UNIVERSITY of HOUSTON | ENGINEERING

Department of Electrical & Computer Engineering

GRC

8TH Annual Graduate Research Conference
And Alumni Day

April 27, 2012
The Hilton UH Hotel & Conference Center
Houston, Texas

Capstone Design Conference

8:00 – 8:55 am	Breakfast and registration Waldorf Astoria Room 210, Lobby
9:00 – 9:10 am	Opening Remarks by Dr. John Glover Flamingo Room 275
9:10 - 9:50 am	Technical Program – Oral Session A Flamingo Room 275
10:00 – 10:30 am	Remarks by • Dr. Rathindra Bose, VC/VP for Research and Technology Transfer • Dr. Badri Roysam, Chairman, ECE Department
10:30 – 10:45 am	Coffee Break, Waldorf Astoria Room 210, Lobby
10:45 – 11:30 am	Technical Program –Oral Session B Flamingo Room 275
11:30 -12:30 pm	Lunch, Waldorf Astoria Room 210
12:30 – 1:00 pm	Plenary Presentation, Dr. Stefan Murry, Waldorf Astoria Room 210, Lobby
1:00 – 3:00 pm	Technical Program – Poster Session Shamrock Room 261
3:00 – 3:45 pm	Technical Program – Oral Session C Flamingo Room 275
3:45 – 4:00 pm	Coffee Break, Waldorf Astoria Room 210, Lobby
4:00 – 5:00 pm	Technical Program – Oral Session D Flamingo Room 275
5:30 – 6:30 pm	Reception and Awards, Waldorf Astoria Room 210

Capstone Design Conference

CDC 2012 Technical Program

April 27, 2012

Oral Presentation – Session A: 9:10AM – 9:50AM

9:10 – 9:30 AM	**VEX 2012 Robotics Competition** Dmytro Chenchykov, Adam Ruiz, Andrew Louie, William Graham(ME), Kelvin Alikah (ME)
9:30 – 9:50 AM	**IEEE 2012 Robotics Competition** Byron Ferguson, Kristopher Dow, Ameen Al-Badri, Tim Godwin

Oral Presentation – Session B: 10:45AM – 11:30AM

10:45 – 11:05 AM	**Solar Panel Interface to Smart Home** Nwamaka Nzeocha, Lester Taylor, Daddi Gbugu, Hai Tran
11:05 – 11:25 AM	**Smart Home Metering** Matthew Fox, Cyril Varkey, Alfonso Perez, Alejandro Juarez

Oral Presentation – Session C: 3:00PM – 3:45PM

3:00 – 3:20 PM	**Zebrafish ECG** Michael Alcantara, Edge Nguyen, Andrew Serranzana (BME), Farhaz Faramarzi (BME)
3:20 – 3:40 PM	**Thin Film Thermal Evaporator** Edward Jablonski, Jon Elizalde, Zakariyya Mughal (BME), Jasmine Patel (BME)

Oral Presentation – Session D: 4:00PM – 4:40 PM

4:00 – 4:20 PM	**Low Cost Source Meter** Samuel Maciel, Satya Thapa Chhetri, Joseph Wanja
4:20 – 4:40 PM	**Digital Color Organ** Dustin Burge, Brian Clark, Maria Herrera, Yi Wu

Robots for 2012 VEX Robotic Competition

Dmytro Chenchykov, Andrew Louie , Adam Ruiz, William Graham (ME), and Kelvin Alikah (ME)

Department of Electrical and Computer Engineering
University of Houston, Houston, TX 77204-4005

Project Sponsored by University of Houston ECE
Faculty Advisor: John Glover

Abstract

The goal of this project is to build a team of two robots to compete in the 2012 VEX Robotics Championship. The competition field, shown in Figure 1, consists of two isolation zones, where each team's scoring robot and several goals are enclosed, and the interaction zone containing scoring objects and one assist robot from each team. There are two rounds in the competition – a 60-second autonomous round and an 80-second driver-controlled round. One of the primary objectives of this project is building intelligent robots highly competitive in the autonomous round. To do achieve this, the robots employ infrared distance sensors (SHARP 2Y0A02 and 2D12X) for object and obstacle detection, a custom camera module for "seeing" arbitrarily placed objects and goals using the OpenCV image processing library running on a TI BeagleBoard xM single-board computer, VEX shaft encoders for position tracking, and standard VEX mechanical parts. The general layout of the system is shown on Figure 2. The primary logic functions of the robot are handled by the VEX/Cortex M3 control module. The image processing module communicates with the control module using 115200 baud UART. The distance and line sensors are interfaced directly to the ADC ports on the control unit. The mechanical design of the assist robot incorporates a "conveyor belt" structure that can hold up to three objects to throw over the fence into the isolation zone. The scoring robot has a similar conveyor belt mechanism , but unlike the assist robot's stationary conveyor, it is placed on a lift arm assembly and is used to lift objects high enough to be dropped into goals. In the beginning of the autonomous round, the scoring robot scores several objects placed in pre-determined positions and begins to use its camera module to actively seek out objects of interest using color thresholding and blob detection, relaying relative location data to the main control unit, which uses this information along with other sensor data to pick up and score objects.

