Ant-Like Robotic Platform

Aeacus Team Introduction

Student Members:

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Special Thanks:

Blake Alberts – Electrical and Computer Engineering

Conceptual Genesis

The Problem:

Social and political consciousness regarding the importance of efficient, persistent recycling of materials has increased exponentially in modern times. Yet state-of-the-art methods of sorting such recyclable materials lag behind desired goals.

With this in mind, what solutions can we develop to address this problem?

Conceptual Genesis

Aeacus' Solution:

Utilization of a eusocial swarm capable of collaboratively manipulating objects in hostile and unstructured environments.

Project Goals:

To design and construct a biologically inspired robotic platform that is able to navigate the difficult terrain of a landfill and has the ability to further develop swarm behaviors and additional sensory systems

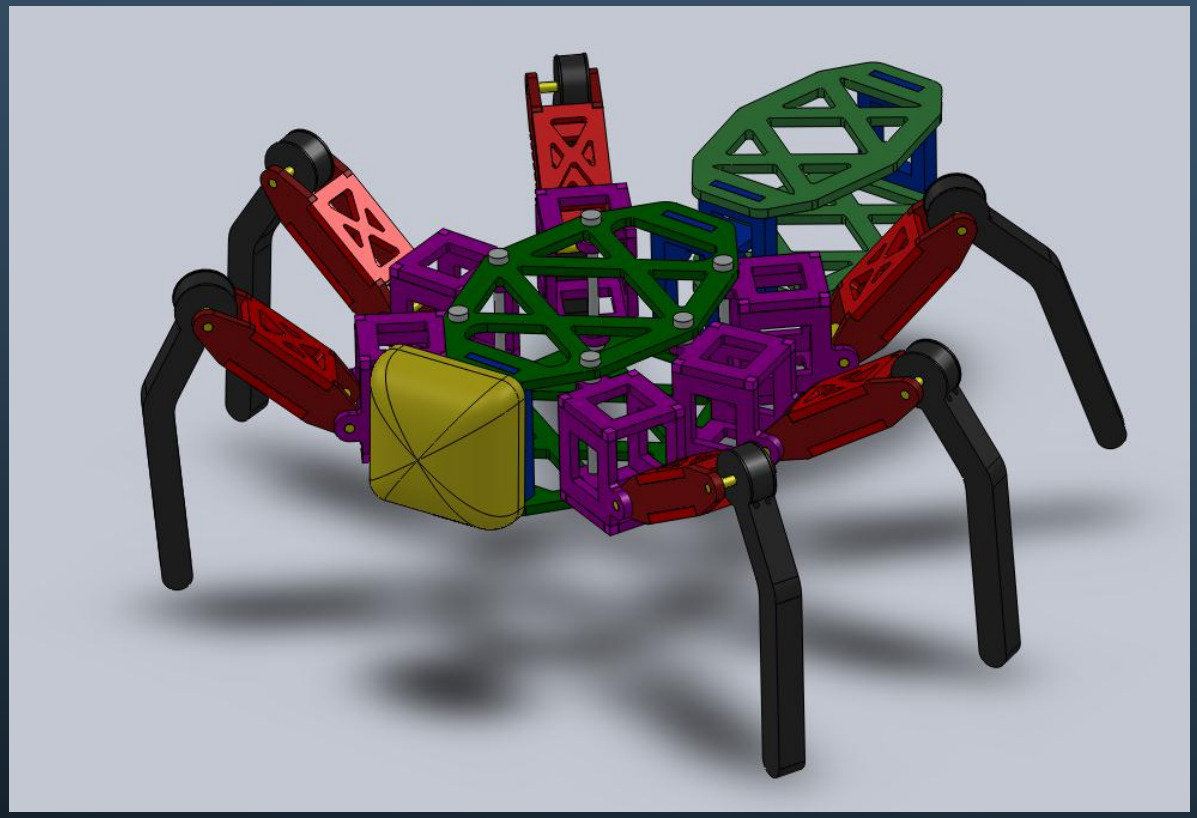
Design Specifications

- Ant-Like Hexapod Robot
- ~5 Pounds
- Lifting Capacity: 2X body weight
- Operational Life: 30 – 45 minutes
- Body Length: 15 Inches
- Walking Speed: 2X body length per second
- Ad-hoc network

Why Ants?

- Statically stable when walking
- Complex task completion via simple execution
- Highly efficient network
- Naturally talented at searching and centrally gathering items

Initial Design



Initial frame design

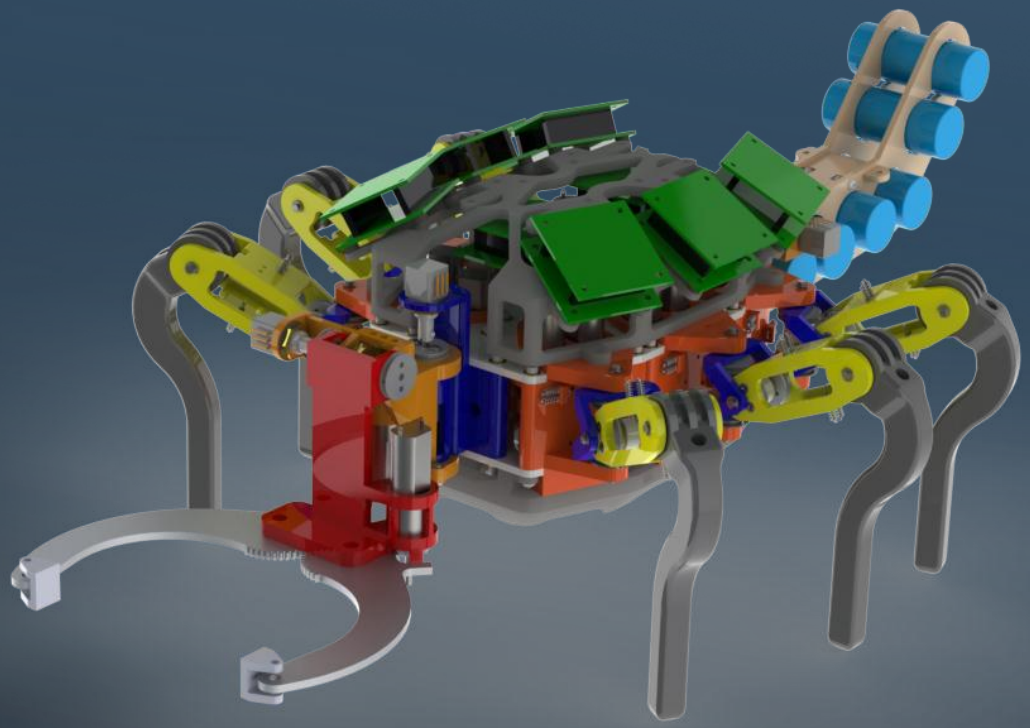
Pros

- Lightweight frame
- Combination direct and pulley driven legs
- Partially modular

