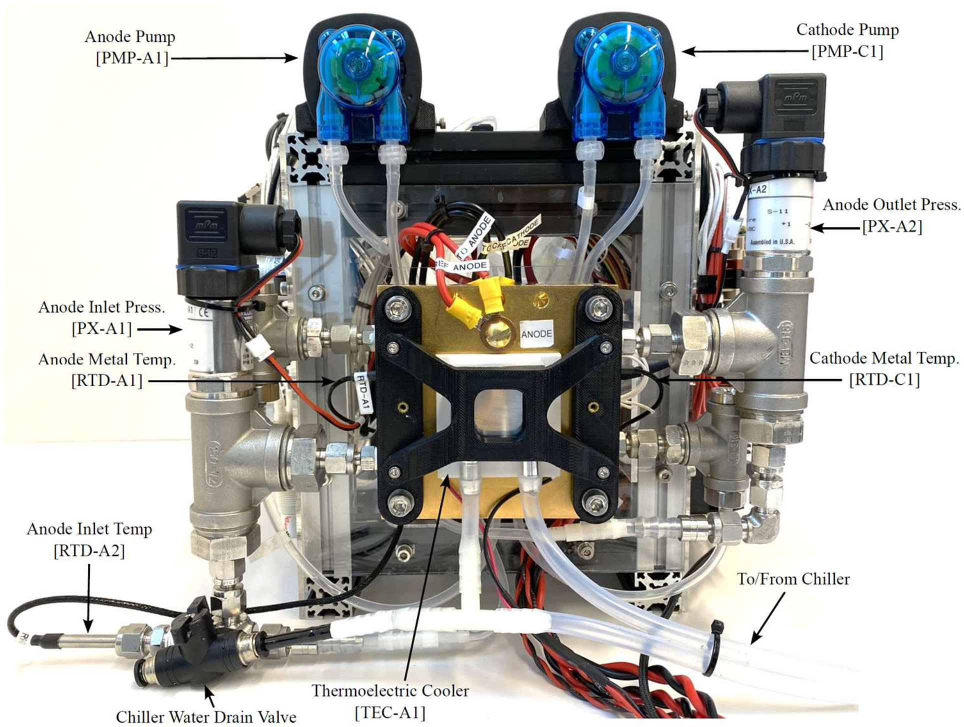
Electronic Portfolio
Peter Morice

This electronic portfolio contains a selection of personal design work. The projects shown here represent a subset of work that would be appropriate to share and should provide a flavor of my multidisciplinary background and interests.

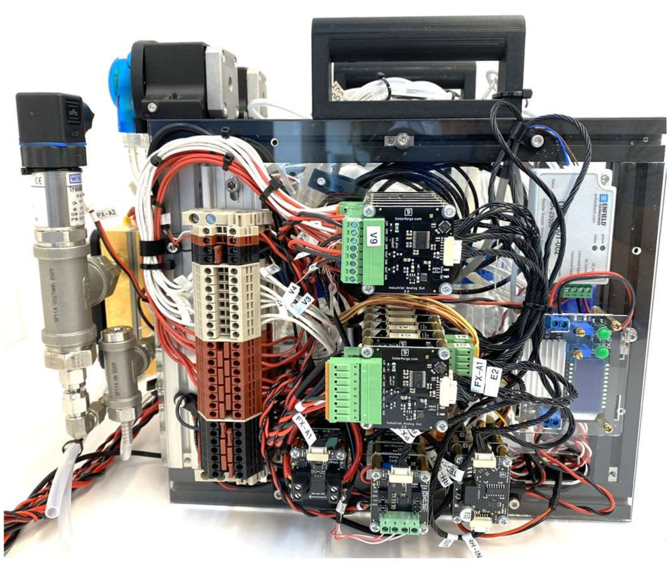
Contents

PEM Electrolyzer Experiment Design – M.S. Thesis Project

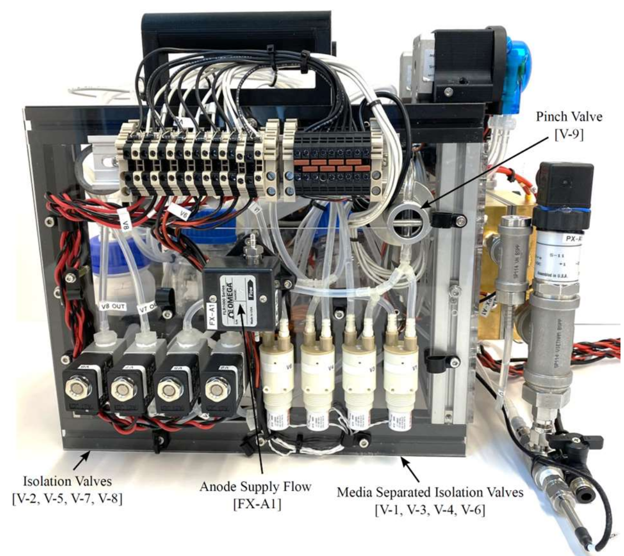
The following experimental test setup is designed to evaluate PEM electrolysis as a method of removing water from milk to produce milk powder. The system includes 19 measured inputs and 12 controlled outputs, integrated using the Tinkerforge microcontroller hardware and programmed to perform automatic tests using Python.



