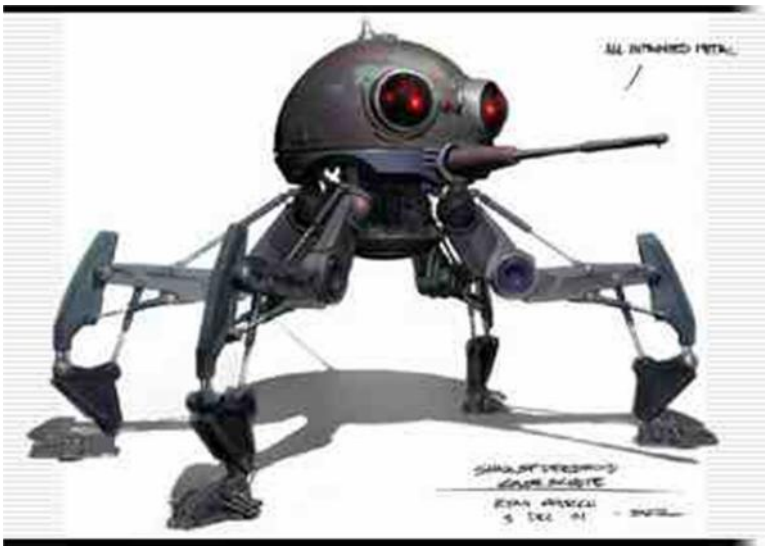
PHI Project Notes

Overview

The name of the robot is “PHI” because, as everybody knows, Greek letters are COOL.

It is loosely based on the Star Wars “Spider Droid”. Loosely because after close inspection, I concluded it wouldn’t work … There are linkages missing, etc unless they use light saber technology or something.



Software

The software is broken into two parts:

1) Firmware (on robot)
    a. Hardware Control (sensors and effectors)
    b. Web server for diagnostics
    c. PhiLink (50 fps telemetry link)

2) Phi Core (on Windows PC)
    a. Remote brain for robot – robot is teleoperated like a puppet through PhiLink. At this point it is mostly WISHFUL THINKING. Only diagnostics and telemetry work.
    b. Self-programmed guided by hardwired instincts and goals
        i. Instincts are things I presume comes wired in “out of the egg”. Things like pleasure seeking, pain aversion, curiosity, investigation, prediction, play, feeling “in control”, etc
        ii. Goals are loose good/bad indicators that guide learning. Similar to instincts but less fuzzy. E.g. at a very low level, a goal of the low joint sensor/motor

subsystem is to explore the causality between motor commands and joint movements. This is how Phi learns it has a leg.

iii. Self-programming is based on various information-theoretic goals.
    1. Maximal communication entropy between systems (ie best channel utilization)
    2. Maximal PIG (predicted information gain). This means that exploration actions are selected on the basis of filling in missing knowledge relevant to the goal.
    3. Best compression between sensor and memory by the "information bottleneck method". Lots of data from sensors but very little is relevant to a particular subsystem. Subsystems compress (and discard) data that is not relevant to its goal. In other words, information goes through a bottleneck.

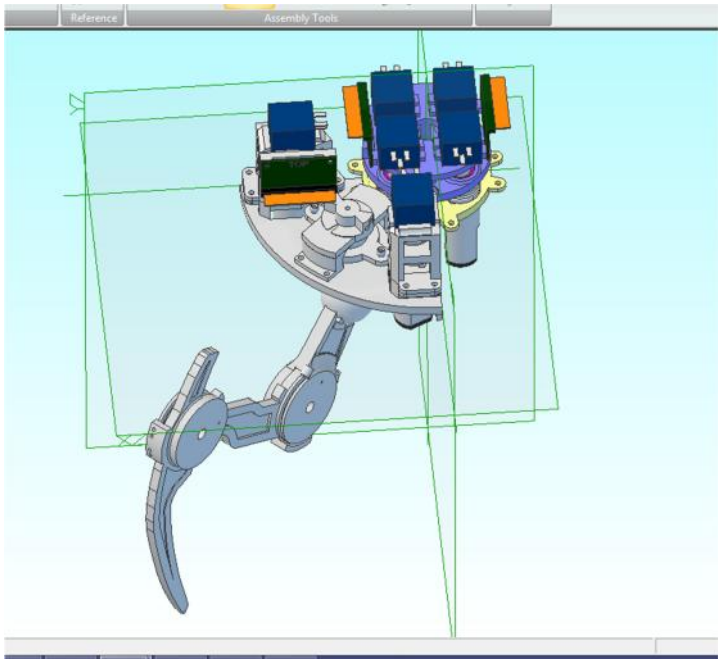
Hardware

Quick summary:

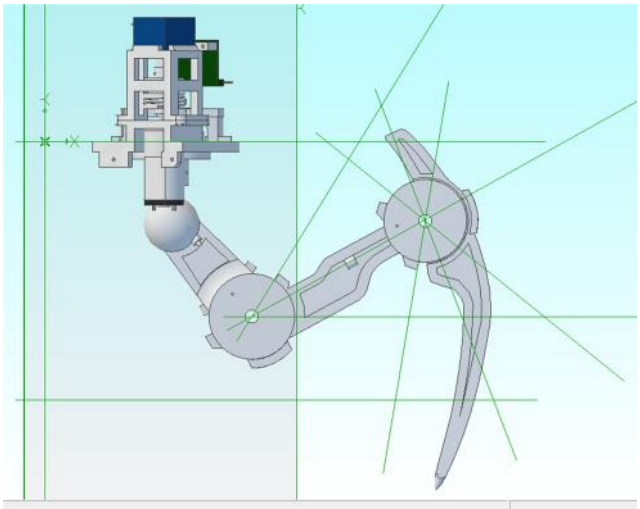
- Raspberry Pi single board computer running Raspbian Linux (derived from Debian)
- Auxiliary custom PCB for: Voltage regulators , Analog-to-Digital converters, SPI and I2C bus expanders, etc.
- 12 gear motors (35:1 ratio), 3 per leg
- 6 motor controllers (one can handle 2 motors)
- 12 Potentiometer based joint position sensors, 3 per leg
- 4 touch sensors on "feet"
- Static Accelerometer – senses acceleration on 3 axes. Good for detecting translational movement of robot
- Digital Gyroscope – senses rotational acceleration around 3 axes. Good for detecting robot rotations.
- 50 fps HD camera (resolution will probably be reduced significantly to keep frame rate up)
- 2400 mAh 9V batteries
    - 9V for motors
    - 5V for Raspberry Pi
    - 3.3V for assorted logic
- On/off switches and assorted blinkenlights

Plastic

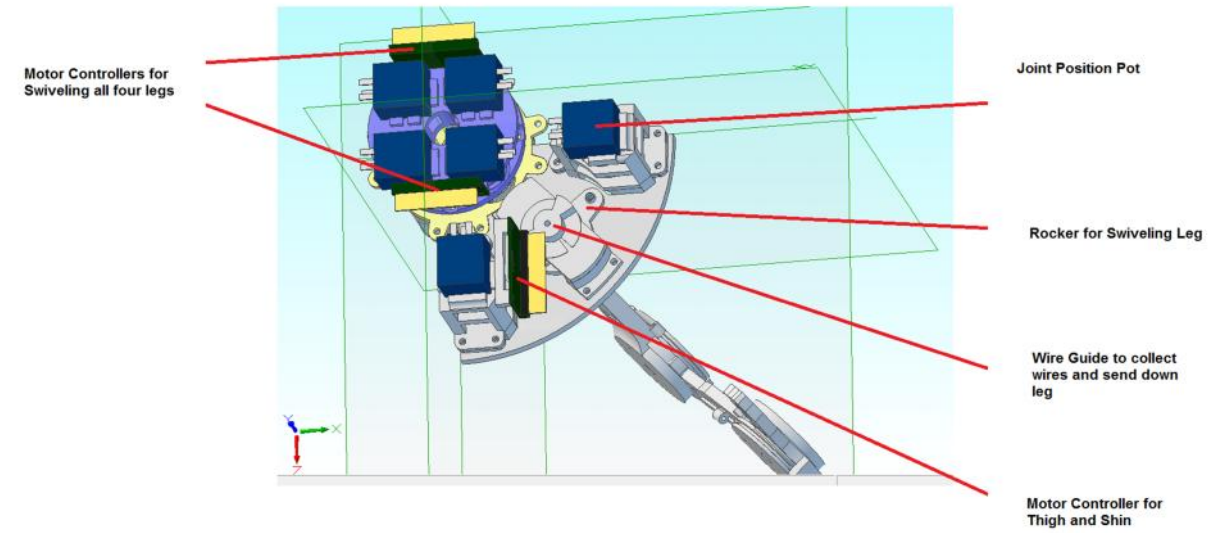
View of one “Quadrant” of robot. Phi is made of four of these, a head dome and an undercarriage dome.