Cons

- High stresses in central frame
- Too small to fit needed motors

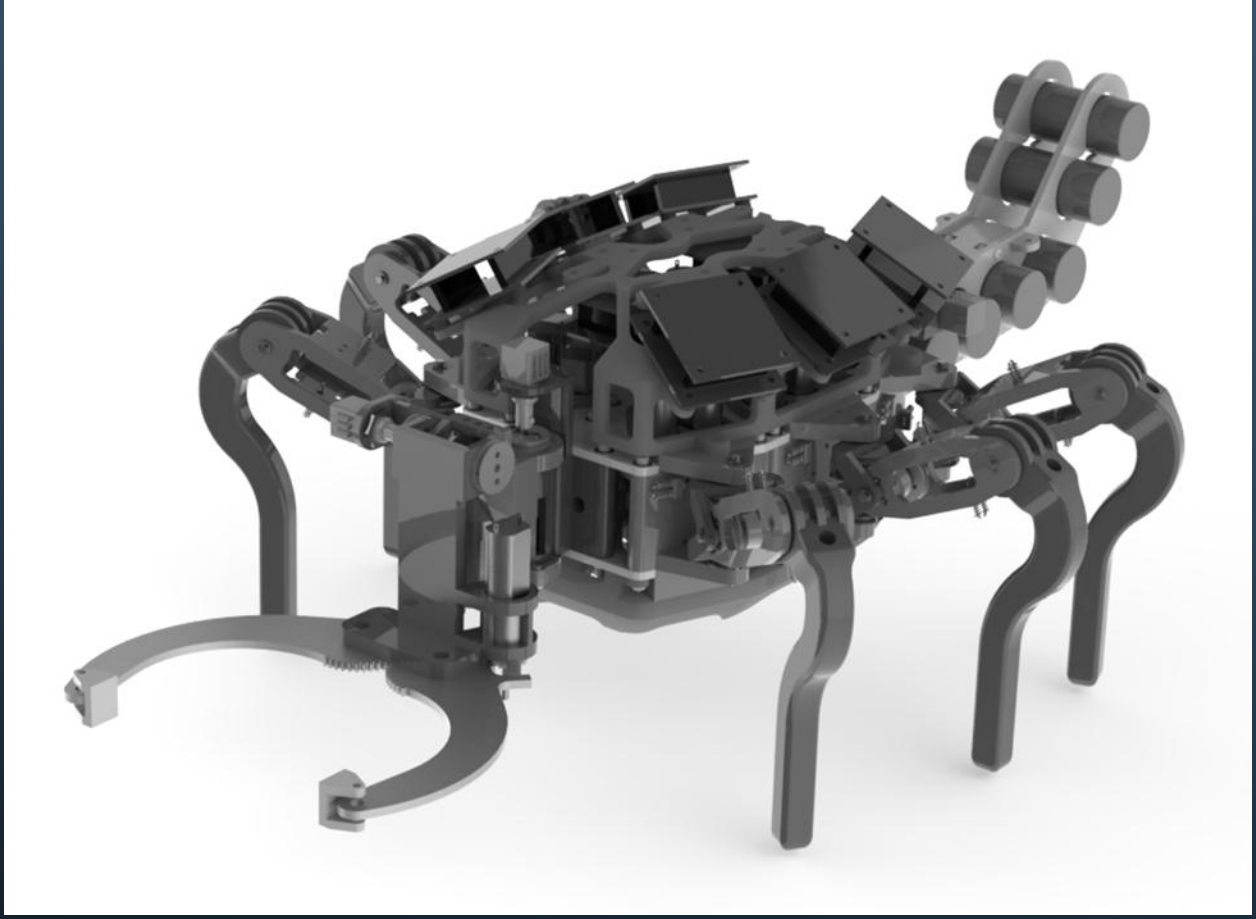
Final Design



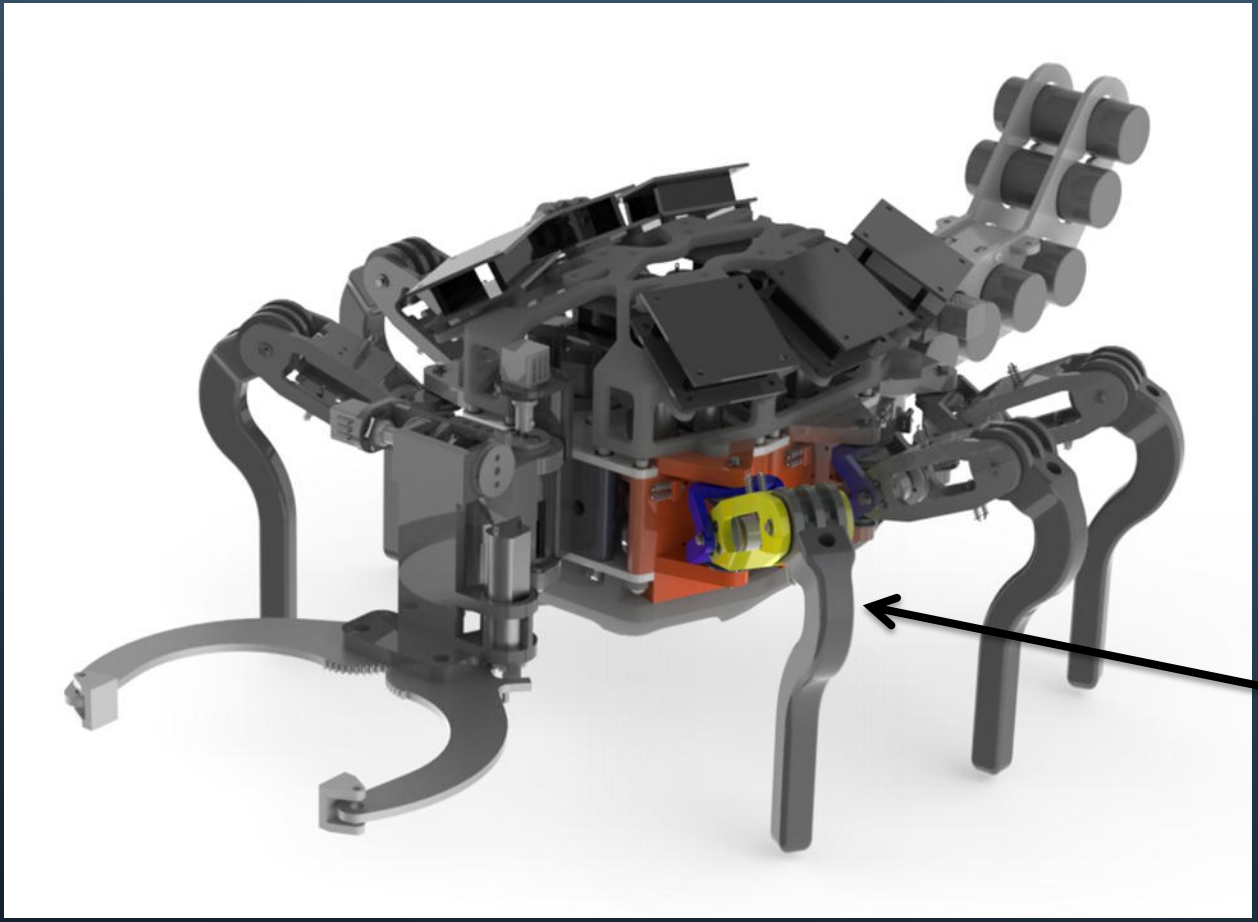
Final design of robot

- Robust plastic frame
- Completely pulley driven legs
- Modular sub-systems
- Stresses dissipated through frame

