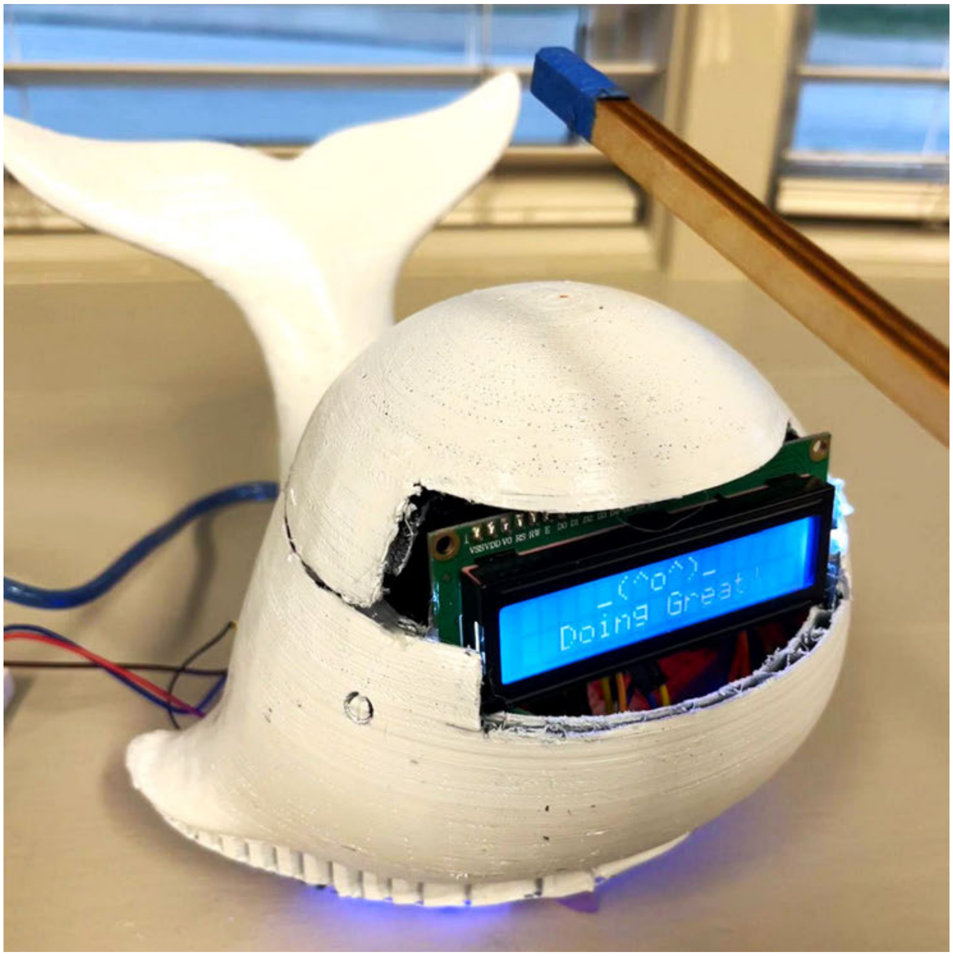
ANBO

Final Project Report



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Problem Statements

A design problem that is present in this study is users getting anxious and not taking a break to relax or disengage from their work.

The team's motivation for this project stems from wanting to create a monk-type robot that a user can meditate with and hopefully lessen their stress/anxiety. From personal experience and observations, we understand that people become invested in their work and seldom take vital breaks. Instead, they want to keep working until completion and the team has observed that this is not the optimal route for mental health. Thus, we have devised a project that involves a robot wooden fish that users can hit to create rhythm for meditation. We think that this approach is interesting because it involves a lot of human robot interaction and unique because the robot will light up to show how intense each hit is. Some specific questions that we had are: Where exactly should users hit so that the location is comparable to a real wooden fish and if the sensor can pick up pressure? How can we use an LCD screen to increase HRI?

We were able to measure success by putting the prototype out for user testing and observed reactions toward the robot. Everyone reacted very positively and loved ANBO! Many even said that ANBO truly helped them distress because hitting on tempo is a mindless activity and allows them to zone out.

Literature review

One of the first things we derived our inspiration from was the chapter 4 "Design" in the book Human Robot Interaction and Introduction (Bartneck et al., 2020, 44). It talked about robot morphology and listed many social robots with varying degrees of complexity, one such robot was Keepon which inspired our entire team. The initial inspiration to make something small, cute and stationary came from Keepon.

We then researched more about the stress people feel while working from home. As the pandemic recessed more and more companies have shown the inclination to continue with this system of working, in fact, work from home looks to be a new normal for the foreseeable future (Case, 2021). But as the offices complete close to three years in the work from home mode many signs of wear on our collective mind have started to show. Nearly 47% of people who worked from home claimed that they suffered from "remote work anxiety" (Wolstenholm, 2021).

Anxiety is our body's natural response to stress. Anxiety is often the vital part of other disorders like panic attacks, phobia, separation anxiety disorder and social anxiety disorder (healthline.org, n.d.). Remote work anxiety leads to other behavioral changes like irritability, sadness and depression (Wolstenholm, 2021). Lifestyle changes are usually the most recommended solution for anxiety. Often new habits like starting to write, or adopting a pet have shown to work wonders in reducing anxiety and stress (Khodarahmi, 2020) (Wei, 2021).

People often consult and solicit the help of trainers to battle their anxiety and control their stress levels. We believe that with the increasing cost of human capital such services can be harder for a common persons' reach, therefore a robot designed to alleviate anxiety in people working remotely would be an ideal point of focus. Furthermore, studies have shown that people are more likely to prefer training with a robot than a human when dealing with their anxiety and stress (Zhu & Deng, 2020). We therefore thought that this task is well suited for a home robot.

Once we decided to incorporate the buddhist monk hitting the wooden fish function as a stress buster our team was concerned that it could negatively impact user behavior and promote actions like hitting robots. We read articles like "Alexa, STOP!" — Are Robotic Personal Assistants Making Us Rude?" by (Kim-Suzuki, 2021) to better understand effects such repetitive actions have on human behavior. We contemplated this problem and took a design decision that a slow hitting to a low BPM beat would not pose this problem.

Research

User Diary Studies

Goal: To understand what people are doing when they are anxious and how the current solutions work.

Participants: 5 male and 5 female participants who have been working from home for more than two months, and self-reported that they have sensed stress to a certain level.

Key Steps:

1. Schedule a face-to-face meeting or phone call with each participant to discuss the details of the study.
2. Walk through the schedule or calendar for the reporting period and discuss expectations.
3. Provide a simple framework as below to support effective activity logging.
4. Evaluate all the information provided by each participant. Plan a follow-up interview to discuss logs in detail.
5. Ask probing questions to uncover specific details needed to complete the story and clarify as needed.

Picture 1: Handwritten diary tools to be distribute to potential users

Picture 2: Collected filled diaries

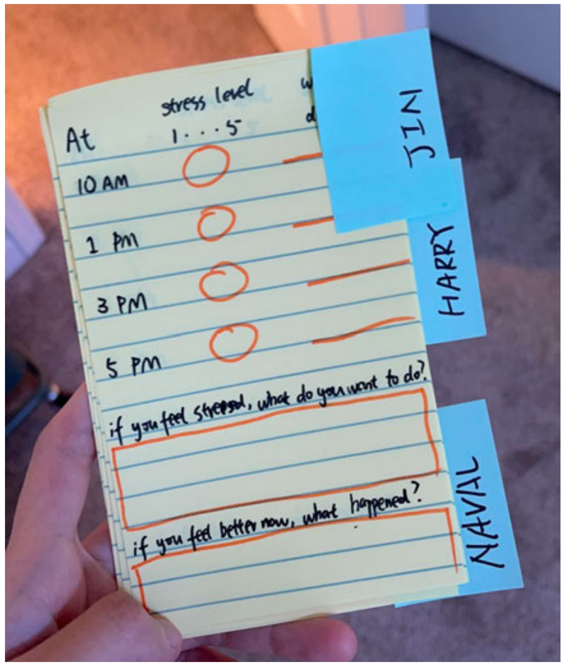

Figure 1. Diary study example

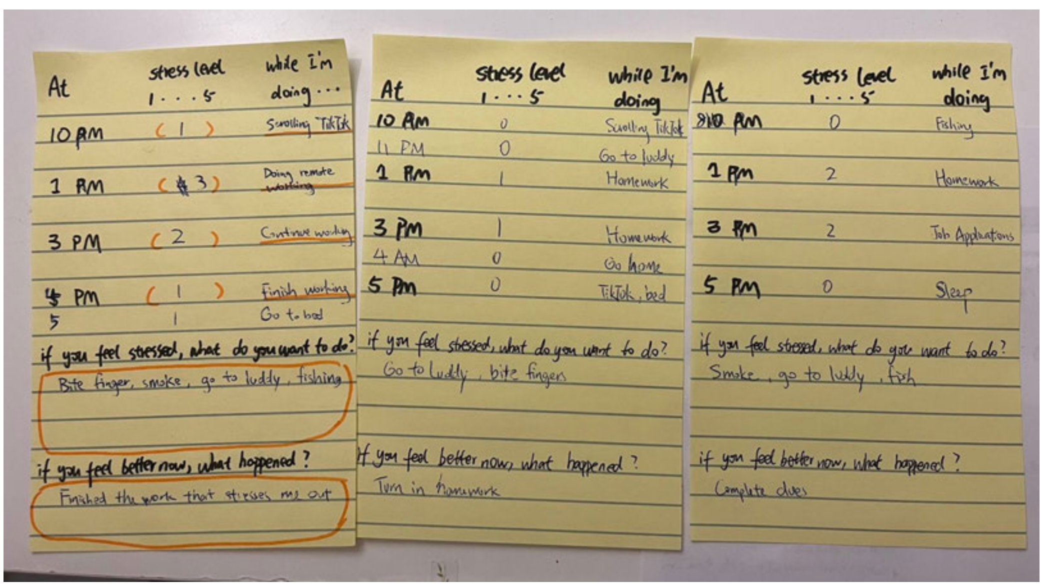

Figure 2. Completed diary studies

Contextual inquiry & Interview

Goal: To inspire design by observing and interviewing users in their work from home context. To learn about how people solve/relieve their anxiousness?

Participants: 2 male and 2 female participants who have been working from home for more than two months, and self-reported that they have sensed stress to a certain level.

Key steps:

1. Introduce myself and take some time upfront to build rapport with my participants.
2. Indicate what I hope to achieve during the interview and that I expect the participant to correct any misinterpretations I may develop as I learn.
3. Let the user know that I will watch while she goes about her work and that she should expect I to interrupt whenever I see something interesting to discuss.
4. Watch and learn.
5. Stop and initiate discussion when the user does something I don't immediately understand or when I want to confirm an interpretation.

Interview Results and Findings

We coded the interview responses and conducted an affinity diagramming exercise to investigate further and derive meaningful insights.

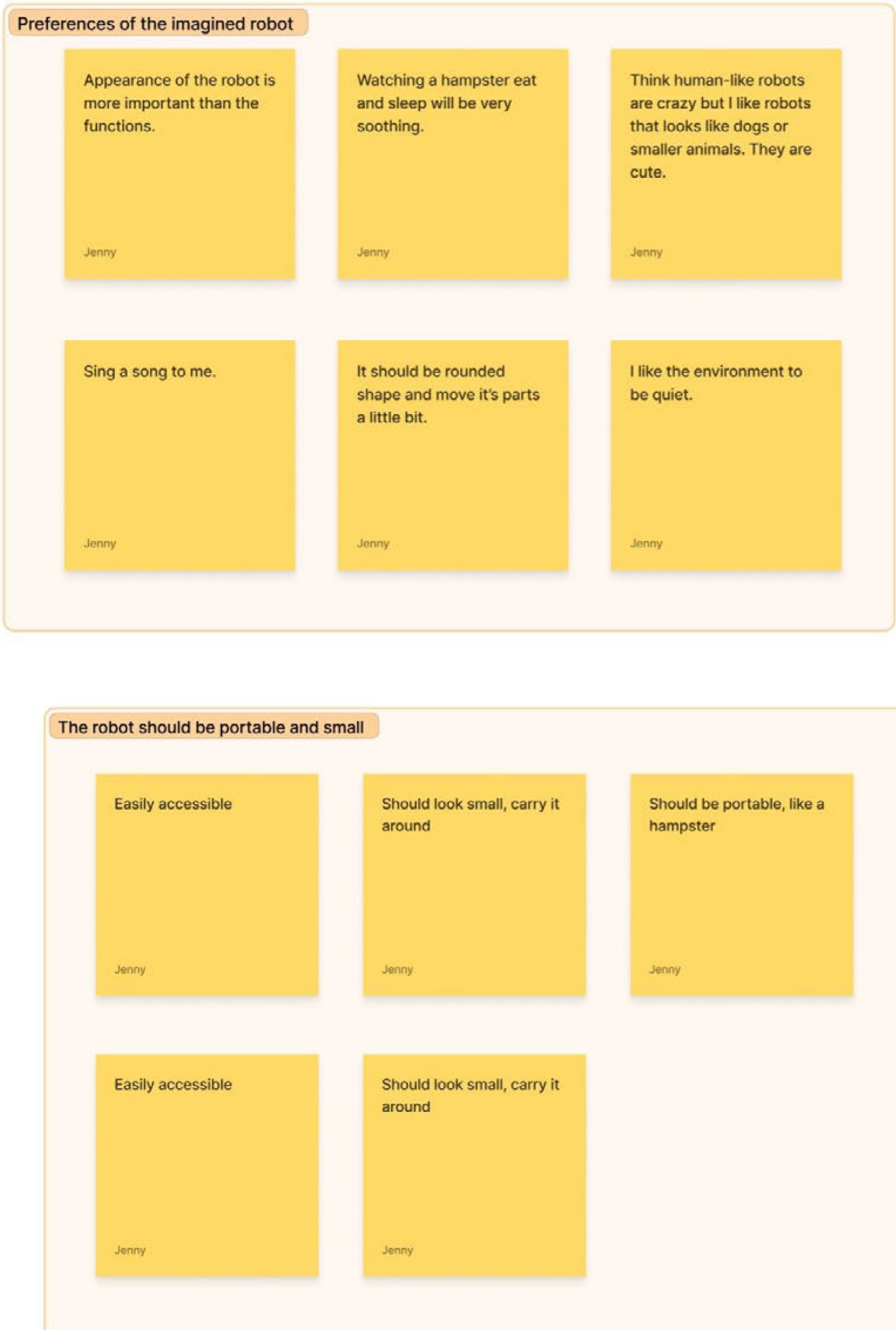

Figure 3. Affinity diagram of interview results

	Interview Findings	Insights for our design
1	People think human-like robots are sort of crazy and don’t like it in their household	Avoid mimicking human appearance
2	Robot animals are very cute, like dogs, or hamsters	Animals could be the our muse
3	The robot should be portable	We should design in a small size
4	People want to watch the robot animal eating or sleeping, just for observing fun	Probably let the robot doing what an real animal is doing
5	The robot should be very easy to access	Don’t make the robot too complicated
6	The appearance of the robot is more important than the function of it	We should pay more attention to its appearance
7	People think round shapes are comforting and cute	Design a round shaped robot, for example, a cute hamster with a round belly and tiny feets
8	People like their working environment to be quiet	Don’t use too much voice design, and try to keep the noise down

Table 1. Interview findings and insights

Dairy Study Results and Findings

The journal entries were coded in a spreadsheet. Using the raw data we tried to extract patterns from it to better understand our potential users.

- People are generally more stressed in the mornings. Most of the participants had a morning stand up meeting where they were due to present some work

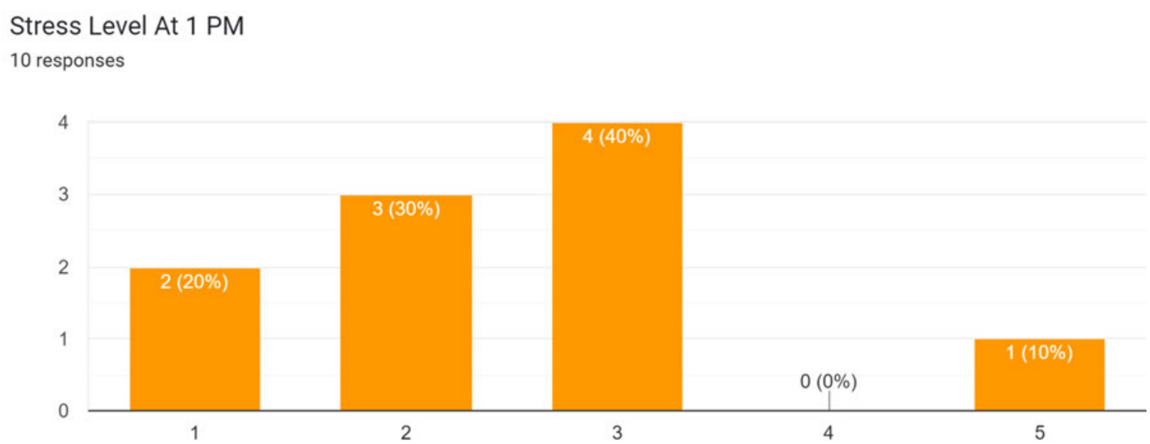

Figure 4. Diary study findings (1)

- There is drop in stress around lunch time. Eating seems to reduce stress or provide the necessary break required. This finding is consistent with participants' open ended question “ What do you do / what helps when you feel stressed?”, and multiple people replied: eating, as something which helps.

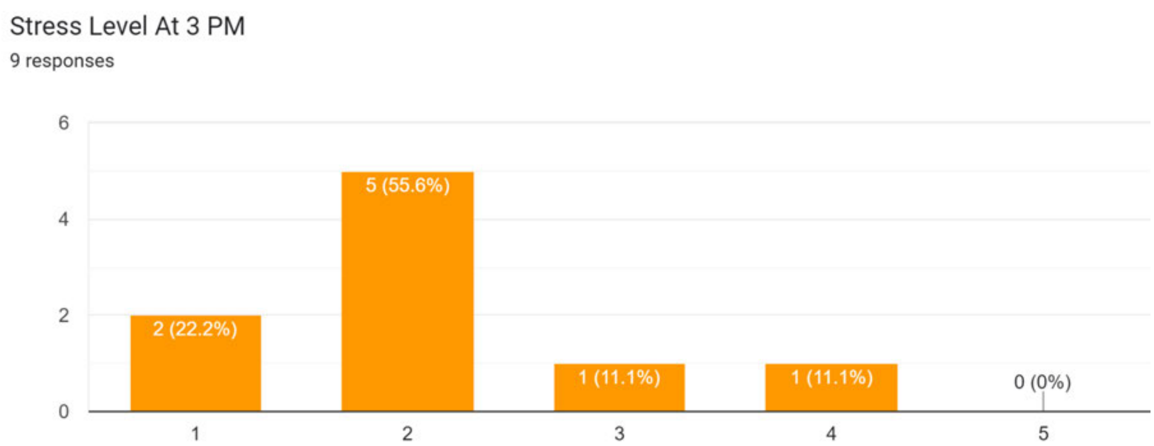

Figure 5. Diary study findings (2)

- Participants were least stressed at 5 pm. Mostly due to the fact that they were wrapping up and no longer worried about their work.

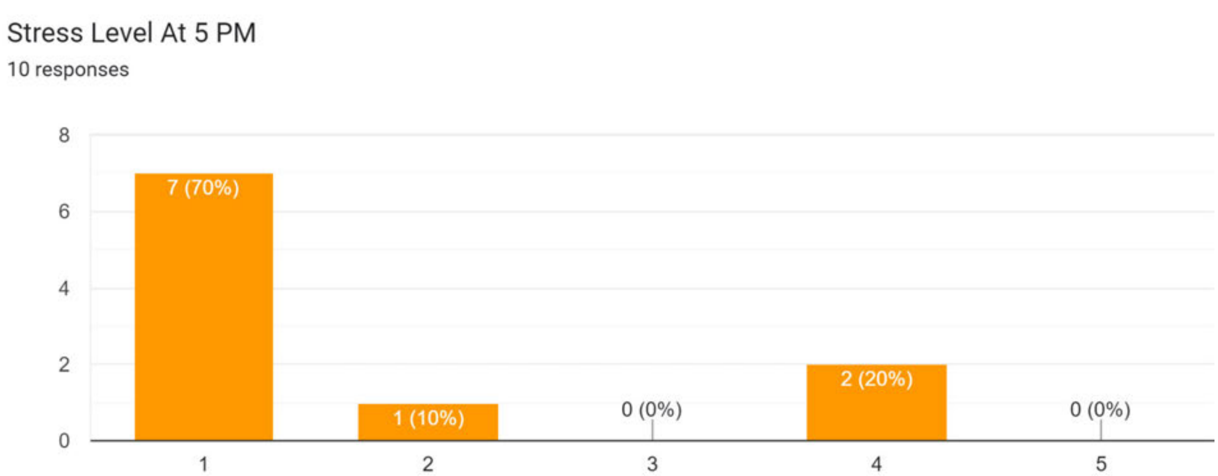

Figure 6. Diary study findings (3)

We were able to identify that some of the common triggers in remote working were the **morning meeting** and the prep work required to do that. The **piling of other work** (like homework or house chores) stressing our participants while they worked. Some other mentions were the anxiety they got from being late or tardy. A robot which helps our participants be on time and probably gives them motivation to grind through the morning blues can greatly help people who work from home.

Next we tried to identify some common practices adopted by our participants to combat that stress. The responses were pretty grim with many participants relying on stress eating or smoking. Only one participant responded with breathing exercise as his coping mechanism. Other responses like going for a arun are also good but probably not possible during the work day. One possible design frame could be to help guide our participants towards better stress coping mechanisms and nudge them away from unhealthy habits like smoking and stress eating.

Prototype Design

Ideation

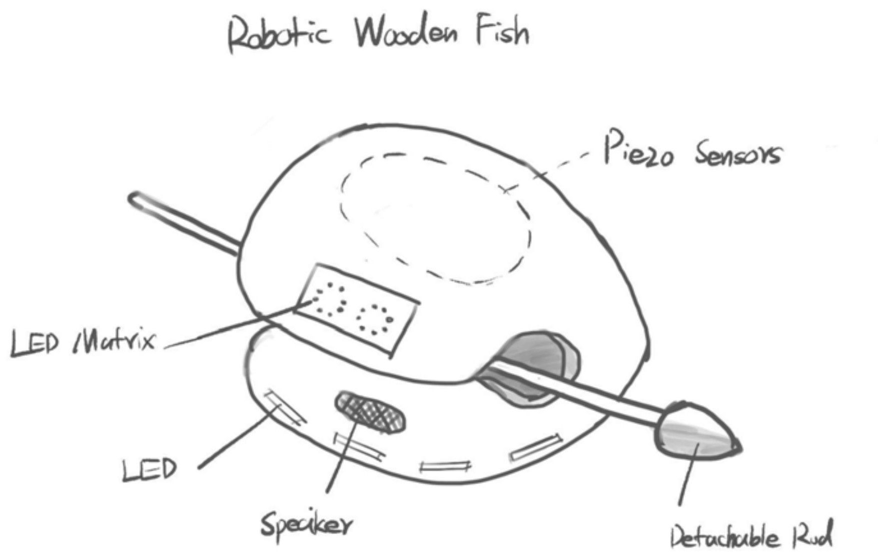

Figure 7. Sketch of Robotic Wooden Fish

Functions

1. **Rest reminder**
    a. Use an LED matrix to the front to show the facial expressions;
    b. Changing the expression to remind the user to take a break;
2. **Meditation session**
    a. The user takes out the rod to start a meditation session;
    b. Play meditating tunes;
    c. Put the Piezo sensor on the top to sense the user's knocking;

d. When the user knocks on it, ripples of light are displayed from the bottom of the robot with sound effects;

e. The user places the rod back to end the session.

Context of use

This product was designed to be used in a home environment. Home is not a strange environment for people, and each of us works, studies, relaxes and rests at home. Home used to be a safe place for people to relax after work, but the pandemic has blended our once-separate work lives and home lives together (Kerman et al., 2022). So it is important for us to help people find a balance between work and life at their homes.

By taking breaks to interact with the product, people can soothe their minds and focus better on their work. Since it is a private environment, the sound generated will not disturb others. Target users are people who work from home on desk jobs, including working professionals and students.

Components

- Piezo sensor (included in Kits)
    - Rigid foam (Dual Trigger Pad - DIY video on Youtube)
- LED matrix
    - Or micro:bit
    - Or Screen
- Bluetooth speaker
- Batteries/Power bank/Charging cable

Materials

- Wood shell

Circuit Design

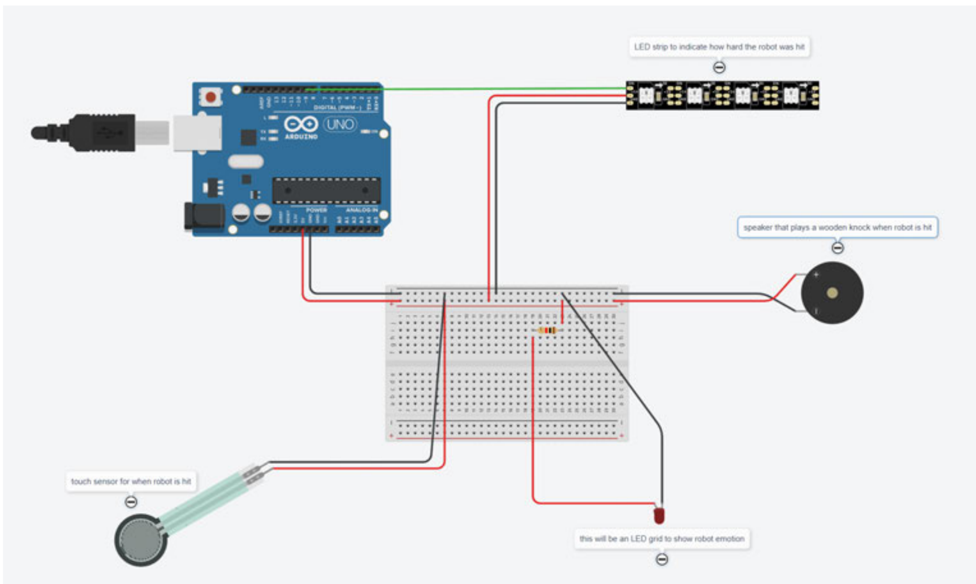

Figure 8. Initial circuit design

Prototype Progress

We start by connecting the pressure sensor and the LED to control the brightness change of the LED by pressure. At the same time, we laser cut a three-tier stand to hold the parts and calculate the size of the product. Then we move on to add more components: screen, speakers, light strips, etc. The code of each component was tested in a separate file, and then incorporated into the main code file after successful setup. As for the shell, we 3D printed a whale-shaped model. Due to size limitations, we removed the internal bracket in the final prototype. We also painted the shell white to match the purpose of the product.

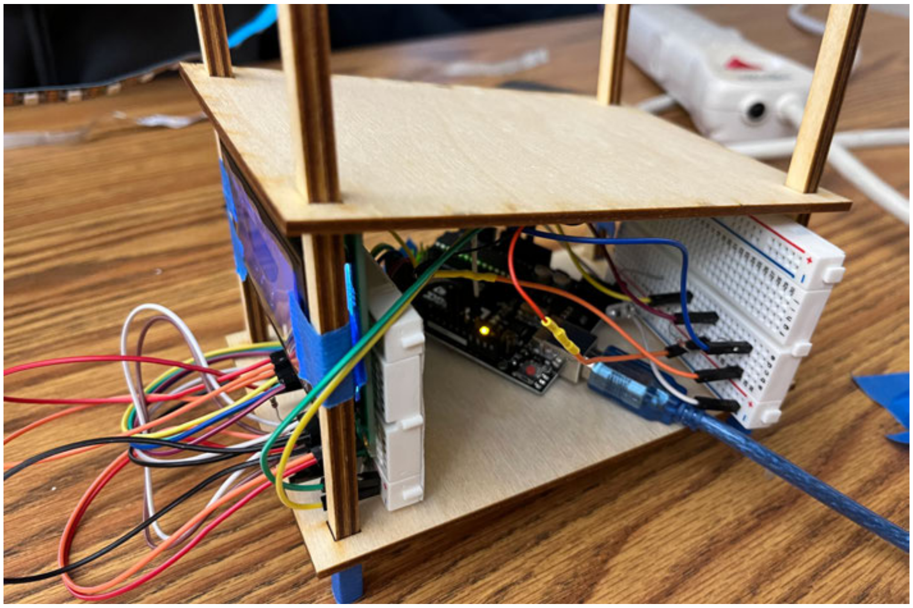

Figure 9. Low-fidelity prototype with internal shelf

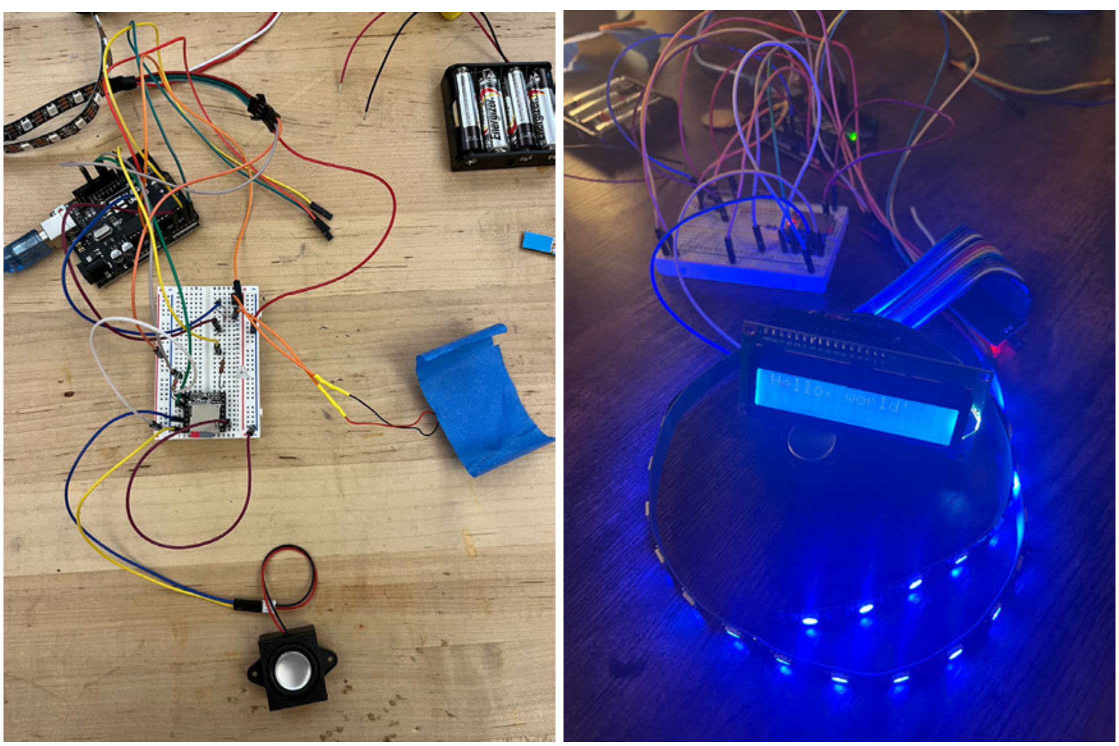

Figure 10. Connect and test more components

Figure 11. Working in progress

Final Prototype

Our final product is a whale shaped cyber wooden fish. It comes with an LED screen, speakers and a built-in LED light strip. It will play a melody with beats to guide the user in meditation. When the user taps on the head of the whale with the included rod, ripples of blue light will be generated from the bottom of the whale. If the user can follow the rhythm well, dynamic expressions and encouraging words will be displayed on the screen. When the user taps too fast, the text and expressions will change and the light will change to red to prompt the user to slow down and calm down. We also provide a button to switch between different styles of melodies.

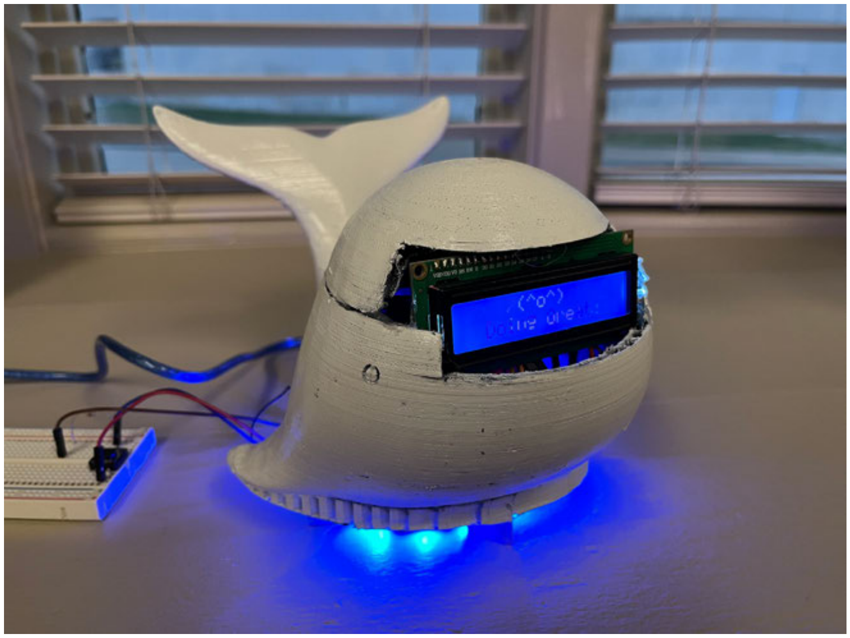

Figure 12. Final prototype

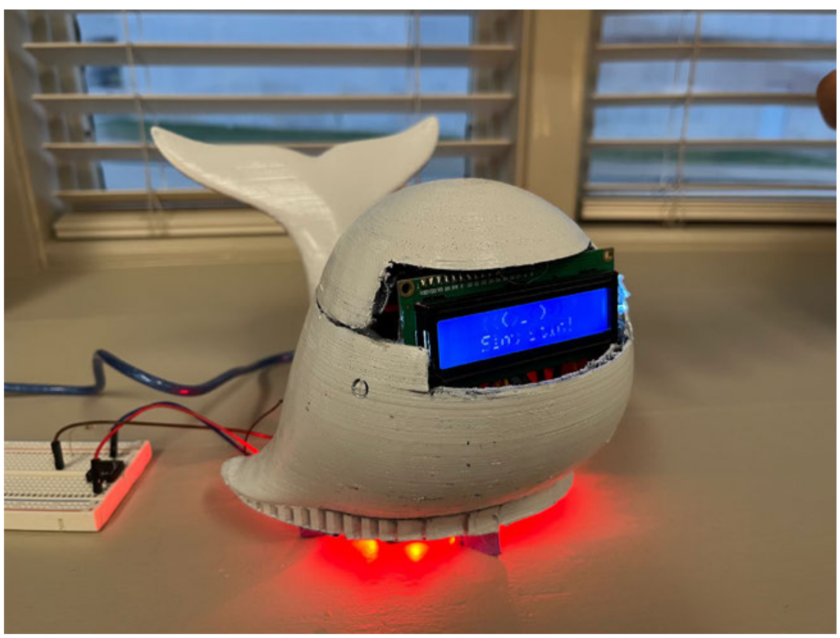

Figure 13. Warning of tapping too fast.

User Evaluation

During the day of presentation, many HRI and Arduino students approached our prototype with curiosity. This is because the concept of the wooden fish is foreign to many, especially American students. In Asia, Buddhism is a popular religion and the wooden fish is used during meditation. Thus, Asian students will be able to catch on quicker. However, in the end, all students understood the purpose of our robot and thoroughly enjoyed testing it. We sat each individual down and explained the main functions of the robot to them, such as: Where to hit the robot, pressing the button to switch songs, keep an eye on the screen to keep interaction, and viewing the lights to see if they are on tempo or not. All users reported that they were able to relieve stress with ANBO. Some claim that they would love ANBO to be at their desk or workstation so that they can destress whenever they would like. I believe that these observations prove that our robot has achieved its goal and is on its way to becoming the best stress relieving robot there is!

Attached below are videos and pictures of users interacting with ANBO:

https://youtube.com/shorts/nCToQYlY-jQ?feature=share

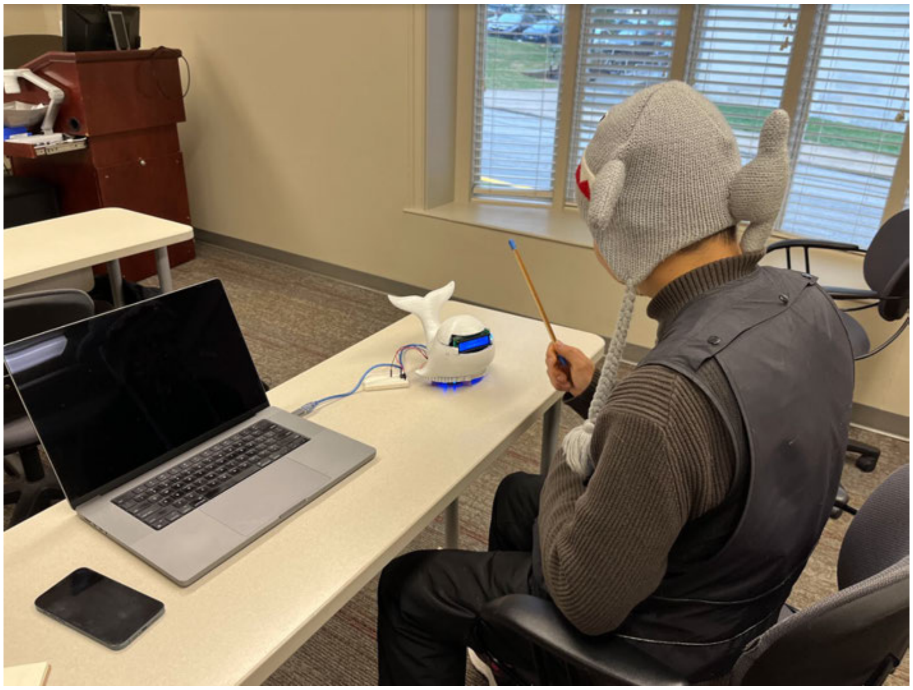

Figure 14. Testing with user (1)

Figure 15. Testing with user (2)

Reflection

This project has been a huge learning experience for all of us in the team. One of the primary learnings from the whole process was the complexity and the unpredictable hiccups of actually building the robot. We faced many unforeseen challenges in making the prototype work from a non responsive screen to the short circuiting board. All in all it was a great experience overcoming all these challenges. But in hindsight we perhaps should have had more testing phases in our design process to better iron out such kinks. We also felt that we had to bargain some of the features we had initially set out in our design process Chief among them was a moving/flapping tail, to attract users attention and indicate it is meditating time. We faced difficulty in finding enough space to fit the component for this feature in our model and while trying to fit them broke the tail of our 3d printed model effectively ruling out the feature.

We received very rich feedback from our classmates. Most of the people reported that beating our robot made them calm down which was our primary objective. One of the cons of the design was perhaps the sensor placement. We had placed it in the feet of the robot and it made it too sensitive, and broke it mid way. We could perhaps have an inbuilt padding in the feet of the fish to house the sensor and protect it and make it more reliable. One of the ethical design concerns which we have prevailed since our concept stage has been the act of beating a robot. This might constitute robot abuse and reinforce such behavior. In future we can perhaps also add a negative output if a user beats it too hard to curb such behavior out. Overall we feel that the robot performed its primary task well, but we could definitely add more social interactions to make it more engaging.

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Appendix: Code

```
#include <FastLED.h>

#include "SoftwareSerial.h"

#include "DFRobotDFPlayerMini.h"

#include <Wire.h>

#include <LiquidCrystal_I2C.h>


// DFPlayer Mini parameters

static const uint8_t PIN_MP3_TX = 9; // Connects to module's RX

static const uint8_t PIN_MP3_RX = 10; // Connects to module's TX

static unsigned long timer = millis(); //timer

SoftwareSerial softwareSerial(PIN_MP3_RX, PIN_MP3_TX);

DFRobotDFPlayerMini player;

#define BUTTON_PIN     3

int buttonstate = 0;


// Pressure sensor parameters

int value = 1023; // pressure sensor value; The higher the pressure, the smaller the value (max =
1023)

int threshold = 200; // Sensitivity of the pressure sensor; the higher the threshold, the more
sensitive the sensor

int hitNum = 0;
```

```
// LED strip parameters
#define LED_PIN     13
#define NUM_LEDS    32
CRGB leds[NUM_LEDS];
int brightness = 0;  // how bright the LED is
int fadeAmount = 10;  // how many points to fade the LED by

// LED Screen parameters
LiquidCrystal_I2C lcd(0x27, 16, 2); // Set the LCD address to 0x27 for a 16 chars and 2 line
display

void setup() {

  Serial.begin(9600);

  // Init serial port for DFPlayer Mini
  softwareSerial.begin(9600);

  // Start communication with DFPlayer Mini
  if (player.begin(softwareSerial)) {
    Serial.println("Connected to DFPlayer");
```

```
  // Set volume to maximum (0 to 30).
  player.volume(28);
  // Play the first MP3 file on the SD card
  // player.play(1);

} else {
  Serial.println("Connecting to DFPlayer Mini failed!");
}

// Switch music button setup
pinMode(BUTTON_PIN, INPUT);

//Set color for LED Strip
Serial.println("Init LED Strip");
FastLED.addLeds<WS2812, LED_PIN, GRB>(leds, NUM_LEDS);
  for (int i = 0; i < NUM_LEDS; i++) {
    leds[i] = CRGB ( 0, 0, 255);
}
FastLED.setBrightness(brightness);
FastLED.show();
```

```
  // LED Screen
  // initialize the LCD
  Serial.println("Init LED Screen");
        lcd.begin();

        // Turn on the blacklight and print a message.
        lcd.backlight();
        lcd.setCursor(4, 0);
        lcd.print("(*^_^*)");
  lcd.setCursor(3, 1);
  lcd.print("Hi there!");
}

void loop() {

  // Switch music when press button
  buttonstate = digitalRead(BUTTON_PIN);
  if (buttonstate == HIGH){
    player.next();
    delay (1000);
  }
```

```
// If hitting interval is less than 1 second
// if (millis() - timer < 1000) {
//   timer = millis();
//   //do something
// }



// Read current pressure value
int value = analogRead(A1);

// When a knock is detected
if (value < threshold){

  // If hitting interval is too small, change lights and screens
  if (millis() - timer < 850) {
    timer = millis();
    // Change lights to red
    FastLED.addLeds<WS2812, LED_PIN, GRB>(leds, NUM_LEDS);
    for (int i = 0; i < NUM_LEDS; i++) {
      leds[i] = CRGB (255, 0, 0);
    }
    // Change to sad face and print hint on screen
```

```
    lcd.clear();
    lcd.setCursor(3, 0);
          lcd.print("{{(>_<)}}");
    lcd.setCursor(3, 1);
    lcd.print("Slow Down!");

  } else {
    timer = millis();

    // Change to happy face
    lcd.clear();
    lcd.setCursor(4, 0);
          lcd.print("/(^o^)/");

    // Randomly print encourage words on screen
    randomSeed(analogRead(0));
    long randomNum = random(4);

    switch (randomNum) {
      case 0:{
        lcd.setCursor(5, 1);
        lcd.print("Good!");
```

```
      break;
    }
    case 1:{
      lcd.setCursor(4, 1);
      lcd.print("Awesome!");
      break;
    }
    case 2:{
      lcd.setCursor(2, 1);
      lcd.print("Doing Great!");
      break;
    }
    case 3:{
      lcd.setCursor(3, 1);
      lcd.print("Fantastic!");
      break;
    }
    case 4:{
      lcd.setCursor(2, 1);
      lcd.print("Keep Going!");
    }
  }
```

```
}

// LED Strip will brighten and then dim
brightness = 5;
while (brightness > 0){
  FastLED.setBrightness(brightness);
  FastLED.show();

  // change the brightness for next time through the loop:
  brightness = brightness + fadeAmount;

  // reverse the direction of the fading at the ends of the fade:
  if (brightness <= 0 || brightness >= 255) {
    fadeAmount = -fadeAmount;
  }

  // wait for 30 milliseconds to see the dimming effect
  delay(10);
}

// Reset led color
if (leds [0] != CRGB (0, 0, 255)){
```

```
        FastLED.addLeds<WS2812, LED_PIN, GRB>(leds, NUM_LEDS);
        for (int i = 0; i < NUM_LEDS; i++) {
          leds[i] = CRGB (0, 0, 255);
        }
      }

    // Reset facial expression on screen
    lcd.setCursor(0,0);
    lcd.print(" "); // Clear Screen
    lcd.setCursor(4, 0);
              lcd.print("_(^o^)_");

  }
}
```