David Gabriel

About Me

I am a graduate student at Northeastern University studying for an M.S. in Electrical and Computer Engineering.

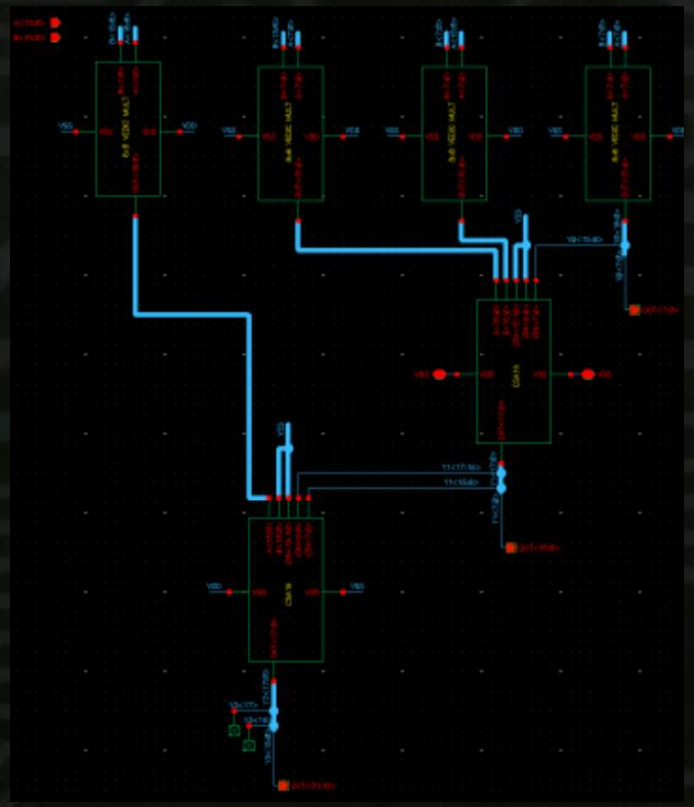
I am extremely passionate about learning and creating and believe both are central to the human experience. Thus, I am eager to continue to apply what I have learned to create impactful technologies.

Northeastern Projects

16-bit CMOS Multiplier

Class: VLSI Design

Researched multiplier architectures and designed transistor-level schematics for a 16-bit Vedic multiplier using Cadence Virtuoso. (Note: this includes the design and sizing of inverters, nand gates, nor gates, xnor gates, half adders, full adders, carry save adders, etc.)



Takeaways:

Gained exposure to the Cadence Virtuoso design software. Learned how to design and simulate VLSI designs. Ran out of time to optimize using logical efforts.

2DES and the Meet-in-the-Middle Attack Simulator

Class: Computer Hardware Security

Implemented double DES in C++, then performed the meet in the middle attack to extract the keys.

```
/ Function to perform the full DES encryption/decryption
nsigned long long DES(unsigned long long block, unsigned long long key, bool decrypt=false) {
    std::vector<unsigned long long> subkeys = generate_subkeys(key);

    // Initial permutation
    block = io_permutation(block, IP);

    for (int round = 0; round < 16; round++) {
        block = (decrypt) ? roundFunction(block, subkeys[15 - round]) : roundFunction(block, subkeys[round]);
        // std::cout << "Round " << round + 1 << ": " << std::hex << block << std::endl;
    }

    // swap left and right
    unsigned long long left = (block >> 32) & 0xFFFFFFFF; // left 32-bits
    unsigned long long right = block & 0xFFFFFFFF; // right 32-bits
    block = (right << 32) | left;

    // Final permutation (IP-1)
    return io_permutation(block, FP);
```

```
Finished generating encrypted List.
Decrypted Block: e5e894365c10f098
Plaintext: 123456789abcdef
DES CRACKED!
Key 1: 0xfedcba
Key 2: 0x12
```

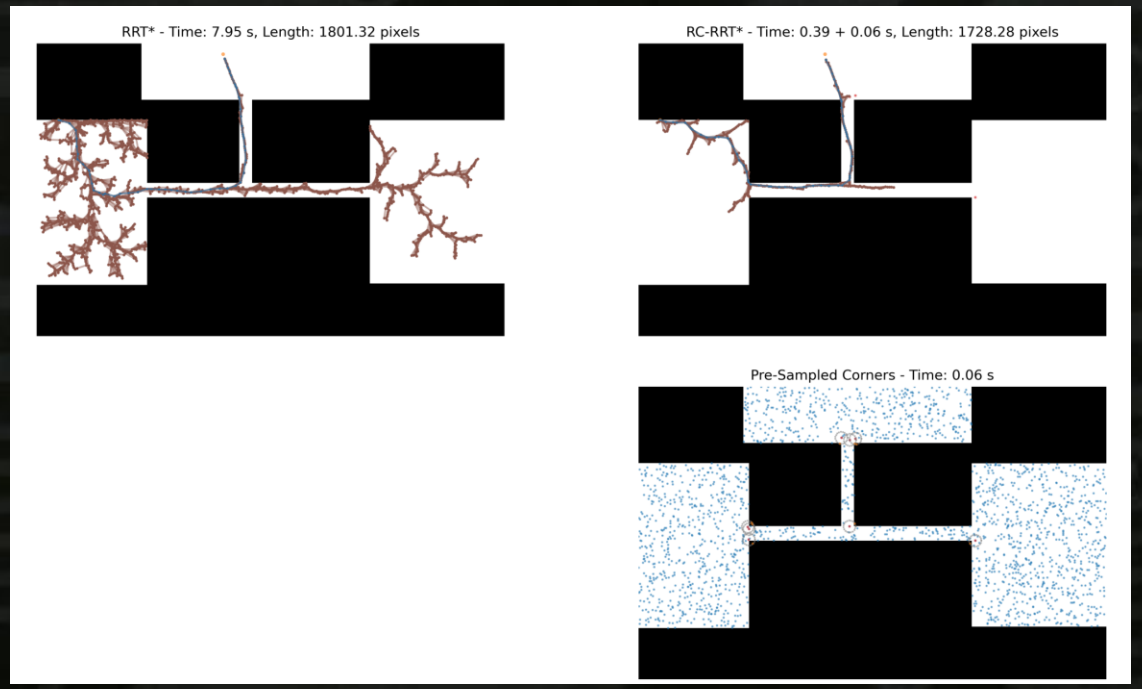
Takeaways:

Gained exposure to hardware security principles and the details of DES.

Region-Constrained RRT*

Class: Mobile Robotics

Implemented and expanded a state-of-the-art RRT* environment sampling and path planning algorithm in Python.