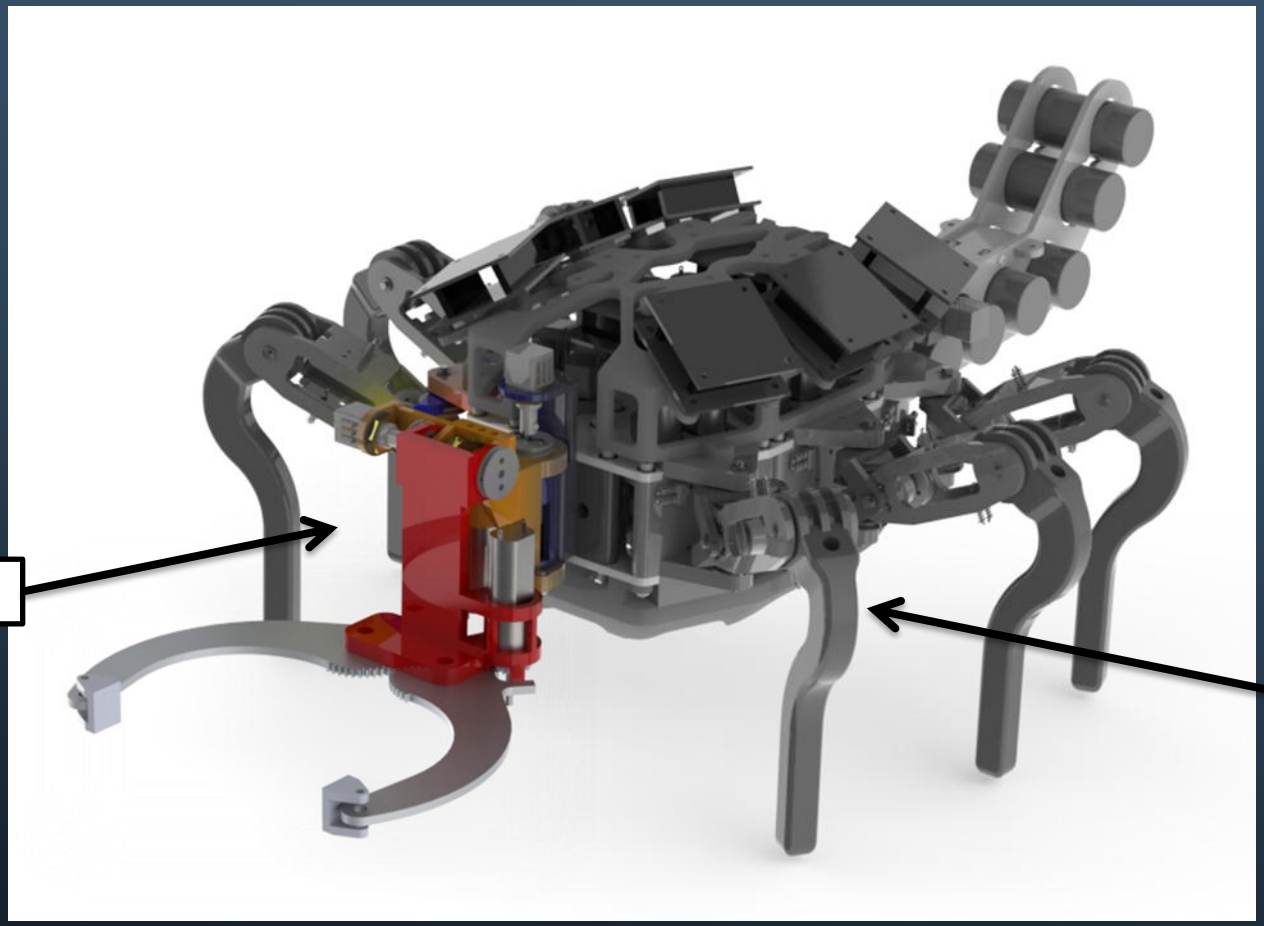
The Robot



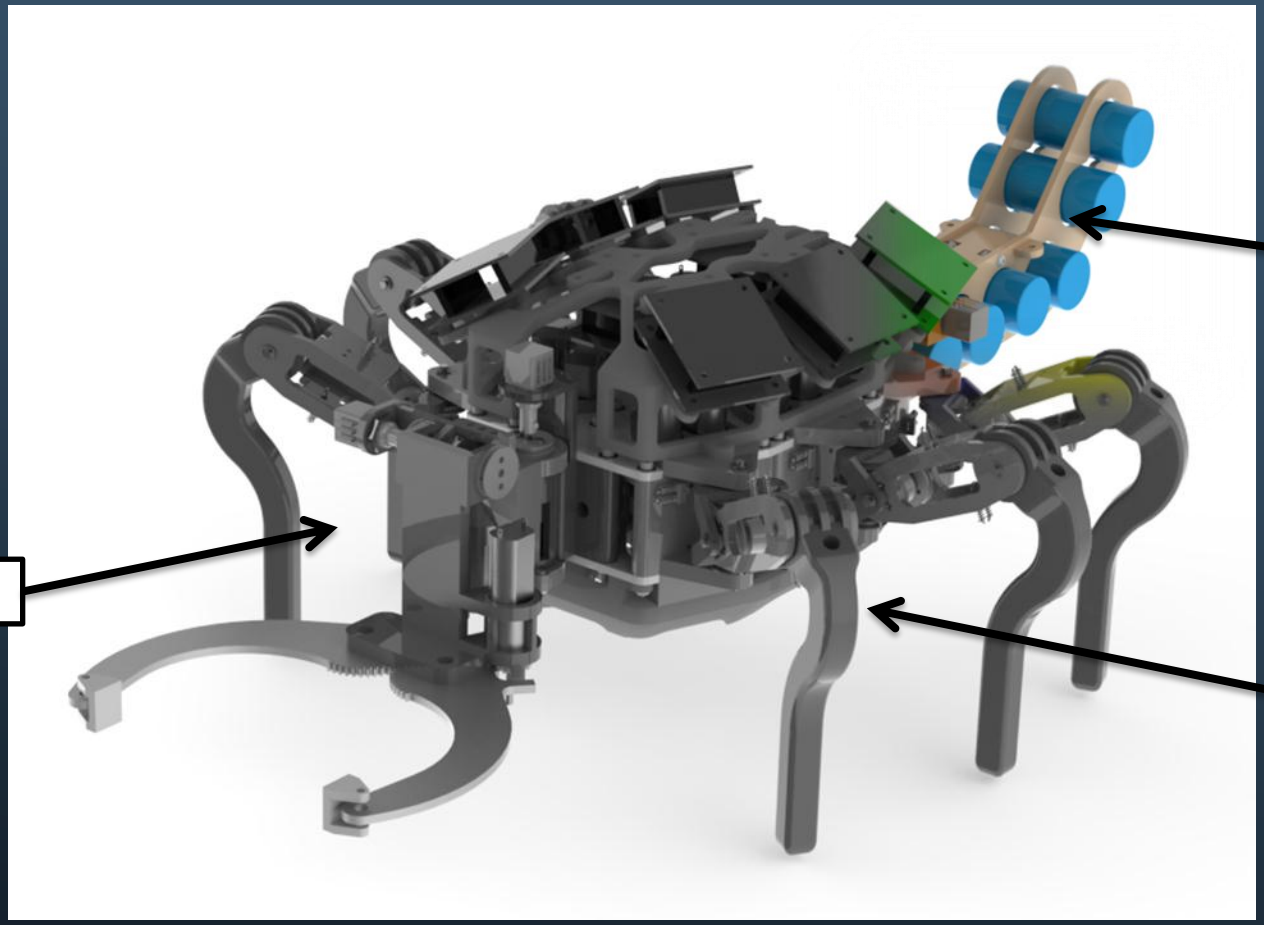
The Robot



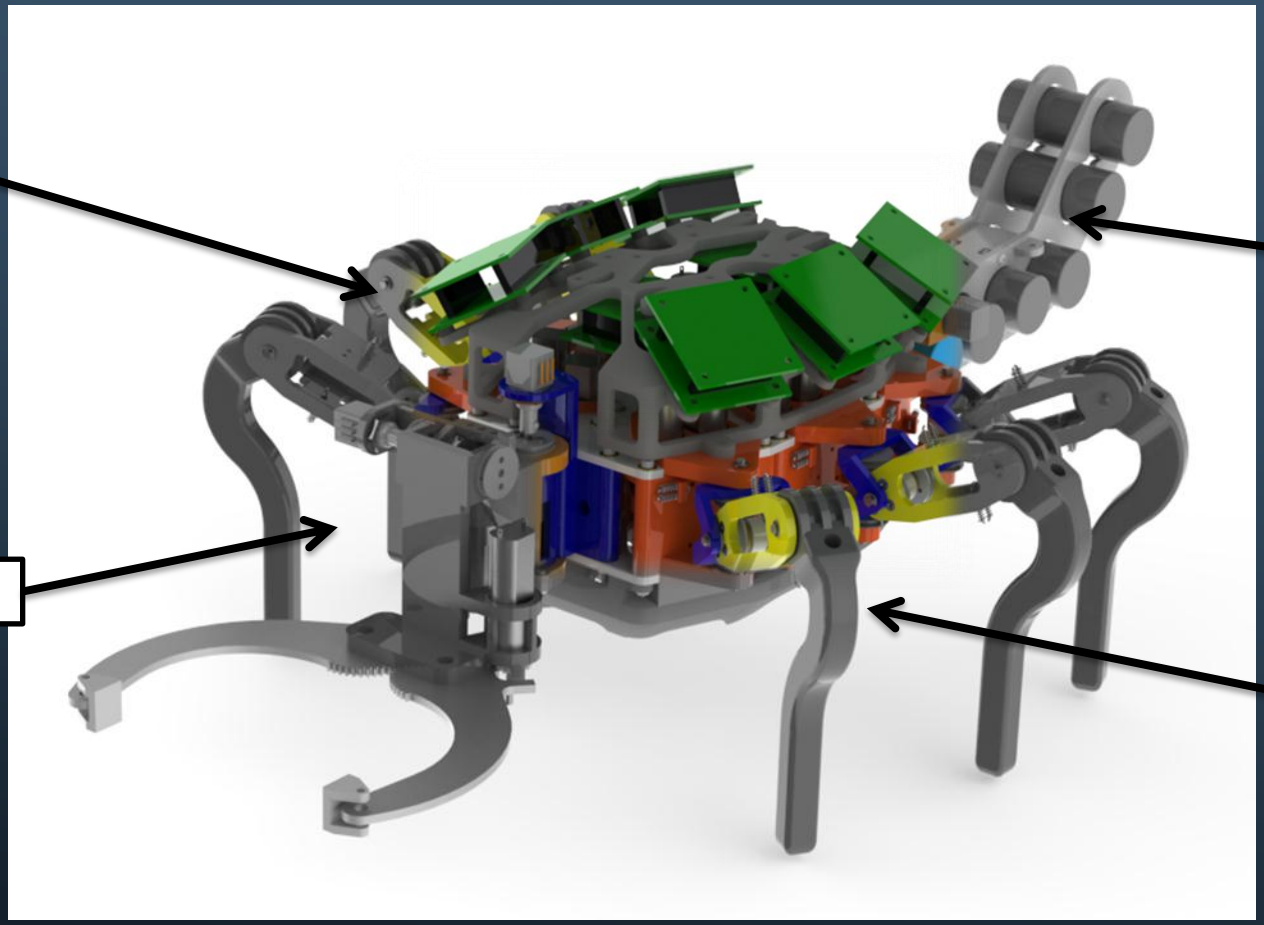
The Robot



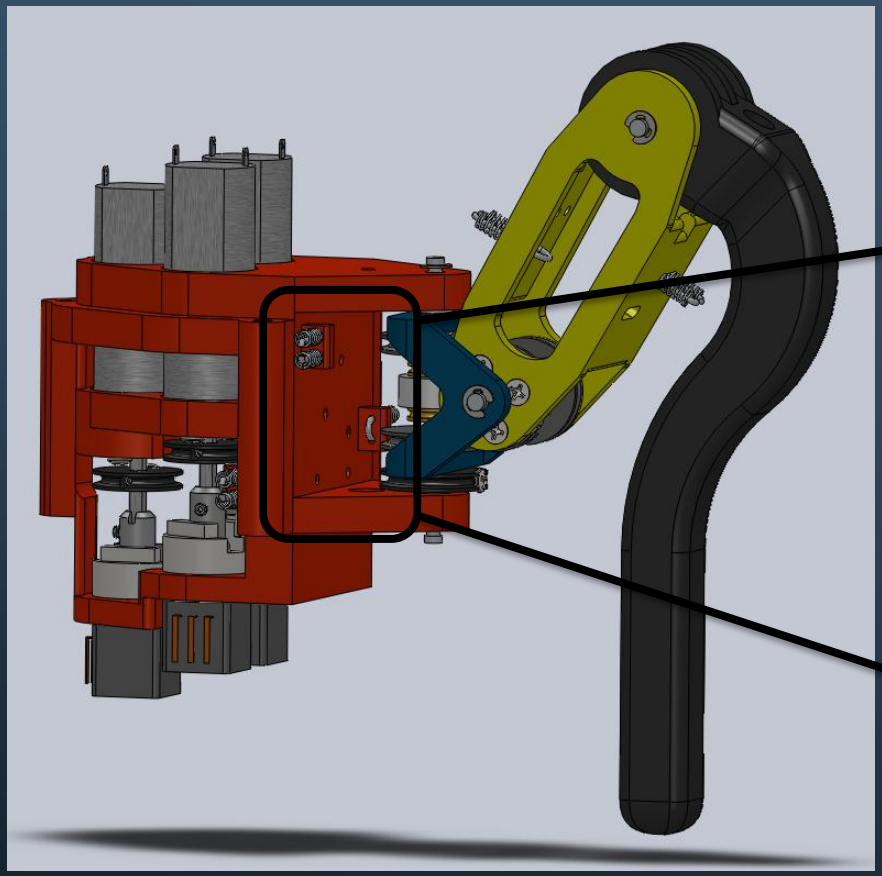
The Robot



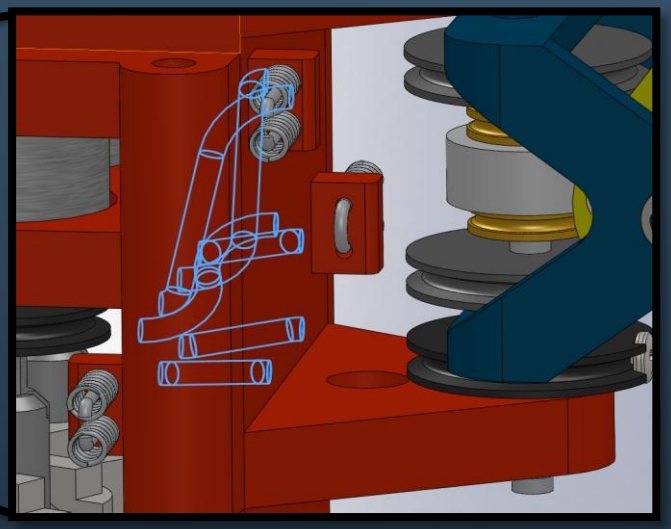
The Robot



Mechanical System

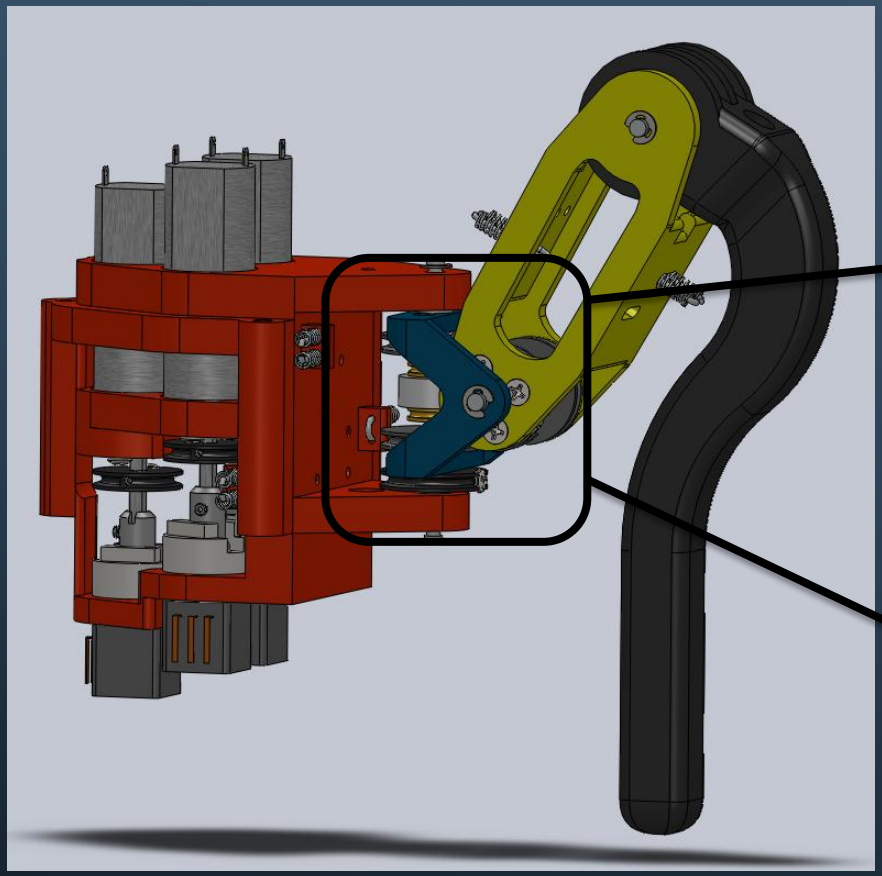


Leg Assembly

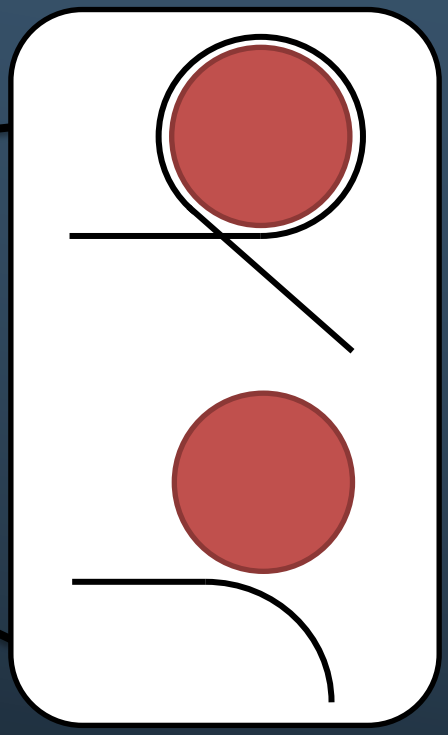


Cable Guidance Channel

Mechanical System

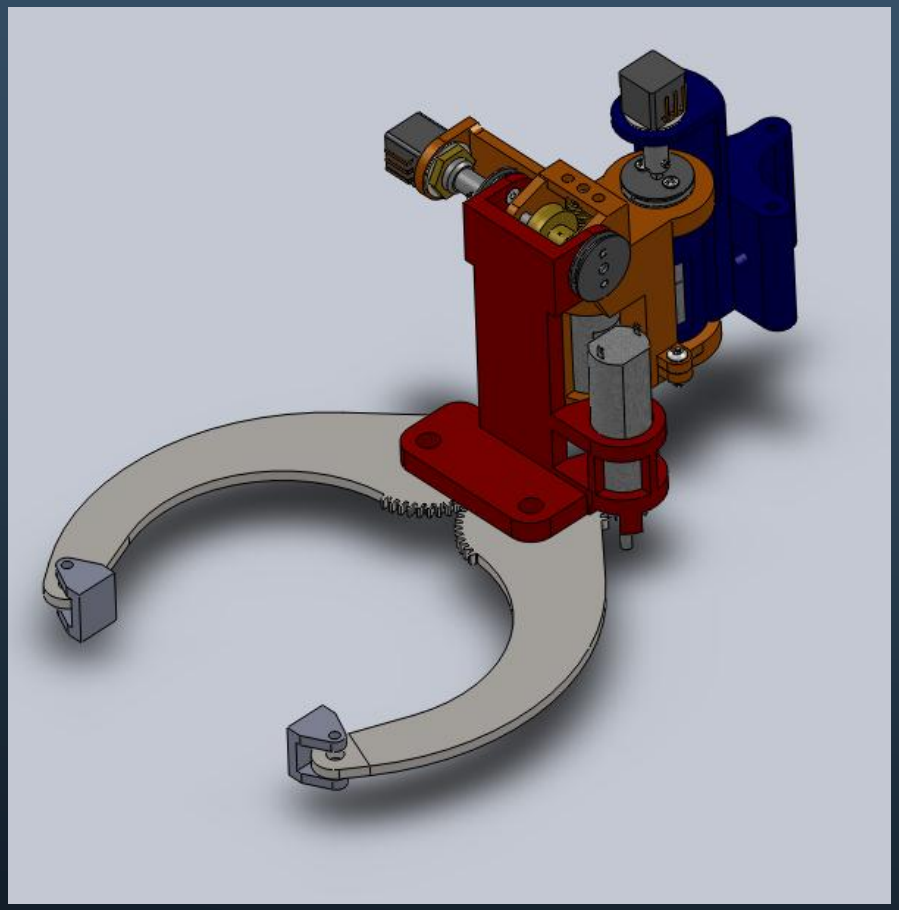


Leg Assembly

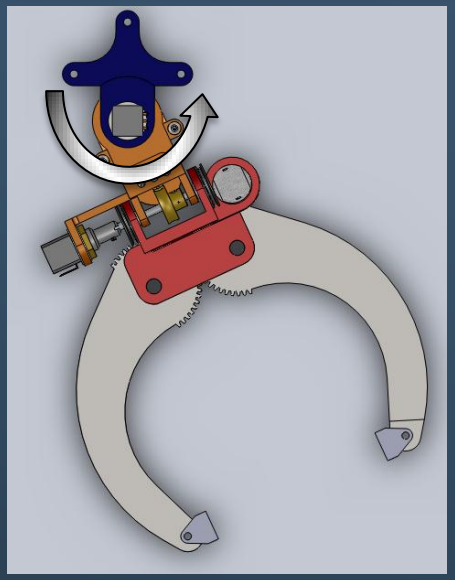


Idler Pulleys

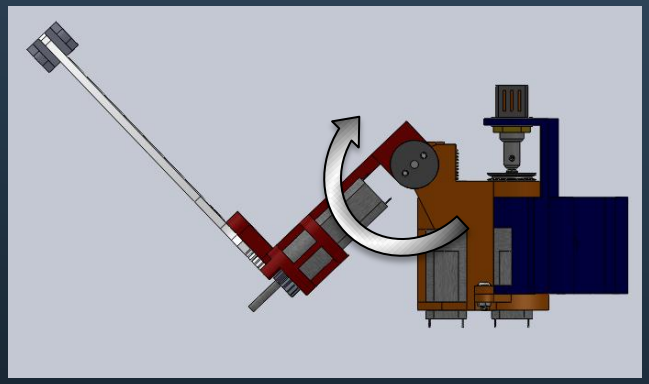
