Hold my hand

: An Ultrasonic haptic device that enable the sense of security for Blind people while they are doing improvisational dance

`HCI Research`   `Hardware Prototyping`   `Problem Solving`

Problem

Visually impaired people often feel insecure when they are dancing without white cane, which means they cannot find their body balance in the space without sight.

Solution

An ultrasonic haptic device applied to a drone that gives a light touch to blind people enabling them to have a clearer idea of where they are in the space, thus, to make them feel safe.

Role & Tools

Personal work, 6 weeks
Research / Ideation / Prototyping / System Development
Esp32 / DJI Tello TT

Inspiration

Once, during a choreography lesson, our teacher instructed us to turn away from the mirror and repeat the dance. Without the mirror, I found it difficult to recall the movements from memory alone. This experience sparked my curiosity about **how visually impaired individuals dance**.

With 15 years of experience in dance and gymnastics, and now as a designer, I am deeply interested in the relationship between the human body and space. Focusing on the visually impaired, I aspire to develop a new technology **to enhance spatial perception** for this community.

WHY dance improv?

The process of dance improv
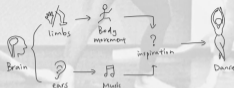
- Random
- Learn slowly compared to normal people –> but improvisation

  can be practised and **learned fastly**

Interview

I find 6 people (3/6 are blind) with different dance background and ask them to dance improv with blindfold.

What is the strongest feeling when you are dancing without the eye-sight?

"I struggle to **position my ankle precisely**, even though my body moves freely. In **larger** or **unfamiliar spaces**, it's challenging to quickly understand my surroundings, which adds to the difficulty."

**Maomao, age 25
Dance enthusiast
(Disabled)**

"When I spin, the air brushing against my skin helps me understand my position, making it feel as though I'm **'painting'** the space with my body."

**Lyon, age 27
Professional Dancer**

"I feel **insecure** without holding a white cane, and easily **lost body balance**."

**Wenwen, age 24
Beginner
(Disabled)**

"I felt a strong sense of uncertainty and loss of control. My other senses, like rhythm, touch, and balance, became sharper, making me focus more on my body's **internal sensations**."

**Zhifang, age 31
dance enthusiast**

"I have to **touch** something that can make me **feel secure.**"

**Coco, age 23
Kpop-enthusiast
(Disabled)**

"I think I can fully rely on my hearing, and this gives me new ways to precept surround environment. My **creativity** in improv"

**Shirley, age 23
Dancer**

Conclusion: **Feeling insecure is the biggest obstacle preventing them from dancing.
Enhancing their safety involves improving their body balance.
Internal sensations offer a unique perspective for creativity.**

Secondary Research

By browsing different relevant academic works, I aim to fully understand blind individuals, and I found that...

• How did blind people dance before?

use white cane in the stage.

accompanied by sighted partners.

• How did blind people perceive the relationship between body and space without eyesight before?

Teacher will **touch** their body and **click fingers**, so that they can have a clear idea of where they are in the space.

`finger clicks` 👆

• How to augment their body balance?

"With regard to self-motion perception, blind individuals have been reported to display a **faster reduction of postural sway** when a **light finger touch** was allowed and showed **superior ankle proprioception** and detection of roll tilts compared to blindfolded sighted adults."

`Light finger touch` `Proprioception`

Academic investigation

- *Faster Balance Control*
- *Cross-Modal Plasticity*
- *Effective Stabilization*
- *Haptic Cues Improve Posture*
- *Enhanced Tactile Acuity in Blind Individuals*
- *Role of Crossmodal Plasticity*
- *Factors Influencing Tactile Acuity*
- *Lack of Effect from Braille Reading*
- *Increased Dependency on Touch for Stability*
- *Challenges with Mobility*

WHY tactile?

