Von Simmons
Robotics

Curiosity is my guide. It takes me to the realms of Engineering, Cognition, and Artificial Intelligence – the domain of Robotics. I seek not to create useful automation but a mind wrapped in a machine. I dream of automata which assist us in exploring the Universe.

UC Irvine, BS Electrical Engineering
von.simmons@gmail.com

The following projects are my first steps into a great journey of learning!

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von.simmons@gmail.com

6 DoF Arm, Inverse Kinematics

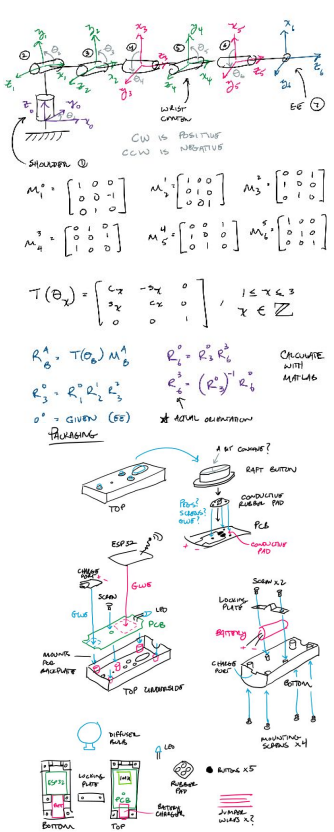
Objective: Use open-source 6DoF arm design to test custom IK algorithm.

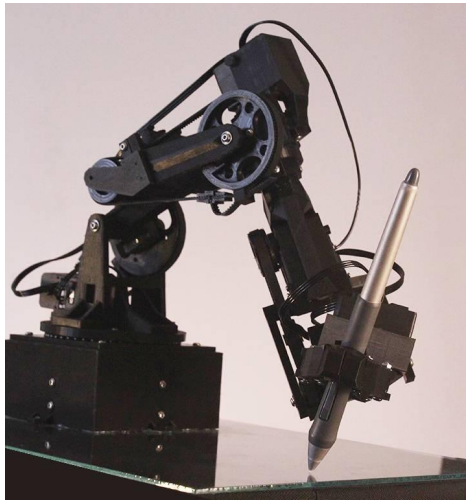
Outcomes: IK was implemented and tested. HMI began development, but was not completed. See documentation.

Course: Angela Sodemann – *Robotics 2* (*https://robogrok.com/Robotics_2.php*)

Following my time on the Saddleback Robotics URC team, I developed an inverse kinematics control scheme to assist with the manipulation mission at the competition. To demonstrate my algorithm, I built an open-source 3D printed arm and used a previous PS4 controller schema to move the endpoint. This project heavily used Linear Algebra, Python, C/C++, MATLAB, and Ultimaker Slicer. I attempted to repurpose an older personal project (javascript 3D engine), to simulate joint movements, though it was not as useful as planned. Additionally, I had intended on using a salvaged PS Move controller to implement better HMI. Due to a bug in Windows this was impossible, so I began designing a custom PS Move controller based on teardown of the original Sony product.

Documentation: https://github.com/vs65497/6dof_ik/blob/main/README.md





IK Derivation: https://github.com/vs65497/6dof_ik/blob/main/ik_calculations_v2.pdf
HMI Controller Design: https://raw.githubusercontent.com/vs65497/6dof_ik/main/motion_controller.pdf

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Inverted Pendulum on Cart

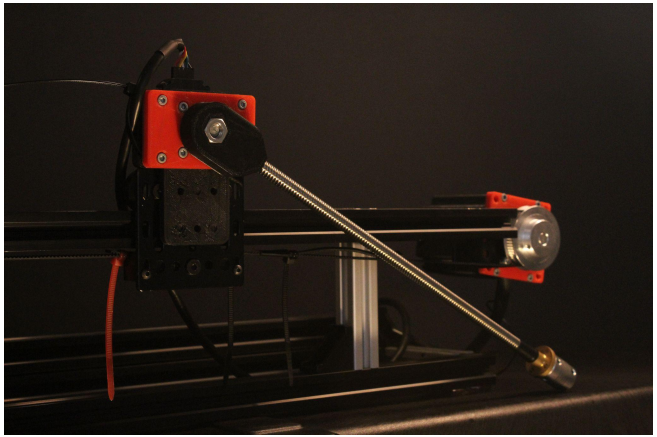
Objective: Swing up and balance an underactuated pendulum on cart using State-Space Control (LQR) and an Lyapunov energy function.

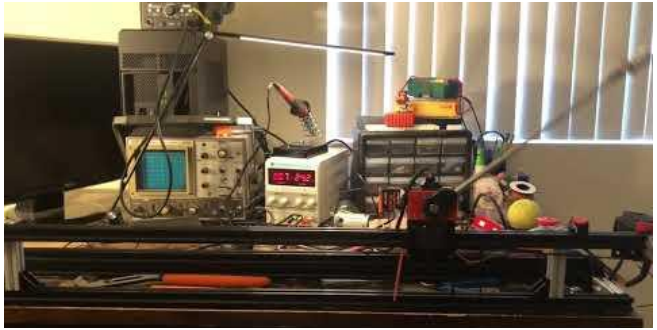
Outcomes: Swing up was achieved, but balance was not possible due to severe backlash in the system. A Kalman Filter was designed (LQG) though not tested.

Courses: Russ Tedrake – *Underactuated Robotics*, Steve Brunton – *Control Bootcamp*.

This project is the result of 9 weeks divided into SolidWorks CAD, ODrive configuration, electrical system design, MATLAB Simulink simulations, software system development (C/C++, Python, Bash), custom mathematics packages, LQR controller, Lyapunov controller, finite-state machine, and controller tuning.

Documentation:
https://github.com/vs65497/InvertedPendulum/blob/main/README.md





Trials: https://youtu.be/Sc8SkmnBHfo

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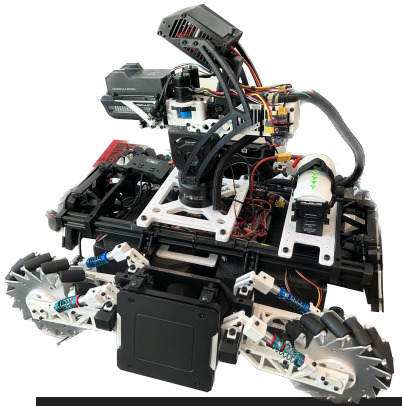
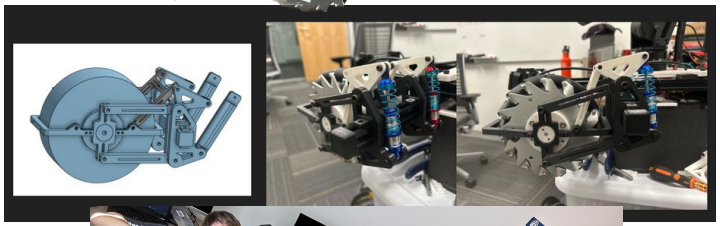
Legacy Robotics, 501(c)3

Objective: Create the UC Irvine Robomaster team and participate in the North American 3v3 and 1v1.

Outcomes: Built much of a first prototype. Learned much about building and running a team.

Contributions: Founder, Captain, Systems Engineer, Mechanical and Software Team Lead, Mechanical Designer, 3D Printing, Mentorship, Accounting, B2B Development, Fundraising, Community Outreach, and more.





Legacy Robotics at UCI was a 2-year project which I founded and ran before transferring ownership in May 2024. I wore nearly every hat on this project at least once. My main technical contributions include designing and building the 3rd generation suspension, designing and building the 1st generation turret, systems engineering for the robot, technical leadership for the mechanical and software teams, and designing curricula to train team members in Control and Mechanism Design. Please ask me about this because there is more than can be expressed in any single documentation.

