PREET KARIA

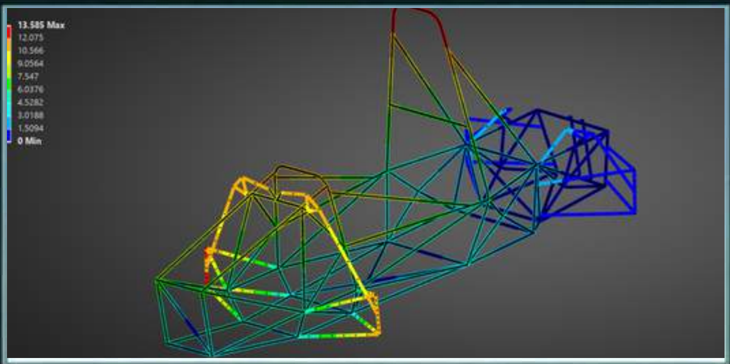
Robotics Engineering Undergraduate • UC Santa Cruz

preetkaria37@gmail.com | 650-789-0786 | linkedin.com/in/preetkaria | github.com/Preet37

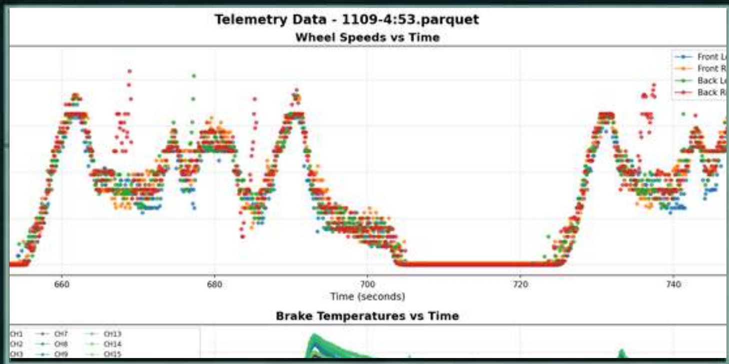
AUTOMOTIVE SYSTEMS – FSAE ELECTRIC

Mechanical Systems Engineer | Formula Slug • Chassis & Driver Controls

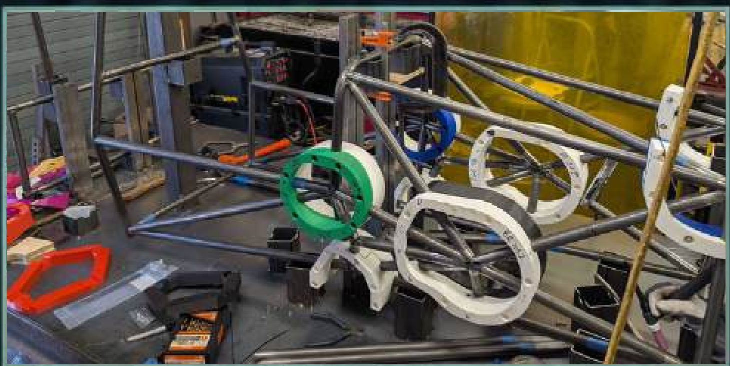
- **FEA Validation:** Executed full-chassis ANSYS FEA to quantify torsional rigidity while optimizing frame geometry to maximize stiffness-to-weight ratio.
- **Safety-Critical Design:** Designed compliant pedal box assembly, validated master-cylinder load paths and pedal arm deflection under maximum braking force scenarios.
- **Manufacturing (DFM):** Led DFM initiatives by designing custom TIG-welding fixtures and alignment jigs to ensure geometric dimensioning and tolerancing (GD&T) compliance.
- **Data Correlation:** Built telemetry pipeline to correlate thermal rise and wheel-speed data with endurance-cycle loading for predictive maintenance.
- **Driver Ergonomics:** Developed CAD for adjustable driver controls by optimizing linkage geometry and sensor alignment for redundant safety-critical operation.



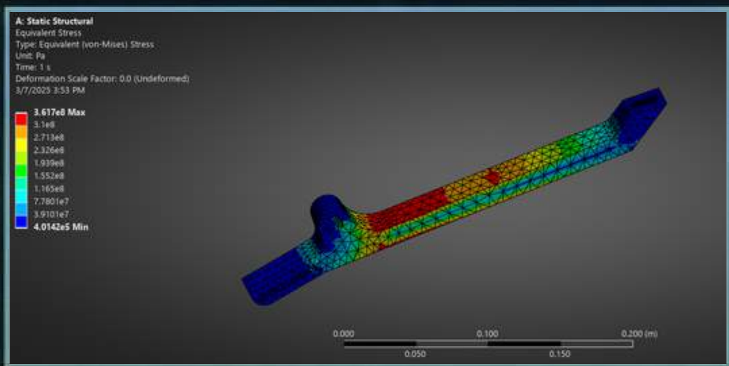
Chassis FEA Simulation
Torsional rigidity evaluation – chassis stiffness distribution.



Telemetry Data Graph
Telemetry validation – correlating thermal load with wheel speed.



Welding Fixture & Frame Construction
Manufacturing DPM – TIG welding fixtures & alignment jigs.



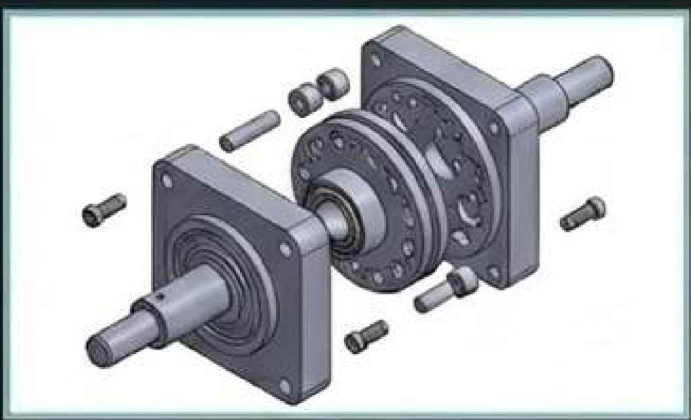
Pedal Box FEA
Safety-critical pedal box FEA – master cylinder deflection.

Real Pedal Box Assembly Close-up
Final pedal box subsystem – optimized linkage geometry & sensor alignment.

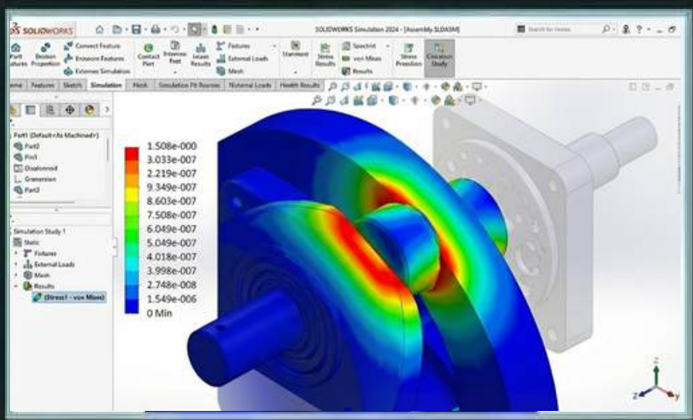
02. MECHANISM DESIGN – CYCLOIDAL ACTUATOR

Mechanical Research Assistant | UCSC Autonomous Systems Lab

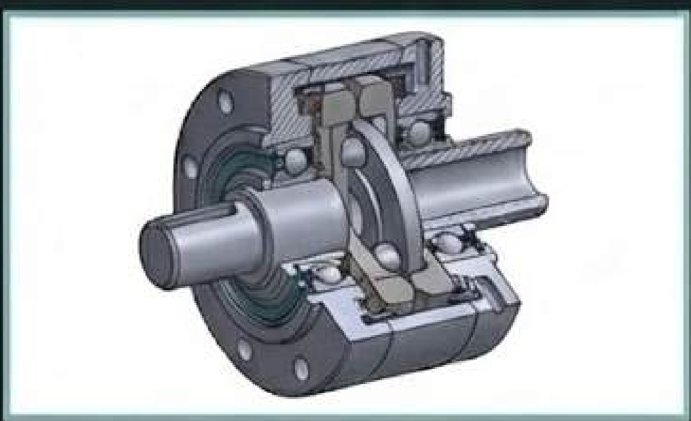
- **Problem Statement:** Current lab actuators utilized spur gears with excessive backlash. This caused positional instability in humanoid limb joints.
- **Design Solution:** Engineered a custom 20:1 reduction cycloidal drive to achieve zero-backlash performance and high torque density within a compact 60mm footprint.
- **Material Selection:** Selected 4140 Chromoly Steel for the output pins to maximize fatigue limit under cyclic loading. Used Al-6061 for the housing to minimize distal mass.
- **Profile Optimization:** Generated custom cycloidal disc profiles using Python scripts to optimize the eccentricity ratio and minimize pressure angle on the rolling elements.
- **Tolerance Analysis:** Calculated H7/g6 running fits for the eccentric bearing assembly to prevent binding while maintaining rolling contact.
- **Validation:** Simulated contact stress (Hertzian stress) in CAD to verify that the lobed discs would not deform plastically under peak torque conditions.



System architecture. Dual-disc arrangement for vibration balancing.



Hertzian contact stress analysis. Validating pin load capacity.



Internal packaging. Eccentric bearing integration and output shaft.

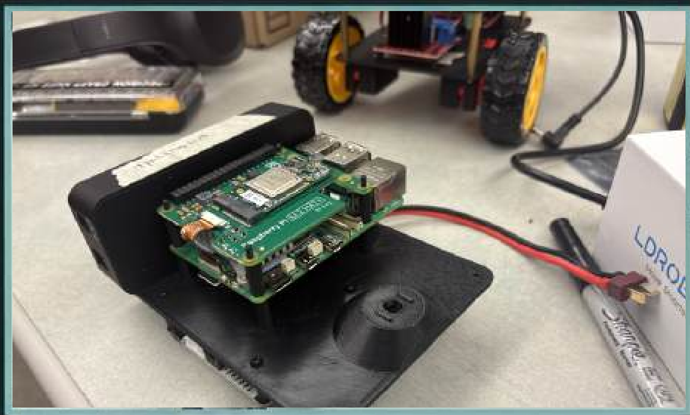
Manufacturing validation. Fit check of cycloidal lobes and housing.

03. ROBOTICS RESEARCH – SLAM & NAVIGATION

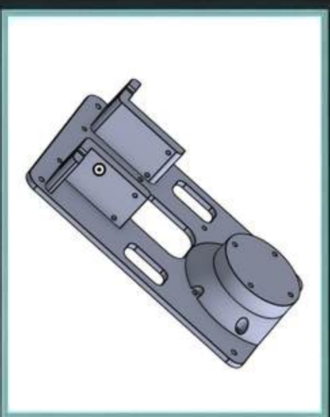
Custom ROS 2 Mobile Robot | Autonomous Systems Lab • UC Santa Cruz

- **Sensor Calibration:** Engineered rigid sensor mounts for LiDAR and Depth cameras with vibration isolation to minimize extrinsic calibration drift during dynamic SLAM operations.
- **Structural Integration:** Integrated RealSense, LiDAR, and IMU into a unified chassis. Ensured rigid relative transformations for accurate sensor fusion.
- **EMI & Routing:** Designed EMI-shielded cable routing strategy with strategic strain-relief points. Ensured signal integrity for high-bandwidth sensor data.
- **Power Distribution:** Developed custom power distribution network with buck converters and fuse protection. Optimized thermal management for Pi 5 compute module.
- **DFM for Accuracy:** Performed DFM optimization on 3D-printed sensor housings by tightening manufacturing tolerances to ensure precise LiDAR alignment.
- **Mechanical Validation:** Verified chassis stiffness and sensor field-of-view clearances to guarantee occlusion-free navigation data.

Full robot assembly. Sensor layout, cabling, and compute integration.



Compute subsystem. Pi 5, active cooling, and mechanical mounting.



DFM-optimized sensor mount CAD.

3D-printed sensor mount. Validated for LiDAR and depth alignment.

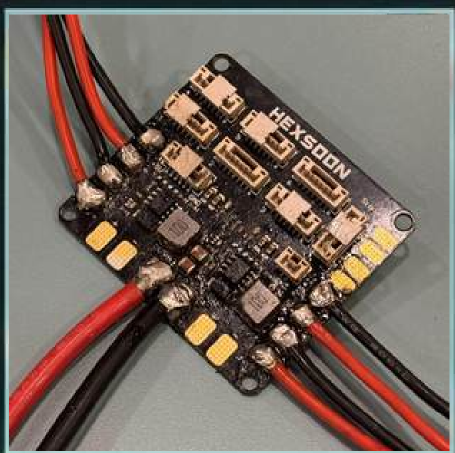
Baxter and Sawyer robots. Subjects of control stack refactoring.

