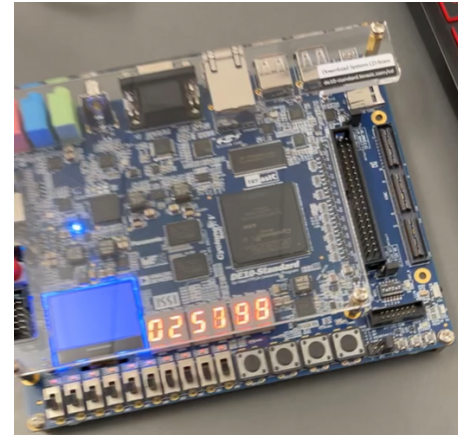


Digital Clock Diagram

The diagram illustrates the internal structure of the Digital Clock, which is divided into three main sections: Hours, Minutes, and Seconds. Each section contains a Counter, a Comparator, and a Bin2Seven converter.

- Hours Section:** Contains two identical units. Each unit has a Counter (rst, En), a Comparator (4-bit input), and a Bin2Seven converter (7-bit output).
- Minutes Section:** Contains two identical units. Each unit has a Counter (rst, En), a Comparator (4-bit input), and a Bin2Seven converter (7-bit output).
- Seconds Section:** Contains two identical units. Each unit has a Counter (rst, En), a Comparator (4-bit input), and a Bin2Seven converter (7-bit output).

The Digital Clock is controlled by the Digital Clock FSM, which receives the clk and rst signals and outputs the 1-Second Clock signal. The Digital Clock FSM also receives the 1-Second Clock signal and outputs the rst and En signals to the Counters.



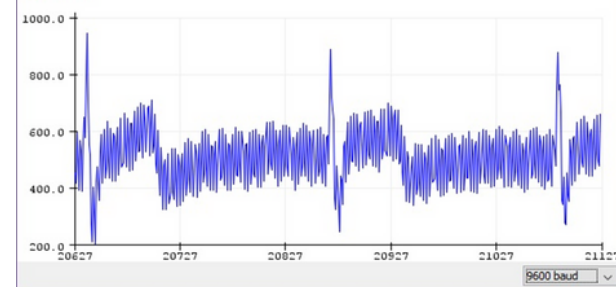
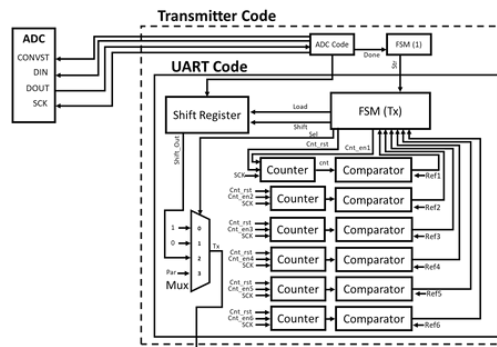
Results

- Use an FPGA to create a digital clock with start, stop, and reset
- Followed given block diagram for programs outline
- Implemented all segments using LED displays and switches on FPGA board
- Successfully programmed and implemented fully functional digital clock on an FPGA

The block diagram illustrates the internal architecture of the ADC module. It is divided into two main sections: **Ref = 100** and **Ref = 12**.

- Ref = 100 Section:**
 - FSM (Finite State Machine):** Receives `rst` and `cnt` signals. It controls the `Comp_sel1` signal and the `cnt` signal for the top Counter.
 - Top Counter:** Receives `cnt` from the FSM and `Comp_sel1`. Its output is `cnt` to the top Shift Register.
 - Top Shift Register:** Receives `cnt` from the top Counter and `SCK`. Its output is `ADC Code`.
 - Bottom Counter:** Receives `cnt` from the FSM and `Comp_sel1`. Its output is `cnt` to the bottom Shift Register.
 - Bottom Shift Register:** Receives `cnt` from the bottom Counter and `SCK`. Its output is `ADC Code`.
 - MUX (Multiplexer):** Receives `SCK` and `cnt` from the bottom Shift Register. Its output is `ADC Code`.
 - 25MHz clock:** Provides a clock signal to the FSM and the bottom Counter.
- Ref = 12 Section:**
 - FSM:** Receives `rst` and `cnt` signals. It controls the `Comp_sel1` signal and the `cnt` signal for the bottom Counter.
 - Bottom Counter:** Receives `cnt` from the FSM and `Comp_sel1`. Its output is `cnt` to the bottom Shift Register.
 - Bottom Shift Register:** Receives `cnt` from the bottom Counter and `SCK`. Its output is `ADC Code`.
 - MUX (Multiplexer):** Receives `SCK` and `cnt` from the bottom Shift Register. Its output is `ADC Code`.
 - 25MHz clock:** Provides a clock signal to the FSM and the bottom Counter.

The module outputs `Done`, `indy`, and `ADC Code`. The `ADC Code` is also labeled as `CONVST` and `DIN`. The `ADC Code` is also labeled as `DOUT` and `SCK`.



Results

- Use **electrode sensors** to amplify and measure a human heart signal
- Use an **FPGA** to read the signal as data to then display
- Convert a generated heart signal from electrodes to a digital signal for FPGA using an **ADC**
- Take the converted digital signal and transmit the serialized data from a **UART** to then be plotted via serial monitor
- Scripted several **test benches** for simulations and debugging in **ModelSim**
- Completed scope of the project with over 1,500 lines of VHDL code

RYAN SHAPPA

ELECTRICAL ENGINEER & PHYSICIST



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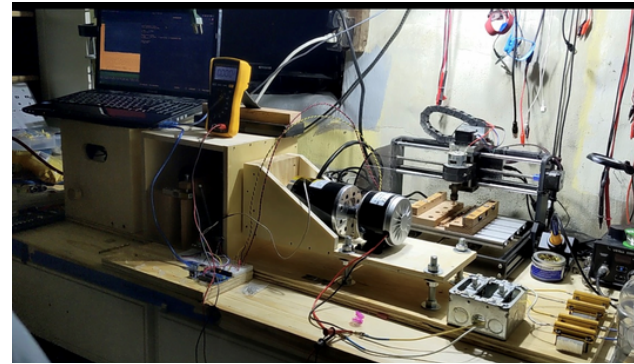
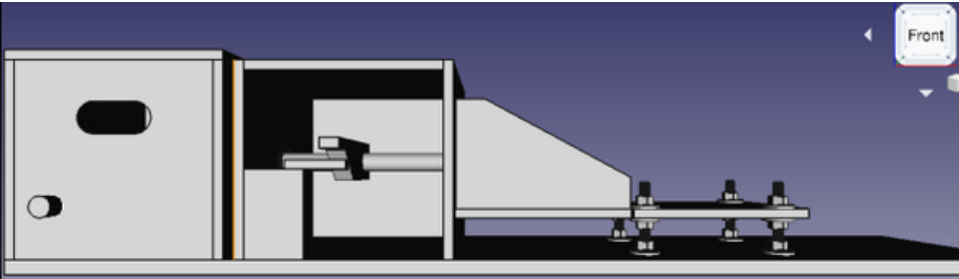


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DYNAMOMETER - CAPSTONE PROJECT



What?

- Design and construct a dynamometer to run various measurement tests on DC motors
- Maintain a **budget** of less than \$300

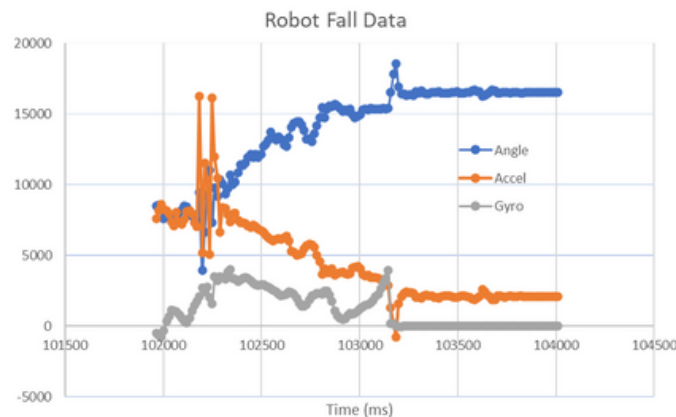
How?

- Constructed frame out of wood per **CAD designs**
- Programmed multiple Arduinos for measurement tests
- Created **Graphical User Interface** (GUI) for user friendly experience

Results

- Machine maintained measurement accuracy of **93%**
- Project will be kept as example for future students

SELF BALANCING ROBOT - CONTROL THEORY PROJECT



What?

- Fabricate and program a self balancing robot using a **parts list** and sensor libraries
- Program robot to undergo a **race** without falling

How?

- Used **Root Cause Analysis** when programming **PID** controller and race task on **RaspberryPi** with **Python**



