Leo Gabriel

Mechatronics Engineering 2025 | University of Waterloo

Robotics · Rapid Prototyping · Machine Design · Automation · Innovation

Rapid Cryogenic Protein Freezing and Substrate Deposition Robot

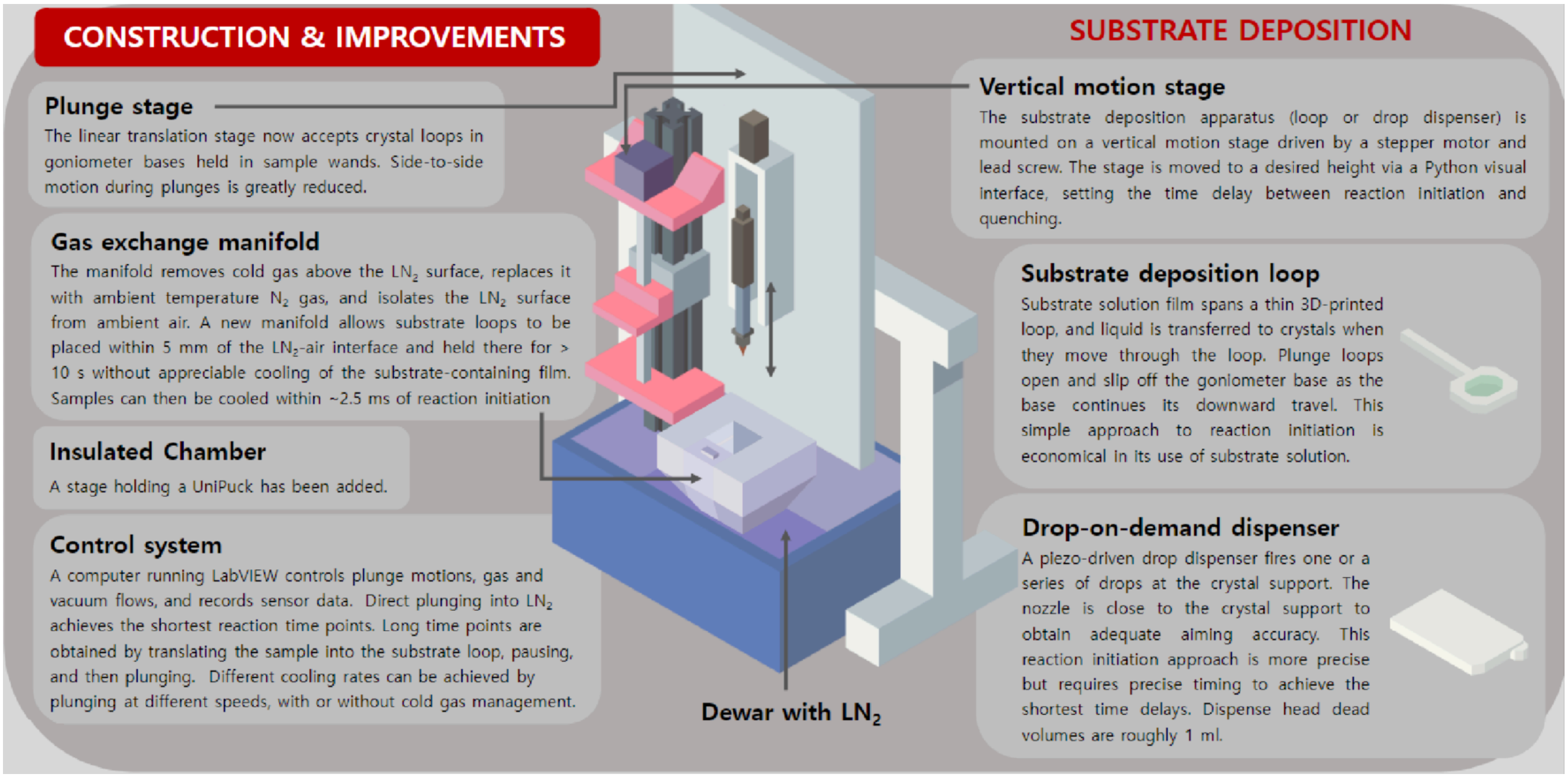
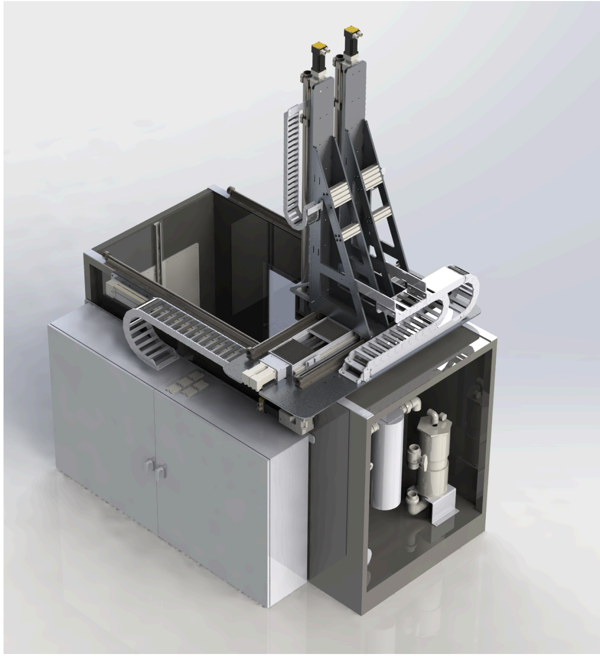