Takeaways:

Gained experience with the RRT* algorithm and implementing state-of-the-art algorithms in general.

R.S.N. Labs

Class: Robotics Sensing and Navigation

Created ROS drivers to record GPS and IMU data and wrote python scripts to analyze data.

Explored the benefits of using an RTK GPS. Explored the correction and sensor fusion of IMU data.

Figure 7: Position (Dead Reckoning)

Takeaways:

Gained experience ROS, GPS data, and IMU correction methods.

Cache Prefetching Simulator

Class: Computer Architecture

Developed C++ code from scratch to (1) simulate a set associative cache and (2) compare tagged prefetching, stride prefetching, and no prefetching.

```
#ifndef TAG_BIT_PREFETCH_CACHE_H
#define TAG_BIT_PREFETCH_CACHE_H

#include "SetAssociativeCache.h"

class TaggedPrefetchCache : public SetAssociativeCache {
public:
    // Constructor
    TaggedPrefetchCache(const unsigned short num_sets, const size_t cache_size, const unsigned int block_size,
        const bool lru_replacement = true);

    // Override the access method to implement prefetching
    bool access(size_t address);

    void store(unsigned short set, size_t index, size_t tag);

    // Print cache and prefetch statistics
    const void printStats();

private:
    unsigned long num_prefetches, num_prefetch_hits;

    // Overloaded CacheEntry struct to include prefetch tag
    struct CacheEntry : public SetAssociativeCache::CacheEntry {
        bool tagbit = false;
    };

    std::vector<std::vector<CacheEntry>> cache;

    // Prefetch next sequential block
    void prefetch(size_t address);
};

#include "TagBitPrefetchCache.cpp"
#endif // TAG_BIT_PREFETCH_CACHE_H
```

Takeaways:

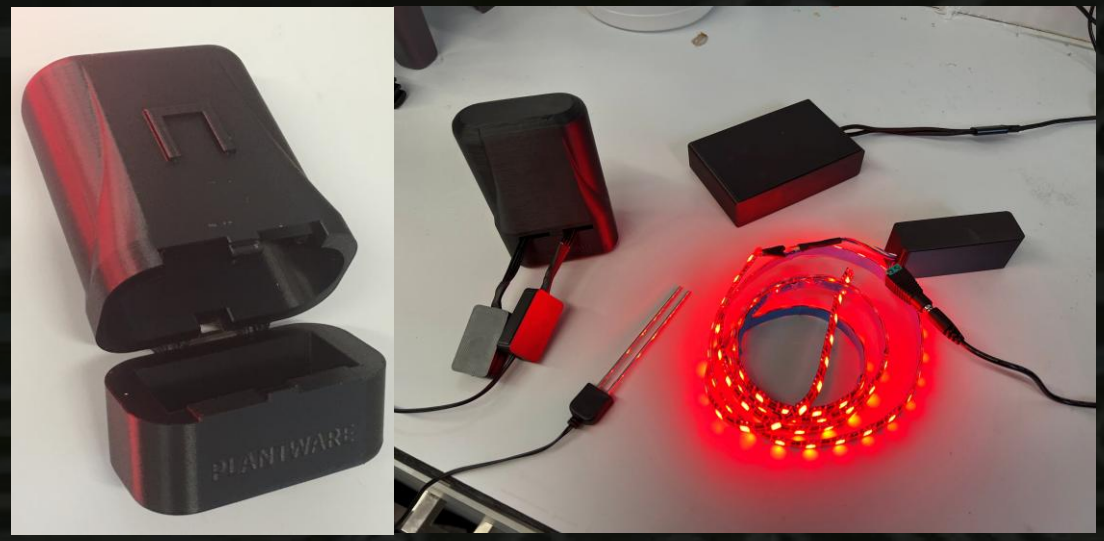
Confirmed my understanding of the different prefetching algorithms and gained experience developing hardware simulators.

Plant Monitoring Ecosystem

Class: Capstone Project

Worked with a group of students to develop an open-source, modular house plant monitoring network.

Designed circuits, wrote C software using the ESP-IDF SDK, and developed 3D-printed housings



Takeaways:
Significantly improved my 3D printing skills, gained valuable experience working in a team.

HW-SW Harris Edge Detector

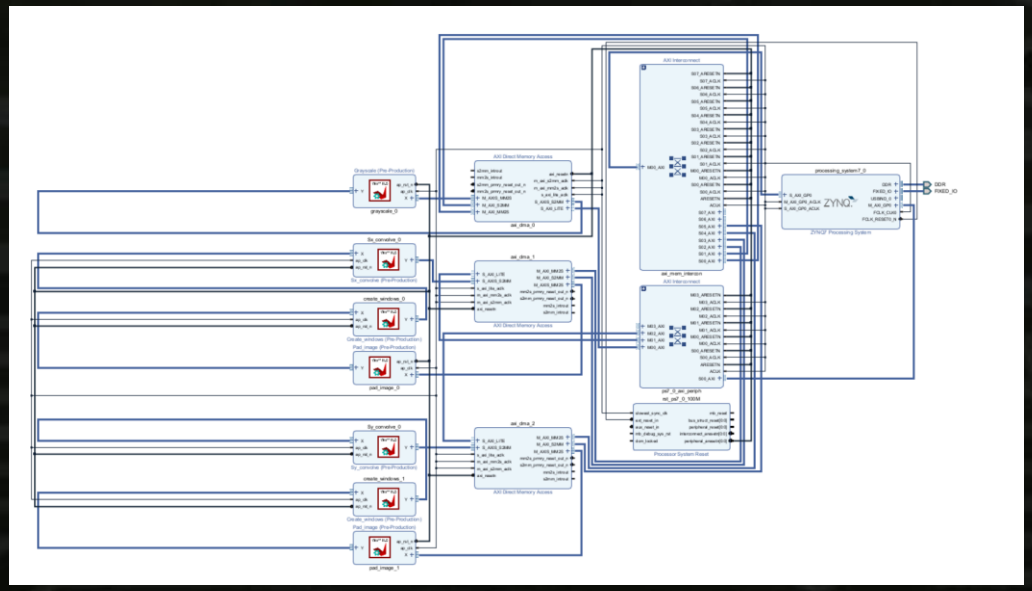
Class: Hardware-Software Codesign for FPGA Based Systems

Wrote python code implementing Harris edge and corner detection in Jupiter Notebooks.

Used Xilinx Vitis to write HLS (in C++) that streams image pixels to the FPGA and perform grayscale and convolution.

Used Xilinx Vivado to test on the PYNQ-Z2's SoC.