	Congenitally Blind (Blind from Birth)	Acquired Blindness (Blind Later in Life)	Sighted people
vision	VOID	MEMORIES	NORMAL
hearing	• Can hear **lower frequencies** better than the sighted. • Understands faster speech rates due to greater reliance on auditory input.	• **Gradually adapts** to increased auditory sensitivity after losing vision. • Hearing improvement is **less instinctive** compared to con-genital blindness.	• Relies on hearing as a supple-mentary sense, generally **less sensitive** compared to blind individuals.
touch	• perceive touch **faster** • **Higher tactile sensitivity** due to extensive use of touch for information (e.g., Braille reading).	• **Touch sensitivity increases** o¬ver time, but adaptation takes **longer** compared to congenital blindness.	• Typically **less sensitive touch** as visual input is the primary sense used for information gathering.
spatial perception	• Develops spatial representa-tion through **touch and sound**. • Excels at echolocation (e.g., clapping or tapping to locate objects).	• **Relies on memory** of visual sp-atial representation. • **Takes longer to adapt** to audi-tory spatial percep-tion.	• Primarily relies on **visual cues** for spatial percep-tion. • Combines visual, audi-tory, and tactile input to navigate effectively.

Insights

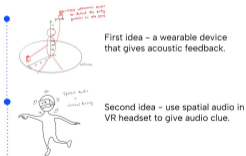The lost of body balance brings blind individuals the sense of **insecure**.

The blind has higher sensitivity in **tactile** feeling than the sighted.

Opportunity

Design a **slow and gentle experience**, which helps visually impaired people to explore other senses to find connection, expression, pleasure, and safety.
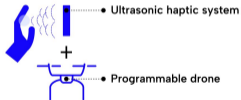
- **Break the barrier of dance**
- **Augment boby balance**
- **Find the sense of inner safe**

Idea iteration

First idea – a wearable device that gives acoustic feedback.

Second idea – use spatial audio in VR headset to give audio clue.

Final idea – instead of focusing on the sound, I started to concentrate on the touch, and I want...

To create a **Non-wearable** device that gives **haptic** feedback

- Ultrasonic haptic system

+

- Programmable drone

Haptic Technology Analysis

Smart white cane
The smart white cane could be use by visually impaired people, but is not accessible for them while dancing.
- Easily to use
- Familiar with
- Inconvenient for dancing

Ultrasonic haptic sensor
Ultrasonic haptic sensor creates a touch-less haptic feedback, which creates an experience of both accessibility and touch-like feeling.
- Body-free device
- Sensitive tactile for the blind.

Accessible for dancing

The reality of touch-like feeling

Other wearable haptic devices
- Easily to use
- Familiar with
- Inconvenient for dancing

Haptic VR gloves
Haptic VR gloves can creates multiple tactile, however, yet it is inconvenient for dance scenario.
- Real-time haptic feed-back
- Inconvenient for dancing

Solution

Start to improv

Palm detection

Hand tracking

Send ultrasonic wave

End of the improv

Development Process

PCB Design

(Credit to Yuchen from PKU)

Coding (Ultrasonic sensor & Hand tracing)

(Collaborate with Yuchen from PKU)

Ultrasonic haptic tests

Stop   Run

Prototype

Ultrasonic sensor
create tactile effects in mid-air

Esp32 chip (build-in)
program integration

Adapter expansion board
a plug-in packaging interface,
which connect both drone and
ultrasonic sensor.

PCB Board
integrated 1*6
ultrasonic sensor

Camera
Hand tracking

User Test

The result was not ideal.
First, the tactile feedback was too subtle to perceive
effectively. The ultrasonic sensor might need at least
two arrays to improve detection. Secondly, the battery
life is very short, lasting less than one minute, as the
ultrasonic sensors were also powered by the drone.

V.I.E.W.

Visibility, Independence, Empowered Women

VIEW is a smart wearable that helps visually impaired women monitor menstrual blood and detect leakage.

HCI Research *Wearable Device* *Problem Solving*

Problem
Visually impaired women often face challenges in evaluating their menstrual health through traditional visual means.

Solution
To address this, I developed a wearable smart device that empowers them to independently monitor and manage their health conditions by using an AI-Learning camera which can detect colors and gives a vibration feedback.

Role & Tools
Personal work, 8 weeks
Research / Ideation / Journey Map / Prototyping
Arduino / HuskyLens / Machine Learning / 3D Print

Desk Research

Citing the research papers I have reviewed, I compiled the data...

