Maseeh College of Engineering and Computer Science

PORTLAND STATE UNIVERSITY

Hardware Troubleshooting Guide

HR-OS1 Humanoid Robots

Revision 1 – (3/21/2017)

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Introduction

The HR-OS1 Humanoid robots are an excellent tool for learning about robot motion, but they can unfortunately fal victim to a wide variety of reliability issues which are a direct result of their small form factor and relatively high complexity.

In this guide, I will provide some simple steps which can be taken to troubleshoot and repair malfunctioning HR-OS1 robots, in addition to some preventative maintenance which can be done to improve the reliability of the HR-OS1 robots.

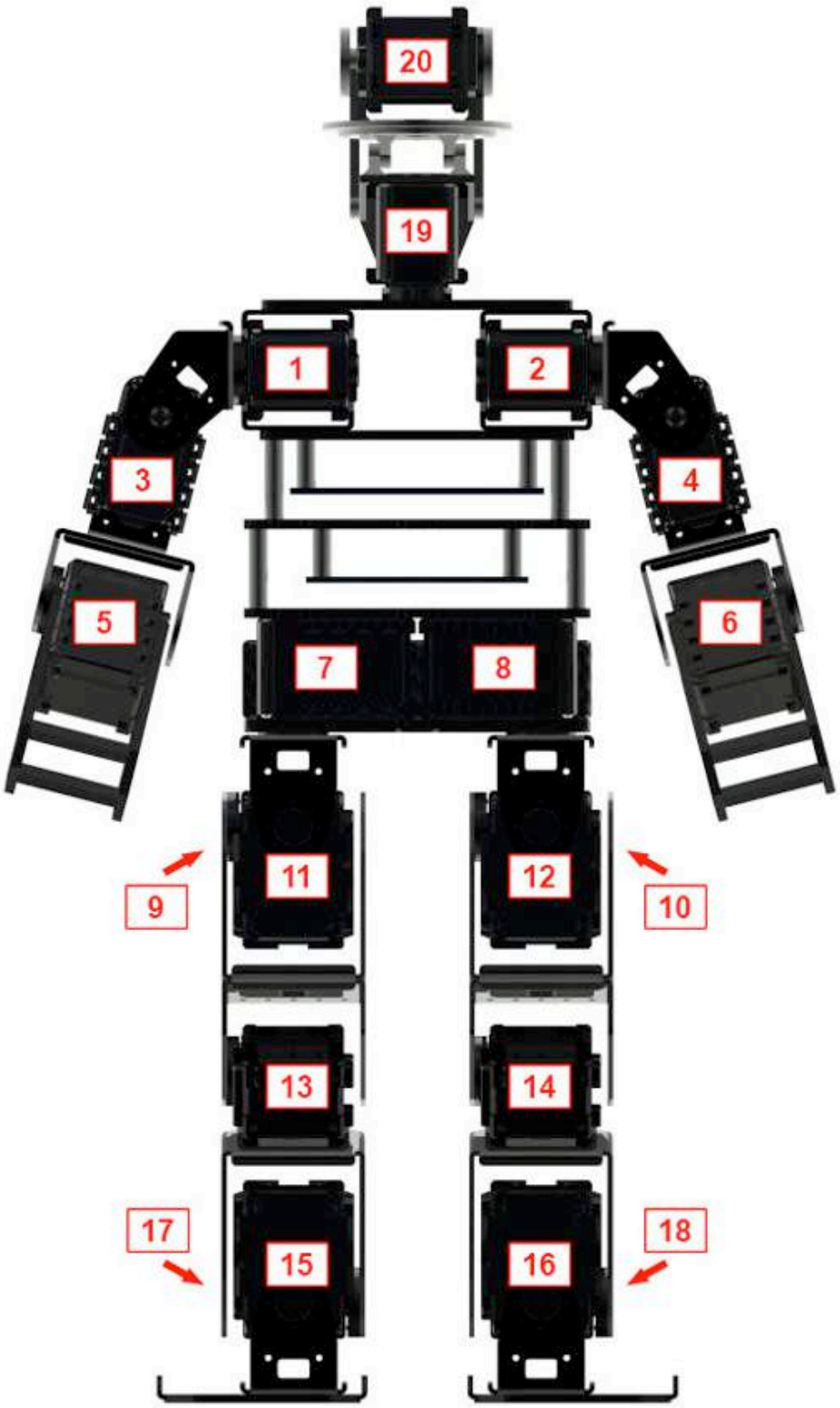
To begin, familiarize yourself with the diagram on page 2, which helps to aquaint the user with the servo ID naming scheme of the HR-OS1 robot platform.

How to use this guide:

