general as a viable and affordable musical instrument to learn and enjoy.

Texas Instruments
Inertial Sensor-Room Layout/Object Discovery with iRobot

The project involves attaching an accelerometer and a gyroscope to the body of the iRobot Create (programmable Roomba without a vacuum in it) to track its movements and some pressure sensors on the front button to determine at which angle the robot ran into an object. The goal of the project is to discover the layout of a room. This can mean establishing the layout of the walls, or a more detailed analyses to discover the location and size of objects on the floor (such as tables, chairs, cabinets, etc). This application can enable a more efficient navigation scheme for the iRobot’s vacuums. Alternatively, this setup can be used for “map discovery” in the indoor navigation applications.

Components: Accelerometer, gyroscope, pressure sensors, microcontroller (MSP430), iRobot Create

References

Texas Instruments
Ray tracing using TI Multi-Core DSP

Ray tracing is a compute intensive but realistic method of rendering a 3-D volume set on to a 2-D plane. It leverages the physical properties of light to accumulate contributions by following the light rays from the eye through each pixel in the image plane to the light source. This is widely used in 3-D animation, scientific visualization as well as rendering 3-D volumes in medical imaging.

The purpose of this project is to implement and benchmark the ray tracing algorithm on the TMS320C6678 (eight core DSP). Since TI’s DSP provides the best in class performance per watt, this will demonstrate the feasibility of lowering the power consumption of such modeling systems. The code available from PARSEC 2.0 benchmarking suite from Princeton University could be used as the starting point for this project (http://wiki.cs.princeton.edu/index.php/PARSEC).

The project will entail:
• Understanding the ray tracing algorithm and code as implemented in the PARSEC benchmarking suite.
• Literature survey to get comparative information of similar algorithms in x86 based processors as well as Nvidia GPGPU (general purpose GPU)
• Compiling and running the ‘raytrace’ benchmark on a x86 based host machine.
• Compiling and running the above on TMS320C6678 EVM (after proper instrumentations to compile the code with TI compiler).
• Parallelizing the code to run on eight cores.
• Optimization of the code to match TMS320C6678 architecture.
  o Optimization over single core to match operations for the ISA (instruction set architecture)
  o Optimization of division of computations and data allocation across multiple cores.

TI will provide the HW and SW tools.
Texas Instruments
Aging in Place
The population of baby boomers is reaching advanced age and families no longer live in the same locations, causing adult children of aging parents to utilize costly services to monitor the aging parents. Baby boomers are also interested more and more in extending their independence as they age and wanting to spend their later years in their own homes. Provide a non-obtrusive technological solution to home monitoring of seniors that will log and look out for abnormal behavior. For example, a system that would learn normal behaviors (time spend sitting on couch, in kitchen, in bed) that would provide an alert when behavior was out of the norm for the individual.

Texas Instruments
Option Pricing Simulation
In 1973, Fischer Black and Myron Scholes derived an equation, now called the Black-Scholes equation, for modeling the price of stock options over time. The equation is a partial differential equation with a term that is dependent on Brownian motion (random drift). In order to accurately price stock options using this equation, the equation must be solved many times using random values (Monte Carlo simulation) for the Brownian drift and thus requires lots of compute power to be implemented quickly and efficiently.

Currently the high-performance computing market for financial systems is dominated by Intel processors using Nvidia GPUs and FPGA’s to accelerate specific applications such as Black-Scholes.

Regardless of the hardware used for running these simulations, parallel programming techniques must be used to achieve good performance since all the hardware platforms use multiple processors or multiple instances of computational units.

Texas Instruments has recently developed a new, multi-core DSP with performance benchmarks on the level of the current high-performance computing devices in the market. The goal of this project is to compare the performance TI’s C6678 DSP against the performance of other devices for running Black-Scholes simulations.

This project will entail:
- Understanding the Black-Scholes algorithm
- Implementing Black-Scholes on TI DSP Hardware
  - Software must implement parallel processing methods to obtain good efficiency
  - HW and SW tools to be provided by TI
- Implementing Black-Scholes on alternate HW for comparison

Texas Instruments
Magnetic Resonance Imaging Simulation
The processing of MRI data requires a great deal of compute power. Currently most MRI systems use high-end Intel servers to implement the image analysis with some systems using general purpose graphics processing units (GPGPUs) as accelerators. These systems require 1000’s of Watts of power as well as cooling systems greatly adding to the overall price of MRI systems. These requirements also make it difficult to construct smaller and more portable MRI systems.