Mechanical System



Head Assembly

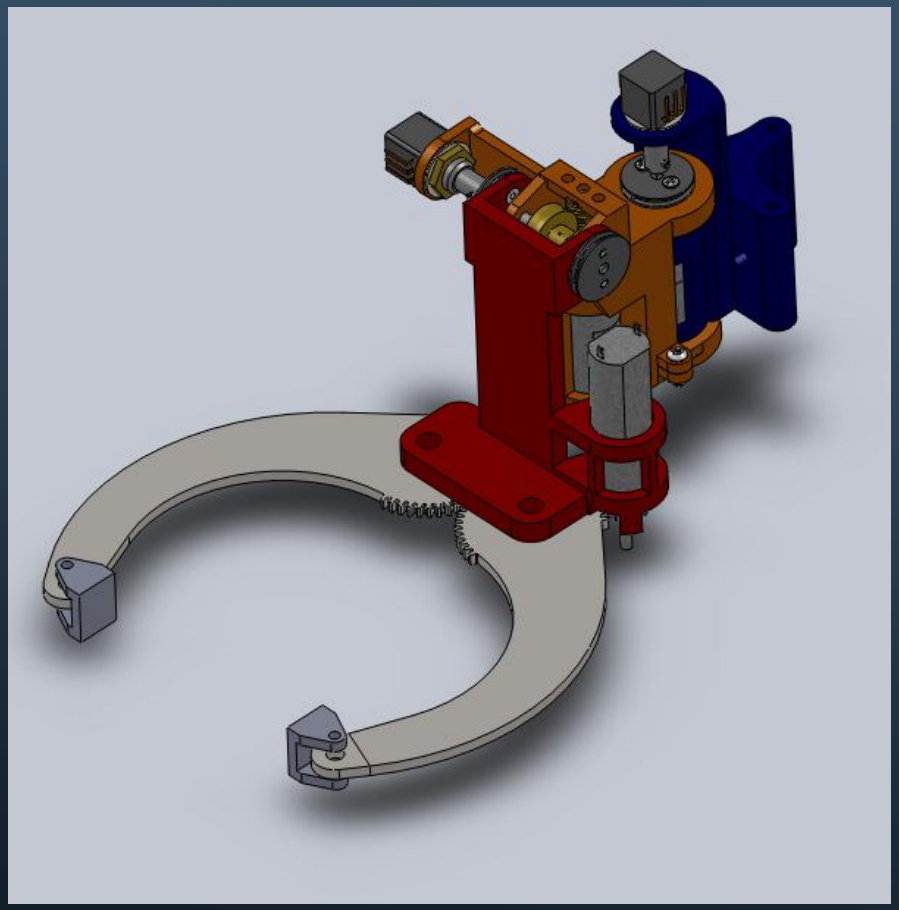


Panning

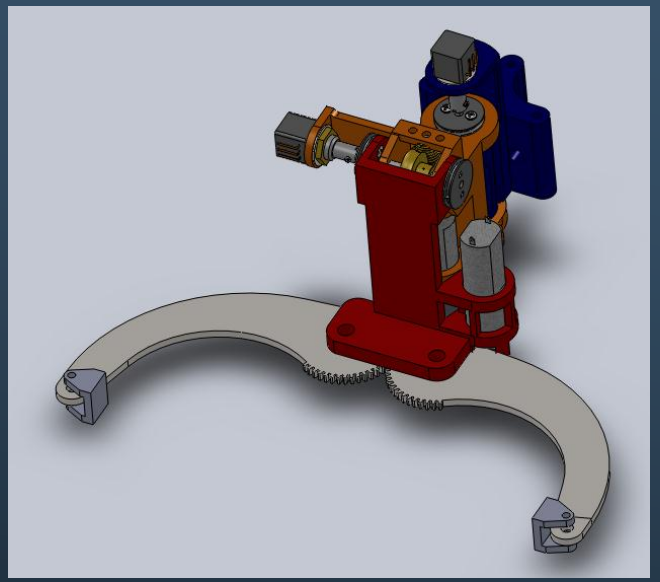


Lifting

Mechanical System

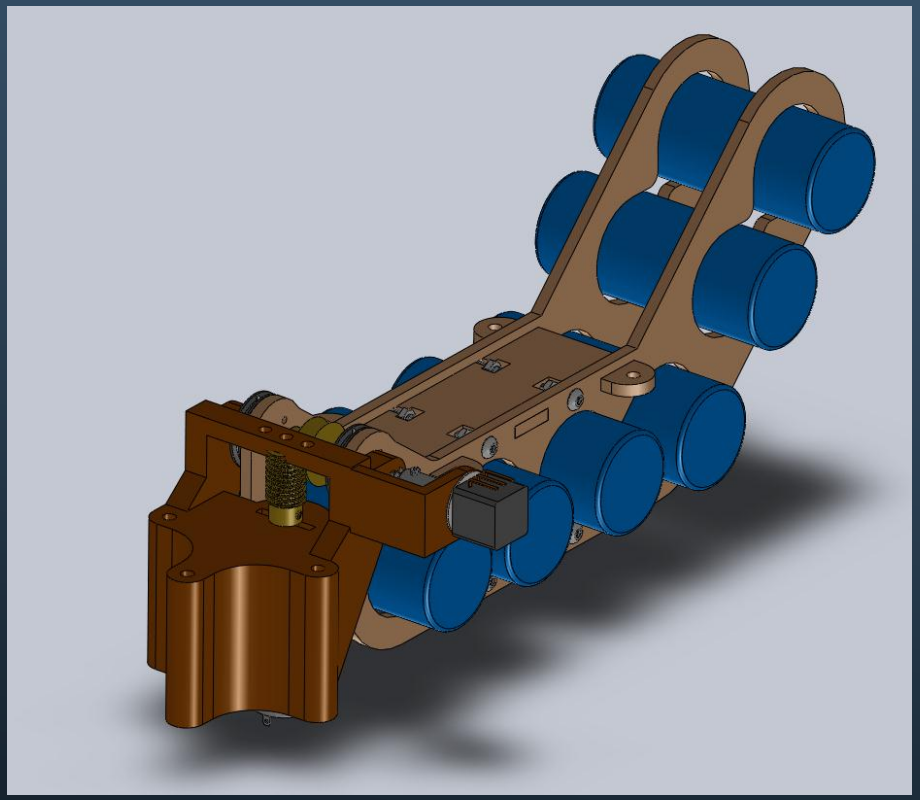


Head Assembly

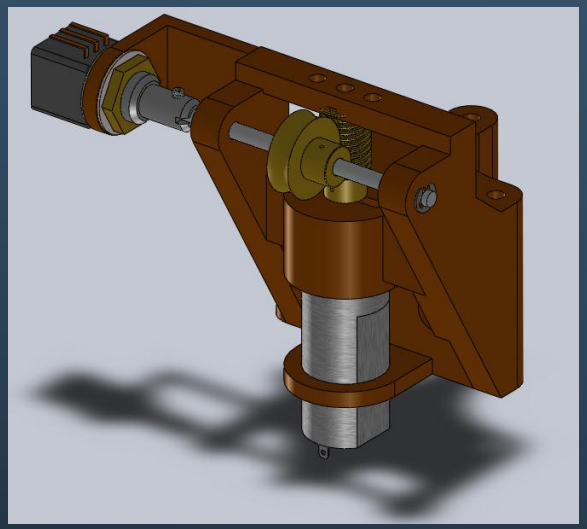


Fully-extended grippers

Mechanical System

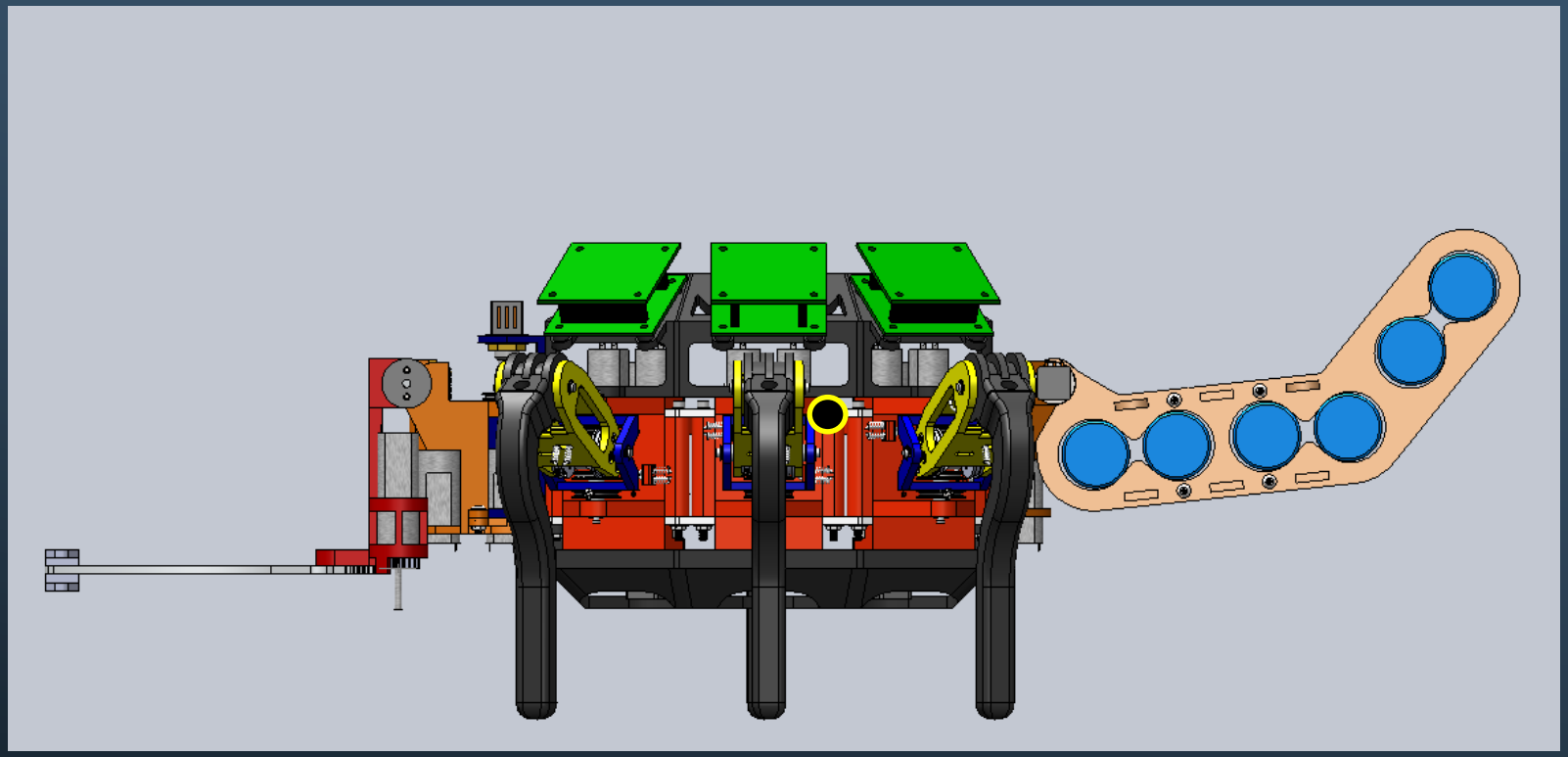


Tail Assembly



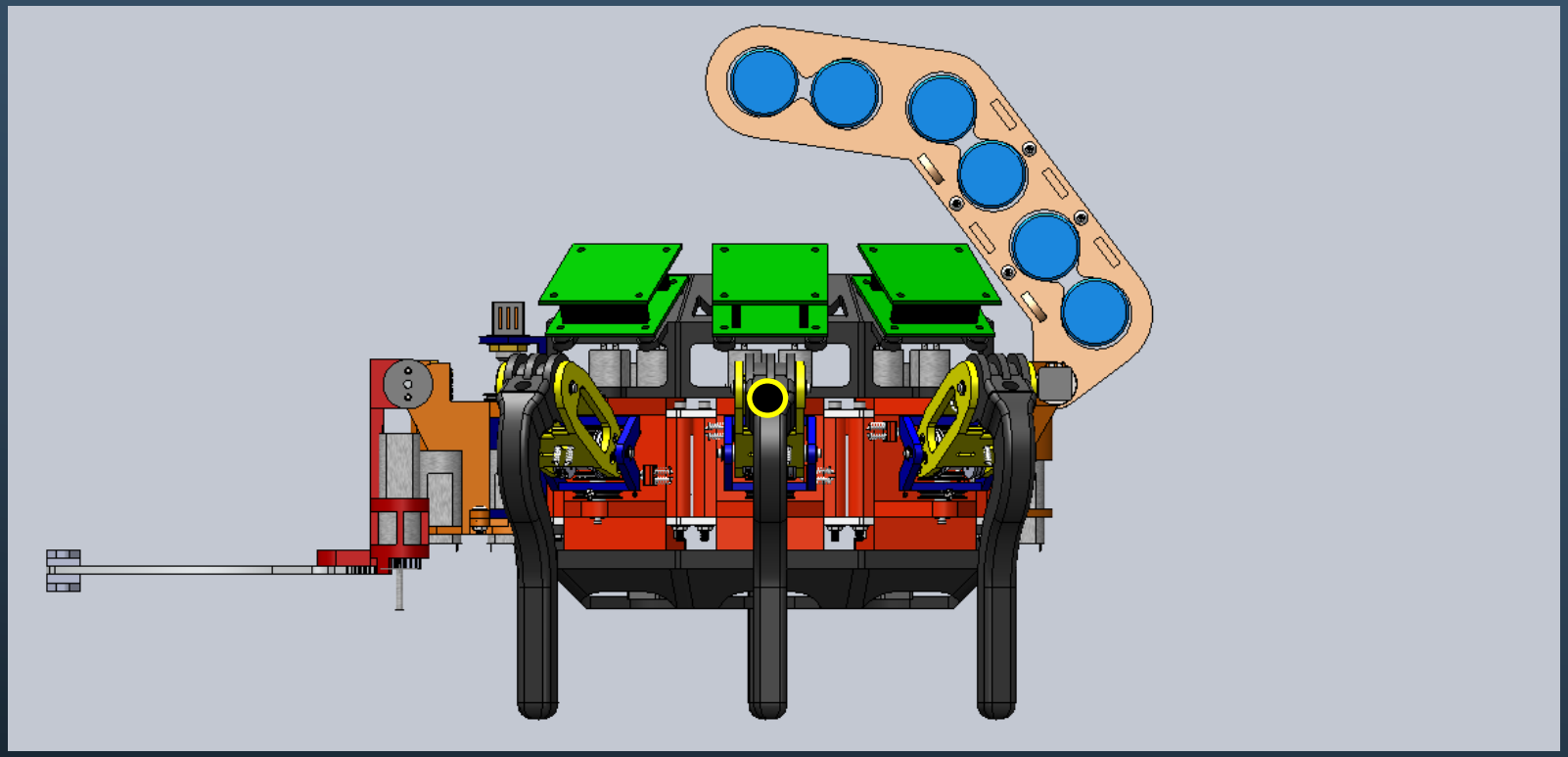
Tail Mount

Mechanical System



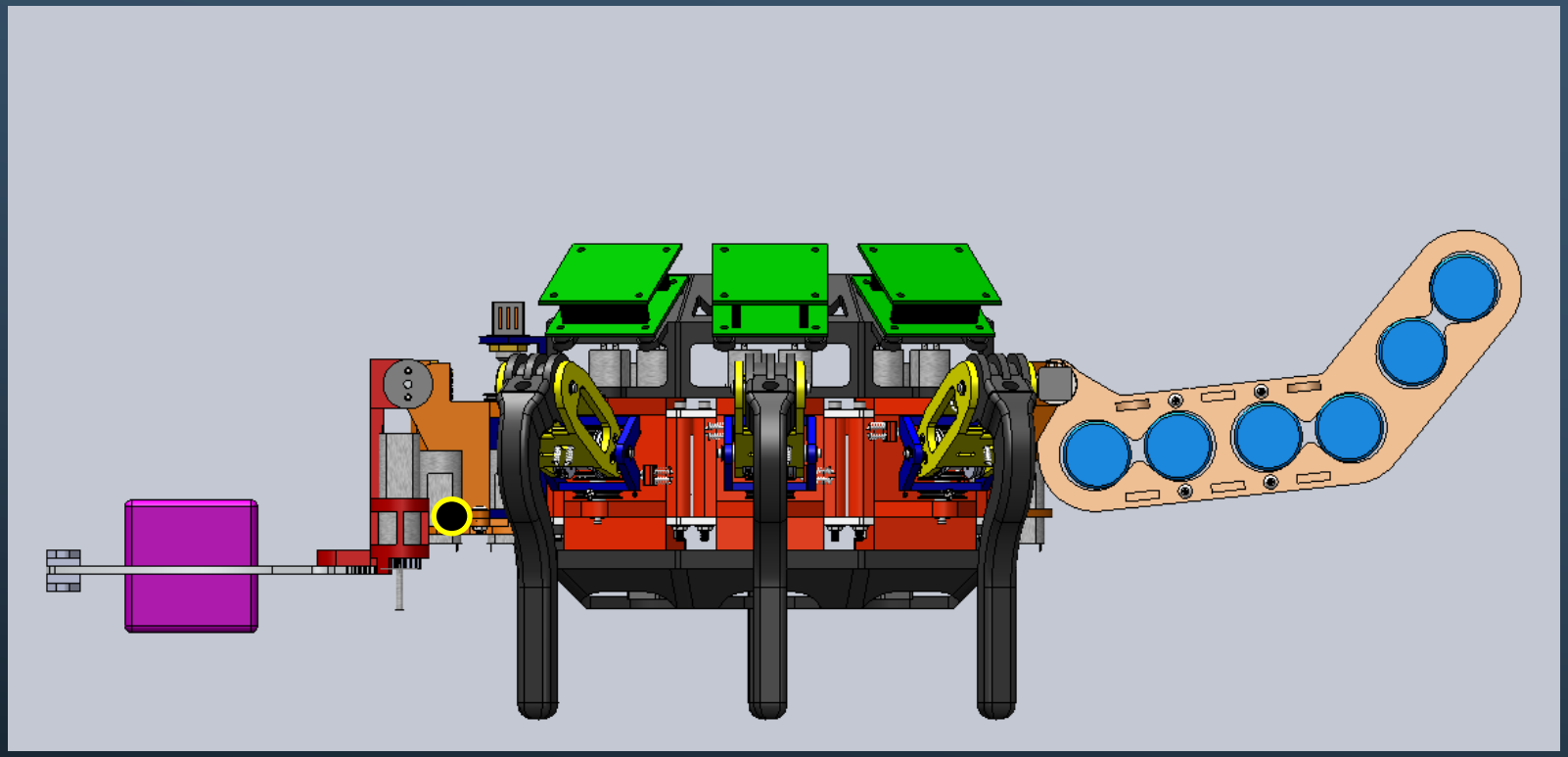
Center of gravity with tail down

Mechanical System



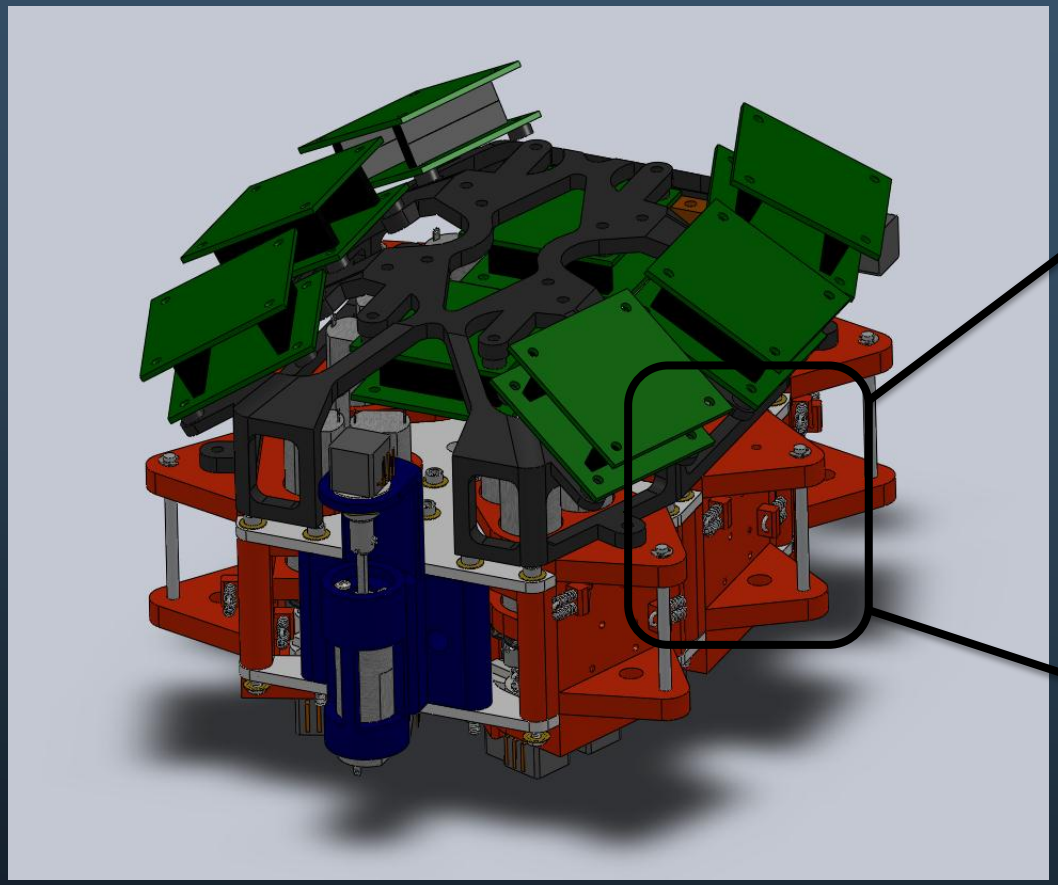
