MycoTouch

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Abstract

The world of microorganisms is invisible to the human eye, yet it is captivating and complicated. Every single day, humans interact with small organisms that they cannot perceive; providing themselves as living vehicles for moving bacteria and unknowingly transporting these microorganisms from place to place and person to person.

MycoTouch is a tangible installation that aims to artistically visualize these invisible activities. This project is a visualization of a fungal landscape whose soil gains new bacteria upon being touched by the human hand. The prototype has uses both a “dirt box” and a “light box” which are connected to each other through the internet. A user's interactions with the dirt influences the visual display of the mushrooms in the light box. In this way MycoTouch is an artwork ultimately about touch, connectedness, and the wonder and appreciation for that which we cannot see or fully understand.

Introduction

The primary objective for this project was to reconnect people with nature and the physical world through use of networked media. Experiencing the natural world has become less attainable for many due to present pandemic restrictions. This project aimed to address this idea in a fun, genuine and intuitive way; leaving room for potential users to ideally “play” with the natural physical elements of our project.

The tangible interface of our prototype is made up of a box of dirt layered on top of six analog photocell sensors. The sensors are connected to an Arduino Uno hidden on the underside of the box. These sensors are placed in a row and correspond to the row of mushrooms in the lightbox. The analog values from the sensors are sent from the Arduino to a TouchDesigner file which is able to compile the data before sending it out to the light box using a TouchOut node. In addition to the physical dirt interface, a web interface was created using ngrok. This allowed multiple users who did not have access to the dirt box to control the mushroom lighting.

For the output part of our prototype, we’ve constructed a box of paper-crafted 3D mushrooms between a layered paper landscape. The whole construction is then put on top of a light pad that, when lit, will light up each individual mushroom and the four edges of the box from the bottom. The colors of the edges and the degree of brightness in each mushroom change interactively as the user touches and plays with the dirt from the dirt box.

Background and Previous Works

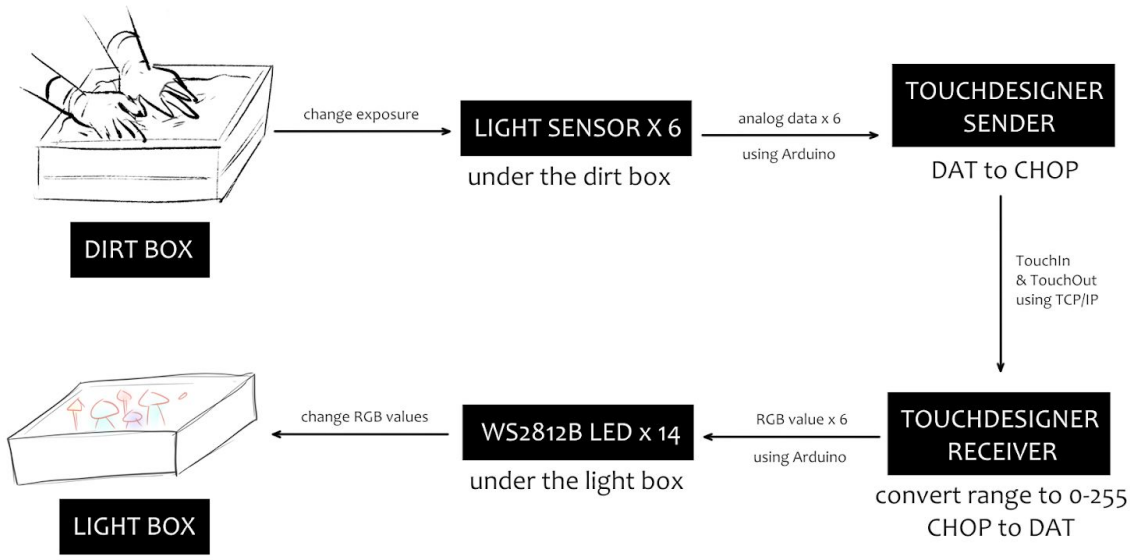
MycoTouch built upon previous projects that were completed in former Computation Arts classes, notably CART 360 - Tangible Media. Incorporating physicality into our project became important due to the abundance of screen-only time that was imposed on many students during the pandemic. Elsa had worked on a project for CART 360 entitled PlayData, which used a wireless conductive clay interface to make changes to a sphere rendered on

TouchDesigner. The aim with MycoTouch was to use an expanded knowledge of TouchDesigner to create a more interesting networked space which had tangible components.

While Hao has knowledge in programming with Python and working with motion graphics, she is specialized in game design and most familiar with game engines. Previous to this course Hao had limited experience working with tangible media, electronics art or using TouchDesigner's LED mapping or data transmitting features. This project allowed for a foray into new TouchDesigner and programming skills. This made this project an interesting challenge for both creators. On a personal level, MycoTouch was an opportunity to open the horizon toward exploring a new form of artistic expression: that of physical networked media.

Methodology

Conceptual Design



System Diagram

The visualization of microorganism activities with fungal growth was chosen not only because of a personal fondness of the creators towards mushrooms but also due to the similarities between fungi and bacteria. Fungal spores like bacteria are microscopic and can be spread easily by human hands. On an aesthetic note, mushrooms have a visual appeal that

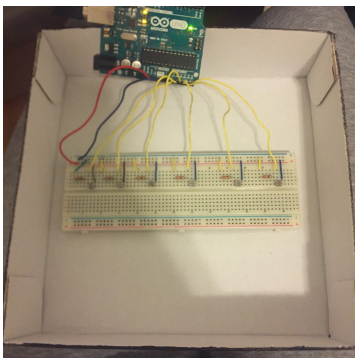
invites whimsicality and playfulness, which were both desired qualities for the end result of the prototype. The light box was made using papercut and origami in order to further emphasize these specific qualities. These materials also allowed light to transmit easily and efficiently.

The tangibility and physicality were also a major part of the project. In MycoTouch users are encouraged to touch the dirt, mix things up, play with the density, and observe the effects their input is having on the mushroom light box.

In order to make the system as subtle as possible and reveal only the two physical components —so as not to distract from the seamless reaction of the mushrooms to the user's input— we decided to send the data through the internet, taking advantage of TouchDesigner's Touch In and Touch Out CHOPs which allow data to be transferred wirelessly between TouchDesigner files on separate computers.

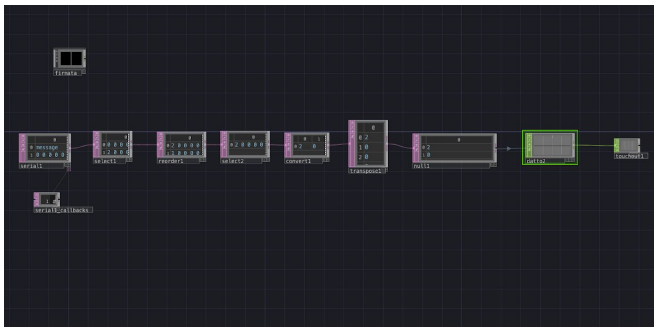
System Description

The dirt box is a painted cardboard box filled with potting soil. As the user plays with the dirt the analog photocells receive more light thereby affecting the resistor values. An Arduino script was uploaded to the Arduino UNO telling it to collect the analog sensor values. The script also used a shared Arduino-TouchDesigner library called Firmata, which allows TouchDesigner to access the Arduino data.


The TouchDesigner file imported the analog reader values and separated the sensors into columns using multiple select DATs and convert DATs. The DAT data was converted to a CHOP node and sent out using a TouchOut CHOP.

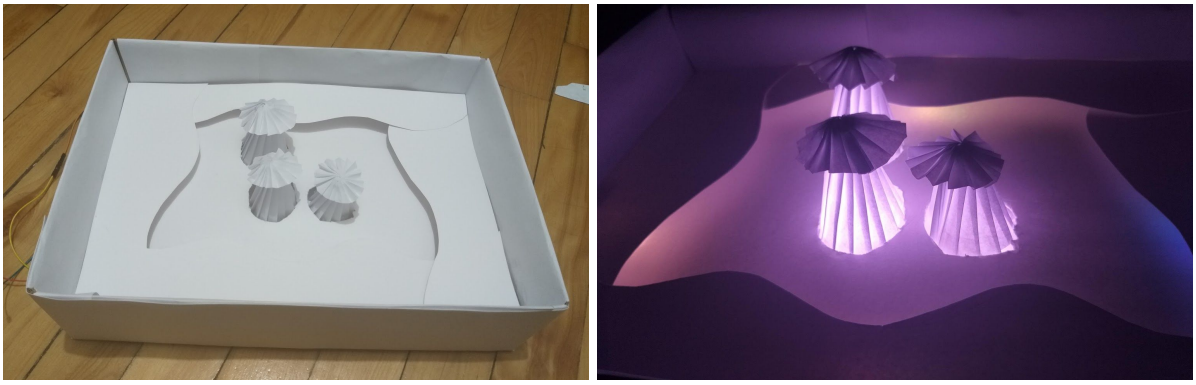
```
#include <Firmata.h>

// the setup routine runs once when you press reset:
void setup() {
  // initialize serial communication at 9600 bits per second:
  Serial.begin(9600);
}

// the loop routine runs over and over again forever:
void loop() {
  // read the input on analog pin 0-5:
  int sensorValue_A0 = analogRead(A0);
  int sensorValue_A1 = analogRead(A1);
  int sensorValue_A2 = analogRead(A2);
  int sensorValue_A3 = analogRead(A3);
  int sensorValue_A4 = analogRead(A4);
  int sensorValue_A5 = analogRead(A5);


  // Convert the analog reading (which goes from 0 - 1023) to a voltage (0 - 5V):
  //float voltage = sensorValue * (5.0 / 1023.0);


  // print out the value you read:
  Serial.print(sensorValue_A0);
  Serial.print("\t");
  Serial.print(sensorValue_A1);
  Serial.print("\t");
  Serial.print(sensorValue_A2);
  Serial.print("\t");
  Serial.print(sensorValue_A3);
  Serial.print("\t");
  Serial.print(sensorValue_A4);
```



A public IP for the dirt box was created by going accessing and making a request in the router settings. This public IP was listed in a parameter in the light box TouchDesigner file in order for the lighting to respond to the analog sensor data.

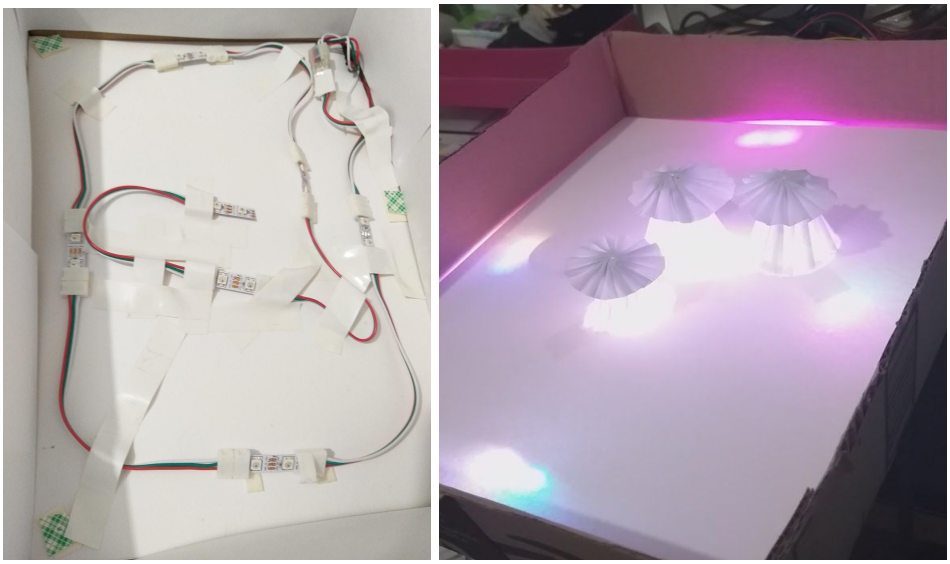
The light box interface is an all-white cardboard box with a ground layer holding three “mushroom lanterns” and a surrounding layer —which adds depth to the composition and shows the edge lights more subtly.

Two mushroom designs that we were considering during the brainstorming process. We finally decided to go with the second (white) design, as it’s easier to secure on the surface and is ideal to be used as a lantern.



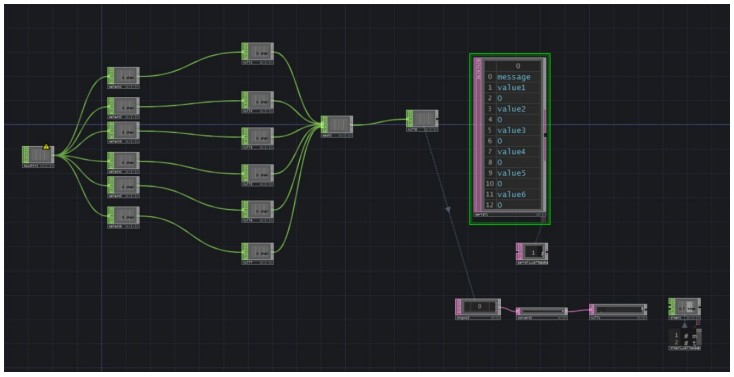
The mushroom box without light (left) and when properly lit up (right). The ground layer has 3 holes cut out for the mushrooms so that they can capture the light completely.

Under the ground layer of the box is a set of 14 individually addressable LEDs (WS2812B) positioned so that the last 3 pairs of LEDs are directly under the mushrooms while the former 4 go around the edges. Unfortunately, due to the lack of tools and the current pandemic restrictions, the LED pattern was unable to be soldered. The alternative that was chosen was to use 3-pin connectors as well as regular tape to secure the whole string down as much as possible. This LED string was then connected to an Arduino UNO and hooked up to the receiver computer with a USB cable. However this was a minor aesthetic issue which was easily covered by the composition on top.