FRONT VIEW



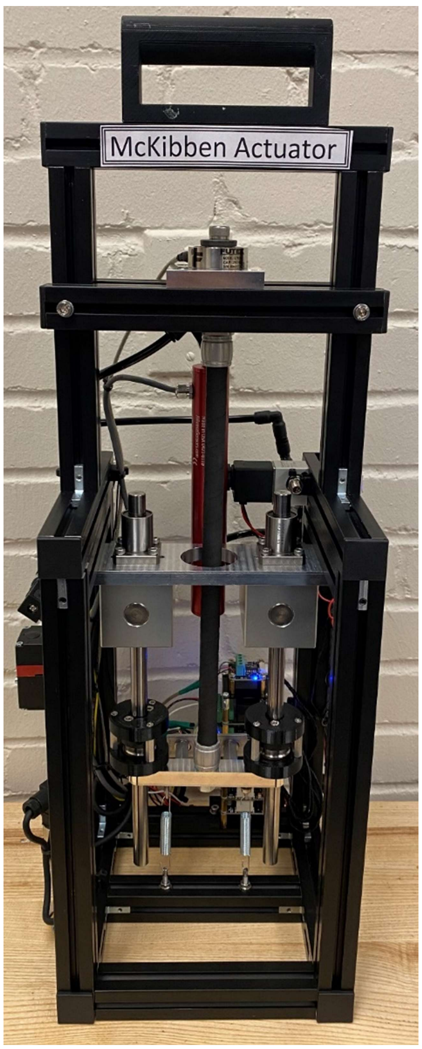
LEFT VIEW

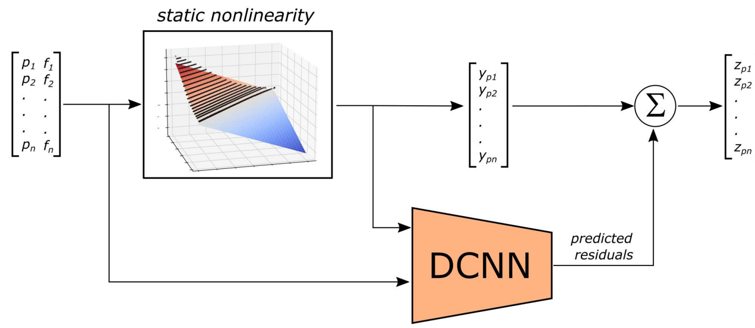


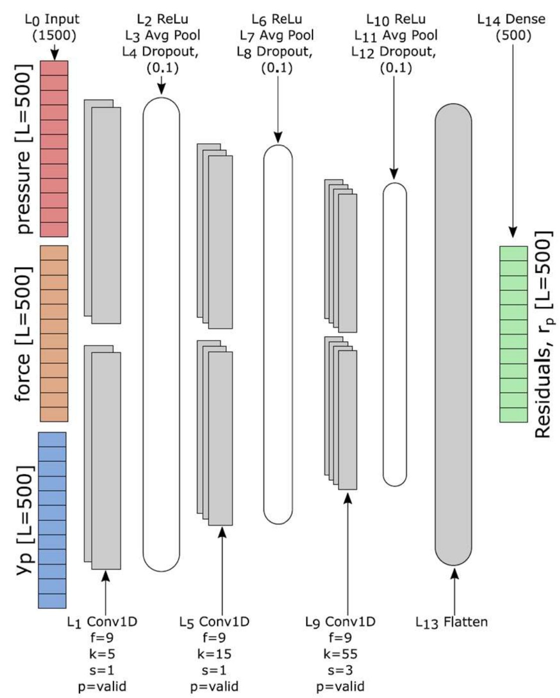
RIGHT VIEW

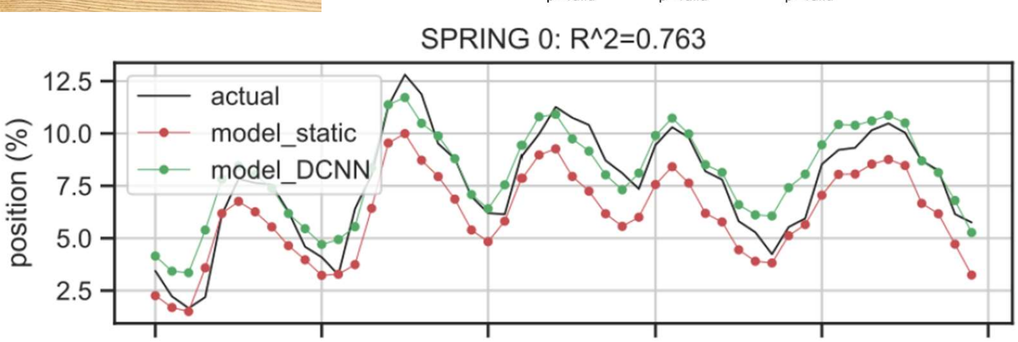
Dynamic Mechanical Analyzer for McKibben Actuator Modeling

A Dynamic Mechanical Analyzer (DMA) is designed around the McKibben Actuator to measure the three primary variables of pressure, position, and force generated by the actuator. The experiment applied a stochastic dynamic pressure input to measure actuator response from the remaining two variables. The proposed model architecture includes a nonlinear static model as a feed forward response, supported by a parallel Discrepancy Convolutional Neural Network (DCNN), which was trained with experimental data to predict dynamic response residuals. The residual prediction is then added to the static feed forward signal in the model, resulting in good agreement of the model predicted response (green trend below) to measured actuator response (black trend below).



