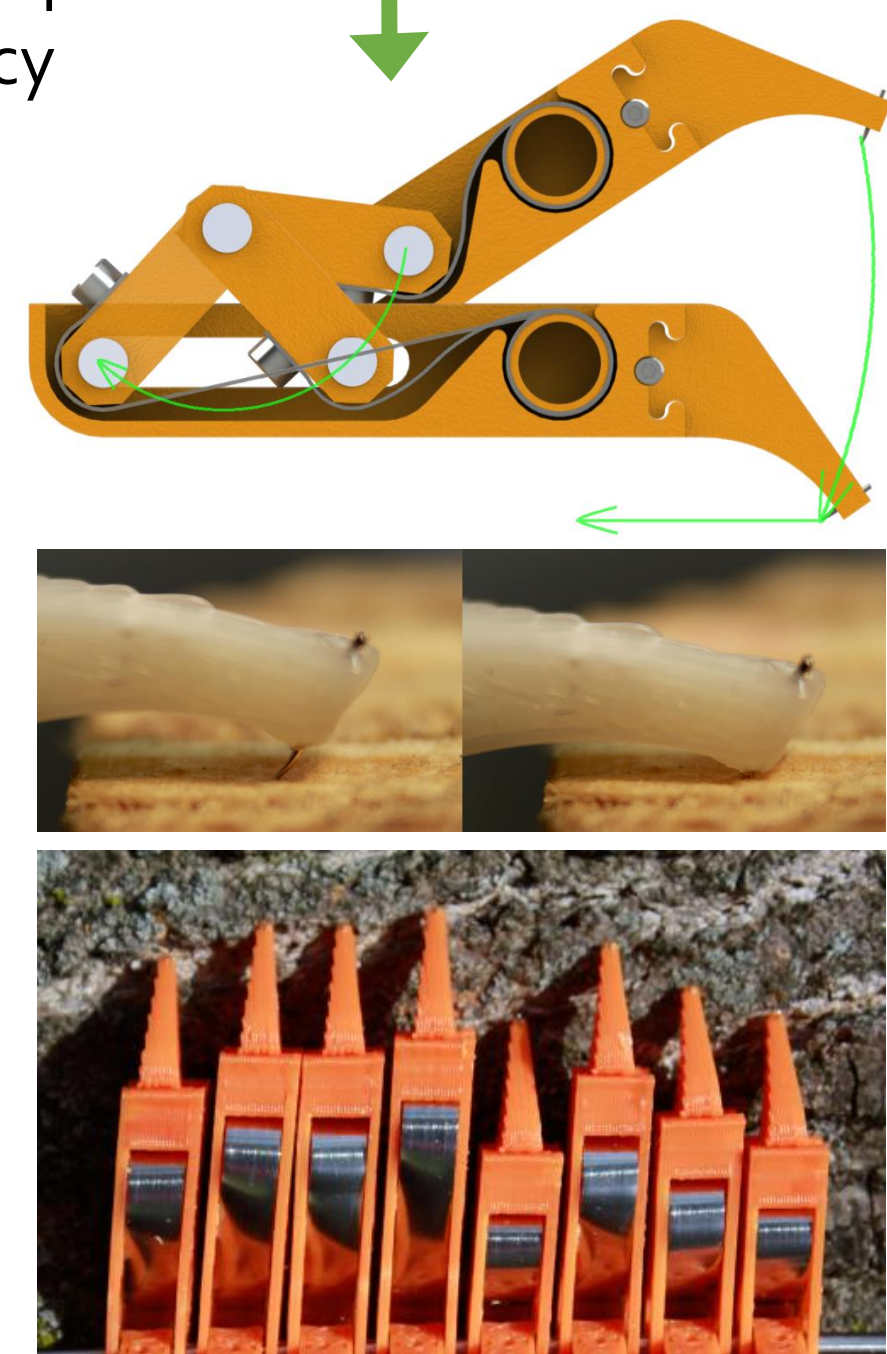