Performed a design space exploration on HLS optimizations and compared the software and hardware implementations.



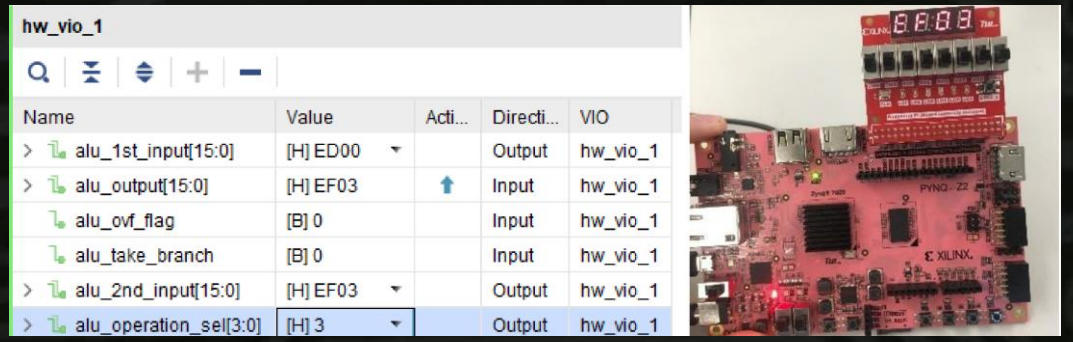
Takeaways:

Gained experience with the Vitis software and HLS

Single Cycle Processer

Class: Digital Design & Computer Organization

Used Xilinx Vivado to write a System Verilog implementation of a 16-bit single cycle processor. Wrote test benches, simulated the modules, and implemented the designs on a PYNQ-Z2 board. Wrote a simple Assembly program and compiled it onto the processor.

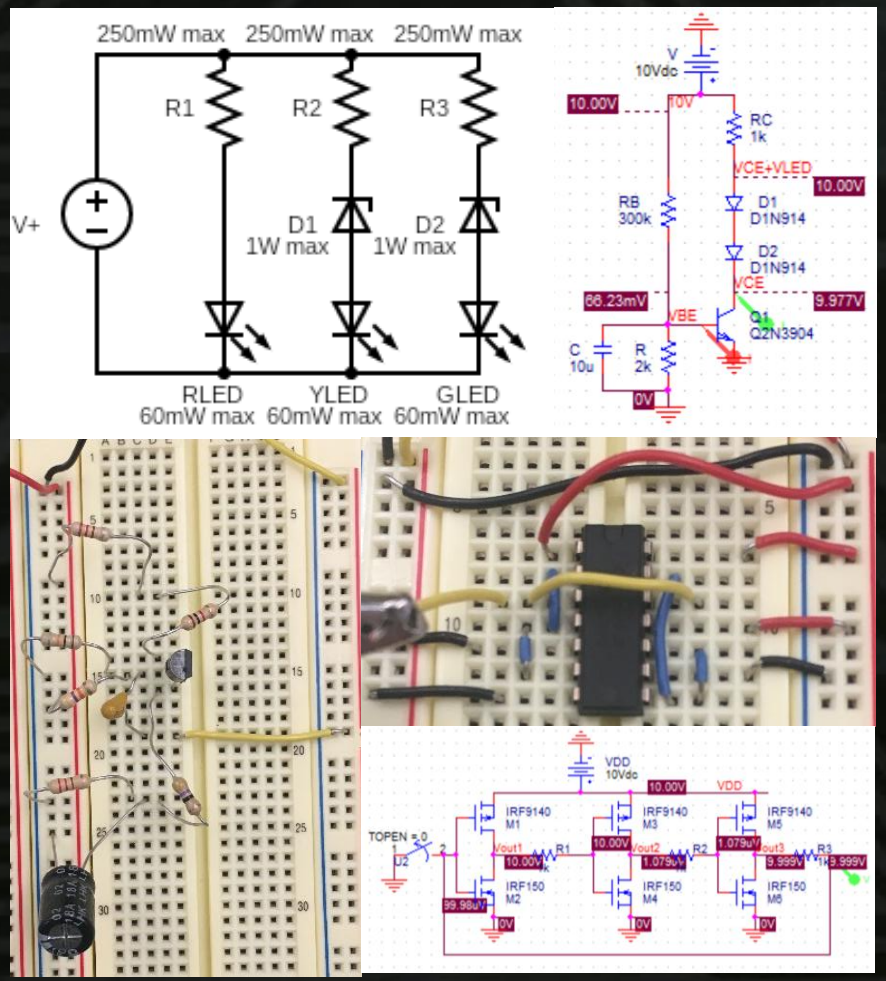


Takeaways:

Learned System Verilog and gained experience with the Vivado software.

Electronics Labs

Class: Fundamentals of Electronics



- Op-Amp Microphone Amplifier
- Voltage Indicator Circuit
- Automatic Night Light BJT Circuit
- BJT Amplifier
- MOSFET Ring Oscillator

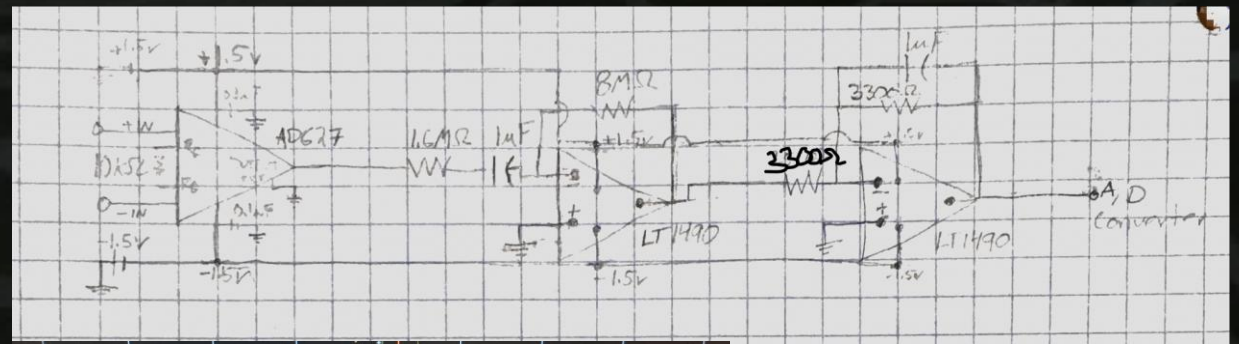
Takeaways:

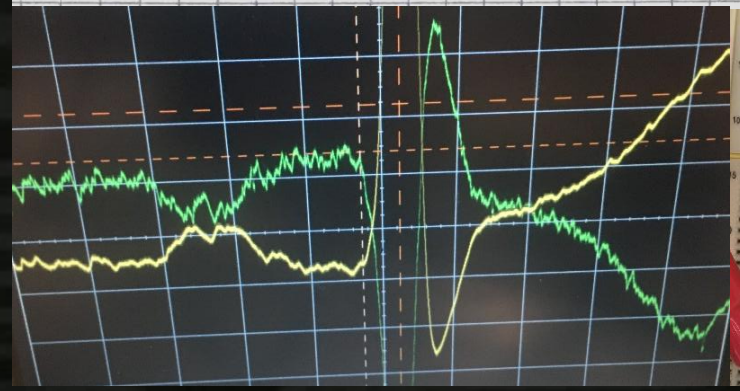
Gained circuit design experience and worked with new devices (primarily BJTs and MOSFETs). Simulated the circuits with PSpice.