According to the data from WHO. Among all visually impaired people, **64.5% are women,** of whom only 39.7% have knowledge about menstrual hygiene management. Of these, 19.9% have received support, and 7.6% of those received support from their mothers.

7.6%

19.9%

those that receiving support

Data that knowledge of menstrual hygiene management

39.7%

Visually impaired women

64.5%
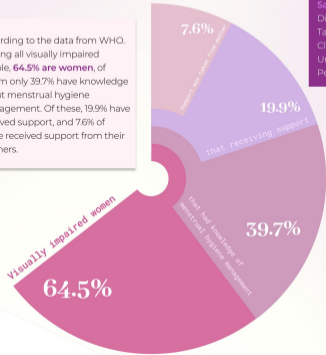
Visually impaired women's practices for menstrual hygiene (N = 187).
 1. Supplies used during menstruation
Sanitary pad 179 95.7
Diaper 19 10.2
Tampons 5 2.7
Cloth 3 1.6
Under pad 2 1.1
Period panties 1 0.5

Sanitary pad

Support was taken from (n = 99)
My mother 68 70.8
My friend 20 20.2
My husband 17 17.2
My sibling 15 15.2

Mom

Mom

Information sources of menstruation
Mother 40%
School 32%
Health care professional 12%
Friend 7%
Relative 7%
Internet 2%

Frequency of changing the supply used - on the day when bleeding is most intense
 Less than four times a day 52.4%
 Four to six times a day 33.2%
 Seven to 12 times a day 14.4%

<4

Washing hands after going to the toilet
Yes 187 100.0

YES

Way of cleaning the genitals
Front-to-back 105 56.1
Back-to-front 59 31.6
Back to back 23 12.3

Front-to-back

Based on secondary research, I have concluded that...

- They are at a **higher risk** of developing **gynecological issues** due to infrequent pad changes.

- **Sanitary pads** are the primary products used during menstruation.

- **Limited independence** during menstruation.

Interview

My ongoing curiosity led me to further understand the real menstrual experiences of visually impaired women. I was surprised to discover...

Do you know when your period is coming?

Actually, I can tell when I have my period. If I suddenly feel wet, I will probably know that my period is coming.
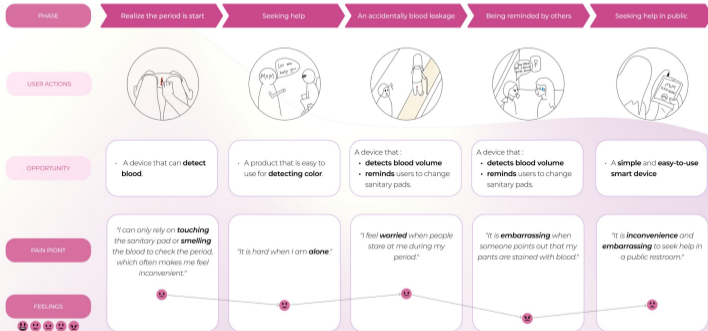
What do you experienced the most during your period?

I have been experiencing menstrual periods for several years now, so I am more experienced, but it often happens that **I don't notice my menstruation at the beginning until it leaks on my pants.**

What's the biggest trouble for you during your menstrual period?

All men are create equal. However, what bothers me the most is that **I can't determine the color of my menstrual blood to assess my health.** This obstacle also exists when I want to know the color of my urine, stool, and the phlegm I cough up.

User Journey Map

PHASE	Realize the period is start	Seeking help	An accidentally blood leakage	Being reminded by others	Seeking help in public
USER ACTIONS					
OPPORTUNITY	· A device that can **detect** blood.	· A product that is easy to use for **detecting color**	A device that : · **detects blood volume** · **reminds** users to change sanitary pads.	A device that : · **detects blood volume** · **reminds** users to change sanitary pads.	· A **simple** and **easy-to-use** smart device
PAIN POINT	"I can only rely on **touching** the sanitary pad or **smelling** the blood to check the period, which often makes me feel inconvenient."	"It is hard when I am **alone**."	"I feel **worried** when people stare at me during my period."	"It is **embarrassing** when someone points out that my pants are stained with blood."	"It is **inconvenience** and **embarrassing** to seek help in a public restroom."
FEELINGS					

Visually impaired women may facing...

visually impaired women **can't recognize the color** of their menstrual blood, thus they **can't estimate their health condition**.

