CENG/ELEC/SENG 499 Design Project

1. FPGA - Synthesis of HCORDIC Processor

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SUMMARY

High-performance Coordinate Rotation Digital Computer (HCORDIC) is a very powerful algorithm for calculating many functions used in arithmetic and DSP applications such as video compression, division, trig functions, etc. The HCORDIC algorithm follows the same scientific logic as the classical CORDIC algorithm. HCORDIC uses the advances in modern processors, which allow us to choose a step size according to our iterative inputs to speed up the convergence speed. The new cordic uses multiplication and a larger look-up table since modern processors come with a multiplier and an onchip RAM. This algorithm has been theoretically proved by our supervisor, Dr. Gebali, to be highly efficient than the existing CORDIC algorithm in calculating the elementary functions.

The purpose of our project is to implement floating point HCORDIC in VHDL and then synthesize it on a spartan 3 FPGA as well as to determine the amount of power used by our design. We have designed HCORDIC algorithm using floating point arithmetic so that we can increase the range of numbers. Our design includes 5 major components: 4 ALUs with feedback and a controller component that controls when to stop the iterations and output the final result. The ALUs make use of the already available adder/subtractor and multiplier to perform fixed-point arithmetic in the mantissa and exponents. We chose to have 4 separate ALUs for calculating the coordinates so that we can achieve the high performance.

Supervisor: Dr. F. Gebali
2. eSteth - a Low Cost Tele-Auscultation System

Group: Christian McMechan, Aaron Patten, Irina Morozov  
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SUMMARY
The stethoscope is one of the most prevalent medical instruments in the world. It is a simple tool for gaining auditory information about a person’s health and can reveal many different kinds of potential health risks without the need for an invasive imaging techniques or unwieldy equipment. The convenient and versatile nature of stethoscopes has made them a staple of the medical professional and a prime candidate for technological enhancement. Electronic stethoscopes are currently available in the marketplace and offer amplification, recording and data transmission capabilities. Although the benefits of using these devices are great, widespread adoption by the healthcare industry and home user alike has not been seen due to high costs and lack of archiving infrastructure. Those who would benefit from affordable telemedicine technology are people in remote communities, tele-nursing patients, and individuals who keep personal health records.

This project (eSteth) demonstrates how an electronic stethoscope can interact with a database and web server to provide telemedicine to people who are working with a very modest budget.

eSteth features a pc application and a web based user interface that allows users and caregivers to store and share medical information using a remote database. Users may use the stethoscope to produce and upload personal recordings to the database where they can be accessed by the user or their authorized caregiver via the web.

Supervisor: Dr. Poman So

3. SDRoid

Group: Brendan Morgan Andrew Lund Howard Chang Mark Messmer  
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SUMMARY
SDRoid brings the power of software defined radio to a portable smartphone. Previously only available on high end desktop computers, software defined radio allows the smartphone to send or receive radio signals using arbitrary modulation. This not only allows the user to update their smartphone to receive the latest 4G network transmission with a simple software update, but it also allows other industries - aviation, military, police, and rescue services - to use
smartphones on their existing radio networks, in addition to using the smartphones built-in features, such as maps, internet access, and custom applications. SDRoid is a proof of concept device which receives low frequency radio signals and uses software to demodulate the signal.

**Supervisor: Dr. Peter Driessen**

### 4. Pulse-Width Modulation AC Voltage Controller

**Group: Justin Saukarookoff, Tim Bodell, Scott Warren, Brent Sutherland**  
**Contact:**

**SUMMARY**  
A transistor based AC Voltage Controller was designed in order to control the intensity of a lamp. Pulse-width modulation (PWM) was used to turn-on and turn-off MOSFETs, controlling the average voltage that is applied to a load. By modifying the duty-cycle of the control signal, the power delivered to the load can be controlled.

The control signals were generated by a microcontroller, and delivered to the MOSFETs via driver IC’s. A synchronizing signal is generated by stepping-down the voltage source and detecting zero-crossings using a comparator.

**Supervisor: Dr. A. Bhat**

### 5. eCasa Home Automation

**Group: Dane Clarke, Phil Dilk, Scott McKelvey, Steven Truant**  
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**SUMMARY**  
The eCasa Home Automation system is a sensor network that a home owner can install to set a schedule that automates the temperature in a room, and when the lights turn on and off, over the course of a week. The user can also monitor power on multiple power outlets in their home. The combination of these three features will allow the user to save money on their heating and electric bill. The sensors communicate over an Ethernet network, which allows the use of cheap, commonplace networking hardware.

**Supervisor: Dr. M. Sima**
6. Who says engineers can’t communicate?
Wireless Communication between USRP1 and MICA2 sensor

Group: Goel Edworthy, Jessie Liu, Mark Graham Johnson, Mike Palazzo
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SUMMARY
As cell phones become increasingly popular, various features have been added such as text messaging, internet, and specially developed applications and games; turning the standard cell phone into a “smart phone”. If the progression of cell phones continues in a similar fashion, in the not-too-distant future, a smart phone could be the only device used by a consumer. With a new wave of smart phone technology, the smart phone would not only serve as a phone but also as a receiver and transmitter for information needed by the consumer or nearby electronic devices. For instance, a consumer could wear various sensors, while playing sports or training, to monitor health and fitness levels. Additionally, users with medical problems could wear sensors to monitor health and control medical or other devices remotely.

By using software defined radio technology, smart phones can communicate with any sensor or wireless device regardless of the type of communication standards or protocols used. The following project will demonstrate this concept by using open-source software radio (GnuRadio) to communicate with a MICA2 temperature sensor mote through the use of a universal software radio peripheral device that can support a wide range of frequencies.

Supervisor: Dr. Lin Cai

7. Labview Software Design of Frequency Locking Laser

Group: Ben Taylor, Hao Chen, Vasil Panov
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SUMMARY
The scope of this project is to demonstrate a highly stable laser control feedback system used to frequency lock a tunable laser. This is accomplished by using a thermal-stabilized reference interferometer in conjunction with a high-speed servo controller. The problem our system addresses is the short-term wavelength stability issue found in narrow-linewidth lasers.

The interferometer is made up of two fiber optic paths of differing lengths immersed in a thermally stabilized ice-water solution. The outputs of the interferometer are detected using a balanced homodyne detector. This reduces the contribution from laser power noise because the photodetected output
depends sinusoidally on the frequency of the laser allowing the laser frequency (and wavelength) to be accurately measured as opposed to being inferred by the scan voltage, which is how laser wavelength is normally ascertained. This ultra-accurate wavelength measurement is used in a feedback control (servo), implemented to actively lock the laser to a specific wavelength. This locked state is a small window of stability which is easily lost due to any large system disturbance. To improve the robustness of the system and allow the locking state to last longer, a Labview program was written to monitor the output of the servo controller and make small adjustments to the laser piezoelectric transducer.

Supervisor: Dr. Tao Lu

Faculty Coordinator for 499 projects: Dr. Nikitas Dimopoulos

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1. Design Your Own Pong Game using the Video Game Creator

Group: Adam Fleetwood
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SUMMARY
Video games have evolved into a major entertainment industry and are popular among people of all ages. Recent advances in motion detection technology have enabled major video game developers to market motion tracking systems at a relatively low cost. The Video Game Creator allows the user to create a simple video game within minutes via a user-friendly interface. Using an infrared sensor and camera, the realized game can detect the motion of the player and react according to the game design, e.g., using one’s hand movement to play a video ping pong game. In addition to its commercial potential, the Video Game Creator has tremendous education value as it provides a step-by-step guide on how a video game is created.

