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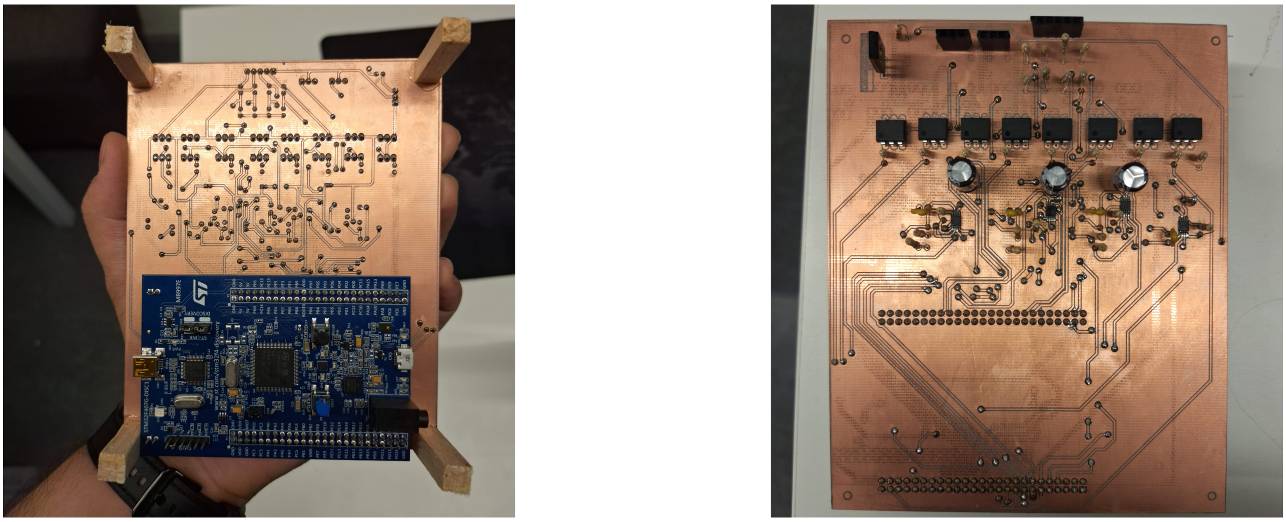
About Me

A highly motivated and detail-oriented Electrical and Electronics Engineering graduate with a strong passion for mechatronics, embedded systems, and automation. Proven ability to lead projects from concept to completion, encompassing hardware design, software development, and system integration. Seeking to apply a diverse skill set to solve complex engineering challenges.

Projects

Battery Health & Performance Management System (BMS)

- **Project Overview:** Designed and developed a comprehensive Battery Management System (BMS) for Lithium-ion batteries. The system ensures operational safety and reliability by monitoring critical parameters and performing active cell balancing. A custom dual-layer PCB was designed and fabricated to integrate all components, centered around an STM32 microcontroller.
- **Key Features & Technologies:**
  - **Central Controller:** Utilized the STM32F407 Discovery Board for real-time data processing and control logic.
  - **Active Cell Balancing:** Implemented a capacitor-based active balancing circuit controlled by a custom algorithm using AQV252G Photomos relays for efficient charge shuttling.
  - **Real-Time Monitoring:** Integrated TMP36GZ sensors for temperature, an INA333 amplifier with a shunt resistor for current, and differential voltage measurement for individual cells.
  - **Custom PCB Design:** Designed and fabricated a dual-layer motherboard in KiCad to integrate all system components.
  - **Algorithm & Simulation:** The entire system logic was developed and validated in MATLAB/Simulink, simulating various operational states to ensure the algorithm's robustness.
- **Image:**



(a) Front view of the BMS PCB.

(b) Back view of the BMS PCB.

Figure 1: Custom-designed BMS PCB with integrated components.

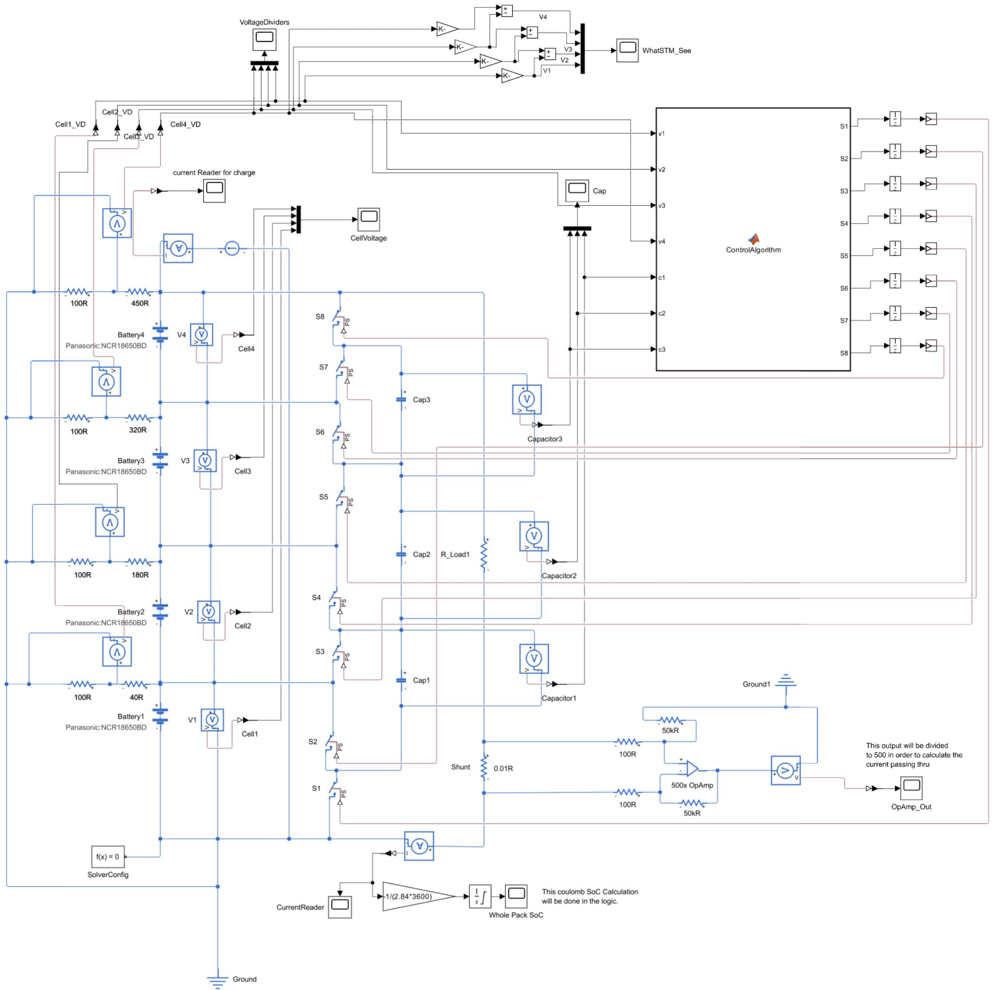


Figure 2: BMS Schematic in Simulink.

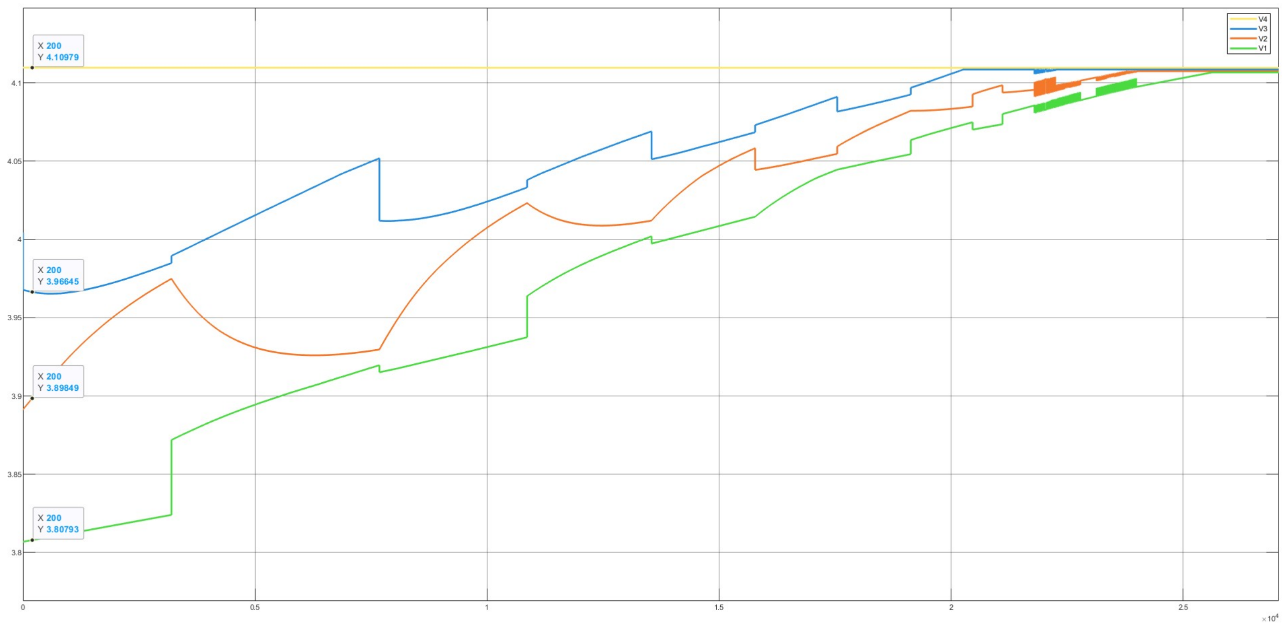


Figure 3: BMS simulation results from simulink.

Remote-Controlled Axial Flux Motor

- **Project Overview:** This project involved the complete design, fabrication, and control of a custom electric axial flux motor. The goal was to create a functional motor from scratch, including hand-wiring the coils and integrating a wireless remote control system. The axial flux topology was chosen for its potential for high torque density and a compact form factor.
- **Key Features & Technologies:**
  - **Custom Motor Design:** Designed an Axial Flux Permanent Magnet (AFPM) motor, specifying stator/rotor geometry, magnet placement, and coil winding.
  - **Fabrication:** Manually wound copper coils for the stator and utilized 3D printing to create the custom motor housing, rotor, and stator supports.
  - **Wireless Control:** Implemented a remote control system using Arduino microcontrollers and NRF24L01+ transceiver modules for motor speed and direction.
  - **Electronics:** Designed a compact PCB in KiCad for the L298N motor driver and NRF24 module.
  - **CAD Software:** SolidWorks.
- **Image:**

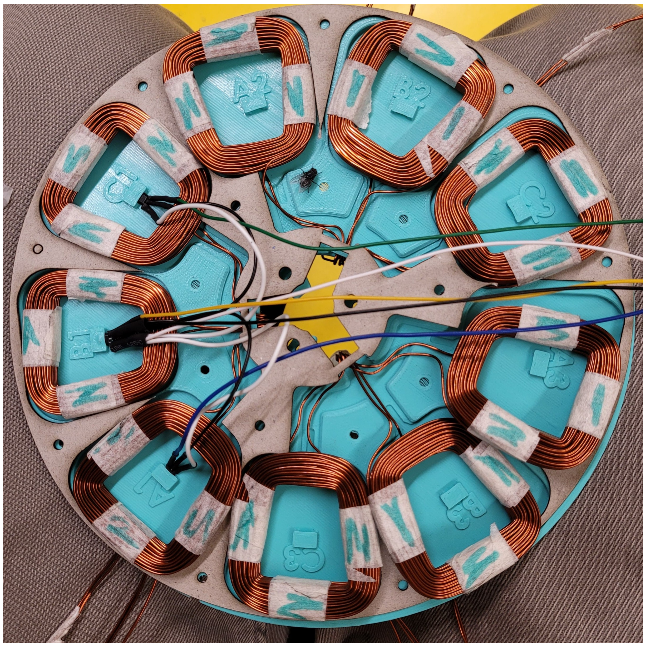


Figure 4: Completed prototype of the custom axial flux motor.

Servo Actuated 3-Axis Gimbal

- **Project Overview:** A mechatronics class project to create a functional 3-axis servo-actuated gimbal for object stabilization. The system uses an MPU6050 Inertial Measurement Unit (IMU) to detect orientation changes, which are then counteracted by three servo motors controlled by an Arduino Nano.
- **Methodology:**
  - **Design:** Modified an existing online 3D model to suit specific requirements and available components.
  - **Hardware:** Arduino Nano, MPU6050 IMU, 3x Servo Motors, 3D Printed Parts.
  - **Control Logic:** Calibrated the IMU to obtain accurate accelerometer and gyroscope readings via I^2C. Processed raw data to determine orientation and mapped the data to corresponding servo motor movements to maintain stability. The control logic was programmed in C/C++.
- **Image:**

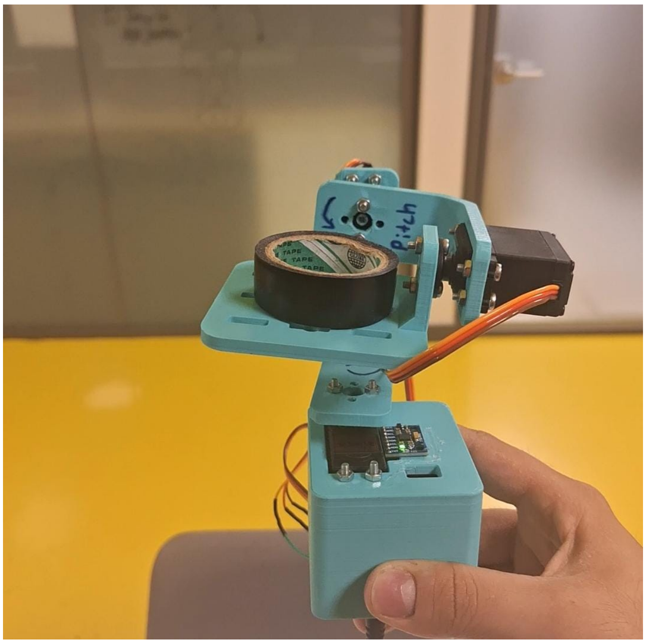


Figure 5: he assembled 3-axis servo-actuated gimbal.

Wind Turbine Grid Integration Analysis

- **Project Overview:** As a power engineer for a wind energy developer, the task was to find the most cost-effective design for integrating a new 200 MW wind farm into the Metropolis power grid. The analysis focused on minimizing total cost, considering both initial conductor investment and the cumulative cost of power losses over a 5-year period.
- **Methodology & Technologies:**
  - **Simulation Tool:** Extensive use of PowerWorld Simulator to model the existing grid and proposed interconnections.
  - **Analysis:** Performed detailed load flow analysis across 27 different scenarios, evaluating three different conductor types and three potential substation connections .
  - **Economic Evaluation:** Conducted a detailed cost-benefit analysis comparing transmission line configurations and their associated power losses over a 5-year horizon.

PLC Automation Systems

- **Project Overview:** Developed two distinct automation projects using Schneider EcoStruxure to demonstrate practical application of PLC programming, HMI design, and control logic.
- **Part 1: Traffic Lights Controller:**
  - **Goal:** Efficiently control traffic at a four-way intersection with both normal and after-hours operational modes.
  - **Logic:** Normal operation followed a timed cycle of red (90s), yellow (5s), and green (120s + 5s flashing) lights. After-hours mode featured all lights flashing yellow at 1Hz.
  - **HMI:** Provided a visual representation of the intersection and buttons to start, stop, and toggle after-hours mode.
- **Part 2: Toy Claw Machine:**
  - **Goal:** Simulate an interactive toy claw machine with full user control and game logic.
  - **Logic:** Coin insertion starts a 90-second timer. A "Start Game" button initiates an automated claw sequence (open, descend, close, ascend, release).
  - **HMI:** Displayed joystick buttons, a start button, a countdown timer, and game outcome messages ("Winner" or "Game Over").
- **Image:**

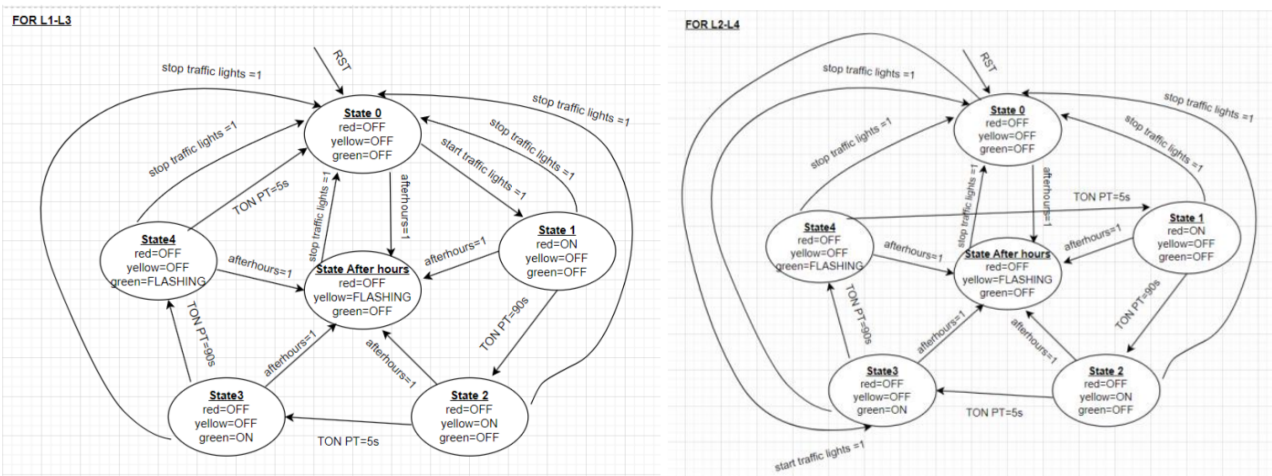


Figure 6: Enter Caption

Zumo Robot Object Detection & Counting

- **Project Overview:** Developed a unique algorithm for a Zumo robot to autonomously navigate a defined circular area, detect its boundaries using reflectance sensors, and count obstacles using an IR sensor. The final count is communicated to the user via LED and buzzer signals.
- **Methodology:**
  - The robot moves forward until it detects the white tape boundary. If it detects an obstacle, it turns to avoid it.
  - Upon reaching the boundary, it performs a scanning turn, counting any objects detected by the IR sensor.
  - This process is repeated for 10 trials from different points along the circle's edge to improve accuracy by observing objects from multiple perspectives.
  - The maximum object count from any single trial is taken as the final result.
- **Technologies Used:** Arduino, C++, Zumo Robot Platform, IR Sensor, Reflectance Sensor Array.

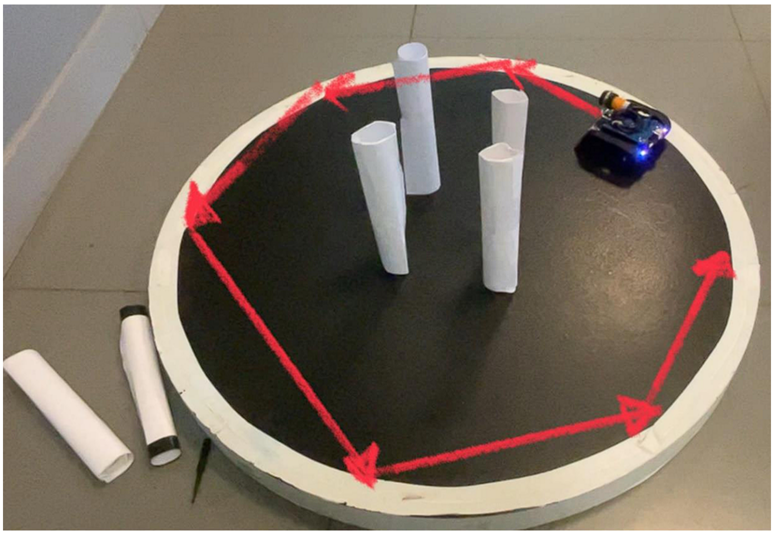


Figure 7: Zumo robot area scanning path.

Machine Learning: Bitcoin Market Analysis

- **Project Overview:** Investigated the potential manipulative effect of Twitter content on the price of Bitcoin. A machine learning model was developed to predict whether the price of Bitcoin would increase or decrease one week after a collection of tweets were posted.
- **Methodology:**
  - **Data Preprocessing:** A large dataset of Bitcoin-related tweets from Kaggle was extensively cleaned and filtered. Filters were applied to include only influential accounts (10,000+ followers) and tweets containing predictive keywords (e.g., "buy", "sell").
  - **NLP:** Utilized the BERT (Bidirectional Encoder Representations from Transformers) model to convert the textual content of daily aggregated tweets into numerical vector representations.
  - **Classification Model:** Employed a Multi-Layer Perceptron (MLP) classifier from Scikit-learn to train on the BERT-transformed data.
  - **Optimization:** Systematically tested 2401 combinations of hidden layer sizes and iteration counts to find the optimal model configuration.
- **Outcome & Technologies:** The final model achieved an accuracy of approximately 73% in predicting Bitcoin's price direction, suggesting a discernible pattern between tweet content and short-term market movements.
  Technologies: Python, Pandas, Scikit-learn, Hugging Face Transformers (BERT), MLP, YahooFinance API.