HURON: Full-Size Humanoid Robot (Lower Body)

Rachel Dancy (ECE), Jonathan Gong (RBE), Aislin Hanscom (RBE), Cameron Huneke (RBE), Peter Lam (ECE), Curtis Lee (RBE), John Marcotte (ME/ECE), Rahil Parikh (RBE/CS), Angelo Ruggeri (RBE/CS), Brendyn Sang (RBE/ME), Kyle Staubi (BME)
Advisors: Professors Mahdi Agheli (RBE/ME), William Michaelson (RBE/CS), Markus Nemitz (RBE/ECE), Cagdas Onal (RBE), Karen Troy (BME)
Acknowledgements: Tim Klein, Ibrahim Al-Tameemi, Washburn Shops Staff, Daniel Ali Tribaldos

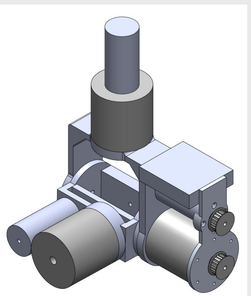
Project Overview

This project aims to manufacture, design, and control the lower half of a self-balancing bipedal robot, named HURON. HURON can react to forces anywhere on the body and move accordingly to regain balance and exhibit a human-like gait for walking for future use in search and rescue.

The Goals of the project:
- Design and fabricate the lower body of a full-scale humanoid robot
- Take a step to react to external forces exerted on the robot

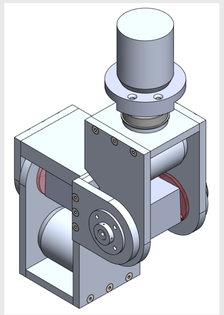
Robot Design

Design Considerations
- Follows proportions of 5' 10" male
- Supports upper body integration
- 12 Degrees of Freedom (DOF)



First iteration of hip assembly

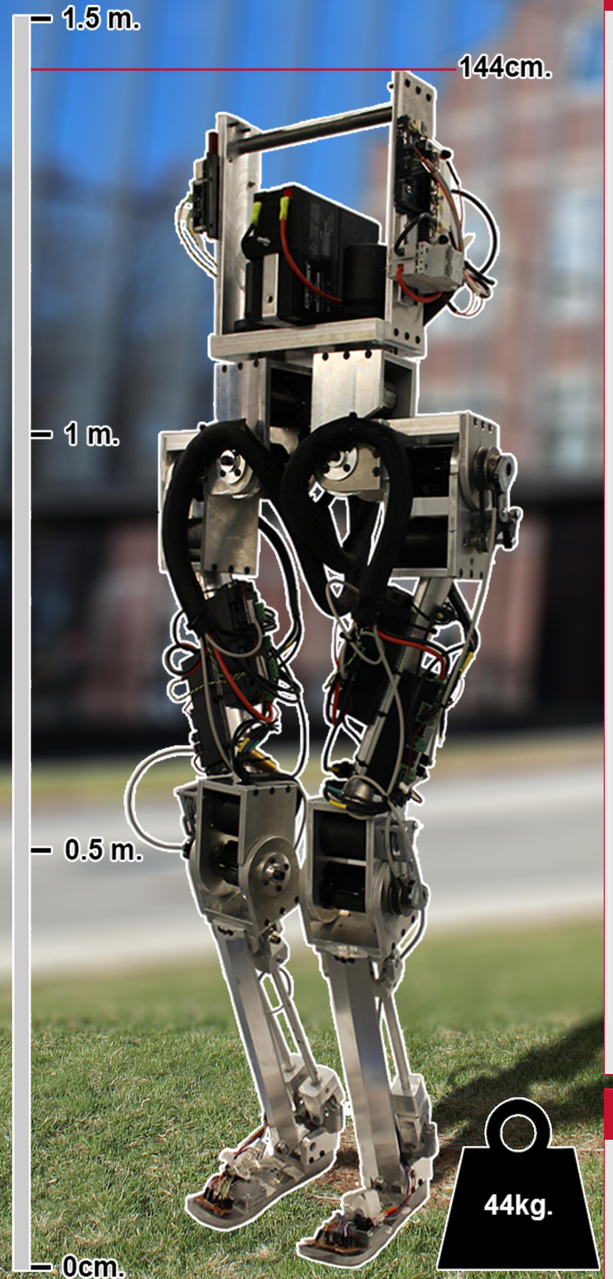
- Decreased total width by 10cm
- Compacted mechanisms to reduce empty space
- Used a simpler bracket structure



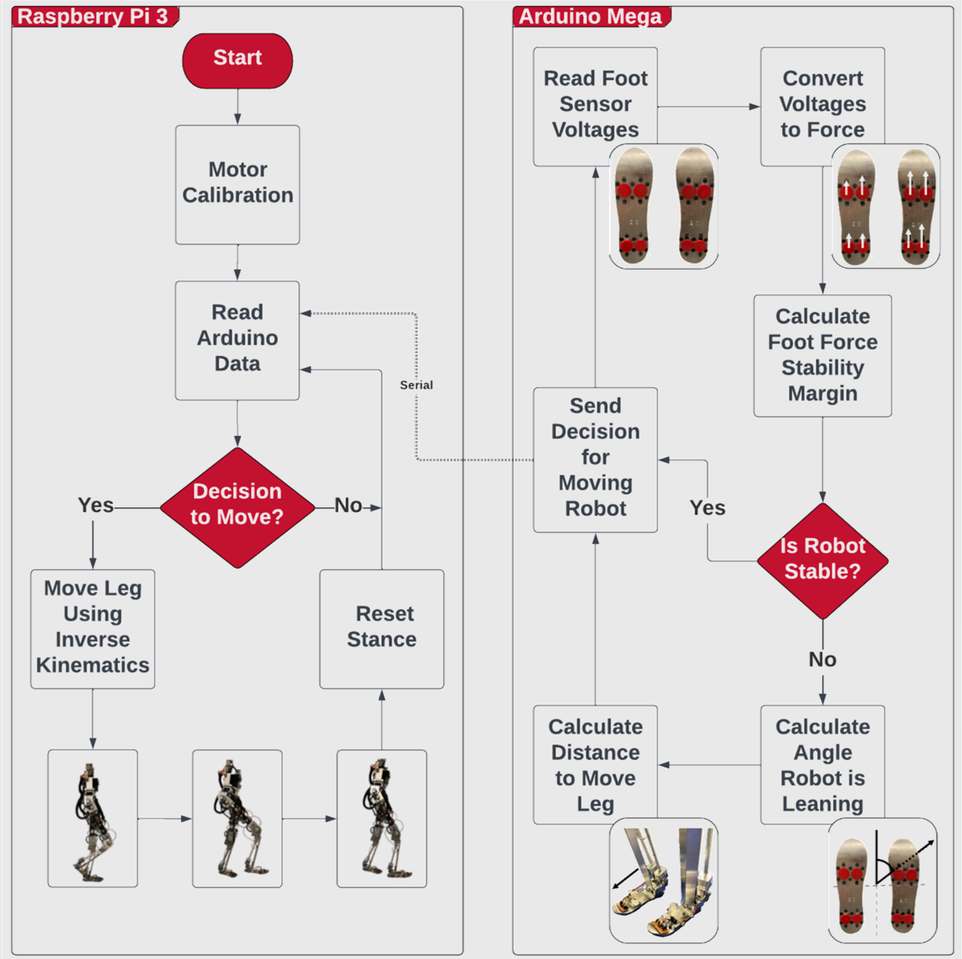
Final iteration of hip assembly

Control System

- Implemented communication between Raspberry Pi 3, ODrive 3.6 motor controllers, BLDC motors, and an Arduino Mega.
- Verified a mathematical model to take an input distance and output the respective joint angles using inverse kinematics.
- Collect force data from force sensitive resistors on the feet to calculate Foot Force Stability Margin.
- Calculated a staple-shaped trajectory of points for HURON to interpret as a reaction to external forces via a step.



System Architecture



Results

- Designed, manufactured, and assembled over 130 aluminum and steel parts using CNC machines into the final robot
- Designed circuits and programmed system to integrate the foot force stability margin theory
- Robot follows gait trajectories to correct its balance based on foot sensor readings