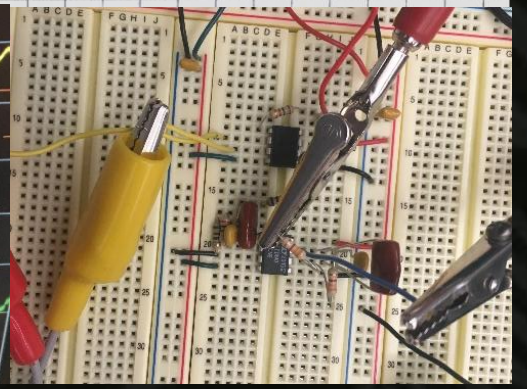
ECG

Class: Circuits and Signals

Used electrodes and an instrumentation amplifier to get the heart signal, used op-amp filters to filter out the DC offset and other noise, and used A/D conversion and MATLAB to filter and process the signal further.







Takeaways:

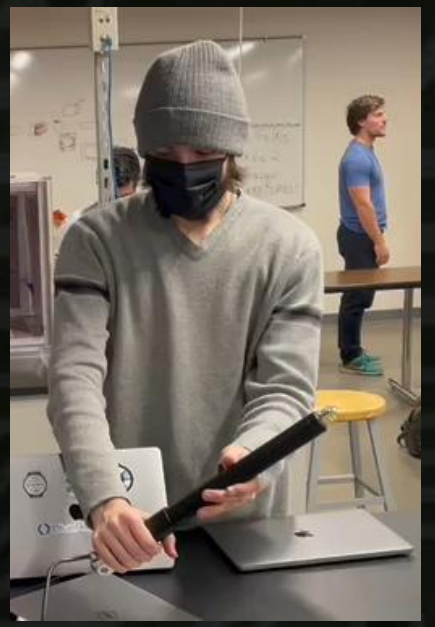
Gained circuit design and signal processing experience by designing my own filters and writing MATLAB code.

Robotics Projects

MATE Robotics

Status: Complete

In my 3rd year at Northeastern, I joined the Marine Robotics club. We built a submersible robot and buoyancy engine to compete in the MATE Robotics competition.



Takeaways:
I helped with miscellaneous electrical engineering tasks, such as setting up telecommunications, actuators, and motors. Gained exposure to waterproofing methods.

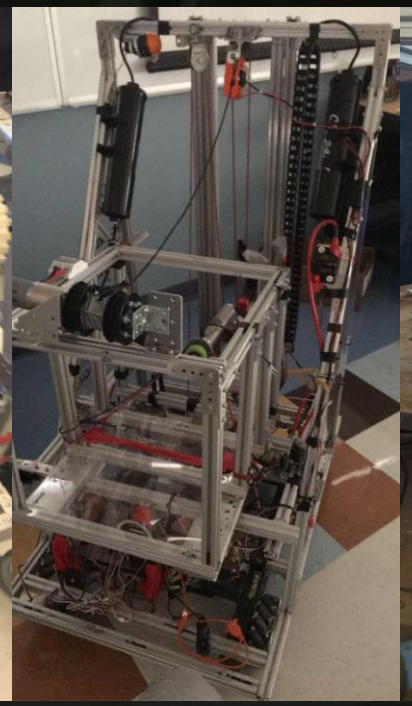
FIRST Robotics

(2017-2020)

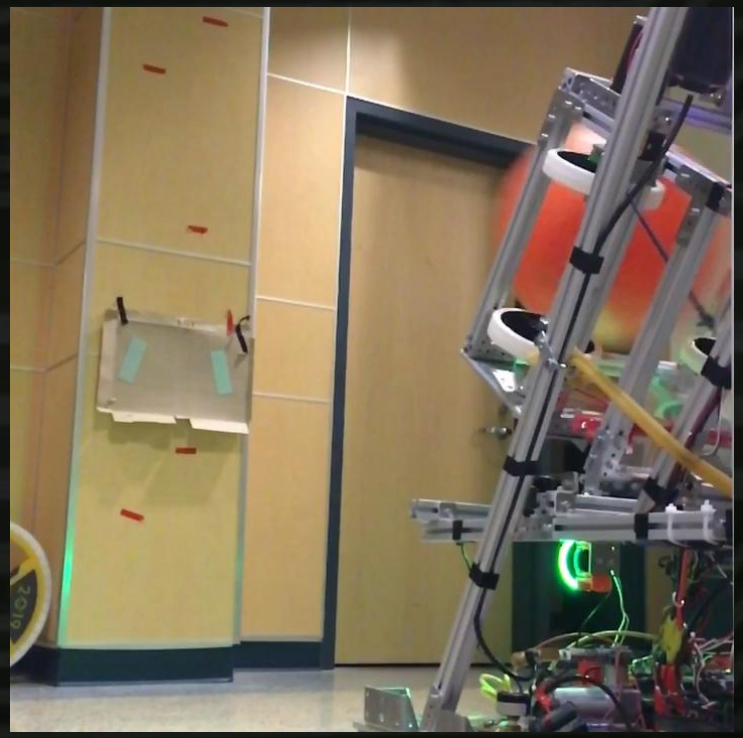
3rd Year: Robot designed to store and shoot dodge balls into targets.