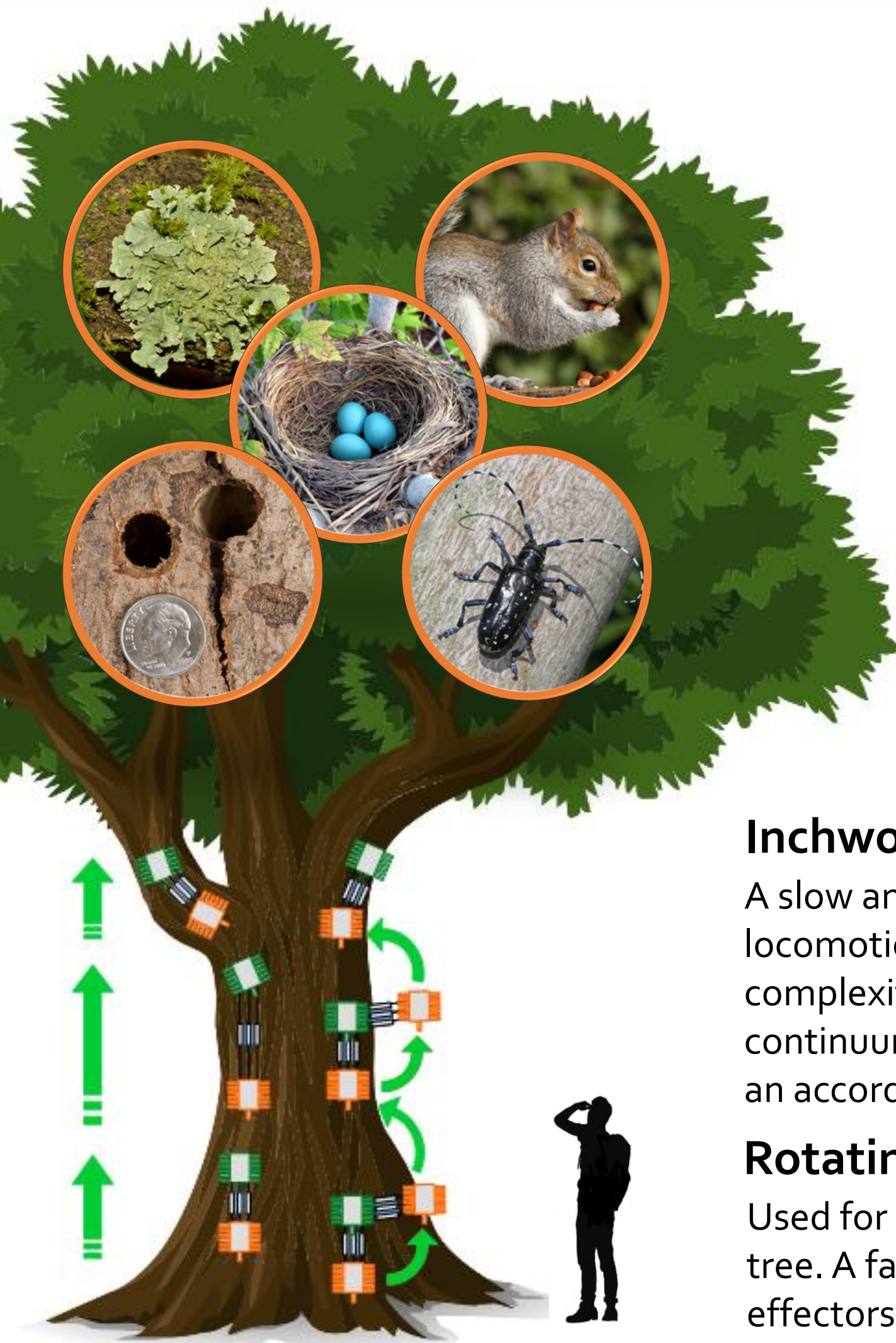


