Standard Operating Procedure: Automated Reach-to-Grasp Task (AutoRG) Calibration

1. Purpose

1.1. This SOP describes the procedures necessary to calibrate the load cell and the handle position of the AutoRG system prior to use

1.2. This SOP calibrates the handle position for the default 7 stage training scheme

1.3. This SOP assumes that the following processes are already completed:
- 1.3.1. The apparatus is completely assembled and primed (see: AutoRG_Assembly_SOP)
- 1.3.2. The software has been downloaded/integrated with a Windows computer (see: AutoRG_SoftwareInitialization_SOP)

2. Equipment and Terminology

2.1. Cage – Refers to acrylic cage in which the rat is placed for the duration of the session

2.2. Stage – Refers collectively to the 4 stage blocks that are pre-assembled into one single stage, of which the cage is placed on top.

2.3. Handle Base – Refers to the base to which the linear motion rail is affixed

2.4. CPX – Refers to the Circuit Playground Express

2.5. CRICKIT – Refers to CRICKIT board that is attached to the CPX

2.6. Pellet Dispenser – Refers collectively to the Pellet Dispense Base and Food Silo that compose the pellet dispense apparatus

2.7. Pellet Dispense Base – Refers to base of Pellet Dispenser that has the 4 legs and includes an insertion point for the Pellet Servo

2.8. Pellet Servo Actuator – Refers to circular piece of Pellet Dispenser that connects to Pellet Servo and rotates within the Pellet Dispenser to allow pellets to be delivered

2.9. Food Silo – Refers to top of Pellet Dispenser that holds the reservoir of pellets

2.10. Pellet Dispense Tower – Refers to the tower block on which the pellet dispenser sits

2.11. Pellet Receptacle – Refers to the receptacle that receives the pellet tubing from the pellet dispenser and re-directs the pellet into the slit of the cage

2.12. Pellet Tubing – Refers to the rubber tubing that connects the pellet dispenser to the pellet receptacle (Saint-Gobain Tygon S3 E-3603 Food Tubing)

2.13. Pellet Servo – Refers to the continuous servo that actuates the pellet dispenser

2.14. Calibration Knob – Refers to knob that is used to calibrate the continuous servo

2.15. Load Cell – Refers to mini load attached to handle

2.16. Load Cell Carriage – Refers to bottom half of load cell casing that connects load cell to linear motion rail

2.17. Load Cell Handle Adapter – Refers to top half of load cell casing that connects load cell to handle

2.18. Proximal Servo Arm Adapter – Refers to servo arm adapter that connects directly to positional servo arm

2.19. Distal Servo Arm Adapter – Refers to servo arm adapter that connects the proximal servo arm to the high cube intermediate joint

2.20. High Cube Intermediate Joint – Refers to joint connecting the distal servo arm adapter to the load cell rail adapter

2.21. Handle – Refers to 1.5mm AF hex key that is affixed to the load cell apparatus

2.22. Load Cell Apparatus – Refers to load cell, load cell casing components, and rail attachment component

2.23. Rail – Refers to the 100mm-long linear motion rail on which the load cell apparatus sits

2.24. Positional Servo – Refers to the positional servo that actuates the movement of the load cell apparatus to modulate the handle distance

2.25. Positional Servo Casing – Refers to SLA-printed casing that encloses the Positional Servo and sits at the back of the Handle Base

2.26. Qwiic Scale – Refers to red analog-to-digital converter that connects the load cell to the Qwiic Adapter.

2.27. Qwiic Adapter – Refers to the component that receives a plug from the Qwiic Scale and projects wires to the CRICKIT and CPX boards.

2.28. CPX Holder – Refers to component where CPX rests; snaps into back of Pellet Dispense Tower.

2.29. Power Cord – Refers to the cord connecting the CRICKIT board to power

2.30. USB Cord – Refers to the cord connecting the CPX (micro-USB) to the computer (USB)

2.31. GUI1 – Refers to the primary MatLab graphic user interface through which the AutoRG assay is run

2.32. GUI1 Code – Refers to the code underlying GUI1

2.33. Calibration GUI – Refers to the MatLab graphic user interface that creates the calibration file

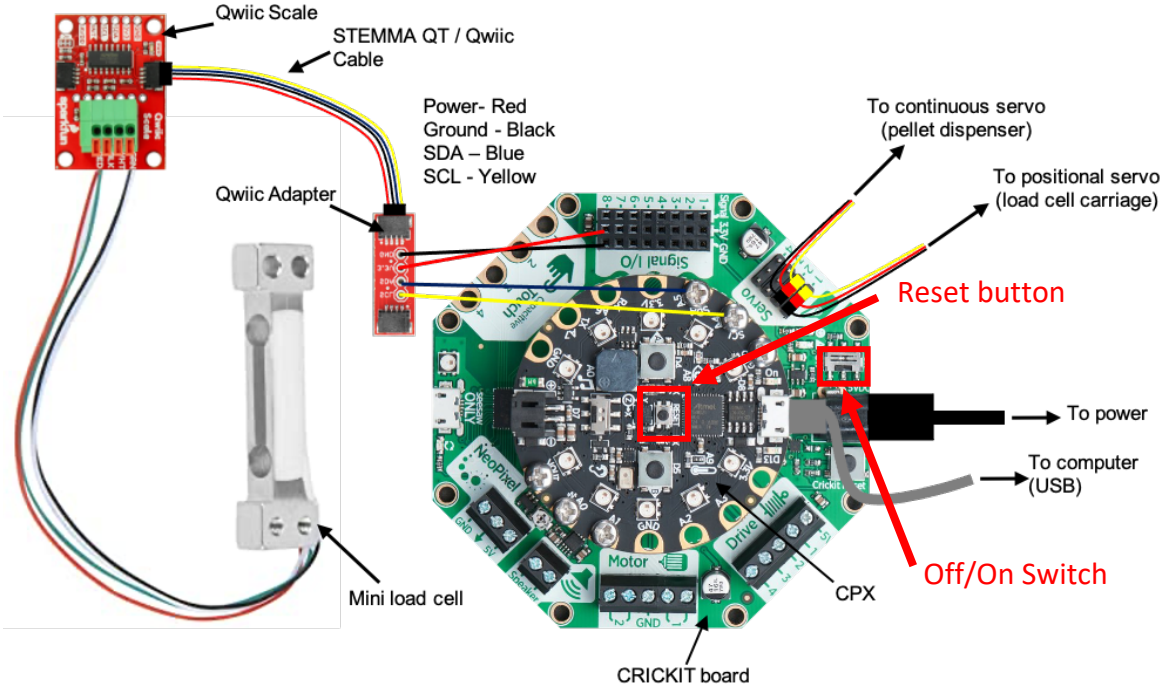
2.34. Calibration GUI Code – Refers to the code underlying the calibration GUI

2.35. Trigger Threshold: Minimum force required to trigger a successful trial and a pellet dispense

3. Assay Procedure

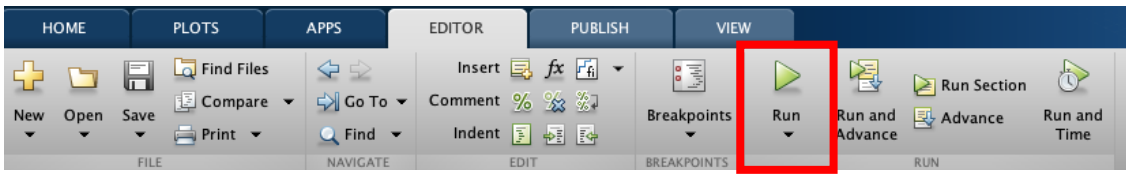
3.1. Plug in USB from CPX into the computer, ensure power cord is plugged into outlet and CRICKIT