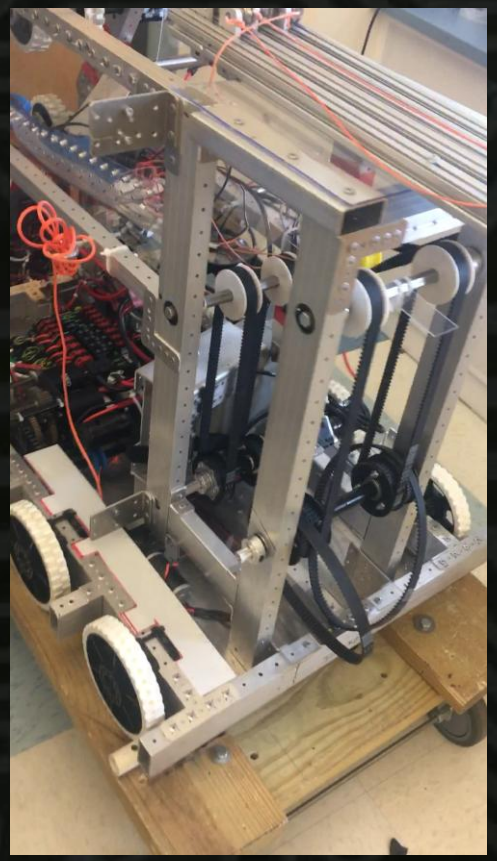
2nd Year: Robot designed to shoot kickballs into bins and could grab disks.

1st Year: Robot that slid milk crates into bins and could pull itself up.



I worked on all aspects of the robots but focused on the mechanical design and construction. I also gained experience with all kinds of motors, pneumatics, and sensors.



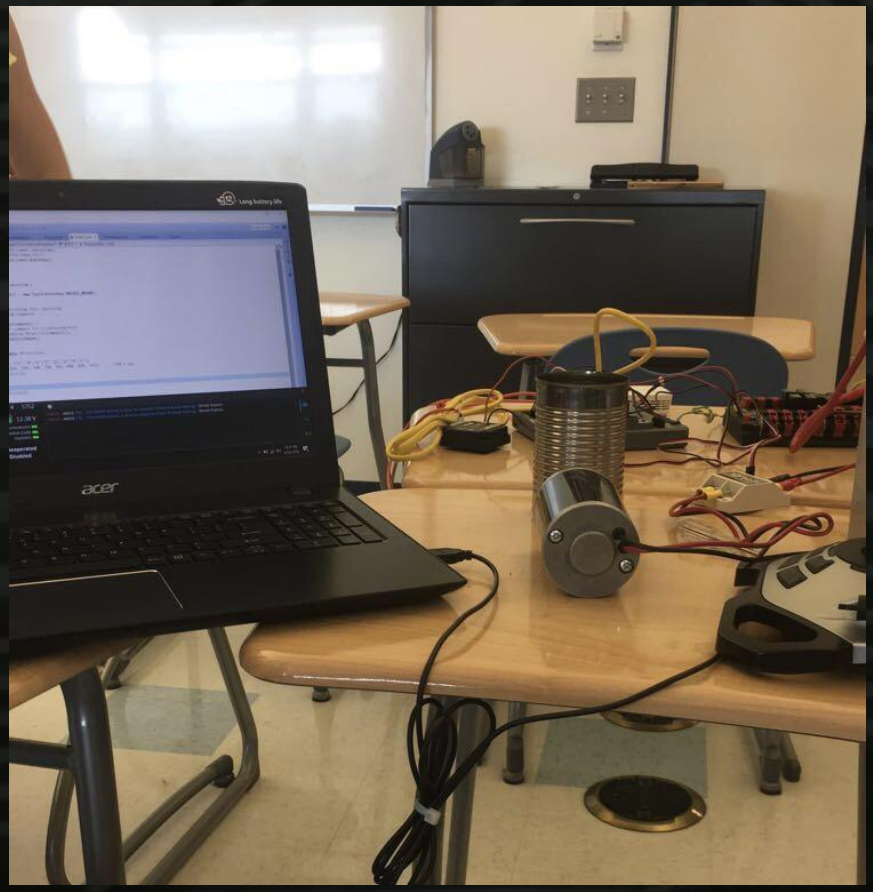


Takeaways:
While on the team I learned 3D modeling, prototyping, designing, and machining. As co-captain I also gained leadership experience.

Singing Motor

Status: Complete (2019)

Programmed a motor to spin at various speeds, creating notes of a song. The notes were then mapped to the keyboard so someone could play the motor as an instrument.



Takeaways:

A video of a singing motor would have been better than a picture of a singing motor :)

Electrical Engineering Projects

MIDI Tap Shoe

Status: Prototyping

Designing and building a tap shoe or tap board that converts the motions and vibrations of tap dancing into a digital signal. Will then create software to allow a tap dancer to change the sound of their tap dancing.

Progress:

I researched many designs and sensors and finally purchased some parts. For now, I am developing using an Arduino Nano IoT and plan to use the IMU to track the motions/accelerations of the feet.

Plant ECG

Status: Brainstorming

Plan to design a PCB and 3D-printed enclosure to sense the action potential of plants. The data can be used to generate music, change lighting, or potentially analyze the plants' health.

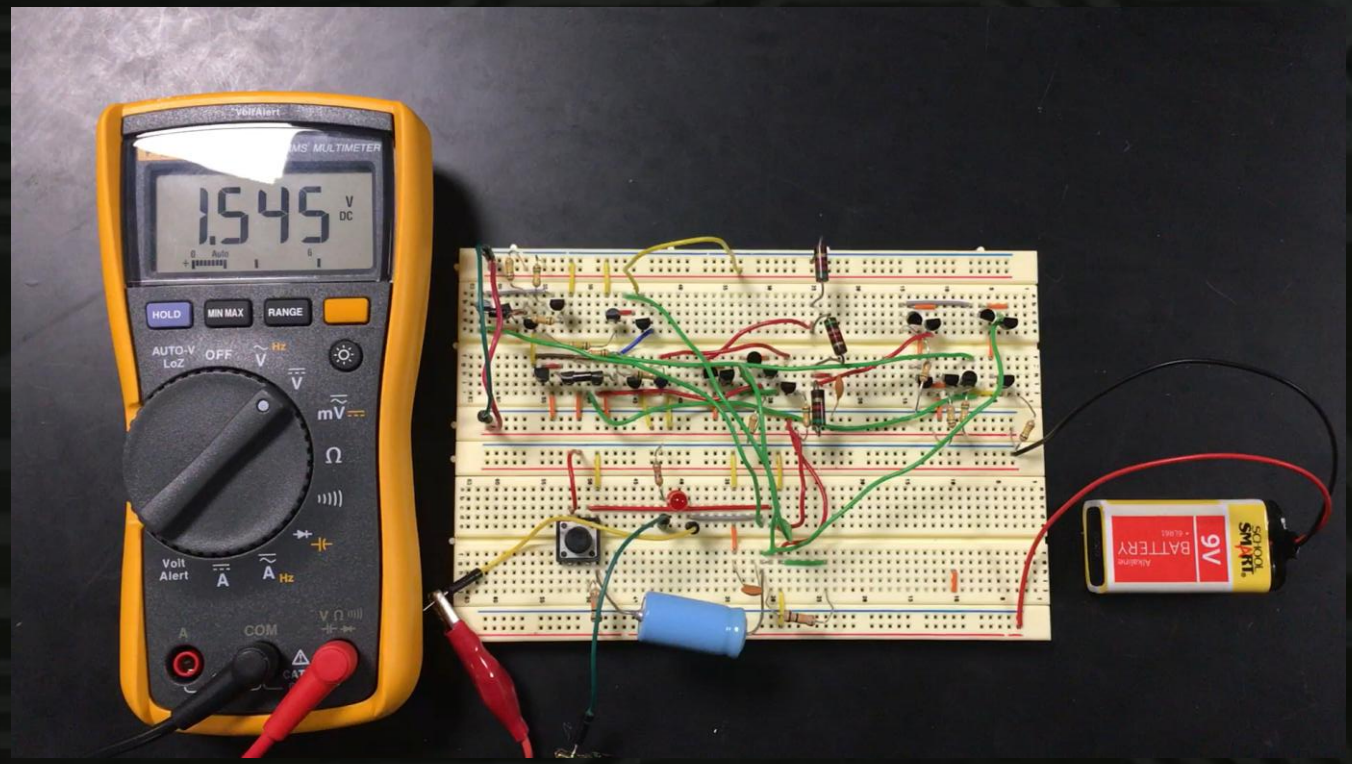
Progress:

Still in brainstorming phase - need $ and time :)

555 Timer

Status: Complete (2019)

Built a 555 Timer IC out of discrete electrical components (borrowed from my high school) to reaffirm my interest in electrical engineering.



Takeaways:

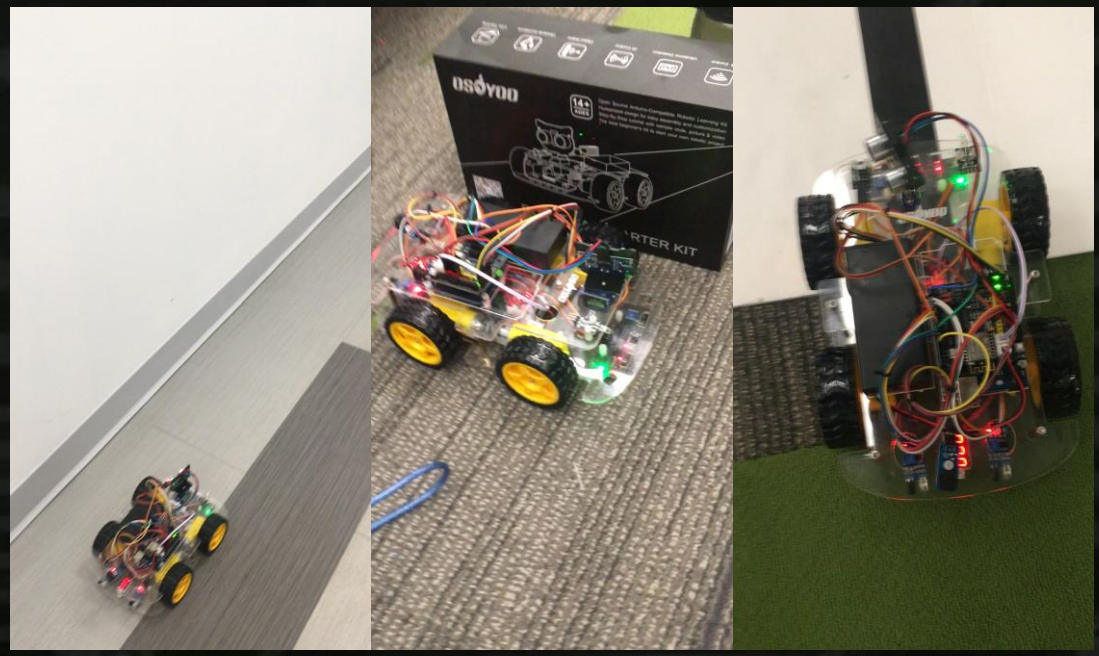
Learned how to read data sheets, learned what an NPN and PNP BJT was, gained experience using breadboards, and learned how a 555 Timer works.

Arduino Projects

Autonomous Car

Status: Complete (2022)

Designed control systems for an Arduino car kit as a part of my classes at Northeastern. The car used an IR sensor to follow a line and distance sensors to follow a wall or parallel park.



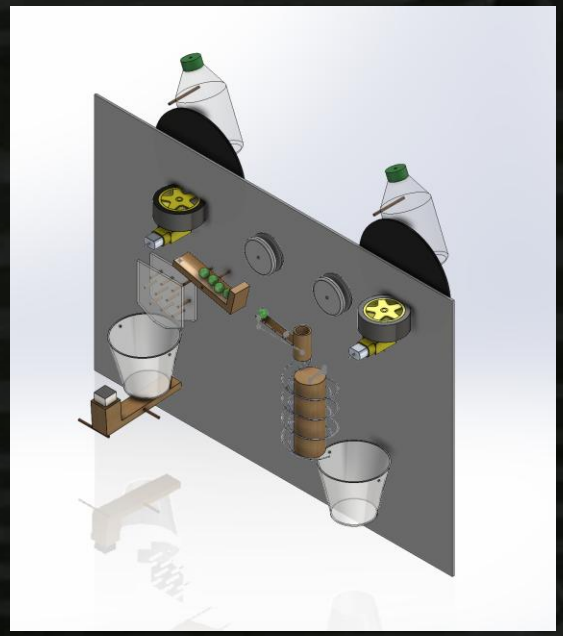
Takeaways:

Gained more experience with Arduino and controlling an autonomous vehicle.

