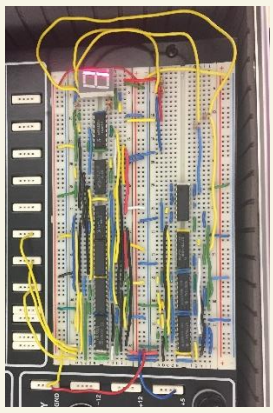
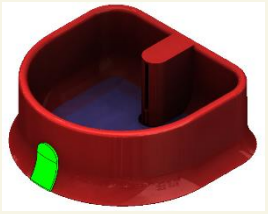




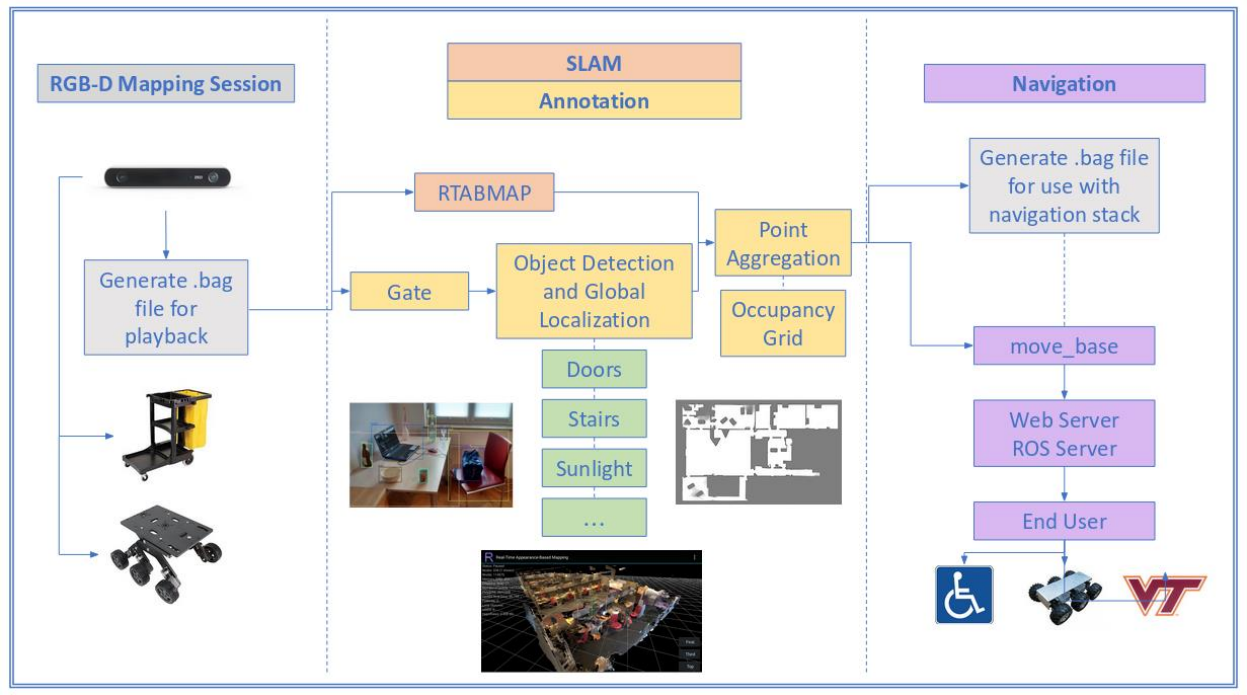
Joshua D. Eckels

Project Portfolio

eckelsjd@rose-hulman.edu

Contents

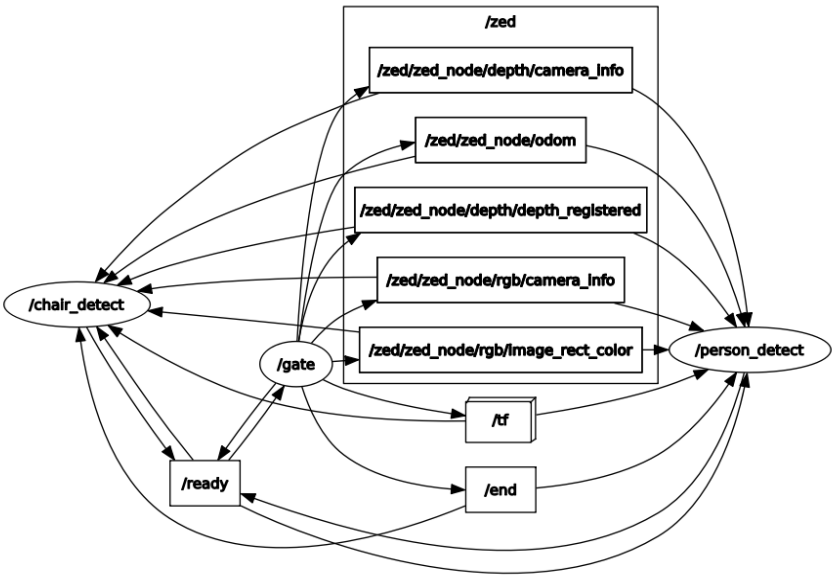
Accessibility Constraint Mapping



This project is part of ongoing academic research at the Assistive Robotics Lab at Virginia Tech. The idea for the project stemmed from the social engineering principles surrounding handicapped navigation on the Virginia Tech campus and grew out of its applicability to both fields of autonomous navigation and social engineering. All research was funded by the National Science Foundation (NSF) as part of a Research Experience for Undergraduates (REU) program at Virginia Tech in Automotive Engineering.