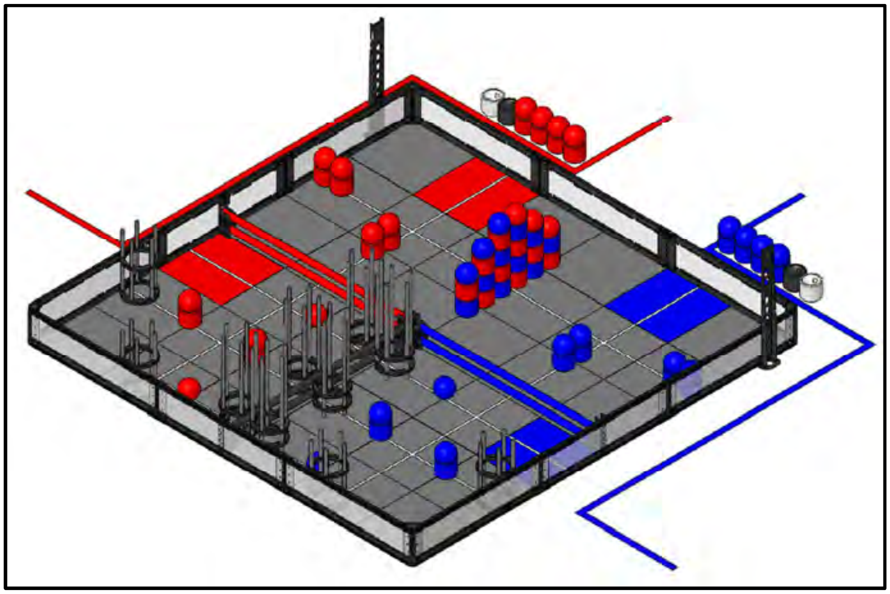


Figure 1 – VEX Competition Track Layout

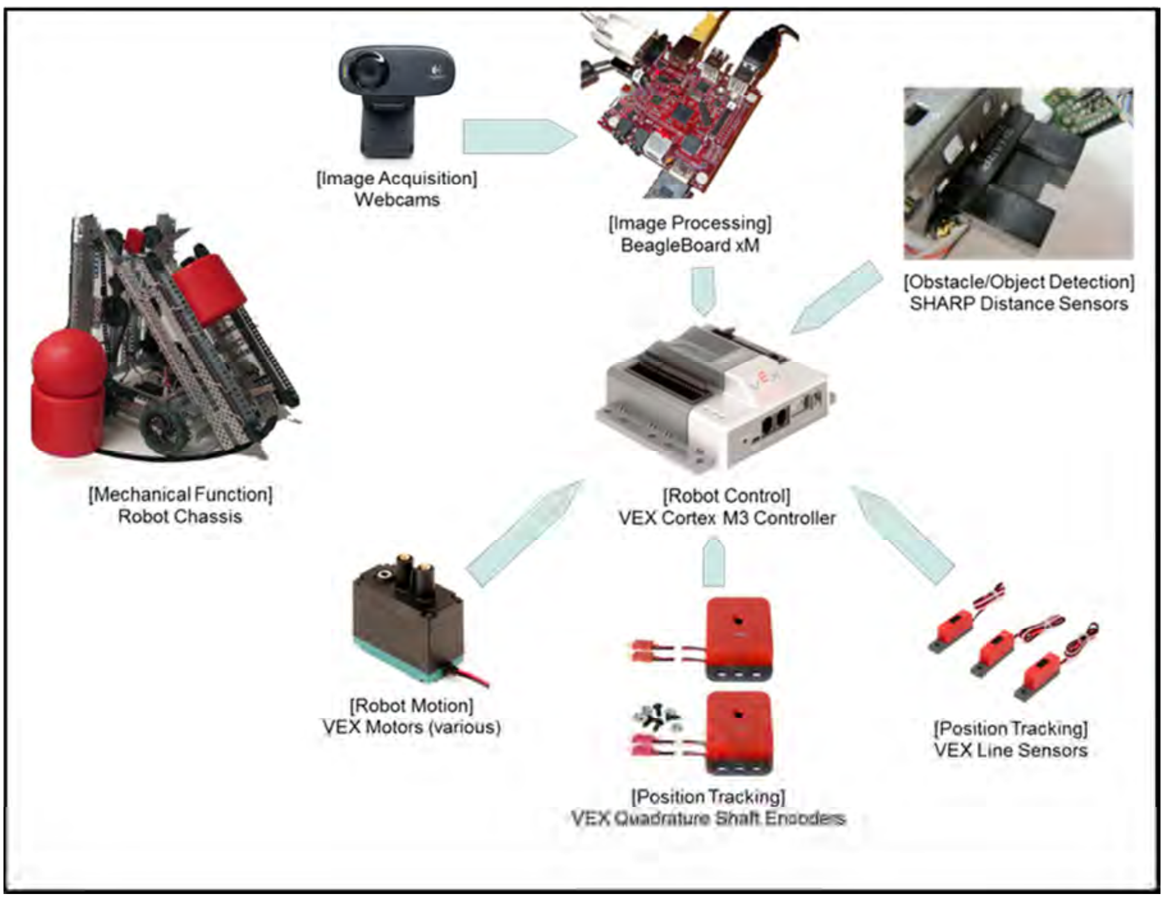


Figure 2 – System Overview

IEEE 2012 Robotics Competition

Ameen Al-Badri, Byron Ferguson, Kristopher Dow, and Timothy Godwin

Department of Electrical and Computer Engineering
University of Houston, Houston, TX 77204-4005

Faculty Advisor: Dr. John Glover

Abstract

The robot (Figures 1 and 2) designed for the IEEE 2012 Robotics Competition is an energy harvesting robot that navigates a predefined playing surface (Figure 3), harvests energy from simulated renewable energy sources, and delivers the energy to a flag raising motor. As part of the IEEE 2012 Robotic Competition rules, the autonomous robot has to harvest from at least two different sources and deliver the acquired energy within the allotted time frame of 5 minutes. The winning team will be determined by the final height of the flag and the time taken to raise it.

The robot uses a hydroelectric source and wind source to harvest the needed energy. Two springs are used as the metal contacts to obtain energy from the electric source and a 3" PC fan is used to collect energy from the wind source. Two super capacitors (.47[F]) are used to store the harvested energy. For movement and navigation around the playing field, two 6[V] motors with built in shaft encoders, four close range IR distance sensors, and two line sensors were configured to an MSP430 microprocessor. The speed and direction of the motors are controlled with pulse width modulation using an H-Bridge motor driver.

All the different components of the robot are assembled, tested, and optimized. This robot meets the competition requirements and can finish the course within the allotted time of 5 minutes.