TI has recently developed a new, multicore DSP, the C6678 that has the same processing power as GPGPUs but at ~4x lower power consumption. The purpose of this project is to demonstrate the capability of DSPs for MRI systems as a low-power alternative to the current solutions.

This project will entail:
- Understanding the image processing algorithms used in MRI systems
- Implementing MRI algorithms TI DSPs
  - Software must implement parallel processing methods to obtain good efficiency
Texas Instruments

Inertial Sensor-Based Gesture Recognition

The project involves building wearable rings each with an accelerometer, gyro, a microcontroller and wireless transmitter and developing an alphabet of gestures. The vocabulary (different kinds of recognizable gestures) can be increased by using multiple rings (for each finger). The goal would be to remotely control a smart phone or any other smart device. Alternatively, a bracelet could be used but would decrease the range of gestures.

An example would be to use the ring to answer a call without touching the screen of the smart phone.

Another manifestation could be the use of the smart phone with inertial sensors as a tool to control other devices (flipping channels on TV, volume control etc).

Components: Accelerometer, gyroscope, microcontroller (MSP430), wireless Tx/Rx (cc430, Bluetooth, Zigbee)

Texas Instruments

Intelligent Doormat

Project:

• Build a doormat device with pressure sensors and MSP-430s to detect the count of people in going in/out of the doorway
• Weight measurement using the pressure sensors to estimate the net volume of people in the building
• A communication device within the doormat to communicate with doormats at different doors to have an (aggregate count/aggregate weight) of people in the building/hall

Applications:

• Estimation of number of people in the building for security
• Energy conservation by automatic control of HVAC and lights by occupancy detection/counting
• Security camera control based on occupancy detection
• Elevator routing and control

Future Expansion:

• Use energy harvesting to self power the device
• Set up a doormat communication network for massive buildings
• Congestion monitoring/prediction for hallways
• Wildlife monitoring/surveillance

Texas Instruments

Automatic Camera and Microphone Steering for Teleconference Applications

A camera and a microphone are part of a typical videoconferencing system. In these applications the camera is steered manually towards the speaker whose speech is captured through the microphone attached to the camera.

In the proposed system, a source localization technique can be employed to determine the location of the speaker and to steer the camera towards the speaker. Additionally, the camera can also be steered automatically towards a certain person on the request of the remote participant. This is also applicable in case multiple persons are talking and the source localizer is confused in picking the desired speaker. The single microphone can be replaced with an array of microphones for better sound capture. Since the array will be steered together with the camera, fixed beamforming can be programmed, which is rather inexpensive to implement. The system can be implemented on a general purpose processor or on an AIC3254.

Equipment: camera, single microphone or microphone array, stand/tripod, general-purpose microprocessor.
Texas Instruments
Auto-Nurse (Speech-Driven Manual Assistant)
Develop an intelligent device that assists a human who is performing a complex but well-known procedure. The prototype device will integrate speech recognition, video analytics, robotic control and perhaps text-to-speech to manipulate objects at the command of the user. I envision a scenario in which different shaped objects are placed on a table; for example a square, star, circle and triangle shape. The user gives a command, such as, “Put the star in my left hand.” The device moves into a position that allows it to identify the different shaped objects, selects the star shaped object, turns toward the user, identifies the user’s left hand, and places the object in the user’s hand. The prototype could be quite simple, in which the geometry of the problem is constrained for ease of implementation.

Applications:
This device can have applications in medical, industrial manufacturing, educational, and rehabilitative applications. An example medical application is providing surgical instruments to a doctor in an operating room. An industrial manufacturing example is handing parts or tools to an assembler upon request. Educational or rehabilitative applications may allow a user to instigate the action, for example “give me the ball”, or the machine may reverse the roles and instigate the action saying “roll the ball to me”.

Texas Instruments
Environment Aware Sensing using Audio Event Detection
Recently in Dallas, a young woman was killed while jogging on the Katy Trail when she abruptly ran into cyclist [1]. The story still has community baffled on how to avoid such tragedies. It was reported that she was wearing headphones and was not aware of the danger of the incoming bicycle. This is a classic case of technology doing its job too well. One of the primary uses of earphones is to isolate one from one’s surroundings to promote focus on a certain activity such as running, reading or just personal space. However, this can become a problem if a fire alarm starts and we don’t hear it or in the above mentioned case, a runner not hearing an incoming cyclist. The problem has also grabbed the attention of some lawmakers on the east coast [2] who look to put some responsibility of traffic accidents on pedestrians, especially those running in densely populated urban areas. In this project, we try to develop new sensing technologies to help make the technology users aware of dangerous events in their surroundings while they enjoy their personal space.

