OpenMutt

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OpenMutt

EPPL — ENGINEERING PHYSICS PROPULSION LAB

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ABSTRACT

- The OpenMutt platform is a low-cost, modular, 3D-printed robotic quadruped, serving as a versatile testbed for multidisciplinary research and education. With its 3D printed 13:1 cycloidal actuator, modular feet, and numerous mounting points, it is optimized for integrating external sensor packages, facilitating advanced research in autonomous navigation and mapping.

PROJECT GOALS

- Design, build, and release open source robust, cheap quadruped with areas of focus in:
    - Robotics education
    - Gear box design
    - Biomimetics
    - Autonomous systems (Navigation and Mapping)

CONTROL SOFTWARE

- Developed custom Python package, Pyodrivecan, utilizing CAN (Controller Area Network) bus communication to control all 12 of OpenMutt's O-Drive motor controllers with a Raspberry Pi and 2-Ch CAN hat.

- Pyodrivecan manages feedback data from each motor concurrently in the background, collecting essential feedback data for control loops (Positions, Torques, etc.)

Raspberry Pi with 2-Ch CAN Hat used to control OpenMutt

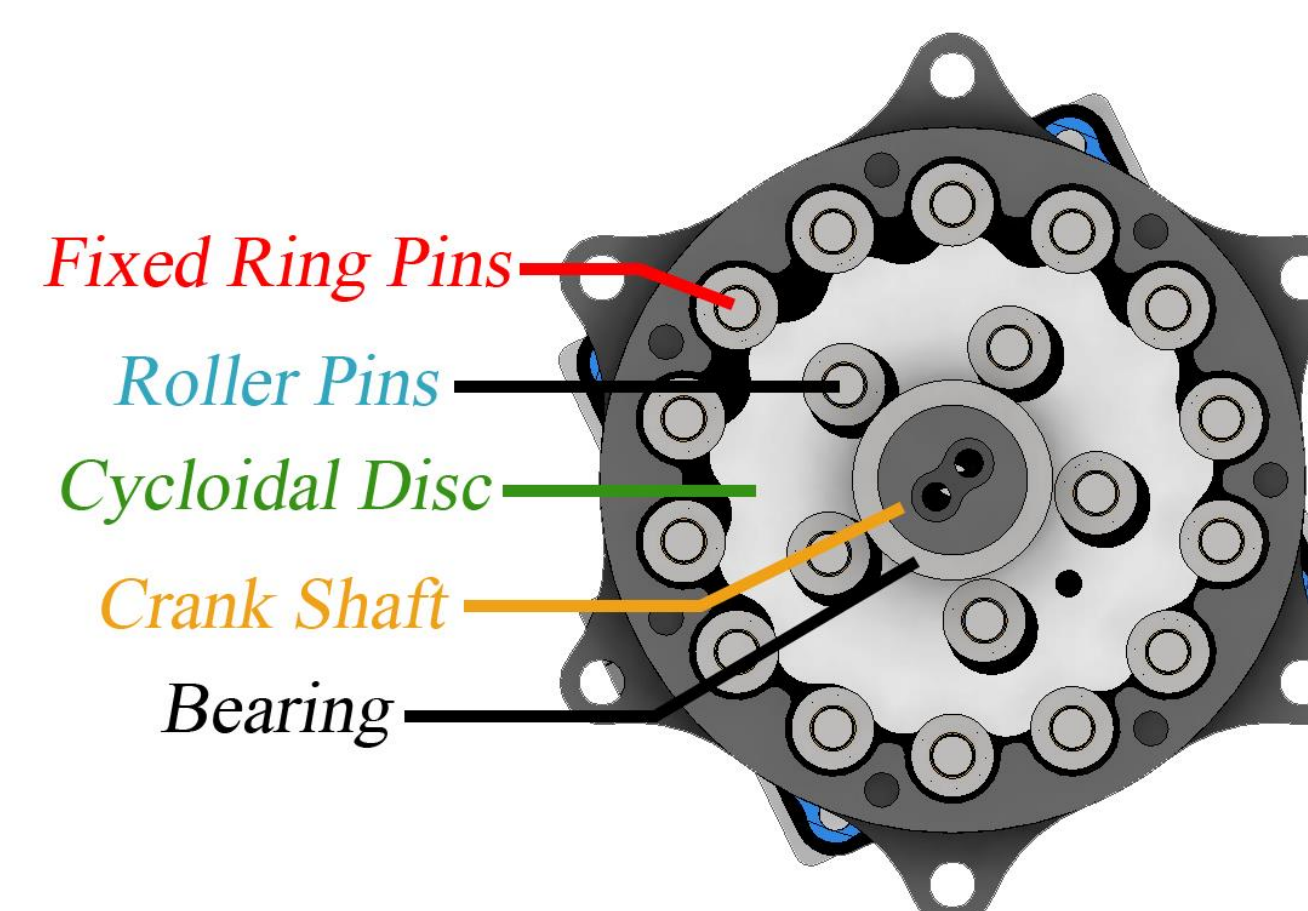O-Drive CAN Bus Configuration
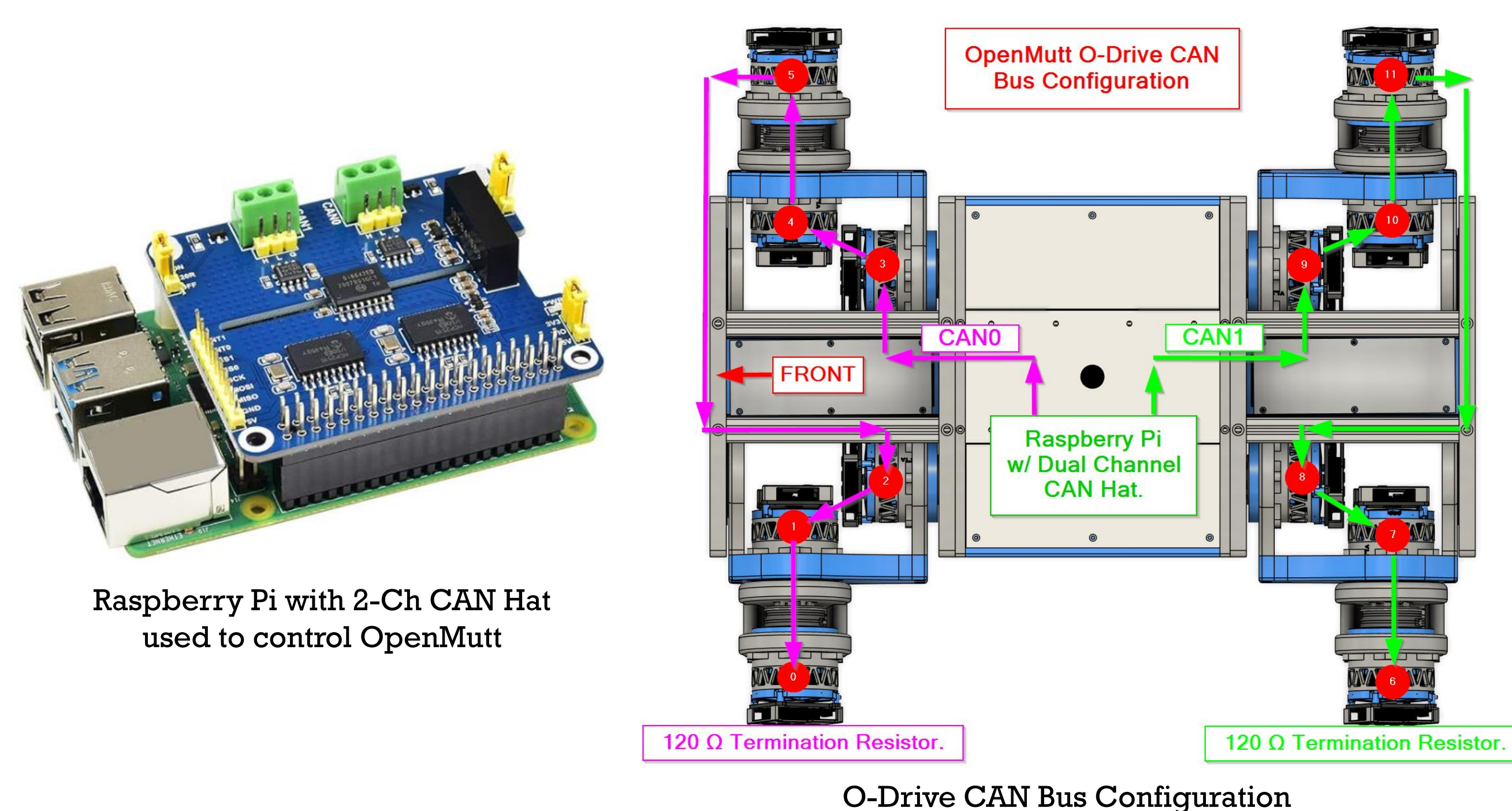
3D PRINTED CYCLOIDAL GEARBOX