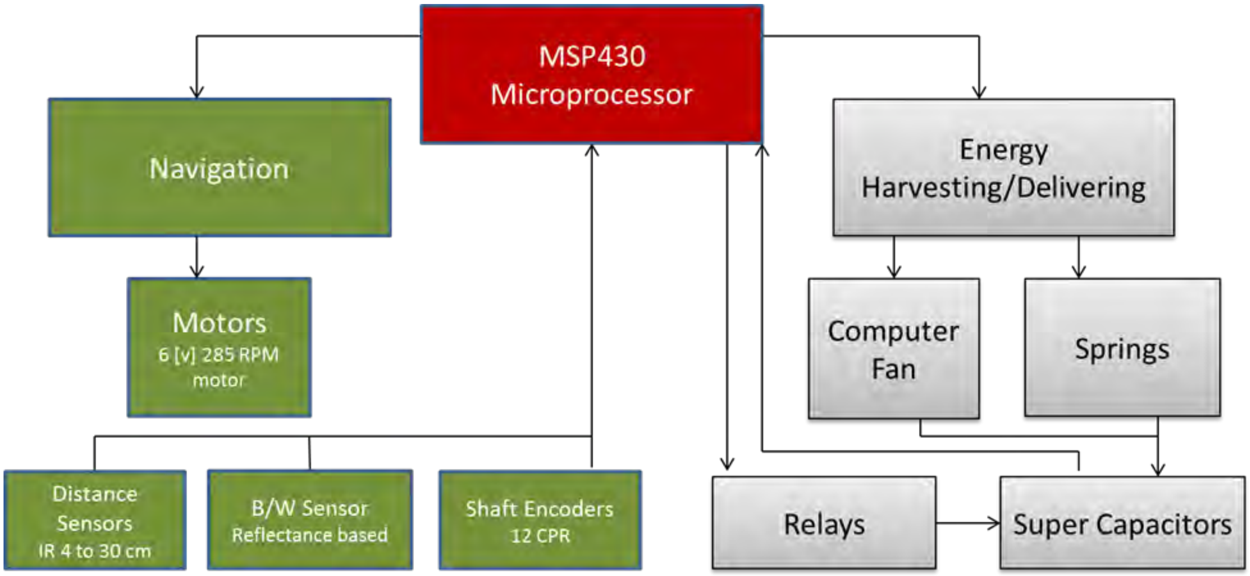
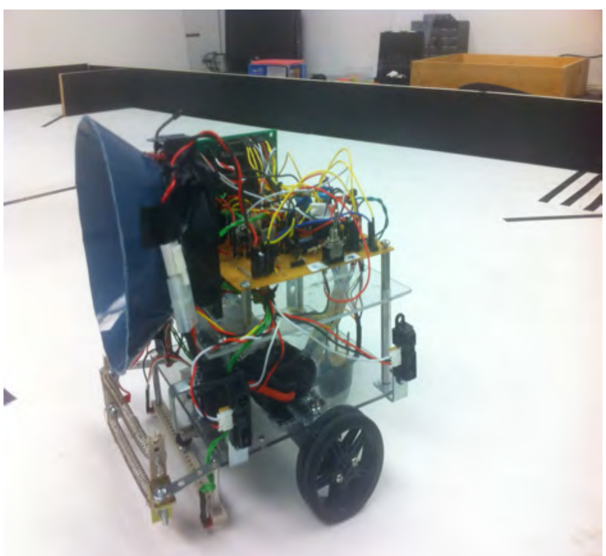


Figure 1: Robot overview diagram



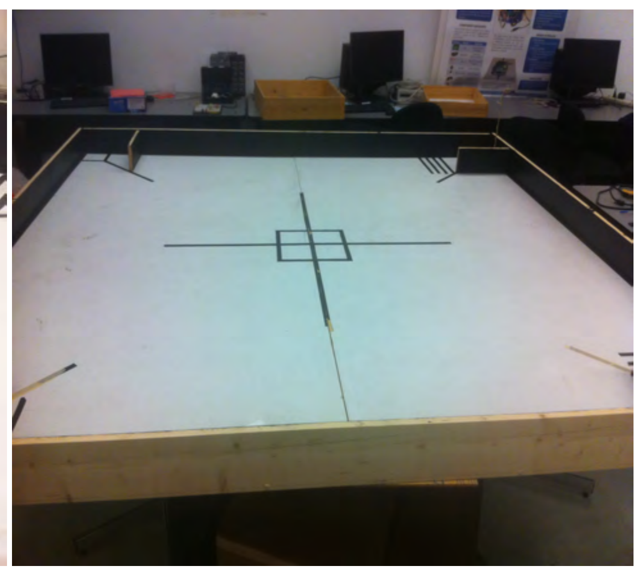


Figure 2: Energy Harvesting Robot

Figure 3: Playing field

Solar Panel Interface to Smart Home

Nwamaka Nzeocha, Lester Taylor, Hai Tran, and Daddi Gbugu

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University of Houston, Houston, TX 77204-4005

Project Sponsored by University of Houston
Faculty Advisor: Dr. John Glover, Dr. Len Trombetta, Dr. E. Joe Charlson

Abstract

The goal of this project is to convert the DC voltage generated by the solar panel to an AC voltage that will be used to power household loads (Figure 1). The artificially designed sun system, necessary because of indoor staging, proved to be a suitable way to emulate outdoor sunlight. The system emits 1000[W] onto the Photowatt M-PW850-80 solar panel (Figure 2). The inverter design utilizes an H-Bridge power stage and a step-up power transformer rated for 2.78A @ $9V_{AC}$ equaling a total of $25[W_{max}]$ of power capable of being delivered to the load. Ultimately a square wave of 60[Hz] and $120[V_{AC}]$ was generated (Figure 3). Many devices contain internal rectifiers, which make them optimal devices to accept power from a square wave signal. Ultimately, two compact fluorescent light bulbs of 5[W] each and computer speakers were successfully powered by our system. The Phase-Matching circuit is a part of this project which provides a 60 [Hz] square wave that is in phase with the signal from the grid as seen in Figure 4. It consists of a zero-crossing detector and a phase-lock loop circuit. Since the square wave produced by the phase-matching circuit acts as an input to the inverter, the inverter's output signal will have the same characteristics as the signal from the grid. This inverter can operate as a stand-alone inverter yet demonstrates the potential to serve as a grid-tie inverter.

