Radar Box Assembly


Z- Axis
X- Axis
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1. General
    a. Materials Used
        i. The box is made of ¼" black acrylic (Glowforge's Proofgrade Thick Black Acrylic).
            1. 3 sheets of the proofgrade acrylic were required to make one box.
            2. https://shop.glowforge.com/collections/acrylic/products/black-acrylic-cast-opaque-glossy?variant=39434532683874
        ii. The ultrasonic mount is made of ¼" black acrylic (Glowforge's Proofgrade Thick Black Acrylic).
            1. This was made from the unused areas of the 3 large acrylic sheets.
            2. https://shop.glowforge.com/collections/acrylic/products/black-acrylic-cast-opaque-glossy?variant=39434532683874
        iii. The Arduino Mega Mount and Table are made of 1/8" clear acrylic (Glowforge's Proofgrade Eco Medium Clear Acrylic).
            1. 1 sheet of the proofgrade acrylic the 3 Mega Mounts and the 1 table for the box.
            2. https://shop.glowforge.com/collections/acrylic/products/clear-acrylic-cast-transparent-glossy?variant=20442191757410
        iv. 3mm acrylic screws and hex nuts
            1. https://www.amazon.com/gp/product/B0C6M6MJ8M/ref=ppx_yo_dt_b_search_asin_title?ie=UTF8&psc=1
            2. 12 M3x10 for mounting the Megas in their mount
            3. 15 M3x12 for affixing the Megas and their mounts and the Uno to the box
            4. 3 M3x20 for affixing the Servo Mount to the base of the box.
            5. 4 M3x20 for securing the Servo to the Servo Mount
        v. Ultrasonic Sensor (HC-SR04) (3)
            1. https://www.amazon.com/gp/product/B0B1MJJLJP/ref=ppx_yo_dt_b_search_asin_title?ie=UTF8&psc=1
        vi. Arduino Mega (3)
            1. https://www.amazon.com/gp/product/B01H4ZDYCE/ref=ppx_yo_dt_b_search_asin_title?ie=UTF8&psc=1
        vii. Arduino Uno (1)
            1. https://www.amazon.com/gp/product/B008GRTSV6/ref=ppx_yo_dt_b_search_asin_title?ie=UTF8&psc=1
        viii. Large Servo (1)
            1. https://www.amazon.com/gp/product/B0C5LWHTQ1/ref=ppx_yo_dt_b_search_asin_title?ie=UTF8&psc=1
        ix. Switch (1)
            1. https://www.amazon.com/gp/product/B0BK1N3SXD/ref=ppx_yo_dt_b_search_asin_title?ie=UTF8&psc=1
        x. Wires
            1. Dupont Wires (M to F, M to M, F to F)

a. https://www.amazon.com/TOAPPNER-Multicolored-Breadboard-Arduino-Raspberry/dp/B089FZ79CS/ref=sr_1_2_sspa?crid=148XVZGMYA9N2&dib=eyJ2IjoiMSJ9.tjHxIQLJsk16_0YVtUGN6bvA8B0INOA5zKMPlJaa8XJyAvNhOPpbUvIFmUr8s7n0Vvt6BNwBlr65_crMc0qW6vzz6VEIQlhWEjiCcYnj9e_j360IlBMY-MfZc2vEB6mCZ7JVNV5CMmud2yKv_LW6e59zwVOdvT_lRjYu3VJv05pRns70fBSGkCscMx2hrM23bQx0fMSNs_Onr_cL545Nhcef7z2x910o0iSQXec5Kug.Tp_NBCVHefCXCD4NPJAjYxOV1zT4Fvbu9rZldr0P8C0&dib_tag=se&keywords=dupont+wire&qid=1721669492&sprefix=dupont+wire%2Caps%2C81&sr=8-2-spons&sp_csd=d2lkZ2V0TmFtZT1zcF9hdGY&psc=1

2. 22 awg Hookup Wire
    a. https://www.amazon.com/TUOFENG-Hookup-Wires-6-Different-Colored/dp/B07TX6BX47/ref=sr_1_5?crid=3VUWPHUKZFROF&dib=eyJ2IjoiMSJ9.nhyepXj99xT6gmjDRY_uvhWRQsyi7hFWDMAvaR8_W2Z0UvTYKXmiV3AA8RiI1fLO6EJd9WBF_gWp3l5k6ryoYgvs0LepF67gPmCyMaExxWOv-3V1UQ2Yo7h2vkD41hzME1HUiIIKtbqqVaLg0CXwrhWYzFe19oCpP5RwU3pYmpMFLqzuWk2uawKuKlWFPvcYbIljAGI3r0GFTpdWy_kA0i3QsLLduEHpgk7BwRmD-pOXChFp17xDz6UPtl2zLaBb7Hg65AAPi28l6mt2xeyaX7HD_RBeiHcvKFaBmvK4r48.g9KIO0qBGxb4pm8WAq2gNb3G7JmaBsiXFIdqzMqNIxg&dib_tag=se&keywords=22+awg+wire&qid=1721669765&sprefix=22+awg+%2Caps%2C97&sr=8-5

xi. PCB (3)
    1. https://www.amazon.com/gp/product/B08151V9TS/ref=ppx_yo_dt_b_search_asin_title?ie=UTF8&psc=1

xii. Header pins
    1. Straight pins
        a. https://www.amazon.com/MCIGICM-Header-2-45mm-Arduino-Connector/dp/B07PKKY8BX/ref=sr_1_3?crid=ISOB760PNZ5H&dib=eyJ2IjoiMSJ9.HQy9JHCy5yJJaCJrptVeuysKV1DyJhSz5FALgAolo2vPwMoR0KJYr4WHD61YUA-zDAfXUFYMQBaUtuHpwdAqeRh9cqoYBiVb-7B5MU8jplW6TeVXl-u_E7J1304WJhp6KDoTHkGlA2fTpZm0hKZ4GmTJfKFXyo37VFb1O1MW4ulbnRAaDkycUnXHPsByfdyBa-3TBwj6Aox1IOwUlDtSM0iaU4k45f3ShCZgJ_640po.Nj69If5qUMGBVHG9POlsSfDm8glMoYNYtIiTwMhUoE4&dib_tag=s

e&keywords=arduino+pins&qid=1721669733&sprefix=arduino+pin%2Caps%2C86&sr=8-3

2. Right angle pins
    a. https://www.amazon.com/gp/product/B01461DQ6S/ref=ppx_yo_dt_b_search_asin_title?ie=UTF8&psc=1

xiii. LCD display (3)
1. https://www.amazon.com/gp/product/B0B5ML6R5L/ref=ppx_yo_dt_b_search_asin_title?ie=UTF8&psc=1

xiv. Soldering Equipment
1. https://www.amazon.com/Soldering-Interchangeable-Adjustable-Temperature-Enthusiast/dp/B087767KNW/ref=sr_1_8?crid=33BO2JLZGMZUW&dib=eyJ2IjoiMSJ9.6KjLy_SIXAgyh5Sla3D5E9TDDgytMkdwU-SzTYeXwr7aMD-Qs7vWbgWPfkXQ3xn0QEI_Xei5GS5gSe7-qeSEqEWtpf1K4XJy2GPDFrWrjxVyIZ7LpWFO0aYbZyDOCbeRbg7MPs-K5-Spf6gUumvyqldaZgvZRiKZDHCUjHdUxtplblARywDFn-b-F02lwC7eI74eNM-RWqAe26eZU8w10SP6pcuquBkrj1qbcbi1oOw2ancjju5Tq2JG4VeIjFDYVmlRmemd6mlWMyWyU-lCIU5ftrySqNm5rZ3wCcn11y8.e6jZgbTnlSLmplpB4I3SZjCceysWz50nz7O9Seesdlw&dib_tag=se&keywords=soldering+iron+kit&qid=1721669848&sprefix=soldering%2Caps%2C135&sr=8-8

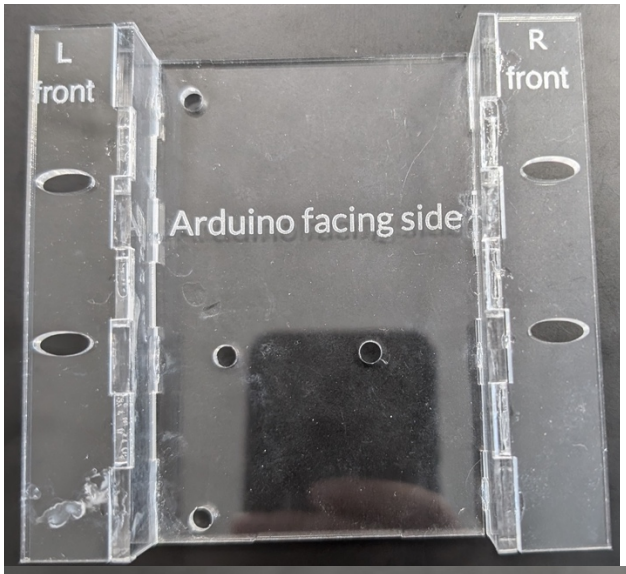
xv. Hot Glue and Hot Glue Gun
xvi. Super glue or CA glue
xvii. Acrylic Paint
xviii. Laquer
xix. 9V AC Power Adapters with 5.5mm x 2.1mm Barrel Jacks (4)
1. https://www.amazon.com/Power-Supply-Adapter-Cable-Arduino/dp/B0852JLTL9/ref=sr_1_3?crid=3SUY5XKW3S1VT&dib=eyJ2IjoiMSJ9.iai3zHcwWJB9MOY4fWuXVR6p79t5pQrbGKopXvFgkrrsHdTOEvQ0tgv_tADnQKErfwBezF6jd1nR9JRUAwZ6eN0sCGuLdsttVsx6oSK6IPfoVaLAgF8QqGbQ2PSPBCpPqv8DgJt3qf2UAkrB3OgptgS-uAVWGbe9mujT8Qr1A676z3fmavzlu0Ljygum4gQElpaa6Jwaq8T6Dzi9Ih_nV0P7fvUtADf_xR5e-_gngyI.G8Grzi1L1J4erebeG59T7O9WBmHCx4BPiiaCGYWOIhE&dib_tag=se&keywords=arduino+power+cable&qid=1721744309&sprefix=arduino+power+cabl%2Caps%2C139&sr=8-3

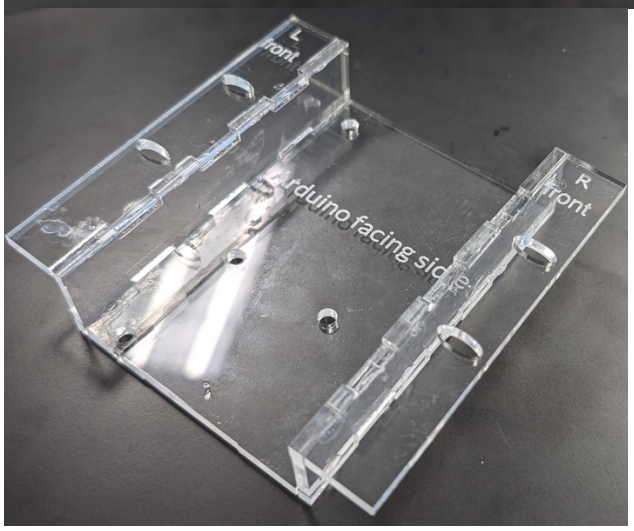
xx. Right Angle Barrel Jack Adapter

b. Glowforge Settings
i. All cuts used a proofgrade cut
1. ¼” and 1/8” acrylic
    a. Speed: 126
    b. Power: Full Power
    c. Number of Passes: 1

