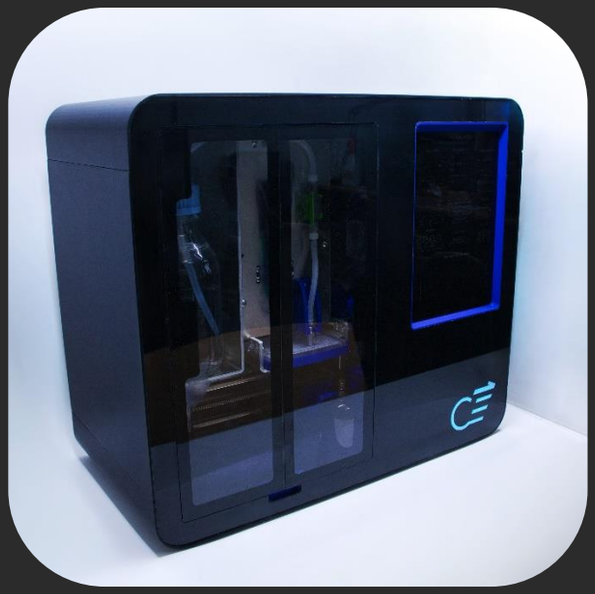
portfolio.

ASHER
VALENTINI

2022-2025

Enjoy this condensed version of my design portfolio. To see more check out my personal website, GitHub or LinkedIn with the images to your right