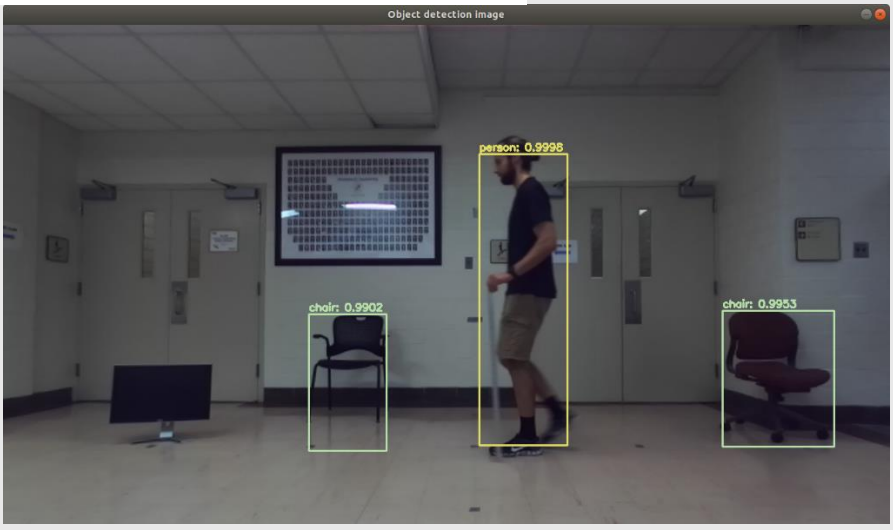
The goal of this project is to provide Robotic Operating System (ROS) nodes capable of identifying potential barriers or constraints in the environment for the purpose of autonomous robot or handicapped/accessibility navigation and traversability.

A long term use of these capabilities would be the potential to generate global maps of the environment (using existing Simultaneous Localization and Mapping (SLAM)-based approaches) that are annotated and labeled with different barriers. These global maps, which have been annotated with the location of barriers such as stairs, doors, and handicap-accessible blue buttons, could then be exploited for front-end use, allowing users to plan an optimized path from point A to point B that accounts for all personally potential barriers, whether the user is a handicapped wheelchair user or a small autonomous rover.



ROS node and topic diagram: SLAM annotators (person_detect and chair_detect) nodes are shown with the gate node and corresponding ZED camera topics.

Computer vision using OpenCV: Chairs and people are detected in the environment using neural networks and computer vision.



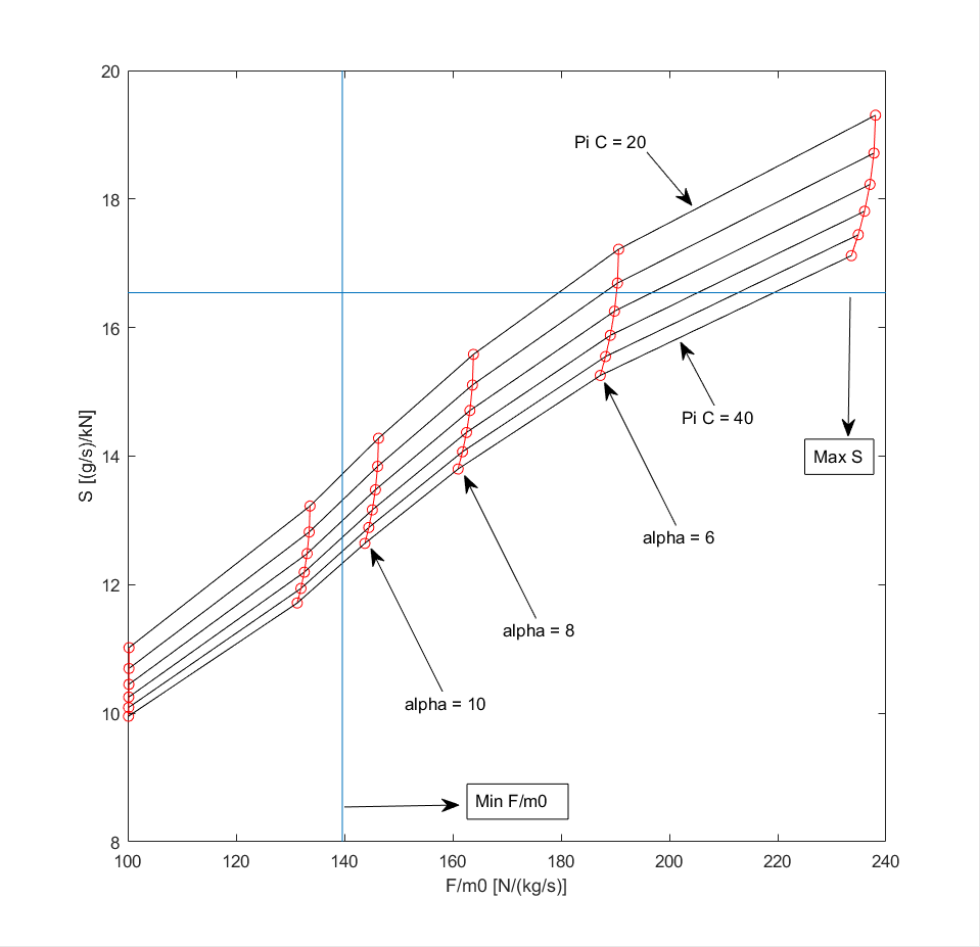
Relevant skills:

- Python software development
- Robotic Operating System (ROS)
- Computer vision (OpenCV)
- Simultaneous Localization and Mapping
- Convolutional neural networks (CNNs)

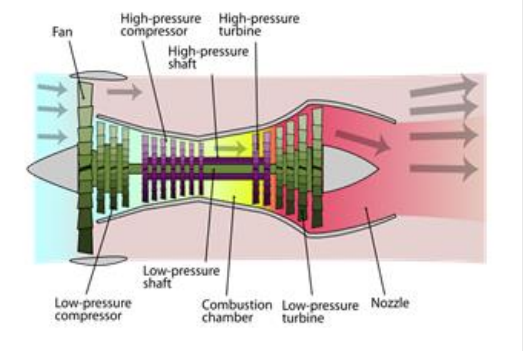
Github:

- https://github.com/eckelsjd/access_mapping.git

Turbofan Cycle Analysis



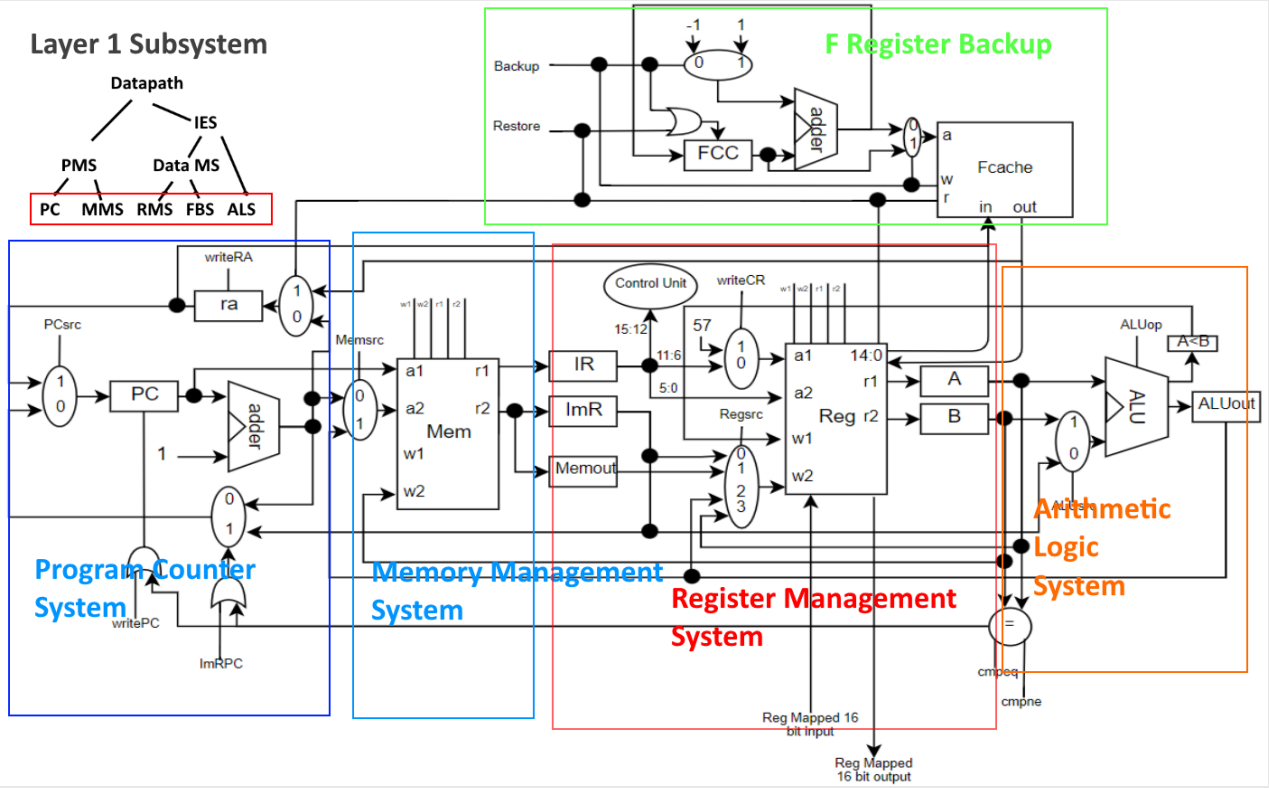
As part of a propulsion systems course, all inlet and outlet properties of a turbofan engine were analyzed with varying bypass and compressor ratios to produce the carpet plot shown above of specific thrust ($\frac{F}{\dot{m}_o}$) vs. thrust-specific fuel consumption (S).



Relevant skills:

- Matlab
- Excel
- Propulsion / thermodynamics
- Real turbofan engine cycle analysis

16-bit Computer Processor



The culminating group project of a computer architecture course had our team of four design and implement a mini computer processor capable of performing several basic algorithms.

A 16-bit assembly language instruction set was modeled off of the 32-bit MIPS assembly language and a load-store and cache-based datapath was implemented, as shown above. The datapath was fully implemented and tested extensively in Verilog. In addition, an assembler and code simulator were built in C++ for our assembly language.

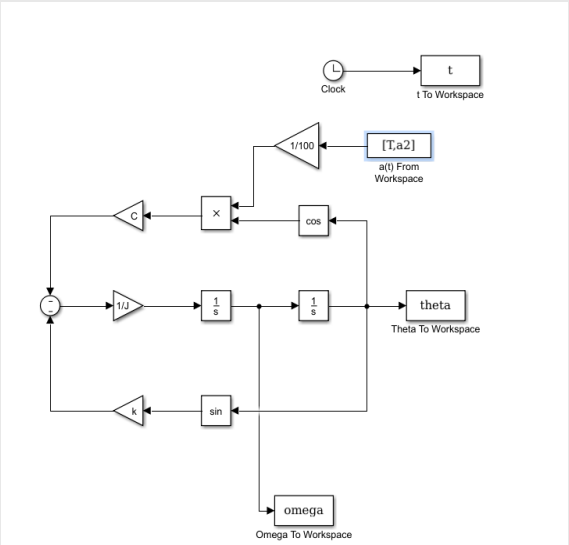
Github:

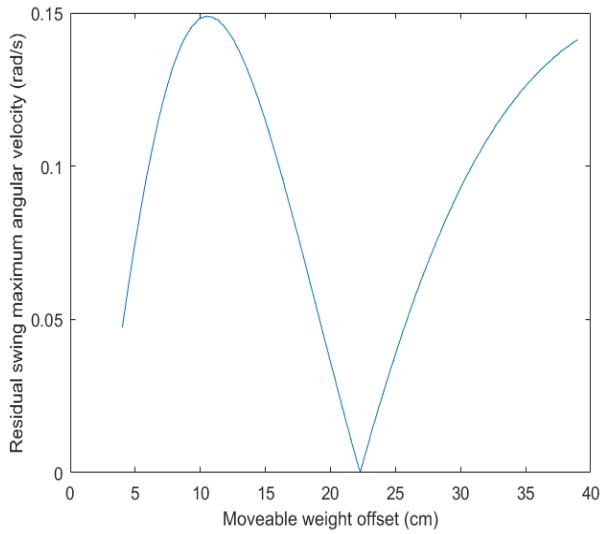
- https://github.com/eckelsjd/assembly.git

Relevant skills:

- Verilog
- C++
- MIPS assembly

Sliding Crane Optimization





This project simulated the second order differential equation modeling the residual swinging velocity of a sliding crane pendulum after its trolley (at the pivot of the pendulum) stopped moving. A moveable weight was adjusted on the pendulum to minimize the residual swing's maximum angular velocity.