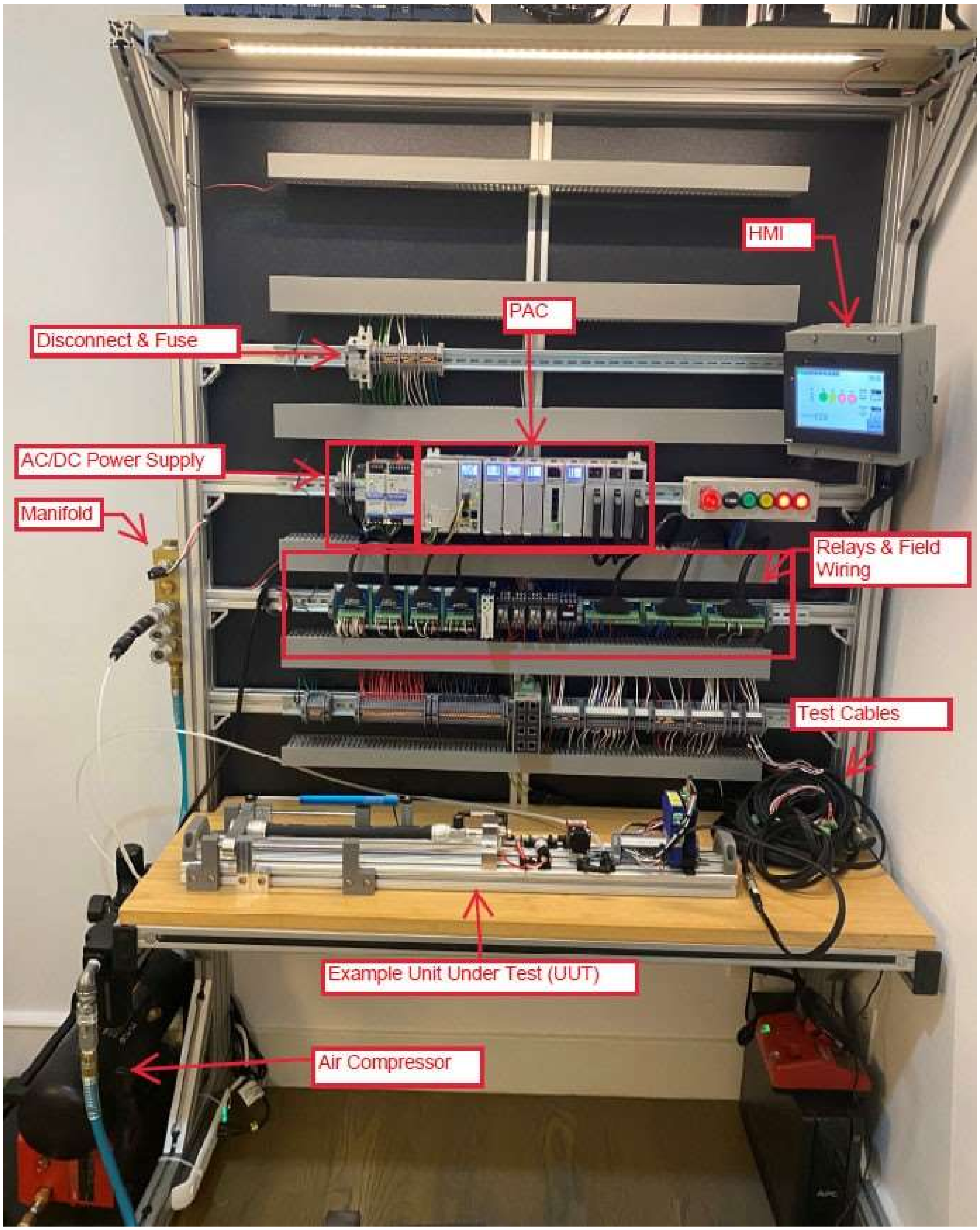




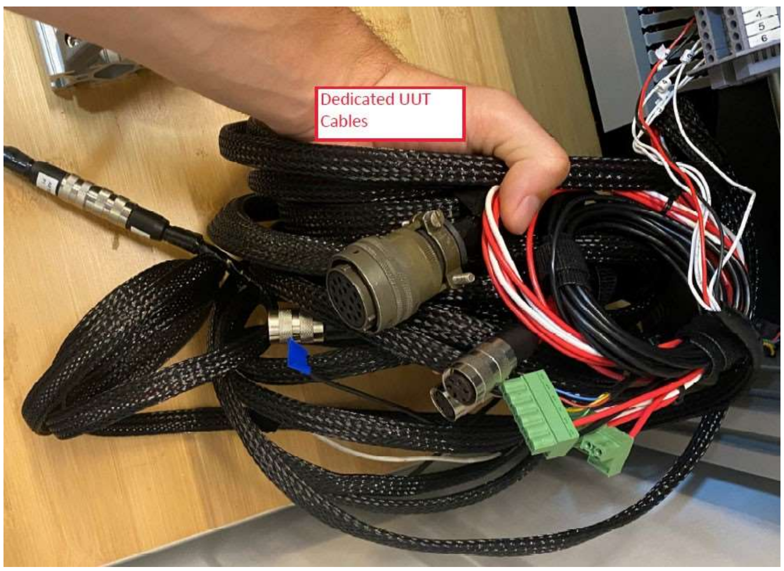


Programmable Automation Controller (PAC) System Test Bench

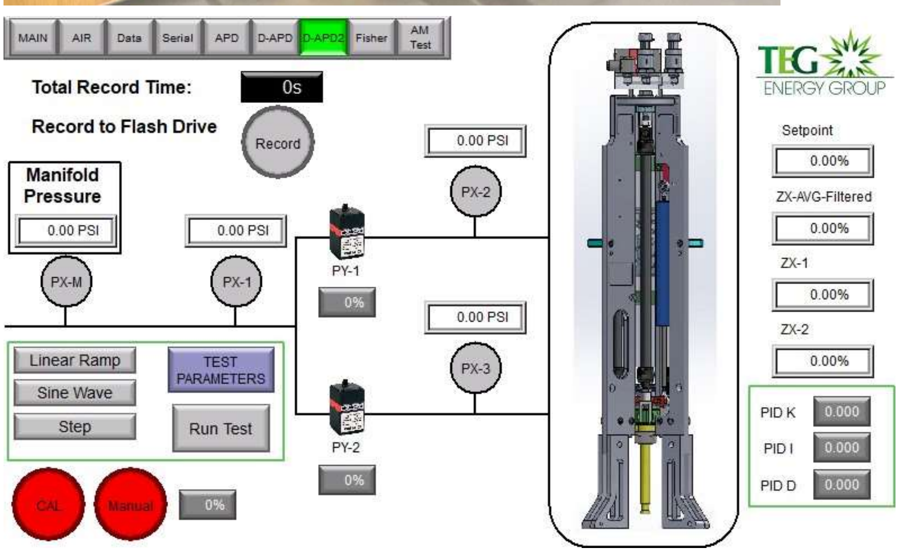
The Programmable Automation Controller (PAC) System is a functional test bench including a CPU, various I/O cards, AC and DC Power, and a Human Machine Interface (HMI). The PAC System is configured to run automated tests and acquire measurement