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FINAL DOCUMENTATION
REFLECTION OF ONESELF
Dec 9th 2022
Website:https://github.com/alcho01/CART360FINAL/tree/main/NOW
For images/videos on Github you might need to download them

ABSTRACT

This paper serves as my final documentation for my project titled "Reflection of Oneself." This documentation includes the approaches I took after presenting the prototype. I have learned a lot throughout the programming and assembly processes. I had to reconfigure some ideas, sacrifice some decisions, and maintain composure throughout this semester-long project.

"Reflection of Oneself" revolves around themes of self-identity and human behaviour. When creating projects, I researched topics that I would want to visualize rather than imagine. Therefore, I thought a good base material would be mirrors since they represent a human's personality, but now that personality is reflected for the individual to see how they behave. For aesthetic purposes, I added plants and vegetation. Plants are an entity of nature, and the word nature has more than one meaning, therefore, I wanted to express the entire system embodying human nature.

As I was working on the final project, I became more invested in what I was making and the artifact became more personal to me. However, the theme remained universal with the intention of having an individual approach the artifact and question what it is they are looking for.

After showing my prototype, there was still a lot of work to be done. I had to schedule time for aesthetics, improve functionality, minimize ambiguities, and find ways to make the system more interactive. I will detail my process step by step from the proposal to the final product.

MATERIALS

- (3) 180 degree Servo motors
- Breadboard
- Jumper Wires
- PIR Sensor
- Servo Shield
- Surface Transducer
- Arduino Mega
- (3) Piezo Disks
- (3) Cams
- 9 Volt Battery

- (4) 2x2 Mirrors
- (3) Reflective Ornaments
- Artificial Plants
- Artificial Grass
- Rocks
- Chinese Decorations
- Cutting Board Resembling a piece of wood
- Coasters Resembling pieces of wood
- Recycled pieces of wood
- Cubed wood blocks

- (3) Pulleys
- Cord
- Styrofoam Board
- Velcro
- (2) Maneki-Neko Piggy Banks
- Screws/Nails
- Hooks
- Papier Mâché Materials
- Hot Glue
- Paint

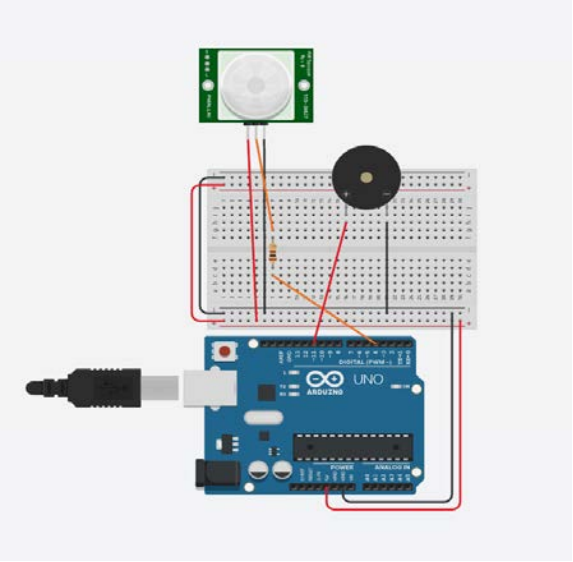
REFLECTING UPON THE PROPOSAL

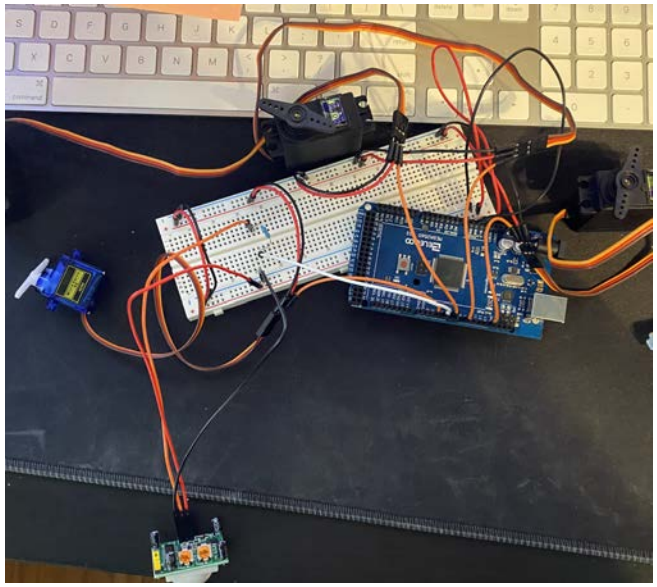
The proposal I pitched had a similar concept to what I ended up building. I continued to use the theme of self-identity and human behaviour and strayed a bit further from the concept of surveillance. However, that does not mean I totally rejected the theme of surveillance. I also followed through with the structure I illustrated in the proposal. For the sensors, I only kept the PIR sensor and omitted the sound sensor. The project also went from utilizing four servo motors to three, and that was due to technical issues with one of the four servos. I will discuss the additions to my project in the process section of this documentation. Simply put, the proposal intended to construct a structure that responded to human detection. Then the user interacting with the system would react based on the feedback the system outputted.