Project:
The project would involve several sensing mechanisms but will depend principally on audio event detection. A first stage would involve indentifying the type of sounds which one might want to detect, such as emergency sirens, car honks, gun shot, etc. Then a suitable audio detection algorithm would have to be designed to identify these specific sounds from other ambient sounds. Some of these ideas are already used in audio analytics, audio scene analysis or in city gun shot detections maps. However, in our case, it would have to be a portable device such as an MP3 player and be low power so it can run continuously for a suitable length of time.

A second stage of the problem would be to merge the audio scene analysis with other sensors’ knowledge such as an accelerometer commonly found on a smartphone to calculate the users’ speed. If a GPS is available, we can now have a geographic location, speed of a user if he or she is running. All this information can help make the algorithm more or less sensitive to some type of noise or events. For example, if it is detected that a running is going through downtown Chicago at peak hour a constant speed (i.e. not stopping), the device should be more aware of the presence of car honks or other threatening sounds related to dense traffic.

A third phase of the problem would be to allow different users to share their information on their surrounding similar to what social media such as Foursquare or Facebook allows. This time, the user would share information about their environment as well as location with other users to make the process more intelligent, akin to the “Urban Noise Mapping” project proposed in [3].

Other issues:
A smartphone has all the sensors and processing power to address this problem. However, it would be interesting to see if this can be done in small enough form factor that it can fit on a headphone. Also, one might want to build a sensor hub around a processor such as an MSP 430 or OMAP processor if higher processing power is needed.

References:

Texas Instruments
Personal Inertial Device
Implement a system using a low-power microprocessor (e.g. MSP430), a gyro, 3-axis accelerometer, compass, and possibly other sensors to perform measurement and/or dead-reckoning navigation.

Applications:
- Measuring short/medium distances (a pen?)
- In-building navigation
- Indicating vertical/horizontals
- Advanced pedometer, fitness device
- Games – can you invent an interesting position-based game?
- Navigation aid for the blind

Texas Instruments
Multi-Sensor Robotics Platform
Project
- Design a system to integrate one or more sensors to MSP430 processor or EVM
- Base the project on a simple off-the-shelf “mobile robot” platform
- Implement one game and one task as initial goals
- Integrate open-source software to achieve to desired goals
- Progressively add new games/tasks and improve functionality of existing ones

Applications
- Games: e.g. robot tag, laser tag, hide-and-seek, obstacle race, robot go-cart race
- Tasks: e.g. find/retrieve lost objects (e.g. remote or car keys under arm-chair), obstacle identification for handicapped, camera trigger to capture wildlife, roam rooms/corridors to find intruder
- Modular with expansion for sensors (think “transformers”: add/remove sensors for individual tasks and games)
- Sensors: e.g. audio, accelerometer, gyroscope, speedometer, proximity, touch, photo/video (data from individual sensors should interact for increasingly sophisticated tasks)
- Control: voice, remote RF/IR, wireless, semi-autonomous
- Initial platform could be expanded by consecutive teams

Texas Instruments
Bike Trainer with DSP Synthesized Inertia
This is something I have wanted to do for a while. I did start to make it but never got past the C2000 DSP starter kit manual. I race bicycles and in the winter I ride a trainer.

This website shows what they are: http://www.cycleops.com/products/trainers.html
The problem with them is they do not feel like riding on the road. It is obvious you are not going anywhere but the point is when you pedal it feels different. They do not have the inertia riding a bike has so the pedaling is not as smooth. Some expensive trainers try to fix this by putting in a big flywheel but even that does not really synthesize the feeling of going up and down hill. So what you need is a trainer like those pictured in the web page but the dissipative unit is a permanent magnet DC motor. It is controlled by some DSP function to synthesize inertia. When you pedal it generates power (puts it back on the mains would be a bonus). When you quit pedaling it coasts but to synthesize riding it would have to drive the wheel on the bike so now the motor is working as a motor. When it is in load mode (it swaps automatically) it has a control function that makes it appear if it was a large flywheel to the rider.