Image: Cornell University LASSP, Thorne Lab

- Worked on system to plunge 10-100μm protein crystals into LN_2 at 2m/s, while accurately depositing μL drops of substrate onto the crystal at a target T minus with 5ms accuracy
- Modeled structures and mechanisms in **SolidWorks**
- Increased encoder polling rates by implementing an **STM32** running custom **C** algorithms, increasing deposition timing accuracy to the 1-10μs range
- Developed a **Python** program for HMI, data processing, setting configuration, and robot control
- Prototyped various mechanisms and improvements for the system using **FDM/SLA 3D printing** as well as **machining**
- Analyzed results using X-ray crystallography at the Cornell High Energy Synchrotron Source beamline

Ultrasonic Non-Destructive Testing (UT/NDT) Machine



- Tasked with retrofitting a decades-old long since decommissioned 9-axis UT machine
- Performed **design calculations** to ensure machine could reach desired accelerations, speeds, cycle times, and precision metrics
- Selected linear amplifiers as brushless servo drivers to reduce EMI to sensitive UT instruments
- **Communicated with manufacturers** to quote and compare different options for various components
- Identified areas that needed repair, replacement, and improvement
- Designed a waterproof machine, as water jets are used as the ultrasound transmission medium
- Conceptualized a new plumbing system to replace worn-out components
- Redesigned Z-axes and other machine components with a focus on increased **rigidity** for accuracy

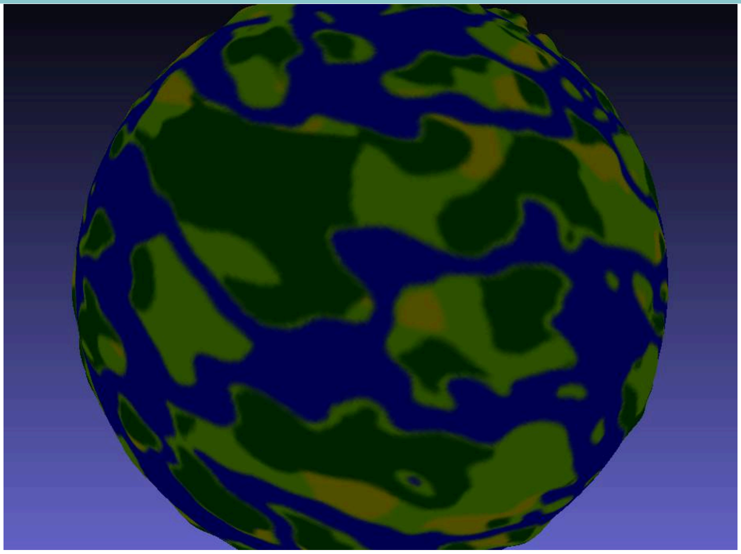
Film Processing Laser Cutter

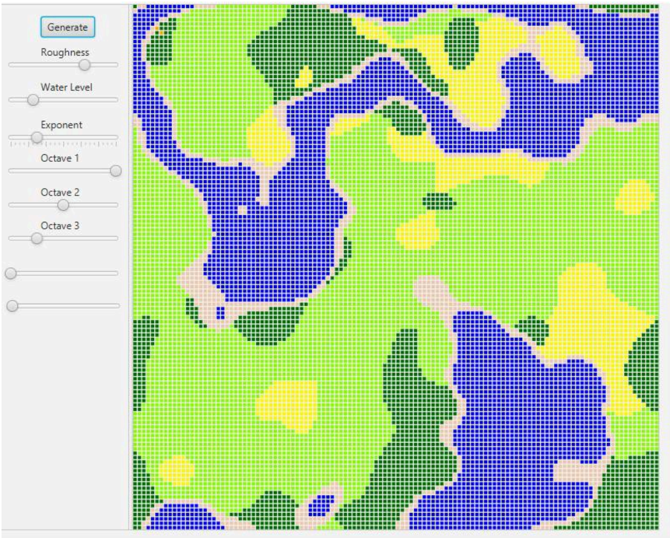
- Owned project to conceptualize, design, and build a film processing machine to automate laser cutting of custom parts on Questat's mass production line for their blood testing cartridge product
- Determined **process flow** for entire production line before diving into this first component of it
- Designed machine in **SolidWorks**, went through several design reviews and iterations before building
- Used **experimentation** as well as **analysis** to make decision on part selection and machine construction
- Developed a **C**++/**Python** real-time system with **TCP/IP** communication between multiple MCUs, the laser cutter, and an HMI
- Decoded packets between computer software and laser cutter to replicate communications in software
- Generated dimensional **drawings** of custom parts for external machinists, and hand-machined other parts in-house on lathe and mill
- Presented and **documented** the project for technical and non-technical staff use and development