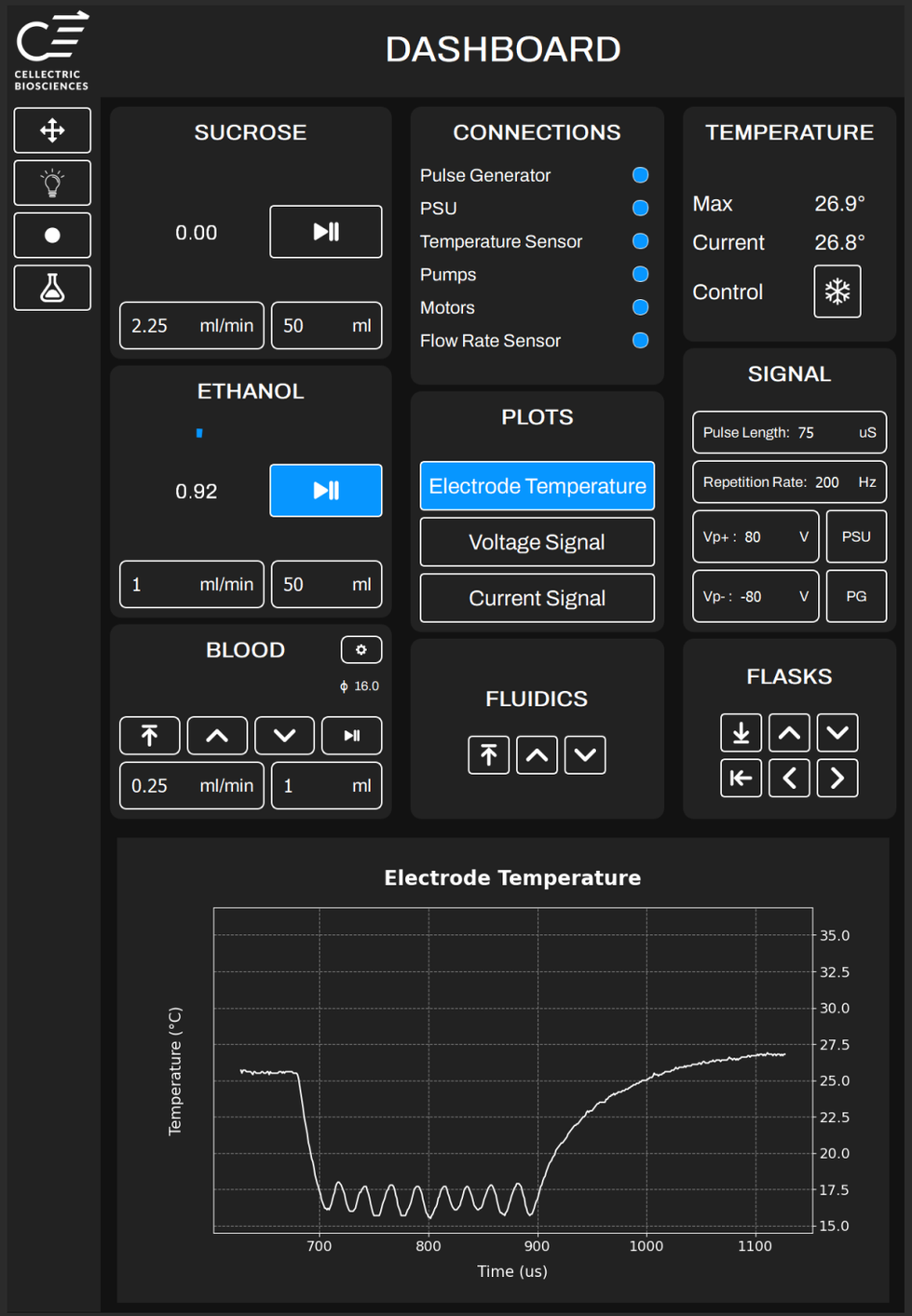




Cellectric Base Station

A medical device (RUO) designed for fully automated and semi-automated proprietary workflows in medical sample preparation. The product's design and manufacturing was a collaborative effort of two mechanical engineers, one power electronic engineer and myself (embedded software and microfluidics).

Key Highlights:

- I held the lead responsibility for the:
  - Microfluidic module's firmware, hardware, and mechanical implementation
  - Control application's software design
  - Graphical user interface (GUI) development
  - Experiment protocol automation
  - Software DevOps (CI/CID pipelines and SW testing)
- Deployed in:
  - 1 hospital
  - 1 clinical trial
  - 3 research laboratories
  - 1 university
  - 2 countries



Cross-Platform Desktop Application with Qt

Here is a closer look at the Cellectric Base Station's control application for sensor feedback visualization and device control.

Key Highlights:

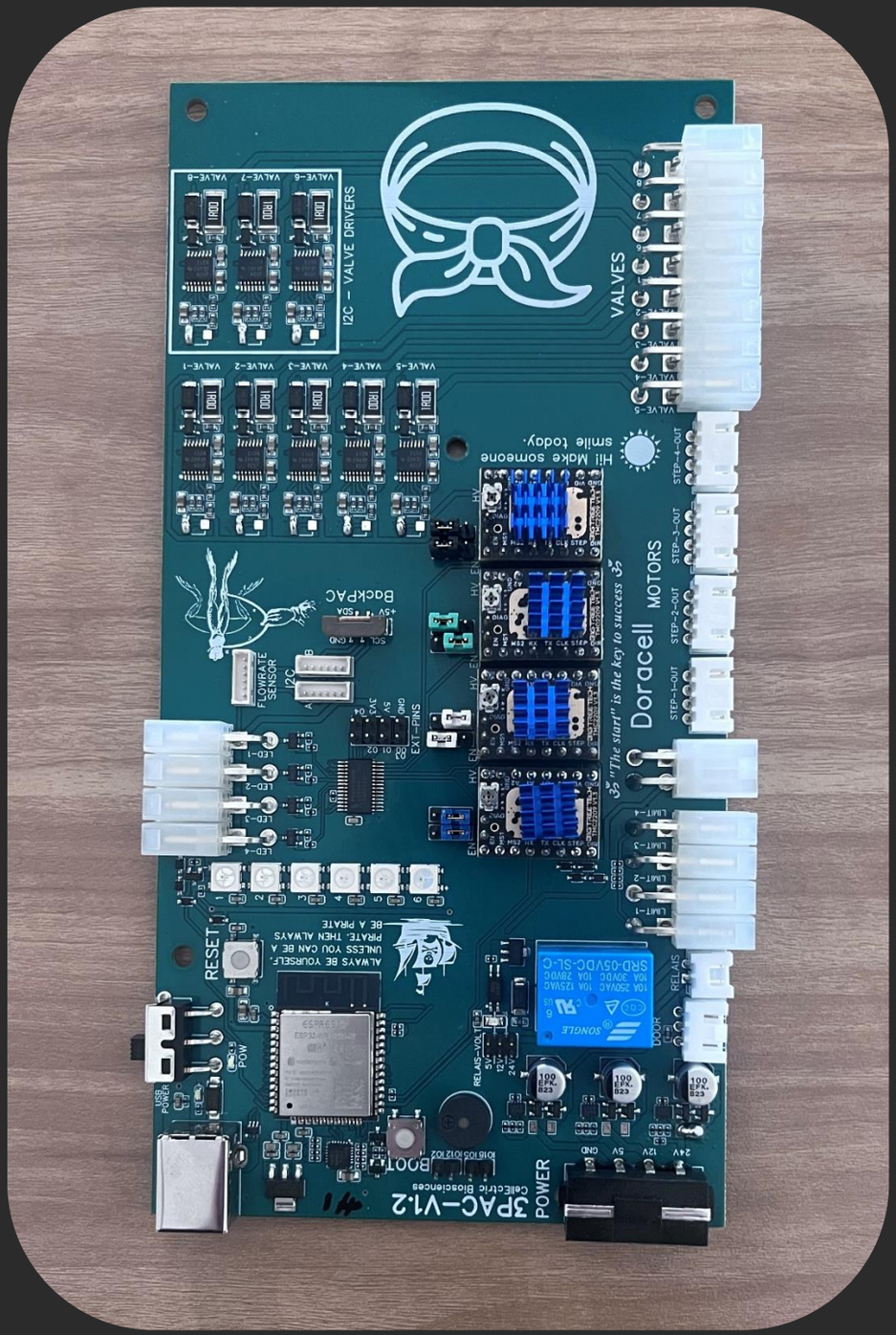
- Multithreaded application following OOP, MVC, and event-driven design patterns
- Embedded protobuf serialization
- Custom built state machine for serial over USB communication sequencing
- Data handling and visualization
    - Working fluid flow rate feedback
    - Current and voltage feedback from a propriety signal generator
    - Temperature feedback
    - Device connection statuses
- Control
    - 2 peristaltic pumps
    - 4 stepper motors
    - 2 peltier pads (on/off algorithm for temperature control)
    - 1 Power Supply Unit's actuation and voltage rail settings
    - 1 Signal Generator's actuation, frequency and duty cycle settings
    - 4 Automated experiment protocols