Supervisor: Dr. Kin Li
1. Retractable Camera Ghimbal for use in UAS:

Group: Adam Grey, Craig Irvin, Maxym Rukosuyev

SUMMARY
This project is to develop and build a prototype camera gimbal for use in the UAVs of Quaternion Aerospace, a Sidney-based company. The company will use the camera gimbal for aerial photography, surveillance, crop monitoring, and site inspection applications. The prototype camera gimbal has been developed for use in either a fixed wing or rotary wing UAV. The gimbal is retractable and is capable of stabilizing the Sony FCBH11 HD Block Camera during flight, while maintaining an overall footprint that fits inside the existing UAV platforms of Quaternion Aerospace. According to the client’s specifications, the gimbal provides pan and tilt actuation of the camera; retracts into fuselage to protect the camera during belly landing; interfaces with an RC pulse width modulated signal to allow the camera to be pointed anywhere in a hemisphere below the airframe; and interfaces to the UAV Autopilot for operating the camera functions (zoom, start/stop recording, take photo). An Inertial Measurement Unit separate controller board interfaces the pulse width modulated servo signal from the Autopilot to the camera gimbal. This system keeps the camera pointing in the same direction regardless of the UAV attitude.

Supervisor/Sponsor: Quaternion Aerospace

2. Open Education Kit:

Group: Earl Bell, John Edmison, Degnan Hembroff, Sydney Jung

SUMMARY
This project is to develop a modular instrumentation and control kit for use in educational settings. The project is organized by Nathan Wren, a recent MECH/Mechatronics Specialization grad, in association with Let’s Talk Science: UVic chapter. The prototype system has been developed as a kit to be used by Let’s Talk Science: UVic chapter for immediate use in science outreach. The aim of the project is to create a means for UVic engineering students, local industry, volunteer organizations and local educators to collaboratively improve the
impact of science and technology curriculum for tomorrow's scientists and engineers. According to the client’s specifications, the system is based around the open hardware/software Arduino platform. It consists of: a microcontroller unit core in a robust enclosure exposing the I/O ports and the hardware reset button, as well as on-board software communication with a classroom computer over USB; plug-in instrumentation modules including an inexpensive optical encoder and a thermocouple; and data display and experiment control software that can be migrated to open source platforms.

Supervisor/Sponsor:

3. Electronic bat swinger with variable controls

Group: James Brooks, Heshan Fernando, John Ogilvy

SUMMARY
This project is to develop a prototype batting device that Canassist can use for challenger baseball leagues. Challenger baseball leagues exist around BC where disabled kids and their parents get together to play a fun game of baseball. Some kids are confined to wheelchairs and unable to swing a bat so their parents have to swing the bat for them. A standalone device that sits on the ground and swings a bat with the push of a button to hit a ball off of a tee would give these kids independence. A batting device for challenger leagues needs to be portable and manageable for a parent to transport to and from the field. Waterproofing any electrical components and safely swinging the bat are the key design issues. Canassist owned an early batting device model using a starter motor, but the design needed further improvements. As per the client’s requirements, the new prototype allows the users to control the tilt and height of the bat and the velocity at which the bat swings. The prototype also offers a simplified user interface with a large button control.

Supervisor/Sponsor: CANASSIST

4. Plug-in Hybrid Electric Vehicle (PHEV) Test Bed with Parallel Powertrain:

Group: Joshua Pacheco

SUMMARY
This project is to review and further improve the parallel powertrain plug-in electric vehicle (PHEV) testing platform currently under development at the University of Victoria, and to proceed with the development and fabrication of
the prototype vehicle and its control system. The existing PHEV design is based on a modular design and serves as an intermediate level experimental powertrain design and vehicle control system testing facility between the hardware-in-the-loop and full size vehicles, and uses a mini-truck to support various unfolding Green Vehicle research activities and industrial collaborations at the University of Victoria. This project extends the existing PHEV design to include three possible powertrain architectures (series, parallel, power split) and develops controls to allow electric vehicle only operation, internal combustion engine starting, and bidirectional electrical power flow to the motors (regen and assistive capability). The testing of the control programs will be performed through hardware-in-the-loop simulation using the dSPACE controller of the existing platform, and the testing of the prototype vehicle will be carried out using the hybried electric vehicle chassis dynamometer.

**Supervisor/Sponsor: Dr. Z. Dong**