data for various hardware designs. The scalability, fast execution performance, and flexible programming make this test system ideal for hardware validation. This setup was installed in my NYC apartment to support my hobby experimenting with actuators of various types.



Above: PAC CPU and I/O card closeup.



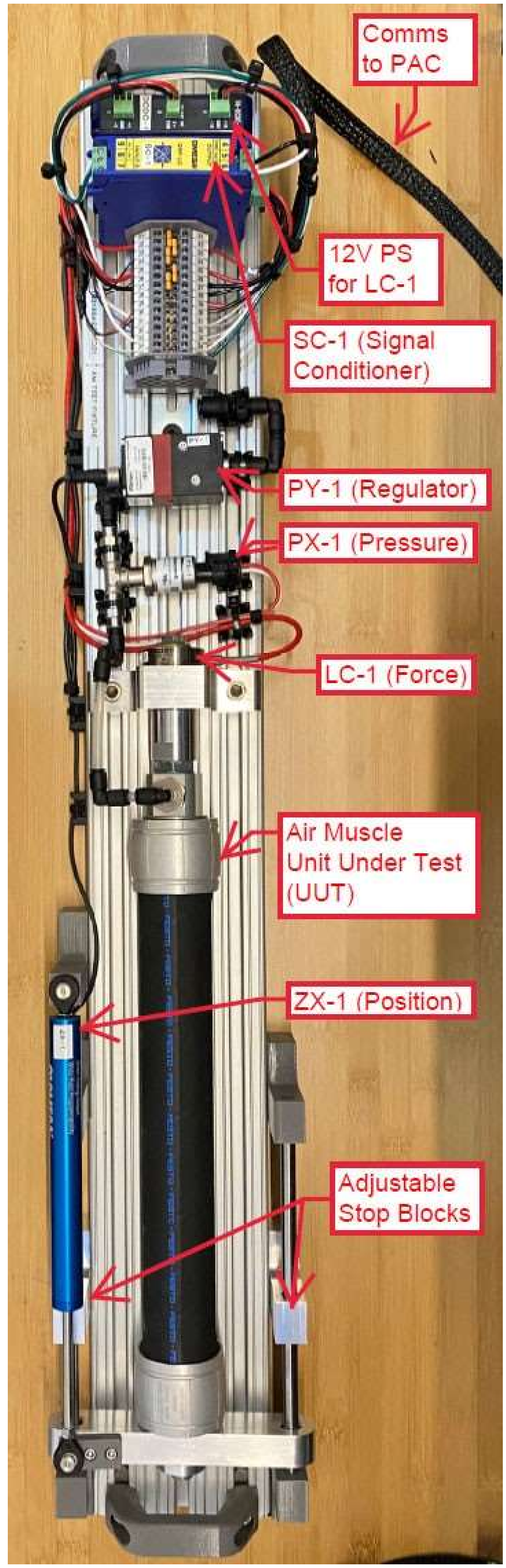
Left: Cables for quick connect/disconnect of various Units Under Test (UUT's)