04. SYSTEMS INTEGRATION – AUTONOMOUS WILDFIRE DRONE

Lead Mechanical & Systems Integrator | Davis Autonomy

- **Refactored Chassis:** Re-engineered commercial X8 chassis to mitigate vibration modes. Validated structural rigidity for high-stability sensor payload integration.
- **Avionics Design:** Designed and fabricated reinforced avionics mounting interface. Optimized center-of-mass placement for improved flight dynamics.
- **Electrical Reliability:** Architected custom aerospace-grade wiring harness with service loops, strain relief, and secure connectorization. Reduced failure points in high-vibration environments.
- **Sensor Integration**: Unified Compute, GNSS, and Telemetry into a tightly integrated mechanical-electrical stack. Adhered to strict SWaP (Size, Weight, and Power) constraints.
- **Load Analysis:** Conducted mechanical load-path analysis for arm-to-frame interfaces. Minimized torsional deflection under max thrust conditions.
- **Validation**: Validated system reliability through iterative flight testing. Proved mechanical robustness in field-deployment scenarios.

Initial system audit – documenting inherited wiring and baseline configuration.



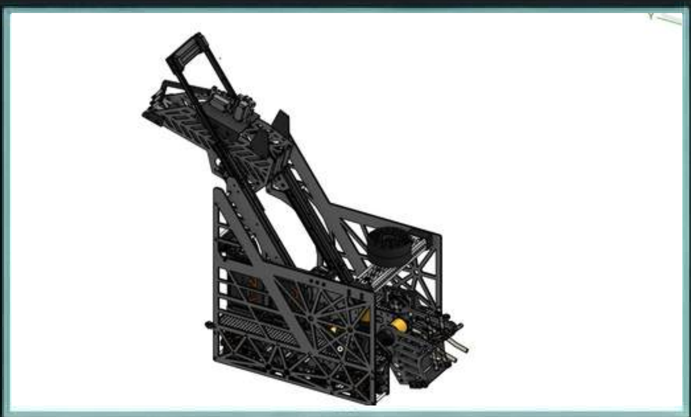
Subsystem development – rebuilding power distribution for mechanical reliability.

Final integrated platform – reinforced frame and field-ready configuration.

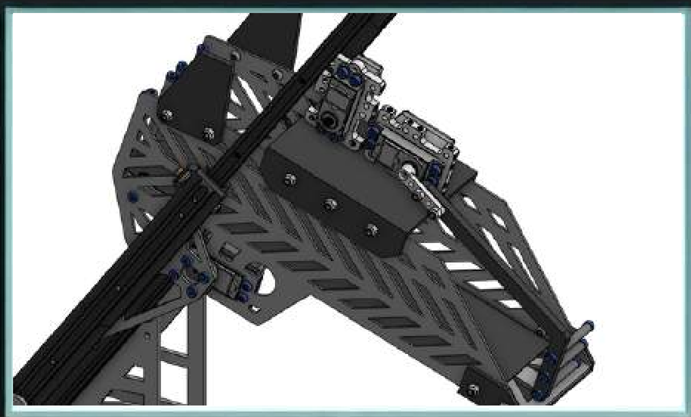
05. COMPETITIVE ROBOTICS – FTC WORLD CHAMPIONSHIP

Lead Mechanical Engineer | Ink & Metal Robotics (Team 5773)

- **System Architecture:** Architected complete mechanical system including multi-stage linear slides, drivetrain, and active intake/outtake subsystems.
- **Mechanism Design:** Engineered custom servo-actuated linkages and lightweight structural plates. Optimized for low moment of inertia and high stiffness.
- **Tolerance Analysis:** Conducted tolerance stack-up analysis for gearbox spacing and slide alignment to prevent binding under dynamic loading.
- **Rapid Prototyping:** Developed manufacturing-ready CAD for laser-cut aluminum and CNC-machined components. Utilized rapid prototyping to iterate on intake geometry.
- **Validation:** Validated mechanism reliability through subsystem stress testing and full-robot competitive play. Secured high-ranking performance at World Championship level.



Full-robot CAD. Integrated slides, drivetrain, and outtake system.



Outtake CAD. Custom plate geometry, servo linkage, and reinforced rail platform.

Rendered outtake. Dual-motor drive integration and optimized plate topology.

Final robot. Validated design via assembly and on-field operation.