

Helios

Smart Light Fixture

Problem Statement

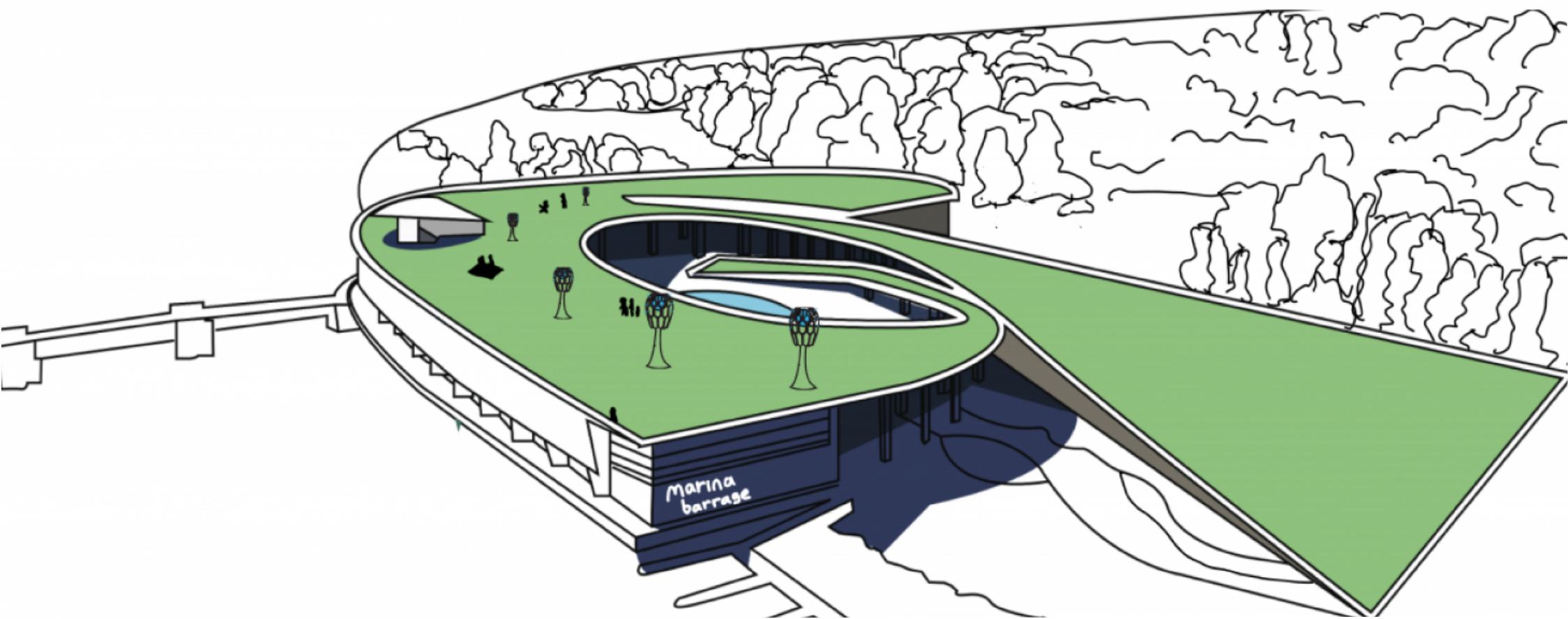
How might we improve the **Green Roof** at Marina Barrage as a **night-time attraction** for families and tourists while **cultivating a safe distancing culture** in the area?

Project Explanation

The smart light fixture incorporates AI technology to detect people and changes colour to inform visitors of the crowd distribution at a glance, encouraging them to settle at low-traffic areas. The design pays homage to the vast greenery and water bodies surrounding the area while acting as a pleasing night-time attraction. Unlike existing solutions, our design acts instead as a gentle suggestion and appeals to people's subconsciousness instead, instilling a social-distancing culture in a non-authoritarian manner.

Inspiration

We envisioned a post-pandemic environment where the **ethos of safe encounters** is weaved naturally and seamlessly into the site itself. In our reimagined **Green Roof, nature transforms into a living art** through interactive light fixtures **inspired by lush garden greenery**. Illuminating the night scene with its **vibrant colours**, these **gardenesque nature-influenced** light fixture would **instil a social-distancing culture** in a manner that **preserves the uniquely tranquil atmosphere** that the Green-Roof is known for.



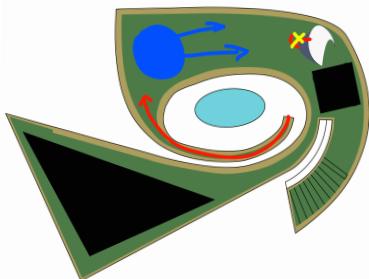
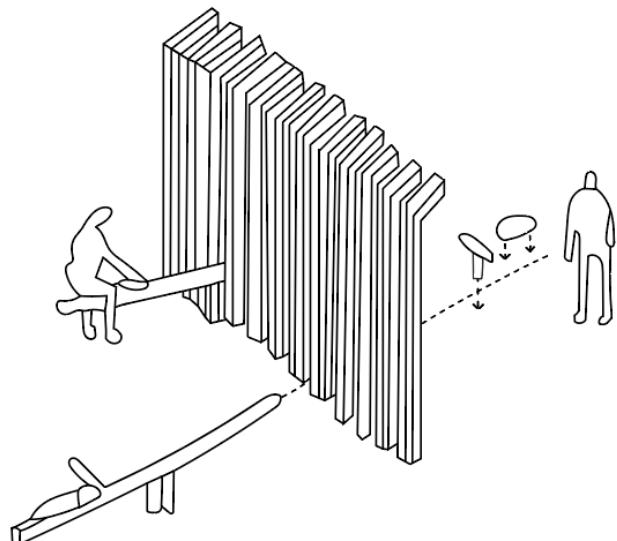
Project Abstract: Conceptualisation Phase

Precendent Analysis: AEIOU Framework

Subject: Teeter-Totter Wall

Insights gleaned:

- **Simplicity** can be effective. Solution does not need to be complicated
- **Context** matters heavily. Solution must fit the circumstances



Site Analysis: AEIOU Framework

Location: Marina Barrage Green Roof

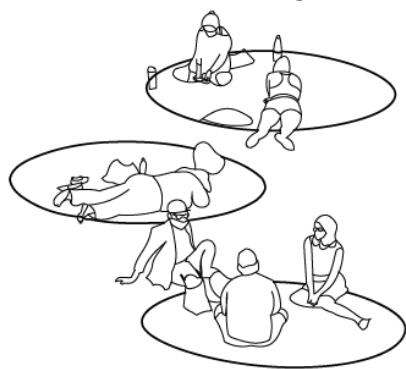
Main Users: Families

Problems Identified:

- Only one entrance/exit
- Uneven crowd distribution; flouting of safe distancing
- Not enough lighting at night

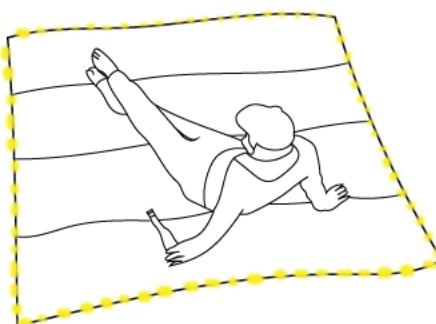
Idea Analysis: Pugh Chart
Solutions considered:

Social-distancing Paint



Rejected

Smart Picnic Mat



Rejected

Smart Light Fixture



Accepted

Verdict: Light fixture is the most effective, practical and feasible

Project Abstract: Prototyping Phase



Rejected

Accepted

Sensor Analysis: Cost-Benefit

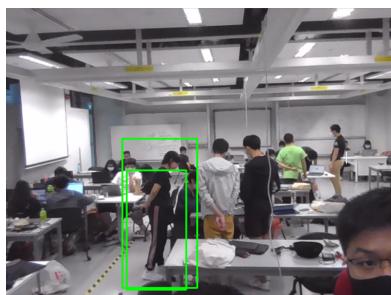
Solutions considered:

- Thermal Sensor (FLIR)
- Light Sensor (Camera)

Verdict: Due to budget constraints, the camera is most practical

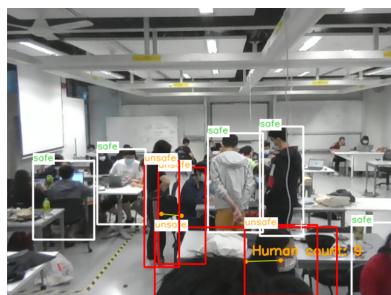
Computer Vision Code Analysis: Speed-Performance Analysis

HOG Algorithm
(Histograms of Oriented
Gradients) **(Rejected)**



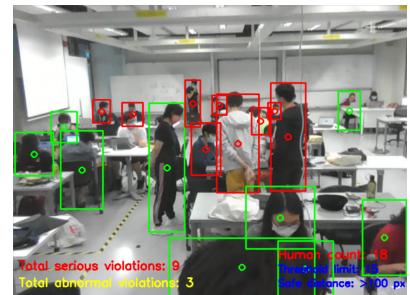
Fast

MobileNet Single-Shot multibox
Detection (SSD) Object
Detection Algorithm **(Accepted)**



→ Accurate

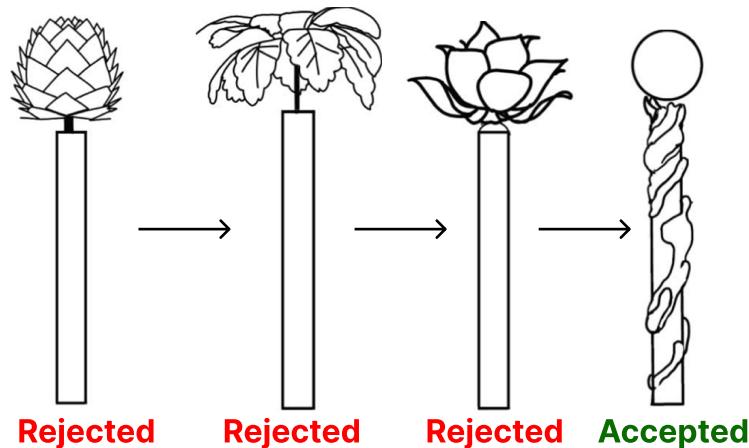
YOLOv3 (You Only Look
Once) Object Detection
Algorithm **(Rejected)**



Verdict: MobileNet SSD has the best balance between speed and performance

Aesthetics Analysis: Iterative Design

Verdict: Final design with round top
and textured pole is most practical to
implement and has the best light
dispersion while staying aesthetically
pleasing.



Research and Validation

Question: On a scale of not at all (1 star) to very (5 star), does the design blend in well to nature?



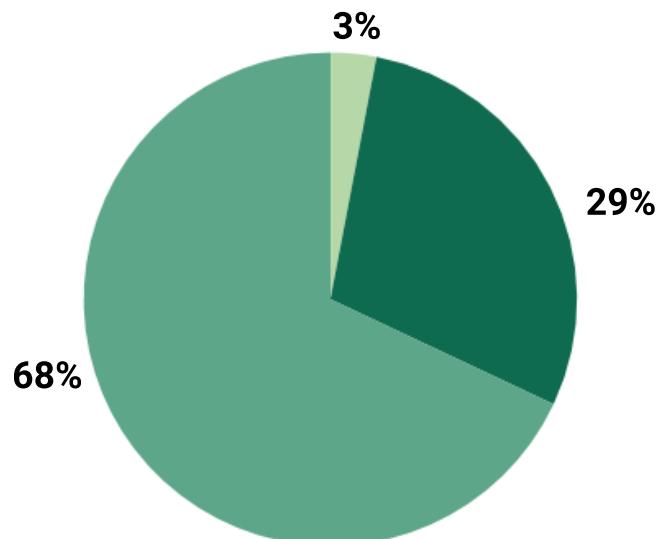
Implication: Our current design blends sufficiently well with the environment

Question: On a scale of not at all (1 star) to very (5 star), how likely will you move according to the lights? (if you are at a red area you will be willing to move to a green area etc)

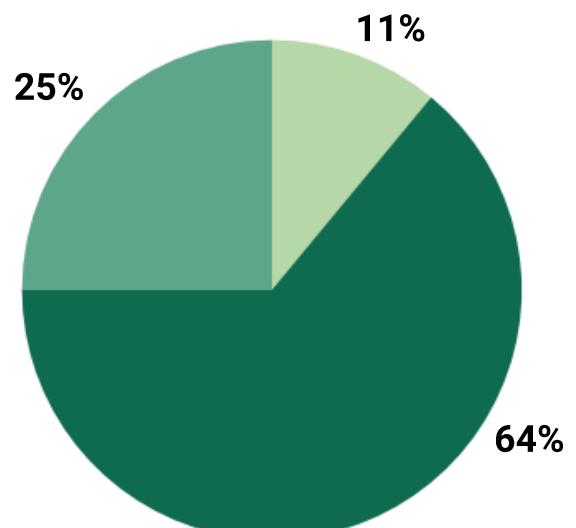


Implication: Our choice of lights is appropriate for our purposes and the solution is intuitive.

Question: Will the addition of light structure affect your willingness to visit the green roof at night?



Question: Now you have seen our prototype, do you think the brightness of our lampshade is appropriate?



● Less Willing ● No change ● More willing

● Too Bright ● Too Dark ● Just Right

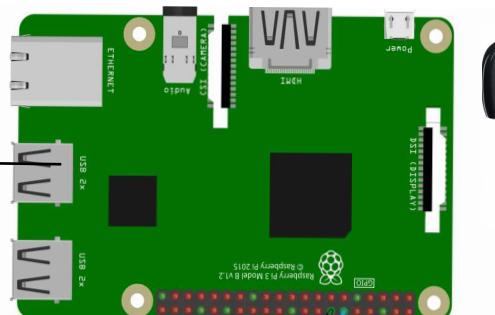
Implication: Our prototype is attractive enough to entice additional visitors

Implication: The translucency of our lamp shade is appropriate and no additional modifications are required

Prototyping: Production Technology and Materials

Raspberry Pi 4

- Processes data from camera
- Runs a Python script with computer vision code
- Instructs LED strip to change color after multiple consecutive detections of a predefined crowd-density scenario

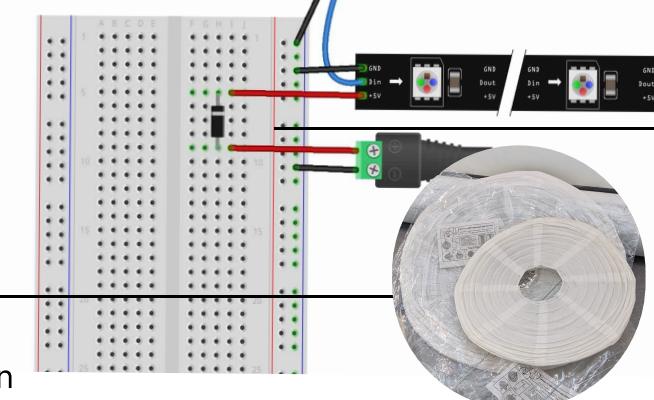


Logitech C525 HD Camera

- Connected to Raspberry Pi 4 via USB
- Collects visual data in real time for processing

16-Inch White Lantern

- White and translucent
- Used for even dispersion of light from LED strip



400 Point Breadboard

- Acts as an intermediary between Raspberry Pi 4, LED strip and 5V Power Source
- Contains a diode to protect Raspberry Pi 4 from output of the 5V power source

5 Volt 2.5A Power Adapter

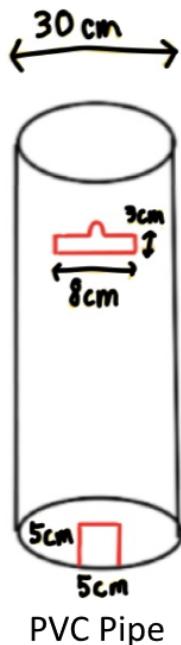
- Supplies power to LED strip



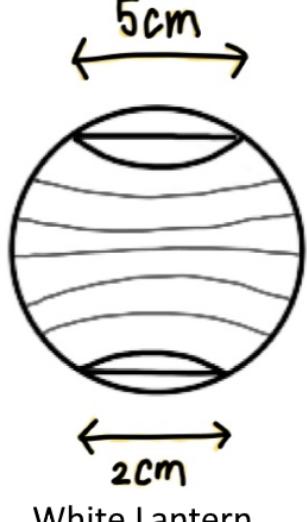
WS2812B LED

- Individually addressable RGB LED strips
- Emits different colors based on crowd density scenario detected by camera

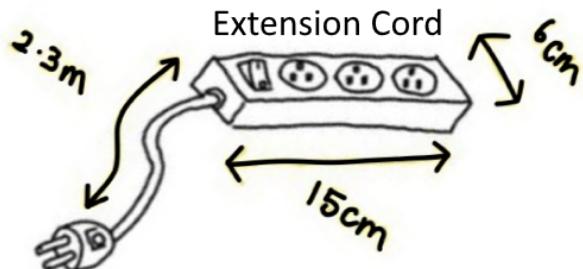
Specifications, Dimensions and Technical properties



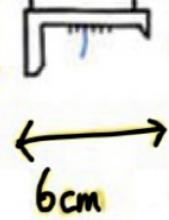
1.8m



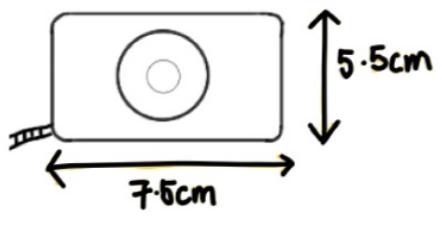
White Lantern



Raspberry Pi 4



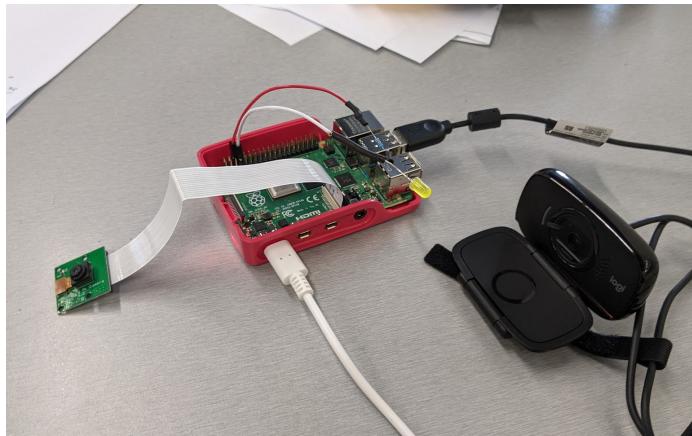
Camera



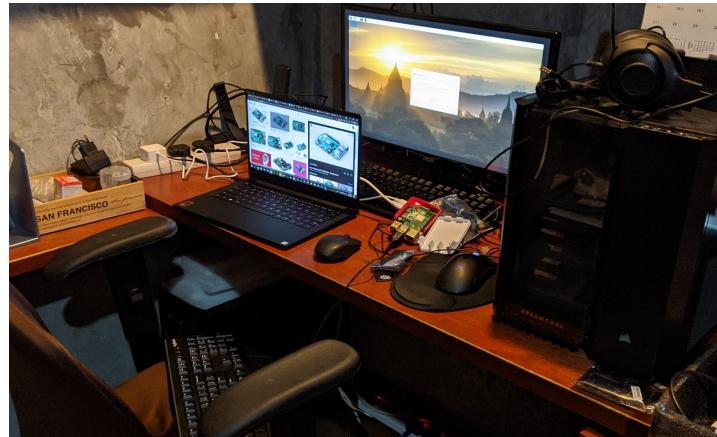
Prototyping process

Software and Electronics

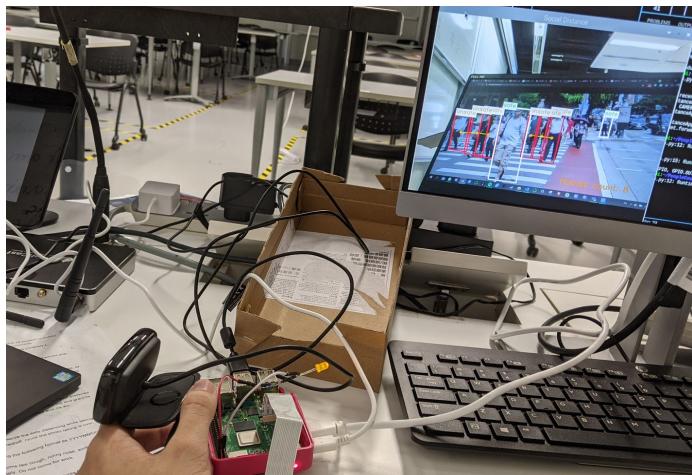
1. Setting up of electronic components



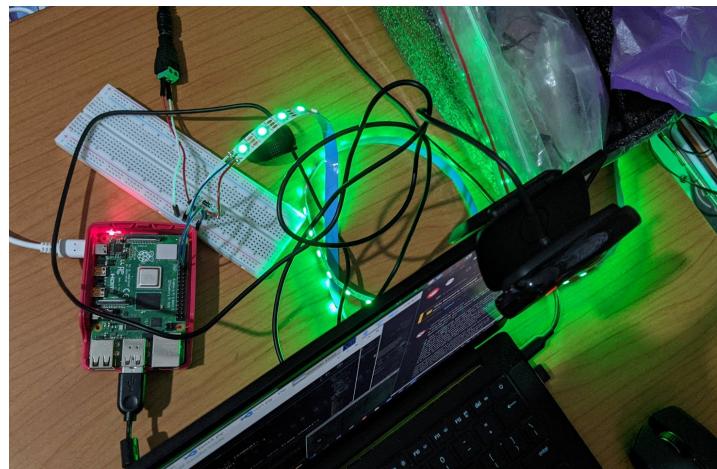
2. Interfacing with Raspberry Pi



3. Testing Computer Vision Code

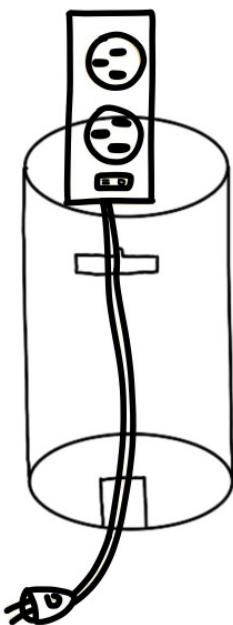


4. Interfacing LED Strip with Raspberry Pi

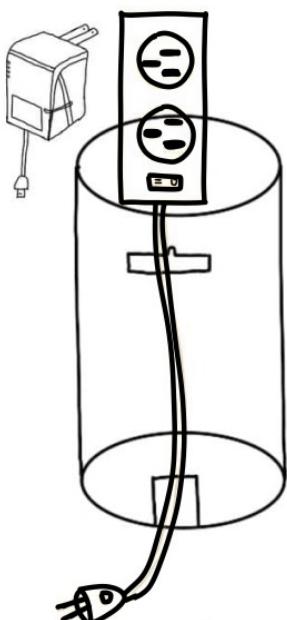


Prototyping process

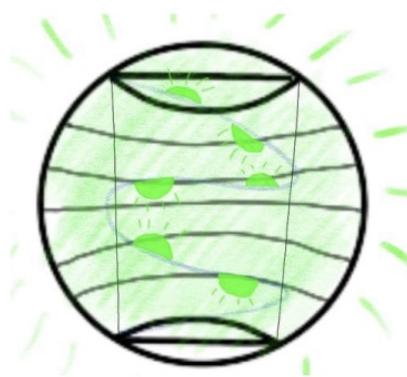
Hardware and Aesthetics



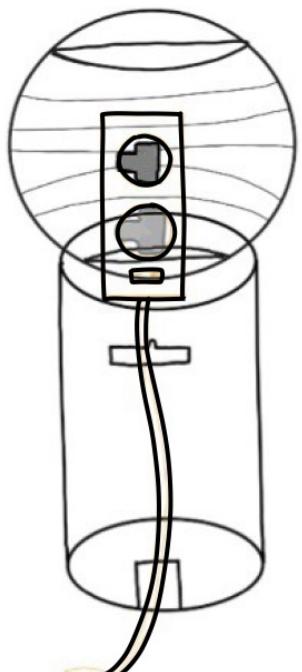
Firstly, the power cord is put through the hollow PVC tube.



Electrical components are wired and connected



LED is inserted into lantern before it is mounted on the PVC tube



Lantern is glued onto the PVC tube to make it stable

Initial

Final



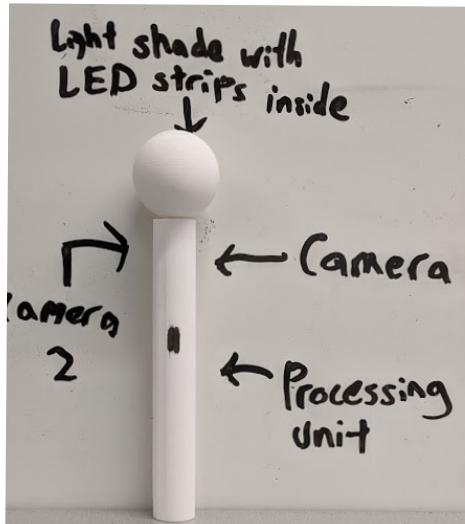
Color Choice

3D model was initially painted blue to pay homage to the nearby water features in Marina Barrage. However, our survey showed that it was incompatible with the site's aesthetic. Hence, the decision was made to paint the final prototype green.

Final Assembly



Planning of component locations using 3d model



Cutting a slot for camera



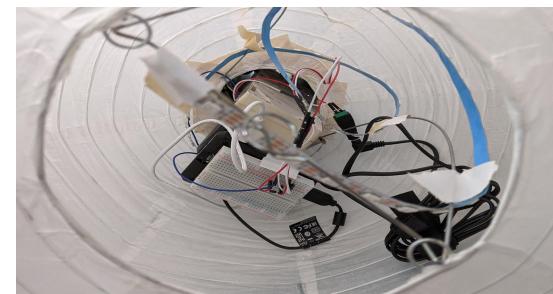
Using glue gun to add texture



Spray painting



Attaching Vines

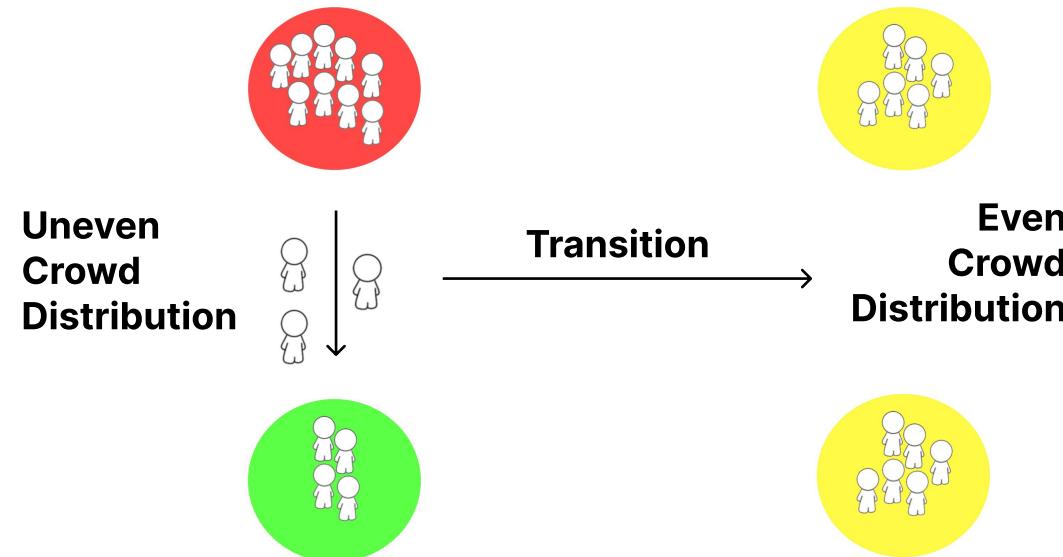
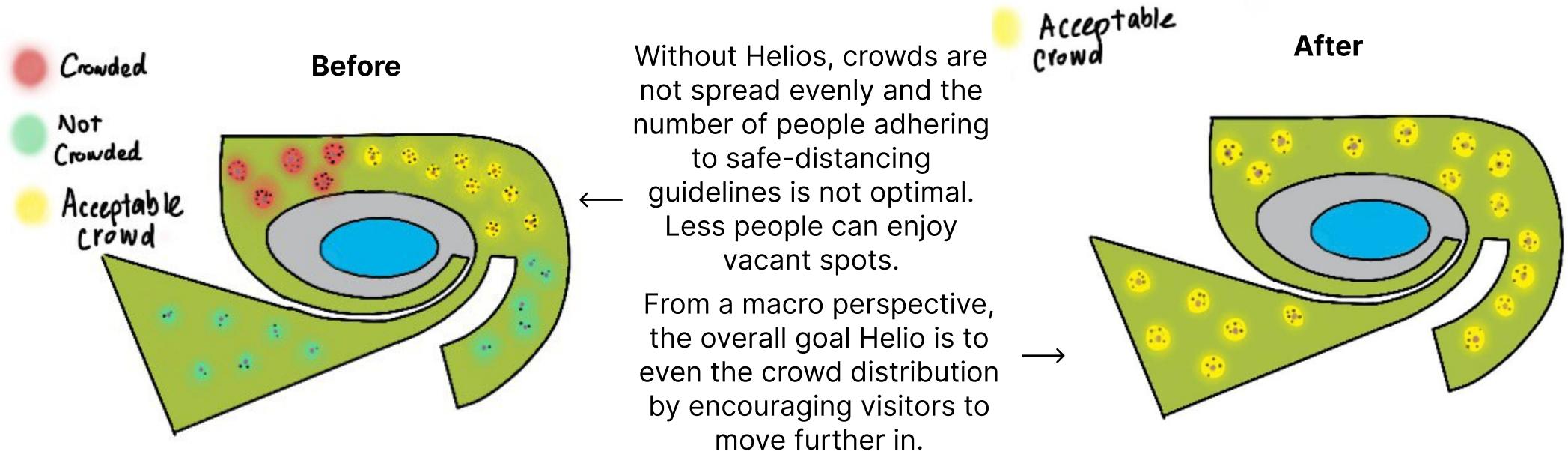


Integrating electronic components



Interaction / Flow

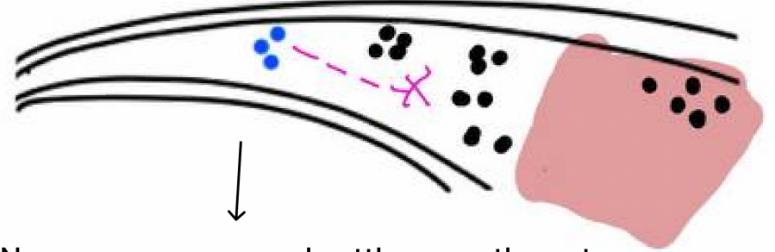
Macro View



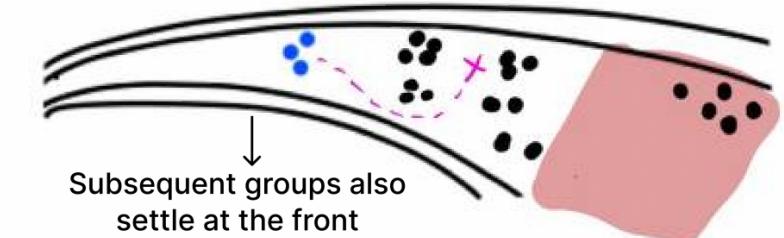
Interaction / Flow

Micro View

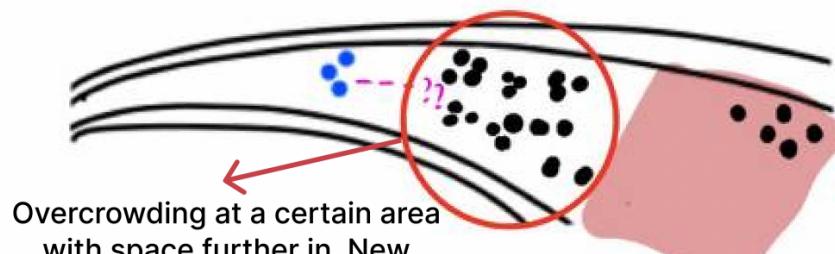
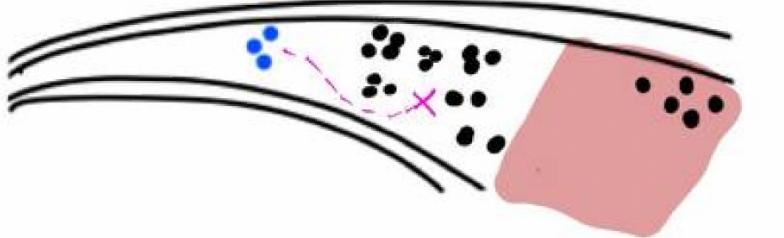
Before



New groups come and settles near the entrance as they can not see the red zone at the back

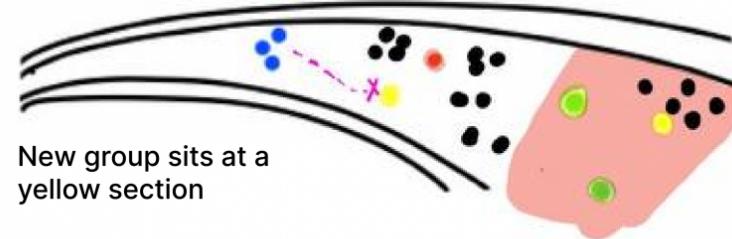


Subsequent groups also settle at the front

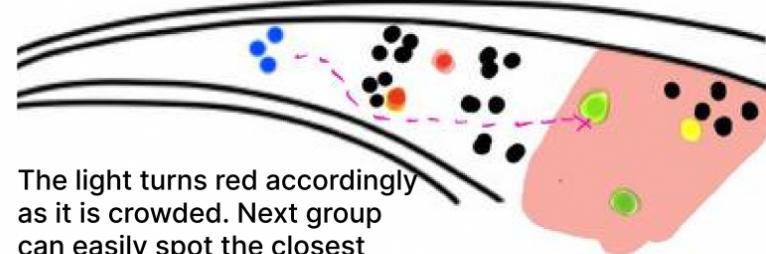


Overcrowding at a certain area with space further in. New group does not know where to settle

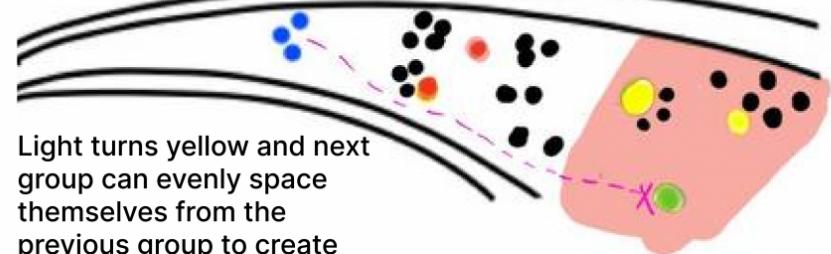
After



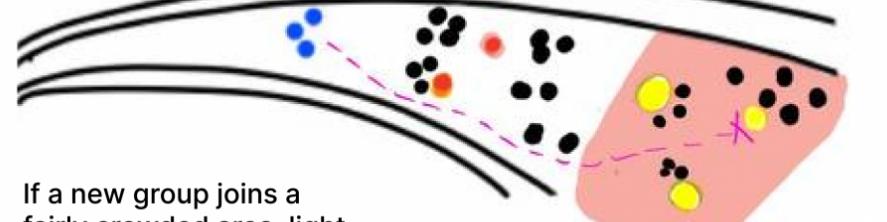
New group sits at a yellow section



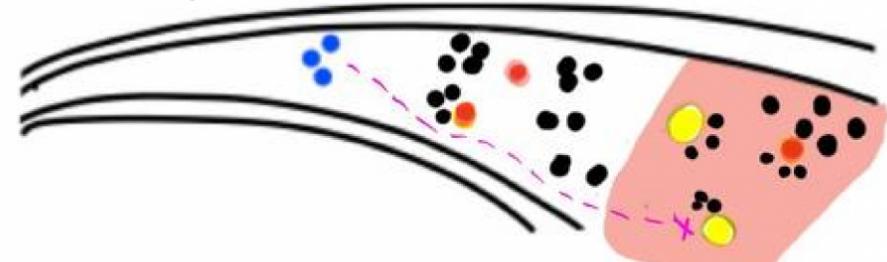
The light turns red accordingly as it is crowded. Next group can easily spot the closest empty area even if its far

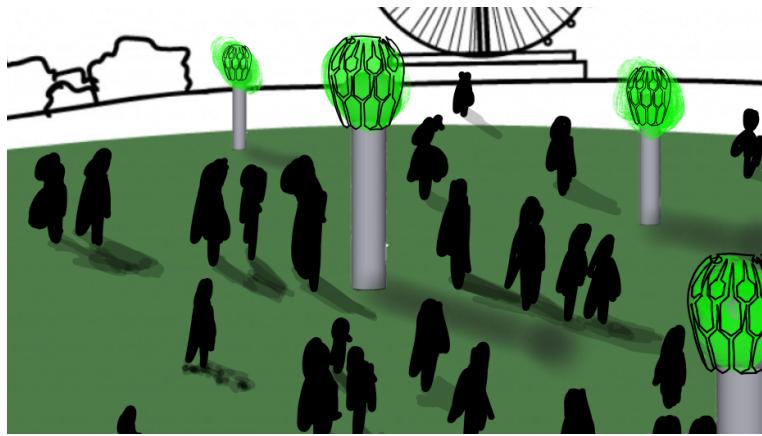


Light turns yellow and next group can evenly space themselves from the previous group to create even distribution

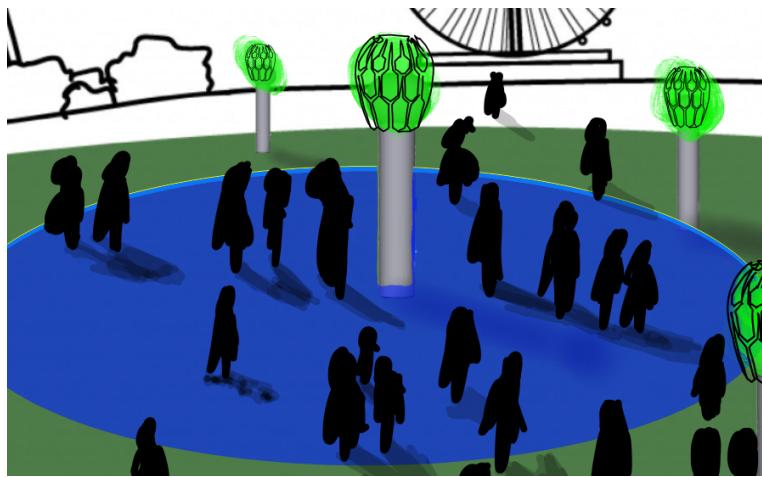


If a new group joins a fairly crowded area, light turns red to indicate overcrowding





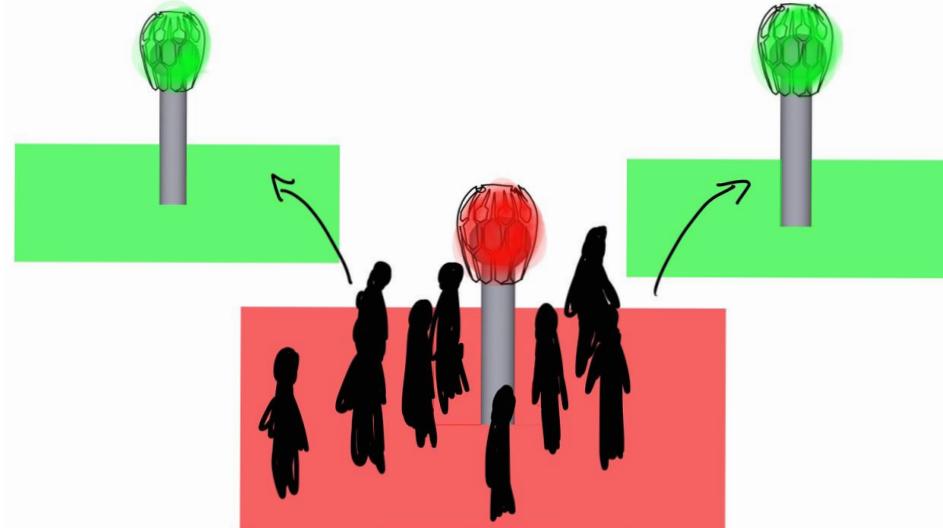
Crowds of more than 8 gathering around an area



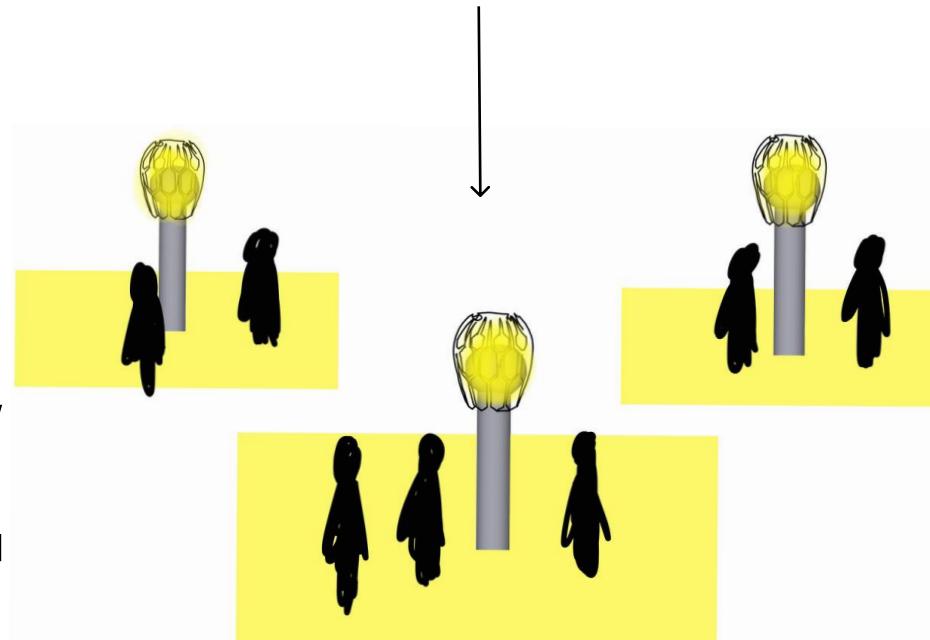
The camera counts the number of people and determines that crowd density is high



Light turns red to show that it is crowded.
Neighbouring light fixtures with low crowd density turns green.



Crowd distribution with the help of the lamp



Keywords and Tags

evolving
interactive
artificial intelligence
organic
nature illuminating social distancing culture
safe encounter aesthetic
intuitive

Creative Challenges

Our group faced great challenge during the initial phase as we **lacked the technical expertise to evaluate the feasibility of our ideas**. There was difficulty in **implementing the necessary software and hardware** for our ideas, necessitating consultations with professors and PhD students. Moreover, our initial inexperience with hardware has led to **difficulties in troubleshooting technical issues** which slowed our prototyping process. In the later stages, material choice and design became a concern as we had to **find a material that was both easy to work with and robust enough**.

Location: Marina Barrage Green Roof