## Introduction

Observing wildlife, monitoring forest health, conducting research, and detecting invasive species and infections are just a few of the crucial tasks that currently require humans to climb trees. Putting people into trees is an expensive and potentially dangerous task. The CHAMP (Compliant Hook Arboreal Mobility Platform) is a tree climbing robot that carries and controls job-specific payloads to improve the safety and efficiency of many arboreal tasks.



3D Printed Individually Compliant Hooks

### Inchworm Gait (left)

A slow and methodical form of locomotion used for navigating tree complexities. Push pull rods form a continuum manipulator actuating like an accordion.

### Rotating Gait (right)

Used for navigating straight sections of tree. A fast form of locomotion. End effectors rotate the entire robot to move end-over-end up the tree.

## Sponsored by

**maxon motor**  
 driven by precision



EPOS4 50/8  
 Digital Position Controller



Position Controlled  
 DCX Motor

## Locomotion

### Gripper

- Grips most common tree geometries
- Passive anti-backdrive enables unpowered position holding

### Individually Compliant Hooks

- Hooks use acupuncture needles to grip tree
- Shallow penetration depth avoids damaging tree
- Small constant force springs permit individual compliance and distributed loading

### Symmetric Continuum Manipulator

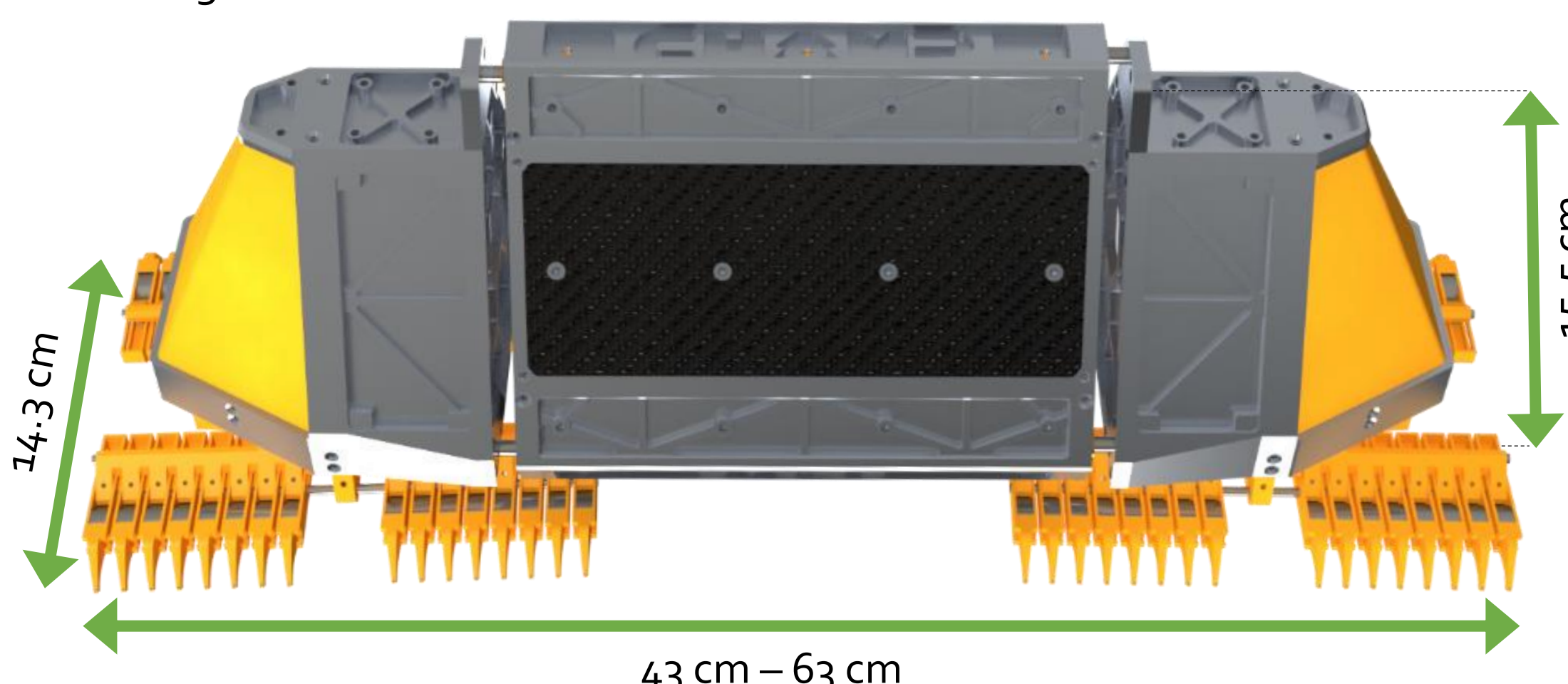
- Supplies three DOFs of locomotion
- Polycarbonate push-pull rods conform to organic tree geometries
- Counter-rotating lead screws condense mechanism
- Passive anti-backdrive enables unpowered position holding

### Abdomen

- Supports multiple payloads via standard M3 bolt pattern
- Manufactured with 3<sup>rd</sup> & 4<sup>th</sup> axis CNC machining

### Gripper Rotator

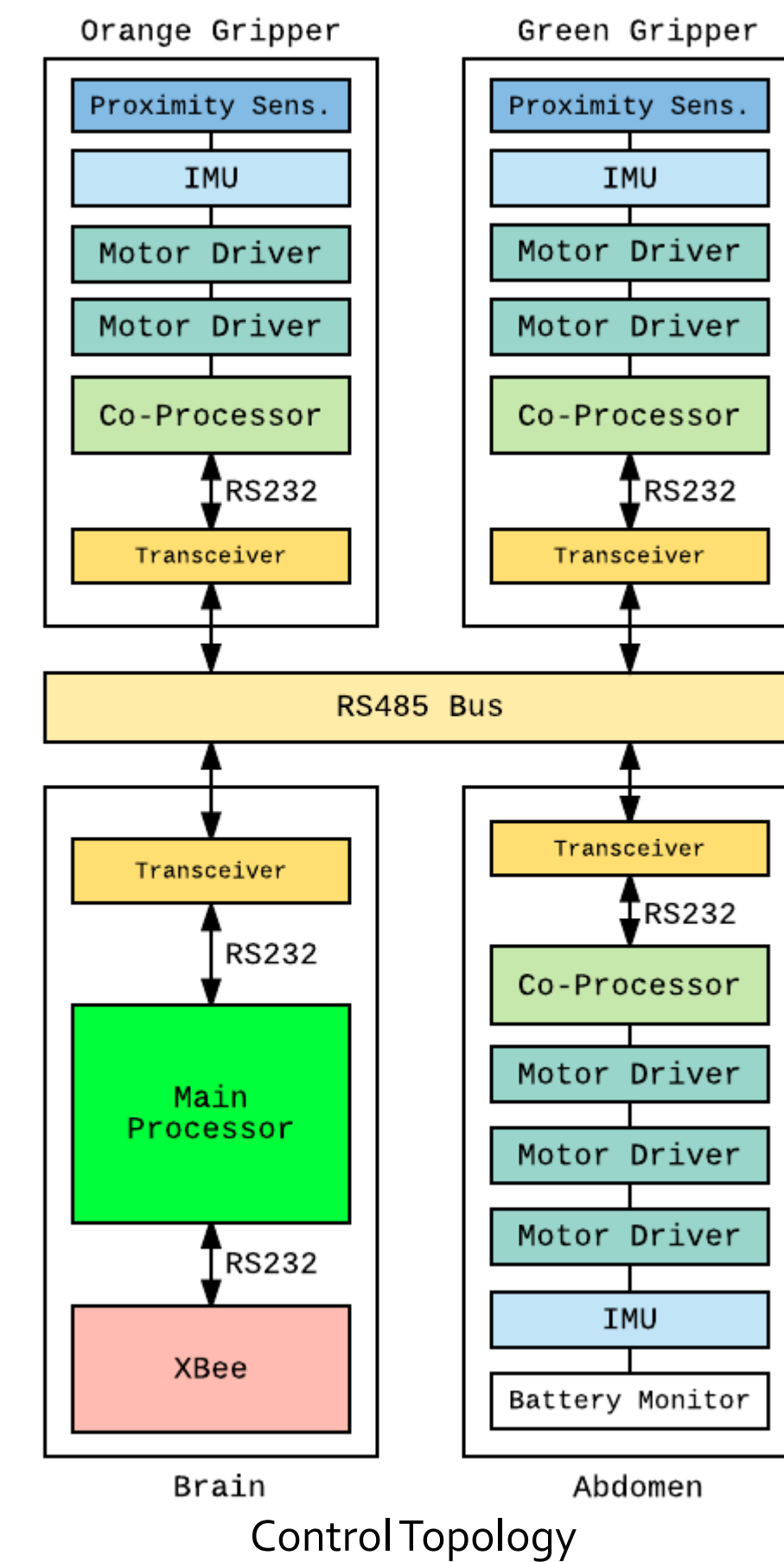
- Capable of 370° of rotation
- Improves grip on directionally-biased bark
- Interchangeable end effectors via standard M3 bolt pattern
- Passive anti-backdrive enables unpowered position holding