Center of gravity with tail up

Center of Gravity

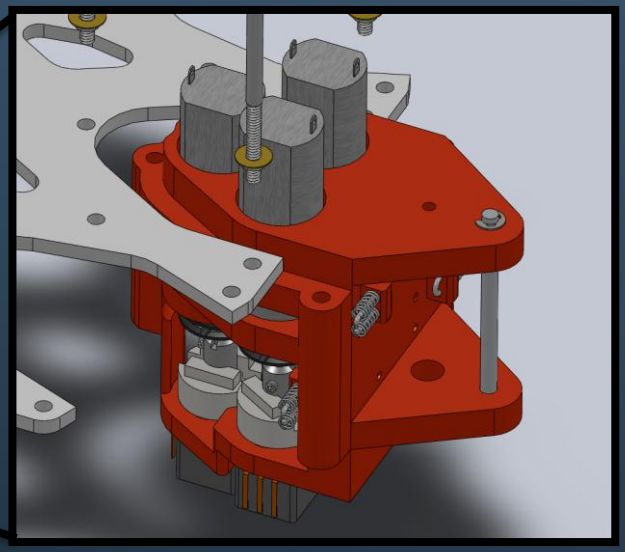


Center of gravity with 10lb weight

Mechanical System

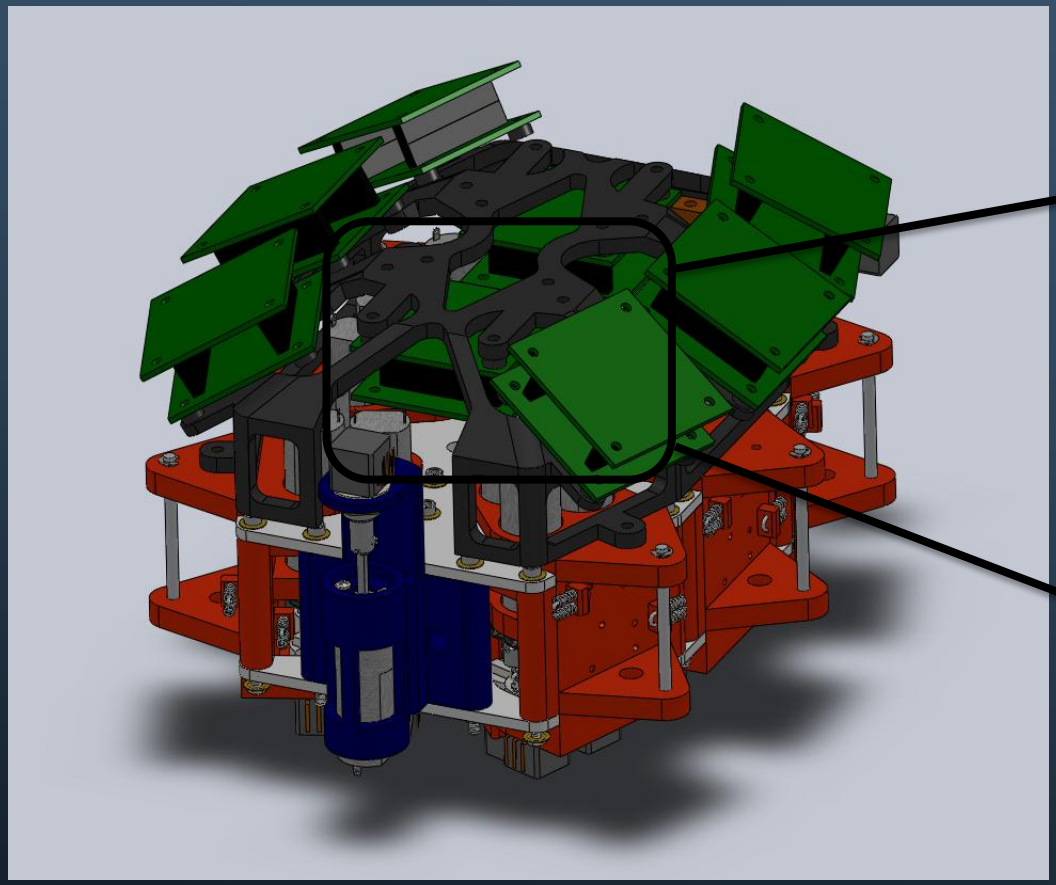


Central Body

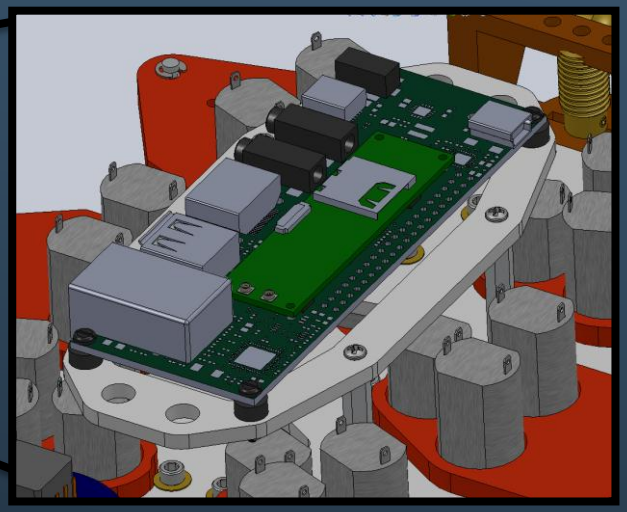


Modular Attachment Points

Mechanical System

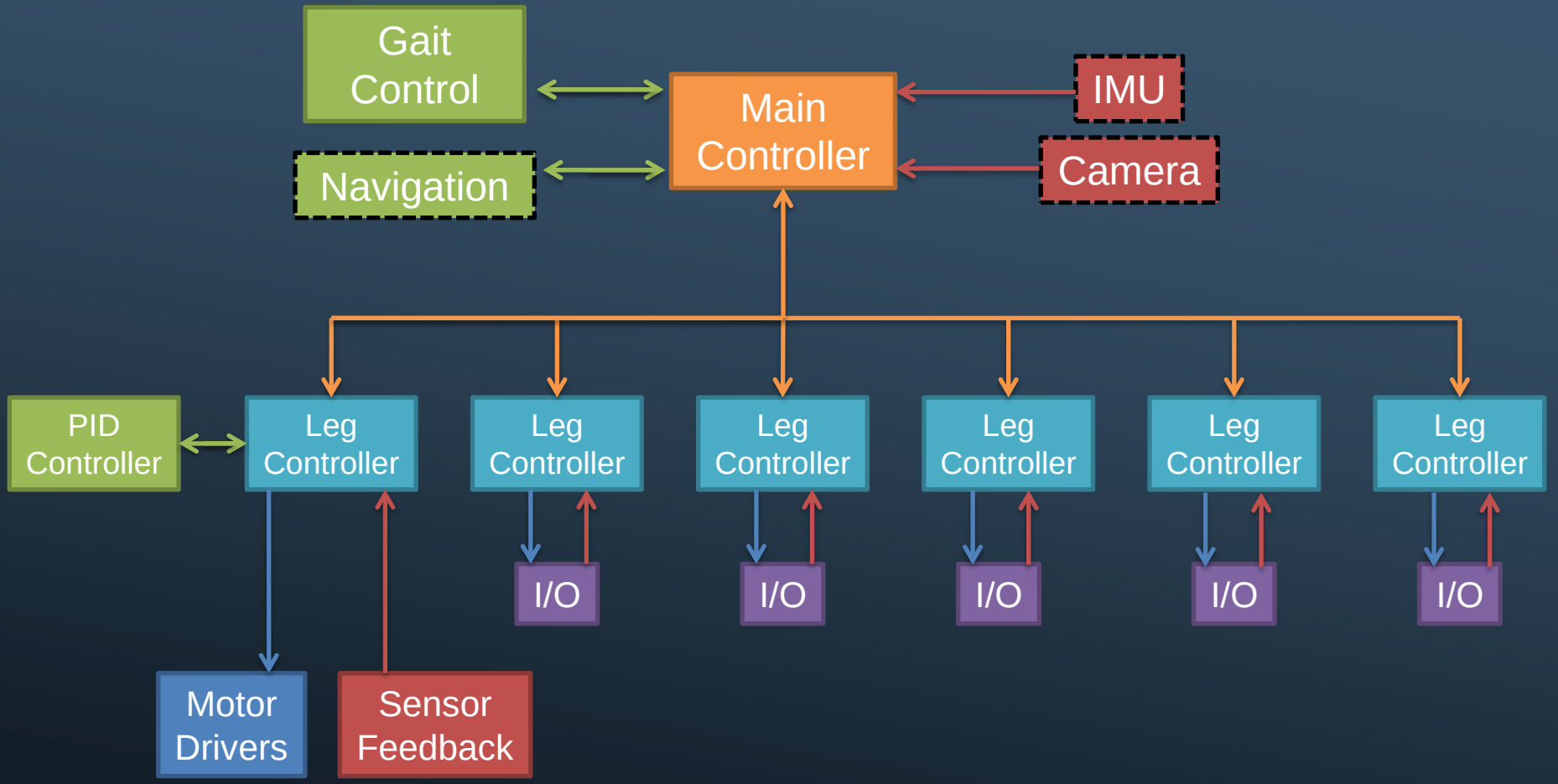


Central Body



Electronics Housings

Control Architecture



Main Controller

Gumstix Overo FE COM

- Texas Instruments OMAP3530
  - 600 MHz ARM Cortex-A8
- 256 MB RAM
- Onboard DSP and GPU
- 802.11bg WiFi, Bluetooth

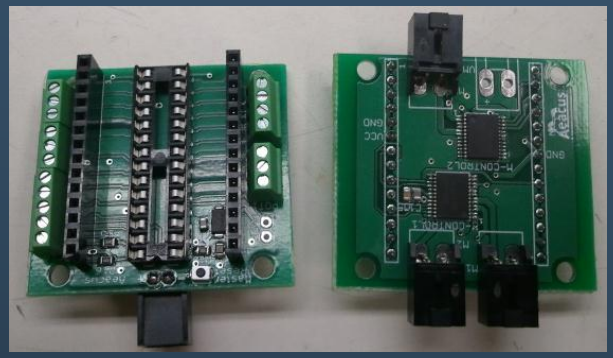