So the problem has Permanent Magnet DC motors (topical), power electronics, sensors, DSP/uController, real time software and control theory. It will be overkill for a bike trainer but building it tackles some hard problems. The problem can be cut into parts though and pieces can be implemented fairly easily. I actually have the mechanical part I can donate and we can get C2000 cards and stuff. None of this is expensive but it will take some work. I really want someone to make this machine and I will help guide the initial design some. I have some ideas that are perhaps starting points but there are many ways to skin this cat.

**Xilinx**

**Portable Calendar Viewer on a Zynq Platform using PetaLinux**
Design and develop an embedded system that reads the calendar information from a mobile device or from a website (like Google Calendar) and displays the information either on the on-board OLED on the ZedBoard or a display connected to the Zybo board. The application must run in a Linux environment on the target board and may communicate with IOS based iPhone/IPAD or Android based tablets.

**Xilinx**

**Smart Home Hub using Zynq**
Design and develop a smart system with home security and monitoring features. The home security feature will permit arming and disarming home security system and monitor activities inside and in the periphery of a house using cameras. Added features of the home security part of the system may include object tracking, identification, and notification. For this project you may use web enabled access. Additionally the smart hub feature may include monitoring temperature in various part of a house, control dampers to adjust the air flow, and turning ON and OFF of AC/Heating system. All the monitoring and controlling may be done using tablet. A mock-up of a home may be built to demonstrate the system functionality. Infrared and BT communication will also be investigated and may be implemented where necessary household appliances to increase efficiency and safety in daily tasks.

**Hardware**

**Baker Hughes**

**Evaluation of Silicon Carbide Thyristors for Downhole High-current, High Temperature Fast Pulser Circuits**
Establish single pulse performance limits of newly available commercial silicon carbide thyristors in fast (less than 10 microsecond) resonant pulser circuits at temperatures up to 200 degrees C.

**Cameron**

**Subsea Pressure Balanced Oil-Filled Cable Integrity Monitoring Solution**
Devise a solution to give advance warning to operators of subsea equipment to the deterioration of interconnecting cables.
Cedars-Sinai Medical Center, Interventional Endoscopy  
**Backward-looking Endoscope/Retrograde View Endoscopic Attachment**

The colon is a tubular structure with many folds and turns. Many polyps occur behind folds and in the blind spots of currently available colonoscopes. Various studies have shown the miss rates to be as high as 22% to 28% based on size of the polyp. Studies have also shown that careful examination behind the folds can decrease the miss rates.

This project will develop a simple ring add on to current colonoscopes that can provide a complete backward view at the time when the examination is being performed. The add-on should be a simple cylindrical ring fitted with cameras and a wireless transmission system that slides over the tip of current colonoscopes without blocking their outlet surface. The system should not use any of the ports of the colonoscope leaving the working channel available for aggressive cleaning, biopsy or surgery. Fitting the clip should take a few seconds and require no special expertise. Images taken by the cameras will be displayed on a separate monitor to provide a complete backward view. The system must include a miniature cleaning device for cleaning the camera lenses.

**Dell**  
**HPCC Datacenter Workloads & Power Infrastructure Planning**

Analysis is required to assess if current server power consumption benchmarking methods utilized in building predictive mathematical models properly reflect the use cases of customers in large datacenter HPCC environments. Challenges would involve analysis of true power consumption at the system, rack, and data center level for an HPCC environment as compared against existing benchmarking methods and modeling, and proposals for improvement of existing mathematical models and datacenter power infrastructure best practices.

We believe this is a project that will allow the student to work at the datacenter solution level, provide abstraction away from Dell and Dell-partner proprietary information, and which will have the potential to result in a final report that would be publishable/sharable without the need for NDA.

**Freescale**  
**Video ADC Utilizing Time-Shifted CDS or Time-aligned CDS Strategy**

In our multi-media age pictures and videos are plastered on our Facebook and Youtube accounts. However, sometimes we minimize the efforts of how they get there. We can use the backup camera in our car or parent’s car and minimize what is happening between the video camera and the display in the car.

This project will introduce the student to designing Analog to Digital converters within Verilog A/AMS and designing the main amplifier at a transistor level (extra credit).

Video can be captured via an old school analog camera and converted digitally via analog to digital converters. The goal of this project is to design a Time-shifted CDS or Time-aligned pipelined ADC converter within Verilog A/AMs which could be used for video quantization within the cadence tool framework. Verilog A/AMS code should be linked to symbols to build up schematic for execution.