- MAD Components M6C10
    - 150KV Brushless Motor
- O-Drive S1 Motor Controller
    - w/ onboard absolute encoder
- 13:1 Cycloidal Reduction
- 80% 3D Printed
    - FDM
        - PLA+, ASA, PC blend
    - SLA
        - Formlabs Durable resin


Cycloidal gearbox components

Fixed Ring Pins
Roller Pins
Cycloidal Disc
Crank Shaft
Bearing
Cycloidal gearbox

Printed Assembled Cycloidal gearbox

SIMULATION SOFTWARE

- OpenMutt URDF file created with masses and inertias.

- Gazebo simulation has working simulated motors and controller for testing new gaits in simulation first.

- A wire frame model was constructed with a Python script to allow for inverse kinematics and joint torque estimations.
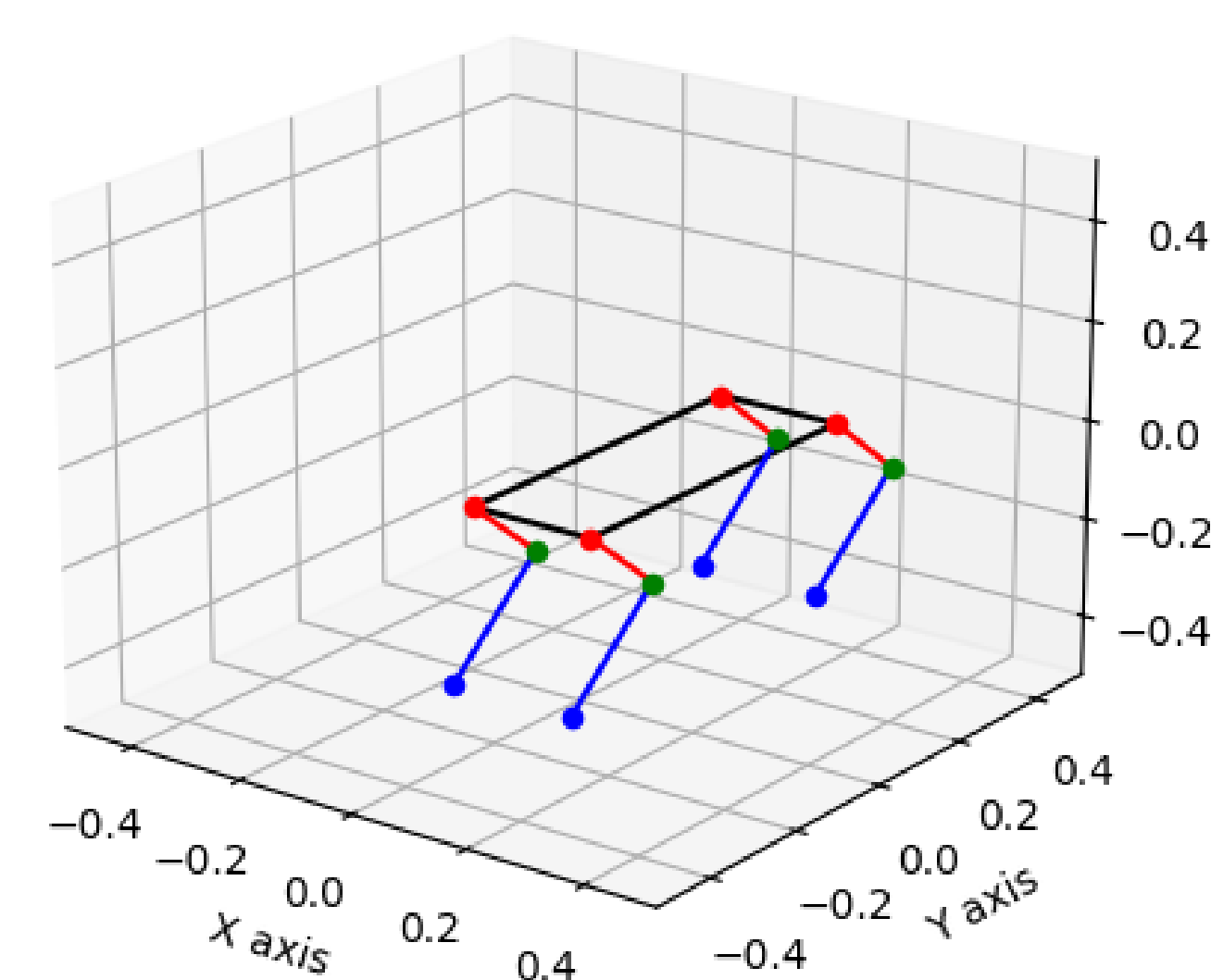

Python Wire Frame model of OpenMutt
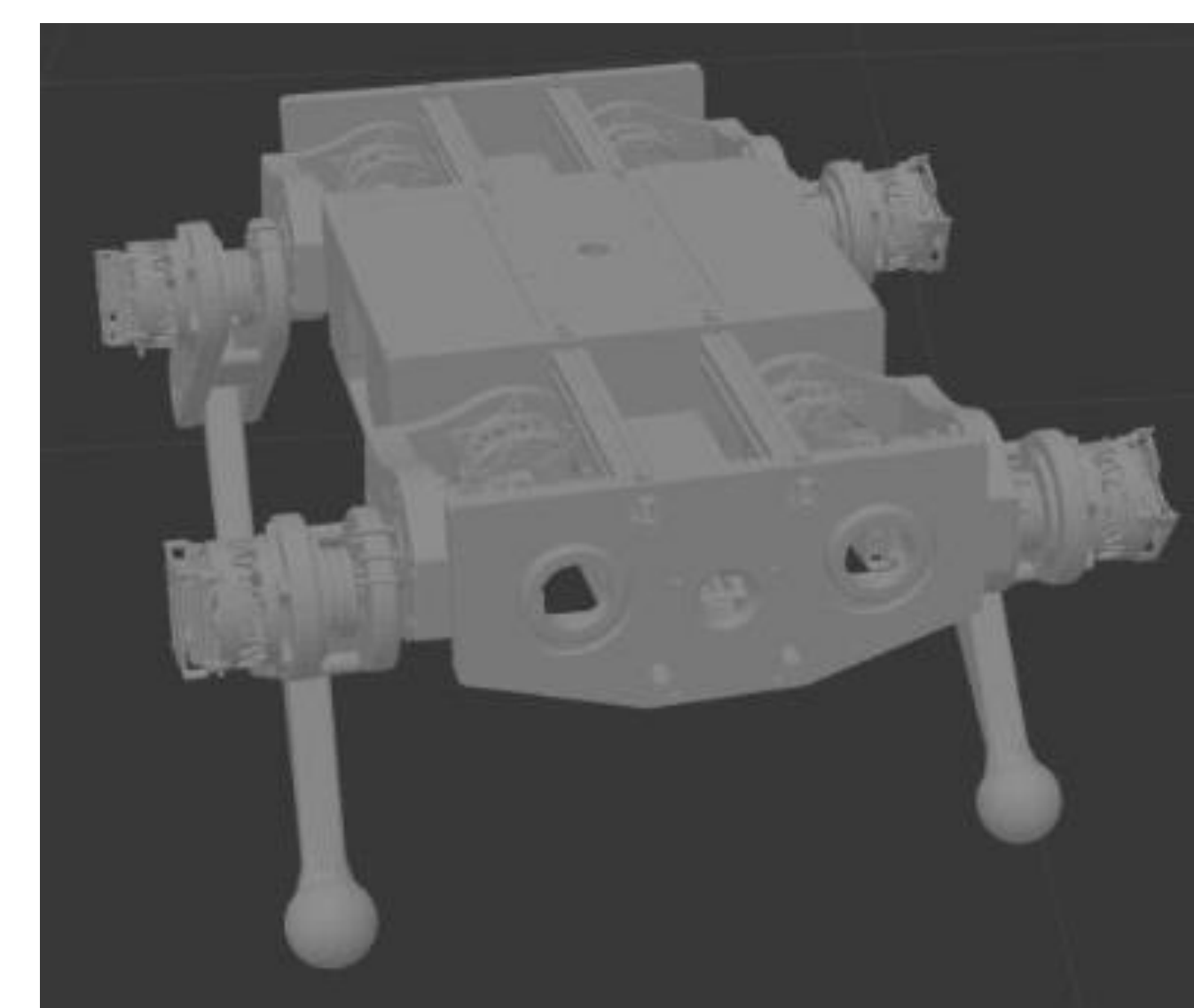
ROS 1 Gazebo Simulation of OpenMutt