The risk of menstrual blood leakage is high, and visually impaired women are unable to detect it, which brings a lot of **inconvenience** and **embarrassment**.

How I want to solve this problem?

Camera + **Vibration feedback** = **A wearable device**

Camera
Cameras can assist visually impaired individuals in detecting blood **color** and determining the appropriate time for pad **replacement**.

Vibration feedback
Vibration is a user-friendly feedback mechanism for VIP. Unlike auditory feedback, vibratory feedback typically operates **silently**, which effectively **avoids any embarrassment** they might feel while using the device.

A wearable device
Wearable devices greatly **facilitate the use** by visually impaired people.

Period Color Research

	Color	Notes
N O R M A L	Bright Red	• Fresh Blood • Fast flow
	Dark Red	• Older blood • Slow flow • Early Pregnancy
	Brown	• Older blood • Slow flow • postpartum • Early Pregnancy
P R O B L E M A T I C	Pink	• Mixed with mucus • Lighter bleeding • **Nutritional problem**
	Orange	• Mixed with fluid • Implantation • **Infection**
	Black	• Older blood • Slow flow • **Vaginal blockage**
S E V E R E	Gray	• Infection
	Green	• Infection

What Color is your menstrual blood?

Bright red isn't the only possible period blood color. You may notice **dark red** or **pink** blood at different points during menstruation. Period blood color can even be **black**, **orange**, **green**, gray, or **brown** for various reasons ranging **from early pregnancy to infection and more**.

Competitive research

Safree - a sanitary pad designed for visually impaired women

👍 • straightforward
• convenient

👎 • **choices limitation** (they have to choose this brand)

Be My Eyes - an App for visually impaired person seek help from volunteers

👍 • convenient
• low-cost.

👎 • **embarrassed** to seek help from volunteers in this situation.

Coding
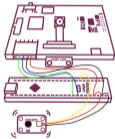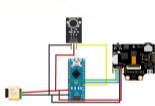
Tactile Feedback Flow

Mode.1 Replacement Detection
Sanitary Pad Recognition → Replacement Detection

Mode.2 Color Detection
Color Recognition → Healthy Detection

if

Mode 1: Unfull
Mode 2: Healthy
not replace feedback
Healthy feedback

Mode 1: Full
Mode 2: Unhealthy
replace feedback
Unhealthy feedback

Prototype

Identify-HuskyLens
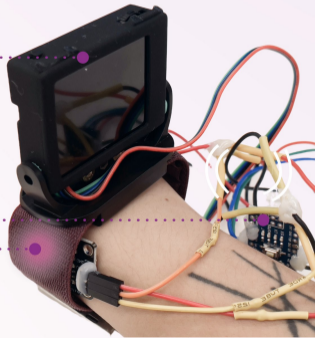HuskyLens, a low cost AI vision camera, which can easily learn colors, objects, etc.
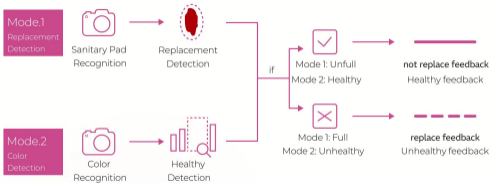
Design-Arduino Nano
As a flexible and compact open source prototype platform, Arduino Nano can be easily integrate with other sensor.

Feedback-Vibration Motor
Vibration motor provides a accesible feedback for visually impaired people. Compared to speaker, it will not make them awkward in the public occasion.

User Flow

Mode.1 Replacement Detection

Mode.2 Color Detection

It's time to change sanitary pod!