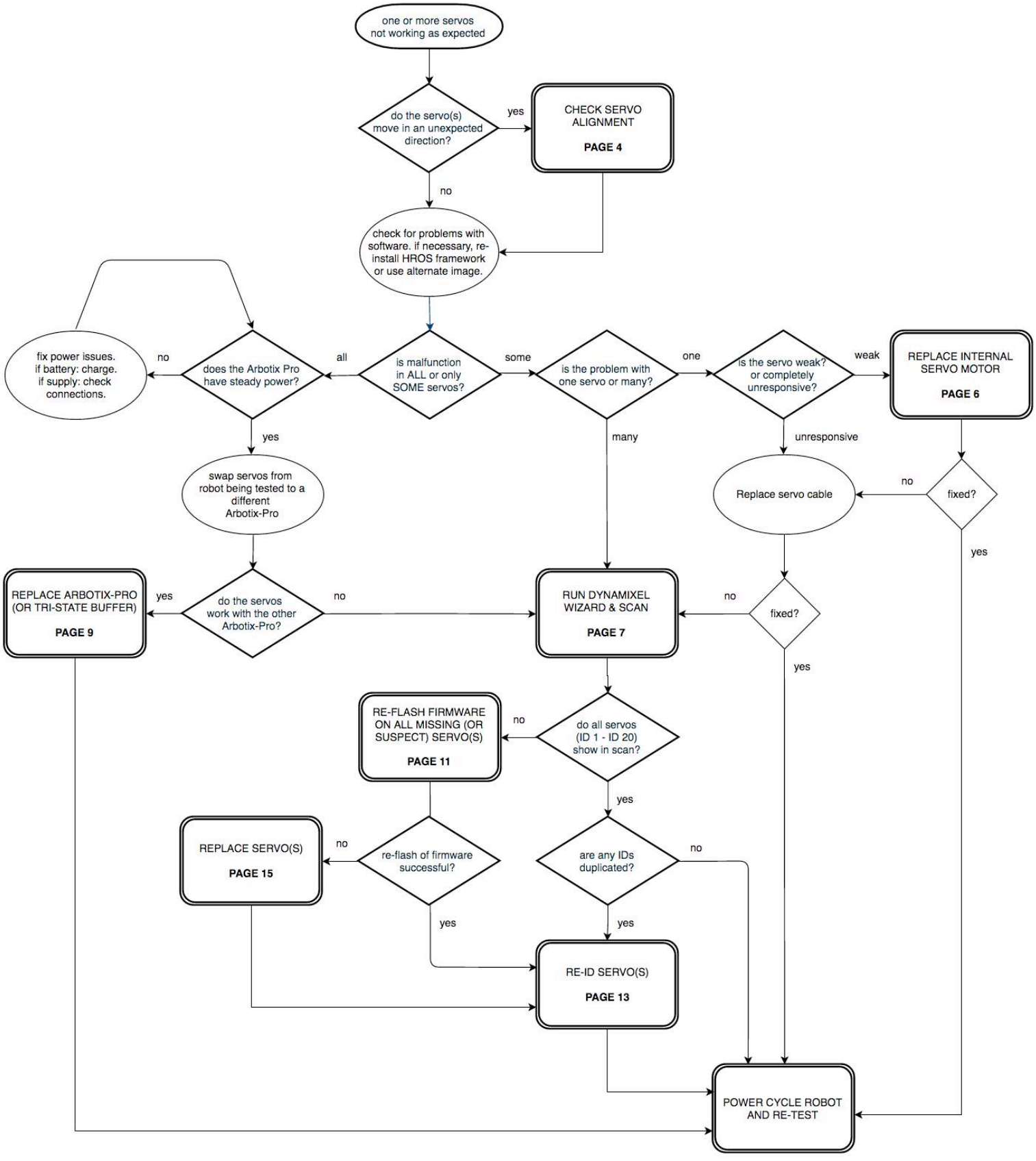
If you already know the cause of the issue you are attempting to fix, and would just like step-by-step instructions for a single repair case, simply use the table of contents below to navigate to the proper page.

If the problem has an unknown cause, please turn to the following page and use the problem diagnosis flowchart to fix your issues.

Table of contents:

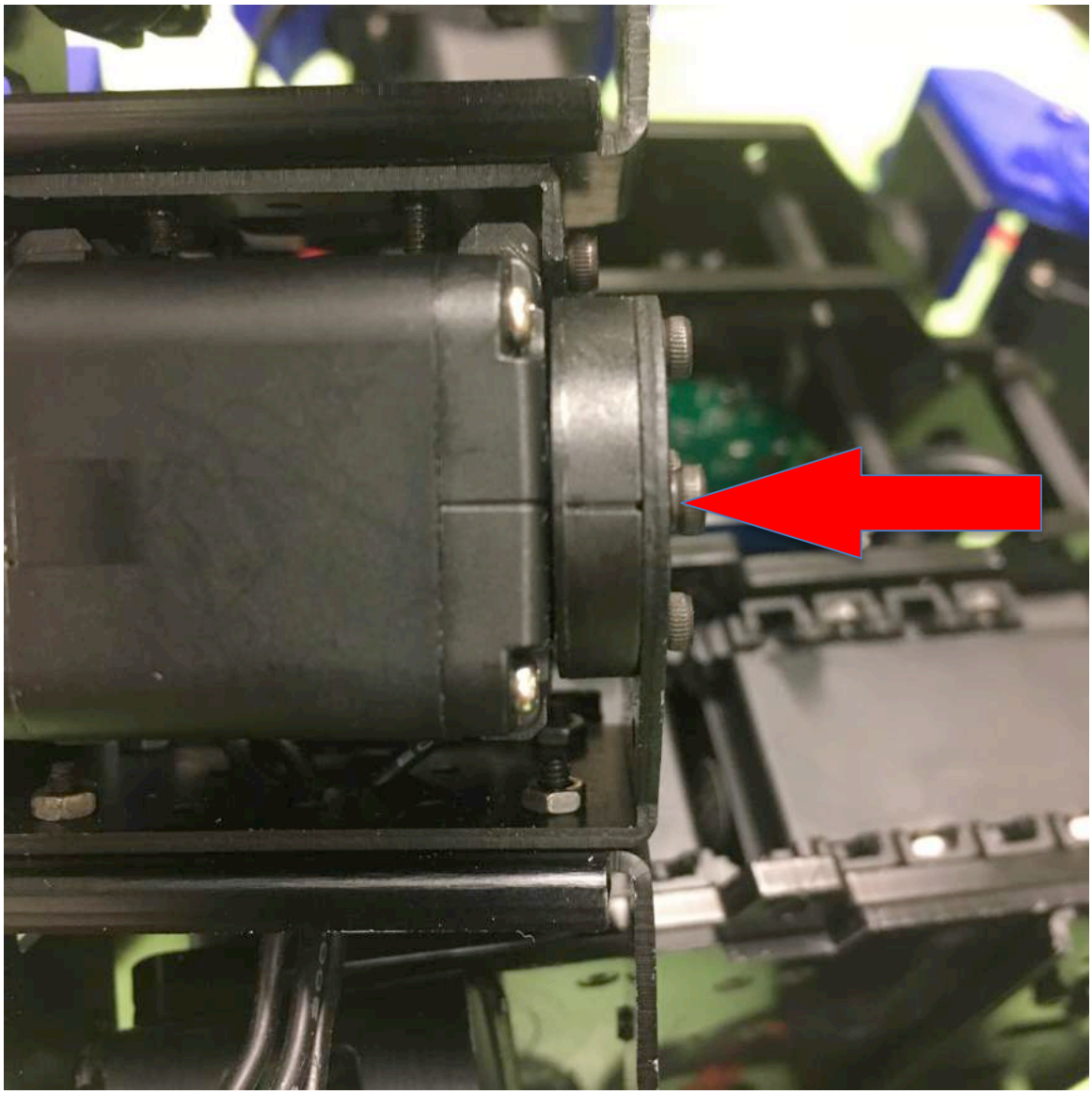


All references to servo ID numbers in this guide follow the above numbering.


one or more servos not working as expected
do the servo(s) move in an unexpected direction?
yes
CHECK SERVO ALIGNMENT
PAGE 4
no
check for problems with software. if necessary, re-install HROS framework or use alternate image.
is malfunction in ALL or only SOME servos?
all
some
does the Arbotix Pro have steady power?
no
fix power issues. if battery: charge. if supply: check connections.
yes
swap servos from robot being tested to a different Arbotix-Pro
do the servos work with the other Arbotix-Pro?
yes
REPLACE ARBOTIX-PRO (OR TRI-STATE BUFFER)
PAGE 9
no
is the problem with one servo or many?
one
many
is the servo weak? or completely unresponsive?
weak
unresponsive
REPLACE INTERNAL SERVO MOTOR
PAGE 6
fixed?
no
yes
Replace servo cable
RUN DYNAMIXEL WIZARD & SCAN
PAGE 7
fixed?
no
yes
do all servos (ID 1 - ID 20) show in scan?
no
RE-FLASH FIRMWARE ON ALL MISSING (OR SUSPECT) SERVO(S)
PAGE 11
yes
are any IDs duplicated?
no
yes
re-flash of firmware successful?
no
REPLACE SERVO(S)
PAGE 15
yes
RE-ID SERVO(S)
PAGE 13
POWER CYCLE ROBOT AND RE-TEST

Checking Dynamixel Alignment

With the HR-OS1 standing in walk ready position (as in the picture on page 2) every single servo (ID-1 to ID-20) should be aligned with the servo encoder notch aligning with the servo casing notch (as shown in the following picture):



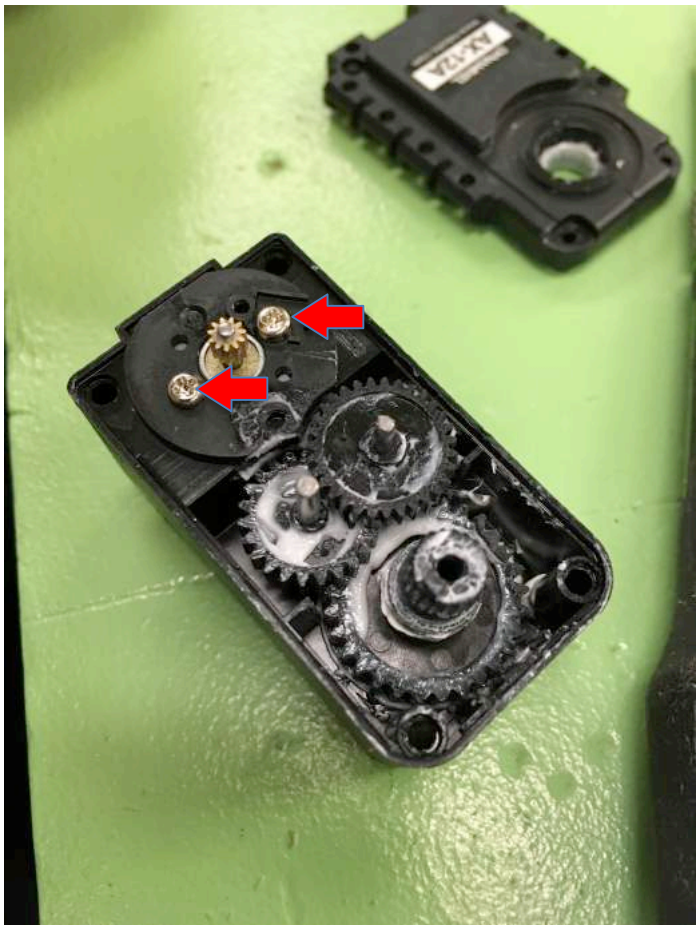
If the servo is not aligned as shown, the four screws which tighten the servo encoder to the bracket must be removed so that the encoder can be rotated until the alignment is correct. When the alignment is corrected, replace the four screws.