1. Capstone Project 2024 – https://youtu.be/5prZuPgV37A
2. Year One - Milestones of 2023 - https://www.youtube.com/watch?v=-XCVgsTe5O8
3. Pre-Season Prototyping (2022) - https://www.youtube.com/watch?v=7hT9oZhGcco
4. Individual Contributor (Progress Report) - https://drive.google.com/file/d/1cgP-LLTiAtr5jk4ZOi2hmmDbhJTNPWQP/view?usp=drive_link

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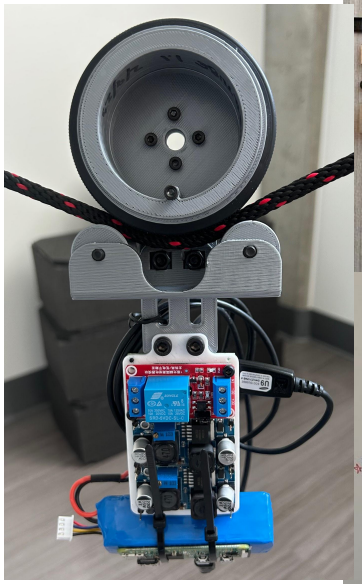
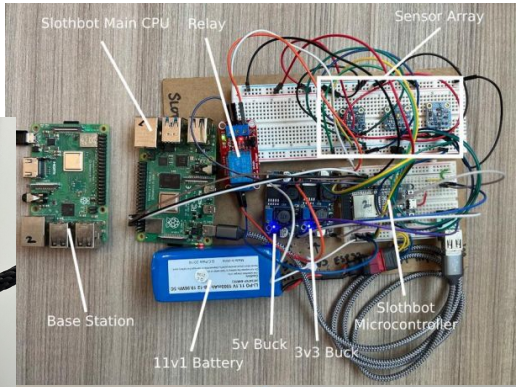
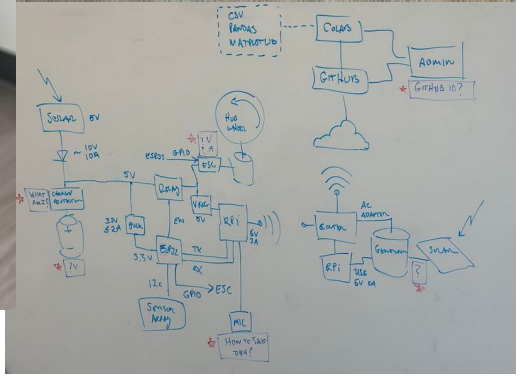
Undergrad Research: Slothbot

Objective: Design a novel wire-traversing robot which hibernates, recharges battery with solar power, and can take environmental measurements.

Outcomes: The hibernating electrical-software system was prototyped. It was able to take measurements and pass data to the cloud before going to sleep for a pre-established time.







Using my knowledge of systems design and electronics, I prototyped a hibernating system with sensors and a salvaged battery. The sensors communicated with an ESP32 over I2C, passed information to the onboard Raspberry Pi (RPi) with UART serial, processed information before handing off to a base station RPi over Wifi, then pushed to a free DIY cloud-based solution comprised of Github and Google Colab.

The ESP32 would enable power to the RPi, starting it up, then wait to do a handshake over UART serial before taking sensor measurements (I2C) and sending them to be processed. Once the onboard RPi was finished processing and sending the information down the pipeline, it would signal to the ESP32 to shut down power which would cut power to the RPi. The next step would have been to get the solar recharging system established (along with battery management) and to add the motor control branch.

1. Final Technical Report – https://drive.google.com/file/d/1EUjWo1Kki8s5aWvUz-fHbmY-Qd52siHc/view?usp=drive_link
2. Concept Design Proposal – https://docs.google.com/presentation/d/1BdE3-vZixO9O-zauqDCkAU-xiimN8lJ-/edit?usp=drive_link&ouid=104846297026439108850&rtpof=true&sd=true
3. Preliminary Design Discovery – https://drive.google.com/file/d/19xVyZ-u2Gyg4w69AsC-jNdUqKiUZ3JQX/view?usp=sharing

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Tactile Sensor

Objective: Develop a vision-based tactile sensor proof-of-concept to be used for robotic manipulators.

Outcomes: YOLOv5 was trained alongside a one-hidden-layer NN which successfully predicted position and depth of depressions in surface of the sensor.

Original Concept: Oliver Brock - *Why I Believe That AI-Robotics is Stuck*

This project involves several simpler modules composed into a complex system. The main complexity lies in its training as chronological order matters and understanding the specifics of inputs and outputs is necessary for successful completion. Technologies used include Python, Google Colab, YOLOv5, Roboflow, online annotation software, PyTorch, 3D printing (TPU required extra modifications to the extruder), and an iPhone camera.

Documentation: https://github.com/vs65497/Tactile-Sensor