Talisha Griesbach

Portfolio of Projects

University of British Columbia MASc Graduate Student in ECE (Power Electronics)

BASc Integrated Engineering (Electrical and Mechanical)

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MASc Graduate Research Assistant and Thesis Projects

Nov 2023 – Present

My research is focused on creating control software for reconfigurable energy systems (RES) to maximize energy reliability, load management and failure detection.

Energy System Communication Interface Development (CANOpen and C#)

This project and experience is sponsored by Mitacs Canada and FUTURi Power. Note that the details below are vague due to my Non-Disclosure Agreement. Please focus on the bold text for the skills learned.

As a Graduate Research Assistant and Software Engineering Intern for FUTURi under the Mitacs Canada program, I developed classes representing state machines and unit tests for the CANOpen communication protocol.

Through this experience, I refreshed my software and computer science theoretical knowledge and gained more practice into coding with Object Oriented Programming (OOP) principles. Among others, I learned the importance of encapsulation and polymorphism for complicated embedded programs for a large hardware system, to write efficient and robust software.

NSERC MASc Thesis Proposal

The objective of my proposal is to research and develop a fully functional and robust control software for reconfigurable energy systems (RES), enabling reliable energy management. The software is intended to be deployed and tested on a microgrid-based RES architecture developed by the research team in the UBC Power Lab. Software prototyping and criteria-based evaluation will be used to determine and implement the most appropriate design attributes. Attributes to be investigated include how the software interacts with hardware, what data is needed, and which algorithms, like machine learning, work best.

The resulting software and design decisions are significant as they provide a well-justified, foundational software framework to be used for the continued development of RESs. This opens doors for more effective utilization of RESs to maximize its potential to contribute to a greener planet.

A copy of my full NSERC MASc thesis proposal which also exemplifies my technical and research writing is attached in page 12.

Projects with Google X’s Everyday Robots

As Electrical Engineering Intern, May 2022 – August 2022

Note that the details below are vague due to my Non-Disclosure Agreement. Please focus on the bold text for the skills learned.

Rigid-Flex Sensor Array PCB

I designed a large, irregularly shaped, custom 6-layer Rigid-Flex PCB, which houses a sensor array for the flagship mobile robot (see image 1). I worked to integrate numerous ICs, sensors, analog and digital signals using best practices for rigid-flex layout, DFM and DFX, resulting in a reduction of manufacturing part count and assembly line issues.

I worked with past electrical designers of the non-Rigid-Flex versions of the board and harness, mechanical engineers, manufacturing engineers and technicians to ensure the design fit the robot and the entire assembly line process. **Through this project, I gained confidence in creating rigid-flex PCB designs using Altium Designer for high-volume production parts.**

Prototyping new motor braking circuits through a test PCB

The main goal of this project was to design and test new braking mechanisms for the motors on the flagship robot. I created three circuits, then designed and tested all three circuits by packaging them in a PCB and running tests. Among other things, I calculated required forces and torques, as well as motor discharging current to implement the testing circuit.

My tests were successful, and I found a new and improved braking mechanism. **I honed my skills of electromechanics, circuit design and PCB design, especially in thermal management and resistive discharging of motors.**

Image 1: Everyday Robots’ Flagship Robot (Image courtesy of Everyday Robots)

Projects with Supermileage Design Team UBC

As Electrical Team Lead, Sep 2019 – April 2023

Urban Electric Vehicle – Custom Brushless Motor Controller

I am responsible for the vehicle's motor controller, from design to integration, for our brushless DC motor: a 48V, 5.07 inch (129mm) Koford motor. I designed the circuit, picked components, validated portions of the design through prototyping and simulations, and implemented it into a PCB using Altium.

The board has the following features and more:

- Wide range of inputs: 10V to 60V input
- Bus voltage sensing
- Over-Current Sensing
- Thermal Sensing Unit
- Hall-Effect sensor inputs for speed control
- CAN Communication (External controller and transceiver)

The top-right circuit in figure 1 below, *Input Connector and Capacitance*, is for the input connector and bulk capacitance of the board. The bottom-right circuit, *Input Voltage Feedback*, is for input voltage feedback to correct accurate voltage levels.