Piezo Driver v1.1

A personal development of a piezoelectric micropump driver circuit board for pressure driven liquid control in microfluidic systems.

Key Highlights:

- Hardware
  - Drives up to 4 Lee Company HP SERIES micropumps (600mBar/pump)
  - Onboard ESP32 with an FTDI UART to USB converter
  - 4 voltage boosters controlling highside voltages to 4 H-Bridges
  - 4 current tracking op amps for peripheral impedance feedback
- Firmware
  - Drive frequency optimization algorithm
  - PID control algorithm regulating PWM signals to voltage boosters
  - H-Bridge driving logic with shoot-through protection
  - RTOS based structure
  - Custom RPC for serial over USB and/or I2C communication



Multipurpose Automation Controller

This board is a co-development with the talented Nicolas Heimburger (who thankfully took charge of routing the PCB). The board is a general controller for peripherals that one might require in any given robotics project.

My Contributions

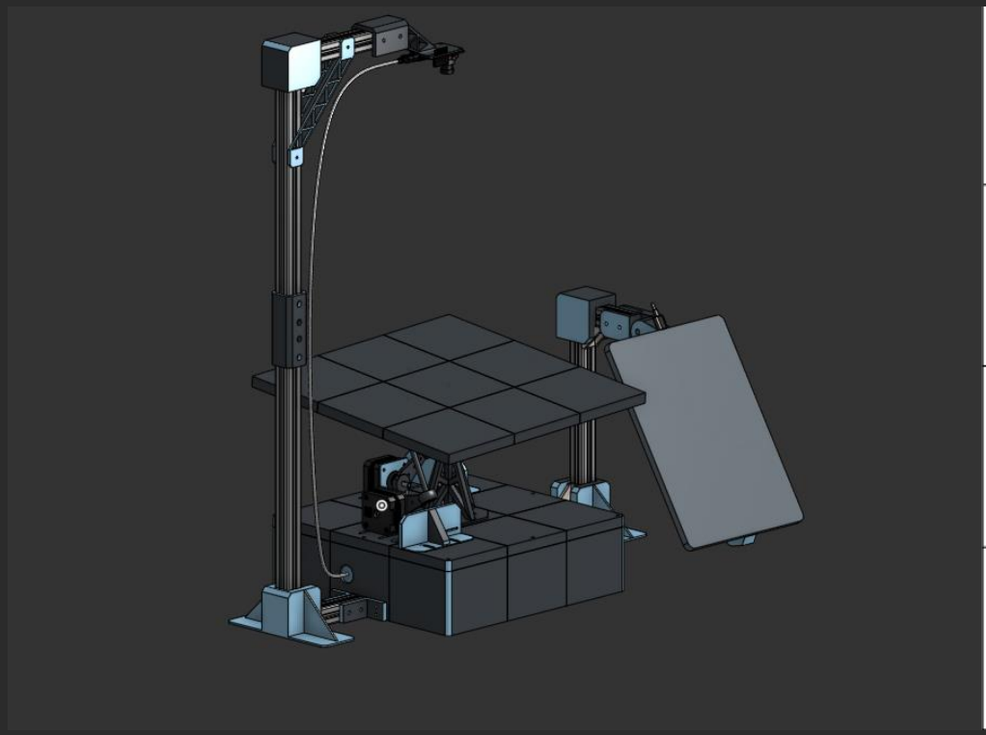
- HW/SW for sensor feedback
- HW/SW for relay control
- HW/SW for LED drivers
- GPIO expander IC integration
- Current regulating IC integration for solenoid actuation and temperature control