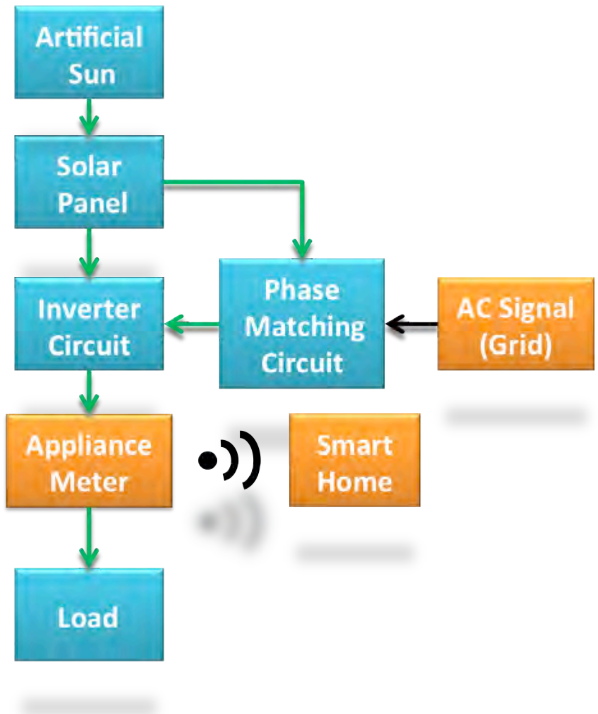

Figure 1. Overview diagram of the Solar Panel Interface to Smart Home.

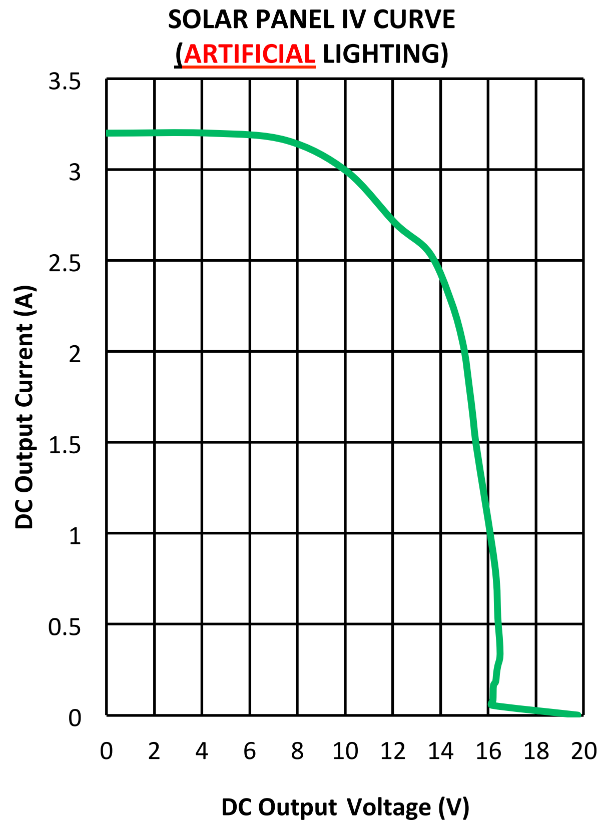

Figure 1. Solar panel IV curve under artificial lighting conditions.

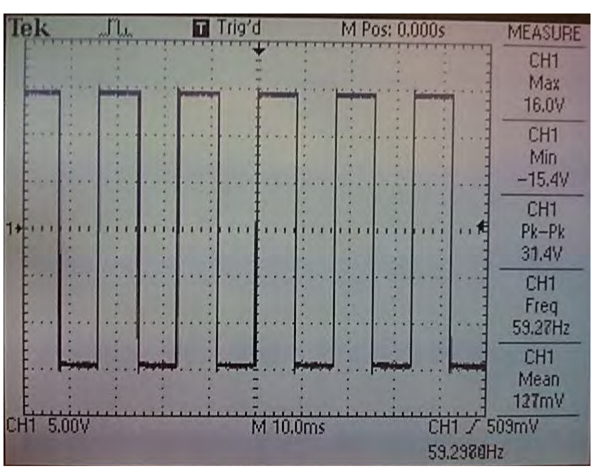

Figure 2. Oscilloscope image showing the output of the inverter circuit before stepping-up the voltage to 120 [V].

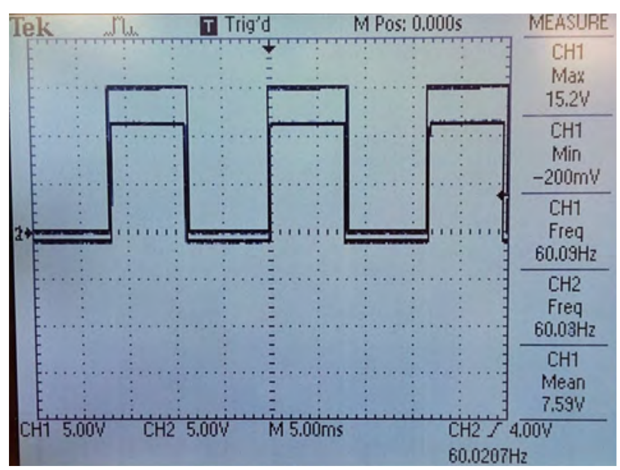

Figure 3. Oscilloscope image showing the output of the phase matching circuit. The output of the PLL (top) signal is matched with that of the grid signal (bottom).