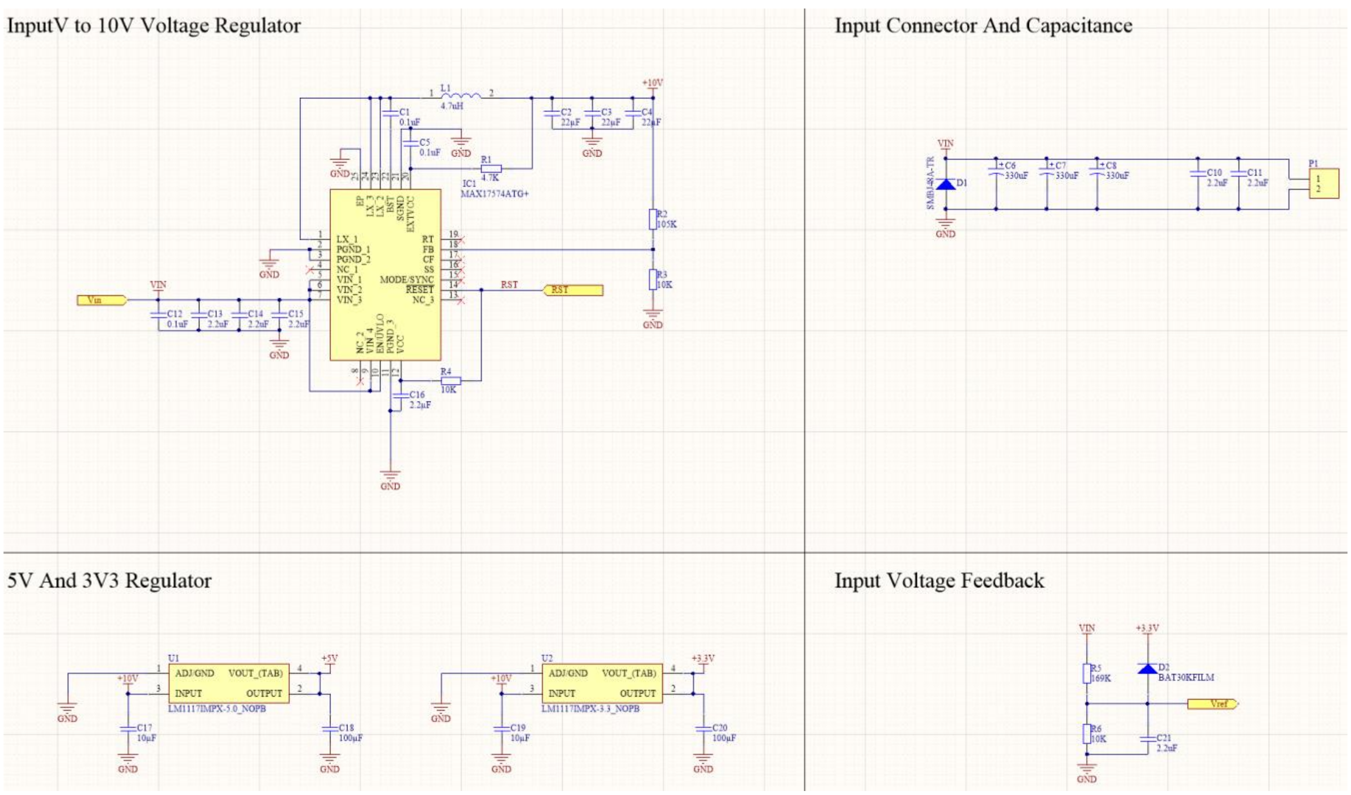

Figure 1: Page 1 of Schematics of Motor Controller

The schematic below shows three half-bridges using a bootstrap circuit, gate driver, and MOSFETs to control the motor phase input. At the top-right of figure 2, have heatsinks to dissipate the heat generated by the MOSFETs, and a temperature sensing circuit using an NTC.

