Perceptive Sensorial

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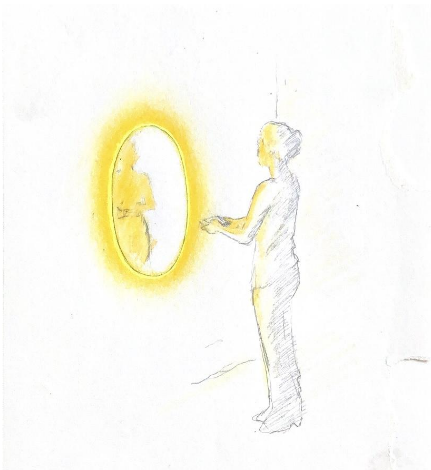


THE VISION

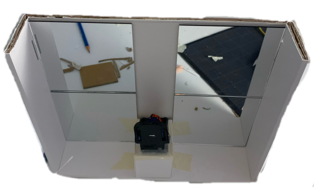
Initially, for our project we wanted to create a magic mirror of sorts, an object for nourishing reflection. This sentiment has remained true, but the design and outcome has dramatically diverged from our original vision. We thought of using a sort of “smart mirror” that could change states based on user input. This mirror would have requested biometric data from the user and cast that information back onto the user through LED lights emitting from behind the glass. The user’s body temperature would inform the color temperature of the LEDs, the brightness of which would have rhythmically adjusted to the bpm of the user’s pulse. Without a continuous offering of both the user’s heart rate and body temperature, the mirror will refuse to engage in any interaction and will stop reflecting. We had to rethink our goals as interaction designers, as this imagined object could not foster a continuous interaction with the person, it is just causing an action rather than creating a relationship between the user and the object. As well as due to time and budget constraints and budget-wise we had to work with a smaller version, which is why we decided to work a 14 inches x 14 inches size instead.

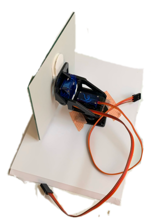
This original idea has been significantly modified, but it still captures the sentiments behind the final object. Still wanting to
to create an interactive mirror, we opted for creating a kinetic sculpture. We booked a wood shop consultation, as well as went for an appointment afterwards to create our piece, to make it work best with our mirrors we needed specific measurements for it to work best and make it even more personal for us too - having it built from scratch. This new object we envisioned would take user input to inform the movement of a mirror surface consisting of tiles, individually moving on a pan and tilt axis. As for the input, we planned on incorporating both motion detection and a pulse sensor. We also wanted to incorporate LEDS, however instead of reacting to a user’s body temperature, we wanted to create a light show synced with the user’s heart beat.

THE PROTOTYPE

Our prototype consisted of one mirror attached to one motor, moving on a single axis—left to right. A motion sensor informed the movement of this motor: if no motion was detected the mirror would move freely, but if movement was sensed the mirror would freeze in a neutral position, facing forward. From this prototype we realized that the movement of the motors had to be much more precise. Because each mirror would only have a small range of motion so that they wouldn't bump into each other, we needed to be able to calculate exactly how far the mirror would swing left to right and up and down. We also needed to be able to get the motor back to a neutral position, so that then when motion was detected, the mirrors could "straighten" out and form a relatively flat surface. The prototype motor quickly proved to us that these hobbyist servo motors were not going to be cooperative. It should be noted that we went into this knowing very little about motors, and despite the research we had done, research that *felt* sufficient but was more or less incomprehensible to us beginners, there was about to be a lot of learning-the-hard-way.

We faced many issues at this step in the process that later informed our approach for our final artifact, namely controlling the direction of the motors and getting them back to a neutral position, getting the motors and sensors to function simultaneously, and getting multiple motors to work at once. Importantly, the prototype told us a lot about how our final artifact was going to look. Based on the structure of the prototype, crafted from a recycled MacBook Pro box, we were able to figure out all of the measurements needed to create the structure to hold our 16 motors.





THE STRUCTURE

After the prototype was done, we decided our final should have 3 rows of 3 mirrors, containing 9 tiles total. This decision was made mainly based on cost and time efficiency. After the prototype we realized that each motor would have to be individually calibrated to find its minimum and maximum; too many motors would have been overwhelming to deal with. We had also decided upon using a one 16-channel Servo Driver Shield to drive all of our motors, so 16 motors became the maximum we could use. In order to have each tile move in two directions, each tile needed two mirrors. With nine mirrors total we would need 18 motors. We didn't want to buy another servo shield just to power two more motors, nor did we want to scale down our project. We decided to have two mirrors only move on one axis, left to right. This ended up working really well, as it was virtually unnoticeable with the other mirrors moving. The effect of creating a fragmentary living surface is still effective without those two motors.

The prototype also gave us a good idea of how we wanted to support these mirrors. The pan and tilt bracket we purchased were designed for go-pros, they have a flat base and a protruding face for the tilt axis. Them being made out of plastic turned out to be a great feature, as we were able to cut off pieces to get a flat face to attach the mirror on with relative ease. These brackets lift the mirror up about one inch, depending on where and how we attached the mirror. We decided to use command strips to attach the mirror to the bracket, so that we could detach and reattach the mirror quickly and easily.

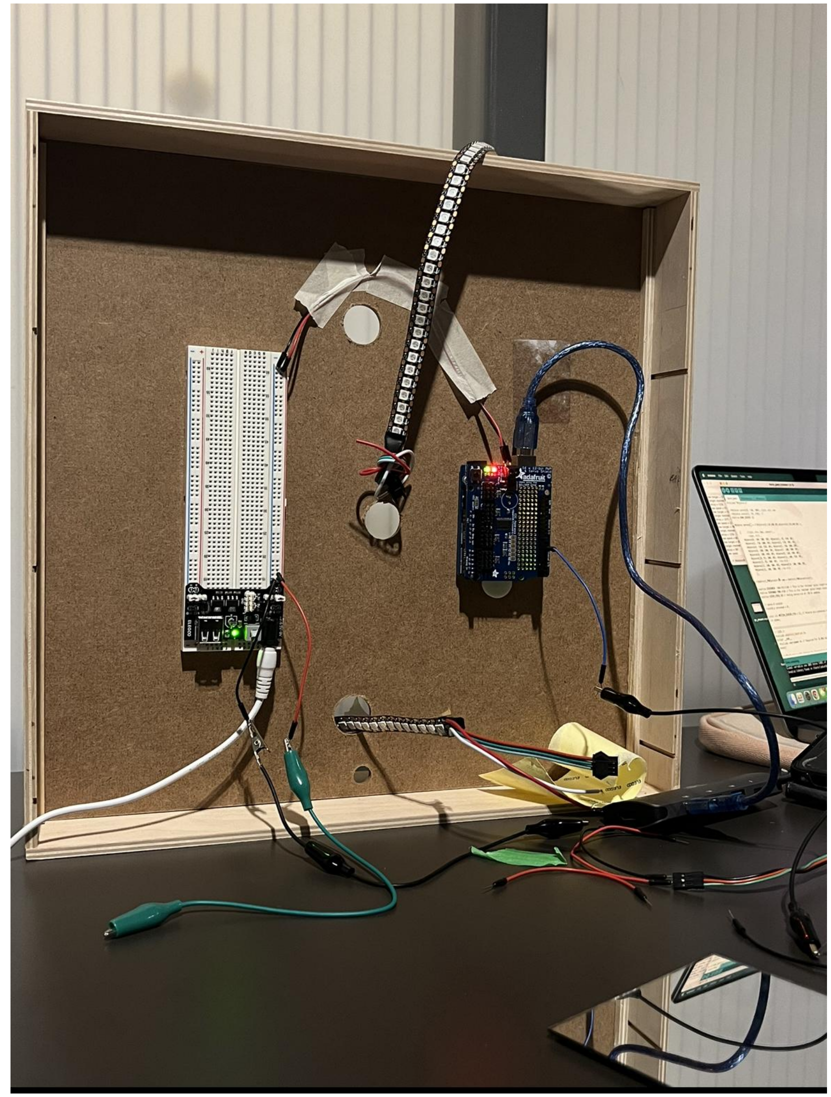
From the prototype we knew that each mirror would only need half an inch between each other to achieve a decent range of motion without bumping into each other. This would have been true if each mirror were aligned perfectly, but that proved to be more difficult than imagined later on. We also knew that each mirror needed to protrude over the surface its base bracket was attached to, so that it had space to tilt downwards.

With all of this information we made a design for a frame-like-container, 14” inches wide by 14” inches tall. The frame would be 4” inches deep, with a wall down the center dividing into two 2” inch sections. The first, front facing section, would have three ‘shelves’ to provide a space to attach the brackets. Each shelf was 1 ½” inches deep, leaving ½” overhang to allow the mirrors to tilt downwards. This also meant that when the mirrors were in a neutral, ‘flat’ state, the overall surface was more-or-less aligned with the edges of the frame. The back section would home all of our circuits and wires, and also give us the option to hang the piece on a wall. Holes were drilled through the divider on each row, providing a pathway for each motor’s wires to travel through.

ALGORITHMIC APPROACH

Firstly, we knew we needed to have precise control over each motor, and needed to get each motor back to a neutral position. Because the servo motors we used had 180° rotation, their neutral position would have to be 90°. That way the motor's position could decrease, getting closer to 0, or increase towards 180°. One of the user-error related issues faced during the prototyping phase, was not aligning the motor at 90° before securing it in the bracket. This caused the motor to stutter and get jammed, or try to move through its own bracket, slowing grinding down the plastic gears. To avoid this, we created a simple program (called “test_Servo_min_max”) that allowed us to a) test each servo’s minimum and maximum pulse length count and b) map those to degrees, to easily set each servo to 90° before securing it in the brackets.

Next, we had to create a program that allowed us to control multiple servos at once with ease. One of the problems we encountered during prototyping was an issue running both the motor and the motion sensor at the same time. This seemed to be caused by both the use of delays and for-loops. Both delays and for-loops seemed to interrupt the sensor's input, preventing it from providing data at a steady and fast rate. So instead we implemented a timer to inform the motors motion, avoiding loops and delays entirely. Secondly, we needed to create a class that we could use to control an array of servos. The parameters of which ended up being the servo's number (which correspond with its pin number), the minimum and maximum (in pulse length), and its neutral position (in degrees) for fine tuning. If no motion is detected, a random "target" degree is calculated for each servo, as well as a random speed using a timer to calculate how quickly the servo's "current" location should increase or decrease. We went with random degree as well as random because it fits with our concept of human movement in front of the mirror which can be random. Once the "target" has been reached, the servo will pause for 0-2 seconds, calculate a new target and speed, and then move towards that target. Once motion has been detected, every motor will concurrently 'snap' back into their neutral position.



FUTURE

For what's to come next, we would love to still incorporate the LED lights that can obtain biometric data; heart beats to pulse behind the mirrors, to make it even more of a personal experience. As well as paint our piece, and hide the wires behind the mirror panels. If possible, we would love to even create a larger frame to fit even a wall to make the concept a bit more intimidating.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