Replacing AX-12a motor

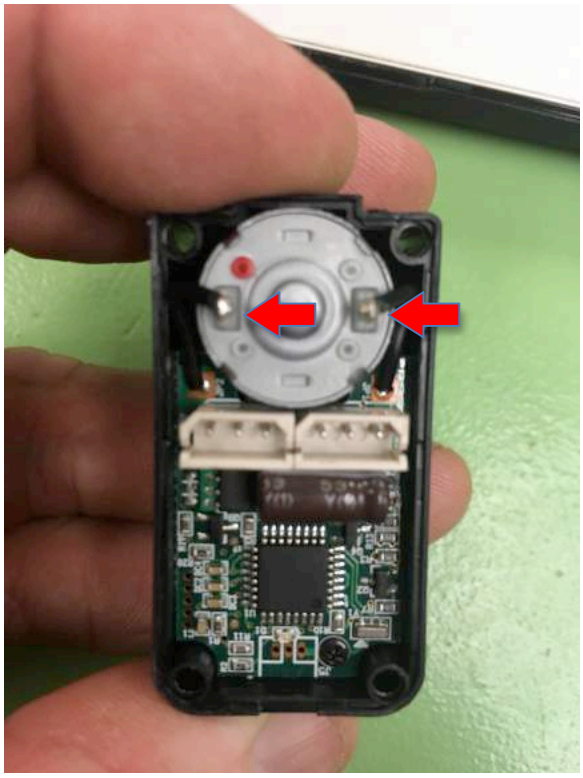
The servo motor part number is: Mabuchi RF-130-12250

To replace:

Remove the four case screws to expose the internals of the servo. Keep track of the gear locations, because they will fall out at some point, and you will need to put them back in (don't worry, it is not at all difficult):



Remove the pair of screws indicated by red arrows in the above picture. Then, flip the servo over in order to expose the back side of the servo:



Desolder the pair of wires marked with red arrows in the left picture above. When finished, the motor should look like the right picture.

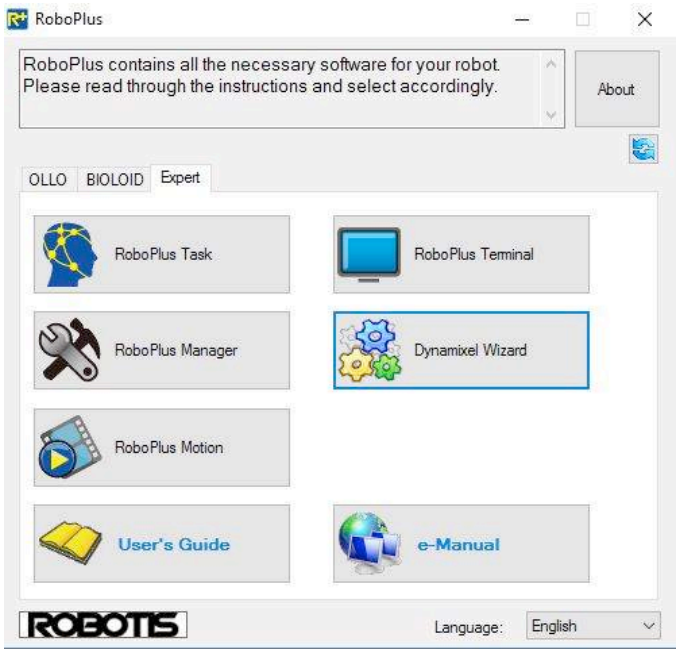
Remove the motor. It slides right out once the two screws and two wires are unattached.

Installation is, of course, the above steps in reverse.

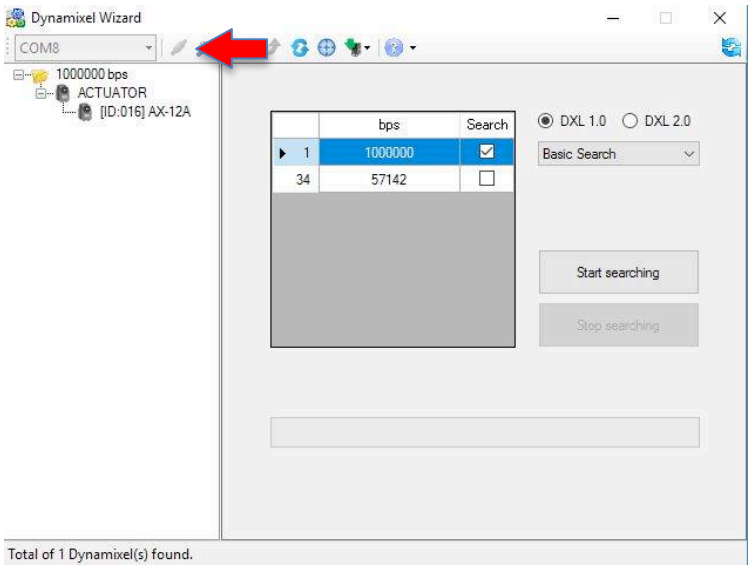
Make sure to align the red dot on the new motor with the left side (per the orientation in the pictures) of the motor, to ensure that the DC motor turns in the correct direction.