PROTOTYPE STAGE

TESTING CIRCUITS

In the very early prototype stage, I was designing my circuits on Tinkercad before actually assembling them. These initial circuits contained four servo motors, a PIR sensor, and a piezo speaker.





BEGIN CODING

I then moved on and began testing different code iterations. I knew that I would want at least two states. A relaxed state which occurs throughout the existence of the system, and a panic state that occurs only when human movement is detected.

The following piece of code was a rough setup for how a state change would occur.

I used a variable “delayer” to affect the velocity of each servo motor. When movement is detected as HIGH the delayer would change to 1 and if not the delayer would return to 5.

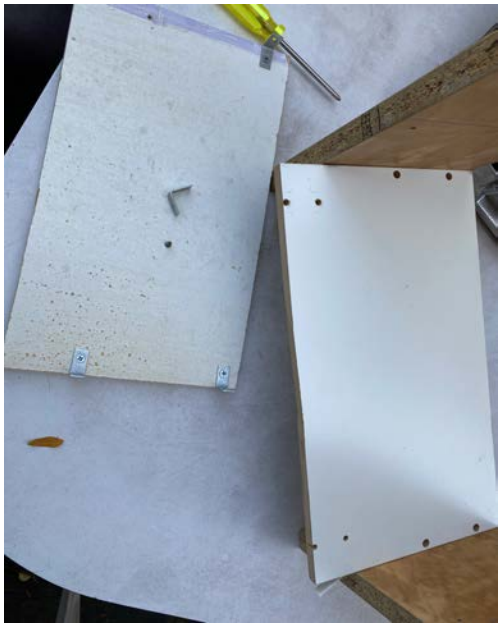
```
void loop() {
  //Read if there is movement via digital
  value = digitalRead(PIR_SENSOR_PIN);
  //Check to see if the input is high
  if (value == HIGH) {
    //Play the buzzer sound
    buzzerSFX();
    //If the motion is detected set the delay speed to 1, to make the rotation speed faster
    delayer = 1;
    //Change the currentmovement state to high if it is low
  if (currentMovementState == LOW) {
    //Read the given line for testing purposes to see if it works
    Serial.println("DETECTED");
    currentMovementState = HIGH;
    }
  }
  else {
    //Read the given line for testing purposes to see if it works
   // Serial.println("STOPPED");
    //turning it off
    if (currentMovementState == HIGH) {
      Serial.println("STOPPED");
      currentMovementState = LOW;
      //If no movement keep the delayer at 5 seconds
      delayer = 5;
      //Count the millis when the PIR goes low
      timeTurnedLow = millis();
    }
   // currentMovementState == LOW;
    //If no movement keep the delayer at 5 seconds
   // delayer = 5;
   }

   /* Create a for loop that runs throughout the program and only changes state depending on if movement is detected.
   This for loop goes from the servo minimum to the servo maximum */
   for (int i = servoMin; i <= servoMax; i++) {
     pwm1.setPWM(servo1, 0, i);
     pwm2.setPWM(servo2, 0, i);
     pwm3.setPWM(servo3, 0, i);
     delay(delayer);
    }
    //This for loop goes from the servo maximum to the servo minimum
   for (int i = servoMax; i >= servoMin; i--) {
     pwm1.setPWM(servo1, 0, i);
     pwm2.setPWM(servo2, 0, i);
     pwm3.setPWM(servo3, 0, i);
     delay(delayer);
    }
```

I kept the servos in for loops because they were intended to run throughout the entirety of the program.

BEGINNING CONSTRUCTION

Once I was satisfied with the code, I began the construction. I started measuring two pieces of wood that would serve as the base of the structure. These two pieces will lay horizontally and vertically one on top of the other in the middle of the structure, and the circuit will be contained within.



ADDING SIDE PIECES

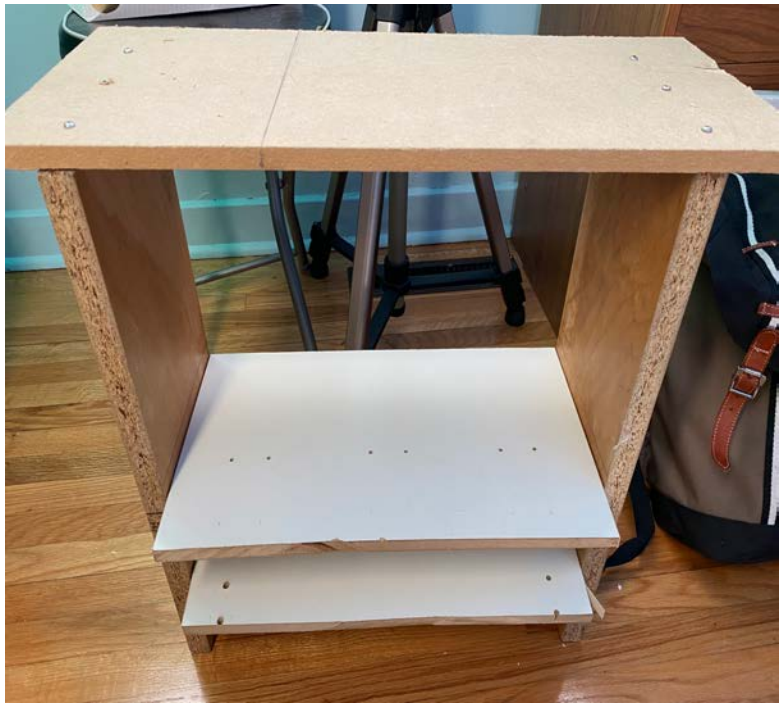
I then established the sides and screwed the base pieces to the side pieces. It gave me a shelf-like structure that was sturdy enough to stand on its own.

I had to precisely drill six holes in the top base piece in order for a string to pass through each end and connect with the servo “tails.”

ADDING TOP PIECE

The last step of the structure was to incorporate the top piece. By incorporating the top piece it made the structure even more stable and now I was capable of screwing in hooks to hold pulleys.

Now it looked like a table with shelves. At this point, it was a lot heavier and the structure was officially finalized for the prototype stage.



ADDING PULLEY SYSTEM

I then added the pulleys to the hooks, and weaved a piece of string through each pulley, into each hole, and finally around the servo "tail." I then performed this task 2 other times.

The pulleys were a little large for my liking because they took up quite a bit of space the mirrors could have taken, but at that point I thought it would still work out decently.

The string was slowly deteriorating because I kept adjusting it to fit tightly through the holes. However, it did manage to hold for a while, and I was planning on changing it anyway.

ATTACHING MIRRORS

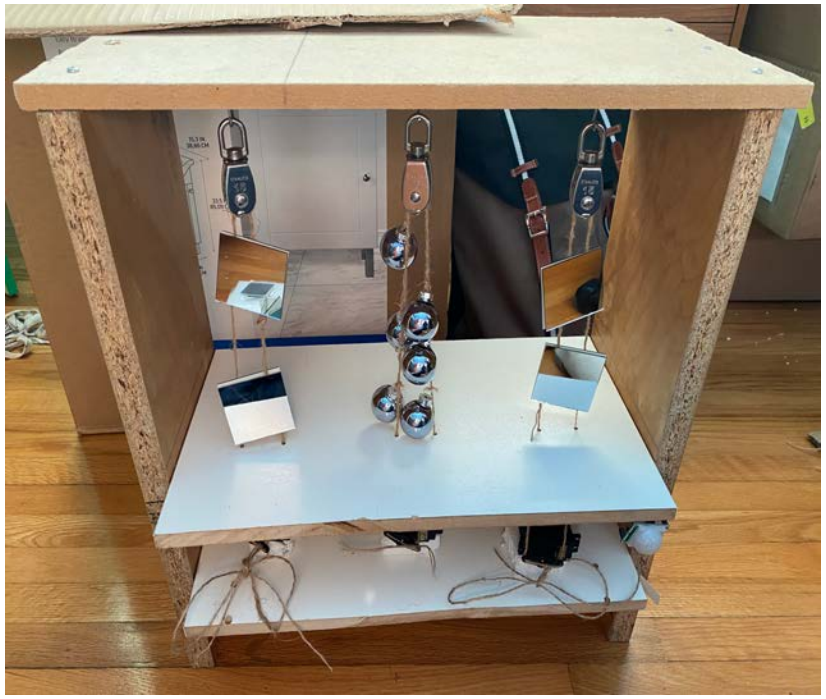
To hold the servos into place I used pieces of styrofoam that I cut into cubes, and hot glued them to the bottom base of the structure.

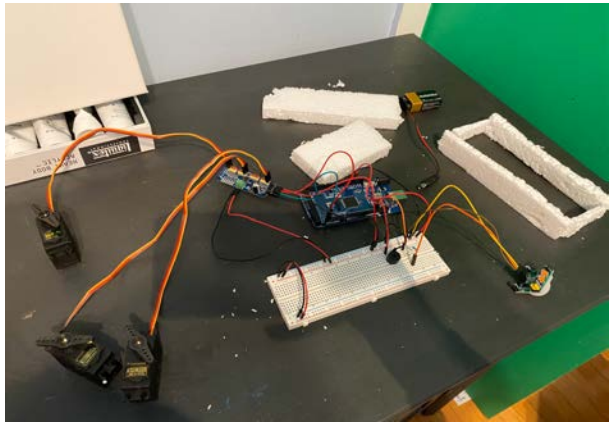
I also started gluing on mirrors and attaching reflective ornaments to the strings. The mirrors were glued on by using a piece of cardboard in between both panels of mirrors. As for the ornaments, I used a fine wire and tied a knot to the string held by the pulley.

PROTOTYPE FINAL STRUCTURE

This was the final structure and circuit for the prototype. I was content with how it turned out, but there were a couple issues. The mirrors were slanted, and I added too many ornaments which clogged up space for their movement.

I wanted people to find a reason to look at the artifact, outside of it being an artifact. The intention was for the user(s) to have a purpose for looking at themselves, and that their intentions may be different than someone else's.





FINAL ARTIFACT STAGE

REMARKS FROM PROTOTYPE STAGE

There are a couple changes that I wanted to make for the final artifact. Some of these changes included, replacing the piezo speaker, increasing the motion of the mirrors, adding an environment which inhabits the structure, and finding more forms of interactions.

DISASSEMBLING THE PROTOTYPE

I had to remove all the previous work done from the prototype because I needed to make one change in the structure. The change that I had to make was cutting a rectangular hole in the bottom base that would permit the extensions attached to the ends of the servo motors.

ADDING CAMS

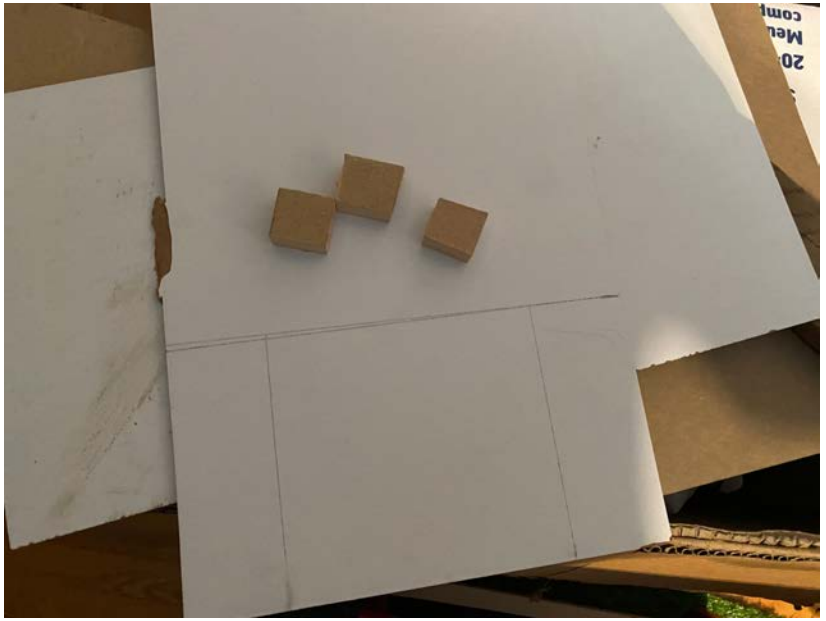
After asking for feedback to extend the movement of the mirrors, one suggestion was incorporating cams. I cut up 3 pieces of corrugated cardboard which were a bit larger than the servo tails, and hot glued them directly onto the tails.

I used a hammer and a screw to form the holes within the cams. The holes had to be precise, because if they were too big the string would be too loose, and if the hole was too small then the wire would not pass through.

COVER PIECES/HIDE PIECE/CUBED BLOCKS

At this point the circuit was still showing, and I wanted to hide it, eventually. I sawed some pieces that would cover the sides and the middle of the bottom and top base pieces. I also used an Exacto knife to cut a styrofoam piece that would be attached to the top layer and hide the pulleys. Another change I did was replacing the temporary styrofoam blocks holding the servo motors for more sturdy wooden blocks.

I also painted the cover pieces in black, and painted the entire structure red to get a closer representation of a shrine/temple.



ASSEMBLE LOGS FOR PIEZO DISKS

A new interaction I added for the final artifact were piezo disks. I used coasters that looked like logs and hot glued them together to create a pressure plate, so when pressed the piezo disk would activate.

The initial intention was to simply hide the piezo under the logs, and have footsteps trigger the piezo. However, the footsteps were not getting detected unless I jumped high up and landed hard on the ground to create a vibration that would transmit to the piezo. This seemed inorganic, and I wanted something that would activate nonchalantly. Therefore, the best next thing was to use them as pressure plates.

I decorated the logs with fake plants that I cut up and glued on to the wood pieces.

I also had to consider where to position the piezo. It had to be in a spot where a lot of pressure would be pursued. To facilitate this issue I used more small wooden blocks and glued those under the logs, then I taped the piezos to the wooden blocks and the vibration would become more accurate.

ADDING SURFACE TRANSDUCER

I had a hard time installing the surface transducer as it kept falling when I was trying to position it. I tucked it into a corner at the top of the structure, therefore, the sound would pass through the top and side of the structure. I used screws to hold it in place.

I showcase the surface transducer in the videos of the system functioning.

MIRRORS AND STRING

I attached the mirrors to the string in a diamond shape. This made the mirrors more secure and it gave off a better aesthetic. I hot glued the mirrors back to back and sandwiched the string in between.

I used a more durable string, and it was also more slippery. Because of this, the pulleys had less tension, and I felt that the motion of the mirrors was more fluid.

This part of the construction is documented in the technical overview video.

AESTHETICS AND DECORATION

To give more personality to the artifact I wanted to add aesthetics and decorations that made sense and added to the experience. I envision seeing this structure in an empty grass field only surrounded by the user. Therefore, I used grass as a platform, and continued along with the forest-like experience.

I found rocks as well as Japanese and Chinese artifacts that I could decorate the structure with.

I used extra mirrors as decorations because it disrupted the colorway of green/black and red.

The last decoration I included were mushrooms I made through Papier-Mâché.

In my opinion, although these objects serve merely as decorations, they bring a story and possibly a connection that the user can comprehend or develop.

Some of the decorations were used to hide wiring or dents created in the structure.

CIRCUIT PROGRESSION

The fritzing diagram application was not available, therefore I worked with Tinkercad. Tinkercad did not have every piece I used available so the diagram is not fully complete.

What was included to the circuit were the surface transducer, and 3 piezo disks that were attached to breakout boards.

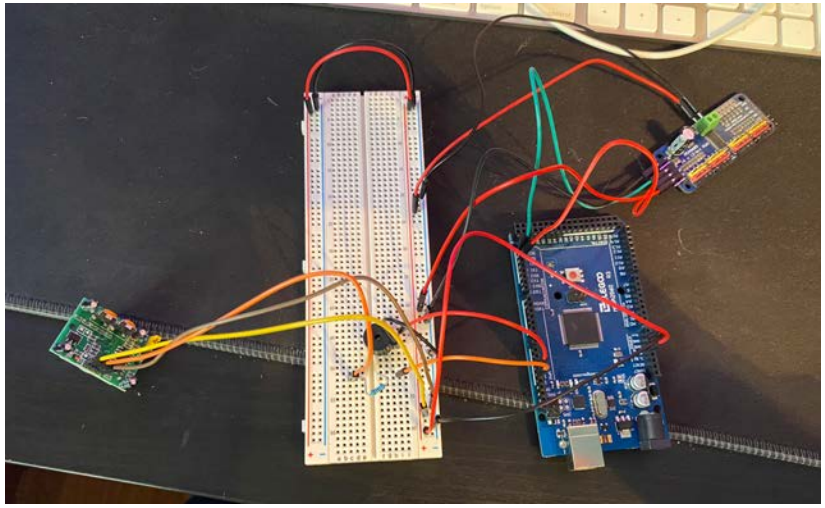
I omitted the piezo buzzer from the prototype because now I had a more powerful source of sound.

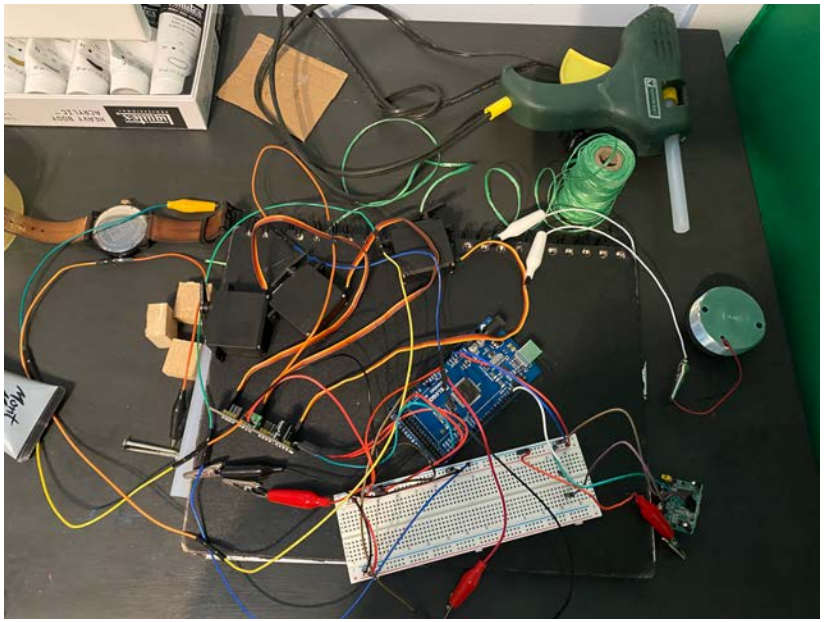
I also intended on using an amplifier attached to the surface transducer. However, I was having issues where the sound would not be projecting as I had intended.

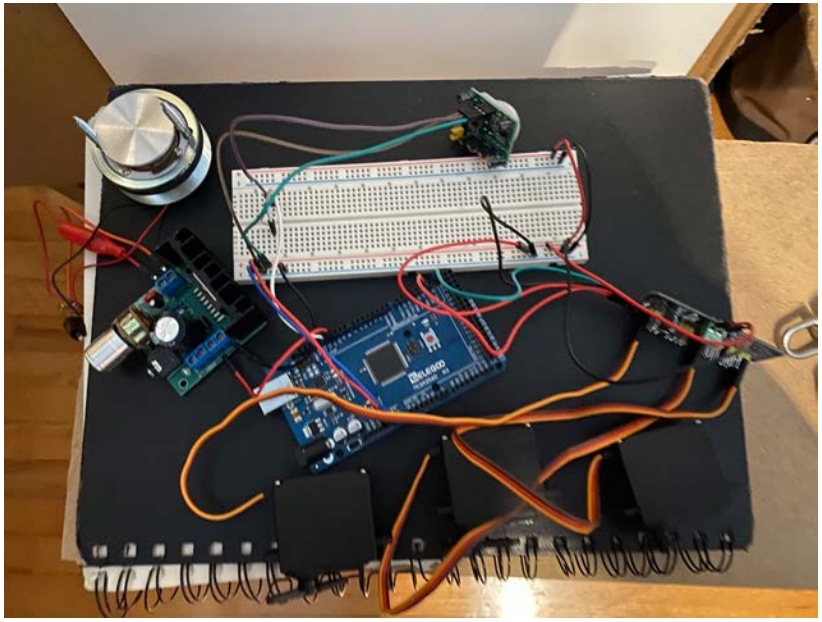
I also used multiple connections of female to male wires to alligator wires to access the floor level where the piezo disks were.

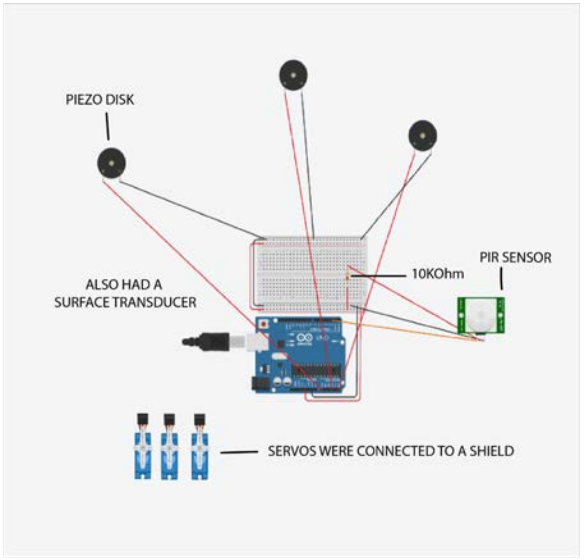
The servo motors were connected to a servo shield freeing up space for the arduino. The piezo disks were connected to analog input pins. The PIR sensor was connected by a 10k ohm resistor. Then I connected the 5V and ground from the Arduino to the breadboard.

Here are a few images of what the circuit progression looked like:









WORK ON CODE

The final code consists of two libraries

- Adafruit_PWMServoDriver.h
- Pitches.h

Adafruit_PWMServoDriver was used for the servo motors since I was using a shield. It facilitated the process of coding and wiring.

Pitches.h was used to create simple melodies that would sound off from the surface transducer.

I commented everything in the .ino file, therefore I will break down the key aspects of the code which include the relaxed, panic, checkForMovement, checkForVibration, and presenceFelt functions.

The relaxed function is straightforward. When no interaction occurs the servos will rotate at a fixed speed.

The panic state occurs from the checkMovement function. The checkMovement function checks if a human is in the vicinity of the PIR sensor. If there is a person, the checkMovement function will activate the panic state function. In the panic function it checks to see if a boolean is activated to true and also if the time is greater than a fixed amount of time set at the start of the program. Both these parameters are met when human movement is detected, therefore, the panic state will form a sequence where each servo will isolate from each other and perform a specified movement. When one servo has completed their movement the second servo will activate and so forth. Once the final servo has been activated the state will return to relaxed.

The presence felt function relies on the checkForVibration function. The checkForVibration function reads an analog value from the piezo disks. If the piezo disks reach a greater threshold than the fixed threshold set at 100, the presenceFelt function will activate. When the presenceFelt function activates, depending on the pressure plate stepped on will trigger the servos to move. If the left plate is pressed, the left and middle servo will move, and if the middle plate is pressed, the middle servo will move. Finally, if the right plate is pressed, the middle and the right servo will move. Also, if the threshold is greater than the initial threshold it will activate an alarm specific to that area(piezo).

The other parts of the code include creating the melodies, and setting up variables or specific library setups.
https://github.com/alcho01/CART360/blob/main/NOW/FINAL%20CODE/FINALCODE2/FINALCODE2.ino

OBSERVATIONS

From my observations, I thought the overall forms of interactions worked well.

The artifact contains three forms of interaction:
1 - Human Engagement through (Movement)

The first type of interaction occurs simply by having a human in sight of the artifact. The PIR sensor calculates when a human is nearby and then will proceed to do what is asked of it.

2- Human Engagement through (Play)

The second type of interaction occurs when the user is looking for themselves in the mirror. I consider this an aspect of play because it requires the user to have a goal or purpose for why they would be interested in what the artifact presents.

3- Human Engagement through (Presence)

The third type of interaction occurs when the user steps on a piezo disk. I consider this as engagement through presence because it requires the user to scan their environment and develop a curiosity for why elements are placed the way they are. This may cause ambiguities, but I want the user to experience an environment that they have never been in.

The element that worked out the best was going from the relaxed state to the panic state. I thought it was more evident than what was seen in the prototype because the servos would stop before transitioning to a new state.

I might have said this a couple times already, but the element I wish worked out better was the piezo disk sensors. Having to press hard on them was the only way they functioned and it screwed up the flow of the other parts of the system by introducing rigid mechanics.

I added the aesthetics to bring to life an environment in which the artifact may inhabit, I also thought that by adding decorations it would demonstrate elements of warmth and get the user's creativity flowing.

IMPROVEMENTS

Although I am generally satisfied with the final artifact, there are still more improvements that could be made to make the experience better.

One improvement would be to find a different medium for calculating the vibration of the piezo disks. I initially wanted footsteps to trigger the piezo disks, but I realized that firm contact was the best way of getting a reading. Therefore, I had to create a pressure plate that felt awkward to step on. I could have instead created hanging aesthetics, and when they get squeezed it would trigger the system. The intention was to make the experience as organic and free-flowing as possible.

Another improvement would be to increase the mirror movement. I did add cams which improved the movement subtly, but there could have been more. I also would have liked to include more mirrors per string, but there were obvious restrictions. I tried finding smaller mirrors, but the smallest mirrors I could find were the ones that I used which were 2x2 inches long. The other alternative would have been expanding the structure. If I had more time, I would have liked to do so, but I also had to consider the transportation and how much heavier the artifact would get.

A final improvement would have been to find a better sound library than Pitches.h. If the tones were more immersive, I believe the experience may have been more engaging.

FUTURE

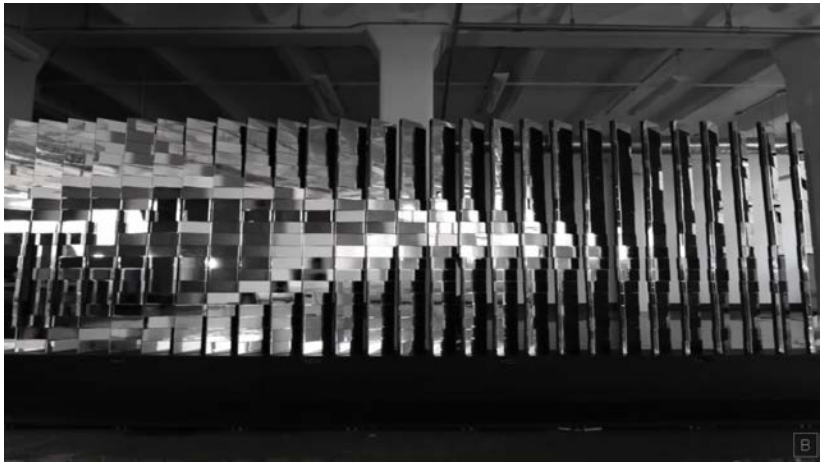
If I continue working on the artifact I would like to address all of these improvements. Perhaps, I would upgrade some of the materials to become more durable or for better performance.

INSPIRATIONS

While I had initial inspirations that I discussed in the proposal, I had researched many more artists that influenced my final artifact. Here are a few that I took inspiration from:

Brixel Mirror - Breakfast Studio

They used similar materials, and similar forms of interaction. It is a large-scale kinetic installation that demonstrates fluidity and simplicity.



Wendy Wischer - Shattered

This installation involved a sculpture formed of triangular mirrors that refract light waves projecting patterns into the environment. The patterns can be interpreted as chaotic in comparison to our current climate crisis. I took inspiration from this project because it enhanced my appreciation of building meaningful relationships that tie materials to real-world issues.

Self and Other - Random International

One last work inspiring my final artifact was Random International's *Self and Other*. My project's title is *Reflection of Oneself* and the theme of my project became clearer after analyzing the piece done by Random International. *Self and Other* reflects a human's anatomy by projecting light rays that encapture the user. Themes of identity and performance are highlighted through this work.

CONSIDERATIONS/CONCLUSION

Special appreciation to all references and individuals that guided me throughout this semester-long journey.

I had highs and lows, but the most valuable thing is that I accomplished what I set out to do from the early proposal stage, when I thought I might not be able to do anything.

REFERENCES

Breakfast Studio, “Brixel Mirror,” 2018,
https://breakfastny.com/works/brixel-mirror

Wischer, Wendy, “Shattered,” 2017,
https://www.granaryarts.org/wendy-wischer-shattered

Random International, “Self and Other,” 2016,
https://www.random-international.com/self-and-other

North, Dyg, “Cam Followers for Automata - Dug’s Tips 16,” 2015,
https://cabaret.co.uk/cam-followers-for-automata-dugs-tips-16/

Lee, Yeo Reum, “Symbolism of Mirrors as the First Step of Individuation and Self-Awareness,” 2018,
https://www.e-jsst.org/upload/jsst-9-1-45.pdf