MiniRHex: An Open-Source Walking Hexapod

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https://github.com/robomechanics/MiniRHex

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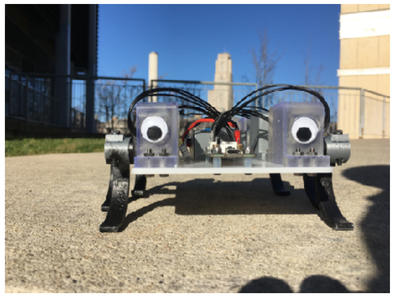
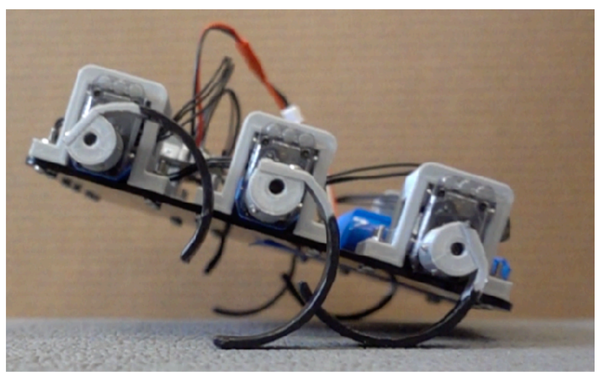
Summary

MiniRHex is a miniature scale hexapod heavily based on the design of RHex. Notable features include a laser-cut frame and 3D printed legs for cheaper construction and an intuitive software package that allows for highly-customizable control over the robot's behavior.



Motivation

MiniRHex was designed to be an educational and outreach tool to allow students to experiment with a fully functional walking robot at a much lower cost. The low price tag lets research groups maintain a fleet of machines, allowing each student more hands-on interaction with the hardware.



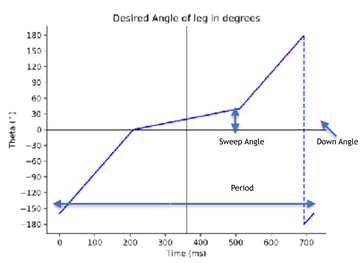
Possible Educational Principles:
- Gait design and optimization
- Leg design and control
- Mobile robot sensor incorporation

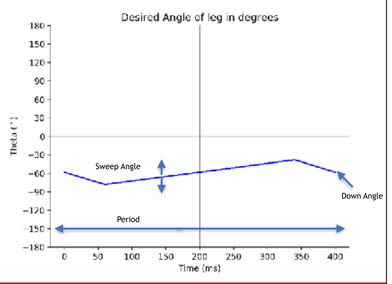
Leg Control

- Carefully calculated leg spring constant to deliver optimal flex on ground contact
- Independent control (position and speed) over each leg
- Clock-driven desired position for each leg
- Intelligent deadzone avoidance
- Same parameterization as RHex (period, duty factor, sweep angle and down angle)

Alternating Tripod Gait Parameter Chart	MiniRHex
Period	720 ms
Duty Factor	0.42
Sweep Angle	40°
Down Angle	20°

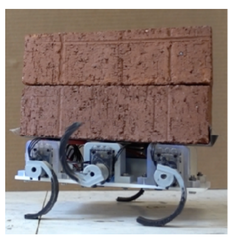
Pronk Gait Parameter Chart	MiniRHex
Period	400 ms
Duty Factor	0.7
Sweep Angle	40°
Down Angle	-50°, - 58°, -66°

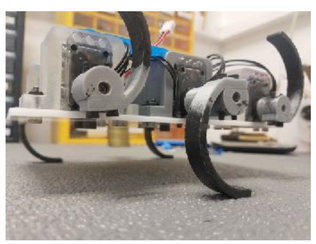




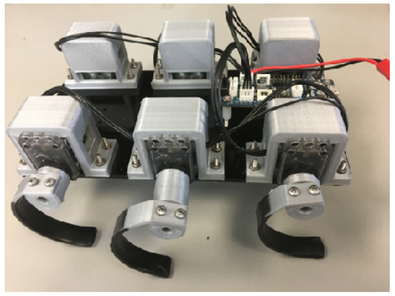
Capabilities

- Behaviors/Gaits:
  - Alternating Tripod (Running)
  - Pronking
  - Jumping
  - Simple adoption of user-defined gaits
- Remote control (gait switching and behavior activation)
- Automatic dead-zone avoidance (legs continue to track desired position without servo feedback)
- Easily modifiable software package for developing new gaits and behaviors

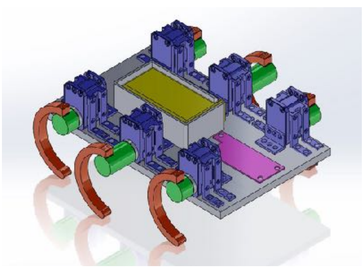


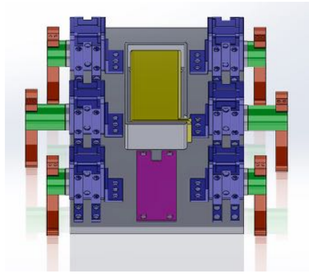


Technical Specifications



Specification Chart	MiniRHex	X-RHex (2010)
Mass	.425 kg	8.6 kg
Carrying Capacity	1.8-3 kg	5-10 kg
Length	0.186 m	0.53 m
Width	0.100 m	0.39 m
Leg Diameter	0.058 m	0.175 m
Experimental Leg Spring Constant	1.98 N/mm	1.4-1.7 N/mm
Leg actuation	Dynamixel XL320 Servo	Maxon Brushless Motor
On-Board Processing	OpenCM9.04	PC104, Intel Atom Processor
Single Unit Price	< $250	~$20,000





Future Work

Although MiniRHex was developed as an educational tool, we have found multiple research avenues that the platform could assist in:

- Development of new gaits and behaviors
- Inertial data collection via visual sensors and IMU
- Testing of autonomous gait-tuning algorithms
- Comparison of control strategy and gaits with full-scale RHex