Rube Goldberg Machine

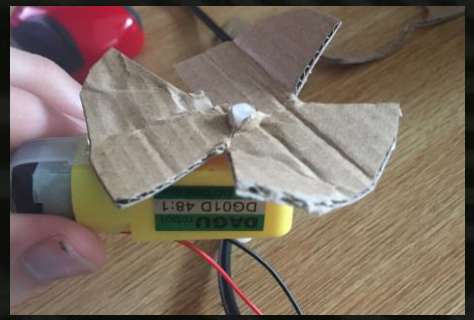
Status: Complete (2021)

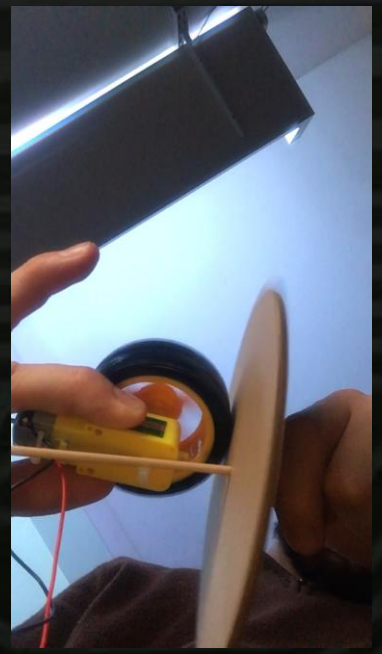
Designed and built a Rube Goldberg plant watering machine for a class at Northeastern that used a myriad of sensors and devices. Created a 3D model in SOLIDWORKS and simulated the design.



Takeaways:

Learned how to design and print a 3D printed part. Gained experience with Arduino and with new devices (such as an LCD display).


DAGU
DG01D 48:1

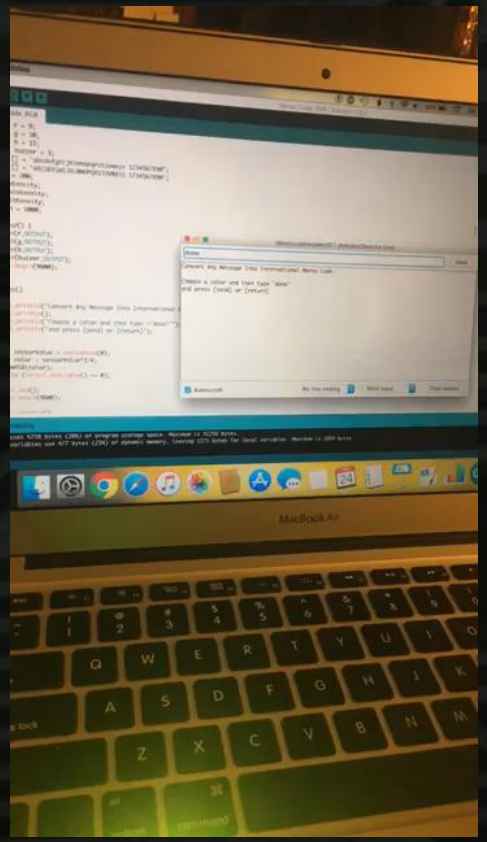



DURACELL
DURACELL

Morse Code Converter

Status: Complete (2018)

When a user typed a sentence into the Arduino prompt, the program converted the sentence to morse code, flashed an RGB LED, and played a buzzer.



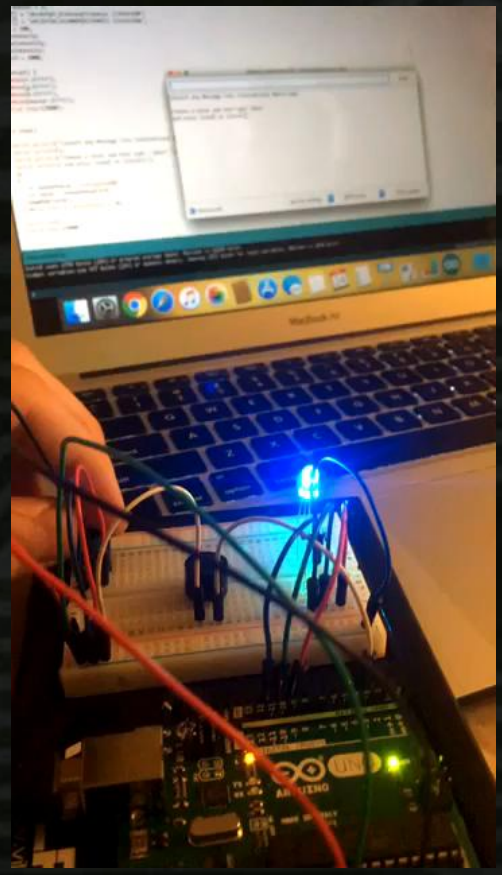
Takeaways:

Gained experience with Arduino and C++.

RGB LED with Potentiometer

Status: Complete (2018)

When the potentiometer was twisted the color of the RGB LED would change.



Takeaways:
Learned how to control devices with a potentiometer and gained experience with Arduino.

Buzzer Song

Status: Complete (2018)

This program played a song through a piezo-electric buzzer.

Takeaways:
One of my first Arduino projects with the kit I purchased.

Programming Projects

C++, C, and C#

Year(s): 2018 – Present

- ASCII Shape Drawer
- Project Euler Challenges (Ex: Prime Number Generator)
- Sort Algorithm
- Encoder/Decoder
- Neural Network Programs (Copied From Book)
- Unity Games
- WORDLE number game (Northeastern)
- U.S. Currency ADT (Northeastern)