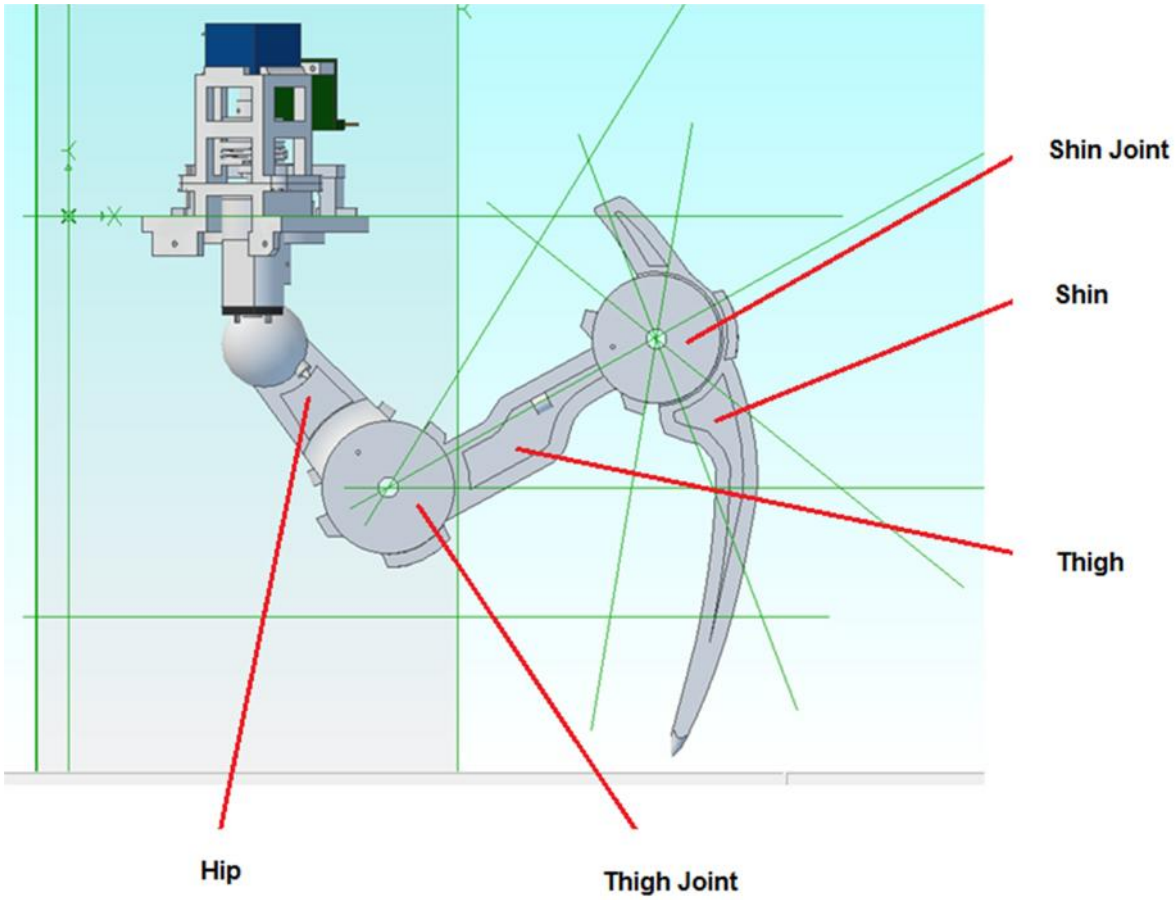


Side view of a Quadrant:



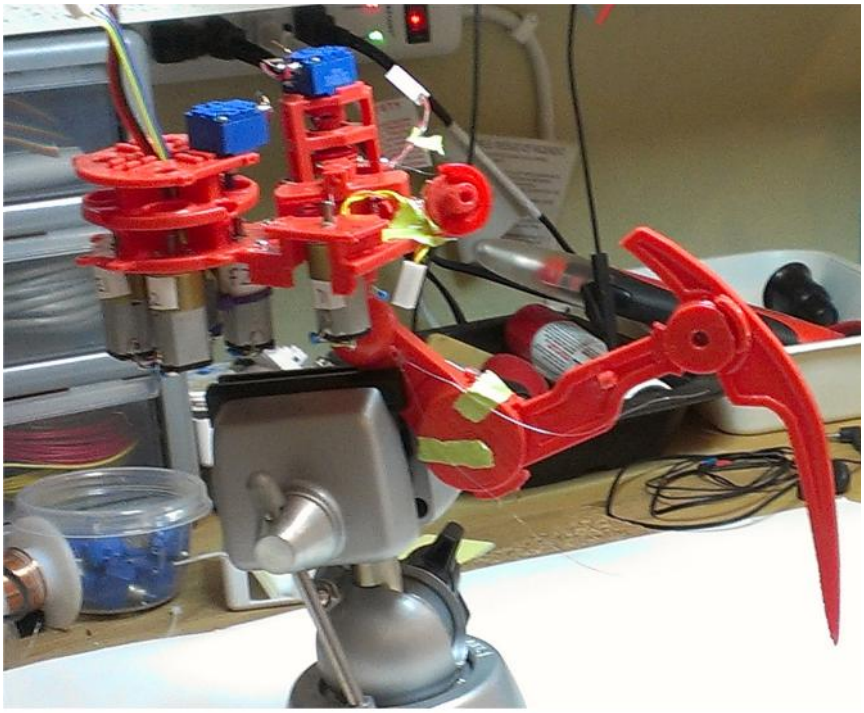
Labeled Components / Nomenclature:

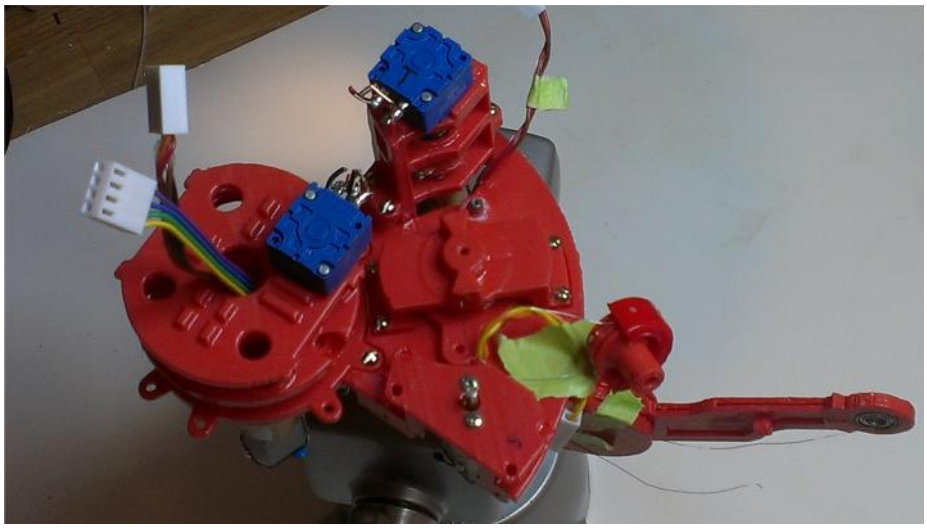


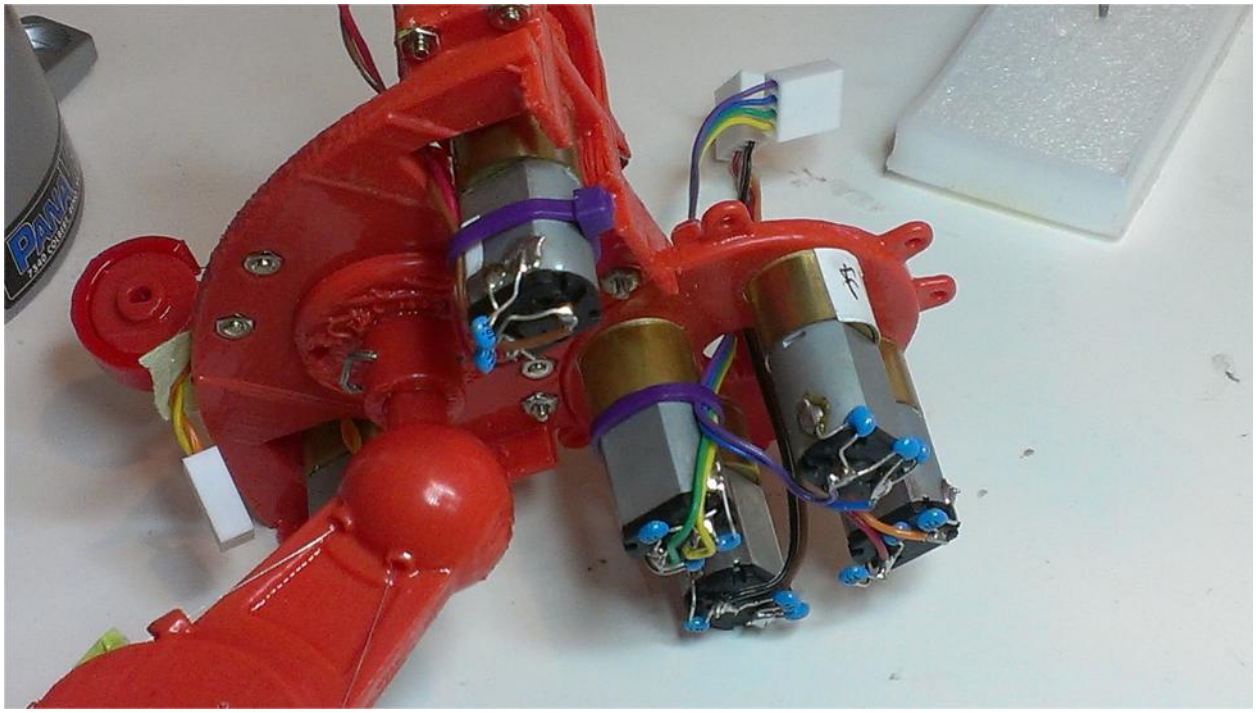


Actual Hardware

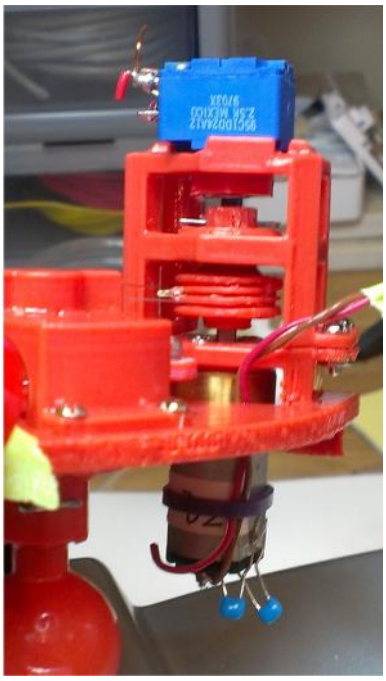
Quadrant (not fully assembled):





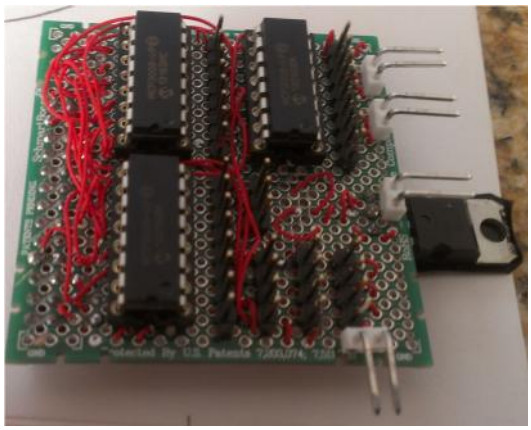


Close-up of pulley-tendon-potentiometer system:

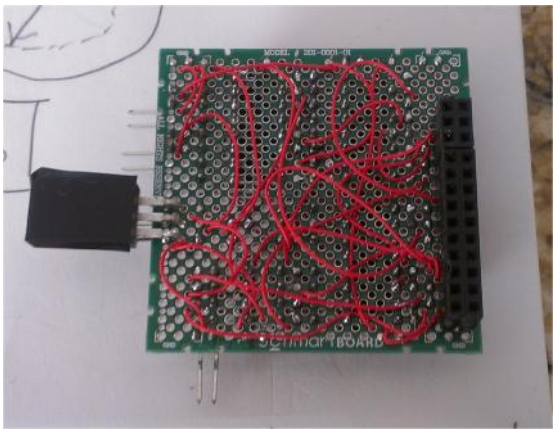


Aux Board

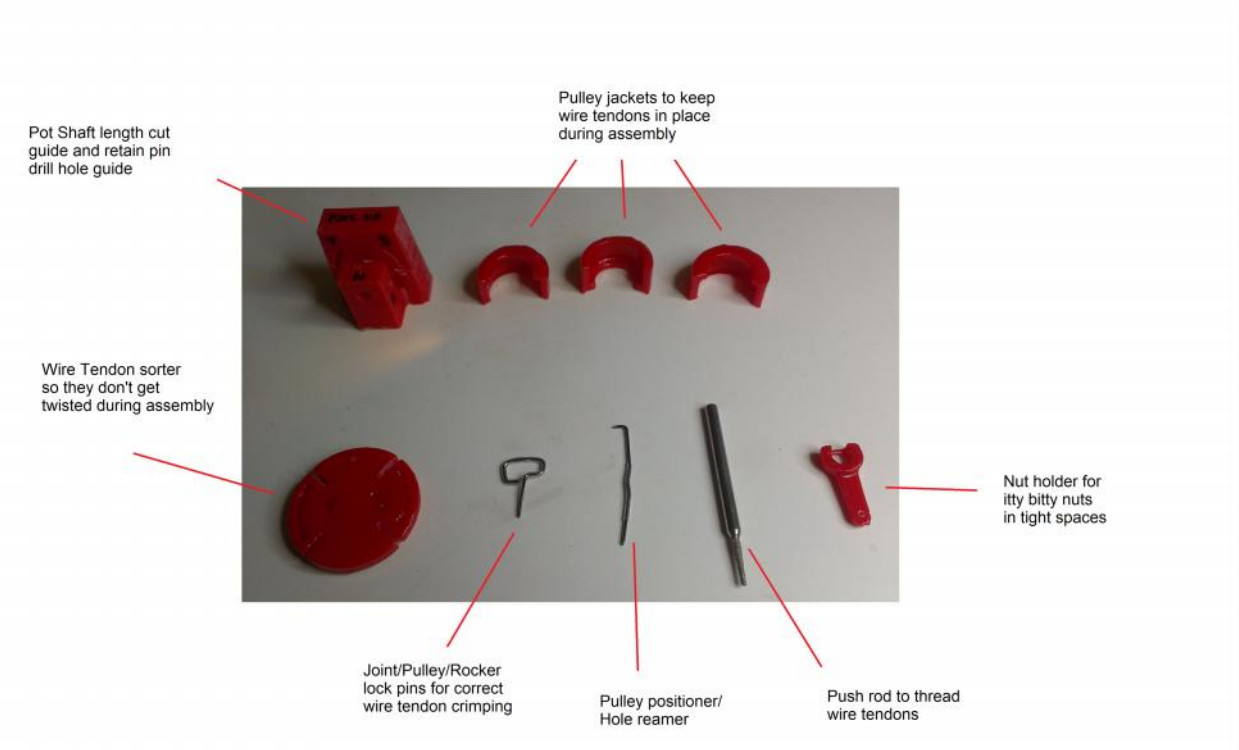
Top:



Bottom:



Assorted Assembly Jigs



Pulley with Jacket Jig

Most Important

Project Mascot (weird Egyptian God)

Keychain (no mugs or T-shirts … yet)