Leg Controller

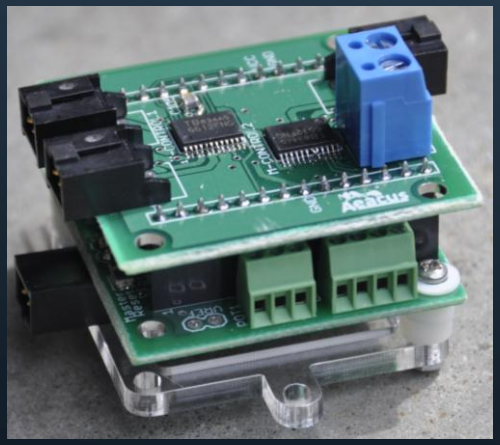
Microchip PIC18F26K22

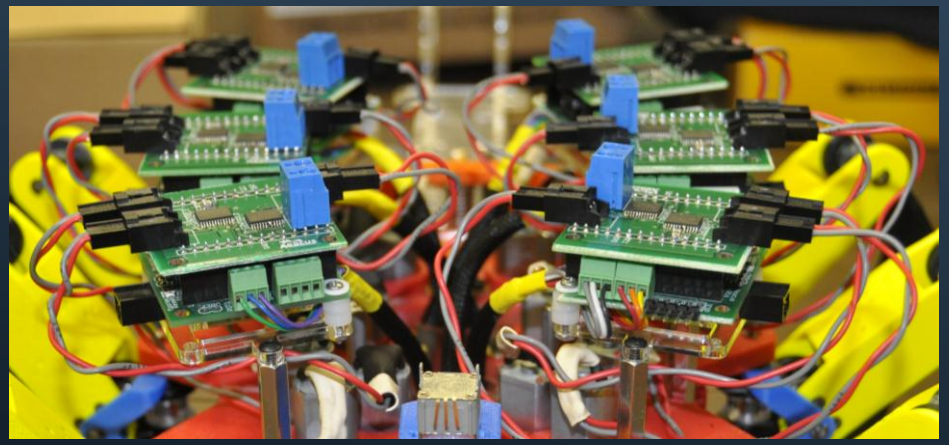
- 8-bit, 16 MHz
- PWM and direction output
- Feedback
  - Current Sensors
  - Potentiometers
- ICSP capable for online debugging

Motor Drivers

- 3x 12V @ 2A peak

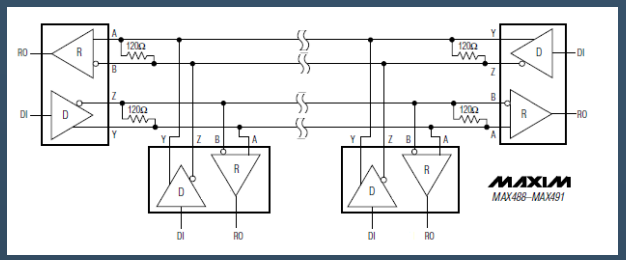






Communications Bus

- Physical layer: RS-485
  - Full-duplex, up to 10 Mbps
  - Master ↔ Slaves



- Link layer: Custom protocol
  - Derived from MODBUS
  - Joints individually addressable
  - Read/write all controller setpoints