Barn Door Star Tracker

- A device to stabilize a camera and lens relative to the rotation of the earth for long-exposure astrophotography
- **Zero-budget** project using tools and materials on hand, mostly found from my garage
- Tuned car window motor and bent lead rod to perfectly counteract the effect of earths ω
- Successfully took longer exposure photos with less star trailing

Map Generator



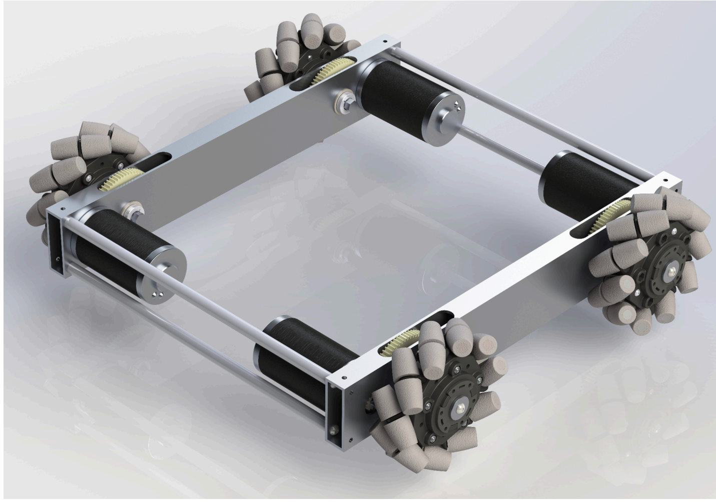


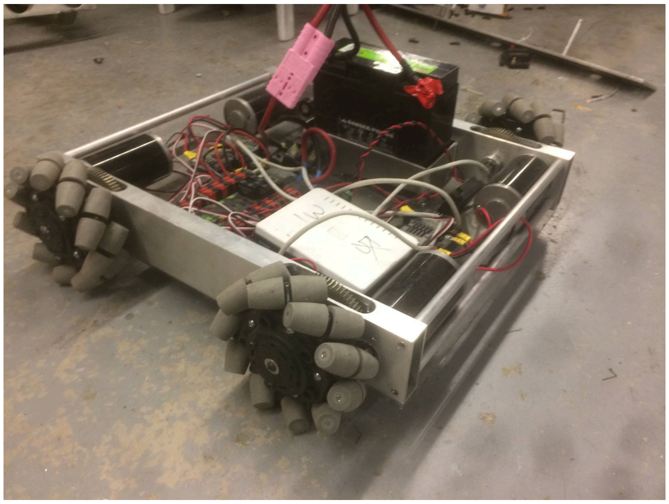
- Used **Java** and open-source libraries to build a procedural map generator
- Generated 3D cylindrical and 4D toroidal noise for 2D/3D maps and globes
- Maps displayed realistically generated and tuneable elevation and climate information
- Exported 3D maps as point clouds to make meshed models in MeshLabs, an open source mesh processing software

Radar Pan/Tilt Manipulator for Testing Rig

- Tasked with creating a rig to reliably **automate** testing of new radar sensors for the eleven-x device seen
- Adapted a found design fo a pan/tilt manipulator to better suit the application and to keep the sensor chip centered
- Rapidly designed, **3D Printed**, and built the device to get testing as soon as possible
- Designed control system around easily procurable and replaceable components (**Arduino**, NEMA 17s, TMC2209s)
- Coded interface to allow easy modification of test configuration and parameters by end-user for varied testing application

Mecanum Drivetrain





- Designed, manufactured, assembled, wired, and coded individually as an 11th grade project
- Mecanum wheels allow omnidirectional movement with pivoting around different points

ATmega Piano

- Stretched the limits of the **ATmega328P** MPU to emulate a piano, outputting MIDI and speaker audio
- Used onboard timers to approximate sine and complex waveforms beyond the capabilities of the onboard DAC
- Developed algorithm to generate chord waveforms on the fly due to memory limitations
- Optimized data structures to fit as much note data as possible withing the chip's limited EEPROM

Leo Gabriel

- Chronic **maker** (3D print, home improvement, automation, anything that crosses my mind)
- Likes cooking and baking (you get **free baked goods** on a **weekly** basis)
- Plays tennis, squash, and badminton (at varying skill levels)
- Plays **trumpet** in UW concert and Animusic bands (personal concert for an extra fee) (not really)
- Dabbles in nature **photography** (loves **hiking**)
- Board game enthusiast (Puerto Rico and Everdell are current favorites)