## Sensing & Control

### Distributed Computing Network

- Main processor handles passing commands between co-processors
- Leaves CPU overhead for completing complex tasks
- Co-processors set position control, process sensor data, and transmit high-level data
- Multiple co-processors enable parallel task execution
- Only 4 wires between co-processors
  - Battery +/-
  - RS485 High/Low

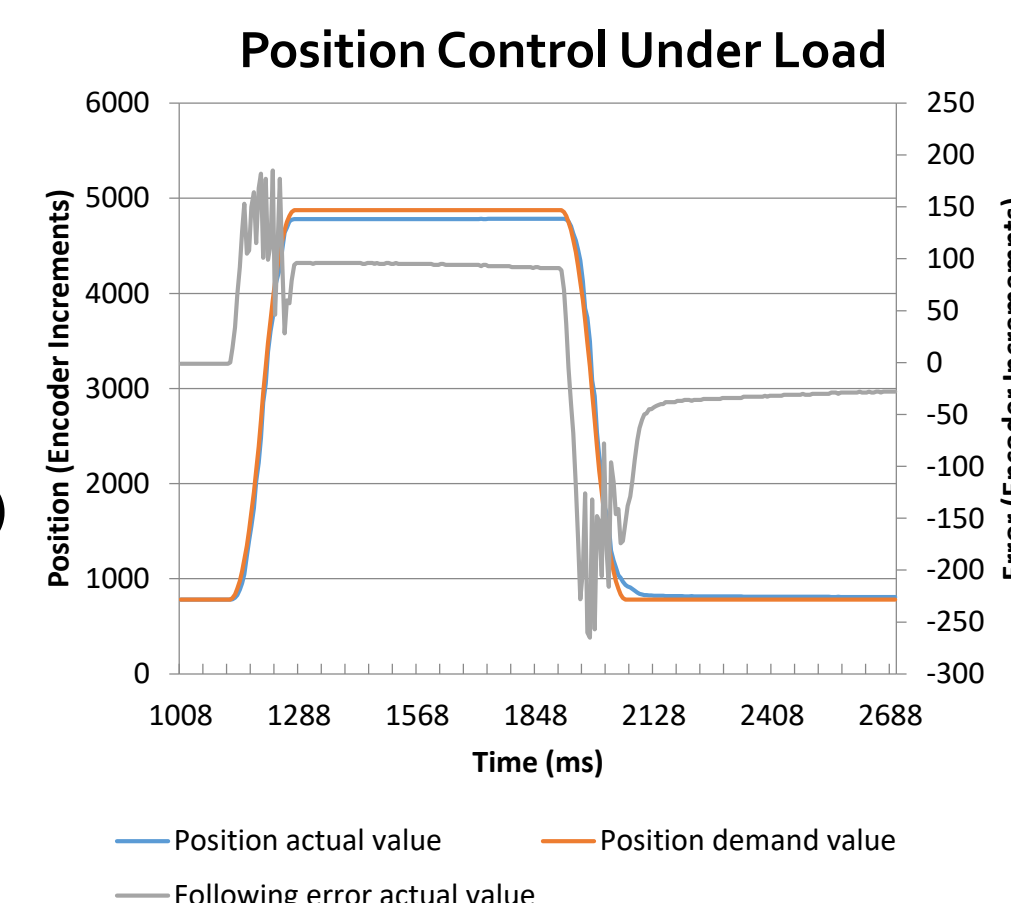


### Abdomen Electronics

- BeagleBone Black
- Atmel328p
- Custom battery board
- Xbee Transceiver
- RS485 Transceiver
- 9 DOF IMU
- Maxon DCX Motors (3)
- EPOS4 position controllers (3)
- Limit switches (6)
- Communication logic level translator

### End Effector Electronics

- Atmel328p
- RS485 Transceiver
- 9 DoF IMU
- Maxon DCX Motors (2 per)
- Limit switches (3 per)
- Power regulation board
- EPOS4 position controllers (2 per)
- Time of flight proximity sensor



## Specifications

Arboreal Mobility	Moves up and down straight sections of tree
	Moves through branches and tree complexities
Payload Support	14.4V, 3A power connection off main robot system power
	Serialized high-speed data interface with main system
Portability	System on tree is less than 2kg, without payload
	Full CHAMP system, including robot, controller, and small payload, is under 5kg and can be comfortably carried