

Rabbit Leg Prosthesis - Engineering Fundamentals

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Intent

Restore walking/hopping mobility to a single hind-legged rabbit via motile prosthesis.

Empathy

- Impact On Rabbit Quality of Life
- Rabbit Health Is Dependent on Motion
- Inadequate Options

Constraints

- Proportional Weight
- Flexible Mounting
- Sensor Driven Kick
- Mimic Natural Foot Motion

Design

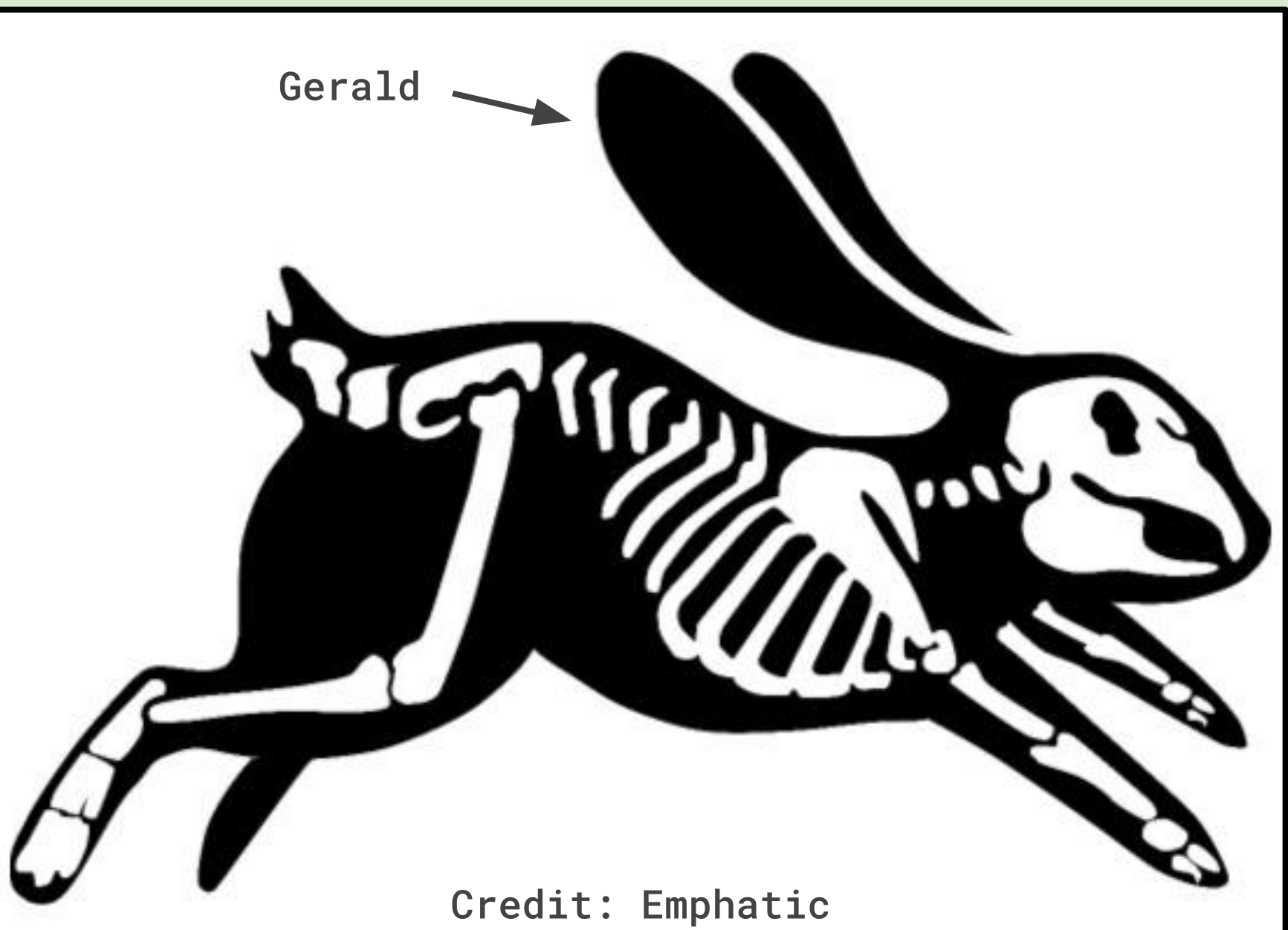
- Single Actuator Control
- Tunable "Tendon"
- Parallel Linkage
- Foot Options