**National Instruments**

**Logic Analyzer app for NI myRIO**

NI myRIO is the latest student embedded system product from NI, and features 32 lines of general-purpose digital input/output that can be used for a variety of functions. One interesting application of these lines is a Logic Analyzer.
Plantronics
Human Energy Harvesting
The ability to translate a typical human’s day-to-day body movements into electrical energy has been proven to be feasible. Micro-machined generators currently exist with the ability to turn physical displacement into usable electricity. The purpose of this project is to determine along which axis, and its respective limb, an energy generator would have the greatest potential for generating harvestable, human-produced energy as well as make a rough assessment as to possible energy generation magnitudes.

The prototype device can be part of the research effort, in that it can function in different ways, record data, and be used to test and compare various strategies for most efficient energy-harvesting.

Qualcomm
Articulated Robot Control Using Snapdragon Processors
An articulated robot is a set of 2 or more structures connected to each other via motorized rotatory joints, the angles of these joints can be varied to position the tip of the structure in a 3-D Cartesian space, good examples are robotic arms and legs. For this project we will be considering a variable length robotic arm, which can move to a specified location or along a predetermined path. In order to achieve this we will integrate an existing inverse kinematics algorithm on a Dragonboard.

The algorithm is expected to perform auto-position-correction of the articulated robot. Assume that each joint is attached with a position sensor and a control board will provide the actual angles of these joints; compare these values to the intended angles (calculated by IK) and compensate for the delta.

Qualcomm
CubeSat
One of our QC engineers is involved in developing a CubeSat (http://www.cubesat.org/) with a group of high school students. He proposed a project of designing Snapdragon processors based CubeSat for Senior Design project if that is of interest to students.

Qualcomm
Megapixel Image Stitching with Dragonboard
Implement a Gigapixel camera by stitching together 1-10 Mpix images from surveillance platform such as UAV. Use the Dragonboard as the processing platform.

Schlumberger
Design of a Down-hole High Frequency AC to DC Power Supply
The project is to design a down-hole AC to DC power supply for powering sensors located below an Electric Submersible Pump (ESP). An ESP is a three-phase induction motor in an oil well AC powered from the surface over a long three conductor cable. The down-hole supply is coupled to the Wye point of the motor with an isolation circuit that blocks the 60 Hz power wave form but passes a higher frequency signal that is used to power the down-hole sensor electronics.

The project is to design the power supply and isolation circuit according to the specifications listed below. The issue is the input signal varies due to motor size and length of cable and is optimized during startup. Also, due to imbalances in the motor and cable, the supply must isolate itself from high voltage from the 60 Hz signal. (DIAGRAM INCLUDED)

Inputs (Up-hole supply to put 600Hz-3KHz power onto the cable):
• Input signal, 5 to 20 volts, 1000 to 2500 Hz
• 1000 VAC of the 60Hz power can be present at the Wye point of the motor

Outputs (Down-hole supply to convert 600Hz-3KHz power to regulated DC):
• 5 VDC, max current 1 Amp
• Ripple, +/- 100 mV
• Accuracy, +/- 10%

Texas Instruments
Brain Wave Meter to Control Room Temperature
Use an existing brain-wave meter, or develop a new brain wave meter, to enable a person to set the temperature in a room just by thinking about it. Use wireless communication to utilize the brain-wave meter and communicate with the thermostat. An example brain wave meter that is pretty cheap is here:

Startup/Vendor Capitalist
DigiClaim
Vehicle Surface Damage Detection
Design and prototype an optical method of detecting surface (hail and collision) damage to a motor vehicle. The output of this system will be passed to another system to determine the extent of the damage on the vehicle. These results will then be used to automate the insurance damage claims and underwriting process.

GlobeLeash Inc.
GPS Tracking System
Ever lost a dog? One that escaped and could not find its way back home? This project is to design a GPS based dog leash, something that enables you to localize and possibly restrain the dog to a limited range. This is like lojack for a dog, except it is designed to be an efficient collar that is a low-power (long battery lifetime) that is bite and mangle-proof.
Skim Detect
Skimmer Detector
Skimmers are the bane of gas stations and ATMs. A skimmer steals the users ATM card number and PIN, thus bankrupting the user. The core idea of this company is the development of a skimmer detector that detects residual magnetism in magstripes.

For more information on skimming and the growing problem from it:
http://en.wikipedia.org/wiki/Credit_card_fraud

If an effective detector is developed, it could have considerable impact for banks, vendors and users. Students with a background in Electromagnetics and systems are preferred.