Smart Home Energy Metering

James Fox, Cyril Varkey, Alfonzo Perez, Alex Juarez

Department of Electrical and Computer Engineering
University of Houston, Houston, TX 77204-4005

Project Sponsored by Department of Electrical and Computer Engineering
Faculty Advisor: Dr. John Glover

Abstract

This project concerns the design of a Smart Home Energy Metering system (Figure 1) which will allow collection, analysis, and control of household energy usage. The project will also allow utility providers to monitor and control energy consumption on an individual household basis. The system is composed of 4 basic components: Appliance Meters (AM), the household Smart Meter (SM), a Home Area Network Controller (HAN) with In-Home Display (IHD), and a Substation Simulator. The AMs monitor the instantaneous and total power consumed by individual appliances and also offer toggle control of appliance power. These devices are designed to be located in-line at an appliance's main power feed and should typically be used in conjunction with a single appliance. The SM monitors overall household energy usage and serves as the communication bridge between the household and the Substation Simulator. The SM is placed in-line at the household utility service entrance, in place of the typical energy meter. The SM is capable of measuring voltage, current, frequency, and instantaneous and total power; all of this information can be made available, in real time, to the utility provider through the Substation Simulator. The HAN acts as the central hub for all communication within the smart home; it is connected to the touchscreen IHD which displays household energy data and allows appliance control. Each AM communicates via the ZigBee Wireless Home Automation Profile in a star topology with the HAN as the central coordinator. The Substation Simulator represents the utility provider's communication endpoint, which relays data to and from the SM. The communication between the utility provider and the smart home allows the provider to monitor usage on a per household basis and also offers load control by way of voluntary large load startup delay requests. This is accomplished by asking a household system to delay turning on large loads such as air conditioners and furnaces for a short time period.

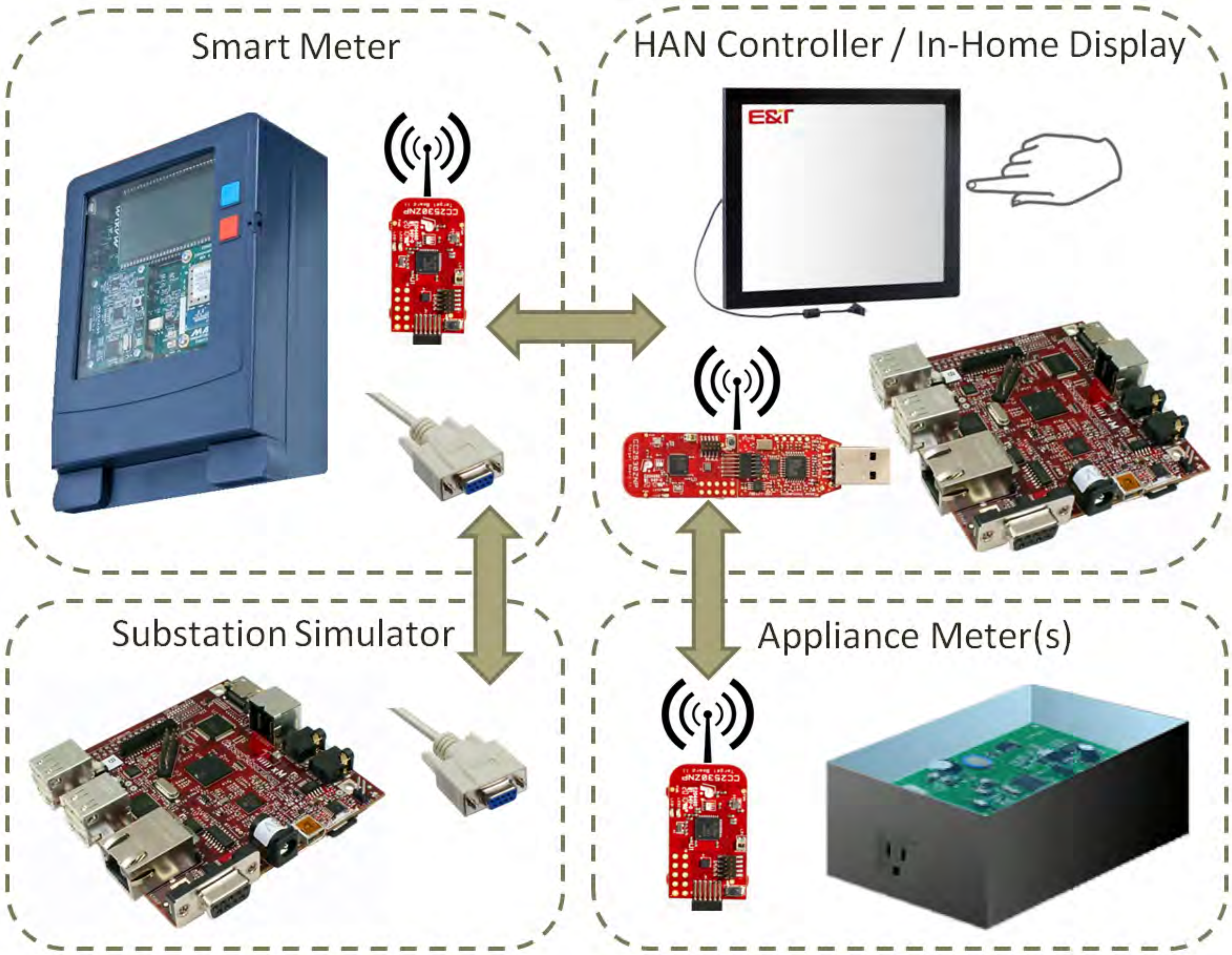

Figure 1 - Smart Home Energy Metering System

Compact Electrocardiogram for Measurement of Zebrafish Cardiac Biopotentials

Alcantara, M., Nguyen, H., Faramarzi, F., and Serranzana, A.