Assembly

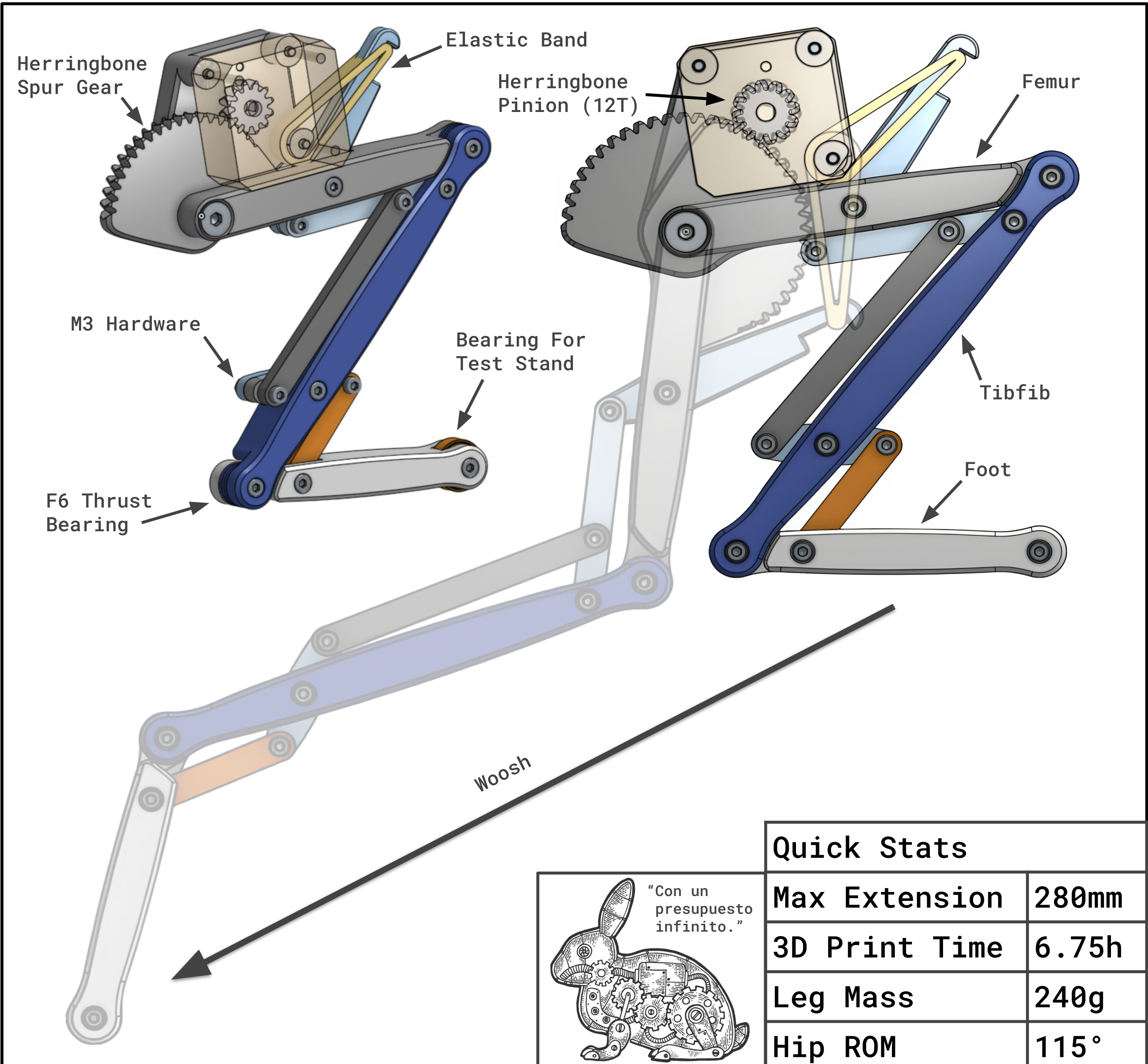
- PETG Construction
- F6 Thrust Bearings
- Herringbone Gears
- NEMA 17 Stepper
- Replaceable Tendon

- Anatomy -

Two main causes of hind-leg paralysis in pet rabbits include strokes and cancer which can disrupt the nervous system and inhibit limb control. The prosthesis mimics a rabbit skeleton with a femur, tibia, fibia, and a unified foot. An elastic tendon adds compliance to the extension linkage.