Results

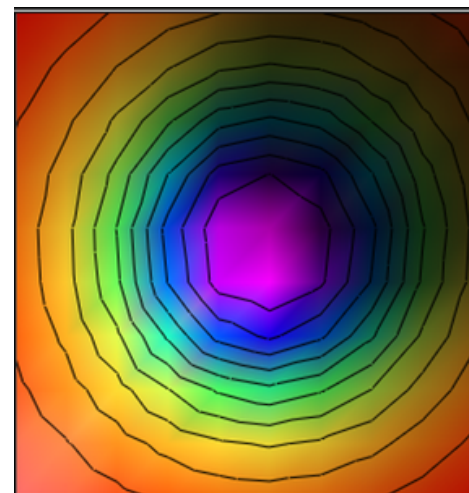
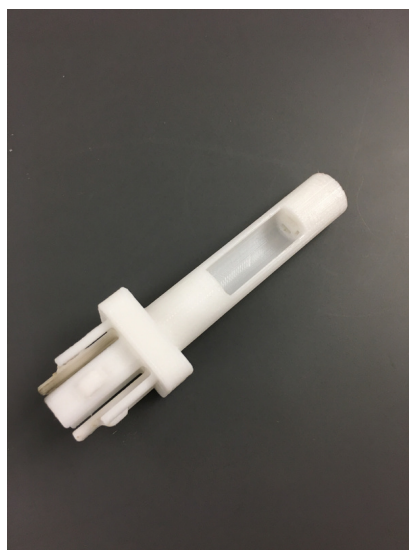
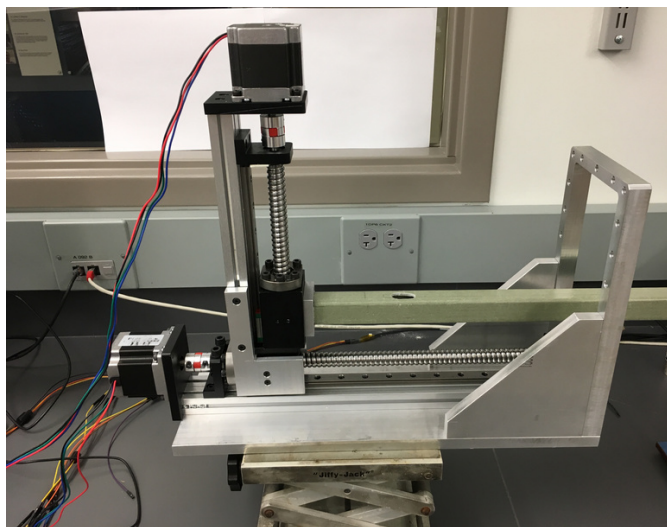
- Won 1st place in class competition

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G-2 EXPERIMENT - FERMILAB SUMMER RESEARCH



What?

- Take measurements of the magnetic field using a **magnetometer** with different magnets
- Develop custom designs for accuracy improvements

Results

- The design and assembly was successful as it was able to take accurate measurements with different magnets of different strengths

How?

- Programmed script in **LabVIEW** to control acquired signals
- 3D-printed fixed probe for **hall voltage sensors**



Probing Regions of the g-2 Magnetic Field

Ryan Shappa
Dr. Paul Bloom, Supervisor
Department of Energy, Visiting Faculty Program



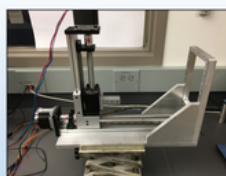
Introduction

- The g-2 storage ring has two sets of straw trackers each comprised of eight modules. These detectors reconstruct the trajectories of positrons arising from muon decays.
- While the magnetic field seen by the muons is measured to better than 250 ppb, the field in the region of the trackers has not been measured. Currently, the particle tracking uses simulation data of the field.
- Measuring the field in this region will improve the quality of the tracking and contribute to uncertainty reductions on the g-2 measurement.



Probing the Field

- Asensor HE244T Hall Probes are used to measure the magnetic field because of their range and precision.
- An electric current is driven through a conductor in the probe. In the presence of a magnetic field, electric charge separates, creating a Hall voltage.
- The HE244T is given a constant current of 1 mA, which produces 100 mV/T.
- The HE244T are only single axis, so three are employed to measure all the components of the magnetic field.



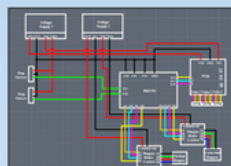
Assembled Linear Actuators and Fixture



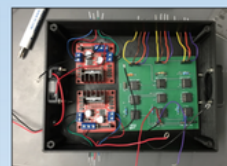
Final Probe Holder Design

Creating the Instrument

- Two linear actuators are used to move the probes in the radial and vertical directions.
- A fixture to connect the actuators to the bulkhead of the storage ring was designed and machined out of aluminum.
- A hollow fiberglass rod was chosen to connect to the vertical actuators for inserting the probes into the magnetic field.
- A probe holder was designed to hold the probes on the end of the rod. Each design was 3D printed, tested, and improved. The final design allows the probes to fit inside of a zero gauss chamber for calibration.
- An enclosure was designed and 3D printed to house the actuator boards and the PCB.



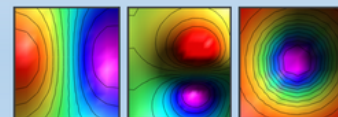
Circuit Diagram of the Assembly



Inside look of the wired enclosure

Testing the System

- A LabVIEW VI is used to acquire and digitize the signals and to control the probe position. All of this was processed through a MyDAQ NI interface.
- A variable gap magnet is used to test the probes, VI, and the absolute calibration procedure. Multiple runs have been made to insure connections are secure, and that the probes are aligned in the probe holder.
- Further testing at Argonne National Laboratory is planned.



X, Y, and Z axis heat maps of a dipole magnetic (uncalibrated).

Future Steps

- The timeline for conducting the final in-situ measurements will be determined by the shutdown coordinators.

Acknowledgements

- We would like to thank the Department of Energy and the Visiting Faculty Program for supporting this project.
- Dr. Mandy Rominsky, Fermilab, VFP mentor.
- Dr. Frank Harwath, NCC, engineering support.
- John Nidzjon, et al, for fabrication support.
- Tyler Weitzel, VFP, go see his poster!