Left: Example of HMI Graphic for a specific UUT

Air Muscle Test Fixture

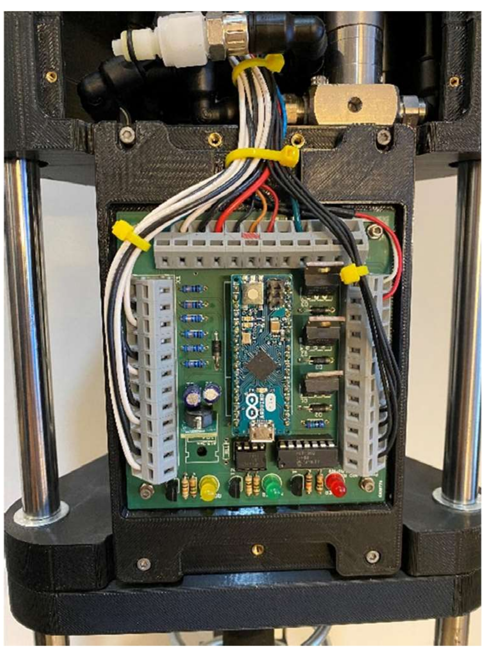
The Air Muscle Test Fixture is designed to test air muscles of varying diameters and lengths. Measured position, pressure, and force are recorded at several fixed contraction lengths determined by the adjustable stop blocks. Control and data acquisition are performed by an external PAC. See the writeup on the *PAC System Test Bench* for details on that system. The data for air muscles of three diameters (10 mm, 20 mm, and 40 mm) is used to validate a mathematical model in MATLAB of the air muscle under test. The mathematical model will be used to inform design decisions and assist in the real-time control algorithm of the actuator assembly.



Right: Air Muscles of various diameters (10 mm, 20 mm, and 40 mm) for test

Modular Redundant Pneumatic Actuator Positioner Device (APD)

The patented design pertains to automated linear actuated valve applications. The modular and redundant design enables multiple air muscle actuator assemblies to be applied to a single valve. The modular design increases flexibility by adding modules to increase force and seat load based on the application needs. It also decreases potential process downtime that may result from failure of any single module by ensuring n+1 module redundancy.



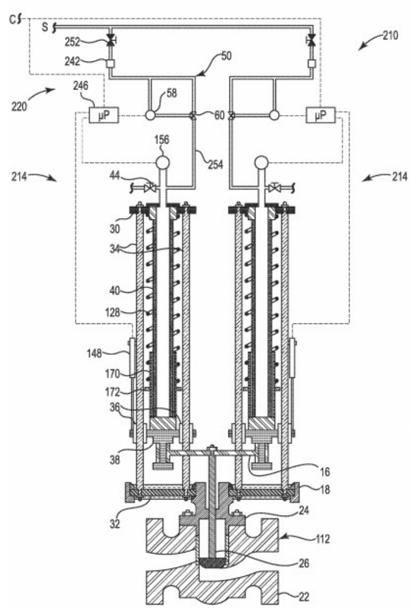
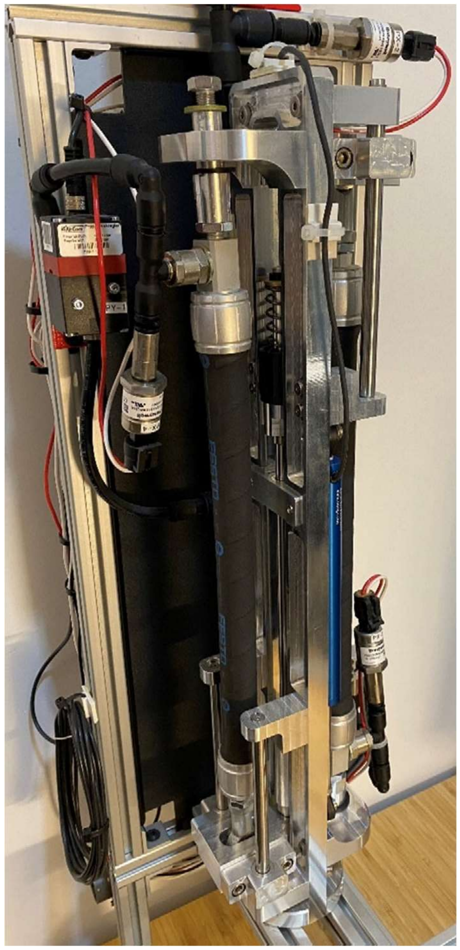
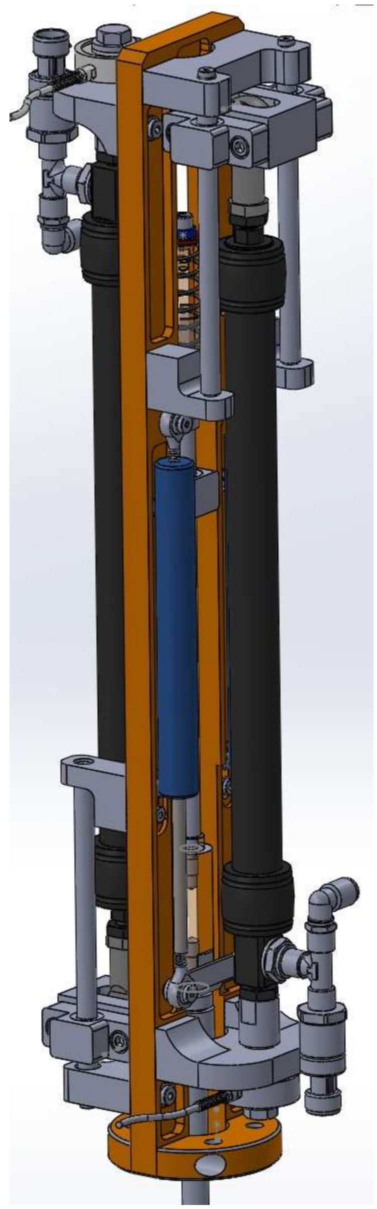