CURRENT STATE

- Full OpenMutt manufactured and assembled.
- One leg test stand built and used for researching and testing gait controls before applied to full dog.
- Full motor controller software developed and tested.
- Testing different materials on end effectors across different terrains. (i.e. silicon sock, TPU fuzzy skin)
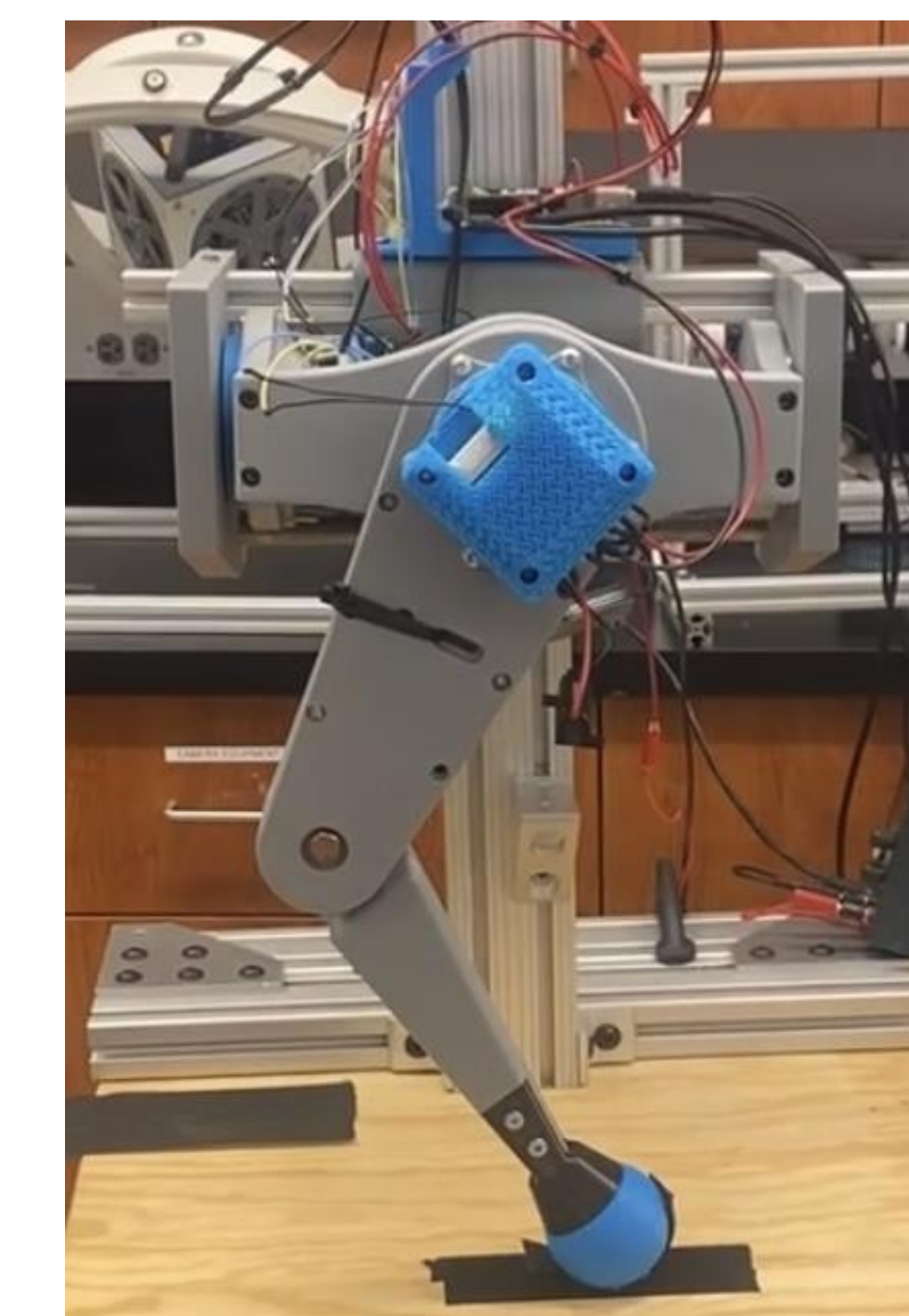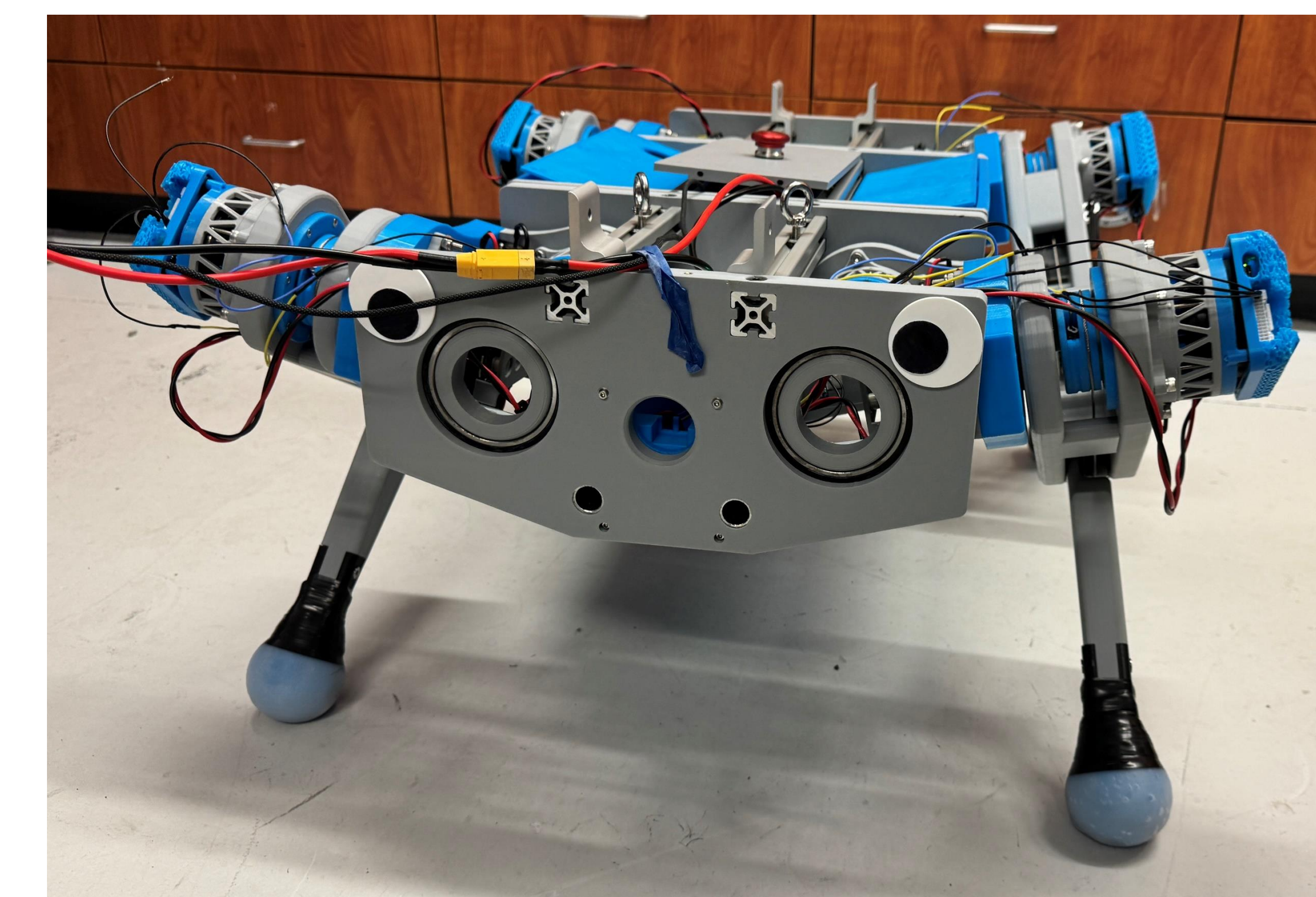