A plot of the maximum residual swing angular velocity as a function of weight offset distance is shown above, as well as a Simulink diagram used to model the system. Matlab and Simulink were used throughout the project for all system modeling and analysis.

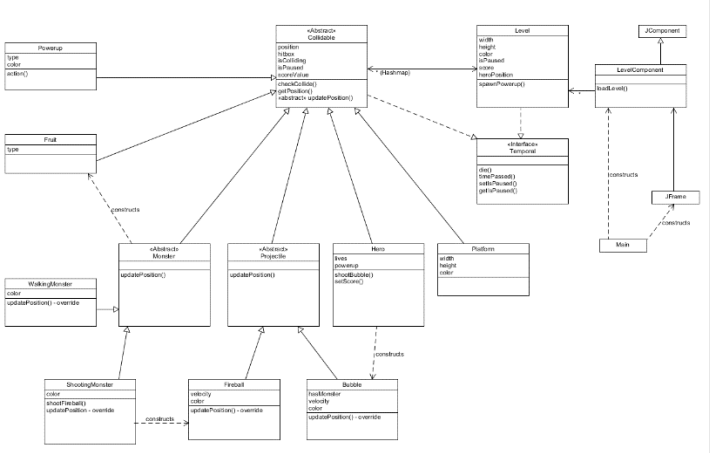
Relevant skills:

- Matlab
- Simulink
- System modeling with differential equations

Java Arcade Game

The classic platform 8-bit arcade game, Bubble Bobble, was implemented as part of a software development course.

Using software engineering principles and Unified Modeling Language (UML), classes were first designed to encompass major components of the Bubble Bobble arcade game. These classes were fully implemented using Java as a platform. A graphical user interface (GUI) was also implemented using Java Swing graphics and provided support for keyboard input.



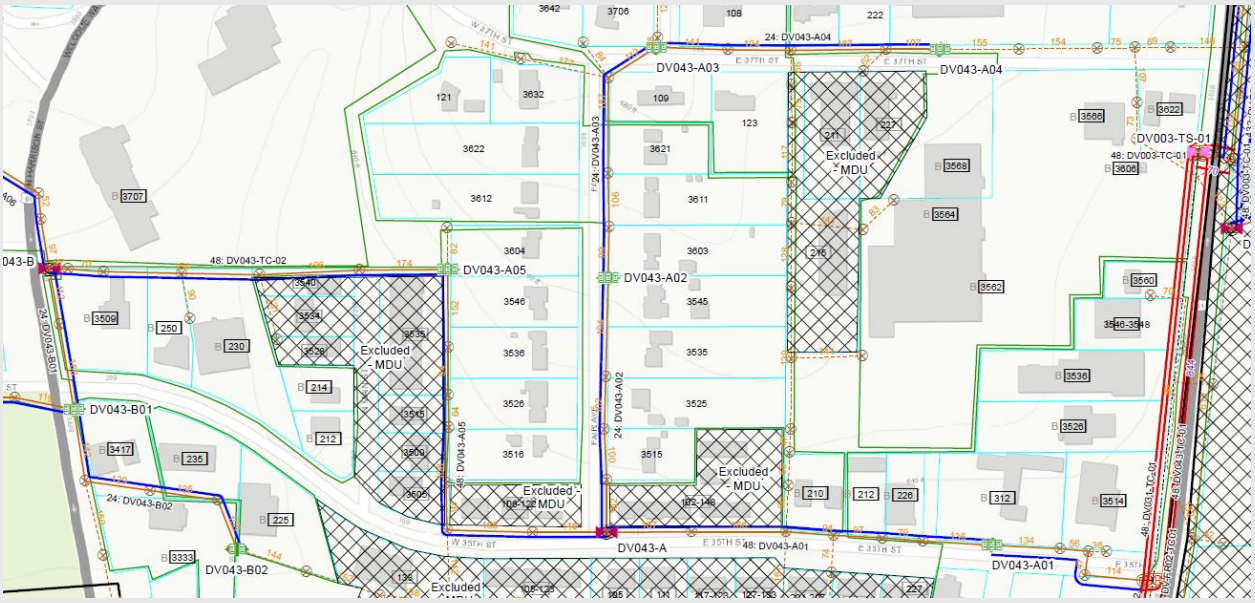
Relevant skills:

- Java software dev
- UML, polymorphism

Github:

- https://github.com/ecksjd/bubble_bobble.git

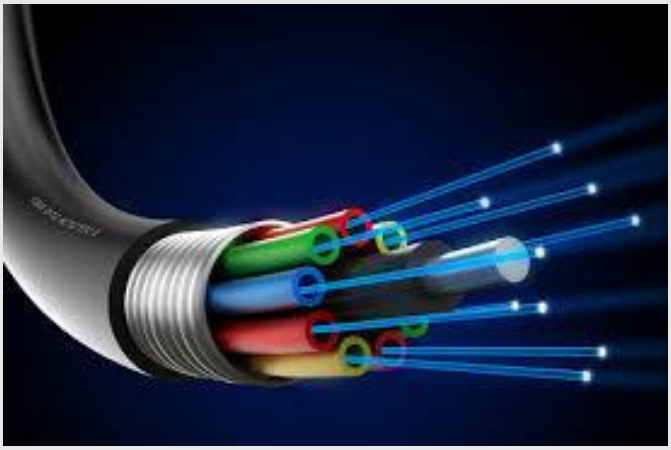
Fiber Cable Distribution



As part of a summer internship at Metronet, (a fiber optics telecommunications company), ongoing project work involved updating and maintaining fiber distribution maps, as shown above.

