WEEK1-2 Topic Research - Fungi and Plants Relationship

What might be wrong in this relationship and what might be underestimated about fungi are the starting points to looking for specific perspectives that the project would like to explore and address. I started my research from evolutionary history to examine fungi and plant relationships.

Fungi were instrumental in enabling the early terrestrial colonization by plant ancestors, which were initially green algae capable of photosynthesis but lacking root systems to venture far from water sources. As evolutionary pressures increased in crowded aquatic environments, fungi and early plants developed a symbiotic relationship to conquer land together. This mutually beneficial arrangement allowed plants to share their photosynthetically produced sugars with fungi, which in return provided the plants with essential water and minerals through their mycelial networks, effectively serving as primitive root systems and facilitating the uptake of vital nutrients.

After the research, I would like to develop my design practice by amplifying the awareness of fungi's existence and their consequential effects on plant ecosystems and, by extension, our entire biosphere. This goal emerges from the critical need to bridge the widening chasm between humanity's empathic connection to nature, which has been gradually diminishing. By casting a spotlight on the often-neglected vibrancy of fungi, the project aspires to reignite a sense of empathy and a fundamental bond between humans and the natural environment.

WEEK3 Primary research

Questionnaire: https://forms.gle/MUvM7v4TFzxAynwX6

I conducted a questionnaire about awareness and understanding of micro-level non-human entities. According to the results of the survey, most of them have limited knowledge about microorganisms, there exists a substantial gap in the general understanding of microorganisms among the participants.

Personal Information

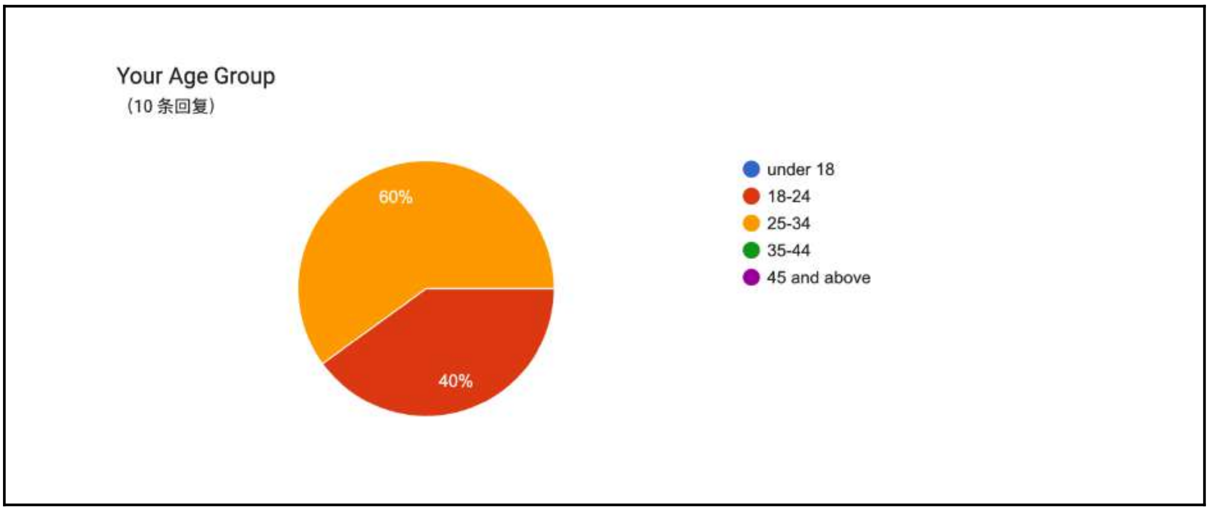


Figure 1.1. Yu, Q. (2023) *Age group Question*

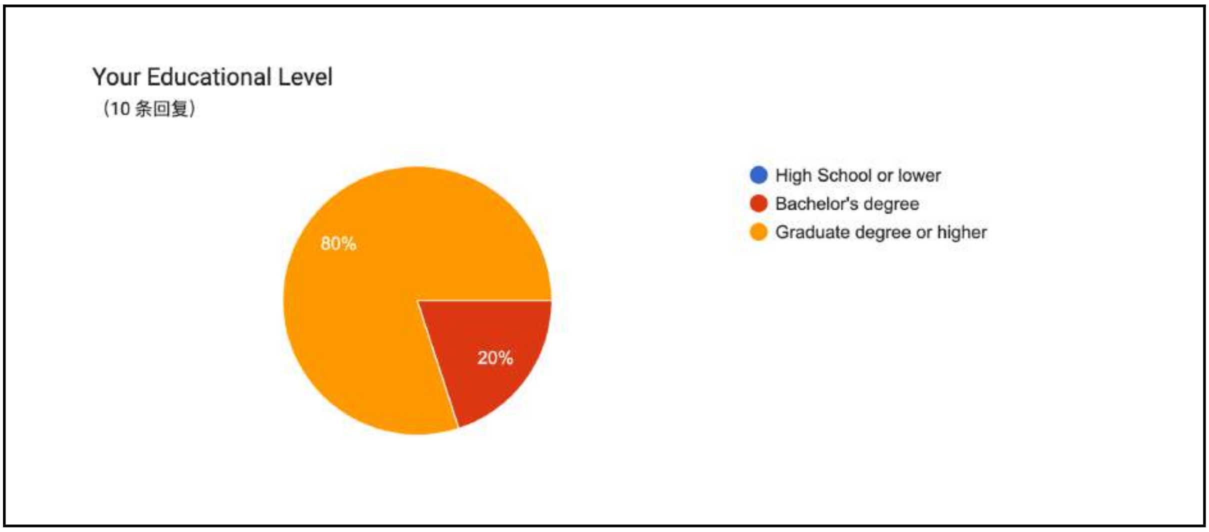


Figure 1.2. Yu, Q. (2023) *Educational Level Question*

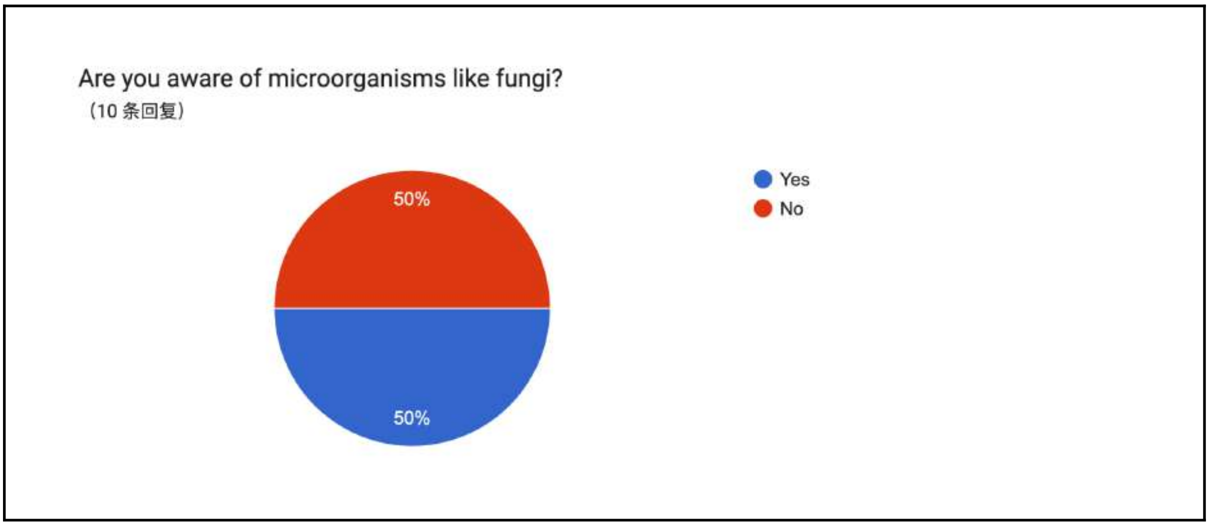


Figure 1.3. Yu, Q. (2023) *Awareness Question*

Main Survey

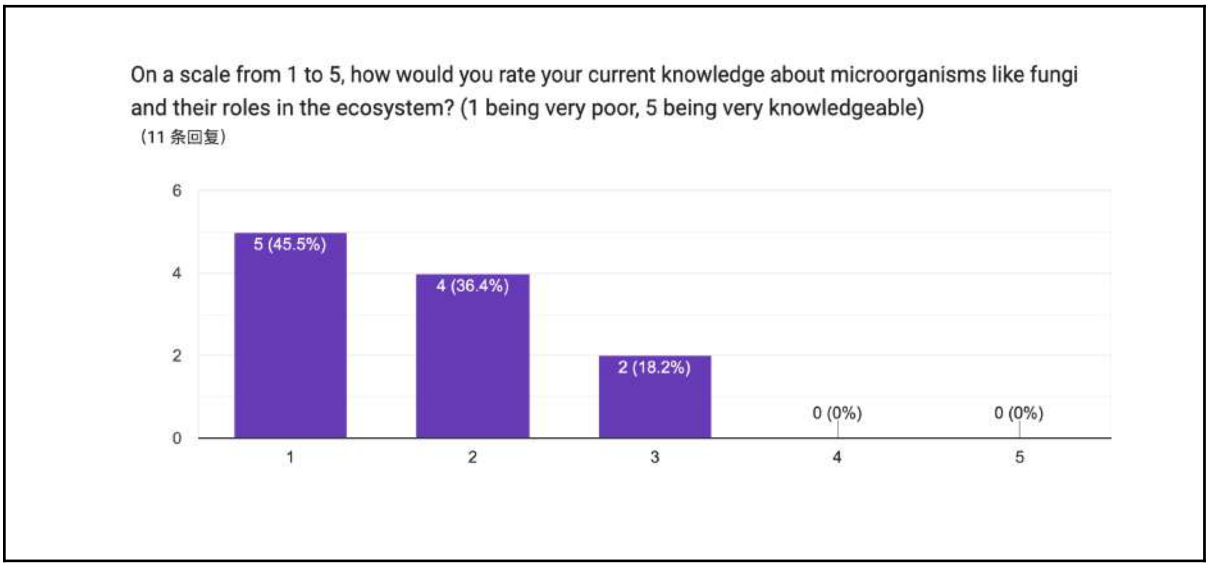


Figure 1.4. Yu, Q. (2023) *Question 1*

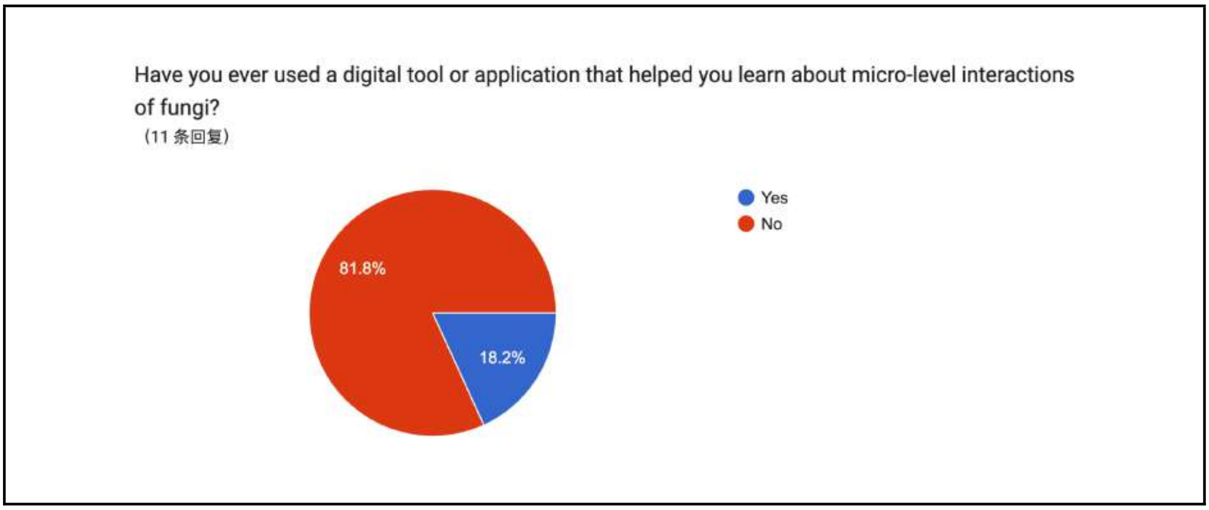


Figure 1.5. Yu, Q. (2023) *Question 2*

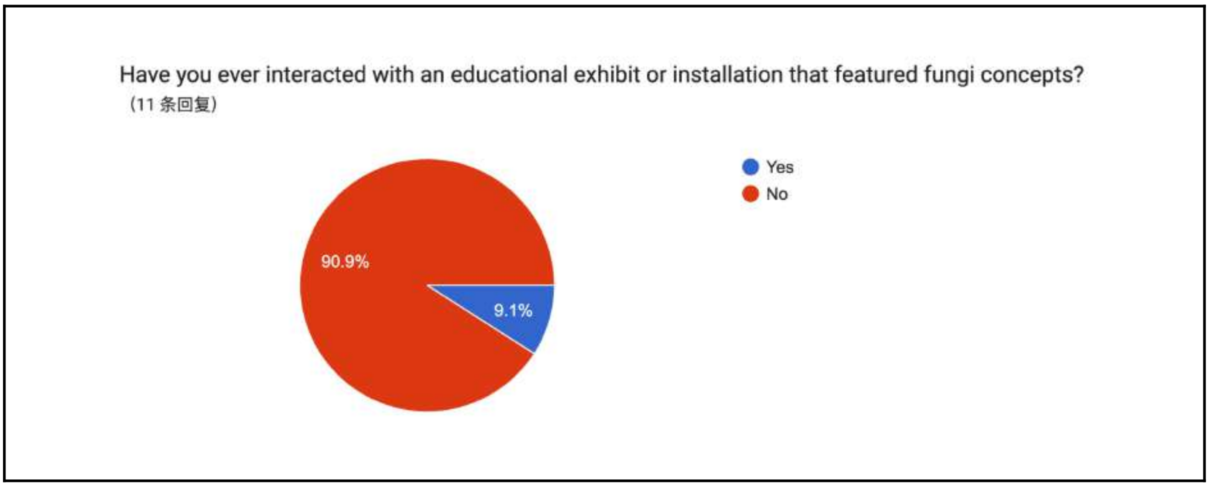


Figure 1.6. Yu, Q. (2023) *Question 3*

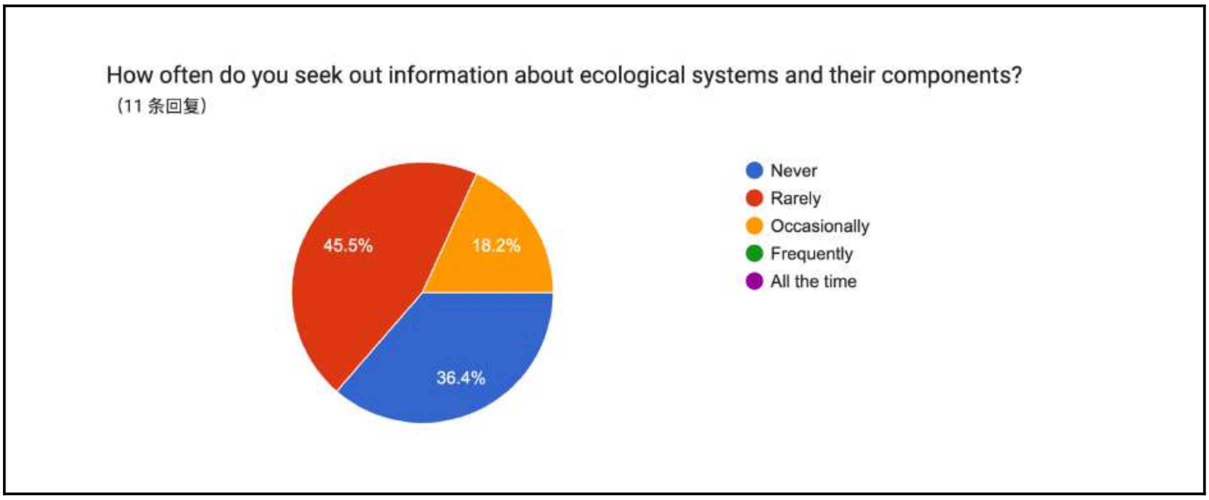


Figure 1.7. Yu, Q. (2023) *Question 4*

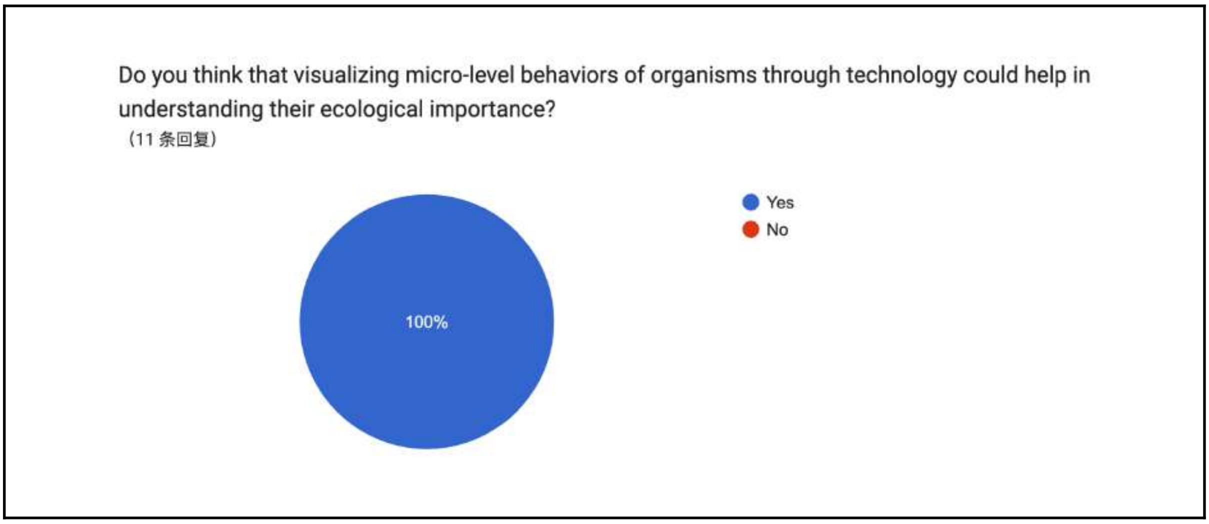


Figure 1.8. Yu, Q. (2023) *Question 5*

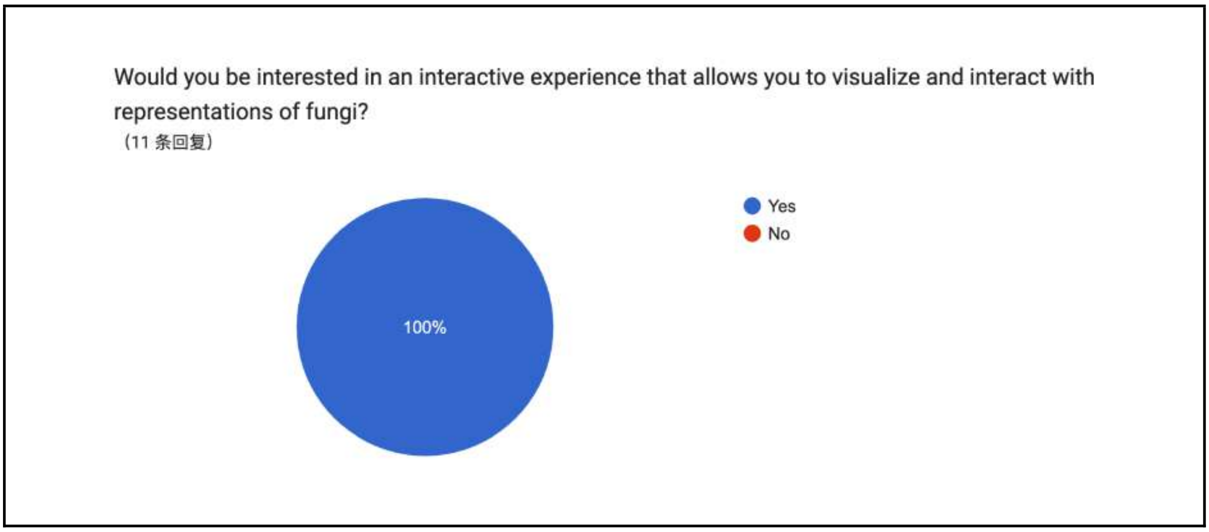


Figure 1.9. Yu, Q. (2023) *Question 6*

WEEK4 Medium and Forms

I mainly consider using installation to simulate the interweaving process between fungi and plants. The sensing technology would be an essential part of this project using this design approach. The current iterations of the project are evolving through an integrated approach that combines Unity, Processing, Arduino, and machine learning technologies.

I shall focus on technology to solve the issue of limited perceptual capability. The installation translates the complex interactions between fungi and plants into a visualization enabling the observation of fungal activity. This installation reevaluates not only the biological roles of fungi but also our perceptual and interactive relationships with the natural world. It calls for a reassessment of our place within the natural hierarchy, promoting the understanding that fungi are essential to the sustainability and vitality of terrestrial ecosystems.

WEEK5 Research of Potential Technologies

“Apparatus” is the equipment that we apply to observe the surrounding world (Barad, 2003). In Haraway’s Situated Knowledge (1988), she talked about the technological progress at the moment determines the constriction of our vision of the world. For example, before the invention of the microscope, knowledge about cell movements in biological beings did not exist. The knowledge is dynamic evolving with the developments of apparatus, opening up our vision. Thus, I have the idea that using technology to re-construct human perception of fungi, the technology could be seen as a medium or tool to enable us to see the movement of fungi.

This week I looked for more research about fungi to see what kind of ‘apparatus’ we are using to understand them and find out potential plans for the installation.

WEEK6 Early Installation Idea

I decided to use a webcam as input to capture human poses and transfer the data to Processing, which then randomly generates images representing fungal diversity. Upon generation of each image, the system forwards the data to Unity, which subsequently renders the plants, simulating the symbiotic growth process facilitated by fungi.

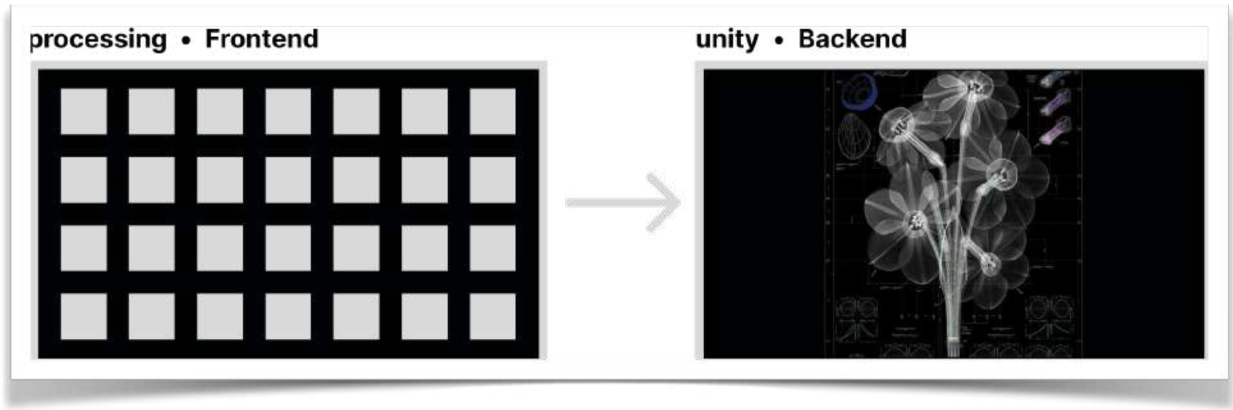


Figure 2. Yu, Q. (2023) *Initial Sketch of Installation*

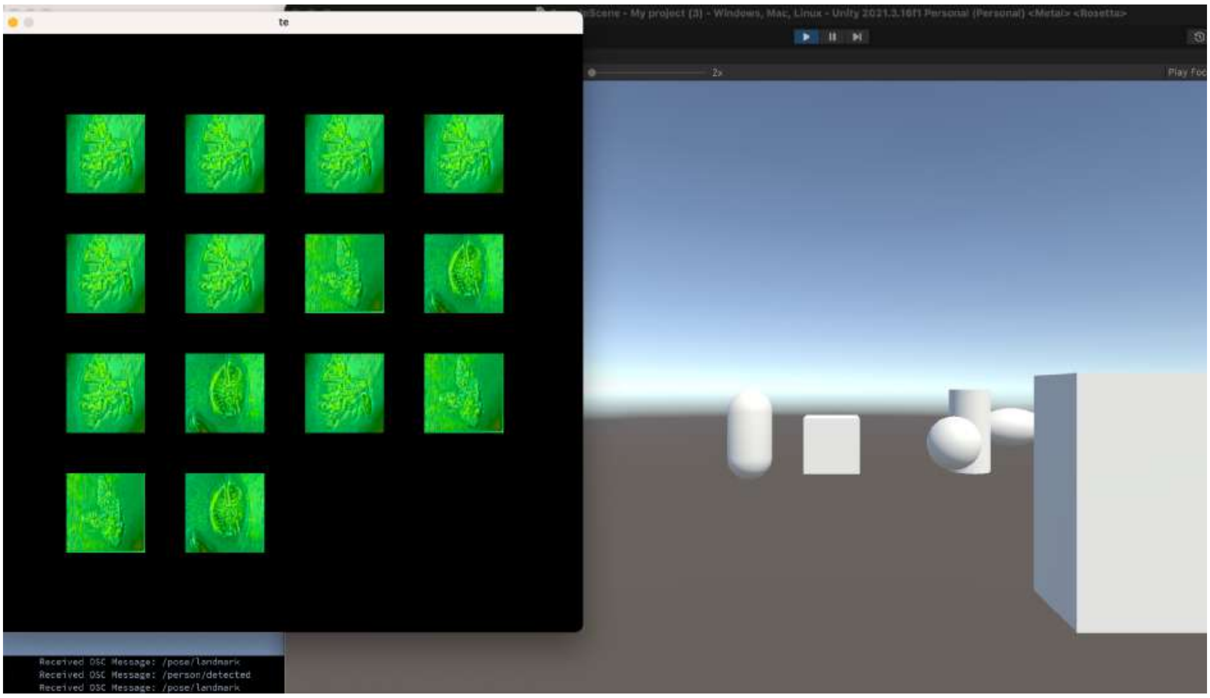


Figure 3. Yu, Q. (2023) *Initial Plan Testing Demo*

Feedback Section

Audience Background For Non-cohort Members: Xiaohan, Yining, Yuzhu

Xiaohan Leng, an interactive designer and digital artist, currently studying at London College of Communication at UAL.

Yining Zhou, a designer and artist, who has studied and worked in the field of interactive arts for five years, and is currently studying for an MDes in interaction at Emily Carr University of Art and Design.

Yuzhu Xiong, a computational designer and digital artist, currently studying at Creative Computing Institution at UAL.

Based on feedback from the current round of audience reviews, respondents consistently report that the interaction between Processing and Unity is weak. The symbiotic relationship between fungi and plants is not being effectively communicated to the audience.

WEEK7 Redesigned Idea of Installation

I followed some of their feedback and redesigned the interaction. Employing a webcam for input to detect human motion and transfer the data to Unity, audiences can create mycelial structures through motion capture, which enables audiences to directly observe the impact of their actions on the mycelium. This data is then transmitted to Processing to generate representative images of various fungi. In this phase, I plan to utilize machine learning algorithms. Following the generation of each fungal image by Processing, the corresponding data is dispatched to control a servo motor via Arduino. The assembly of plants and servo motors, which will control the oscillation of the plants as a representation of plant growth, facilitates an interactive experience. This interaction allows audiences to observe the process of fungal movement and its impact on the plant ecosystem, thereby fostering a resonance between humans and the natural environment.

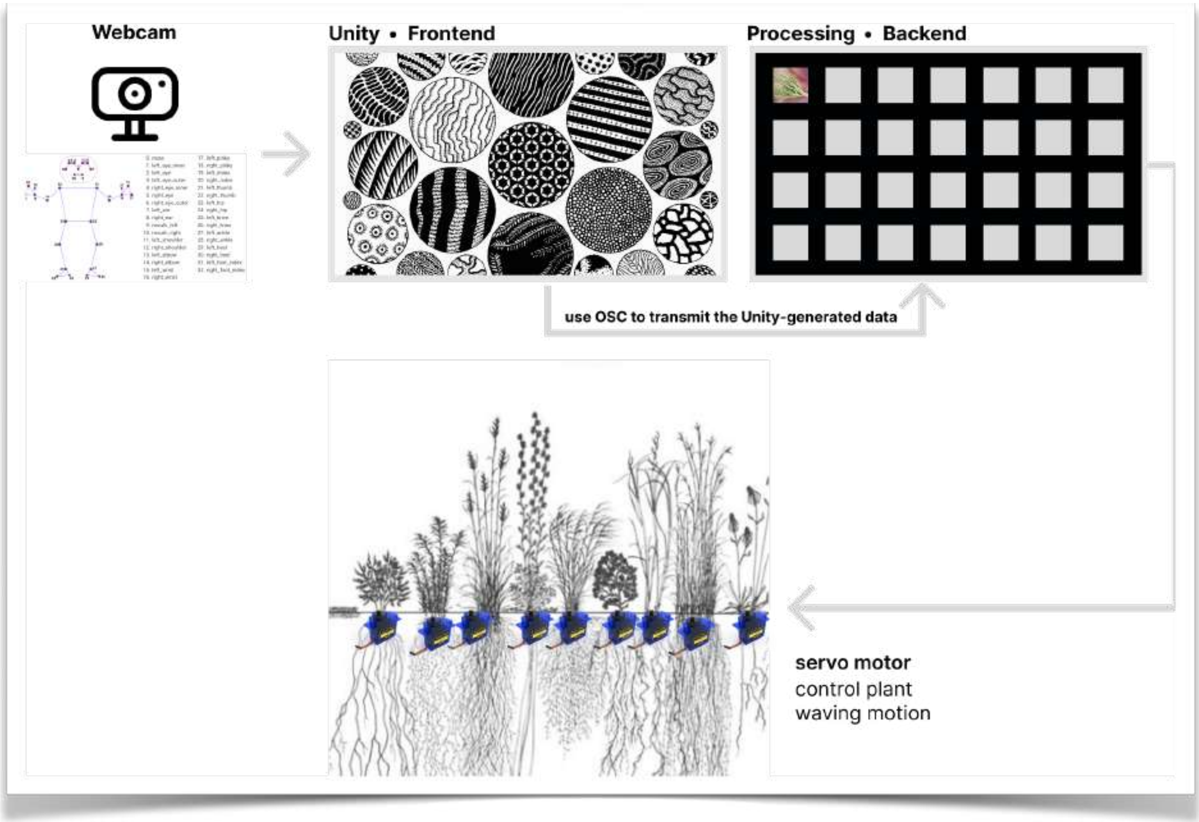


Figure 4. Yu, Q. (2023) *Revised Installation Sketch*

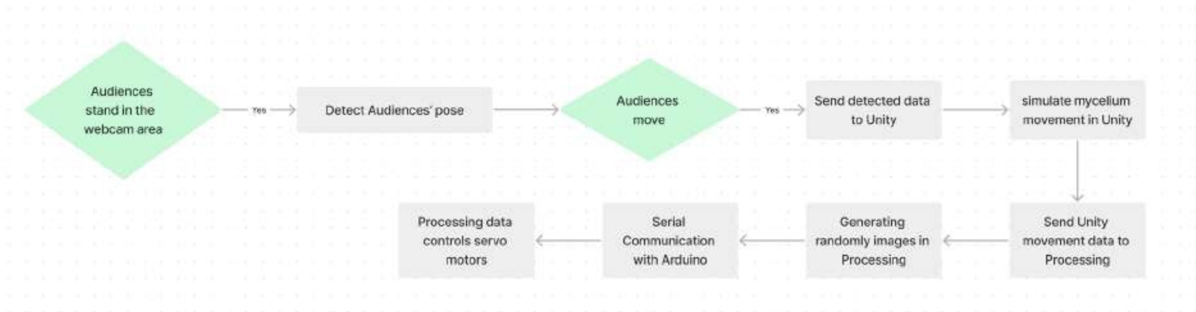


Figure 5. Yu, Q. (2023) *Flow Chart*

WEEK8 Webcam Test & Connect with Unity

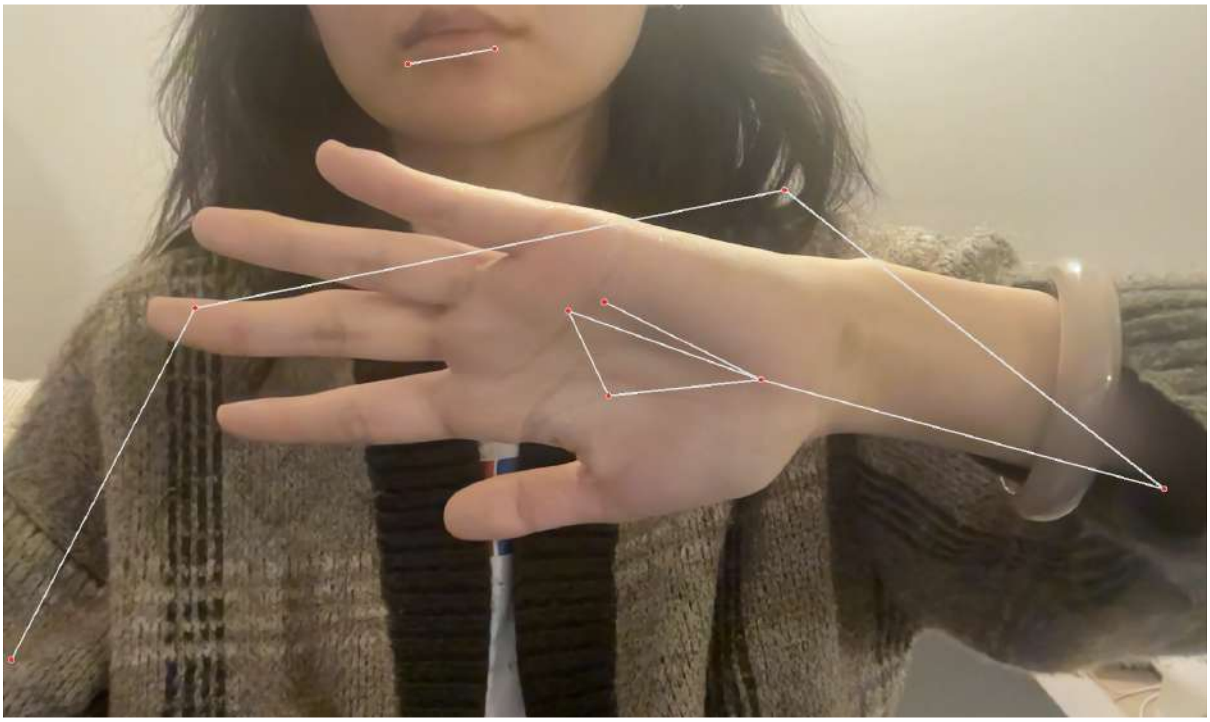


Figure 6. Yu, Q. (2023) *Webcam Test*

I utilised the MediaPipe library to perform real-time human pose estimation. It captures video frames, converts them to RGB colour space—since MediaPipe requires RGB input—and processes them with a pre-trained machine-learning model to detect human poses. The model identifies various body landmarks, which are points like the nose, shoulders, or wrists, to determine the posture of a person in the frame. For instance, if the model detects landmarks consistent with the position of raised arms, it interprets that the person has their arms raised. As the video is captured frame by frame, the pose is continuously updated. Alongside pose estimation, OSC and UDP protocols send this pose data over a network to Unity to achieve real-time body movement integration.

WEEK9 Unity Development

In Unity, I designed visual effects by creating 3D models and particle effects to depict hyphae, which floated within the scene. Human motion was captured via a webcam, facilitating the control of the move GameObject in Unity. Upon the move GameObject encountering hyphae, hyphae models react by bouncing off, thereby visualizing mycelium movement.

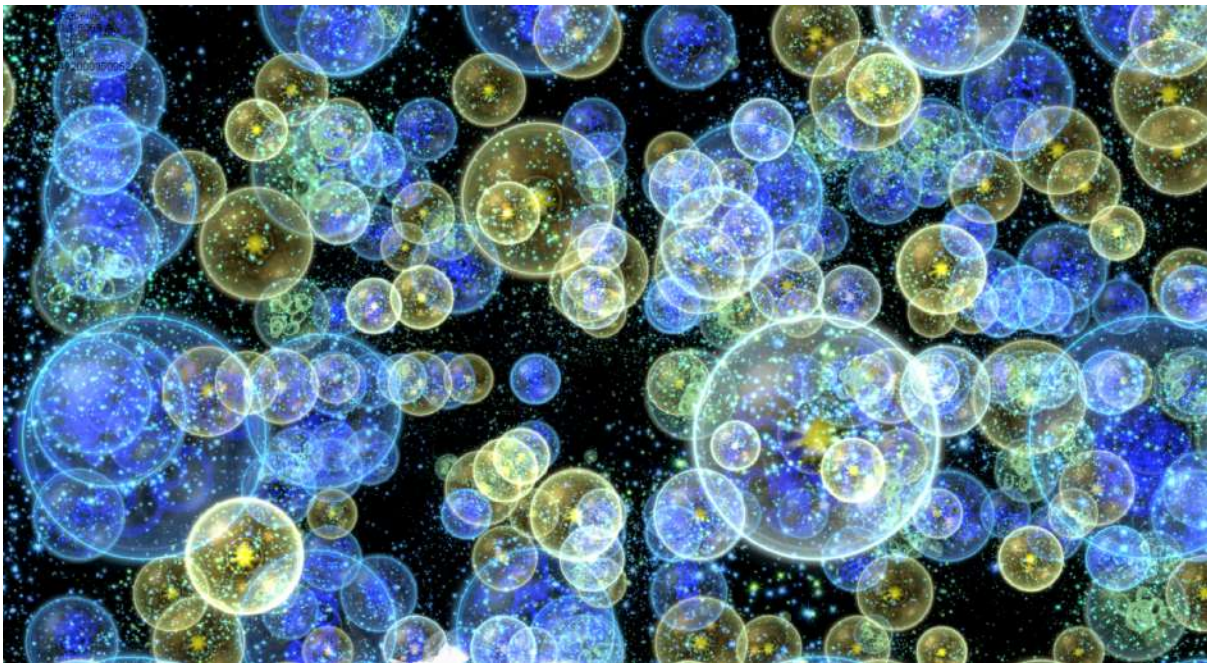


Figure 7.1. Yu, Q. (2023) *First Version Visualisation of Unity*

However, post-testing indicated that the visual presentation suffered from an excess of colour (Figure 7), the visual effects didn’t respond predictably and understandably, obscuring the interaction with GameObject, and the models did not adequately mimic the structure of mycelium.

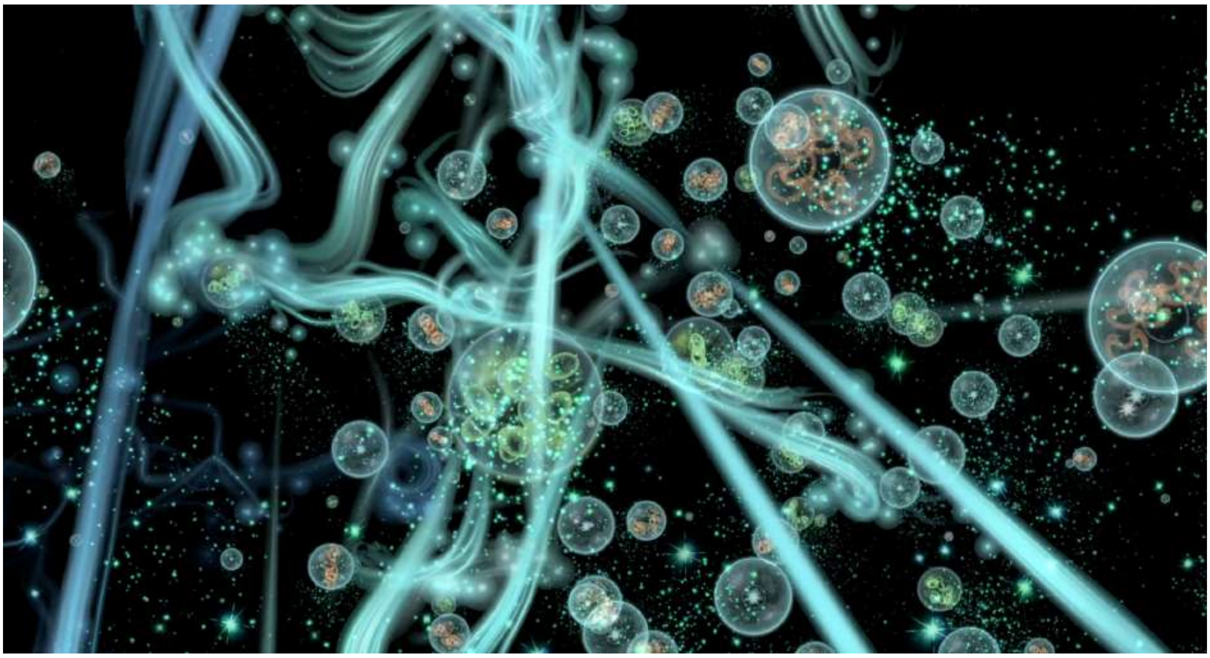


Figure 7.2. Yu, Q. (2023) *Second Version Visualisation of Unity*

I redesigned the presentation form of the mycelium(Figure 7.2), it appears on the screen via motion capture, enabling audiences to observe how their movements influence the formation and behaviour of the mycelium. As the audience moves in the Unity environment, it can help visualise the development and distribution of mycelium within the Unity ecosystem. By linking the growth and movement of mycelium to the audience's movements, it creates a more interactive experience. Users can directly influence the virtual environment, which can make the experience more engaging and memorable.

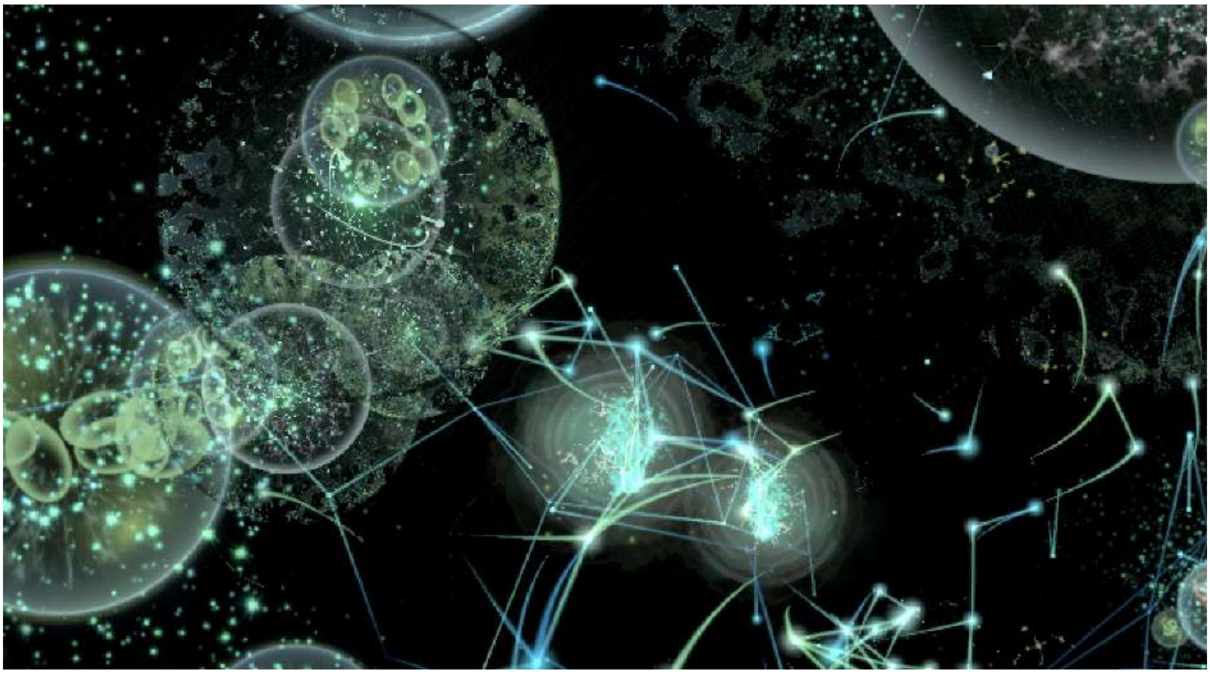


Figure 7.3. Yu, Q. (2023) *Final Version Visualisation of Unity*

Also, I reduced the excess colour elements and refined the visual presentation to avoid obscuring the interaction. This clarity allows users to more easily see and understand their impact on the mycelium, making the simulation more intuitive and user-friendly.

WEEK10-11 Processing test & Machine Learning Trained Images

Processing

I used OSC to transmit the Unity-generated data to Processing. In Processing, the received data from Unity will serve as the basis for generating visual representations of fungi diversity.

In Processing, my initial setup allowed images to appear randomly, but this felt too monotonous visually. To enhance the experience, I visualized the image generation process while Processing received signals from Unity. This simulates the growth of hyphae into fungi, creating a more cohesive and engaging interactive process. I've designed it to reflect the organic development of fungi, making the entire interaction more consistent and visually dynamic.

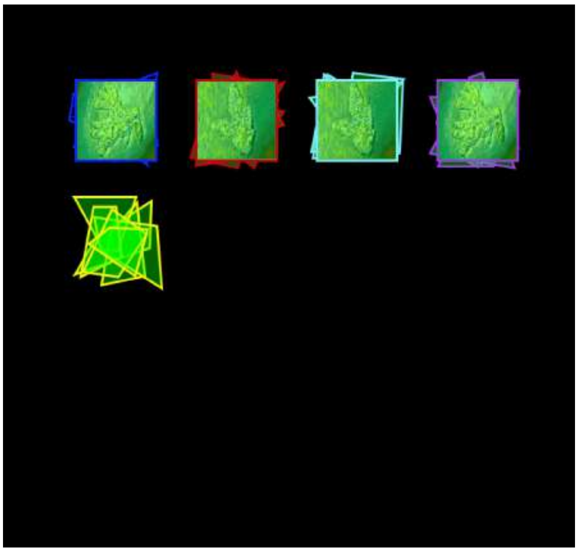


Figure 8.1. Yu, Q. (2023) *First Version of Processing*

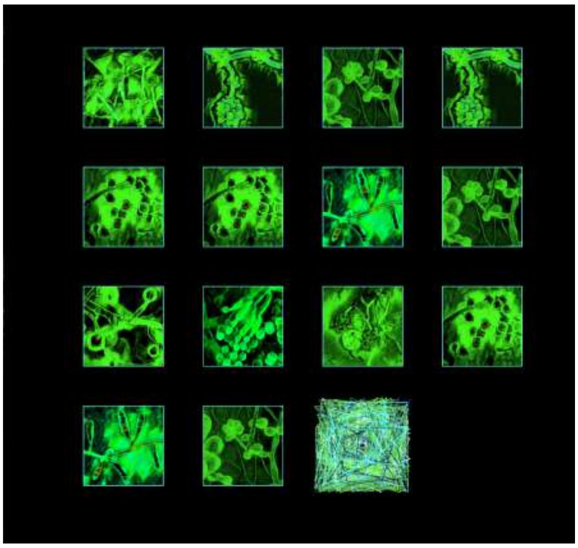


Figure 8.2. Yu, Q. (2023) *Final Version of Processing*

```
noFill();
//stroke(255);

float d = grid * 0.6; // Calculates the diameter for the graphics based on the grid siz
int x = margin + currentCol * (grid + 50); // Calculates the x position for the current
int y = margin + currentRow * (grid + 50);  // Calculates the y position for the curren

if (millis() - lastActionTime < graphicDisplayDuration) { // Checks if the current grap
  // Displays a graphic.
  int colArrayNum = (int) random(7); // Chooses a random index for the color array.
  stroke(colArray[colArrayNum]); // Sets the stroke color for the graphic.
  DisplayObject newObject = new DisplayObject(x, y, d, colArray[colArrayNum], true); //
  displayObjects.add(newObject); // Adds the new DisplayObject to the ArrayList.
} else {
 // Removes graphics before generating images.
  Iterator<DisplayObject> iterator = displayObjects.iterator(); // Creates an iterator
  while (iterator.hasNext()) {  // Loops while there are elements in the ArrayList.
    DisplayObject obj = iterator.next();
    if (obj.isGraphic) {
      iterator.remove();
    }
  }


  String[] imageFiles = {"1.jpeg", "2.jpeg", "3.JPG", "4.jpeg", "5.png", "6.JPG", "7.JP
  String randomImage = imageFiles[int(random(imageFiles.length))];
  DisplayObject newObject = new DisplayObject(x - imageSize / 2, y - imageSize / 2, ran
  displayObjects.add(newObject);
```

Figure 9. Yu, Q. (2023) *Processing Code*

Machine Learning Trained Images

I tried to train the images with DCGAN(Figure 10.1, Figure 10.2) at the beginning and tried with different epochs, but the result didn't meet my requirements. Then I tried with the Pre-trained MSG-Net(Figure 10.3), which is a neural style transfer model, that can help generate visual representations of fungi diversity in real-time.

Figure 10.1. Yu, Q. (2023) *Trained Images with DCGAN(*Epoch = 200)

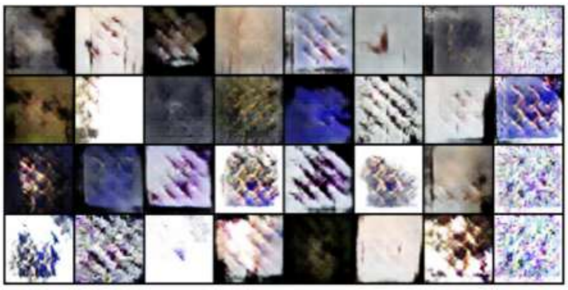


Figure 10.2. Yu, Q. (2023) *Trained Images with DCGAN(*Epoch = 50)

Figure 10.3. Yu, Q. (2023) *Trained Images with PyTorch style transfer*

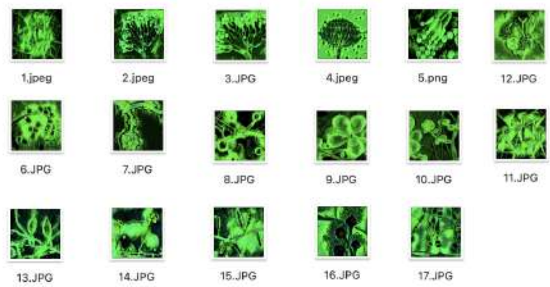
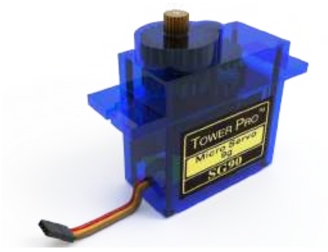


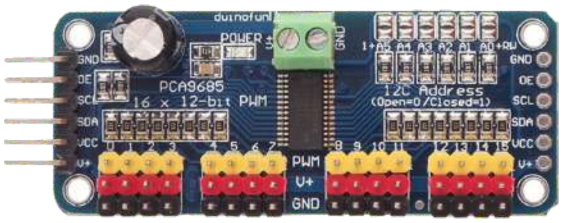
Figure 10.4. Yu, Q. (2023) *Trained Images with PyTorch style transfer*

WEEK12 Arduino Test

Arduino receives signals from Processing and translates them into physical movements using 16 servo motors. Upon receiving a start signal, the script activates the servo motors to control the plant installation's mechanical movement, cycling them through two positions, 0° and 120°, to create a movement pattern.



16* servo motors



PCA 9685

Circuit Test with 8 Servo Motors

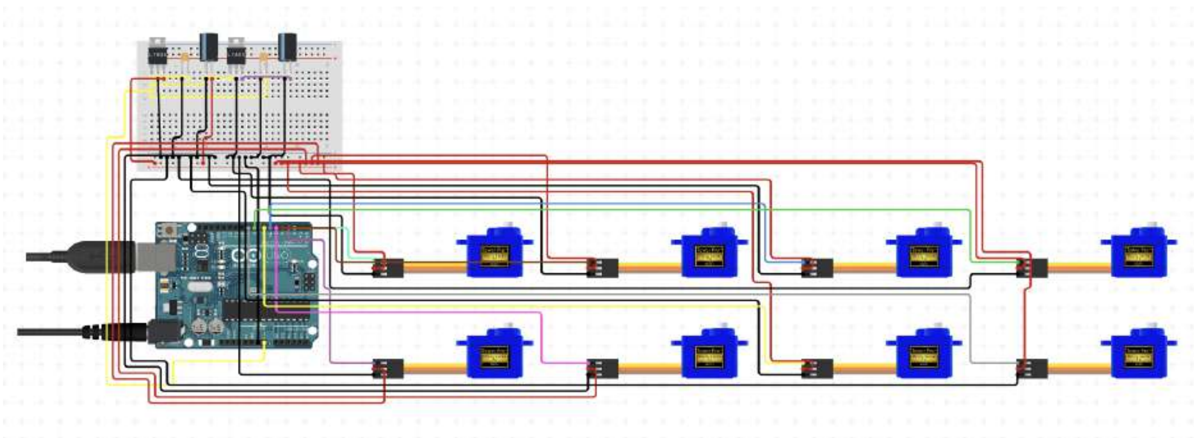


Figure 11. Yu, Q. (2023) *Schematic with 8 servo motors*

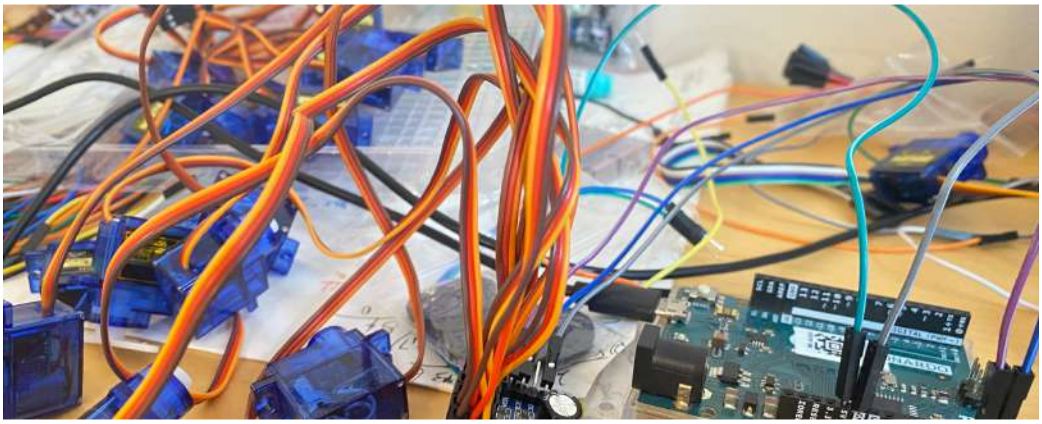


Figure 12. Yu, Q. (2023) *Test Arduino with 8 Servo Motors*

Circuit Test with 16 Servo Motors

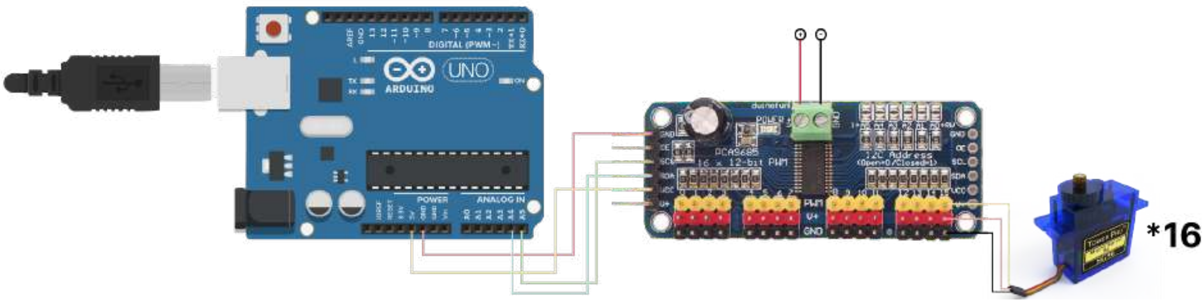


Figure 13. Yu, Q. (2023) *Schematic with 16 Servo Motors*

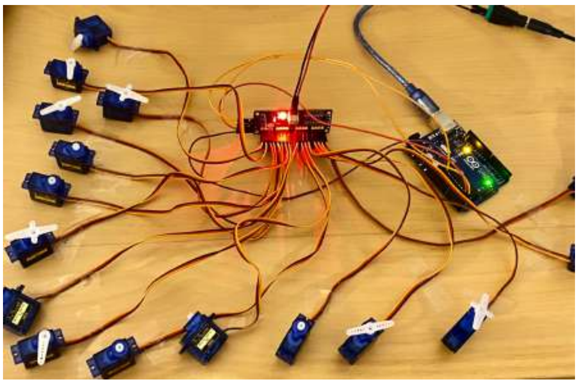


Figure 14. Yu, Q. (2023) *Test Arduino with 16 Servo Motors*

Figure 15. Yu, Q. (2023) *Arduino code*

WEEK13 Laser Cutting & Assembling

This week marked significant progress in the integration of hardware and aesthetics for the project, which primarily involved laser cutting and soldering.

Laser Cutting

In detail, the laser cutting was executed on 3mm transparent Acrylic material, a choice that was not only practical but also visually engaging. The transparency of the acrylic adds a modern, sleek look while allowing viewers to glimpse the inner workings of the project, which can be quite fascinating. This material was specifically chosen for its durability and clarity, ensuring that the servo motors are not only securely mounted but also showcased in a way that highlights the mechanical beauty of their operation.

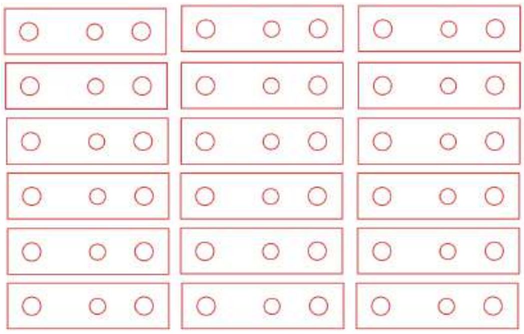


Figure 16. Yu, Q. (2023) *Laser Cutting Sketch*

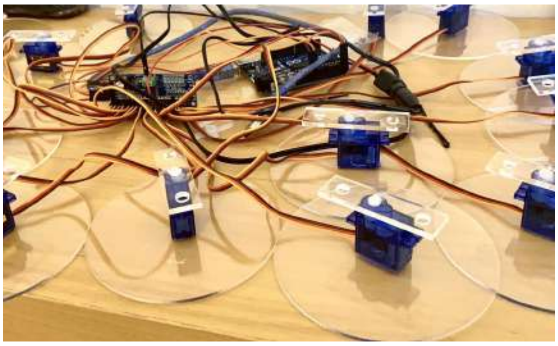


Figure 17. Yu, Q. (2023) *Acrylic Laser Cutting*

Assembling

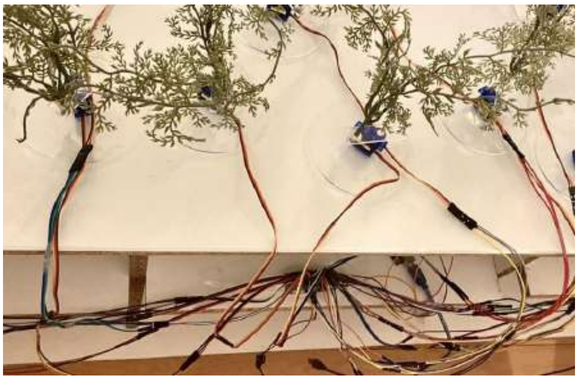


Figure 18.1. Yu, Q. (2023) *Assembling*

Figure 18.2. Yu, Q. (2023) *Assembling*

Final Outcome

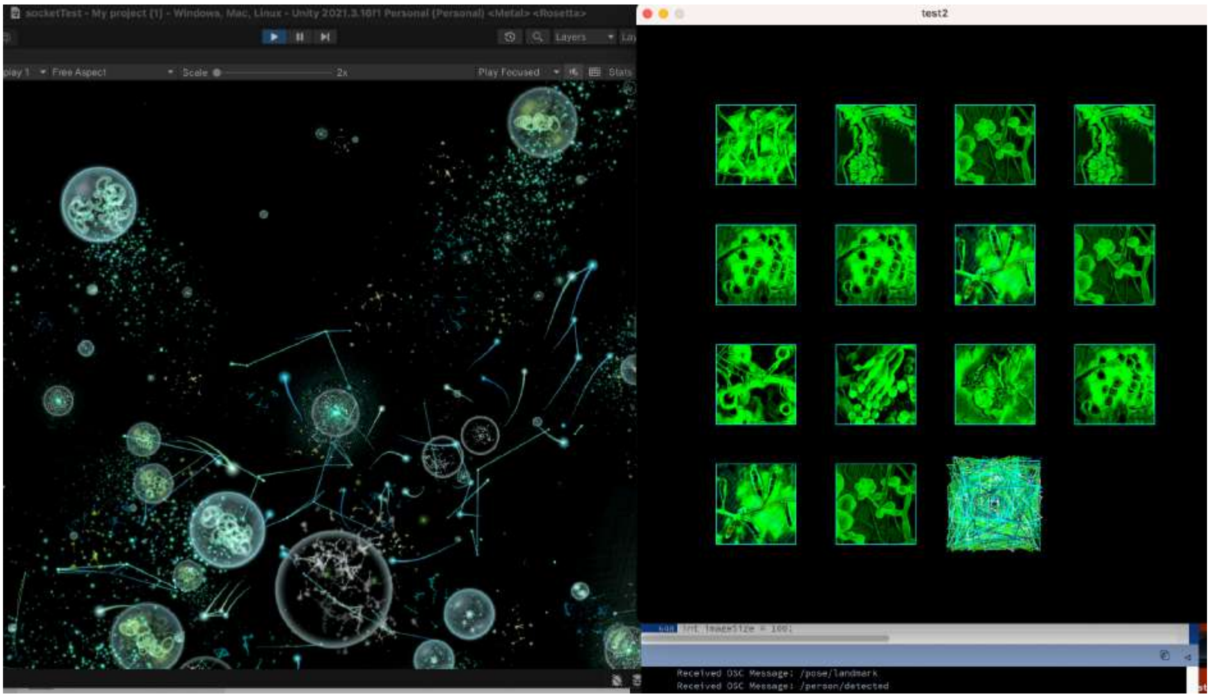


Figure 19.1. Yu, Q. (2023) *Final Outcome of Screen Visualisation*

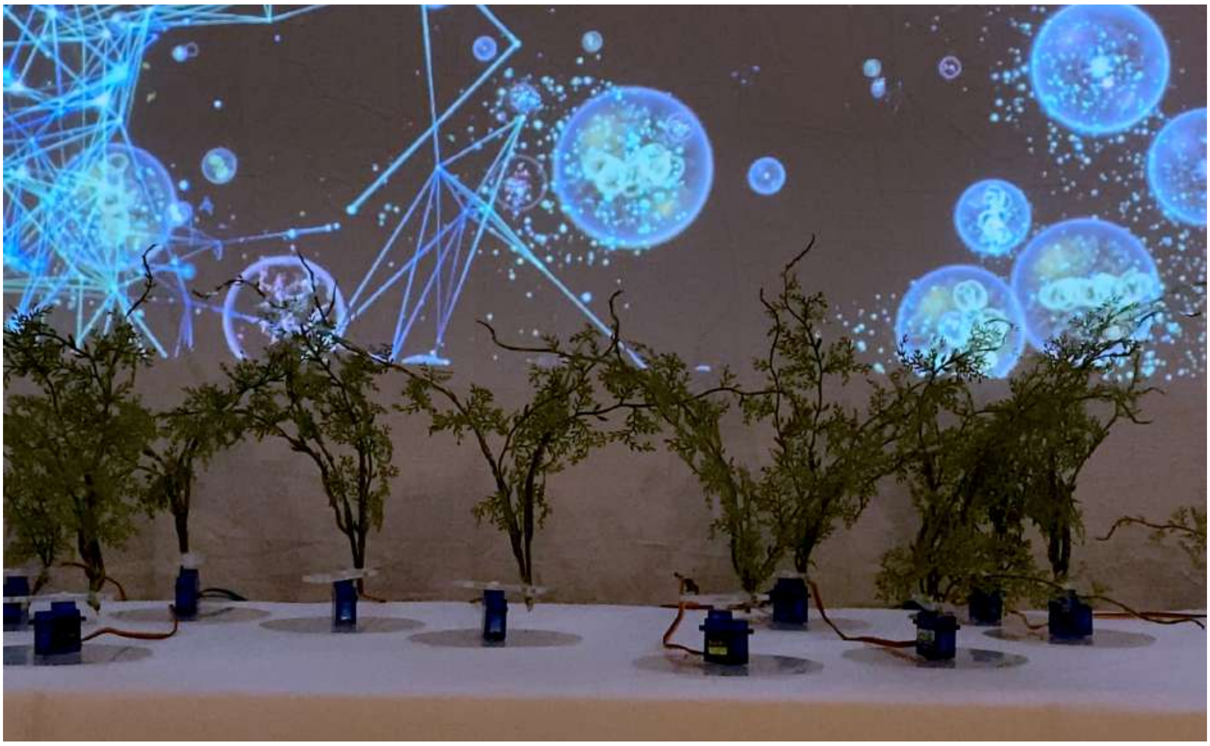


Figure 19.2. Yu, Q. (2023) *Final Outcome of Physical Plant*

Figure 20.1. Yu, Q. (2023) *Interaction with Installation*

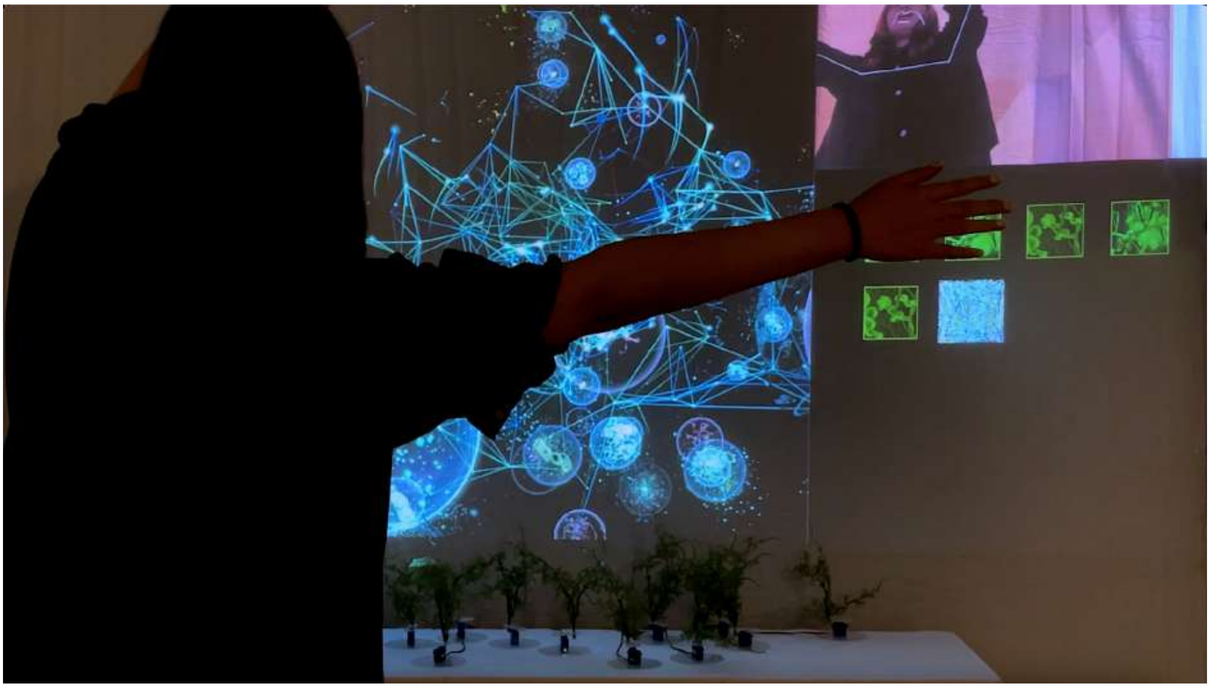


Figure 20.2. Yu, Q. (2023) *Interaction with Installation*

Code References

Motion Capture:

https://github.com/hasanavi/OpenCV-Unity3D-Object-Tracking

Pytorch Style Transfer:

https://computervisionrutgers.github.io/MSG-Net/

https://colab.research.google.com/github/zhanghang1989/PyTorch-Multi-Style-Transfer/blob/master/msgnet.ipynb#scrollTo=bqO1brl1LumW

Dataset used:

https://www.kaggle.com/datasets/mdwaquarazam/microorganism-image-classification

Debugging and proofreading code: ChatGPT