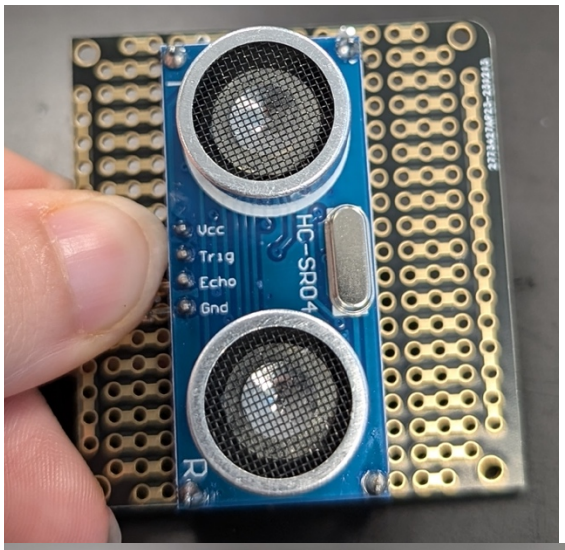
            d. Focus Height: Auto
        ii. Engraving to 0.08” Depth
            1. Allows for room for the lid to slide
                a. Speed: 250
                b. Power: 100
                c. Lines per inch: 225
                d. Number of Passes: 1
                e. Focus Height: Auto
        iii. General Engraving
            1. For text and labels, used HD Graphic Engrave
                a. Speed: 300
                b. Power: 16
                c. Lines per inch: 450
                d. Number of Passes: 1
                e. Focus Height: Auto
2. Print the provided .STL files for the Radar Box itself.
    a. Pieces: Back, Bottom Feet (print 4), Bottom, Lid, X Axis Side, Y Axis Side, Z Axis Side
    b. Many pieces have engraved sections on both sides. To prepare both sides:
        i. Cut and engrave all interior pieces first. On your device’s software, you may have to hide or ignore sections that are for the exterior.
            1. Design elements to print on the interior- Engrave top to 0.08” and exterior cut.
            2. All remaining elements can be cut/engraved from the exterior side.
            3. The “Engrave top to 0.08 depth” piece allows for the lid to slide. The settings will vary for this step depending on the material and lasercutter being used.
        ii. Flip the piece over to the opposite side for the exterior cutting/engraving. Ensure the design aligns with the shown cuts from the prior step. On your device’s software, you may have to hide or ignore sections that are for the interior.
    c. If you’d like to paint the engraved text/labels continue to the following, otherwise continue to step d.
        i. Keep the masking on the pieces and spray the exterior pieces with a clear lacquer. Let fully dry.
        ii. Paint a generous coat of acrylic paint of the color of your choosing into the engraving. Let fully dry.
    d. Remove all masking from the cut pieces.
3. Create Mounts for Arudino Megas
    a. Three are needed in the box (one for each axis side)
        i. Print the provided .STL files for the Arduino Mega Mounts and remove masking
            1. Our pieces were cut from 1/8” acrylic

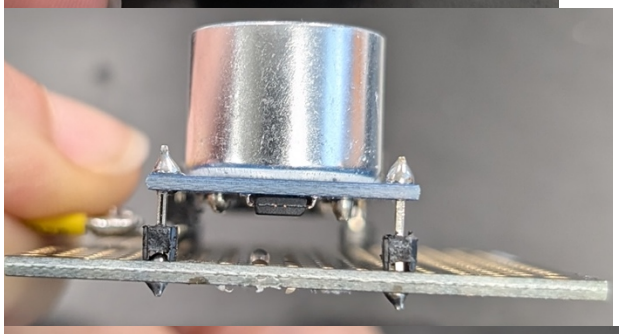
ii. Assemble the pieces and secure with a super glue. The final product should look like:

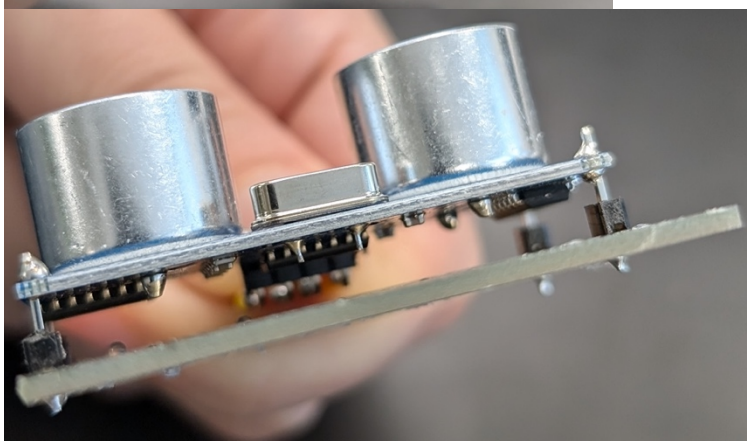
1. 

2. 
3. 

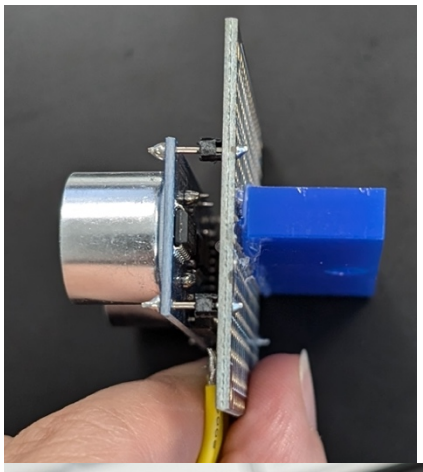
4. Prepare Ultrasonic Sensors
    a. Solder the sensor to a PCB using pins in the corner holes.

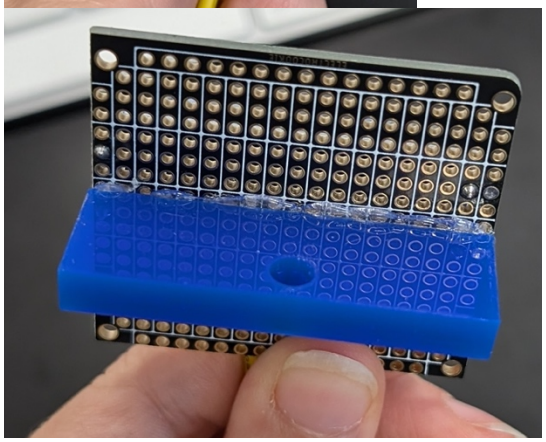
i. 

ii. 

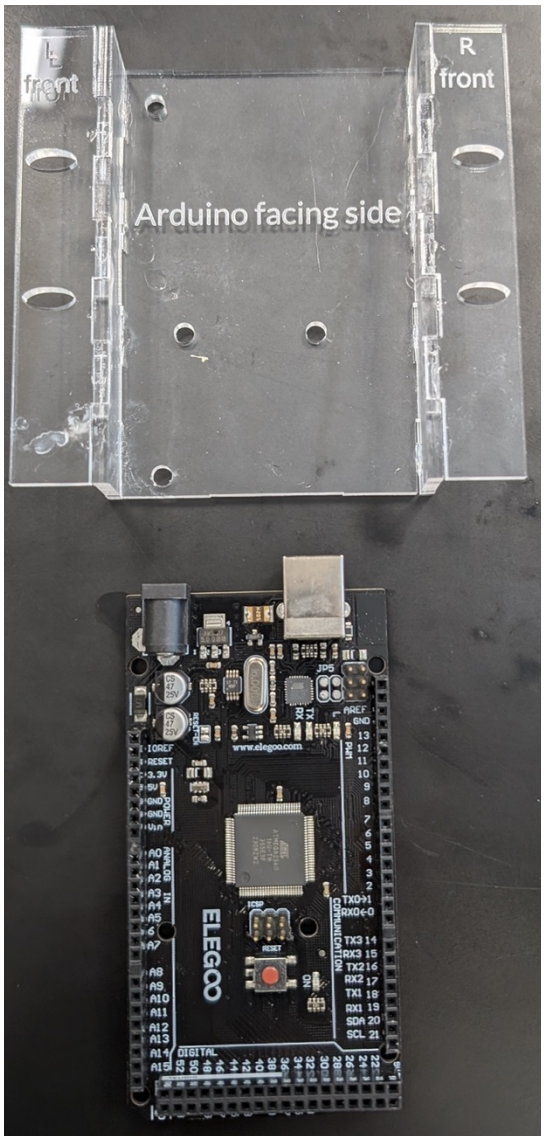
iii. 

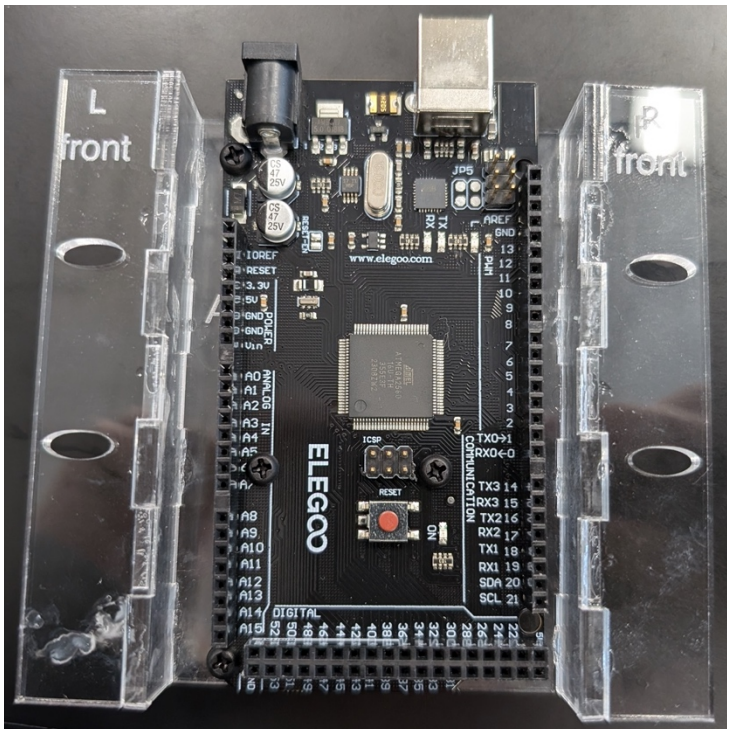
b. Cut the Ultrasonic sensor .STL files in ¼” acrylic
c. Hot glue the acrylic to the back of the PCB.

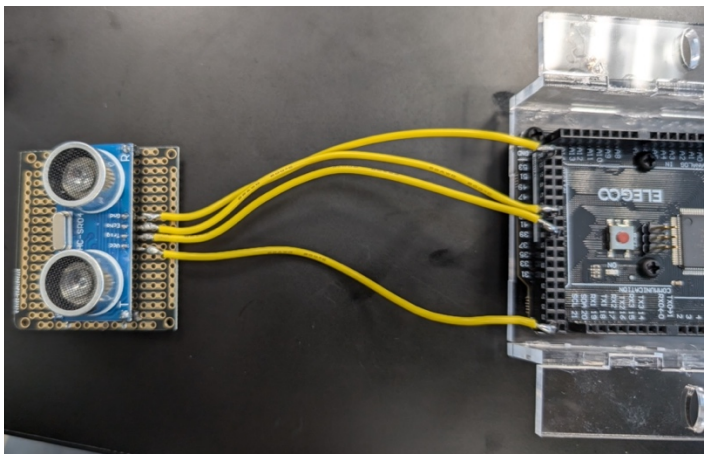
i. 

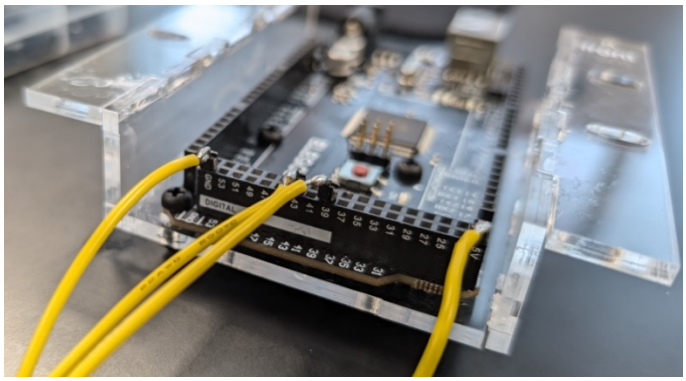
ii. 

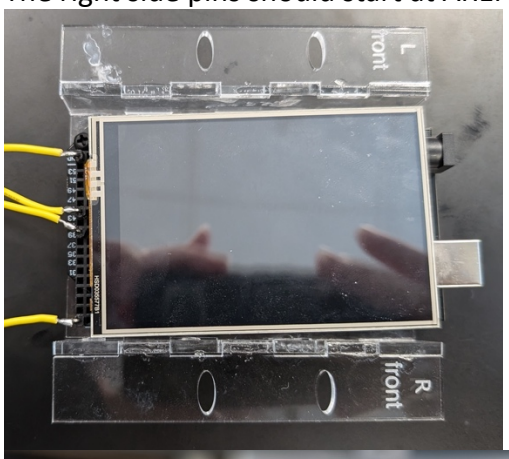
5. Prepare Arduino Uno
    a. Load the Arudino Uno with its code.
6. Prepare Arduino Megas and Ultrasonic Sensors
    a. Load each Mega with its respective code (X, Y or Z)
    b. Secure each Mega to an acrylic mount with four 3x10mm acrylic screws and nuts.

i. 

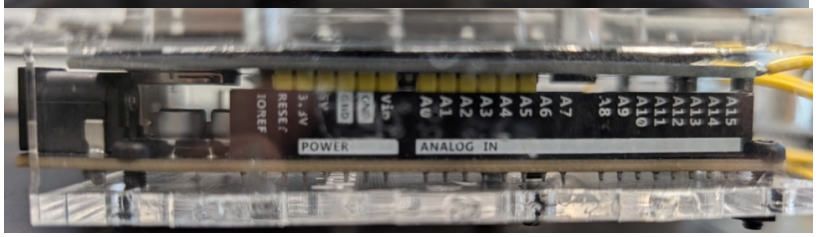
ii. 

c. Connect each Mega to the Ultrasonic Sensor in the following configuration (Ultrasonic Pin to Mega Pin)
    i. GND to GND
    ii. Echo to 43
    iii. Trig to 39
    iv. VCC to 5V
        1. For the X and Y sides, the wires should be approximately 5 inches in length. For the Z side, the wires can be up to 8 inches in length.
        2. Soldering a right-angle header pin to the end for the Mega side allowed for a better fit next to the box interior.
3. 

4. 

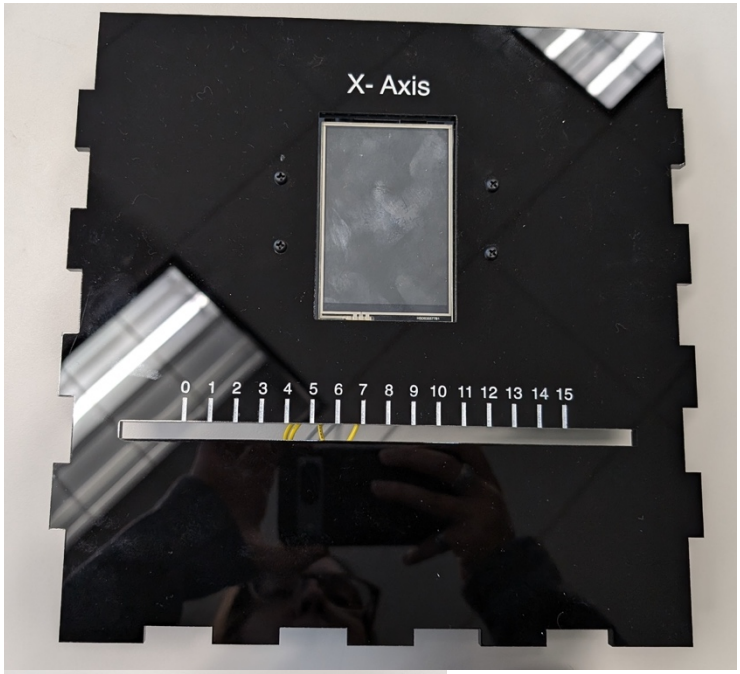
d. Connect the 2.3” TFT Touch Screen to each Mega
    i. The left side pins should start at RESET and connect down to A5
    ii. The right side pins should start at AREF and connect down to 0
    iii. 

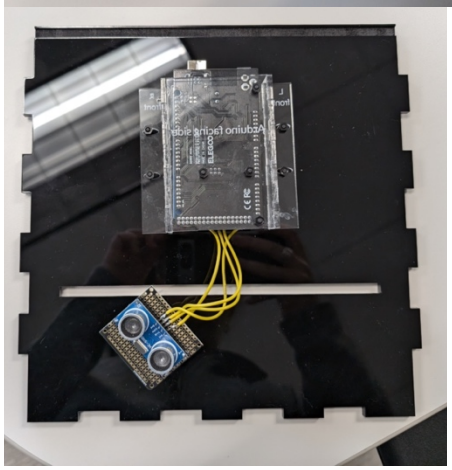
    iv. 

    v. 

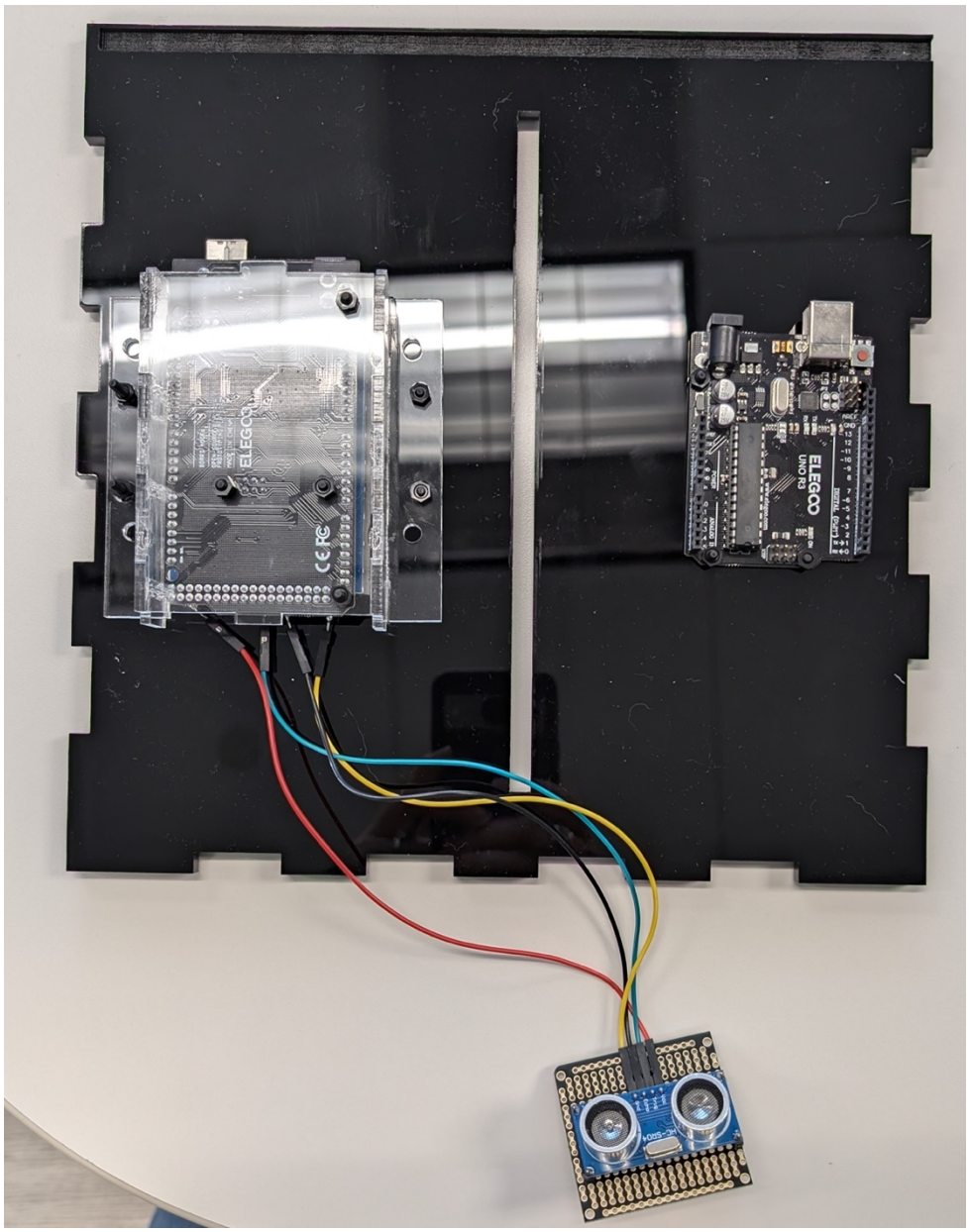
7. 3D print the Servo Pieces
    a. Pieces: Servo Mount, Pinion Gear, and Pusher
    b. Our pieces were printed in PLA
    c. Sand/file pieces as necessary so the pusher slides easily in the servo mount.
8. Side Assembly

a. With four 3x12mm acrylic screws and nuts, attach the Aruino Mega with its mount to the appropriate box side. For example, the Arduino loaded with the X side code should be mounted to the X side of the box.

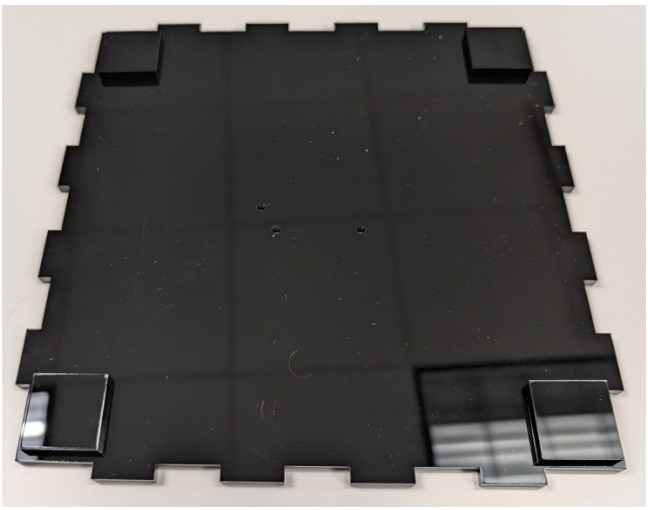
i. 

ii. 

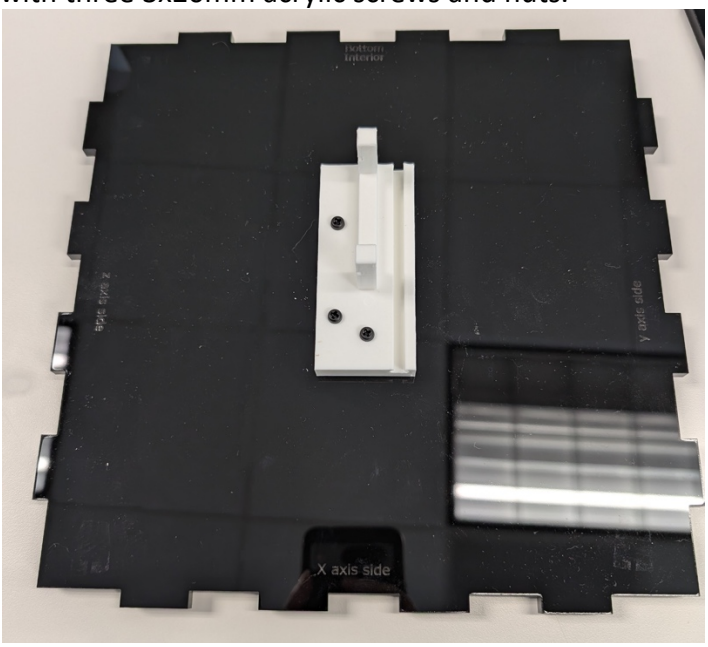
b. The Z side will also have the Arduino Uno mounted directly to the box. Use the 3x12mm acrylic screws to secure the microcontroller

i. 

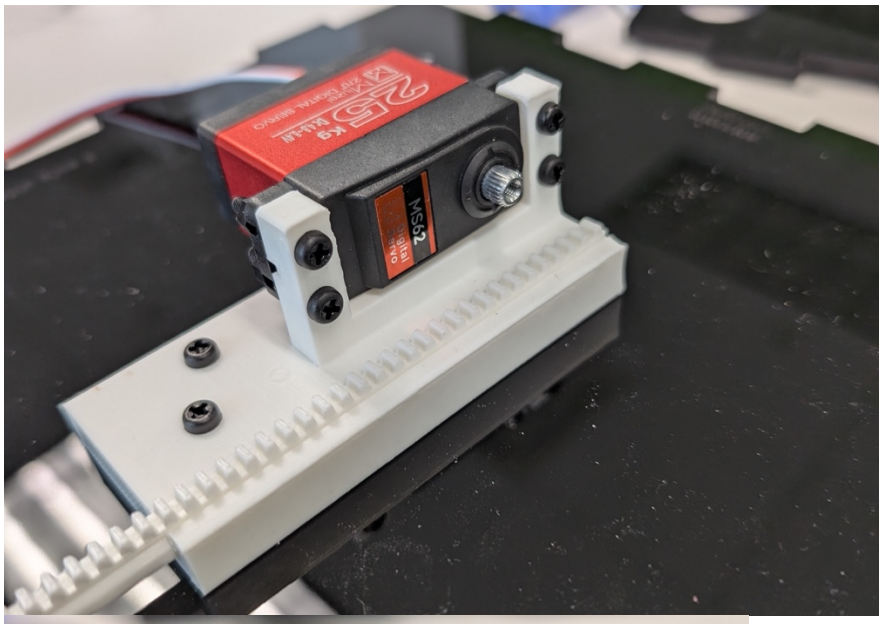
9. Bottom Assembly
    a. Superglue the four feet to the four corners of the base of the bottom piece.

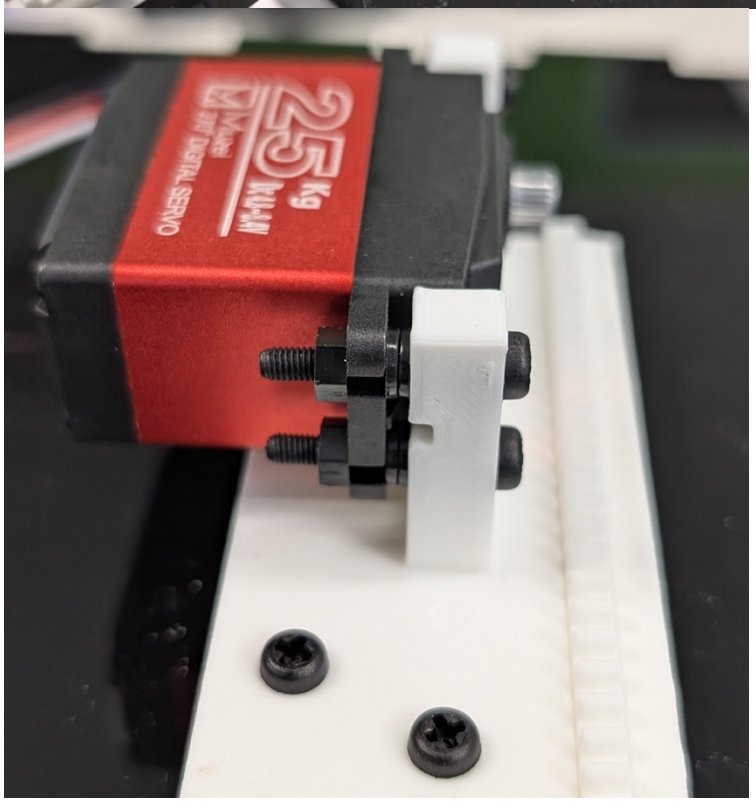
i. 

b. Place the Servo Mount on the bottom piece, lining up the holes. Secure the mount with three 3x20mm acrylic screws and nuts.

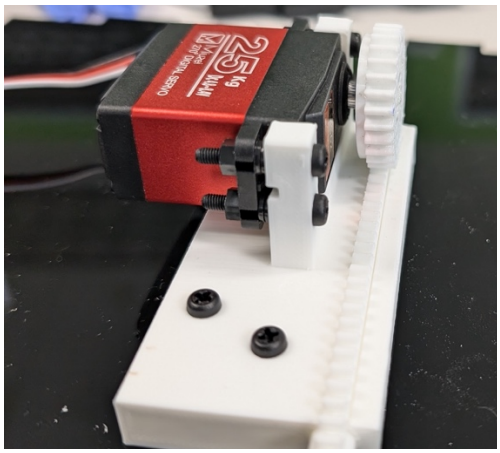
i. 

c. Place the pusher into the servo mount.
d. Mount the servo in the mount with four 3x20mm screws and nuts.
    i. Gaskets may be needed to appropriately space the servo. Ensure spacing with the servo horn on and align the pinion with the teeth of the pusher.

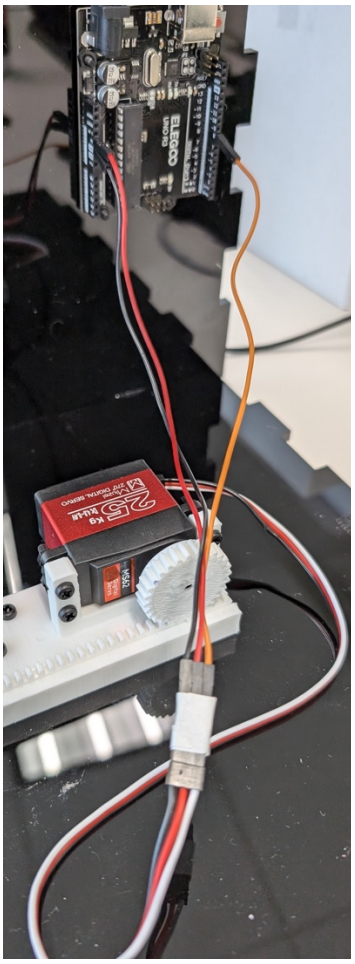
ii. 

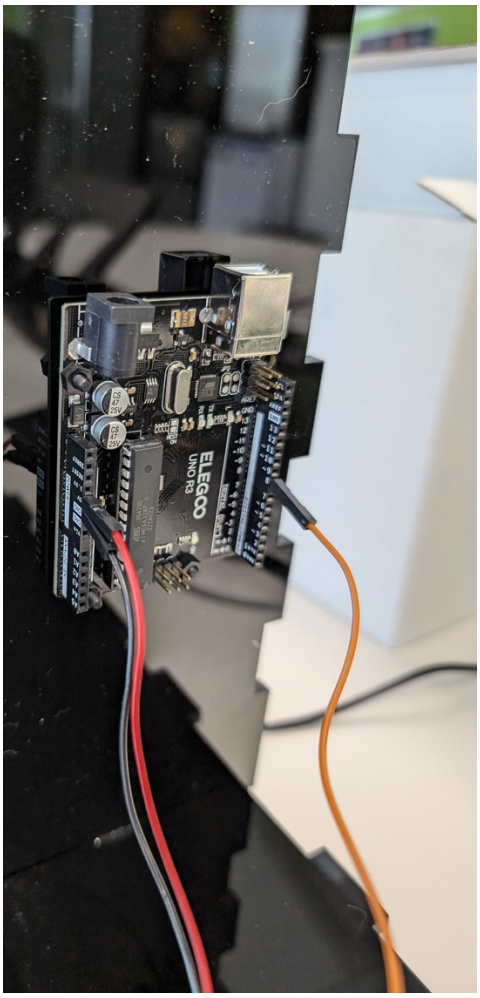
iii. 

e. Affix the circular servo horn to the servo and secure with a thread-forming screw.
f. Superglue the pinion gear to the circular servo horn, ensuring the gear teeth are engaged with the pusher and wait to cure.

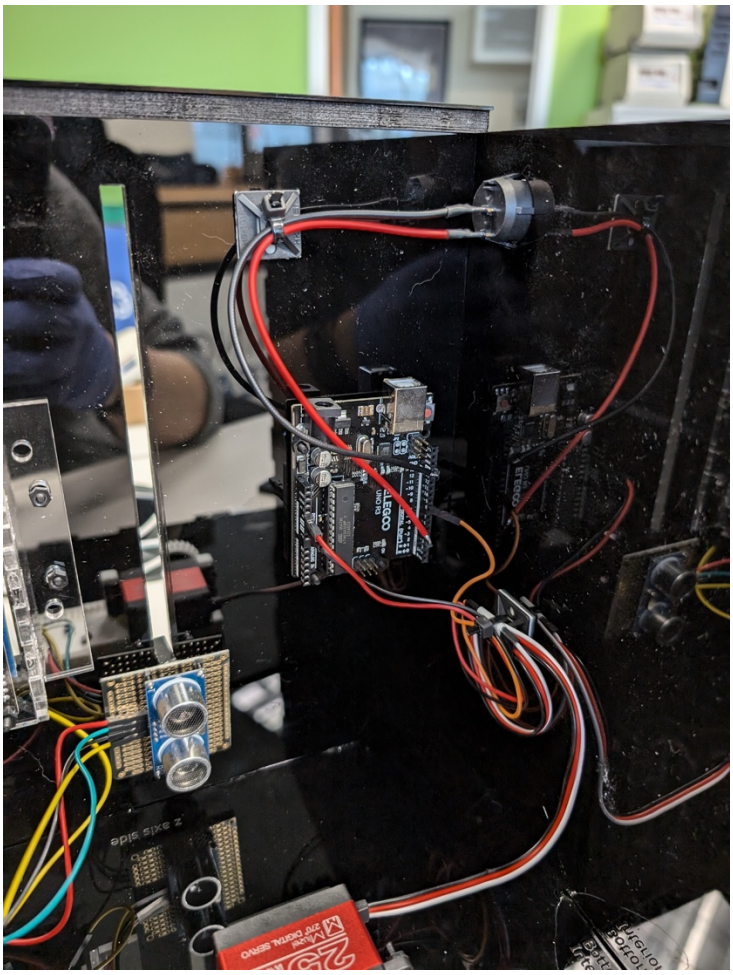
i. 

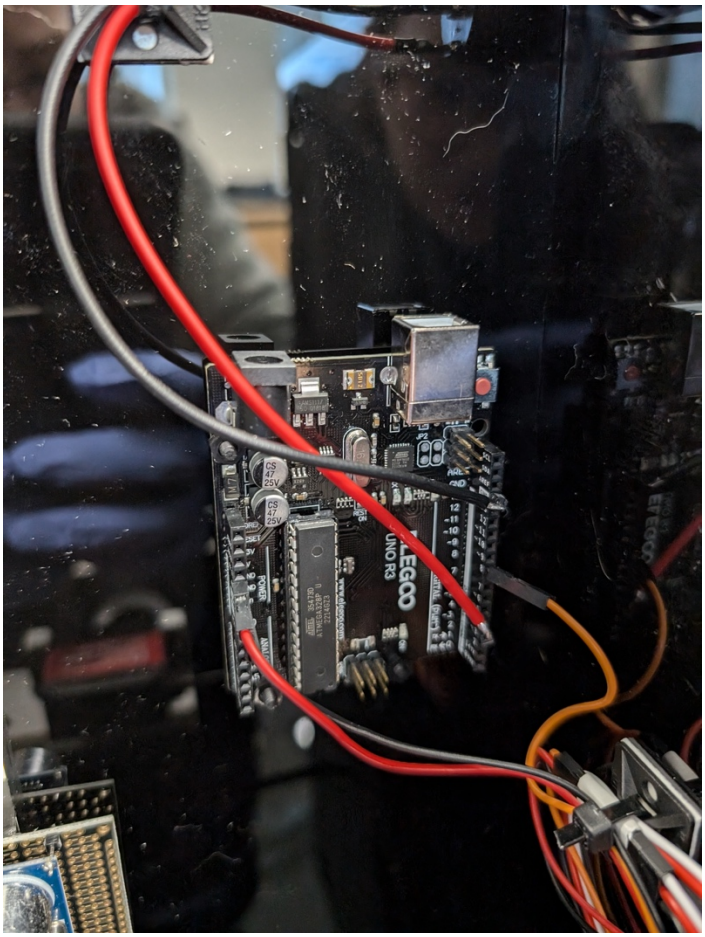
10. Back Assembly
    a. Superglue the switch to the switch hole and allow to cure.
11. Full Box Assembly
    a. Using a CA or superglue, connect the four sides to the bottom. Ensure time to cure fully.
        i. It is recommended to start with the Z side and begin wiring the Arduino Uno while there is space to access everything.
            1. Connect the Arduino Uno to the Servo with the following connections (Arduino pin to Servo color wire)
                a. GND to Black
                b. 5V to RED
                c. 8 to White

i. 

ii. 

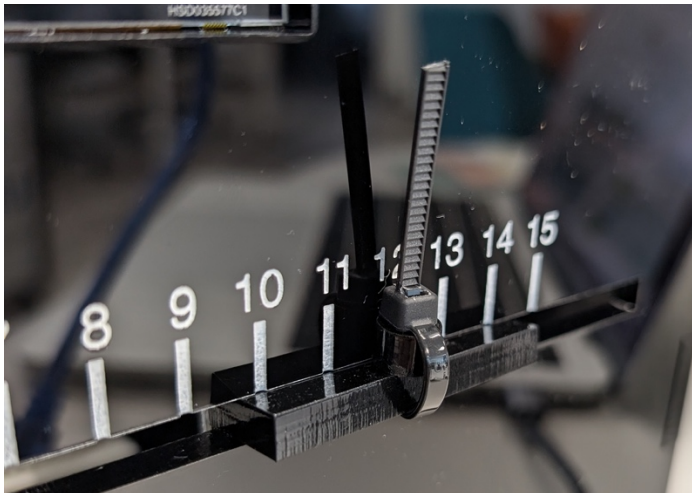
ii. If the Back pieces is placed next, the final connections can be made to the Arduion Uno.
    1. Connect the Arduino Uno to the Switch with the following connections
        a. GND to black
        b. 3 to red

i. 

ii. 

iii. The remaining sides can then be assembled/secured.

b. Place each ultrasonic sensor in its track and hold in place with a zip tie pointing to the cursor numbers.

i. 

ii. 

c. Run the power cables through the back opening and connect to each Arduino.
    i. To manage the wires and keep them out of the way we recommend using zip ties to affix the wires at various locations along the interior.
    ii. We recommend using a right angle power adapter for the X and Y sides as the cords may otherwise interfere with the opening and closing of the lid.