Credit: Emphatic



Quick Stats

Max Extension	280mm
3D Print Time	6.75h
Leg Mass	240g
Hip ROM	115°

- Iteration -

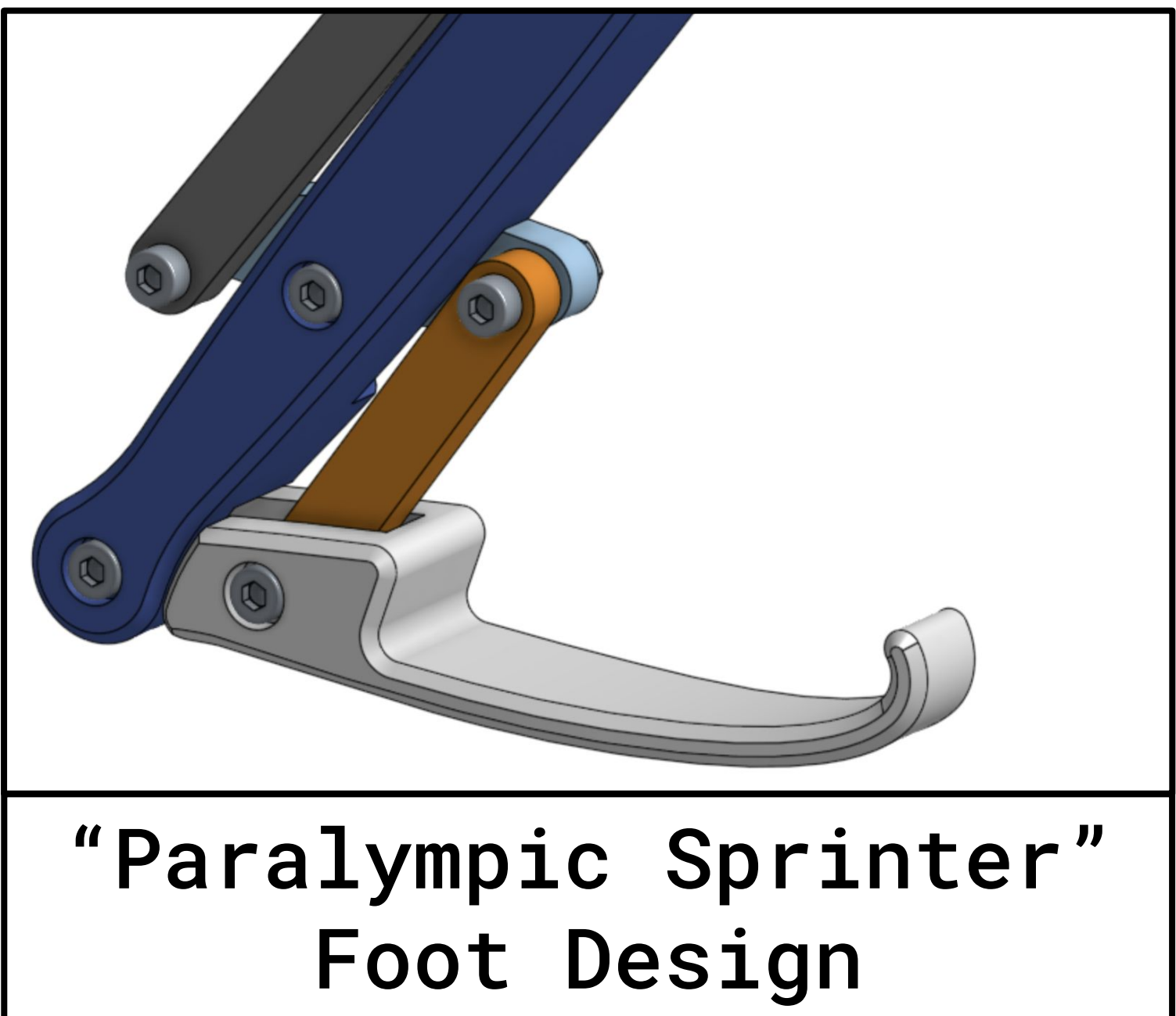
The first version used two stepper motors for independent control of the hip and "kick" motion. While it enabled dual axis control of the leg position it came at the cost of a larger weight and a more complicated control system. Removing a stepper motor and linking the "kick" to the hip reduced the weight by 35% and simplified the control loop to a single flex sensor that drives the hip stepper motor.