Header Byte	
7	Status: ACK/NAK (1,0)
6	Command Enable (enabled when sending a command)
5	ACK/NAK Enable (enabled when responding)
4	Broadcast Enable (enabled when broadcasting to all)
3	Source Address (0 to 9 ASCII – 0x30)
2	
1	
0	

Header Byte

Byte	Field	Character	Hex	Description
1	Start Transmission	STX	0x02	Signal start of transmission
2	Leg Address	1 to 9 0	ASCII 0x30	Specific leg controller Master controller
3	Header			See table
4	Command Type	R W D ?	0x52 0x57 0x44 0x3F	Read value Write value Returned data Ping
5	Sub-command	P V C T	0x50 0x56 0x43 0x54	Position Velocity Current Torque
6	Joint Number	0 to 9	ASCII	Joint number
7	Sign	+ or -	ASCII	Data sign
8	Data	0 to 9	ASCII	Data digit 1
9			ASCII	Data digit 2
10			ASCII	Data digit 3
11			ASCII	Data digit 4
12			ASCII	Data digit 5
13			ASCII	Data digit 6
14	End Transmission	ETX	0x03	Signal end of transmission
15	Checksum (CRC-16)	0 to F	ASCII	High byte
16		0 to F	ASCII	Low byte

Packet Format

Gait Types

- Two primary periodic gaits: tripod and wave
- Non-periodic gaits position legs individually
- All are statically and dynamically stable

Wave gait: millipedes

Tripod gait: ants

Questions?