Department of Electrical & Computer Engineering
University of Houston, Houston, TX 77204-5060

Project Sponsored by Indus Instruments,
Dr. Sridhar Madala
Faculty Advisor: Dr. John Glover, Dr. Ravi Birla

Abstract

In recent years, the zebrafish (*Danio rerio*) has become an increasingly popular model organism in various fields of research, which include the area of tissue regeneration and the testing of drug-host interactions. The behavior of the organism's heart is one of the major factors analyzed in these studies, and such data is obtained through the use of electrocardiography (ECG). Although several bioamplifiers capable of capturing the signals produced by the zebrafish heart already exist, many require additional hardware and preparation before an ECG can be obtained. In an attempt to fill this niche, a compact, USB-powered device for the express use of obtaining zebrafish ECGs was constructed, as shown in Figure 1. The design is comprised of three main components: the TI ADS 1292 (amplifier and analog-to-digital converter), the MSP430 Launchpad (microcontroller and USB connection), and a custom LabView VI (ECG visualization and data export). The device is still in its prototype stage and has yet to be tested on live zebrafish. However, the design proves to be feasible as the components are able to function, and further adjustments to the VI can be implemented with little effort.

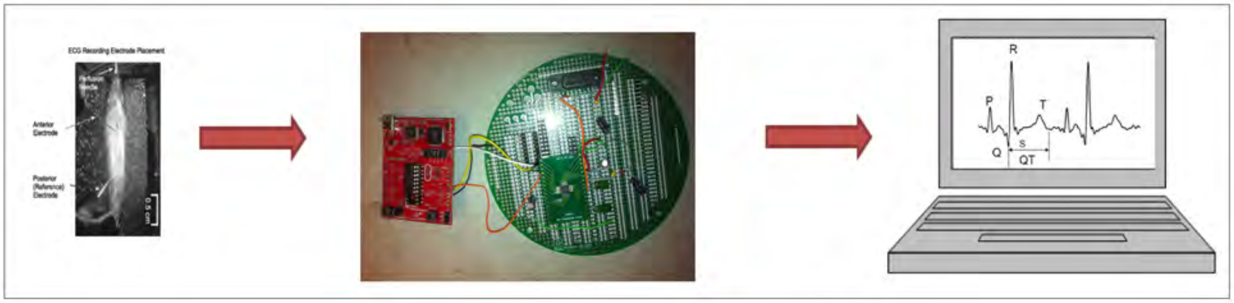

Figure 1: Project Overview

Semi-Automated Thin Film Thermal Evaporator

Jon Ander Elizalde[1], Ward Jablonski[1], Zakariyya Mughal[2], and Jasmine Patel[2]

[1]Department of Electrical and Computer Engineering, [2]Department of Biomedical Engineering University of Houston, Houston, TX 77204-4005

Project Sponsored by Department of Electrical and Computer Engineering, Nano-Engineering Minor Option (NEMO) Program UH
Faculty Advisor: Dr. Paul Ruchhoeft

Abstract

One method for concentrating material onto a wafer for nano- and bio-engineering applications is through thin film thermal evaporation. A thin film thermal evaporator is used to deposit metals on the Angstrom scale onto different materials. The device is composed of four major components: a heating element (voltage regulator and transformer), a rate deposition monitor (crystal rate monitor), internal components (material basket, substrate table, quartz crystal) and a vacuum system (turbo pump, rotary pump, thermocouple gauge, and ion gauge), shown in figure 1. To vaporize and evaporate a material, the heating element runs a high current through a tungsten basket containing the material to be deposited. When a vacuum is formed within the chamber, the evaporated material spreads upwards from the basket and onto a wafer with normal incidence (figure 2), where the rate of deposition is measured by a quartz crystal. Our team designed, built and semi-automated a thermal thin film evaporator for use by the Nano-Engineering Minor Option (NEMO) students, a device which will allow hands-on experience as opposed to simply seeing a TA use it. The heating element used is a high-current, low-voltage variable power supply. The maximum current output by the power supply is roughly 100A, which is fed into the basket holding the deposition material. The simple vacuum system uses a rotary vacuum pump assisted by a turbo molecular drag pump. Three pressure gauges (an ion gauge and two thermocouple gauges) measure the pressure of the chamber and the fore line leading to it. With a leak rate comparable to similar vacuum systems, a base pressure of approximately 10^{-4} torr is the lowest pressure our system can achieve. To semi-automate the process, we created a LabVIEW GUI (figure 3) which informs the user of three things: the current pressure within the chamber (measured by the ion and thermocouple gauges), the rate deposition onto the wafer (measured by the crystal rate monitor) and when the user should move to the next step. Overall, this system cost roughly $32,911.01 to build.