Quarter Model Test Stand of OpenMutt
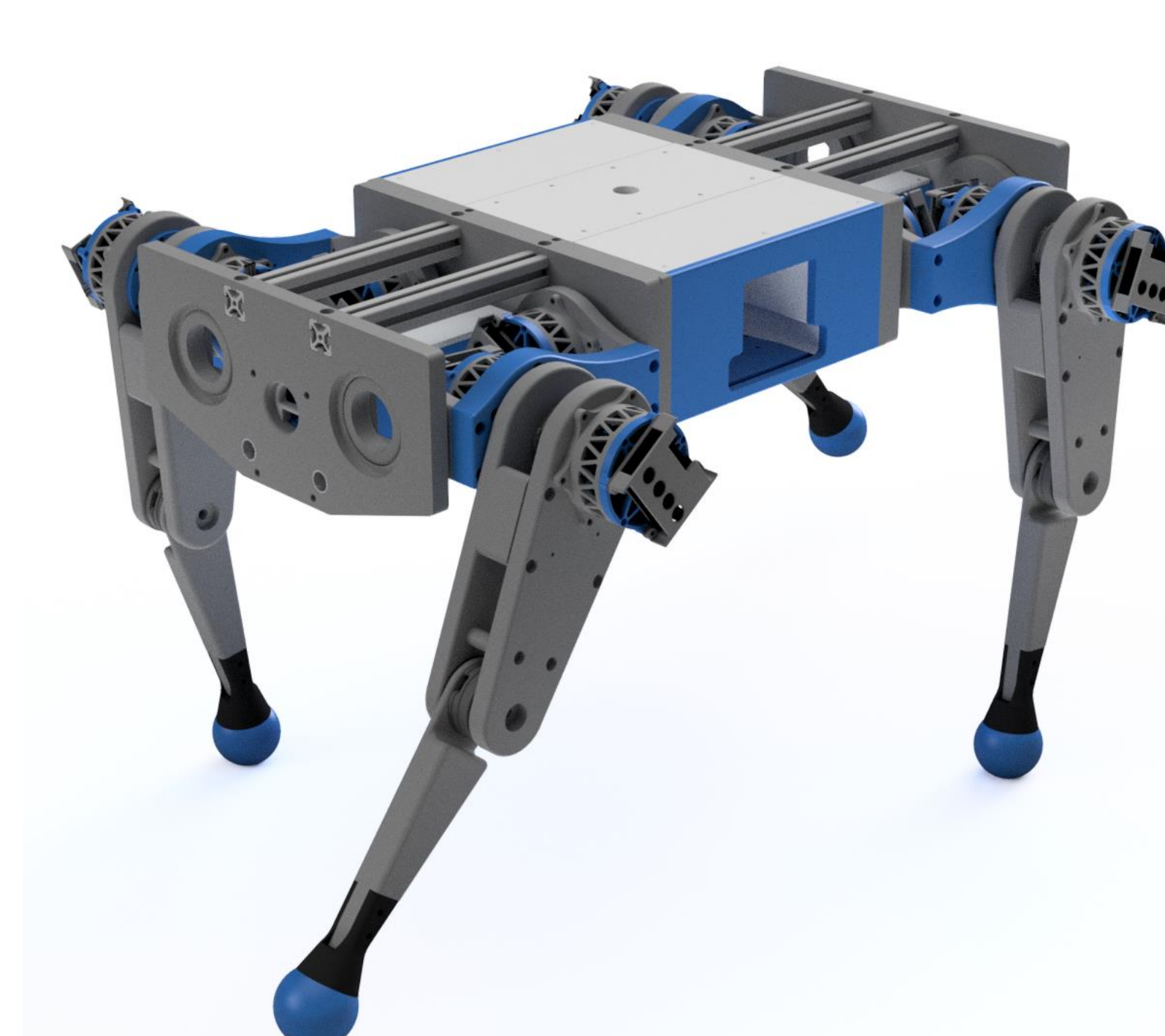
Full OpenMutt CAD Model

MOVING FORWARD

- Working developing and testing walking gaits.
- Continuing developing in mechanical design to lessen actuator load.
- Integrating sensors for autonomous mapping and navigation
- Document and distribute information on the dog for others to advance on robotics research.

Full Model of OpenMutt Standing