Fig. 3

Double Acting Positioner Device (DAPD)

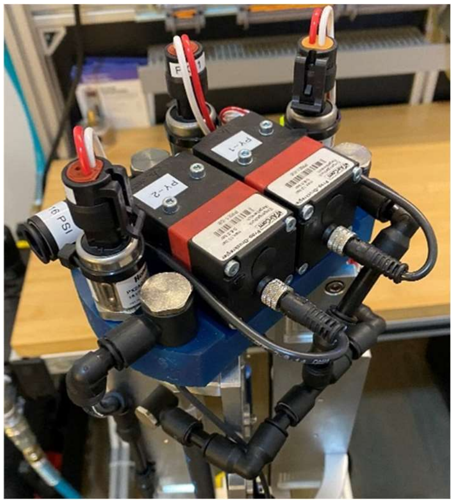
The DAPD fixture was designed to test opposing air muscle actuators, where one of the actuators simulates the effect of a constant force preload throughout the stroke range. The effectiveness of various control strategies are tested including, force control, position feed-forward control, and position calibrated open-loop control.

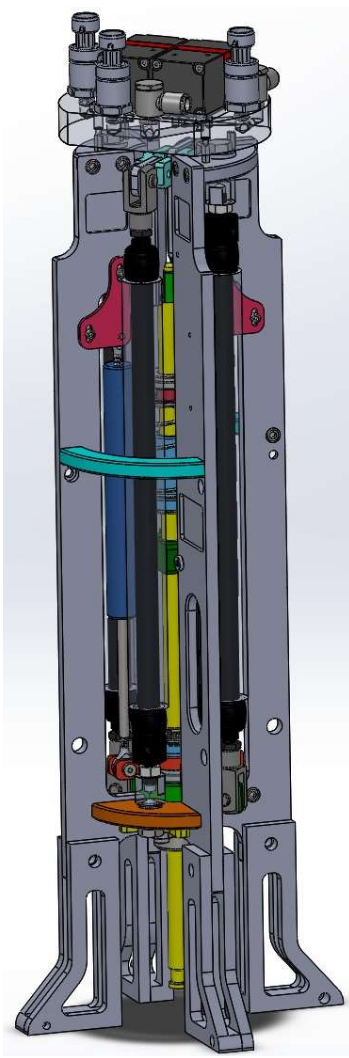




Double Acting Positioner Device (DAPD) Rev 2

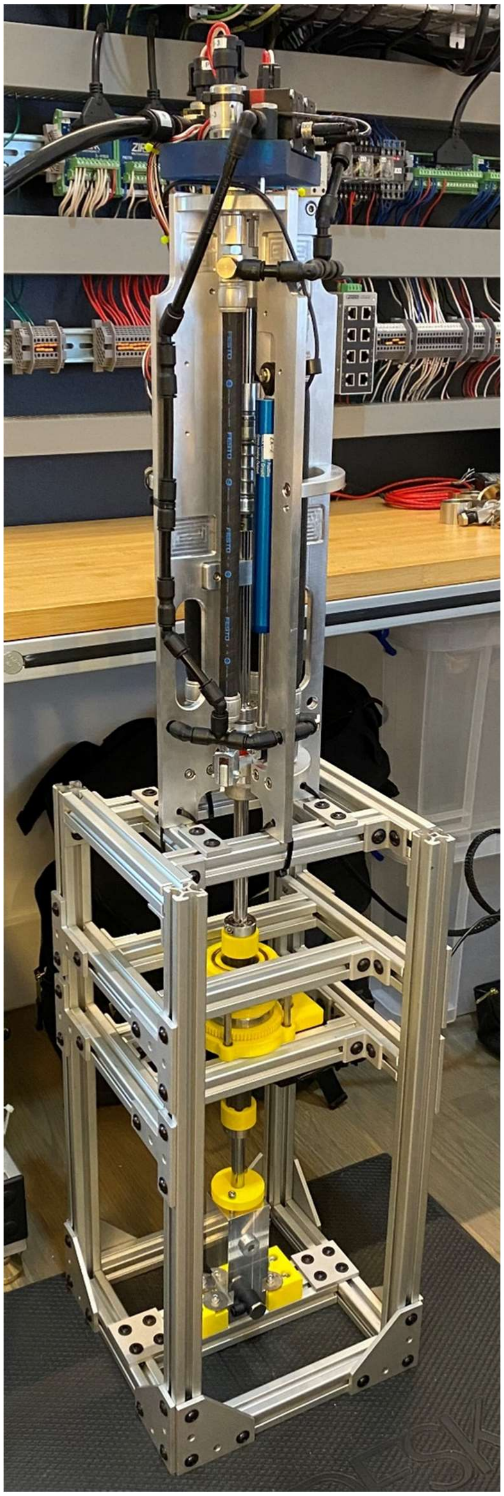
A revision of the DAPD design with onboard pneumatics and electronics.