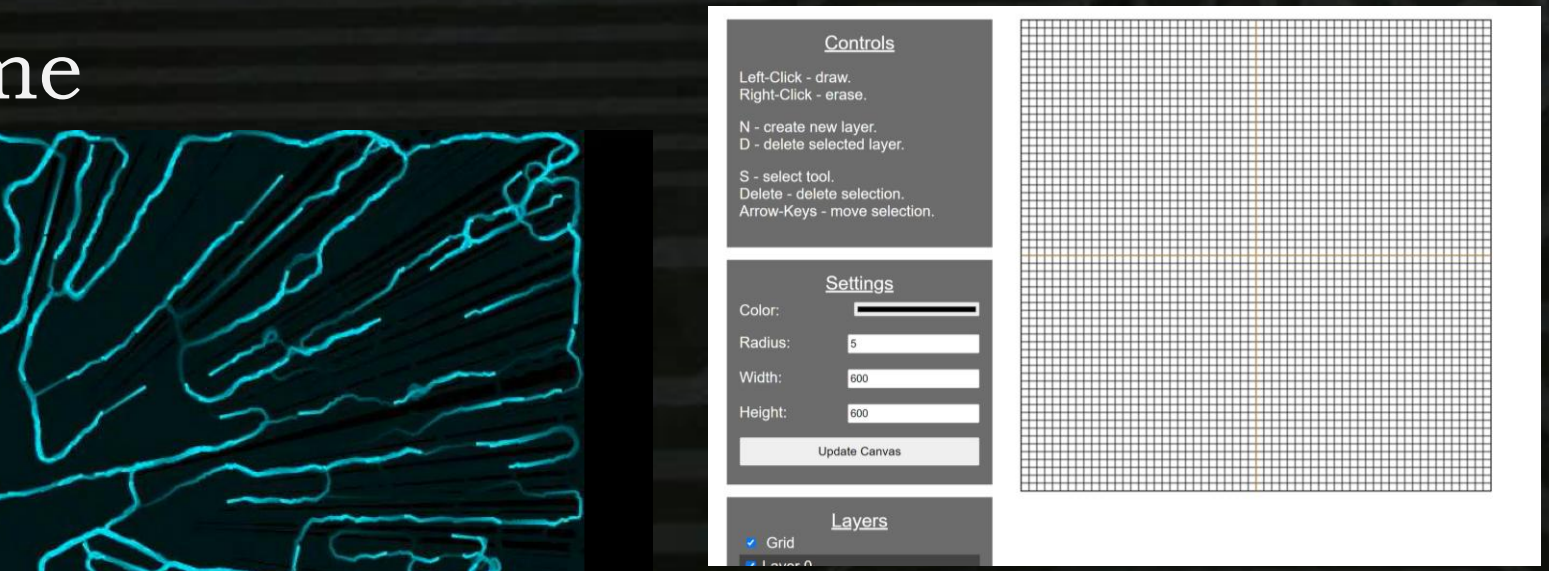
JavaScript, HTML, and CSS

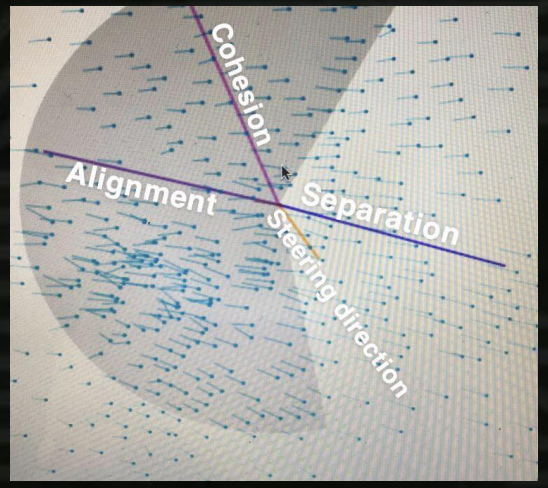
Year(s): 2018 – Present

- Website: davidagabriel.com
- S.A.F.E Application
  - (a mobile application that would give administrators and first responders access to the status of students and staff in a school shooting emergency)
- Slime
- Boids
- Pixel Drawing Software
- “City Navigator” Genetic Algorithm
- Wii Tanks
- Sprite Sheet Animator
- Asteroid Shooting Game
- Snake Game
- Pong

Slime

Pixel Drawing Software





Boids

MISC

Year(s): 2018 – Present

- Swift Binary and Hexadecimal Converter Application
- Java Gravity Mortar Simulator
- TI-BASIC Math Programs (Ex: Quadratic Equation Solver)
- BASIC Programs
- Python Programs
- AppleScript Programs

Contact

Email: gabriel.d@northeastern.edu

Phone: (978) 578-8887

LinkedIn: http://www.linkedin.com/in/david-gabriel-northeastern

DAVID GABRIEL

U.S. Citizen · gabriel.d@northeastern.edu · (978) 578 - 8887
12 Smithson Drive Beverly, MA 01915 · LinkedIn

Education

NORTHEASTERN UNIVERSITY · Boston, MA — May 2024
Bachelor of Science in Electrical Engineering · GPA 3.95
Coursework: Physics 2, Calculus 3, Differential Equations, Fourier Series & PDEs, Circuits and Signals, Embedded Design, Fundamentals of Electronics, Fundamentals of Linear Systems, Robotics, Fundamentals of Electromagnetics, Noise and Stochastic Processes, Fundamentals of Digital Design and Computer Organization, Fundamentals of Engineering Algorithms
Activities: IEEE, Marine Robotics, Husky Environmental Action Team, Northeastern University Dance Company, Tau Beta Pi Honors Society

BEVERLY HIGH SCHOOL · Beverly, MA · GPA 4.73 / 5.00 — June 2020
Activities: FIRST Robotics Team (co-captain), Computer Programming Club (co-founder), Math Team, National Honors Society, Dance (competed on a national level and performed in a pre-professional company)

Work Experience

SPECTRO SCIENTIFIC · Chelmsford, MA
Electrical Engineering Co-op — July – December 2022
- Independently designed, assembled, tested, programmed, debugged, and reworked various PCBs
- Designed, constructed, and created cable drawings for over 35 cable designs
- Wrote 5+ programming and testing work instructions
- Searched for over 40 electronic part replacements using Digi-Key and Octopart

STUDENT PAINTERS · Beverly, MA
Branch Manager — February – August 2021
- Managed an exterior painting business that produced $140,000 in revenue, the 5th highest in the nation, and won the Excellence in Quality Award
- Hired and led 8 employees and worked with over 35 homeowners
- Performed marketing, made hundreds of calls, and gave over 150 estimates

Exterior Painter — June – August 2020
- Worked on a five-person team that produced $160,000 in revenue, the 2nd highest in the nation

Skills

Hardware: Arduino, circuit design, soldering, fine wire rework, oscilloscopes, digital multimeters, function generators, VNAs, 3D printing, basic machining (hand tools, drill press, miter saw, band saw, mill, lathe)
Programming: System Verilog, MATLAB, C++, Python, Java, JavaScript, HTML/CSS, C, BASIC, AppleScript, Swift
Software: Altium Designer, Spice, Xilinx Vivado, Quartus Prime, AutoCAD, SOLIDWORKS, Linux OS, MAC OS, Windows OS
Languages: Spanish (intermediate), Italian (basic)

Projects

WEBSITE PORTFOLIO · https://davidgabriel.us — September 2020 – December 2022
- Designed and developed a website using HTML, CSS, and JavaScript to learn UI/UX design and share my art

ARDUINO PROJECTS (MISC) — January 2019 – June 2022
- Created an autonomous car, Rube-Goldberg machine, morse code converter, buzzer song, and LED "ping-pong" game

ELECTROCARDIOGRAM – NORTHEASTERN — December 2021
- Built an ECG circuit using an instrumentation amplifier, op-amps, and discrete components
- Used A/D conversion to record heart signal on the computer and used MATLAB to process further

555 TIMER — December 2019
- Researched and built a 555 Timer integrated circuit out of discrete electrical components