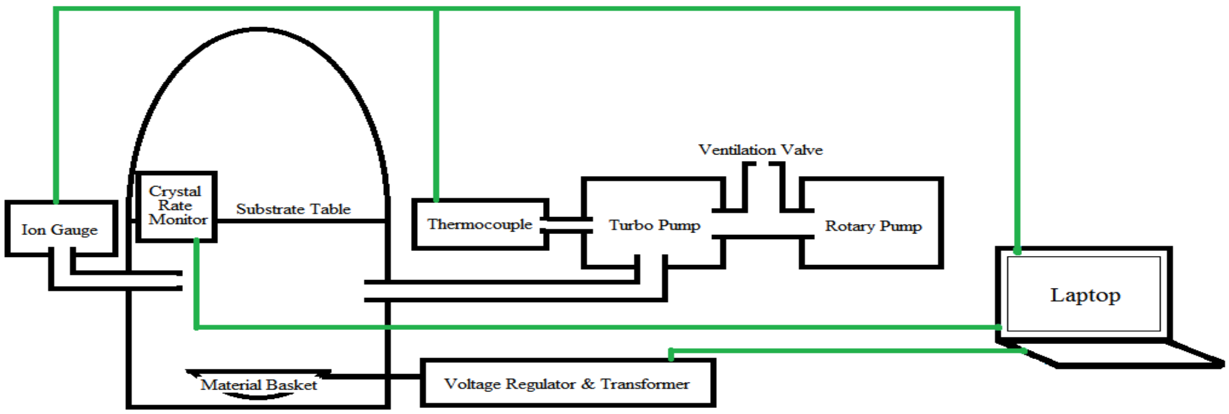

Figure 1: Thin Film Thermal Evaporator Schematic

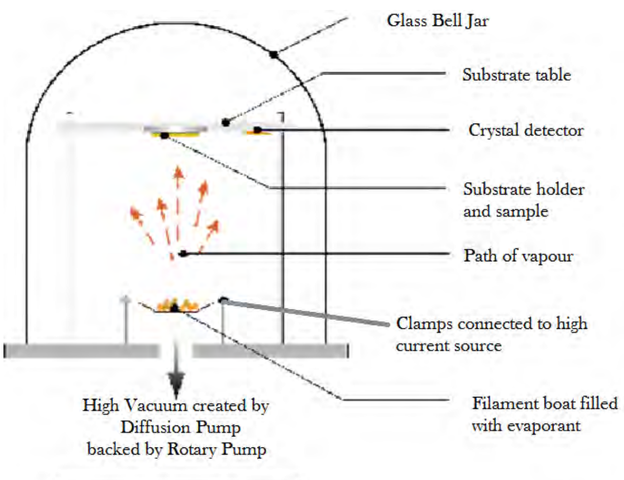

Figure 2: Bell Jar Thermal Evaporator Chamber. Credit: http://www.betelco.com/sb/phd/ch3/c34.html

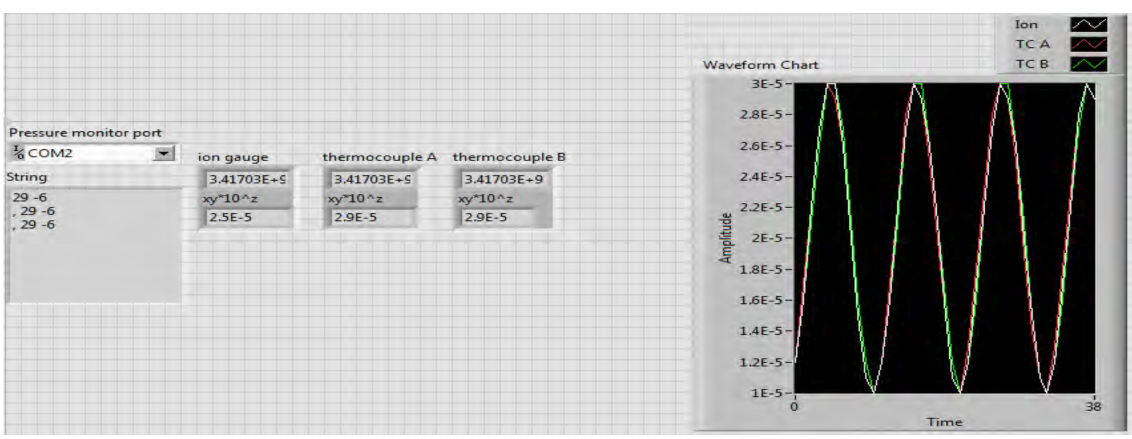

Figure 3: LabVIEW GUI showing sample pressure readings

Low Cost Source Meter

Samuel Maciel, Satya Thapa, and Joseph Wanja

Department of Electrical and Computer Engineering
University of Houston, Houston, TX 77204-4005

Project Sponsored by Department of Electrical & Computer Engineering, University of Houston
Faculty Advisor: Dr. Dmitri Litvinov, Dr. John Glover

Abstract

The purpose of this senior design project was to design and construct a low cost source meter. Many electronic projects require a tight coupling of both sourcing and measuring of a given circuit. With a source meter, you are able to get voltage and current sourcing as well as voltage and current measurements. In order to develop a low cost system, our project implemented a design that integrated a converter box connected to a computer through a standard PC sound card running a custom user interface. In order to achieve this design, our group designed a system that communicates to the PC sound card through the use of a decided range of frequencies. The final block diagram of the project is shown in Figure 1. We took our working ranges of voltage and current and superimposed them on a 100 – 10100 [Hz] frequency band. Our group used an Analog Device "ADuC845" microcontroller to handle the conversion of analog voltage or current to its respective frequency and vice versa. The computer's user interface is constructed in LabVIEW, which is also handling the backend tasks of reading the frequency and decoding it to display the correct voltage or current readings to the user. This user interface also allows the user to set a desired sourcing value for the converter box to output.

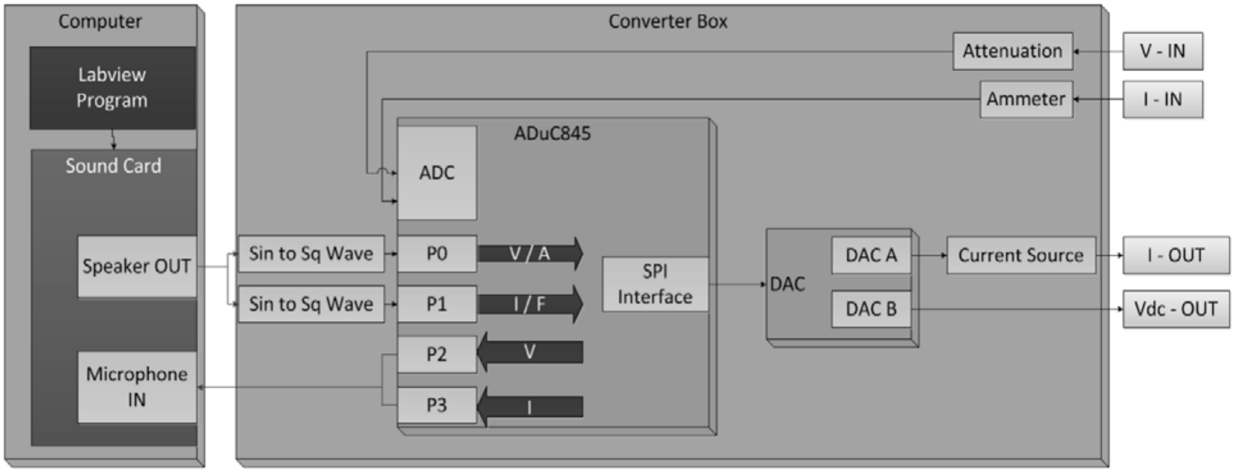

Figure 1 - Block Diagram for Source Meter

Digital Color Organ

Dustin Burge, Brian Clark, Maria Herrera, David Wu

Department of Electrical and Computer Engineering
University of Houston, Houston, TX 77204-4005

Project Sponsored by The University of Houston Electrical Engineering Department
Faculty Advisor: Dr. John Glover

Abstract

Since the 1970s, color organs have been popular with electronic hobbyists. These devices convert an audio input into a visual display. Generally, music is used to create a multisensory experience for the listener, with high and low sounds represented by different colors of light. Most current color organ designs are built using static analog filters, allowing little to no real-time manipulation of the variables used to determine their visual output. Additionally, LEDs are switched on or off based on a single threshold, resulting in a product that provides an interesting visual display for a very limited selection of audio samples. Team 8 has designed a digital color organ that solves these problems, utilizing two Texas Instruments microprocessors. An overview of the color organ can be seen in Figure 1. The first microprocessor board, utilizing a TMS320C5515 DSP chip, receives an audio input signal and filters it into three frequency bands, calculating LED brightness levels for each. It then implements audio effects, including equalization, echo, and reverb, before recombining the signal and sending it to an external speaker. The second microprocessor, an MSP430F2618, outputs pulse width modulation signals to drive six LED arrays at varying intensities, where the brightness of each is determined by the amplitude of the bass, mid, and treble bands of both the left and right audio signals. It also accepts input signals from dials and switches to provide real-time control of audio equalization, frequency thresholds, echo, and reverb. Communication between the microprocessors utilizes the I^2C serial communication standard. The resulting device is both aesthetically pleasing and very simple to use. Sine waves inputs of varying frequency were used to test the device. In each test, equalization was utilized to determine that the output signal was audible only in the desired band, and that the correct set of LEDs was activated. These tests proved the effectiveness of both the digital filters and the current-amplifying LED driver pictured in Figure 2. To encourage use by hobbyists, the organ was designed to be both inexpensive and simple to assemble. The cost of parts, assuming a manufacturing run of 1000 organs, is less than $300 per organ.

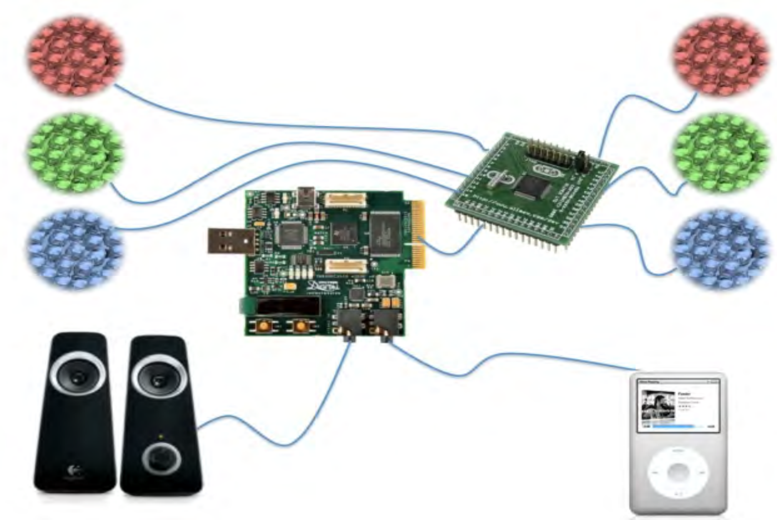

Figure 1 - Digital Color Organ Overview

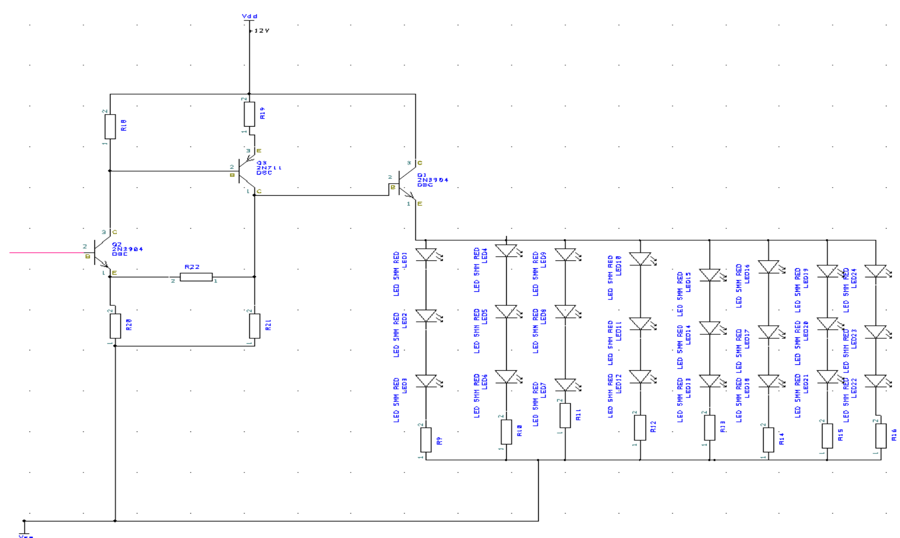

Figure 2 - LED Driving Current and Voltage Amplifier Schematic

Conference Proceedings

ECE-CDC 2012

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