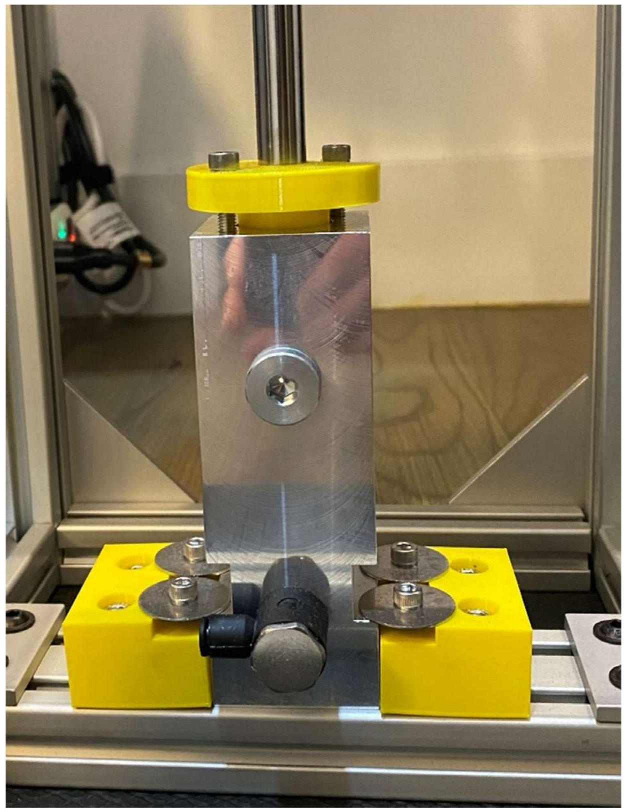




Friction Test Fixture

Packing friction on the valve stem is simulated using a pressurized manifold with chevron geometry Delrin packing seal rings. DAPD is mounted on the fixture to actuate and measure response under various loads, achieved by tightening the packing retainer plate.



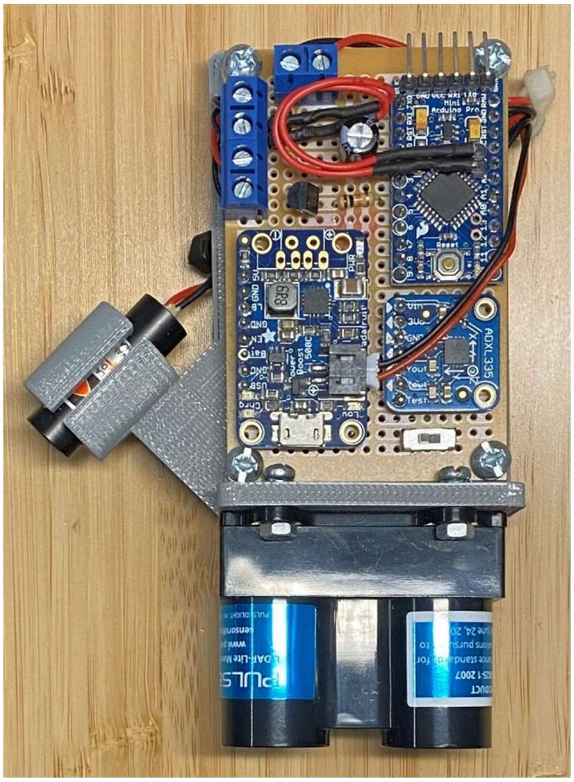


Above: Pressurized manifold with packing seal rings located between the shaft and the manifold. The packing retainer plate (yellow part on top) can be adjusted to vary compression of the seal rings.

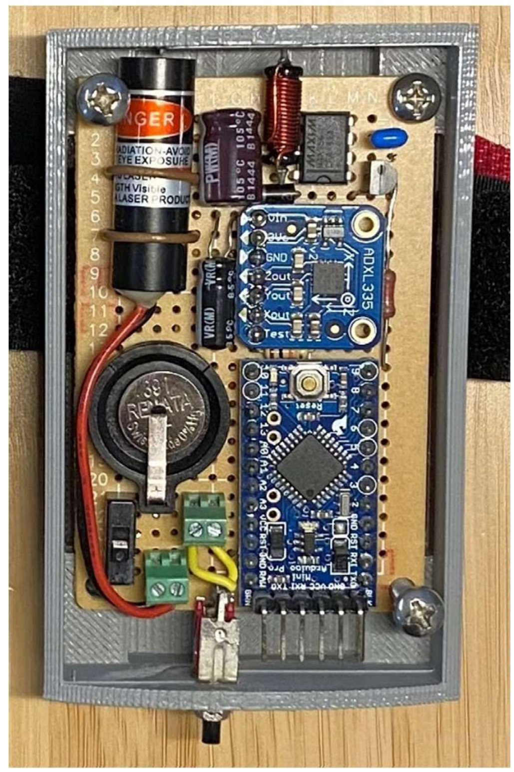
Above: Delrin packing seal rings are stackable to seal the gap between the shaft and the manifold.

Laser-10 Project

Laser-10 project is a mobile device to assist soccer referees in measuring the 10-yard minimum distance between the foul and the defensive wall during a free-kick situation. The current method, where the referee paces 10 steps to set the defensive wall, produces inconsistent and imprecise results based on the height and gate of the individual referee. Additionally, there is no means to verify the measurement. Laser-10 eliminates the uncertainty by producing exact, repeatable, and verifiable free-kick setup according to the FIFA regulations, no matter which referee is using the tool.



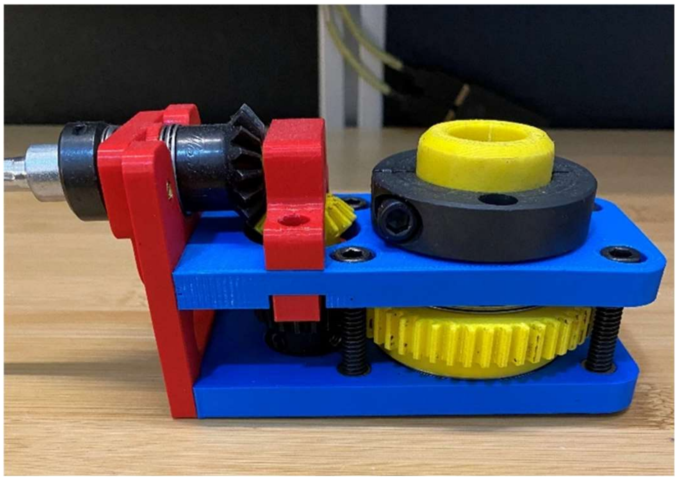
Above: Rev 2, the hand-held version, uses two measurements: (1) MEMS 3-axis accelerometer to determine the tilt angle, and (2) pulsed laser diode range finder to determine the distance to the ground. These two measurements are used by the microprocessor to calculate the distance of the laser pointer on the ground. The laser pointer blinks faster as it approaches the 10-yard distance on the ground.

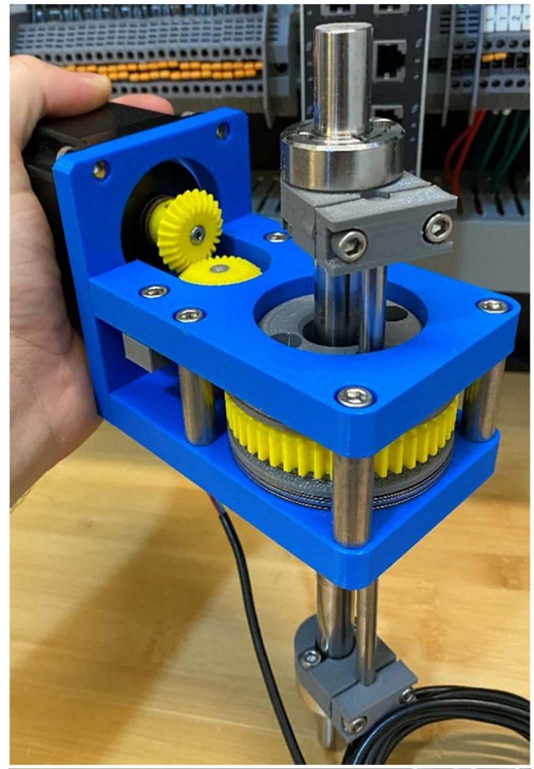


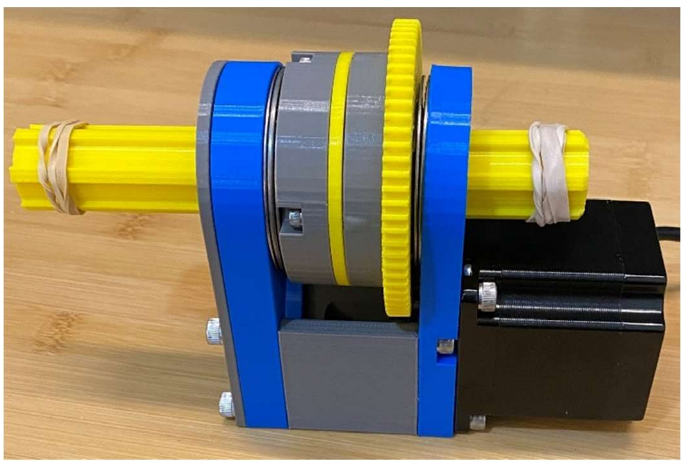
Above: Rev 3, the arm-band mounted version, uses only one measurement of the MEMS 3-axis accelerometer to determine the tilt angle. The measured distance to the ground is replaced by a calibration step in which the referee stands at the center of the soccer field and points the laser at the line that makes the center circle, which is always a 10-yard radius. Once this value is set by the referee in calibration mode, it is retained until a new calibration is performed. Eliminating the pulsed laser diode device reduces the unit cost by a factor of twenty compared to Rev 2.

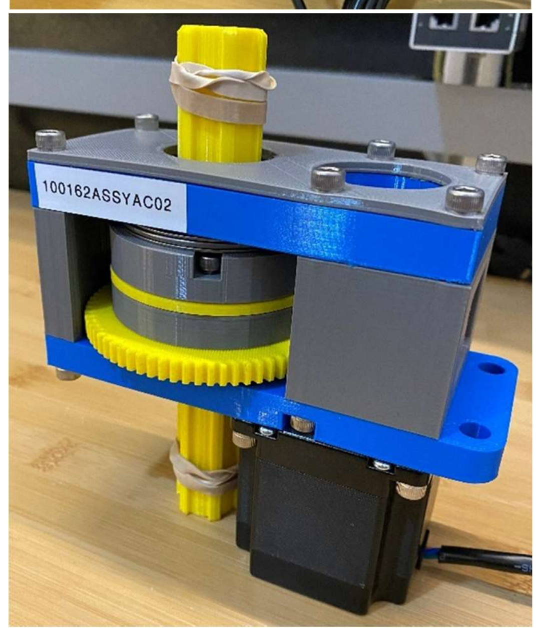
Mechanism Design Iteration Using Rapid Prototyping

Below are five examples of iterating powertrain designs using rapid prototyping.









Mechanism Design Iteration Using Rapid Prototyping - *continued*

The mechanism below is the latest revision that resulted from various iterations described above.