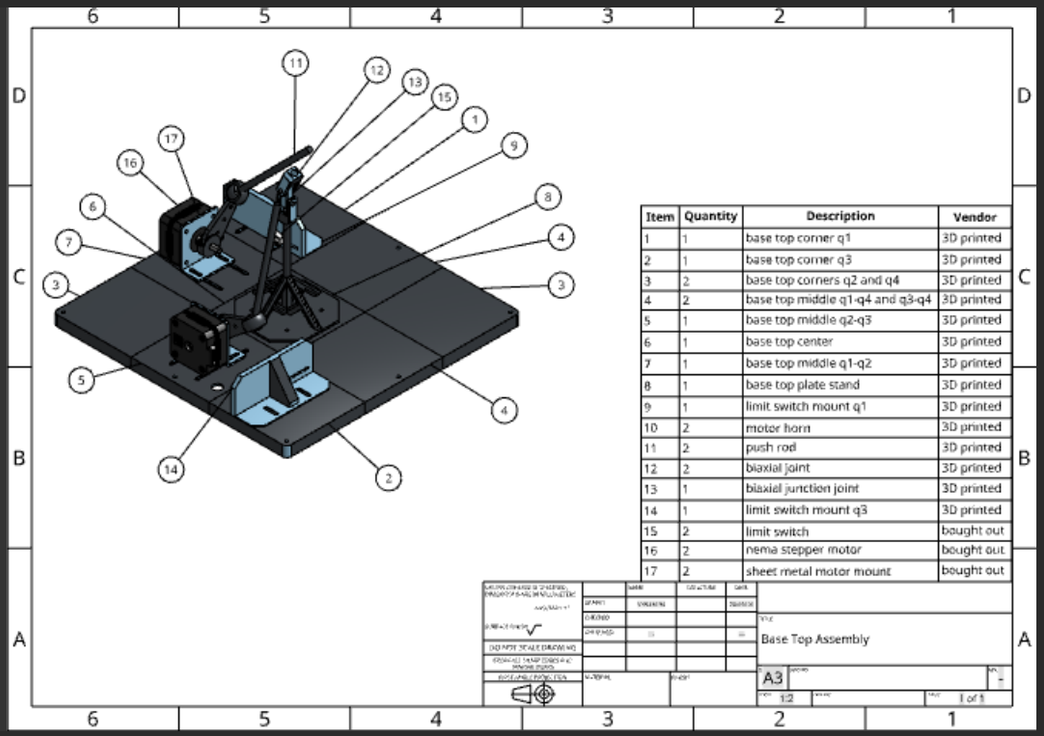
Stepper Motor Driver Board

An industry development of a stepper motor driver *control board* for interfacing with TMC2209v1.1-v.3 stepper motor driver *breakout boards*.

Key Highlights:

- Hardware
  - 4x stepper motor driver interfaces
  - 4x limit switch sensor feedback interfaces
  - 8x jumper interfaces for hardware based microstep configuration
  - Interfaces for I2C and USB transport layers
- Firmware
  - ESP32 to TMC2209 UART interface for software based microstep configuration
  - Impedance based limit detection
  - RTOS based structure
  - Custom RPC for serial over USB and/or I2C communication protocols
- Personal/Commercial applications:
  - Belt drives (Personal Project)
  - Lead screws (Personal Project)
  - Syringe pumps (Personal Project)
  - Peristaltic pumps (Cellectric Base Station Microfluidics Module)
  - Ball on a Plate (Personal Project)





Item	Quantity	Description	Vendor
1	1	base top corner q1	3D printed
2	1	base top corner q3	3D printed
3	2	base top corners q2 and q4	3D printed
4	2	base top middle q1-q4 and q3-q4	3D printed
5	1	base top middle q2-q3	3D printed
6	1	base top center	3D printed
7	1	base top middle q1-q2	3D printed
8	1	base top plate stand	3D printed
9	1	limit switch mount q1	3D printed
10	2	motor horn	3D printed
11	2	push rod	3D printed
12	2	biaxial joint	3D printed
13	1	biaxial junction joint	3D printed
14	1	limit switch mount q3	3D printed
15	2	limit switch	bought out
16	2	nema stepper motor	bought out
17	2	sheet metal motor mount	bought out

Base Top Assembly

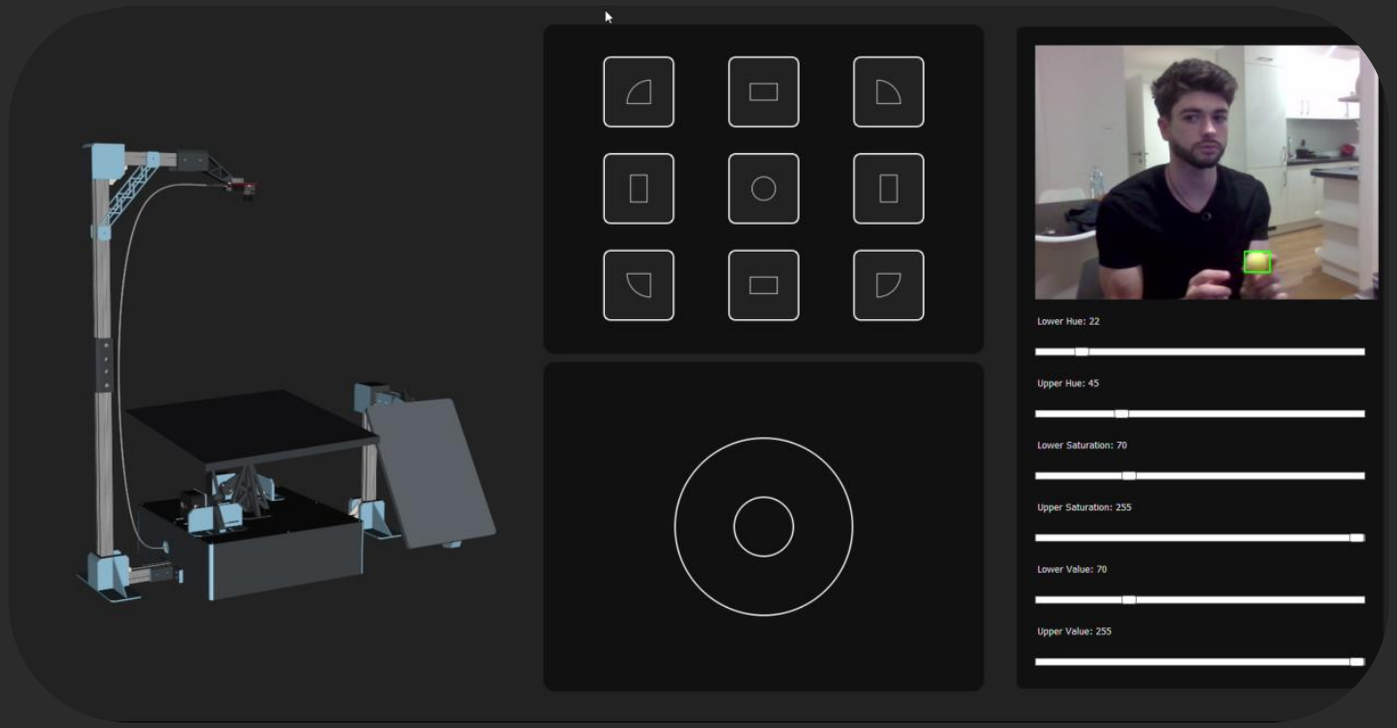
A3

Ball on a Plate

Like its name, this personal project is underdevelopment. The idea being to control a plate's orientation to automatically balance a ball at various set-point positions on the plate. The projects mechanical, electronic, and motion tracking software design are all complete. Currently, I am working on the position control algorithm.

Key Highlights:

- Manual/Automatic control over plate orientation
- Cross platform control application with interactive GUI
- Ball position video feedback
- Embedded switching power supply
- Electronics housing unit
- Compatible with OpenMV and OpenCV feedback



Cross Platform Control Application with Qt

Here is a closer look at the Ball on a Plate's control application and GUI. The software allows the user to control the plate's two axis with a custom joystick widget (logic implemented) or select a quadrant for the system to automatically place the ball (logic underdevelopment). In addition to control, the GUI displays motion tracking video feedback and an *interactive* 3D model of the system.

Key Highlights:

- Libraries and Modules
    - VTX for embedding 3D images into a GUI
    - Custom module for 3D image mouse tracking
    - OpenCV data handling
    - Motion tracking algorithm reflected on video playback
    - Custom joystick widget module
- Multithreaded application following OOP and event driven architecture design patterns
- Custom built state machine for serial over USB communication sequencing