Running a scan in Dynamixel Wizard

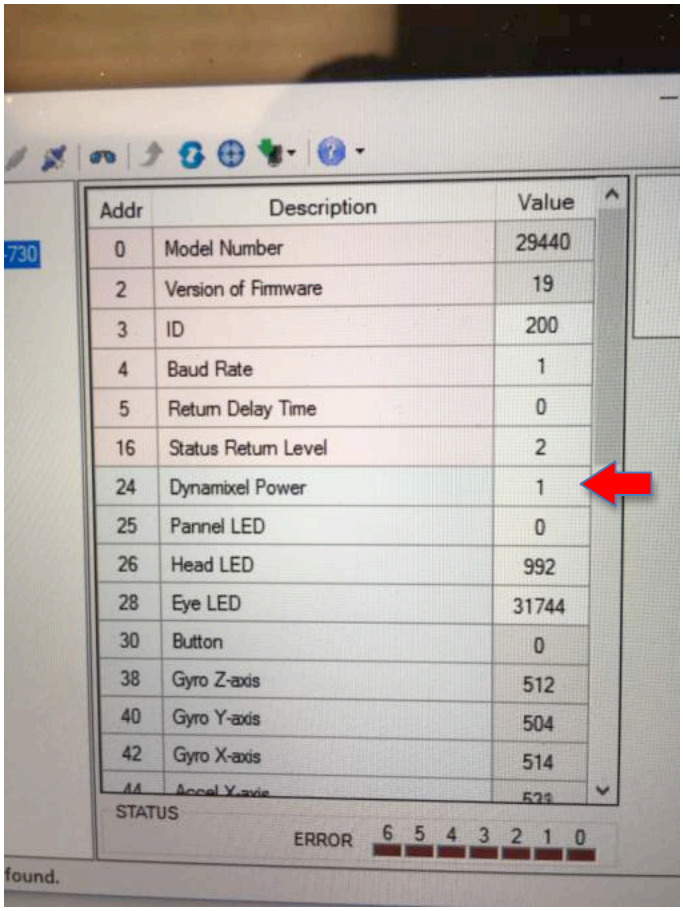
You need to first download and install the RoboPlus software, and open the Dynamixel Wizard:



If scanning all servos, hook up a USB to microUSB from the port on your computer to the port on the front of the Arbotix-Pro. Click connect icon:



Next, search for servos. At first, no servos will show up but ID-200 (CM-730), which is actually the Arbotix Pro board registering itself as a servo under the ID 200. Click on the Arbotix Pro (ID 200), and turn on the dynamixel power by changing the value from 0 to 1:

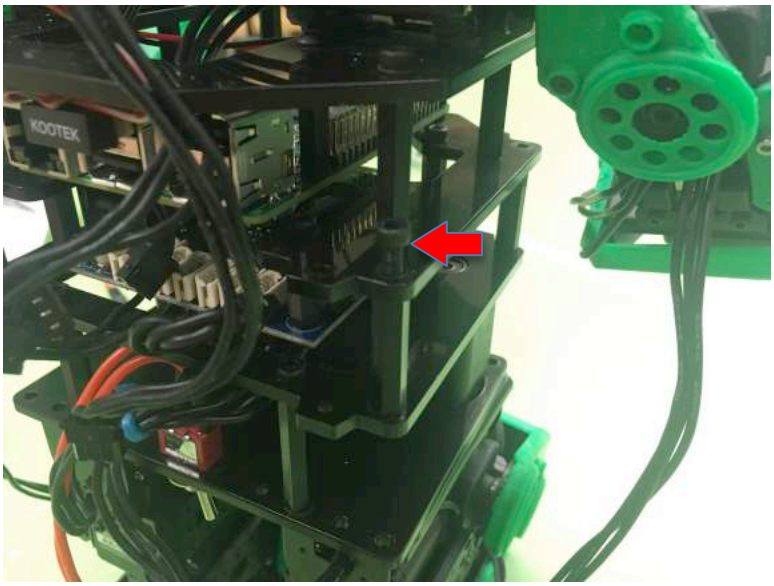


Disconnect and reconnect. Re-search. Now all of the working servos should show up in the scan. If a servo is missing, it probably needs a firmware re-flash or has a bad cable. If the servo shows up in the scan, but is “unknown”, then the servo should be re-flashed, but most likely needs replacement.

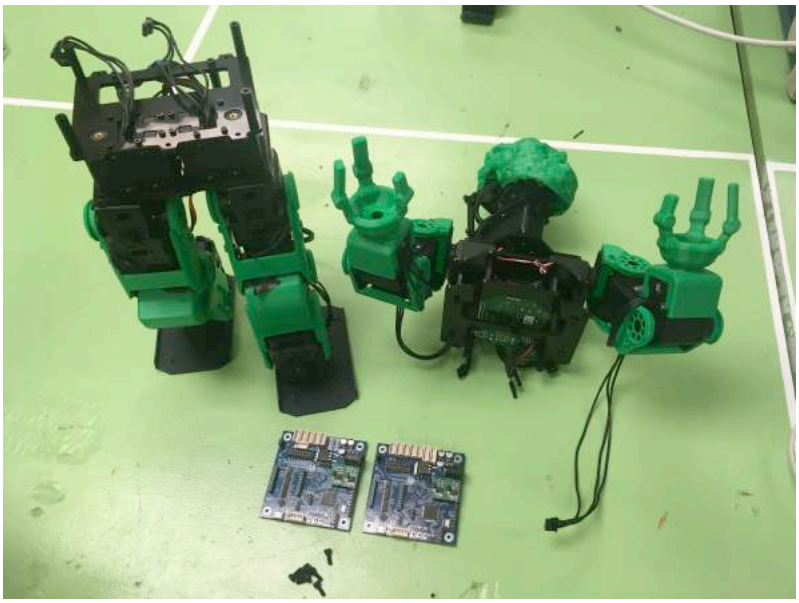
Re-flash and replace as necessary until ID-1 through ID-20 all show up in the scan.