Left: The LED pattern. Each cut includes 2 LEDs for better brightness and more interesting color combinations. Right: The mushroom box before cutting the ground layer and putting on the second layer. The main mushroom light didn't look very effective, as it spilled out of the scope of the mushrooms.

The lightbox was attached to a TouchDesigner file. After this particular TouchDesigner file received all the data from the sending TouchDesigner file's TouchIn node, these values were converted into integer values ranging from 0 to 255 in order to be used by the Arduino UNO's Serial DAT.



Check Project files/Receiver/mushroom_receiver.toe folder for a more detailed structure on data output.

The Arduino script then used this data to manipulate the RGB values of 14 lights. The number and positioning of the sensors only corresponded in an approximative sense to those of the LEDs. Therefore, each LED ended up being controlled manually via a script which implemented direct sensor values instead of pixel mapping. Considering the small number of LEDs that were ultimately used in the final prototype and how their arrangements are not the standard matrix grid, this solution made the most sense. The result is a smooth transitioning of brightness when a light sensor is slowly uncovered then covered again, enhanced with whimsical color changes from the background —as if the whole landscape responds to the user's hand (demo video can be found here).

```
leds[1].setRGB(value1*0.5, value1*0.5, value2*0.5);
leds[2].setRGB(value3*0.5, value2*0.5, value2*0.5);
leds[3].setRGB(value3*0.5, value4*0.5, value3*0.5);
leds[4].setRGB(value4*0.5, value4*0.5, value5*0.5);
leds[5].setRGB(value6*0.5, value5*0.5, value5*0.5);
leds[6].setRGB(value6*0.5, value1*0.5, value6*0.5);
leds[7].setRGB(value1*0.5, value1*0.5, value3*0.5);
leds[8].setRGB(value5*0.5, value3*0.5, value3*0.5);

leds[9].setRGB(value1, value1, value1);
leds[10].setRGB(value2, value2, value2);
leds[11].setRGB(value3, value3, value3);
leds[12].setRGB(value4, value4, value4);
leds[13].setRGB(value5, value5, value5);
leds[14].setRGB(value6, value6, value6);


FastLED.show();
```

Check Project files/Receiver/ledcombo/ledcombo.ino for full script. The edge LEDs are made dimmer compared to the mushroom LEDs, with only half the latter's brightness. Their colors also vary randomly using mixes of the 6 original values.

Due to covid-19 restrictions, the audience did not have the chance to interact directly with the MycoTouch project, therefore making the “playfulness” and the delight in physical interactivity difficult to translate during the CART 451 presentation. In order to make the project more accessible to multiple users, an online interface was developed which allowed users to control the mushroom box via an online trackpad. While the feeling of interacting with physical dirt can not be replicated, the user was still able to enjoy the way the mushroom box responded to their mouse or their touchpad. This trackpad was hosted using ngrok, and thus the link used was only temporary (working demo can be seen in Documentation/ngrok_interaction.mp4).

Conclusion

The creators of this project were encouraged during the testing process when the lights responded quickly and accurately to Elsa’s manipulation of the dirt box. As previously mentioned, the limitations surrounding Covid-19 made this project unable to presented in its desired space, which would have been in-person. Ideally MycoTouch would be for a live audience. However, the current iteration of this project achieved a visually satisfying result using scripts and a design system that is easy to use and customizable; should this project be expanded upon in the future.

The challenges that were faced during this project were issues primarily regarding the light box. Originally a functioning LED grid was envisioned instead of using just an LED strip. After a couple failed attempts using the professor’s existing LED matrix, the idea of using pixel mapping was reevaluated. In the end a light pad with fewer LEDs that did not require an external power source aside from the Arduino itself was used. The lighting animation was therefore technologically less complex, but still visually captivating. The initial goal of creating playfulness using elements from nature was still preserved even with a simplified system.

The technical lessons that were learned throughout the building of this project were how to create multiple networking features using TouchDesigner, LED mapping and Arduino. Artistically, this project taught the creators how to design physical environments for electronic components which are engaging and invite the users to participate. This project emphasized a

lesson on how design can be utilized in order to create a seamless and intuitive experience when using networked media. In a future development of this project it would be interesting to craft together a fully-fleshed LED matrix with using coordinates for the corresponding light sensors, allowing for an even more realistic bacteria-fungal growth metaphor.

Keywords

Tangible Media, Physical Installation, Papercraft, Physicality, Mushrooms, Interactive Art, Networked Media, LED Mapping

References

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