Using geographical information systems (GIS) software, the fiber distribution was spread into new regions, while placing and tracking all fiber and telecommunications equipment and providing a bill of materials and cost analysis for the company. The project also involved performing quality control on previously designed distribution maps.

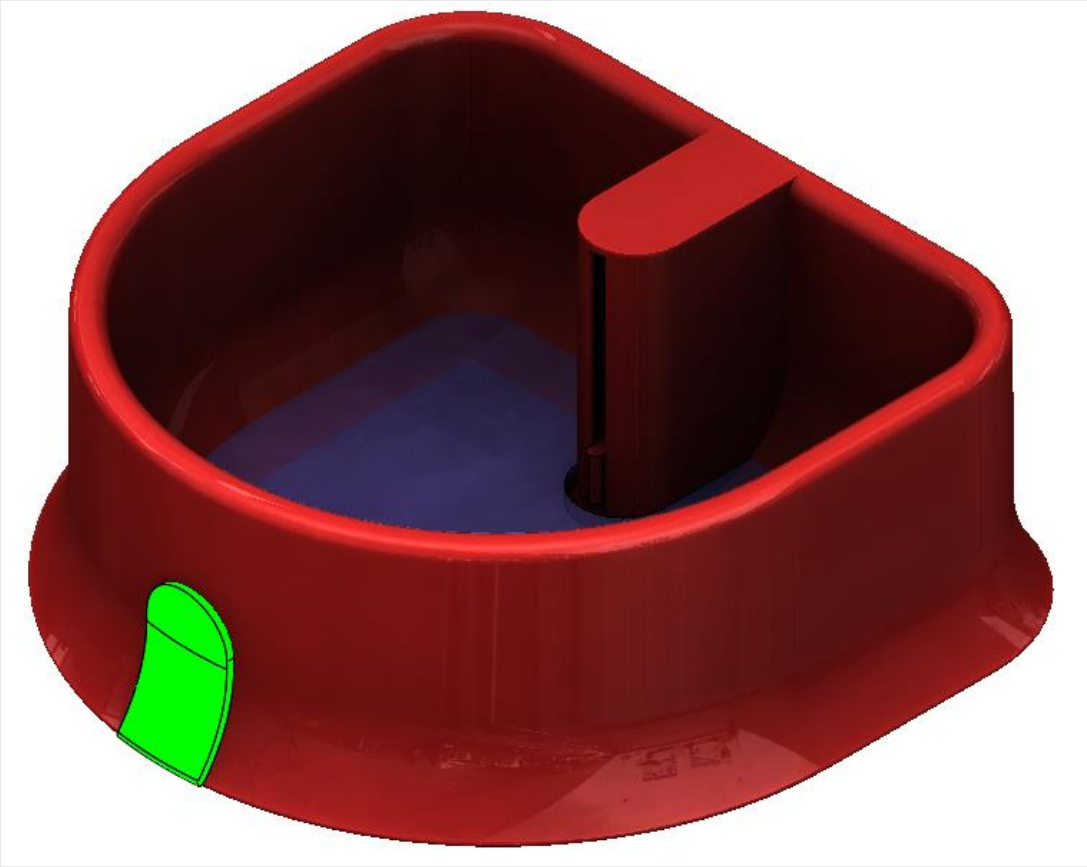
A full guide and documentation of the project was written and reviewed in a fifty-page procedure manual.



Relevant skills:

- Geographical information system (3-GIS)
- Bill of materials and cost analysis
- Microsoft Excel, Word

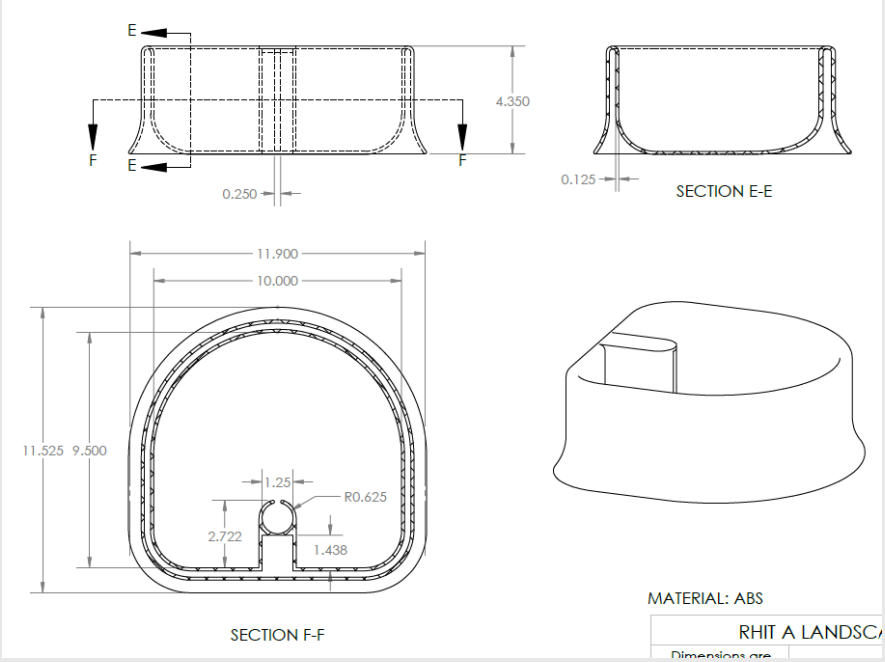
Pet Bowl Design



As part of an entry-level engineering design course, the pet bowl shown above was designed, prototyped, and documented following basic design process principles. The green LED at front indicates low water level by means of a floating magnet that triggers an on-board hall-effect sensor circuit.

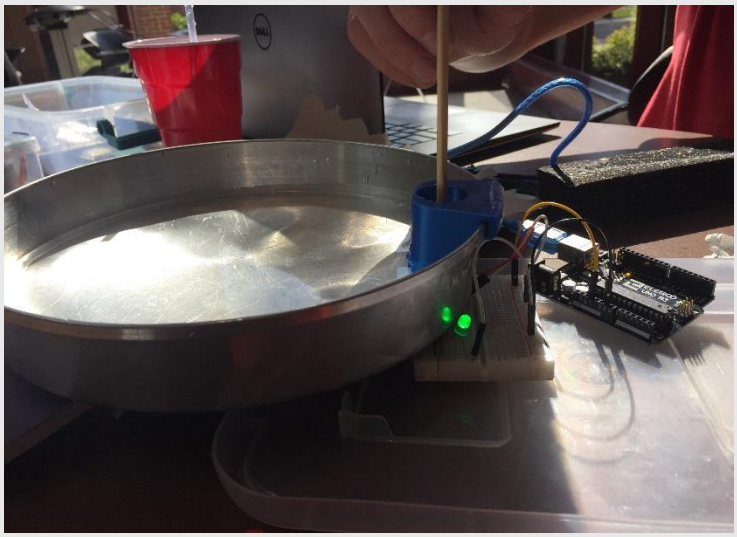
The market was first evaluated and product benchmarking was performed on similar products. Several gaps in the user's experience were discovered and solved with several design ideas. A decision matrix was used to evaluate all design ideas against tangible metrics. The chosen design was further revised and reviewed to meet original design goals.

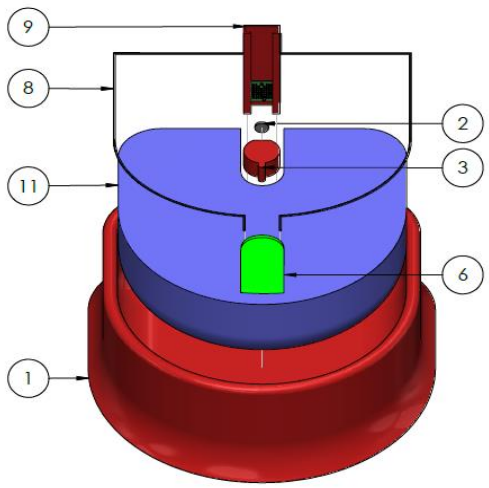
Solidworks was used to implement part geometry and show the final product. The design was prototyped, tested, and evaluated against design criteria. The whole project was documented in detail.



Solidworks design and drawing: Solidworks is used to fully describe part geometry and produce a viewable result of product design for the end user.

Product prototyping: A magnet with a basic hall-effect sensor circuit is setup and shown to the right. The green LED lights up as proof of concept for a low water level indicator for a pet bowl.

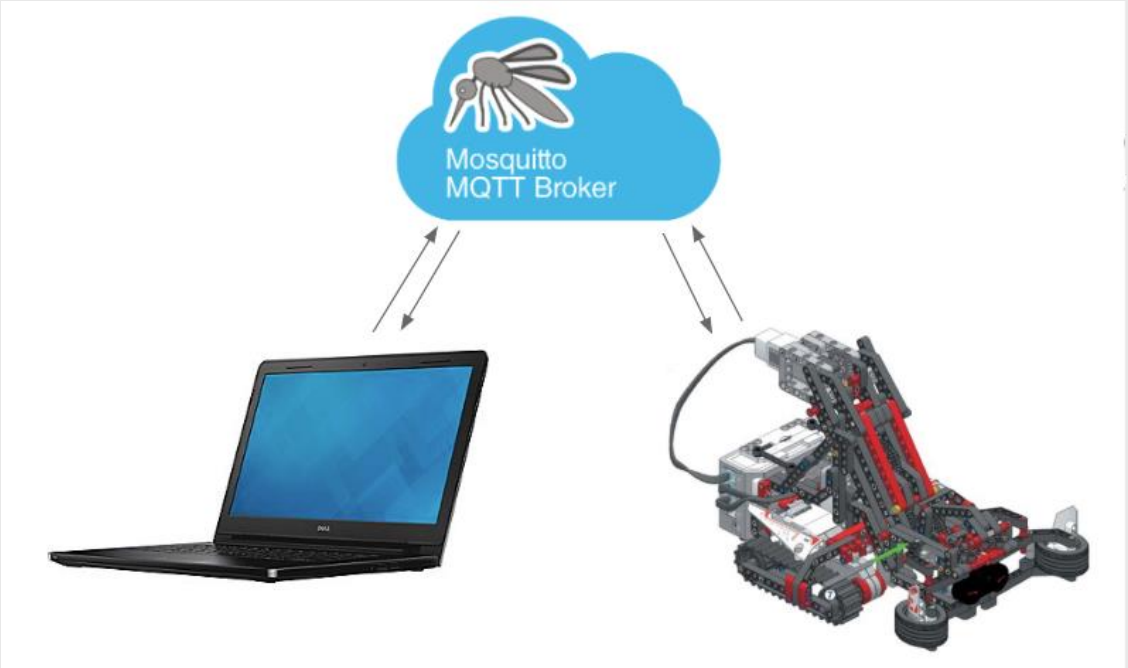




Relevant skills:

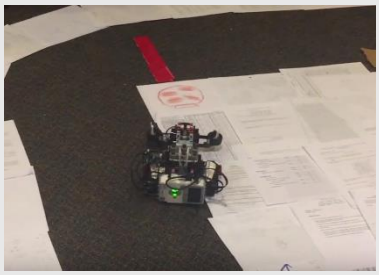
- Solidworks
- Integrated circuits
- Product benchmarking
- Design evaluation
- Prototyping
- Functional analysis
- Cost analysis and math modeling

Python Robotic Control



Using Python as a platform and MQTT communication through a Linux command-line, the popular Mario Kart game was simulated with a legoEV3 robot. A laptop was used for keyboard communication and control of the legoEV3 robot, and the robot was programmed to respond to the environment in a fashion similar to the Mario Kart game.

The full project is located on the Github page below, and a video demonstration is included on Youtube.



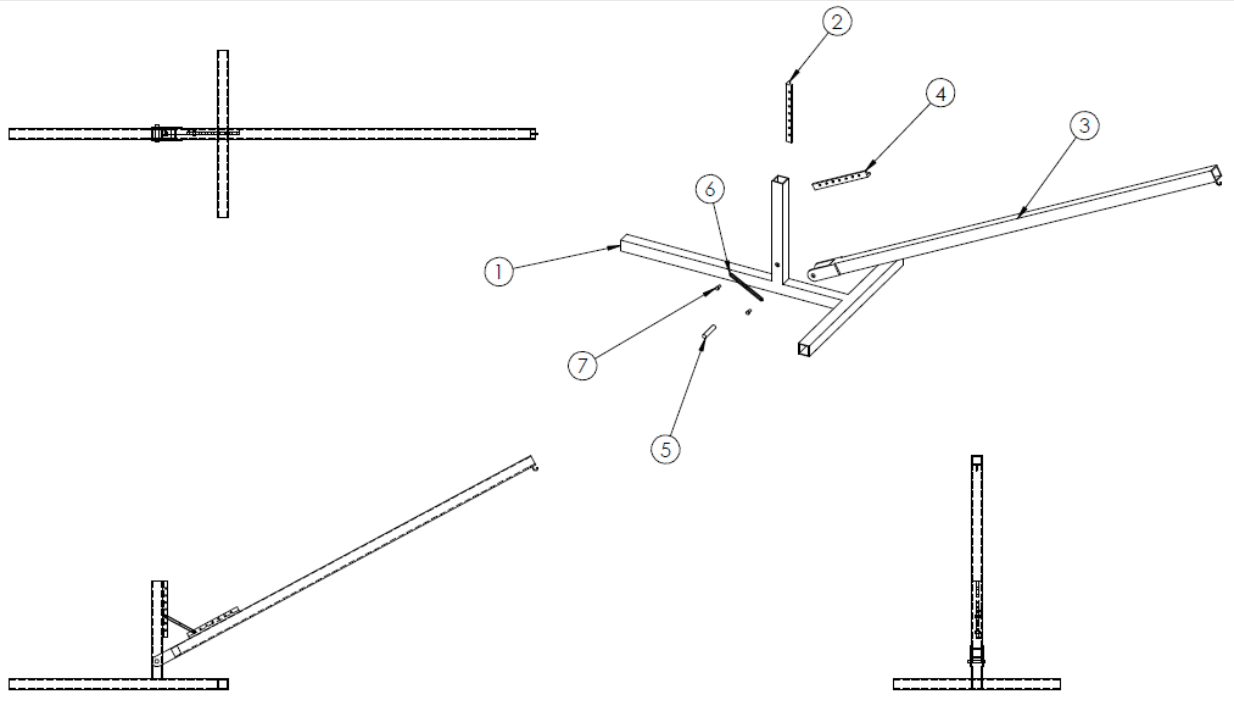
Relevant skills:

- Python robotics
- Linux / Shell
- Server / Client comm

Websites:

- https://github.com/eckelsjd-rose-old/ev3dev-curriculum.git
- https://youtu.be/EWk-NJnEr0Q

Crane Linkage



The goal of this project was to design and fabricate a link to hold the crane assembly (shown above) in a static state when a given load is applied.

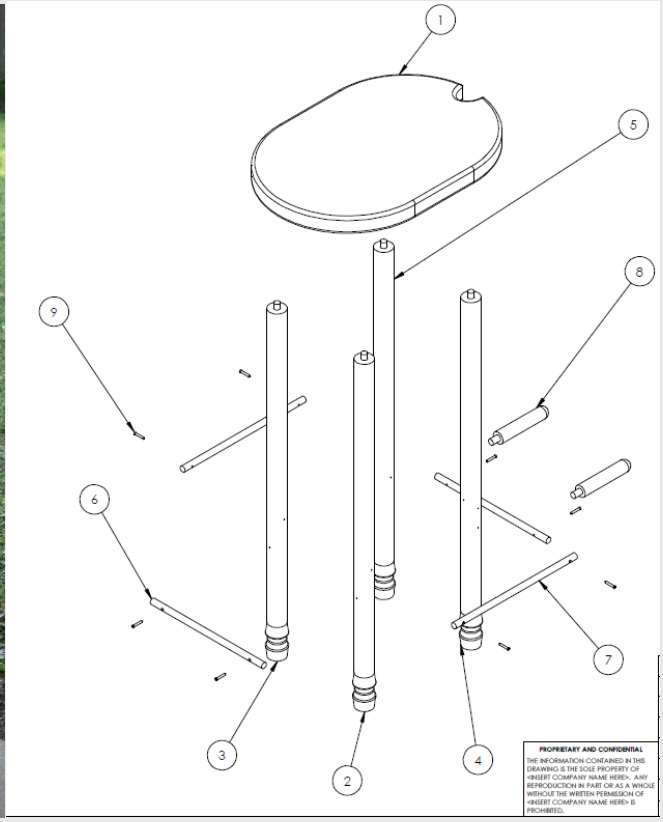
The crane assembly was first measured and modeled into Solidworks. A set of parameters was developed to fully describe the link geometry in relation to the crane geometry. Material analysis was performed on the plastic link to determine stress and strain relationships. Optimization was performed using Maple software to minimize the weight of the link.

The link was drawn, fabricated, and tested on the crane assembly for static failure.

Relevant skills:

- ❖ Solidworks
- ❖ Material analysis

Guitar Chair



A school Solidworks idea turned into a personal summer project. Instead of buying a guitar stand online, it was way more fun to turn an old school project into reality.

From machining oak wood in the shop environment to painting those final beautiful coats of polyurethane, the improvised guitar wood stool and stand turned out for the better.

Relevant skills:

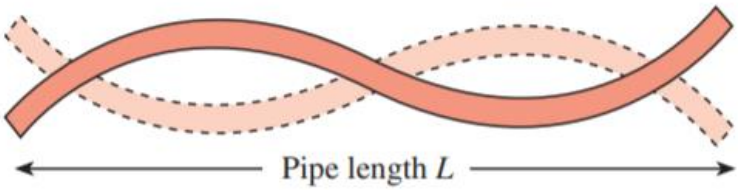
- ❖ Shop tools (mill, lathe, etc.)
- ❖ Solidworks
- ❖ Wood fabrication

Fabrication: The wood stool is shown above being assembled in the shop after machining all individual parts.

Copper Xylophone

Inspired by my love for music and newly-found talent for woodworking, the copper xylophone shown above was a quick summer project to prove some of the physics of sound I had been studying at the time.

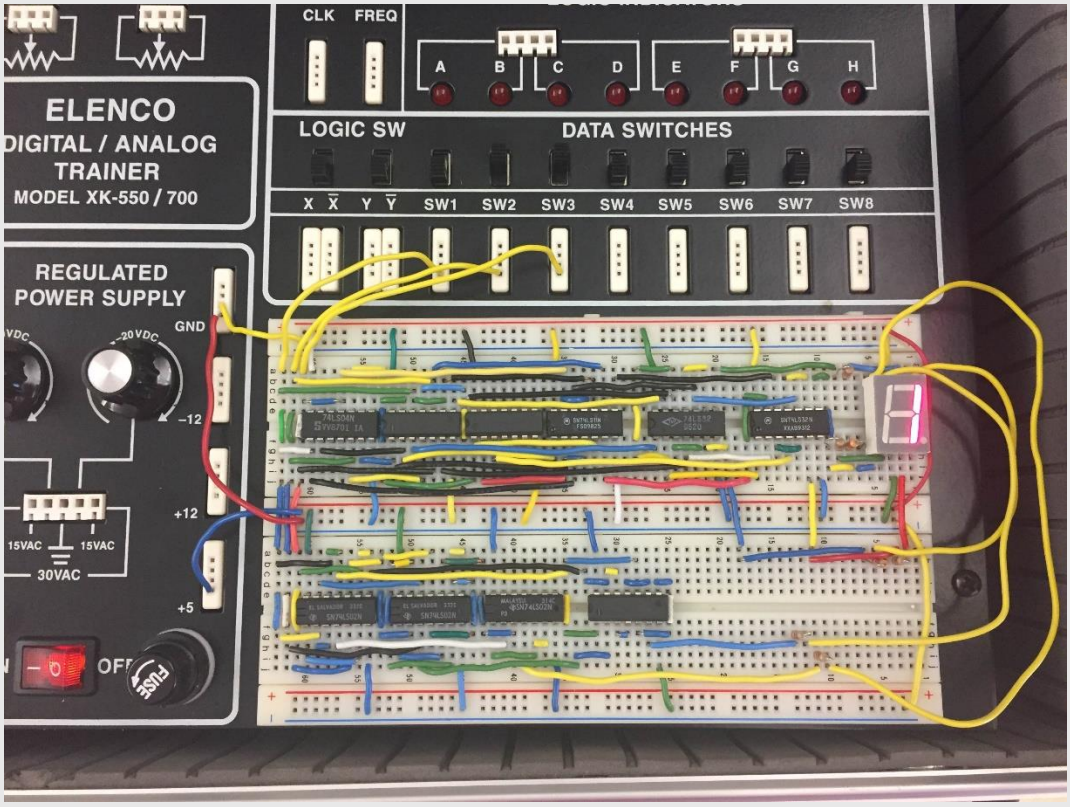
The wood frame was machined and cut to size in an aesthetic fashion. The copper bells were cut from regular old copper pipe that was laying around the house. The eight bells were cut to length to produce a full C scale, using properties of the material and the equations developed in the paper linked below.



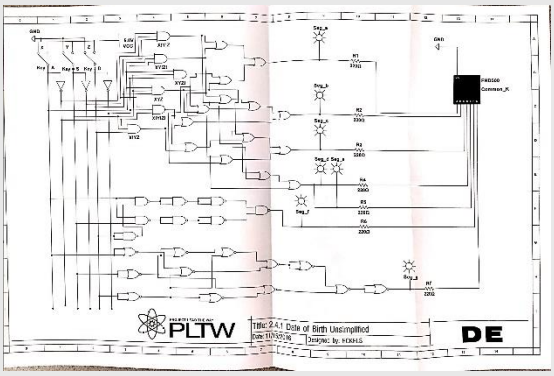
Websites:

- http://users.df.uba.ar/sgil/physics_paper_doc/papers_phys/lapp.pdf

Integrated Circuit Electronics



A school project turned into a personal hobby, and a hobby turned into a field of study in computer science, the digital electronics circuit shown above displays my date of birth one digit at a time on the seven-segment display.



While the project is more cool-looking than useful, I am including it here because it began my study and interest into the vast black box of computers. I suppose it also demonstrates a pretty thorough understanding of bread-boarding. So many hours, wasted . . .

Relevant skills:

- Absolutely None

About Me

If you are reading this, then you have made it further than most. This page is for my most long-term project to date. I have been working on this one since I can remember, and there is still quite a bit of work left. This page is just intended to give some background on who I am and what I do, outside of writing boring documents like this one all day.

I am currently pursuing my BS in mechanical engineering at Rose-Hulman Institute of Technology in Terre Haute, IN. If you haven't heard of the school, then you probably haven't heard of the city either. My other primary interests in school are computer science and aerospace engineering.

I love playing music on the piano and guitar, and I have a sick taste in music, (which essentially means if its Rock, its good). I'm really into running, cycling, and swimming, and hope to do an Ironman soon. I love flying, and I dream of going to space one day.

Interests, Aspirations, etc.

- ❖ Piano, Guitar, Choir
- ❖ Building and flying a plane
- ❖ Completing an Ironman
- ❖ Going to Mars
- ❖ Becoming a chess grandmaster