Arbotix-Pro removal/replacement

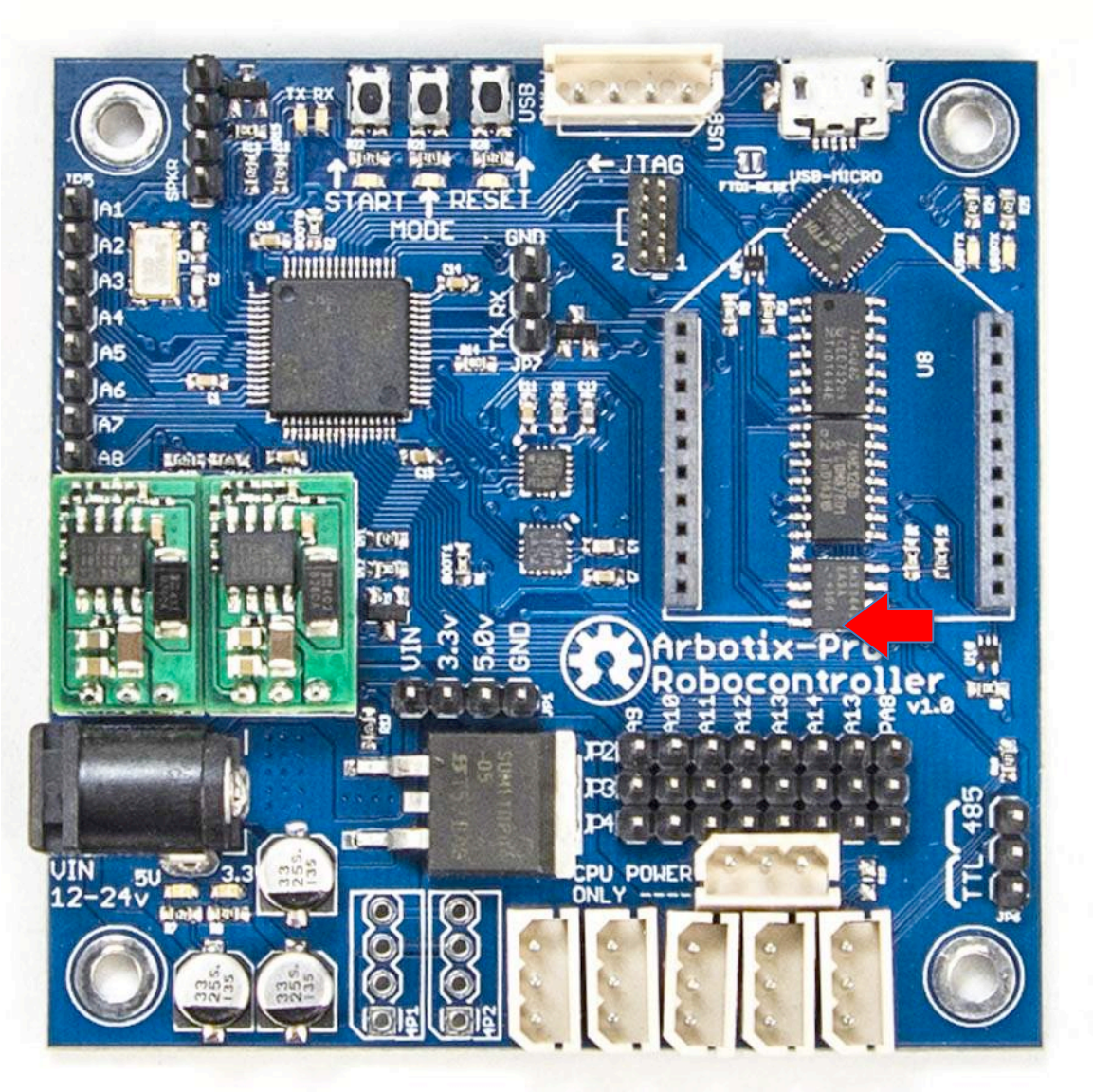
Remove the four screws which hold the platform between the Arbotix-Pro and the Raspberry Pi (or Intel Edison) to the rest of the robot:



Ignoring the robot's screams of pain, viciously rip it in half (making a diagram of where the serial cables and power cables attach for future re-assembly):



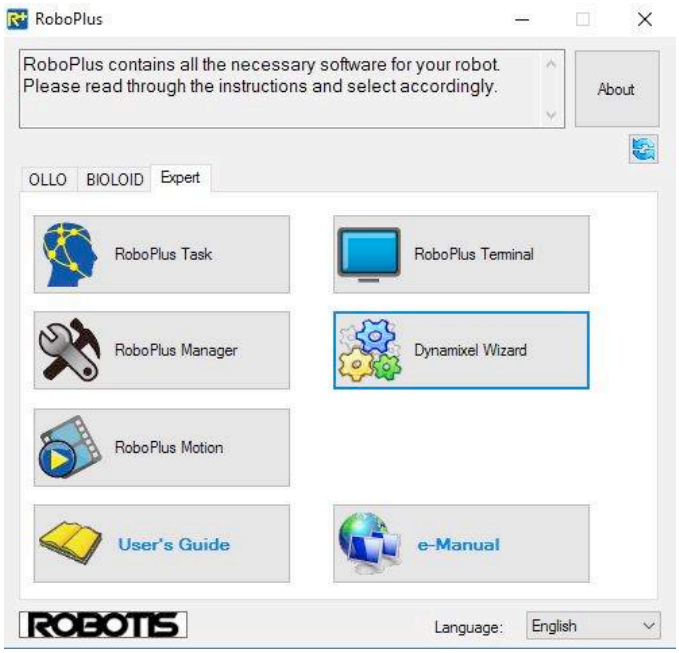
If the intent is to replace the tri-state buffer, it is located here:



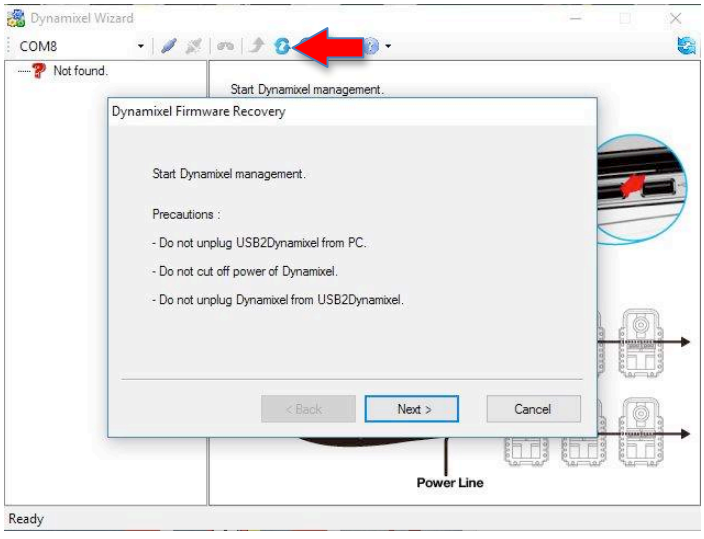
Once the Arbotix-Pro is repaired (or a new one has been obtained), the installation is the reverse of removal.

Reflashing the firmware of an AX-12

You need to first download and install the RoboPlus software, and open the Dynamixel Wizard:



Hook up a USB2Dynamixel to the servo being reflashed. Make sure it is the only servo attached in the serial chain. Click the firmware recovery icon:



Next, the firmware recovery with try to search for servos. You must, in EXACTLY this order:

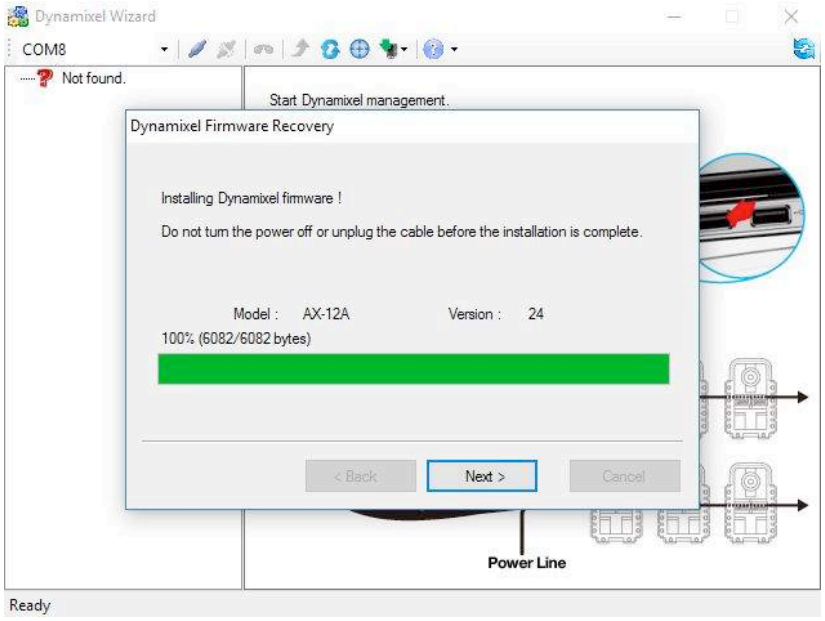
Click search

Unplug the servo at the USB2Dynamixel

Plug it immediately back in.

Continue the onscreen instructions to finish flashing the servo firmware.

If you see the following result:

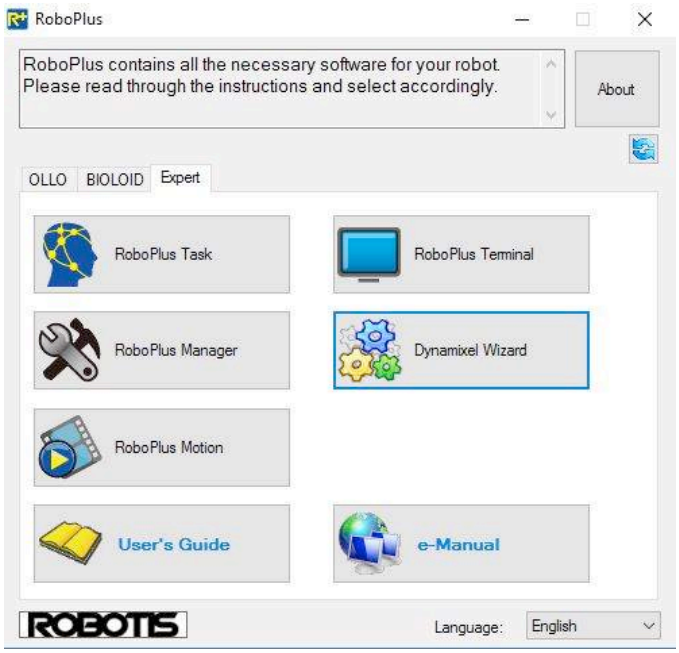


The firmware recovery was successful and the servo is ready to be re-tested in the robot, but only AFTER the SERVO ID has been reset to the correct ID (see page 2, then follow instructions on the following page (13).

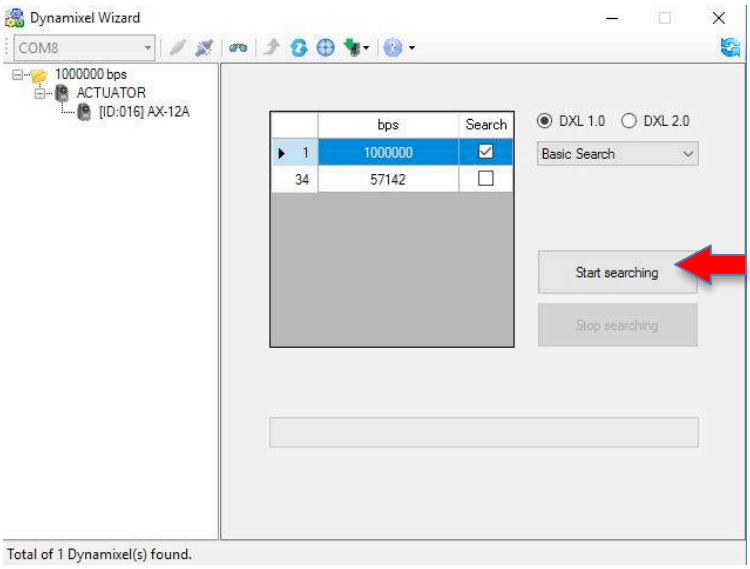
If the firmware recovery fails, the servo is bad and needs to be replaced.

Re-IDing an AX-12 servo

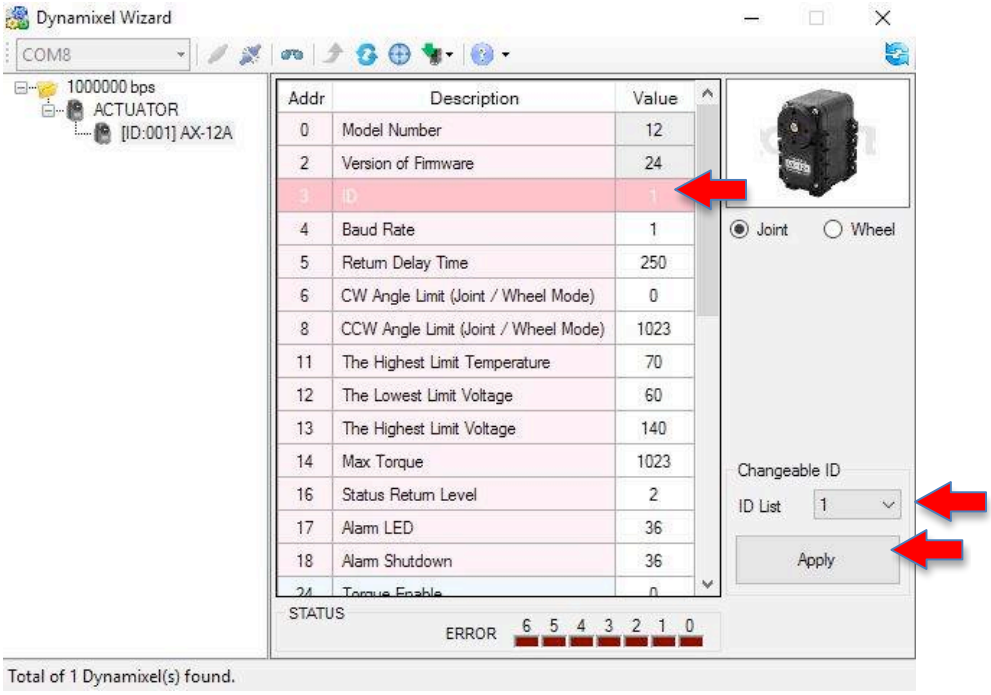
You need to first download and install the RoboPlus software, and open the Dynamixel Wizard:



Hook up a USB2Dynamixel to the servo being re-ID'd, and scan for the servo:



Next, open the servo's address table by clicking on the servo name, click on ID, reset the ID to the correct ID using the drop-down menu, and finally, click apply.



Verify that the servo ID has been updated in both the address table window and the ACTUATOR subtab on the left. If all appears correct, detach the servo from the USB2dynamixel and retest.

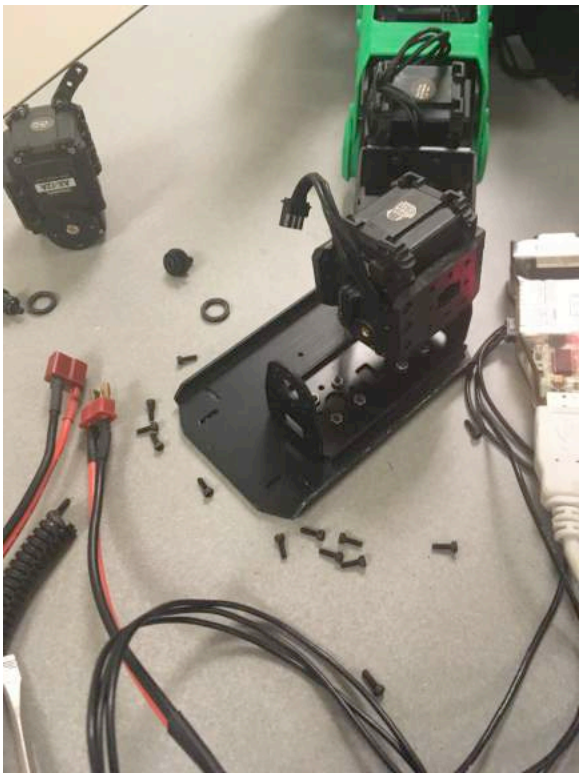
AX-12a servo replacement

Since each location on the HR-OS1 has its own quirks and peculiarites as far as removal and replacement is concerned, I will just be covering to basic steps:

Remove serial cable(s) at AX-12a being removed

Remove all mounting screws which hold the servo to the rest of the robot, including the four screws which attach the servo encoder to whichever joint it actuates. In most cases, there is also a central large bolt immediately opposite the encoder on the other side of the servo casing which also needs to be removed. Remove the servo from the joint.

If you were removing the ankle roll servo, for example, the results at this point would look like this:



As with all other procedures outlined in this manual, there-assembly is the reverse of removal. Make ABSOLUTELY CERTAIN that you align the servo encoder properly upon re-installation. See page 4 for details about this CRUCIAL step.