- Firmware -

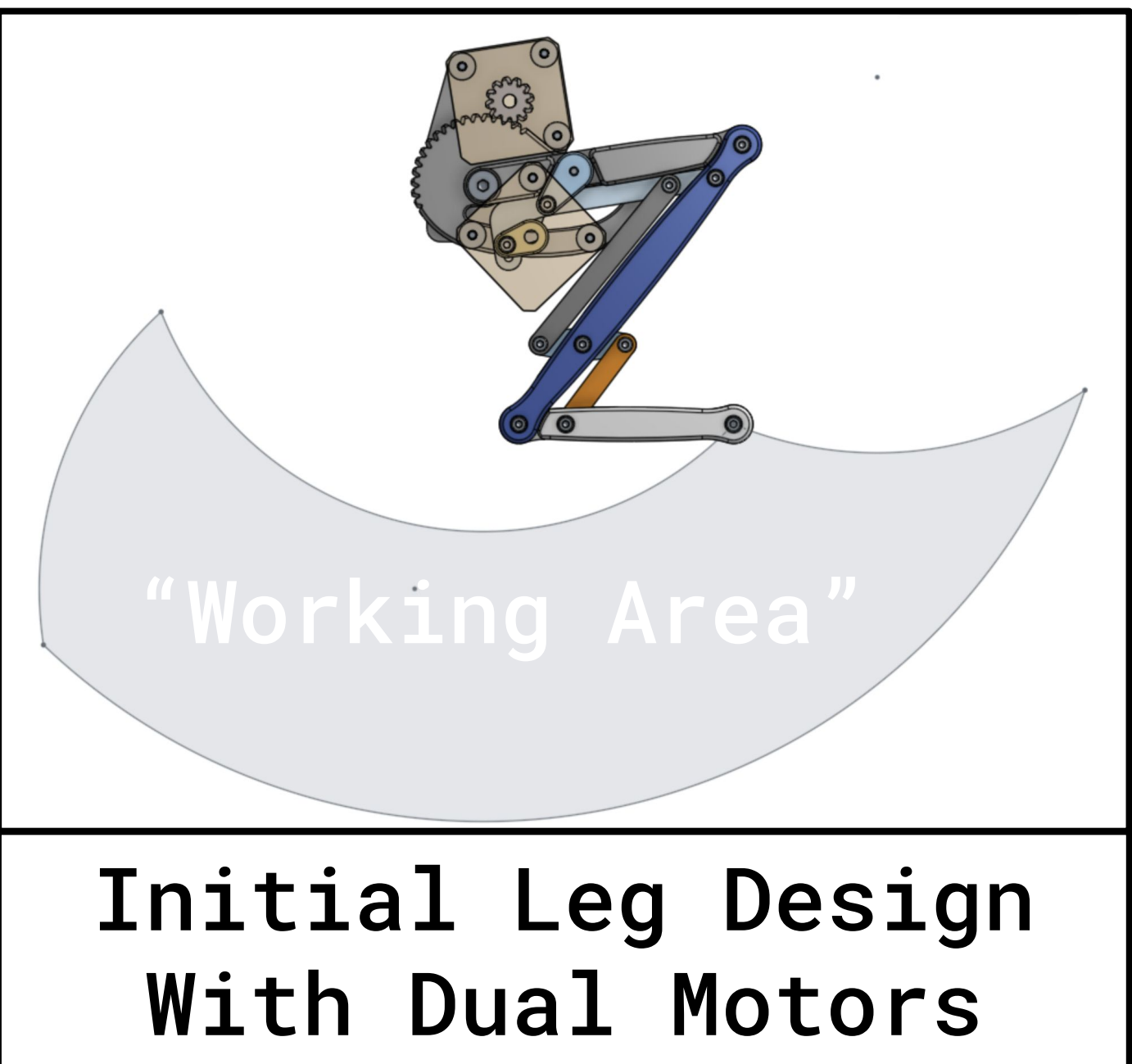
Code is loaded onto an Arduino Uno that reads data from the flex sensor to control the leg. A sleeve mounts the sensor to the rabbits other leg.

- Longevity -

Each component of the prosthesis is designed to be rigid and repairable. The members are modeled to withstand forces and torque well beyond their scope of use. The plastics won't degrade in sunlight or water. Most importantly the parts are cheap and replaceable, just like interns.



"Paralympic Sprinter"
Foot Design



Initial Leg Design
With Dual Motors

- Cost Analysis -

Part	Cost Per	Qty	Cost
3D Printer Filament	\$0.02/g	50	\$1.00
NEMA 17 Stepper	\$9.99	1	\$9.99
F6 Thrust Bearing	\$1.94	3	\$5.82
606-2RS Bearing	\$0.86	1	\$0.86
Assorted Hardware	\$5.00	1	\$5.00
Assorted Rubber Bands	\$2.32	1	\$2.24

Total Cost - \$24.91