OR Your blood color is xxx
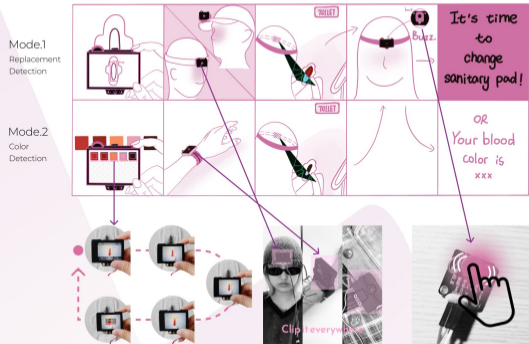
Final Product
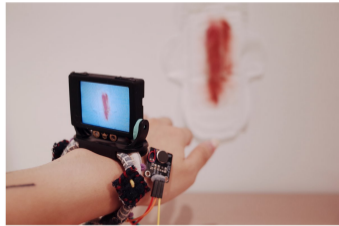
User Test

Reflection

In this project, I aimed to understand the dilemmas faced by visually impaired individuals. However, I believe that people with sight can never truly grasp the reality of what they experience.

During one of the interviews, I reflected on the real reason why they rarely change their sanitary pads, even during heavy bleeding. I started to consider whether financial constraints or other deeper factors could be influencing this behavior.

In the design process, I struggled with translating Braille into vibration patterns. My initial iteration used Morse code as a vibration pattern, but I realized that if they cannot see, how would they understand what the colors represent? In my final design, I chose to use "pulse" and "successive" vibrations to convey different feedback.

The most significant challenge for them is the issue of dignity and how they are perceived by others. I believe designers should focus on inclusive design rather than exclusive solutions.

COS_MATRIX

: An immersive ritual composed of laser images, optical devices, and photosensitive canvas / reflective material.

`Laser Performance`   `Real-time audio visualization art`   `Immersive Design`

Concept

Cos_Matrix utilizes spatial media, taking the entire Earth network as the computational subject to transform collected **cosmic data**. Through the fusion of science and mysticism, it creates an electronic or cyber-ritual in the form of an integrated audiovisual performance of graphics and sound. In this ritual, humans are positioned as **observers**—participating in a ritual space dominated by technology and electronic media, thereby achieving **a trance experience** similar to traditional rituals.

Role & Tools

Graduation Project, 4 months
Research / Iteration / System Development / Data Visualization
Blender / Touch Designer / Lasercube / Oscilloscope /Arduino

Kuda Lumping

Shaman

Tarot
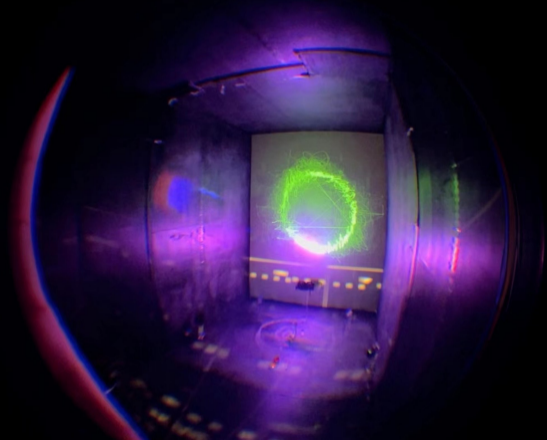
EISA

With a passion of explore the cultural ceremony, especially Shaman dance, I had a chance to experience "**Eisa**" in Okinawa, Japan, on August, 2023. At that time, I fully engaged myself in this ceremony. When I became a part of the dance, I couldn't feel time passing and I thought that this is called the "**trance**".

IMMERSIVE Methodology Research

Delphi mentioned **five key design criteria** in immersive design——transition into/out of the environment, in-experience user control, environment design, user context relatedness, user openness and motivation.

Immersive experience framework: Delphi approach.

*Adapted from Huggin-Burridge

Cos, Matrix is an integration system. It consists of several steps with different tools and technologies.

The framework begins with data collection. Once the data is converted into audio form and the program is integrated, the projector will display an image that reflects the sound of our space.

Data collection

NASA API

Data Import

Data Conversion

OSC Input

Signal Processing

Audio Analyze

Program Integration

OUTPUT

Visualization

Laser Performance
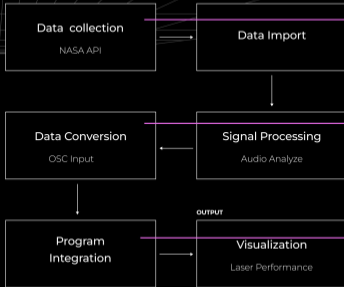
NASA Space Sounds API

NASA has released a series of space sounds via sound cloud. We have set some of the hassle in accessing these sounds, so that developers can play with audio files.

NASA's API Provides an open source data of Space Sound, which I used for this project.

I used Oscistudio to adjust the audio data and convert it into (x, y) coordinates.

I used TouchDesigner to integrate the program and turn it into a live performance.

MATERIAL EXPERIMENTS

Reflective Material
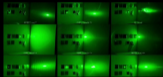
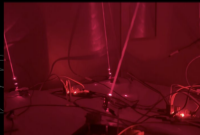Photosensitive Canvas
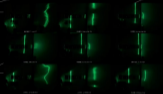
—— **Mirror acrylic** has the lowest rate of light loss.
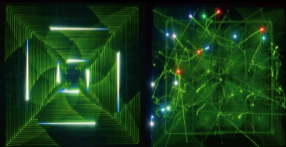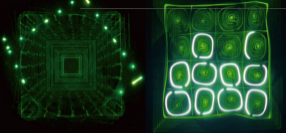
—— Blending photosensitive pigment with white pigment can create a **4D laser show**.

Minimum Viable Project (FIRST ITERATION)

In order to test the final effect, The first iteration create a **spontaneous laser system** which consists with an Arduino Mega 2560 and 9 laser modules controlled by it.
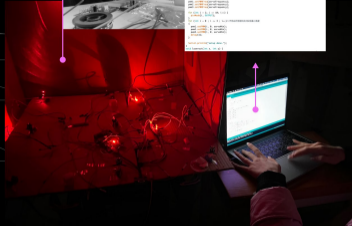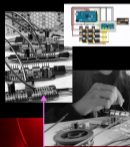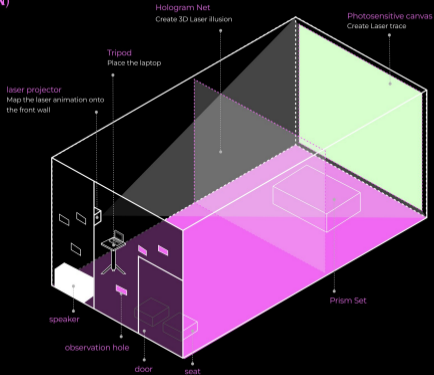
SPATIAL IMMERSION (SECOND ITERATION)

In this iteration, Cos_Matrix became an integrated system composed of a laser projector, photosensitive material, and mechanical prisms, which was exhibited at the graduation show in June 2024.

Exhibited in Liangzhu, Hangzhou, China

Hologram Net
Create 3D Laser illusion

Photosensitive canvas
Create Laser trace

Tripod
Place the laptop

laser projector
Map the laser animation onto the front wall

speaker

observation hole

door

seat

Prism Set

FINAL ITERATION

I used reflective material as the reflection media of laser projector in this final version. This work exhibited in **Media Lab, Shanghai,** in July, 2024, and simultaneously held a workshop of it.

Exhibited in Media Lab, M50, Shanghai, China
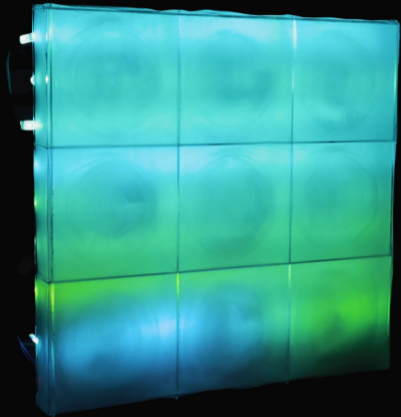
SaSa

Interactive Art Installation Design

Interactive Installation   OSC Protocol   Hardware Development

Type & Role
Duo Project , 6 weeks (Class project)
Collaborator: Xuehang Huang
Concept Development / Prototype / Coding (Part) / Iteration

Tools
Raspberry Pi / C++ / OSC Communication Protocol / Rhino / Laser Cutting

01 Inspiration

When I was little, I loved the sea. However, living in an inland city made trips to the beach rare and precious. I discovered that I could hear the sound of the sea by listening to the echo inside conch shells. Every time I heard it, it **triggered memories that made me feel safe and fulfilled**. So, I began to think about **other form of memory triggers** that could evoke positive feelings in people.

02 Memories can be triggered by...

Melody

Scent

Dream (Dejavu)

And...what else?

03 Ideation

I want to make a modular interactive installation

04 Sketch

I want to create a maze with pinballs that produce a **'SaSa'-like** sound, **triggering people's memories**.
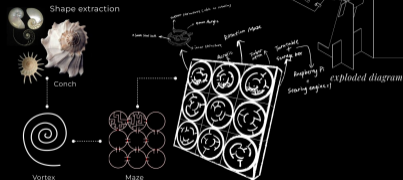
Shape extraction

Conch

Vortex → Maze

exploded diagram

05 Prototype

Coding   Motor control

Materials Acrylic, Wood, Motor
Tools   Laser Cutting

Ultrasonic Sensor (Distance)
As people approach, the rotation speed of each motor increases.

Motor
Controls the rotation of each maze.

Raspberry Pi

In the final iteration, we covered the facade with **translucent paper** and added **RGB light strips** to simulate different environments, aiming to better evoke specific memories.

translucent paper

RGB strip

Fire-burning

Seawave

Tree-swaying

OSC Communication
We use OSC Communication protocol to connect iPad with Raspberry Pi.
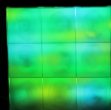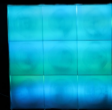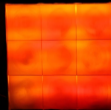
ZOMIA

——A new media dance performance

Performance   Interactive Dance   CG Animation

Concept
ZOMIA is a story of a Javanese girl escapes her tribe's
cruel traditions, finding freedom and self-awakening
in the mysterious ZOMIA region.

Type & Role
Performance, 5min
Team Project, 4 weeks
Collaborators: Yueling Chen, Xinchen Liu
My Role: Director, Visual Producer (Part), Music Composer
(Part), Choreography, Dancer

Tools
Motion Capture / Visual Effect / Animation / Visual Jokey
Unreal 5 / Maya / Motion Capture / Ableton Live / Touch Designer

As a body artist and an admirer of regional culture, particularly from Southeast Asia, I came across the concept of ZOMIA. Driven by my enthusiasm to create a new media dance work, I began crafting my own story set against the backdrop of Zomia.

Concept: What is ZOMIA represents?

1 **a geographical term:**

Zomia is a term coined in 2002 by historian Willem van Schendel to describe **a vast area of Southeast Asia** historically **beyond the control of lowland governments**.

2 **a group within a civilization:**

ZOMIA is an **ideal refuge** for hill tribes escaping lowland domination—a fragmented region challenging traditional narratives. ZOMIA embodies a state of **mutual dependence** and **benefit**, rather than control and subjugation.

3 **a story of a woman's self-awaking:**

A Javanese girl **escapes** her tribe's cruel traditions and the belief that she was **'born this way,'** finding freedom and **self-awakening** in the mysterious Zomia region.
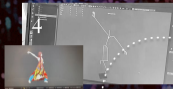
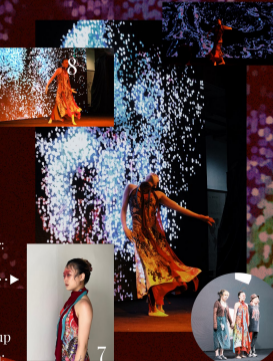*Development Process:*

Ableton Live: Composition

Maya: Rigging

Unreal 5: Animation

Choreograph

Move.ai: Motion Capture

Touch Designer: Make it to Live

Make up Design:

Final Performance: