ECE 4890 Fall 2008: Design Project RFPs

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Introduction

This document contains inputs received from the outside spnsors, faculty members, and other interested parties, with regard to senior design project ideas. The names of the submitters is available by request. When you have formed a possible design team, request project contact information from Dr. Wickert, and proceed to interview the submitter/customer for more details, and perhaps the formation of a preliminary requirements specification.

As more RFPs are submitted to me, they will be integrated into this document. Check back for additions and changes.

RFPs

Project 1: Multisensory Feedback System for People with Multiple Disabilities for Use in Live Performances

This project involves designing and installing a sound activated lighting and vibration system to improve accessibility to arts programming for people with multiple disabilities. Music has been recognized as a stress reliever and genuinely enjoyable experience for people of all ages. Music can also be used to improve cognitive processing skills. Making arts programming, including musical productions, available to people with multiple disabilities creates an opportunity for individuals to enjoy the programming and develop cognitive abilities. People with multiple disabilities are often unable to access the full experience that live musical productions offer. This may be due to visual, sensory-motor and/or cognitive disabilities that inhibit the body's ability to process information. Providing a multi-sensory experience, such as that produced by a sound-light combination, improves accessibility for people with multiple disabilities.

Product

A system that would engage individuals with visual, cognitive and auditory impairments through the use of vibration boards and lights that work in real time during concerts, plays and other arts programming.

Application

The system would be designed for use in auditoriums, practice rooms and other venues when arts programming is currently available.

Design Requirements

Ideally, the system should be exceptionally easy to install in multiple locations. It also needs to be very user friendly, so the operators (building staff or possibly high school students) could be easily trained. The system should cause minimal disruption to the non-disabled audience members and the performers.

Possible Areas of Engineering Involved

Analog, digital, and power electronics circuit design. Signal processing is required to convert input audio signals directly from a microphone input and/or an audio sound board, to signals capable of driving the sensory devices.

Skills the Students will Gain

Board level electronics design and packaging. Interfacing low-level analog signals to high voltage and high current devices, e.g., lamp driver and vibration driver circuitry.

Project 2: Adaptive Solar Energy Collector and Power Manager

To extend the lifetime of remote battery-operated devices, on-site energy collection and management can allow substantially longer operating lifetime and increased functionality with additional power. Power gleaning can be accomplished by taking advantage of whatever form of energy is freely available at the target site such as light (solar/artificial), vibration, and heat.

This project targets sites with infrequent available solar energy to provide a power source to augment or replace the normal battery pack associated with an RF transceiver system. By managing the load on the solar array optimal energy harvesting can be obtained throughout the light cycle. Power consumption management will also prolong backup battery life by supplying power from the solar-battery with fall-back to the backup battery when solar-battery power has been exhausted. Minimal power consumption, especially during periods of non-charging is a critical design goal.

Product

Solar power collector/manager for a standalone RF transceiver.

Application

RF transceiver for remote locations with intermittent at best and generally non-existent power infrastructure needs long-life power source with low operating cost and near-zero maintenance.

Senior Project End Solution

Stand-alone board which connects to a solar array for energy collection, a solar-battery for electrical energy storage and a backup-battery. The system will have a low-power microprocessor to manage optimal energy collection from the solar array as well as load management and switch over to the backup-battery when the solar-battery is depleted.

Possible Areas of Engineering Required

Evaluate efficacy of various energy storage systems (Li-ion batteries, low self-discharge NiMH batteries, super caps, etc) and determine metrics for trade-off such as long life and efficiency of energy storage. Evaluation, selection, implementation and programming a μC-based system for lowest energy consumption. Develop instrumentation procedures for measurement of extremely low current consumption. Evaluation and selection of proper solar cell technologies. Evaluation of boost circuitry architectures for voltage step-up.

What the Student Gains

Real-world experience developing a mixed-signal (analog + digital) product with embedded microprocessor control. The student also learns how to evaluate and select from various possible technologies and circuit architectures in order to select the most appropriate technologies for the microprocessor, solar cell, and energy storage sub-systems.

Project 3: Project: HD/SD-SDI Closed Captioning De-Embed and Display Unit

Closed captioning has long been a standard feature in analog television systems, as a visual aid to the hearing impaired. It is also a feature of digital television standards, such as high definition and standard definition serial digital interface (HD/SD-SDI). The formats of these two video standards are defined by the Society of Motion Picture & Television Engineers, or SMPTE, standards 259M for standard definition and 292M for high definition. Closed captioning, as well as video, audio, and time code are all embedded in both serial digital streams.

Newer movie theaters are beginning to feature closed captioning support for big screen movies. This involves using a mirror mounted at a special angle at each seat, reflecting a flipped image of the closed captioning text displayed at the rear of the theater. Similar technology for television studios is in demand, both for hearing impaired employees and for situations where the sound needs to be kept to a minimum, as well as a debug tool for closed captioning embedders. This project will realize this demand.

Product

An HD/SD-SDI closed captioning de-embed system that would extract the closed captioning text from the data stream and display it on an LCD display.

Application

Useful to movie theaters or television studios, or any user, that utilizes HD or SD-SDI interfaces, such as hearing impaired video editors.

Senior Project End Solution

A stand-alone board that has an SDI coaxial input and a character display LCD output. This system will feature an FPGA to receive and de-embed the closed captioning data, as defined by the EIA-608B, EIA-708B, SMPTE333 and SMPTE334 specifications. The central FPGA would be configured with a SPI flash memory, and interface directly with a character LCD screen. It should be able to work with high-definition and standard definition sources.

Possible Areas of Engineering Required

Understanding the specifications of the various transport protocols of closed captioning and the video standards themselves, FPGA design work with Verilog HDL, interfacing with an LCD via I2C or SPI, multi-layer printed circuit board design with high speed transmission lines (1.5GHz), and so on.

What the Student Gains

Valuable experience with FPGA simulation and synthesis, and high speed digital design practice. Valuable experience working with industry-standard video protocols and a detailed understanding of digital video itself. Good experience with schematic capture and prototyping with layout of the board. Work with local television studios and possibly local theaters to implement this product into their workflow.

Project 4: Measurement Automation of Anechoic Chamber

The RF anechoic chamber is typically used to house the equipment for performing measurements of antenna radiation patterns, electromagnetic compatibility (EMC) and radar cross section measurements. Testing can be conducted on full-scale objects, including aircraft, or on scale models where the wavelength of the measuring radiation is scaled in direct proportion to the target size.

To revolutionize the development of scalable test and control applications in the anechoic chamber, measurement automation is required. Using the industry standard Labview software, a cost-effective interface can be obtained to control hardware, analyze data, share results, and distribute systems.

Project design tasks

- Design measurement routines for antenna pattern measurement and EMC compliance testing in the anechoic chamber
- Program routines with Labview and interface with various instruments including network analyzer, spectrum analyzer, power meter, and positioner.
- Perform antenna pattern measurement and an EMC compliance test

Possible areas of engineering required

- EM, RF/Microwave engineering, Labview programming

What students gain

- Hands on experience of interfacing Labview with RF equipment including network analyzers, power meter, and spectrum analyzer. Experience and knowledge of antenna pattern measurement and EMC compliance test.

Project 5: Precise UHF Transmitter with Very Long Battery Life

New ideas for applications of wireless sensors are increasing rapidly. However, when the product idea hits reality, there are at least two main difficulties: The first and foremost concern is the power source or battery life. AC power is not desirable, dangerous, or perhaps not even available for small sensors, and nobody likes to change batteries, especially on sensors that might have been placed in inconvenient (or even forgotten) locations. Secondly, these wireless sensors generally need to coexist within other transmitters the IMS bands (to avoid FCC licensing requirements for each installation), thus requiring care in achieving the FCC spectral constraints.

Product

A tiny UHF transmitter for battery-powered applications where battery life is expected to be 10 years, transmission range ~ 100 feet+, and the UHF frequency accuracy is to be +/- 10 ppm even over commercial temperature range.

Application

Small wireless sensors that might be placed throughout a facility or home, providing independent sensing, analysis and transmission at intervals varying from seconds to hours. Precise transmission frequency is required by customers due to their receiver constraints.

Senior Project End Solution

Stand-alone printed circuit board; battery-powered; with on-board small antenna, using a new micro-controller based UHF transmitter IC (EM 6869).

Areas of Engineering Required

- Small Antenna design, implementation and measurement.
- Antenna matching design and optimization.
- Crystal oscillator development (crystal spec investigation and frequency pulling).
- Analysis and characterization of crystal oscillator versus environment.
- Implementation of uC firmware for transmitter.
- Implementation of uC firmware for crystal temperature compensation.
- Analysis and design trade-offs for long battery life vs long transmission range.
- Design and development of demo PCB.
- Measurement and Evaluation of resulting product.

Project 6: RFID Sensor for Domestic and Imported Fruit and Vegetable Produce Monitoring

Preliminary form

Goal

- Reduce Spoilage and Optimize Placement
- Recognize shipments at risk
- Rotate ripest stock to front
- Redirect frozen stock to juice
- Dispose of spoilage early to reduce expenses and provide partial recoupment

Assumptions

- Currently monitor conditions at truck or cold-storage container level

- Temperature for individual boxes and pallets can vary within a truck or container
- Continued exposure at higher temperatures accelerates ripening and spoilage
- Continued exposure at lower temperatures causes crystallization and destruction
- Ripening produce can be salvaged by pushing to front of retail bins
- Damaged fruit can still be used for fruit or cattle food

Basic Requirements/Issues

- Use low cost RFID to monitor produce temperature from packing through shipping to destination (main project)
- Monitor humidity (optional)
- Monitor gases released during ripening (optional)
- Record shipment date, supplier, bin, etc.
- Regularly monitor temperature, humidity, gases, etc. and store compressed results in internal memory
- Deliver results to RF receiver on demand
- Cost – Can we get below $5?

Other Applications

- Monitor human organ during transport
- Chemical transport

Project 7: Bluetooth-Cell Phone Controlled Ski Boot Heater.

Currently there are products on the market that use D size batteries and other 'primitive' solutions for heating ski boots. The problem with these solutions is that they do not have enough energy stored for a day of skiing and do not have a closed loop control to not heat when the foot is warm.

Product

Boot heater: Bluetooth temp control via a cell phone, vibration charging while skiing, closed loop temp control, Lithium ion batteries, inductively coupled charging from 120v.

Application

Controlled heating of ski boots

Senior Project End Solution

A heating element for boot insertion, closed loop temp control, Lith-ion charging circuit, 'vibration' current generator for charging while skiing. Bonus: Bluetooth radio integration, cell phone control software, inductively coupled charging circuit.

Possible Areas of Engineering Required

Analog control theory, EM theory (this will be tutored and simplified, no Maxwell eq required), filter design, power switching technology, Bluetooth radio protocol integration, C++ on Windows Mobile 5.

What the Student Gains

You'll gain real life experience in the above disciplines and access to a seasoned EE to consult/guide the student in the development. Development cost for components and circuit board prototypes will be covered up to $1000 for this project (all charge need to be approved in writing prior to purchase).

Specs to follow

Project 8: Multi-node 802.15.4 Radio Based Network with Network/DC Performance Characteristics Based on SOS Embedded Operating System

- Participate/drive the porting of SOS to Atmel based (RF230) hardware
  - Develop build tools for ATmega1281 + ATRF230 systems
  - Realize the implementation of SOS on these systems
  - Develop a sample application on SOS and Atmel hardware
- Performance characteristics
  - Publish network related metrics
    - » Network latency > 50 node network
    - » Network collisions, re-try, failure…
  - Power saving techniques
    - » Sleep techniques and associated power consumption
  - Geographical/geometric coverage per node

The SOS OS is managed by UCLA and is an alternative to TinyOS. It is completely C based and my serve to bring low power wireless networks to realization.

Required hardware will be provided by Atmel, Colorado Springs. Additionally, appropriate software tools and consultation with Atmel engineers will be made available.