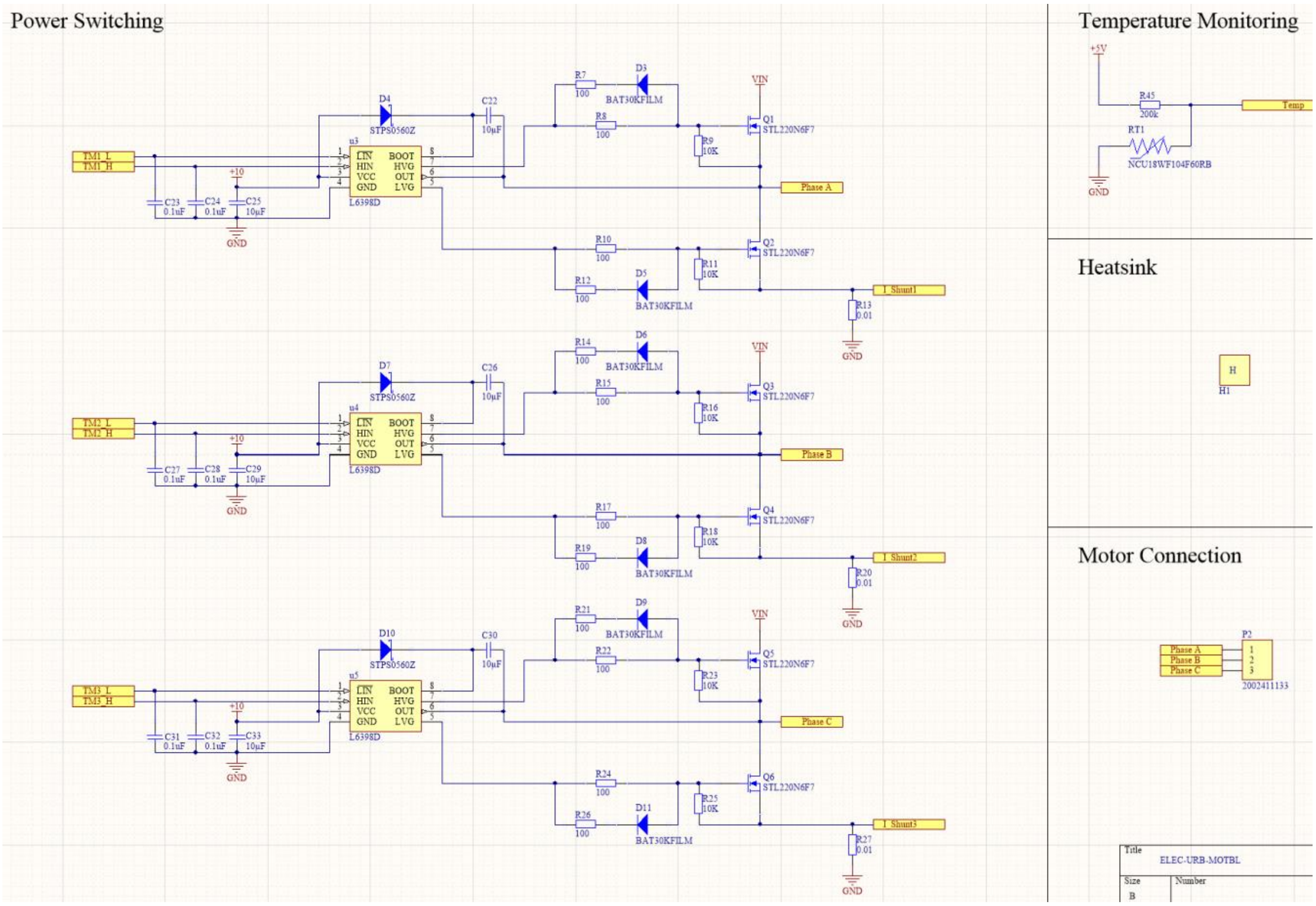

Figure 2: Page 2 of Schematics of Motor Controller

The top-right circuit schematic in figure 3 below is the hall-effect sensors input from the motor to determine the position of the motor. This will be used as an input for the Field-Oriented control to determine the error signals and thus what current needs to be fed to the motor.

Other than the hall-effect sensor input circuit, figure 3 below show the circuits for analog signal conditioning. Figure 3 shows the current amplifier circuit which, together with the hall sensors, allows for two types of operation: sensor operation with the hall-effect sensors, and sensorless operation with the current amplifiers. This gives the team the choice of operating it whichever mode we want, considering the benefits and costs of using each mode and making testing, debugging and iterating on designs easier.

Shunt resistors are used to gather data to prevent over-current events, as visible in the current amplifiers and over-current sensing circuits, and a comparator in the over-current sensing circuit to communicate with the microcontroller on whether the current is within the limits relative to the reference current on the far right of the schematic page.