3.2. Switch CPX on. Click reset button in center of CPX.



3.3.Open GUI_scale_calibration.m on MatLab

3.4. Click “Run” to open Calibration GUI

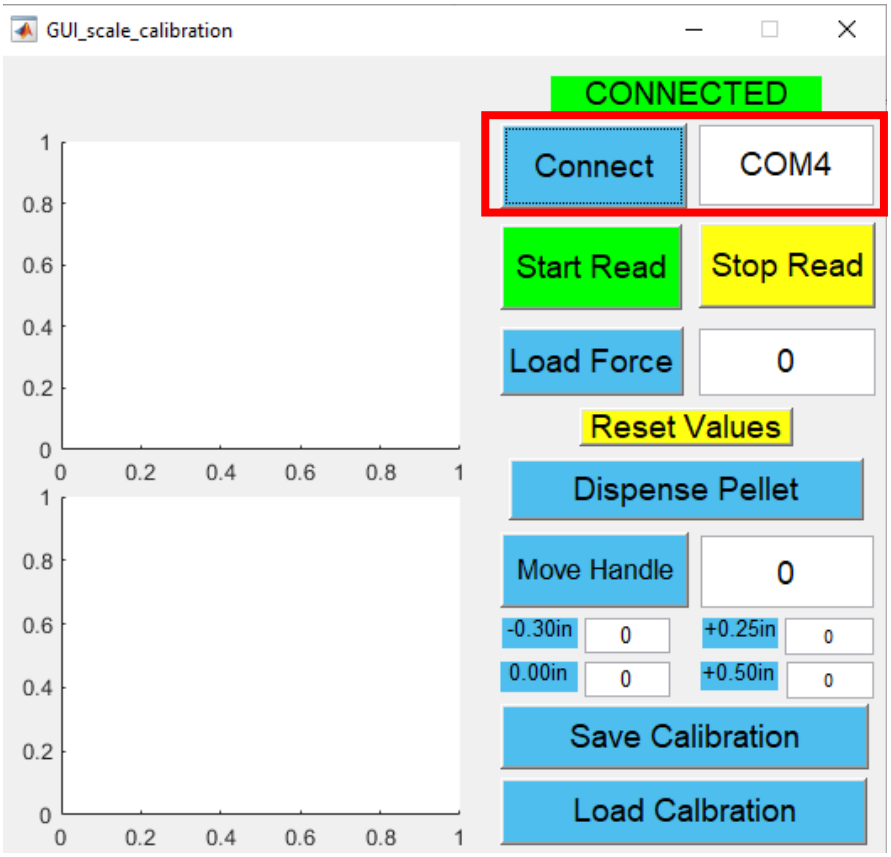


3.5. Determine the mass of any object in grams, preferably larger than 200 but smaller than 500 grams. This object may be a precision weight with a hook, or any arbitrary lab object with a hook attached (e.g., adding an adhesive Command hook to the object).

3.6.In the textbox beside “Connect”, enter the port designation for your USB serial connection (CPX) (e.g., COM5). Click the blue “Connect” button.

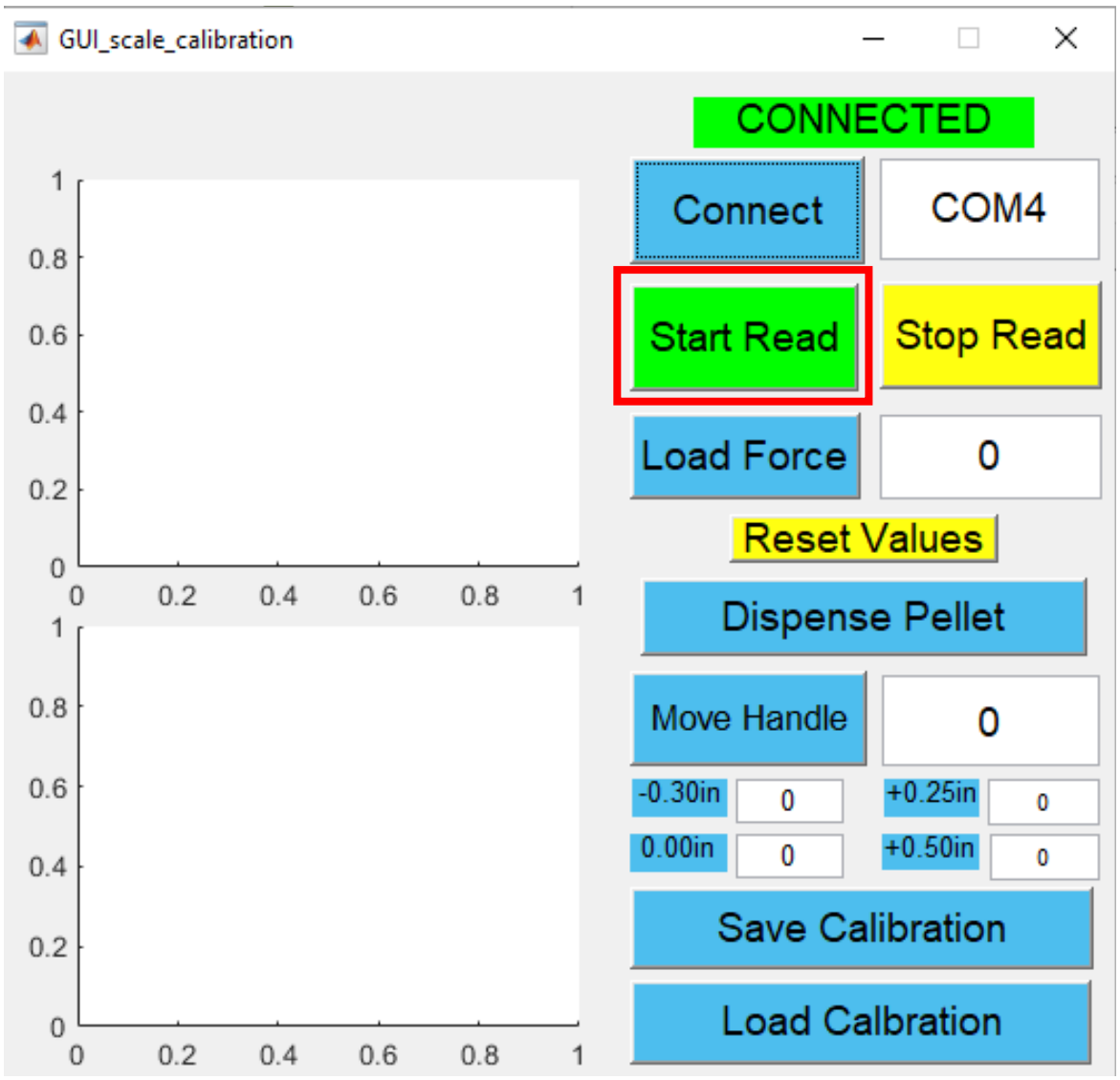
3.6.1. To check the port designation for your CPX, go to Device Manager > Click on “Ports” > See port designation for “USB Serial Connection”

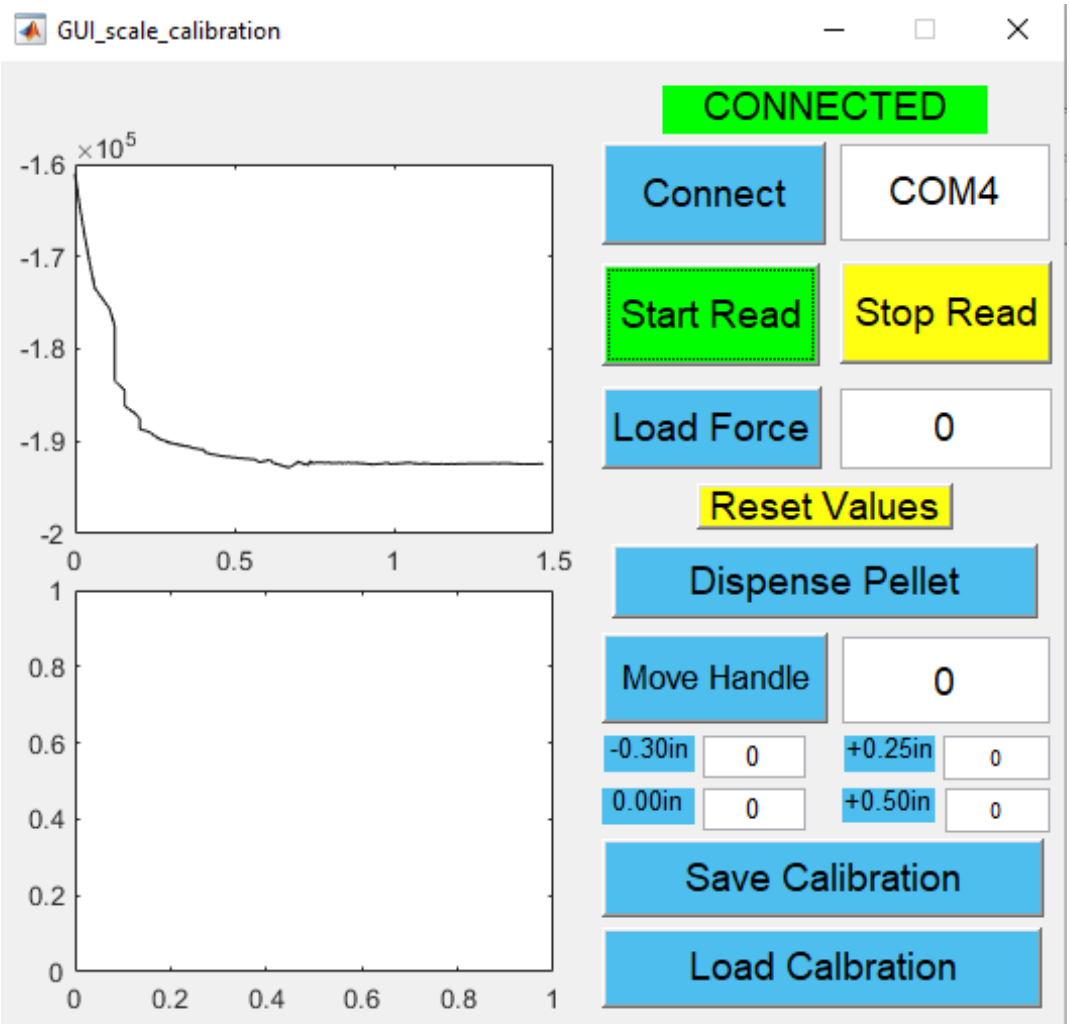
3.6.2. Check that a green “CONNECTED” box appears at the top of the GUI



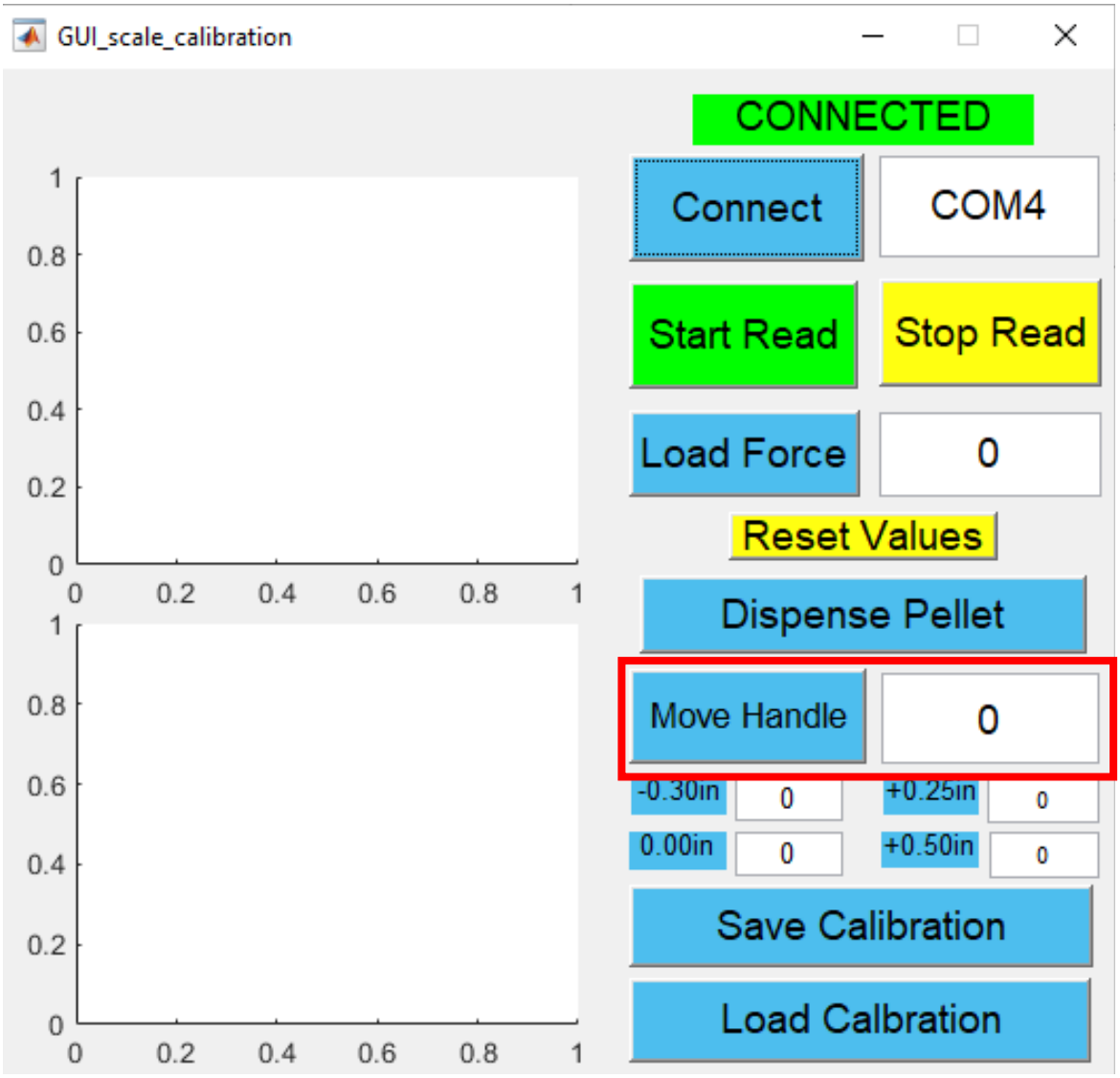
3.7. Click green “Start Read” pushbutton

3.7.1. *Note: Raw force readings should begin to appear as a plotted trace in the upper left plot. If no force trace begins plotting, check the CPX is plugged into power, into the computer, and switched on.*



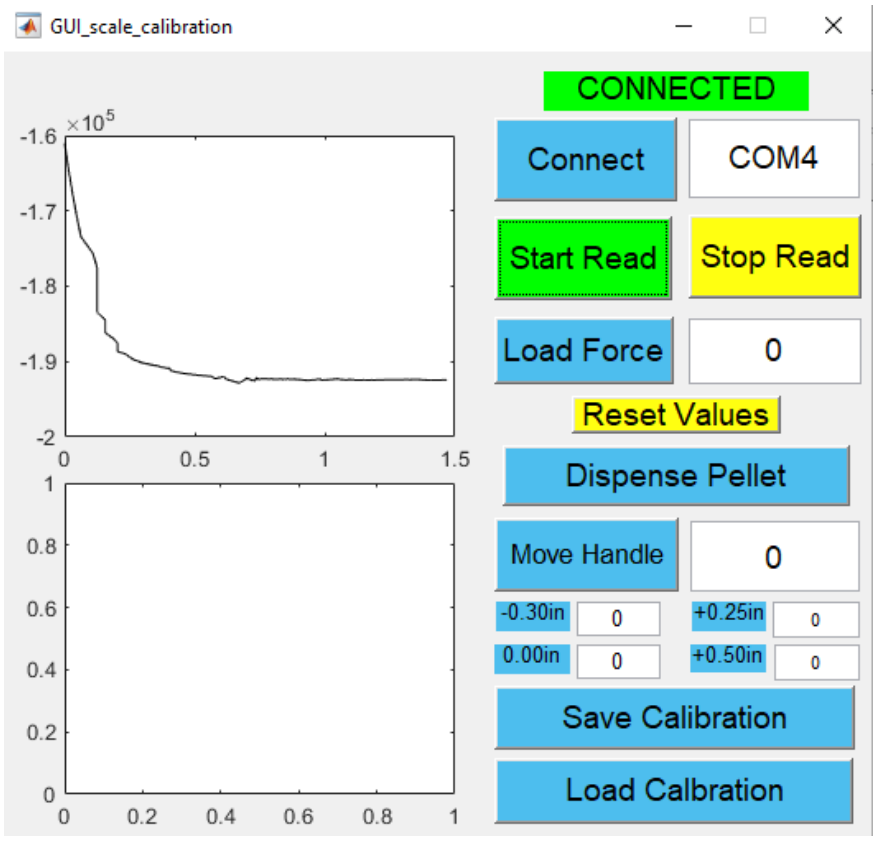


3.8. Enter “0” into the text box beside the blue “Move Handle” button. Click blue “Move Handle” pushbutton to actuate handle position. If necessary, remove servo arm and reposition it such that this angle of 0º corresponds to a fully extended arm



3.9. With fully extended servo arm, wait a few moments while force trace stabilizes (change in graph scale will show seemingly large fluctuations, but fluctuations should be numerically small). With the handle in its horizontal, neutral position, enter “0” in the textbox beside the blue “Load Force” button. Click the blue “Load Force” pushbutton.

3.9.1. *Note:* This load corresponds to a load of 0g of force applied to the load cell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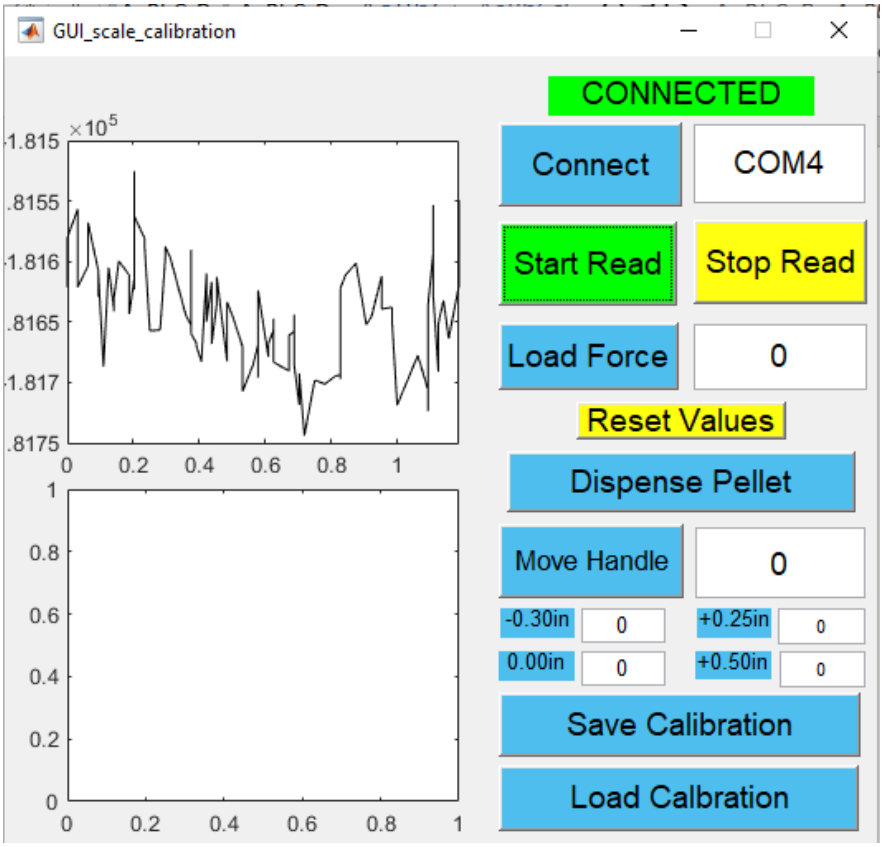
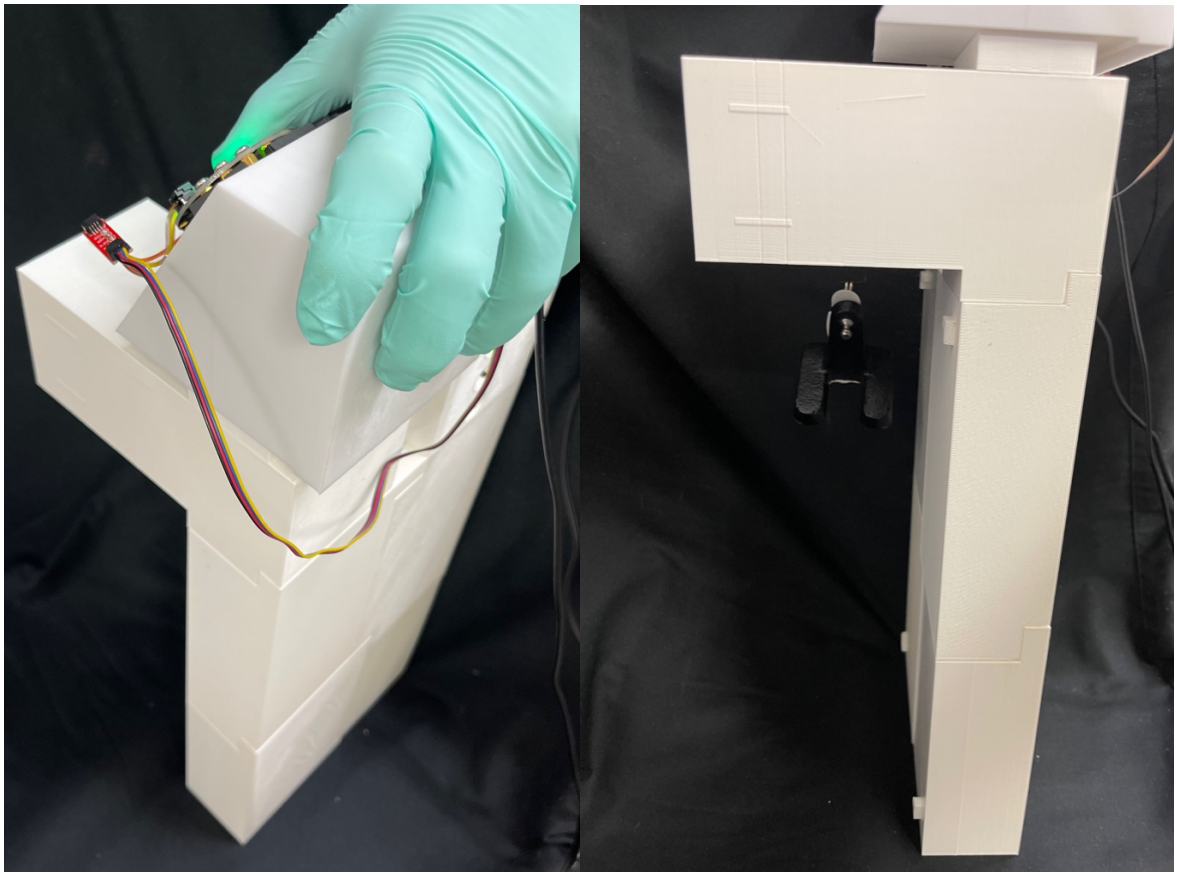
CONNECTED
Connect
COM4
Start Read
Stop Read
Load Force
0
Reset Values
Dispense Pellet
Move Handle
0
-0.30in
0
+0.25in
0
0.00in
0
+0.50in
0
Save Calibration
Load Calbration

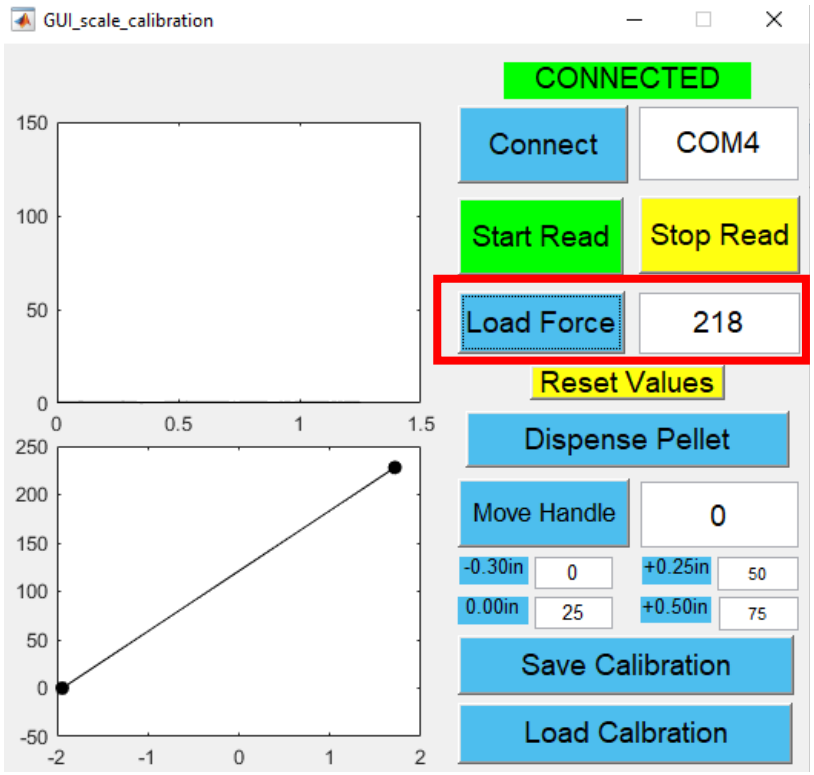

GUI_scale_calibration
CONNECTED
Connect
COM4
Start Read
Stop Read
Load Force
0
Reset Values
Dispense Pellet
Move Handle
0
-0.30in
0
+0.25in
0
0.00in
0
+0.50in
0
Save Calibration
Load Calbration

3.10. Remove acrylic cage from stage. Unplug and remove pellet dispenser from pellet dispense tower. Turn entire system on the back edge of the stage such that the handle is hanging (as pictured). Hang pre-weighed, hooked mass to the handle. Allow force trace to stabilize.

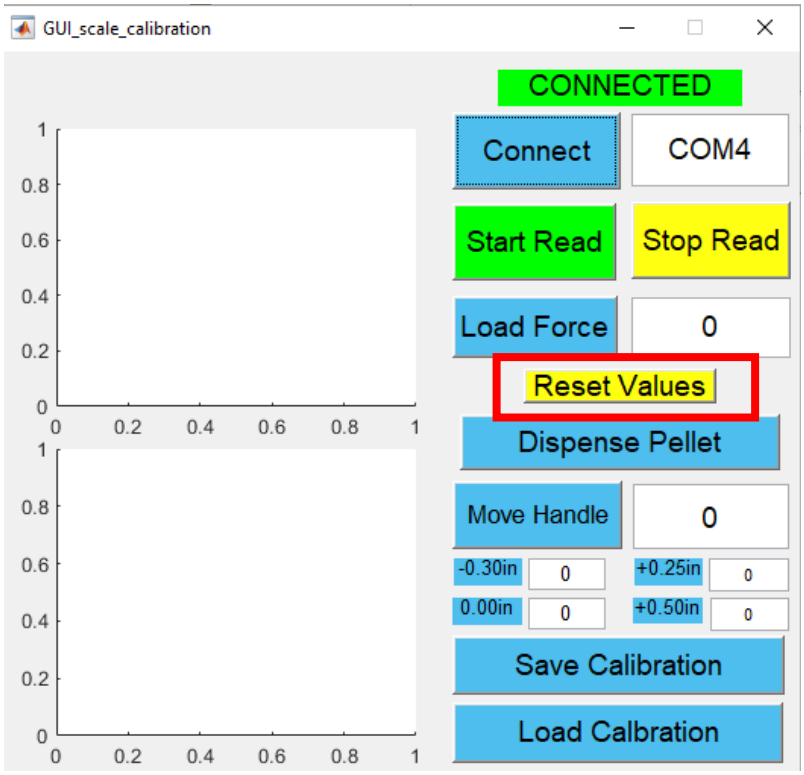


3.11. Enter mass of pre-weighed object (including the hook) into the text box beside the “Load Force” button. Click the “Load Force” button.

3.11.1. A single line should appear in the lower left plot window, indicating the two masses used and the corresponding raw values. System will interpolate loadings between 0g and the user-chosen load.



3.12. If any error was made between steps 3.8-3.11, click the yellow “Reset Values” pushbutton and repeat steps 3.8-3.11.

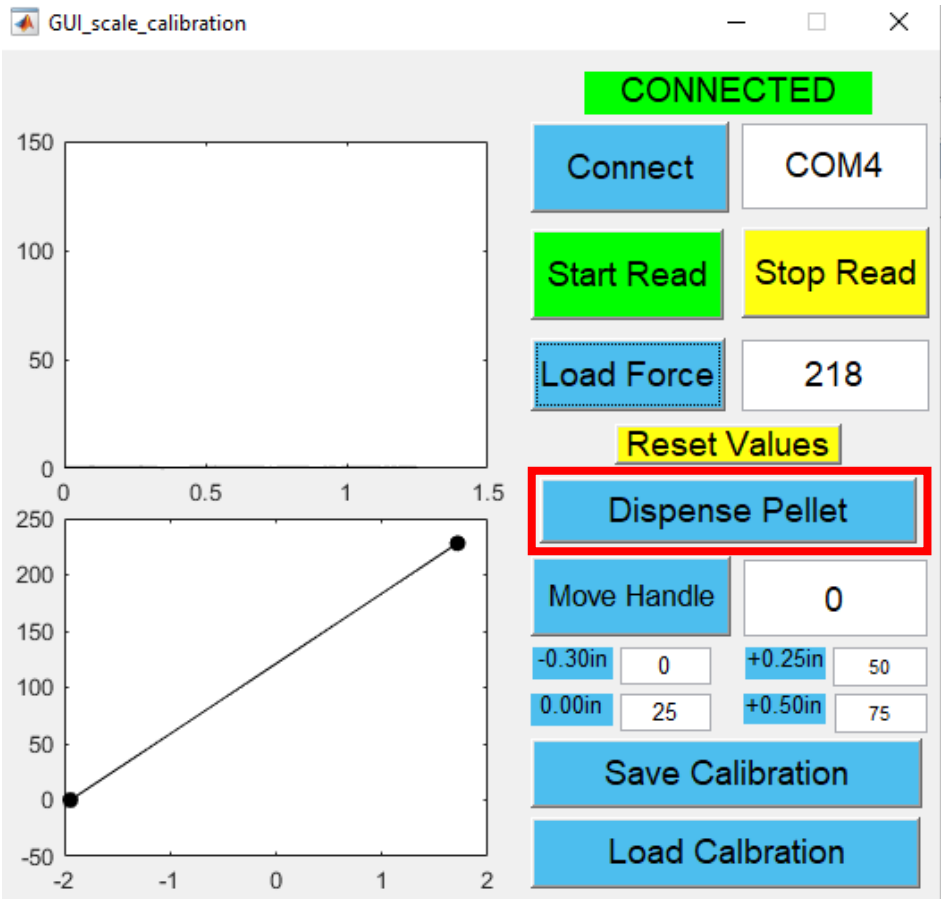


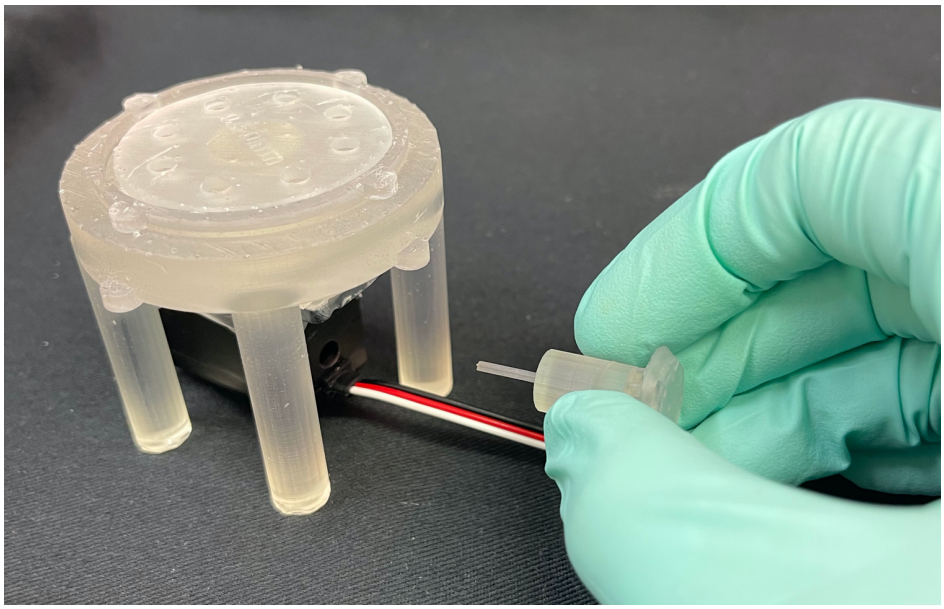
3.13. Remove the mass, return system to its horizontal, neutral position, replace the acrylic cage, and replace/replug in the pellet dispenser.

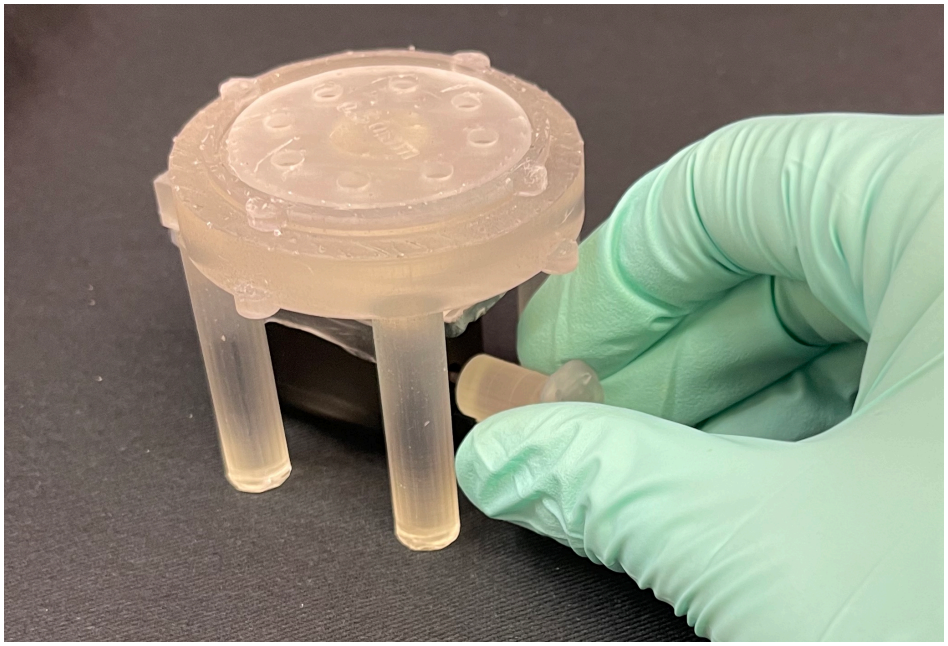
3.14. With an empty pellet dispenser, click blue “Dispense Pellet” push button:

3.14.1. If servo of pellet dispenser continuously spins – Use calibration knob to calibrate pellet servo attached to pellet dispenser. Insert thin key of knob into hole of pellet servo and turn knob to modify speed of pellet servo spinning. If turning the knob does not modify the speed of spinning, readjust the position of the key so that it is firmly inserted into the pellet servo calibration hole. Turn knob until servo is no longer spinning.

3.14.2. Once pellet dispenser is no longer spinning Check that pellet servo is calibrated by pressing blue “Dispense Pellet” pushbutton again. Pellet dispenser should complete one rotation and then come to rest.

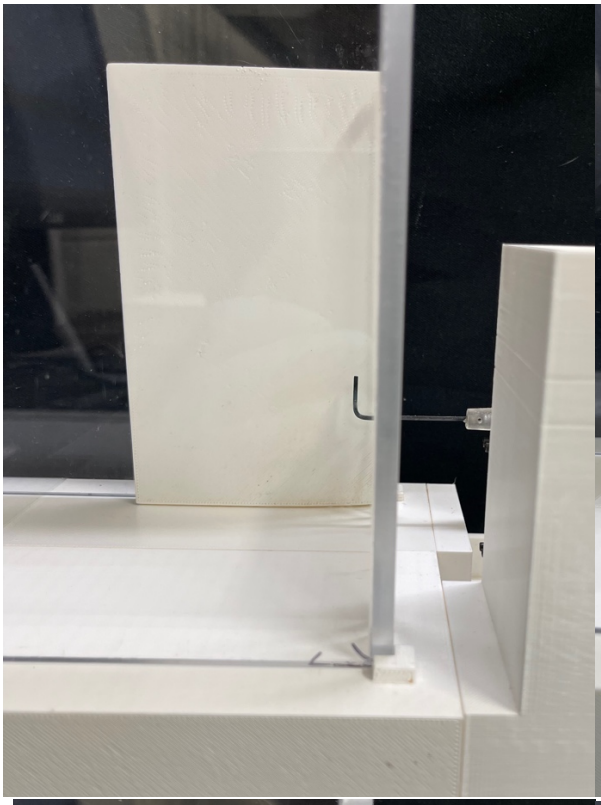
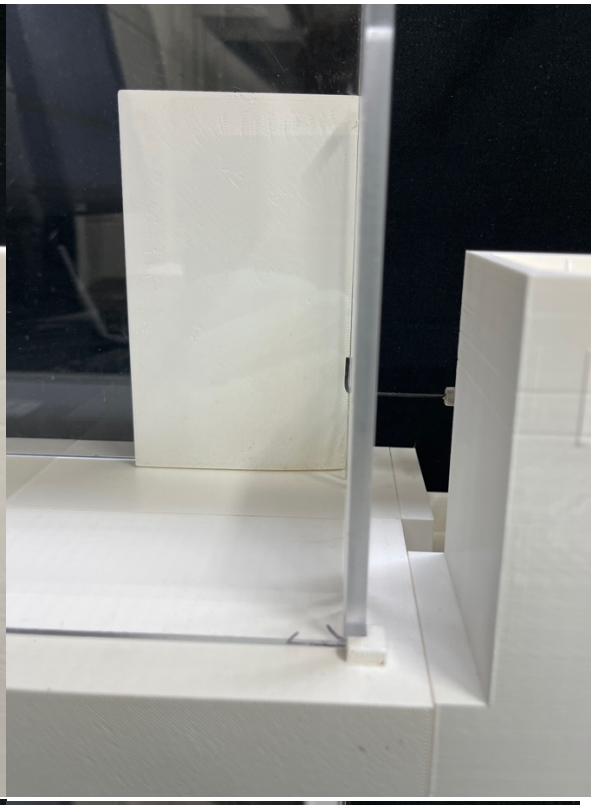
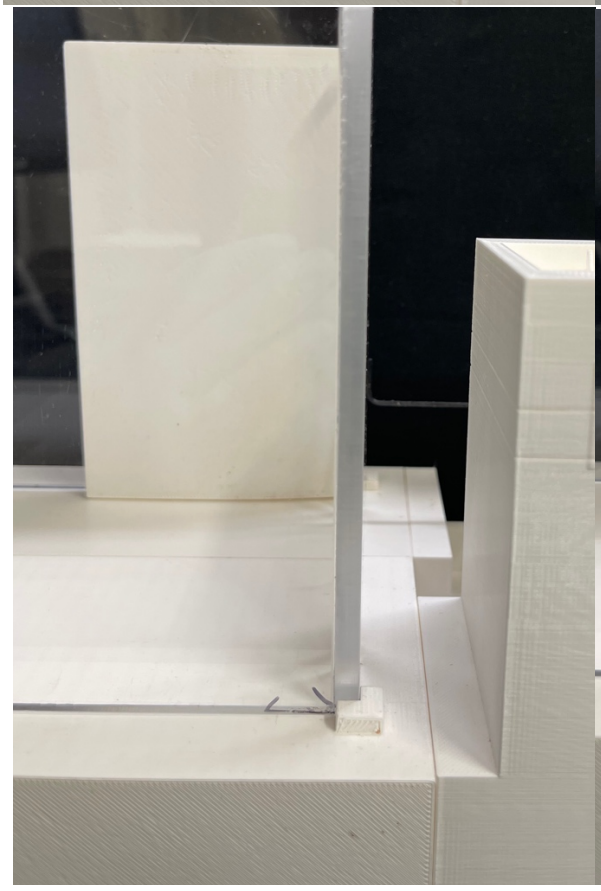
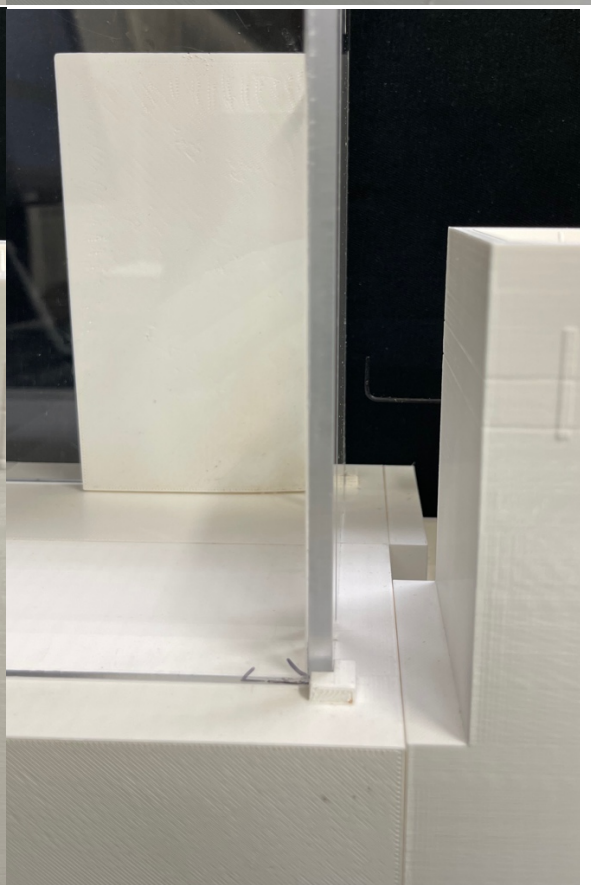


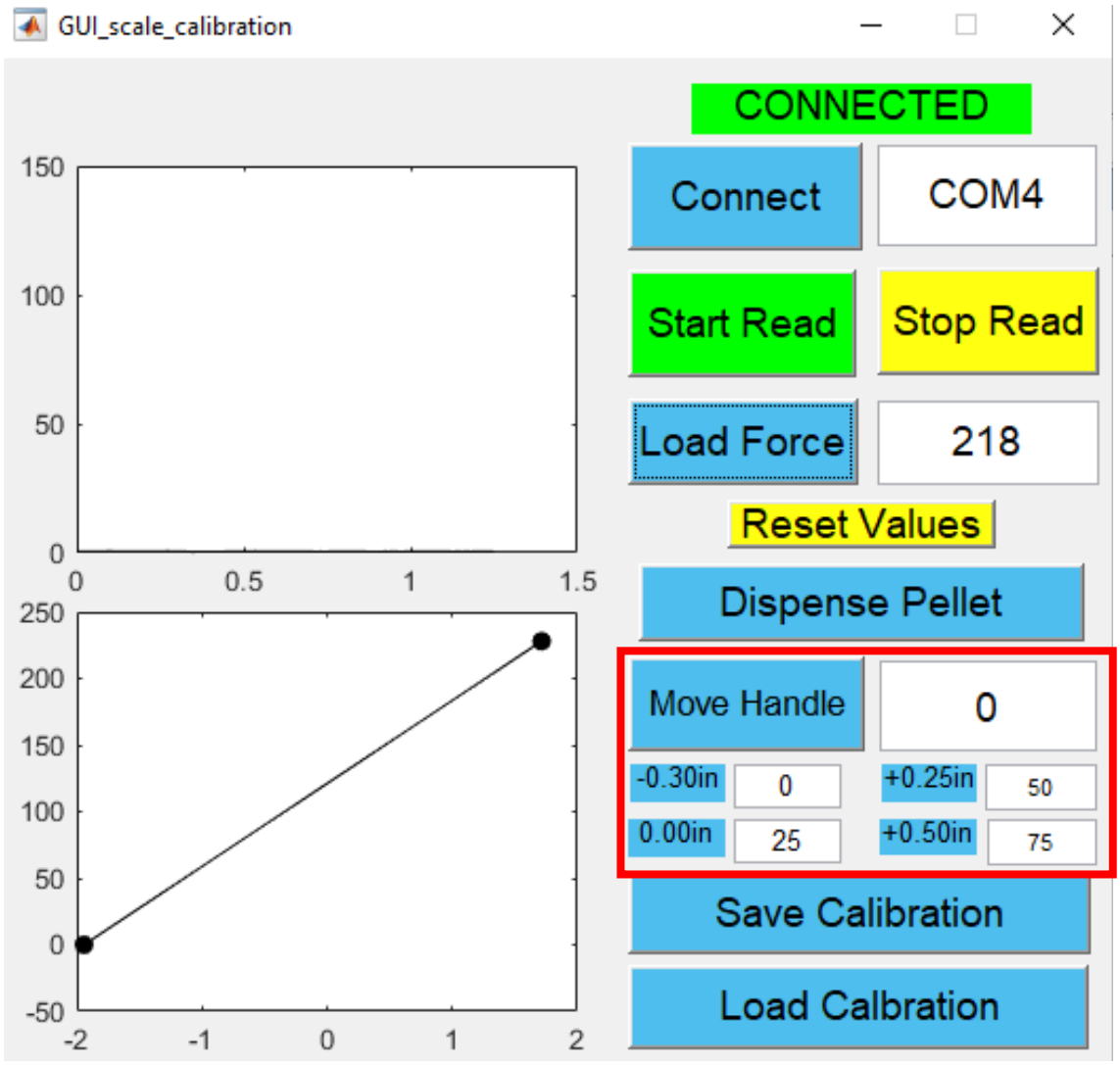




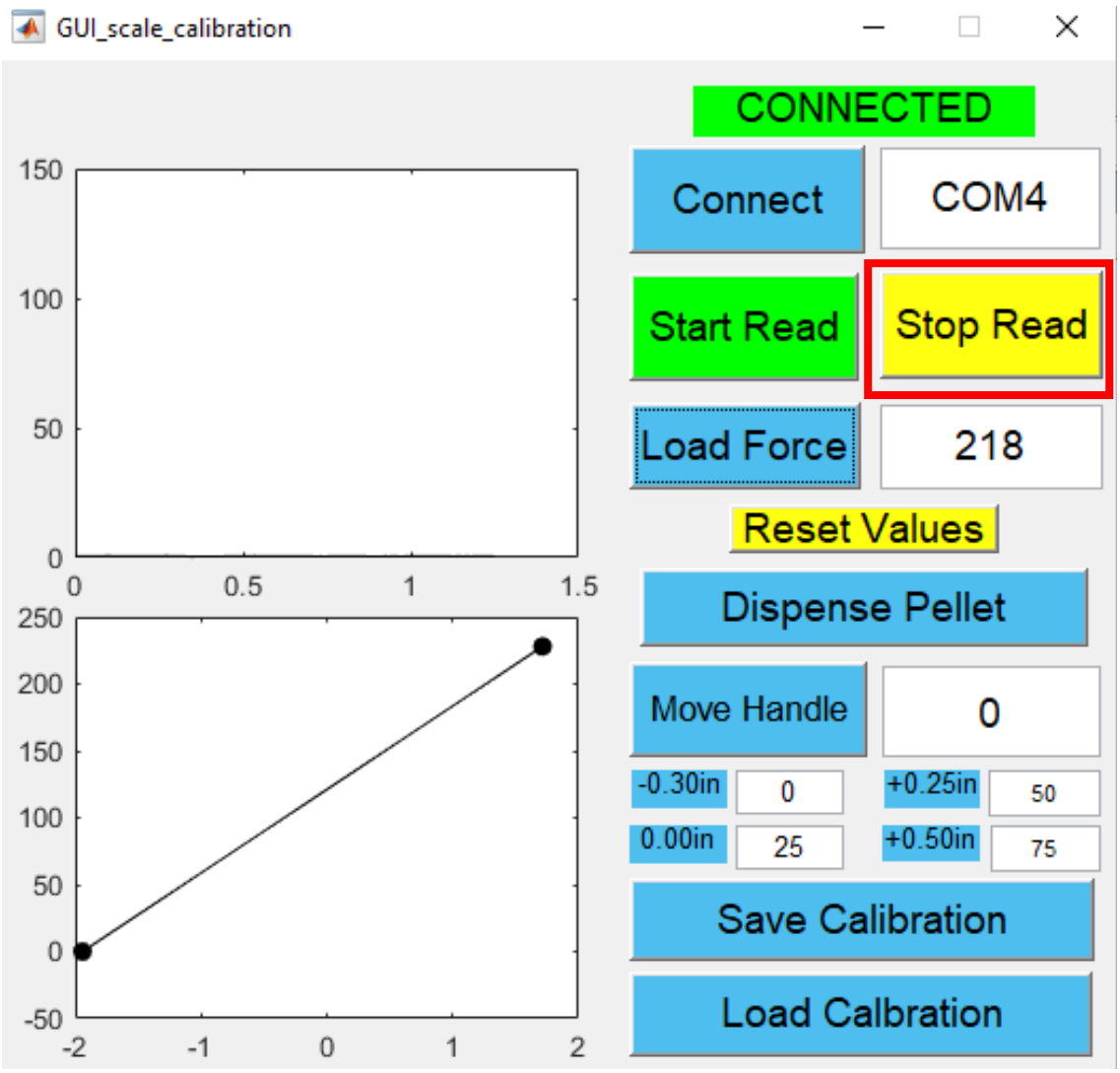
3.15. Input positional servo angles corresponding to stage-based distances (Default training stages use -0.30in, 0.00in, +0.25in, and +0.50in).

3.15.1. Measure desired distance with a caliper from the inner wall of the acrylic cage. Input test angles in the text box beside “Move Handle” and click the “Move Handle” pushbutton until the handle is at the appropriate distance with respect to the inner wall. Enter this angle in the corresponding text box. Repeat for each handle distance specified on the GUI.


GUI_scale_calibration
CONNECTED
Connect
COM4
Start Read
Stop Read
Load Force
218
Reset Values
Dispense Pellet
Move Handle
0
-0.30in
0
+0.25in
50
0.00in
25
+0.50in
75
Save Calibration
Load Calbration
150
100
50
0
0
0.5
1
1.5
250
200
150
100
50
0
-50
-2
-1
0
1
2

3.16. Once all distances have a corresponding servo angle inputted, click yellow “Stop Read” button.



3.17. Click blue “Save Calibration” button. Save Calibration file with a name that documents the date in which the system was calibrated. This file will be accessed by the assay GUI (“GUI1”) during assay execution.

3.18. Exit out of Calibration GUI once Calibration file is saved.