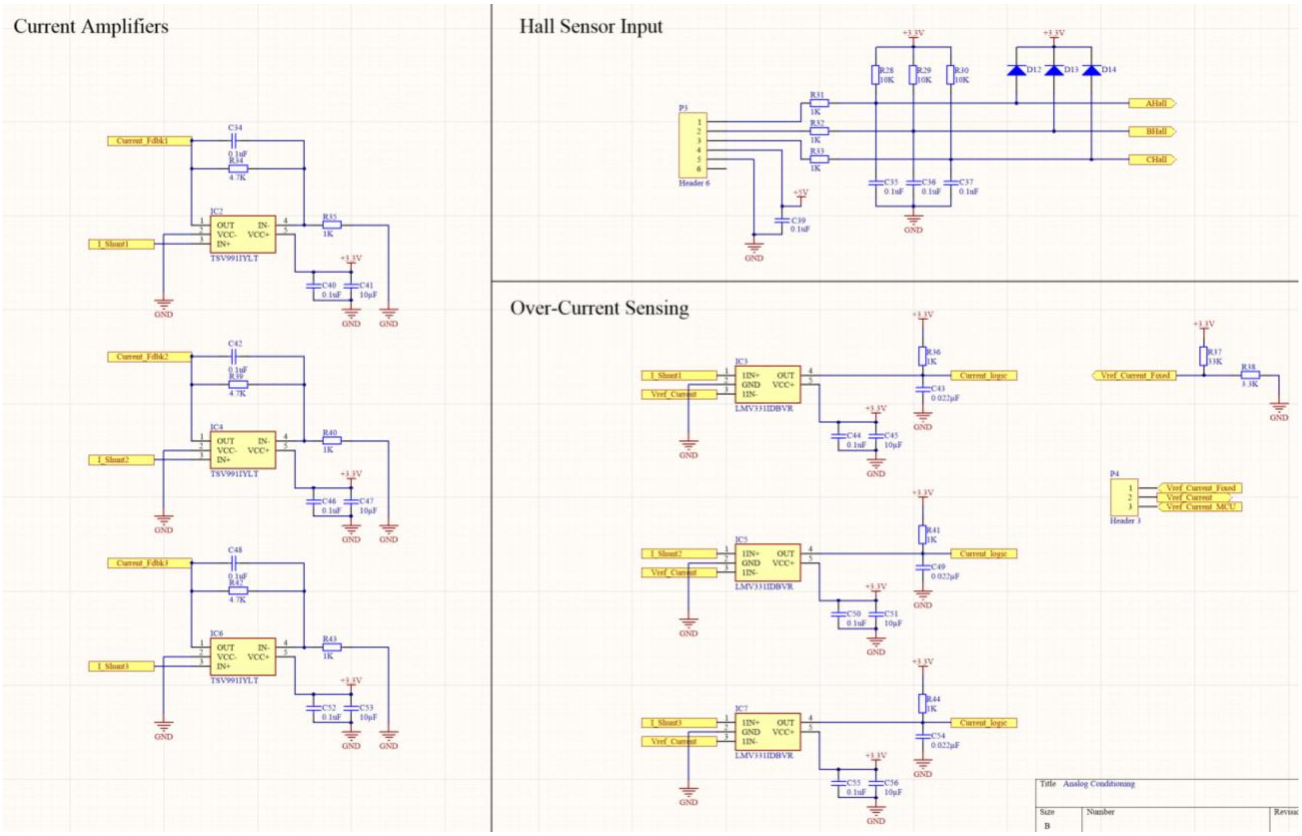

Figure 3: Page 3 of Schematics of Motor Controller

Figure 4 shows the connections between the header pins on the motor controller, and the Nucleo board.

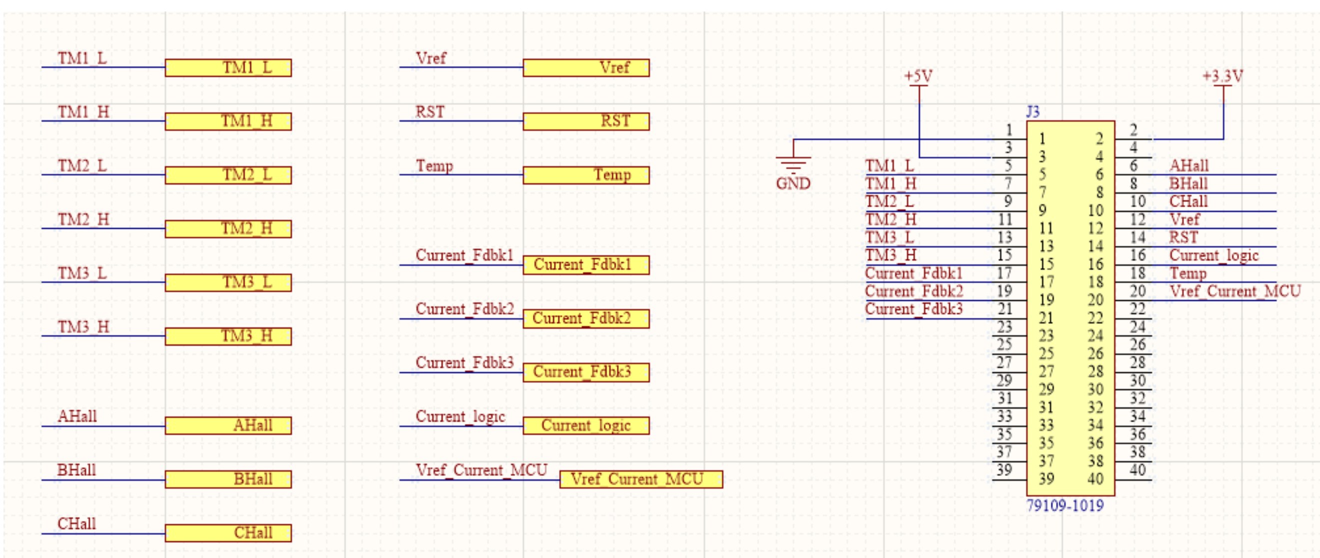

Figure 4: Page 4 of Schematics of Motor Controller

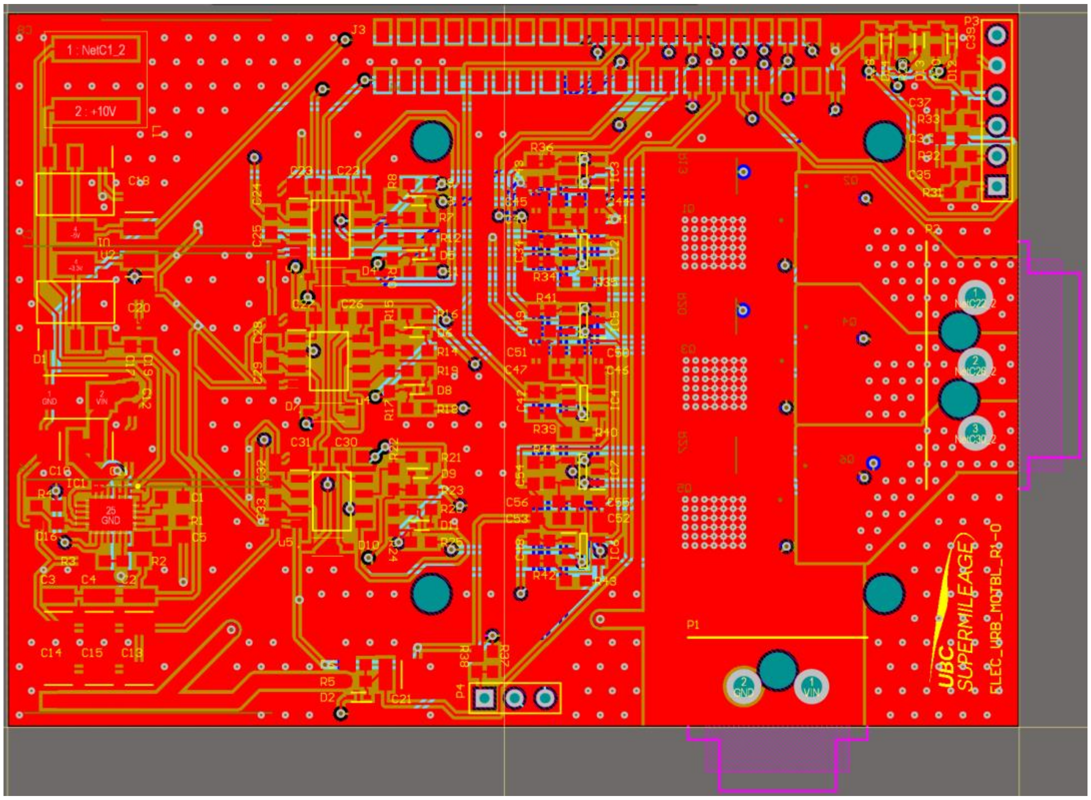

Figure 5: Top-view of Board of Motor Controller

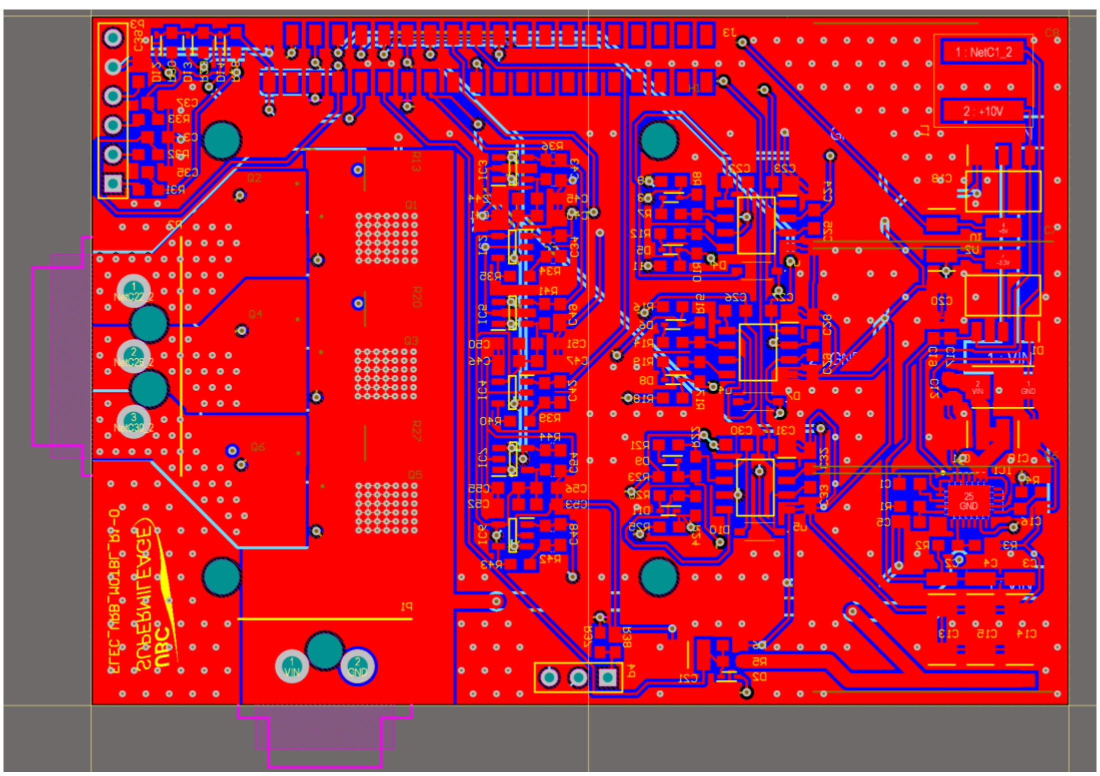

Figure 6: Bottom-view of Board of Motor Controller

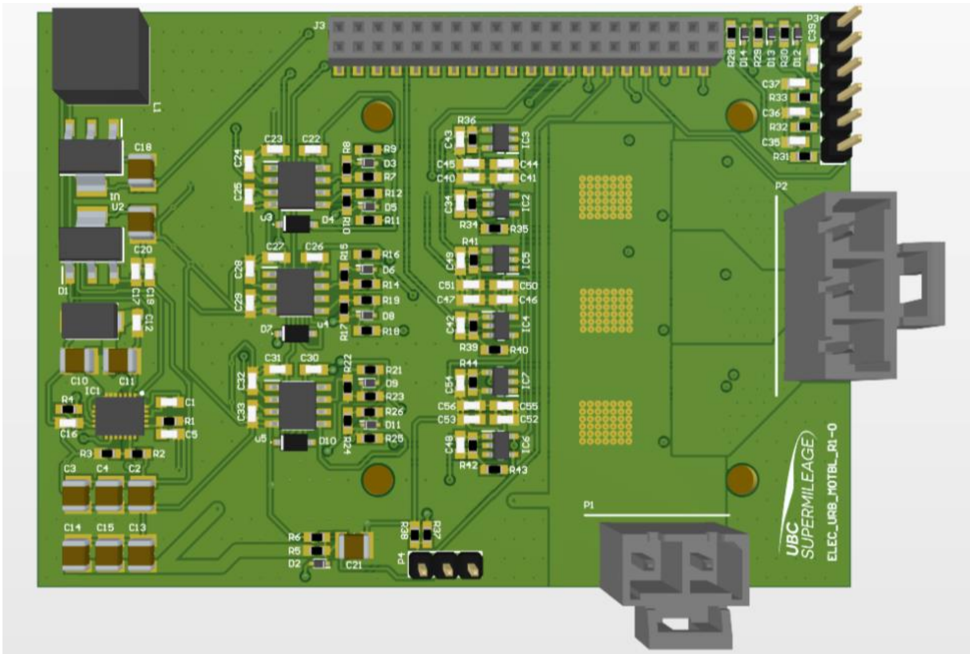

Figure 7: 3D View of Board Design of Motor Controller

The project is still ongoing, and is currently in its firmware development stage. For this, I used STM32 Motor Control Software Development Kit (SDK) to code the STM32 Nucleo-L452RE in C++.

Ultra-Efficient Fuel Cell Vehicle Electrical Systems

In 2021, UBC Supermileage completed and ran its first-ever fuel cell vehicle. I designed, fabricated, tested and debugged the control system of the vehicle. I implemented numerous control features including oxygen pump control, voltage reading and monitoring, current measurement and emergency braking. During the fuel cell vehicle's world record attempt, I was present as a field engineer, where I troubleshooted, fixed and optimized controls and power systems with limited resources. You can view a video showing the electrical systems during a bench testing (on the dynamometer) during our 2021 summer track days in Mission Raceway, British Columbia, by clicking the link here.

Ultra-Efficient Gas Vehicle – Electronics and Motor Control

For this project, I led a team of two new first-year student members in creating the gas vehicle's electrical system from ideation to integration. I acted as both a designer and a mentor in this project, where I taught the members electrical concepts from scratch. As the gas vehicle is simpler than the urban electric vehicle, the board design is currently in progress by my two mentees, from which I will provide feedback on and refine together for the SAE competition in June 2022.

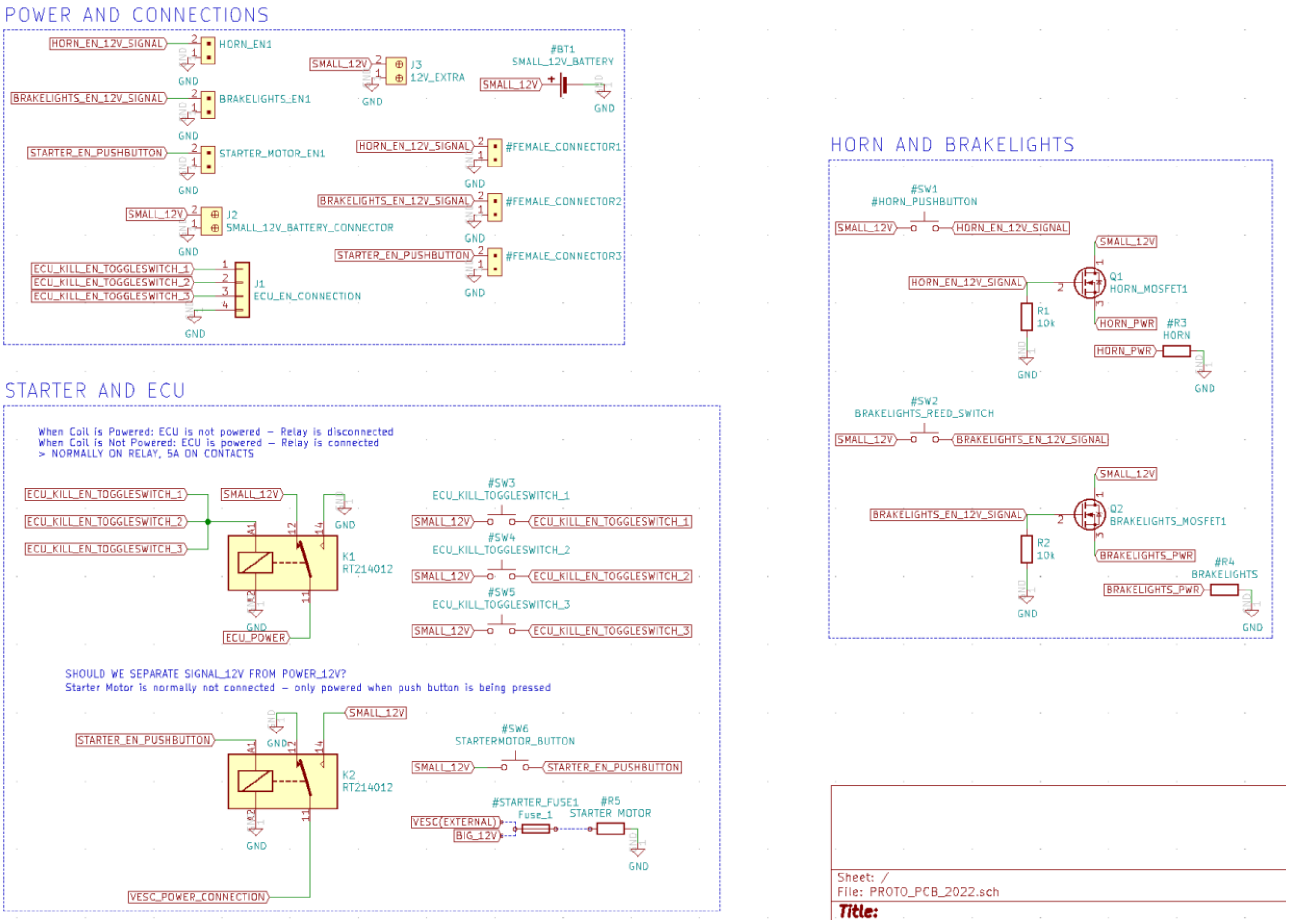

Figure 9: Schematic of Motor Controller

Projects at A&K Robotics

As Robotics Engineer Co-op, May 2021 – Sep 2021

Due to my non-disclosure agreement, I can only provide a high-level description of my work at A&K Robotics, listed below.

1. Designed a Buck Converter PCB from the ground up
    - Chose a high-performing automotive-grade buck converter integrated chip (IC)
    - Performed calculations to decide inductor, capacitor and other component values
    - Step 36V down to 5V, providing up to 8A from 2A
    - Successfully increasing robot power capacity by 200%

2. Spearheaded robot's power protection circuit
    - Researched and implemented improvements to the robot's power protection, quality, distribution, and thermal performance
    - Researched protection ICs, Zener diodes, TVS diodes, and picked components based on needs and specifications
    - Removed unnecessary components to decrease the main board size by 30%
    - Substantially limited noise, voltage and current spikes through redesigning the power circuitry and layout
    - Prepared a report and presentation for the company's CEO, CTO and CFO

3. Utilized Arduino and C/C++ for sensor development, testing, and CAN bus communication verification
    - Used Linux and BASH to connect to robot's system and read CAN output
    - Used an oscilloscope to analyse CAN output of motor controller to debug for issues

4. Mechanical Projects:
    - Used Fusion360, surface modelling and 3D Printing to create mounts and robot parts
    - Designed a sheet metal battery enclosure

Projects at Kardium

As Electrical Test Engineer Co-op, May 2020 – Dec 2020

Due to my non-disclosure agreement, I can only provide a high-level description of my work at Kardium, listed below.

1. Designed and fabricated circuits, PCBs and jigs to automate product testing, resulting in decreases in testing times ranging from 40% to 80% among 4 test protocols
    a. The main project I worked on was a jig to test the 122 electrodes of Kardium's catheters. I designed voltage dividers, isolation circuitry, chose components, placed and routed the PCB, ran signal integrity analyses, and PCB production-related work such as Bill of Materials, vendor communications, and mechanical integration. I tested the board to ensure that it works, and conducted rework with soldering under a microscope.
    b. Furthermore, I created the C# scripts and GUI to send serial data to the STM32 microcontroller, as well as to communicate with multimeters. For my test protocols, I also designed wire harnesses which connected to this PCB and Kardium's products.

2. Translated biomedical design standards (IEC 60601, AAMI, ANSI) into detailed test protocols
    a. Became the "owner", i.e. the person responsible for, 4 test protocols, including 1 which I created from scratch based on IEC 60601
    b. Improved and automated test protocols using both hardware and software tools: MATLAB (with the MATLAB GUI tool), C#, Altium, 3D Printing and Mechanical Modelling, Protoboard Circuits, among other things

3. Main Mechanical Test Protocol Details:
    a. I had to test the tensile strength of a Kardium in-house product, and compare it to regulatory standards. To use the Lloyd Tensile Tester, I had to create a custom attachment onto the load cell.
    b. I used SolidWorks to model the attachment based on the caliper's measurements of the inserts and pins in the Lloyd, and fabricated it with 3D Printing. I fitted the attachment, and made some minor adjustments including drill sizes and removable features.

Technical Writing Sample:
NSERC MASc Project Proposal and Sample Bibliography

Research and Development of Software for an Intelligent Reconfigurable Energy System

I am a Master of Applied Science student at UBC's Power Lab under Dr. Martin Ordonez focusing on energy management software systems. I have a strong hardware and software background from my interdisciplinary engineering undergraduate program and extensive industry work experience.

Introduction

The rise in electrification is a strong effort in combating climate change; however, it poses major challenges to the traditional energy grid unprepared for such a substantial capacity shift [1]. This results in impacts on reliability such as brownouts and vulnerability to weather events, highlighting the urgent need for grid modernization to secure a future of sustainable and reliable power. [1-2]. An emerging solution is to design smart grids with the ability to immediately and autonomously change their configuration, called a reconfigurable energy system (RES). An RES implements its architecture considering conditions and events to maximize efficiency and reliability. Yet, there is a lack of RES research focused on the design of control software to best implement an RES [3-4].

Objective

My objective is to research and develop a fully functional and robust control software for RESs to maximize reliable energy management. The software is intended to be deployed and tested on a microgrid-based RES architecture developed by my research team in the UBC Power Lab.

Research Approach

Software prototyping and criteria-based evaluation will be used to determine and implement the most appropriate design attributes. Attributes to be investigated include hardware interaction methods, data inputs and outputs, user interface, and control algorithms, such as machine learning. The main tools identified for development are as follows:

- **A Digital Twin** model of a grid generates meaningful data for the control algorithm through instantaneous data exchange with its physical counterpart [5].
- **Object-oriented programming (OOP)** based application, as OOP is a powerful tool to represent physical networks, with well-researched best practices and evaluation criteria [6].
- **Machine Learning (ML)** is promising for control and load management and has many models relevant to energy systems [4, 7, 8].

The hardware on which the software will be implemented is an RES local area microgrid, with a main controller determining the configurations. Components include PV panels, battery storage, loads, inverters, and a switch array for architecture reconfiguration. This is available to me in the UBC Power Lab, where we are developing an RES from the component-level with state-of-the-art power electronics equipment.

Significance

The resulting software and design decisions are significant as they provide a well-justified, foundational software framework to be used for the continued development of RESs. Additionally, further prototyping, research, and data collection methods can be built upon this work. This amplifies the optimal utilization of RESs and their potential to contribute to a greener planet.

Bibliography

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[5] N. Bazmohammadi et al., "Microgrid Digital Twins: Concepts, Applications, and Future Trends," in IEEE Access, vol. 10, pp. 2284-2302, 2022, doi: 10.1109/ACCESS.2021.3138990.
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[8] R. A. Iringan Iii, A. M. S. Janer and L. A. R. Tria, "A Machine-learning Based Energy Management System for Microgrids with Distributed Energy Resources and Storage," 2022 25th International Conference on Electrical Machines and Systems (ICEMS), Chiang Mai, Thailand, 2022, pp. 1-6, doi: 10.1109/ICEMS56177.2022.9983198.

Other works identified for further literature review and research reference

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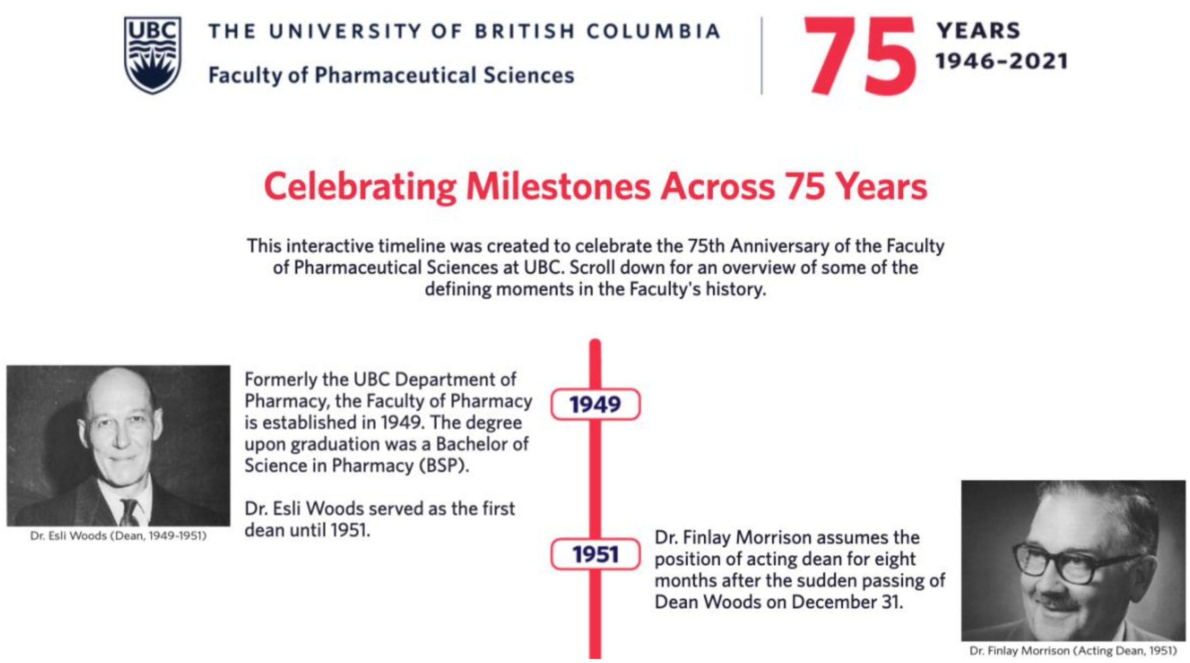
Projects at Office of Marketing and Communications
UBC Faculty of Pharm. Sci.

As Marketing & Communications Assistant, Sept 2021 – Apr 2022

- Spearhead marketing, communication and content creation projects from conceptualization to execution, ranging from Faculty brand video production, internal newsletters to special media features
- Design graphics for use in digital and print marketing, using Adobe Illustrator, Photoshop and InDesign

Sample Designs:

I created a timeline to showcase the milestones of the faculty from its inception to its 75th anniversary. I used Webflow to create an animated timeline previewed below, which can be accessed through [this link].



Digital Media Designs: