Reflective Resonance

Creating a socio-cultural impact

Media
Touch Designer, Arduino IDE, Blender 3D, Grasshopper

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Problem Statement

To design an immersive, interactive experience using XR, new media, or tangible prototypes that incorporates or enables a narrative through user interaction, with a focus on creating socio-cultural impact.

Keywords

Cultural Differences and HCI | Adaptive and Personalized Interfaces | Cultural Inclusivity | Harmonic Wave Forms

Project Overview

In today's globalized world, cultural heritage often feels distant or generalized, and individuals may struggle to connect with traditional art forms in a personal, meaningful way. By reimagining Rangoli/ Raangoli (रांगोळी)/ muggu (ముగ్గు)/ kolam (கோலம்)/ mandas (माँडना)/ pookkalam (പൂക്കളം) a centuries-old, highly symbolic Indian art form, through digital interactivity, we provide an engaging way for users to connect with themselves, their cultural roots and a diverse community of people with similar personality types, thus fostering a sense of cultural appreciation and inclusivity.

This project aims to bridge this gap by creating an interactive platform where users interact with a physical UI and the narrative unfolds with their inputs,

Brain and Patterns

A striking aspect of an orthodox rangoli in dots, specifically 108, joined by curved lines to form a symmetrical design. From an artistic point of view, symmetry represents order, harmony and serenity. Symmetry is an innate quality of nature seen from the single-celled to complex organisms. This stable form of visual property called visual harmonic is well perceived by our brain, and we respond to it immediately.

It was Ernst Mach who first studied human response to symmetry. His research also revealed that humans are more sensitive to vertical symmetry. Further studies in 2002 observed that our brain is wired to perceive symmetry either consciously or unconsciously and forms a universal element in all that we construct art to architecture. We are familiar with a form of the symmetrical sound wave: music. The little research available on harmonics shows that when a longitudinal sound wave agitates particles on a membrane, they settle into symmetrical patterns, much like the rangoli designs.

This direct phonetic link between sound waves and visual patterns gives rise to different waveforms producing different designs. The study of such harmonic waveforms is called Cymatics. Conversely, the fluid, symmetrical compositions of rangolis and symbols form visual harmonics which the brain perceives immediately.

Dr. Christopher Tyler even mapped the brain centers that respond to visual harmonics using fMRI. His study reveals that the visual cortex or the occipital lobe activates when one perceives symmetrical patterns. His research goes on to explain that we are capable of discerning symmetry in an object in less than 0.05 seconds, showing that our brain is hard-wired for symmetry.

The 16 Personalities

16 personalities is a framework that evolved from the *Myers-Briggs Type Indicator* (MBTI). To understand 16 personalities, we must first understand MBTI.

MBTI is the earlier and more popularized framework for understanding personality. It gives insight into how people make decisions, process information, and interact with others.

First, individuals take a test that evaluates four dimensions of personality. Next, they are given the results of the test in the form of a four-letter identifier. This identifier tells you how you spend your energy, how you receive information, how you make decisions, and how you view the world. These dimensions can be framed as follows:

Each type is defined by a unique combination of four traits:
Introverted (I) vs. Extraverted (E)
Sensing (S) vs. Intuitive (N)
Thinking (T) vs. Feeling (F)
Judging (J) vs. Perceiving (P)

1. ISTJ - Introverted, Sensing, Thinking, Judging (The Inspector)
2. ISFJ - Introverted, Sensing, Feeling, Judging (The Protector)
3. INFJ - Introverted, Intuitive, Feeling, Judging (The Advocate)
4. INTJ - Introverted, Intuitive, Thinking, Judging (The Architect)
5. ISTP - Introverted, Sensing, Thinking, Perceiving (The Crafter)
6. ISFP - Introverted, Sensing, Feeling, Perceiving (The Artist)
7. INFP - Introverted, Intuitive, Feeling, Perceiving (The Mediator)

8. INTP - Introverted, Intuitive, Thinking, Perceiving (The Thinker)
9. ESTP - Extraverted, Sensing, Thinking, Perceiving (The Persuader)
10. ESFP - Extraverted, Sensing, Feeling, Perceiving (The Performer)
11. ENFP - Extraverted, Intuitive, Feeling, Perceiving (The Campaigner)
12. ENTP - Extraverted, Intuitive, Thinking, Perceiving (The Debater)
13. ESTJ - Extraverted, Sensing, Thinking, Judging (The Director)
14. ESFJ - Extraverted, Sensing, Feeling, Judging (The Caregiver)
15. ENFJ - Extraverted, Intuitive, Feeling, Judging (The Protagonist)
16. ENTJ - Extraverted, Intuitive, Thinking, Judging (The Commander)

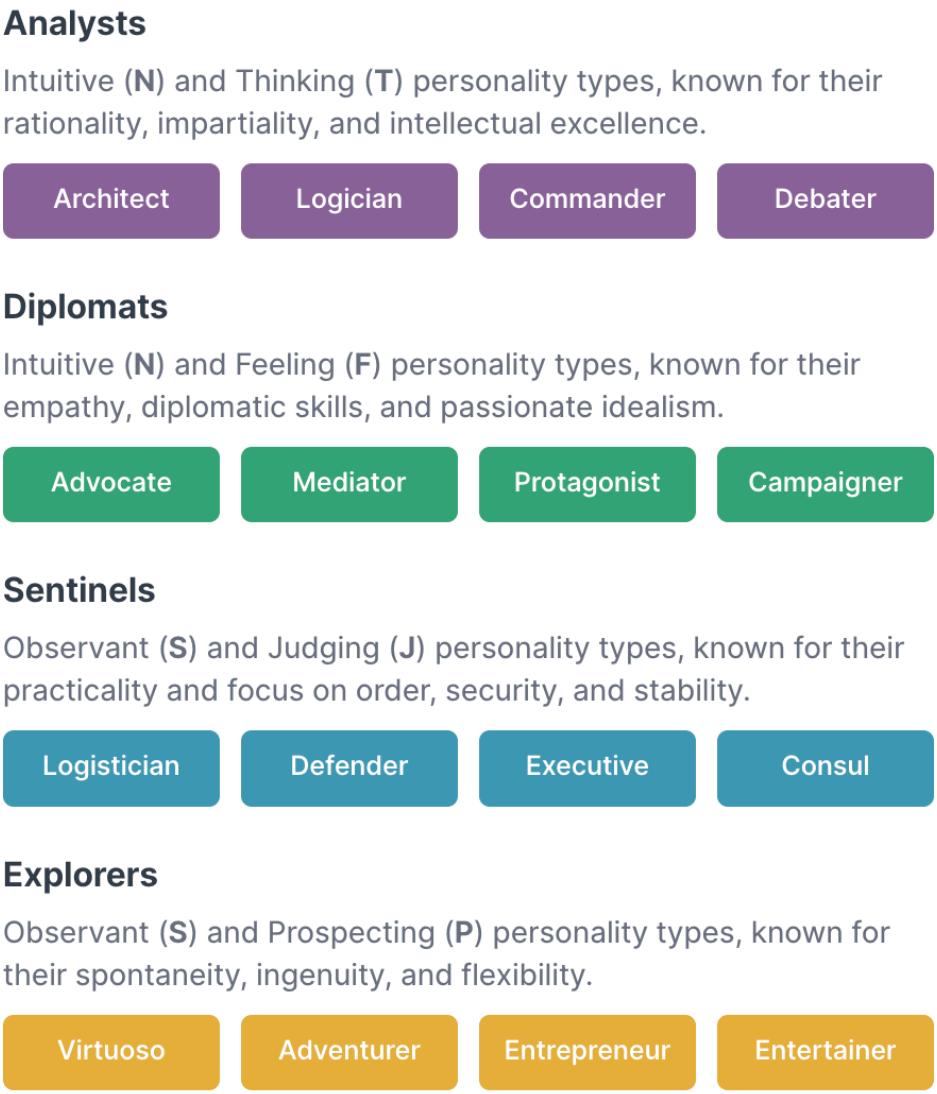


Fig. 1 *Archetypes for each personalities. Credits: https://www.16personalities.com/free-personality-test*

Design and Interactivity

The interaction works of the following principle:

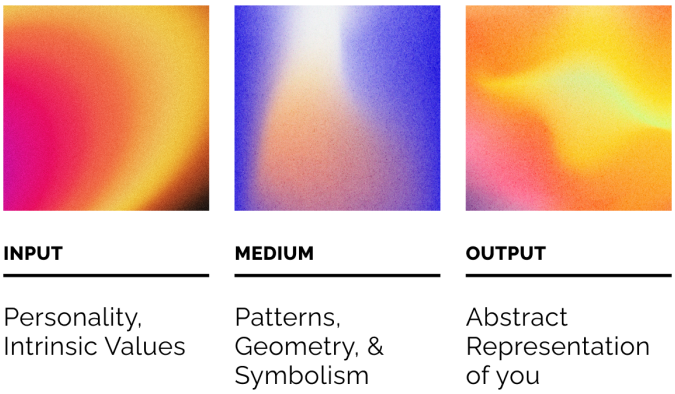


Fig. 2 *Working of the interactive model*

Motif Creation

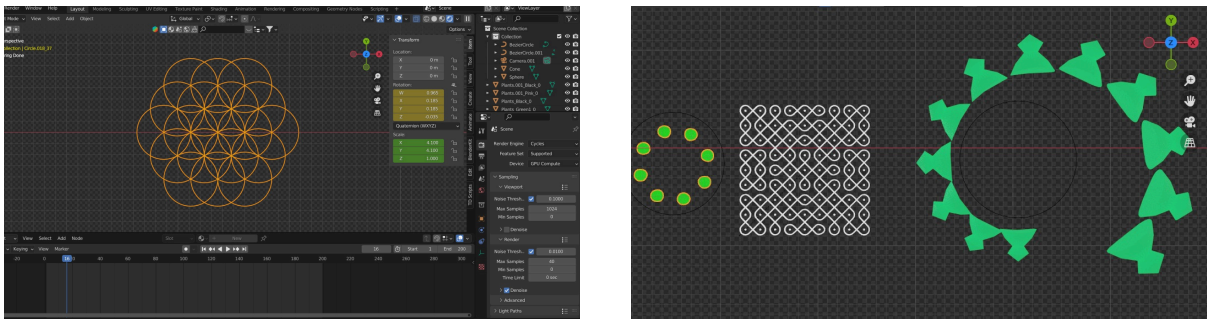


Fig. 3 *Motif creation on Blender 3D*

In this project, traditional Indian design elements were recreated using Blender 3D, blending cultural symbolism with geometric precision. The foundational framework drew inspiration from Pulli Kolam, where a grid of dots provided the base for symmetrical designs through interconnected lines and curves. The project explored fractal and tessellation patterns, emphasizing repeated and scaled designs inspired by nature, such as honeycombs and star formations.

Motifs like lotus flowers symbolizing purity, spirals and curves reminiscent of vines, and geometric shapes reflecting natural order were integrated to reflect harmony. Spiritual symbols, including Lotus Mandalas (cosmic energy), Chakras (spiritual energy centers), and celestial patterns (sun, moon, and stars), added a divine dimension. Additionally, auspicious icons such as the Swastika (good fortune), conch shells (divine sound), and Deepam lamps (enlightenment) enhanced the cultural significance.

Colour & Shape Psychology

The combined effect of colour and shape taps into our emotional responses by aligning intrinsic attributes of visuals such as hue, brightness, and contour with emotions and mental associations. For instance, warm colours like red or orange, paired with bold, angular shapes, can evoke feelings of excitement or urgency, while soft, cool colours like blue combined with rounded, gentle shapes create a sense of calm and trust. This emotional mapping enables information in graphics to resonate more deeply with observers, enhancing engagement.

Fig. 4 *Colour Psychology Model*

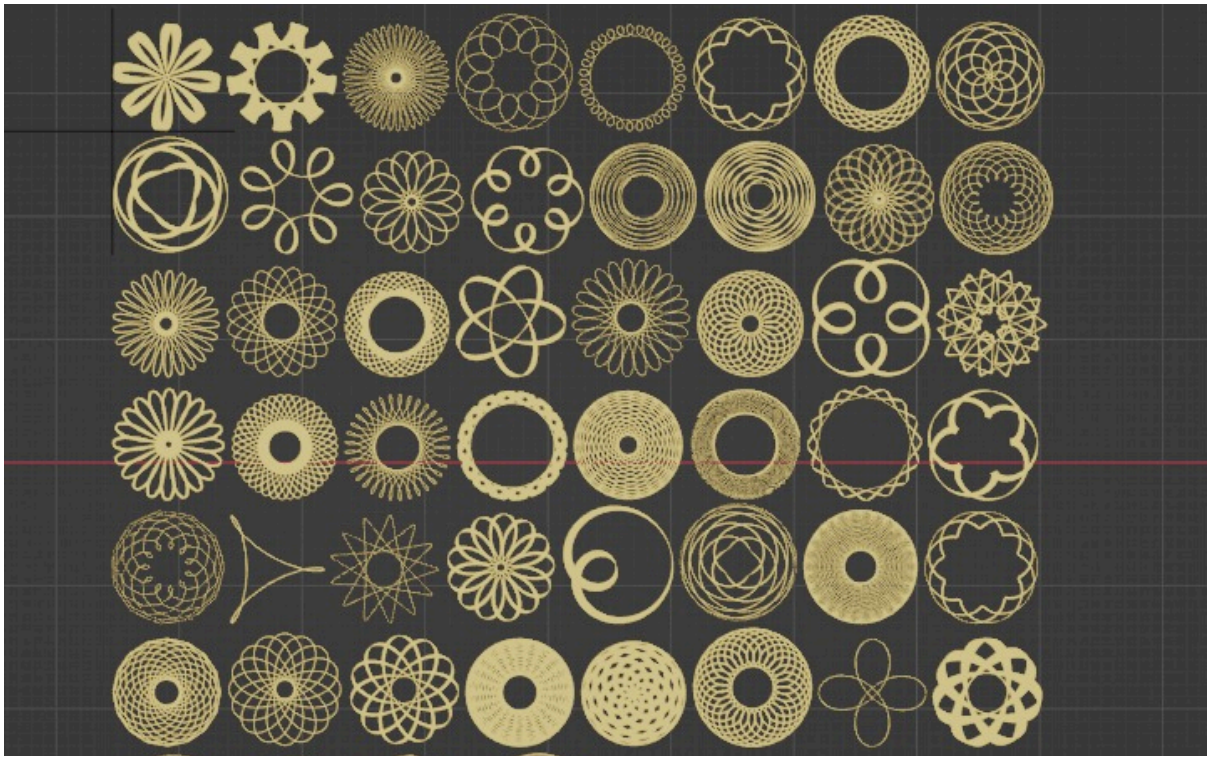


Fig. 5 *Motif exploration for different personalities*

Pattern Creation and Brainstorming

Our exploration focused on the concept of layered decision-making, where each question progressively narrows down the possibilities, creating more complex patterns. As participants move through the quiz, each choice branches out: a single answer leads to two distinct outcomes, and the second layer further splits into four. This step-by-step approach allows each response to build on the previous one, forming a dynamic and evolving pattern that visually represents the participant's journey. The structured layering not only guides users through an interactive experience but also reveals a unique final outcome shaped by their individual choices.

Fig. 6 *Motif exploration for different personalities*

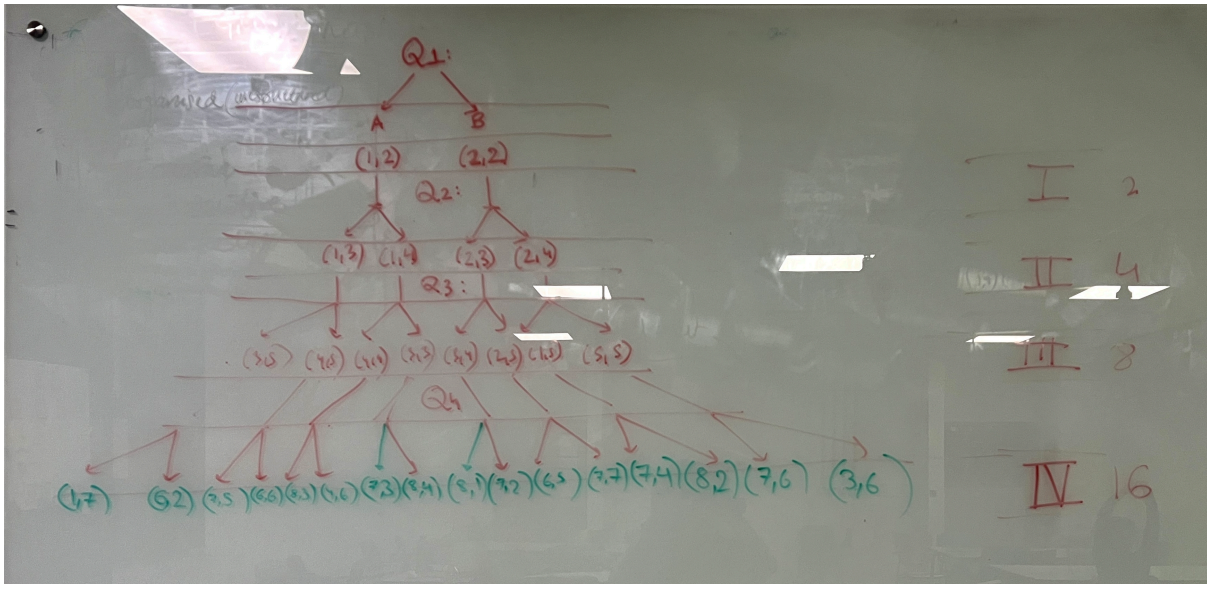


Fig. 7 *Network Map*

To start, variables are gathered by defining constant ***n*** and ***m***, which control key parameters in the equation. Code is then used to incorporate these constants as input values within the math node. The cosine function is applied to establish patterns and spatial relationships, with alternating and combining functions in the math node to create the desired effects of addition and subtraction. Negative spaces within the pattern are generated through careful configuration of the math node, allowing particles to form the pattern within these spaces, which is further enhanced using a normal map.

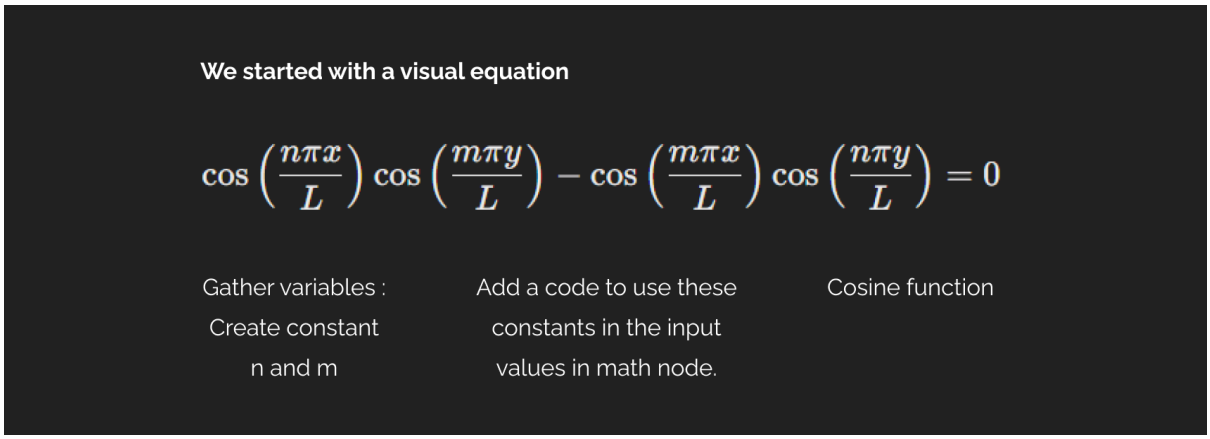


Fig. 8 *Understanding of the particle motion on TouchDesigner*

To create particles, an add node is used to position them within the geometric space, assigning them a shape material known as "point sprite." Multi GSL is then applied to control the velocity and position of these particles, allowing for precise adjustments based on the required value range. These values are further refined using the normal map, which helps to achieve the desired particle distribution and movement within the visual space.

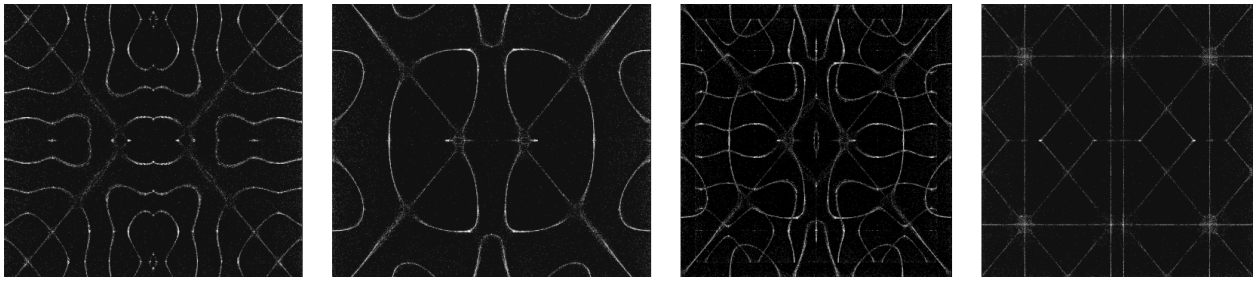


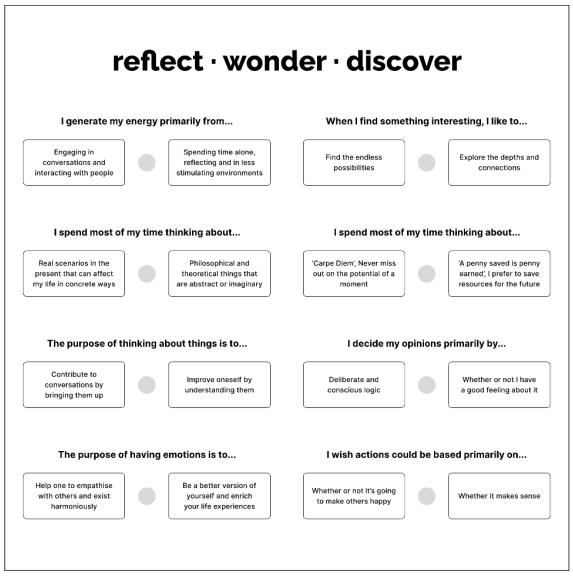
Fig. 9 *Chladni effect output*

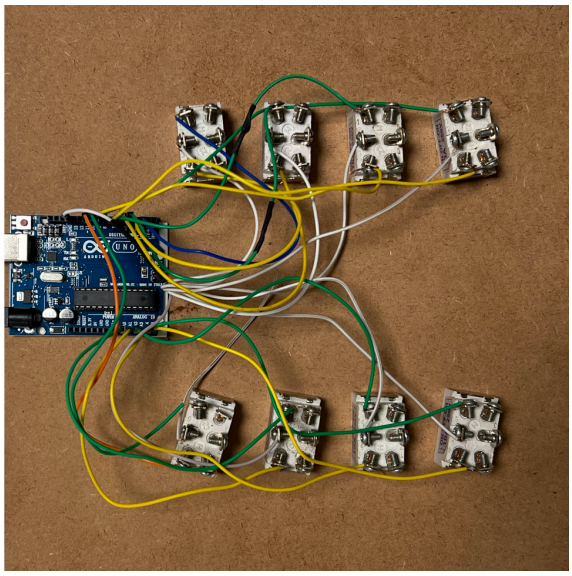
Technicality

Physical UI-Arduino-Button Integration

Each switch is configured with three distinct output positions: left, neutral, and right. Through coding, each switch was mapped precisely to its designated function, creating a clear system where:

Position "1" represents the left switch position,
Position "0" is the neutral or center position,
Position "2" represents the right switch position.
This setup allows each switch to perform multiple functions based on its position, with outputs dynamically adjusting as each switch is toggled between left, center, and right.





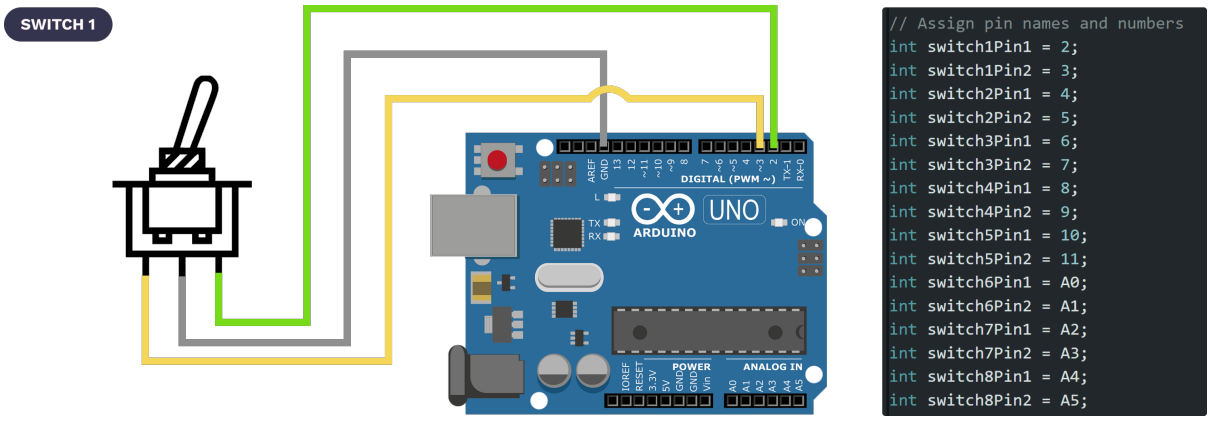


Fig. 10 *Input and Circuit Mapping*

In the installation, human interaction was used to generate the Chladni effect through a simple three-way switch connected to an Arduino Uno board.
The user, as seen in figure 10 with the questions, selects between two options by flipping the switch towards the chosen side. A common ground is wired from the center node of each switch and connected to the Arduino board's ground pin. The two opposite nodes from each switch are connected to the Arduino's digital and analog inputs, following a specific sequence.

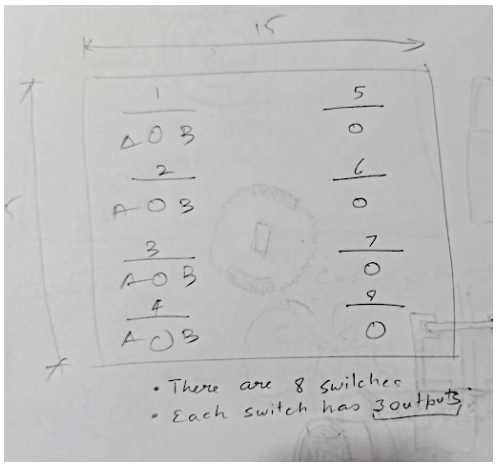


Fig. 11 *Logic*

The programming is set so that if the switch is in the center position, the system reads a value of 0. When flipped to the right, the program registers a value of 1, and flipping it to the opposite side results in a value of 2. The positions of all the switches are transmitted to TouchDesigner, which controls the visual output. As the user flips the switches in response to the questions, corresponding graphics are generated on the display screen, creating the Chladni effect.

Arduino-TouchDesigner Integration

```
// Switch 6
if ((switch6State1 == LOW) && (switch6State2 == HIGH)) {
  Serial.print("1");
  Serial.print(" ");
  c6 = 1;

} else if ((switch6State1 == HIGH) && (switch6State2 == HIGH)) {
   Serial.print("0");
   Serial.print(" ");
} else if ((switch6State1 == HIGH) && (switch6State2 == LOW)) {
   Serial.print("2");
   Serial.print(" ");
   c6 = 2;
}
```

	0
0	message
1	0 1 2 1 1 1 1 6 8 1 1 2 1 10011121
2	0 1 2 1 1 1 1 1 1 1 1 2 1 10001121
3	0 1 2 1 1 1 1 1 1 1 1 2 1 10001121
4	0 1 2 1 1 1 1 1 1 1 1 2 1 10001121
5	0 1 2 1 1 1 1 1 1 1 1 2 0 10001120
6	0 1 2 1 1 1 1 1 1 1 1 0 0 10001100
7	0 1 2 1 1 1 1 1 1 1 0 0 0 10001000
8	0 1 2 1 1 1 1 1 1 0 0 0 0 10000000
9	0 1 2 1 1 1 1 1 1 0 0 0 0 10000000

serial1

	0	1	2	3	4	5	6	7	8	9	10	11	12	13
0	message													
1	0	1	2	1	1	1	1	6	8	1	1	2	1	10011121
2	0	1	2	1	1	1	1	1	1	1	1	2	1	10001121
3	0	1	2	1	1	1	1	1	1	1	1	2	1	10001121
4	0	1	2	1	1	1	1	1	1	1	1	2	1	10001121
5	0	1	2	1	1	1	1	1	1	1	1	2	0	10001120
6	0	1	2	1	1	1	1	1	1	1	1	0	0	10001100
7	0	1	2	1	1	1	1	1	1	1	0	0	0	10001000
8	0	1	2	1	1	1	1	1	1	0	0	0	0	10000000
9	0	1	2	1	1	1	1	1	1	0	0	0	0	10000000
10	0	1	2	1	1	1	1	1	1	0	0	0	0	10000000

convert5

1	chan1
2	chan2
1	chan3
1	chan4
1	chan5
1	chan6
1	chan7
1	chan8
0	chan9
0	chan10
0	chan11
0	chan12
10000000	chan13

datto1

Fig. 12 *TouchDesigner operators*

1. The Arduino was coded to give the outputs in a linear line based on the switches which are activated.
2. Using DAT Serial, the Arduino output entered TouchDesigner.
3. DAT Convert made it into a table.
4. CHOP Datto then converted it into a form, from which the vales could used to create CHOP references and control which visuals got displayed.

Myers-Briggs Type Indicator

```
//variables for the sequencer
int c1 = 0;
int c2 = 0;
```

```
// Switch 8
if ((switch8State1 == LOW) && (switch8State2 == HIGH)) {
  Serial.print("1");
  Serial.print(" ");
  c8 = 1;

} else if ((switch8State1 == HIGH) && (switch8State2 == HIGH)) {
   Serial.print("0");
   Serial.print(" ");

} else if ((switch8State1 == HIGH) && (switch8State2 == LOW)) {
   Serial.print("2");
   Serial.print(" ");
   c8 = 2;

}

// Combine the values of c1 to c8 into a single number
Serial.print(c1);
Serial.print(c2);
Serial.print(c3);
Serial.print(c4);
Serial.print(c5);
Serial.print(c6);
Serial.print(c7);
Serial.println(c8);
```

	0
0	message
1	0 1 2 1 1 1 1 6 8 1 1 2 1 10011121
2	0 1 2 1 1 1 1 1 1 1 1 2 1 10001121
3	0 1 2 1 1 1 1 1 1 1 1 2 1 10001121
4	0 1 2 1 1 1 1 1 1 1 1 2 1 10001121
5	0 1 2 1 1 1 1 1 1 1 1 2 0 10001120
6	0 1 2 1 1 1 1 1 1 1 1 0 0 10001100
7	0 1 2 1 1 1 1 1 1 1 0 0 0 10001000
8	0 1 2 1 1 1 1 1 1 0 0 0 0 10000000
9	0 1 2 1 1 1 1 1 1 0 0 0 0 10000000

serial1

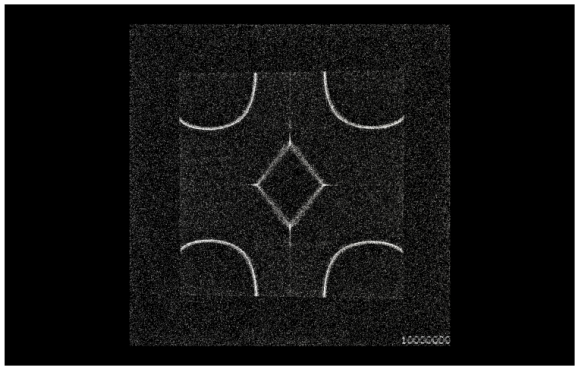


Fig. 13 *Code taking the the 8 digit values & Corresponding values received in TD*

Additionally, each switch contributes to an 8-digit code consisting of 1s and 2s. A pre-prepared key, created by running the quiz 256 times, allows for a corresponding lookup of each digit. This system provides instant feedback on the current code, revealing the participant's input in real-time. The 8-digit pin also functions as a diagnostic tool, indicating which switch is active and in what position, facilitating easy troubleshooting for any loose or incorrect connections.

Network River

As there were over 70 operators, feeding different lines and switching on and off, proper spatial arrangement was required to keep things manageable. Here's a glimpse:

SECTION 1
Input from Arduino and converting it

SECTION 2
Chladni Effect Formation

SECTION 3
Switch interactions

SECTION 4
Assigning colour ramps

SECTION 5
Combining different visuals and effects part. Layering.

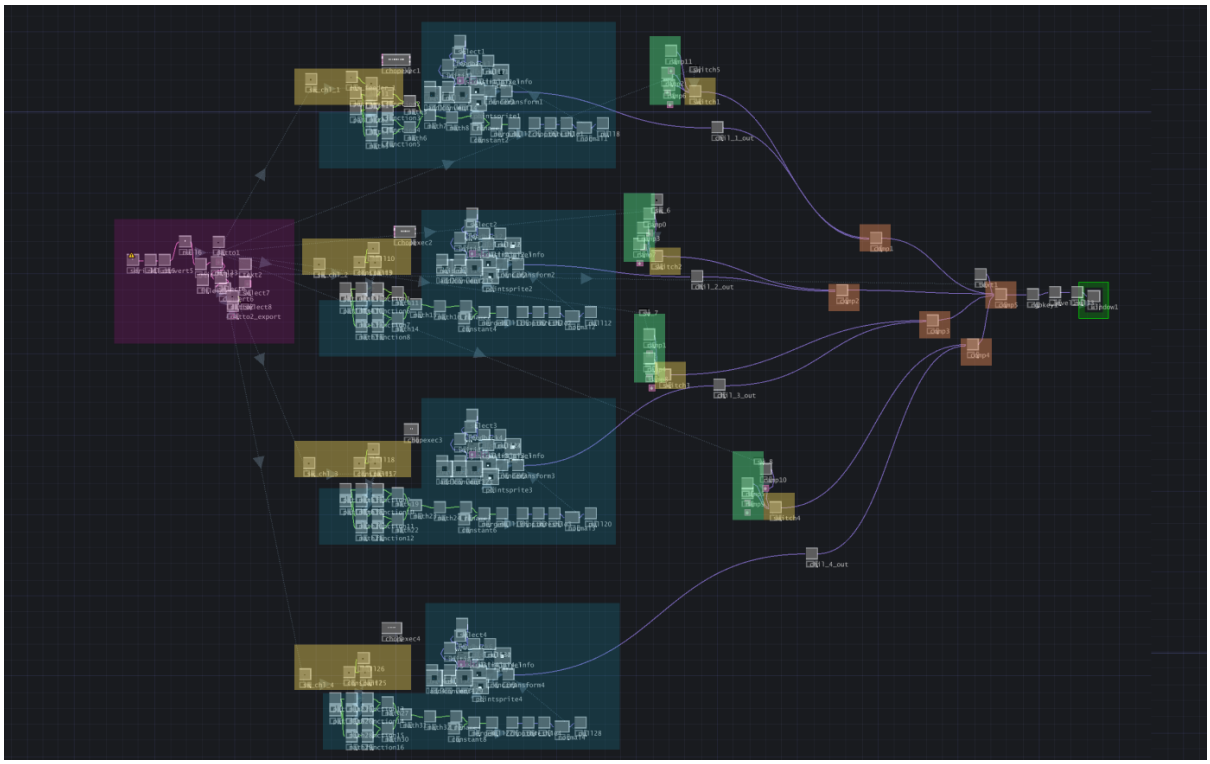
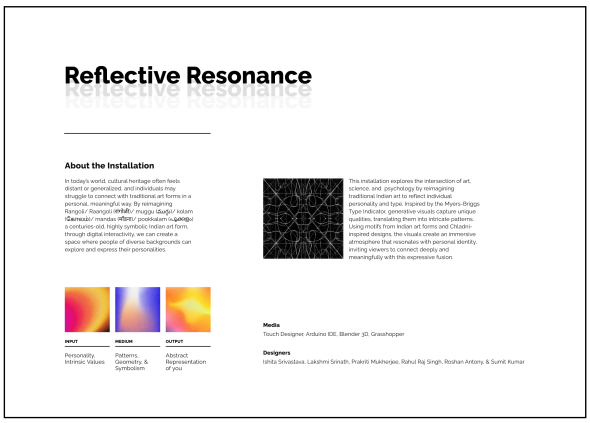


Fig. 14 *Working in sections*

Curation and Exhibition Design

Our team took a hands-on approach in designing the HMI Horizon Exhibition, aiming to create a space that was as engaging as it was informative. We crafted interactive corners, where visitors could experience. To ensure a seamless and intuitive user flow, we organized the exhibition into clearly defined thematic zones, allowing visitors to move fluidly through each section and engage with the content step-by-step.



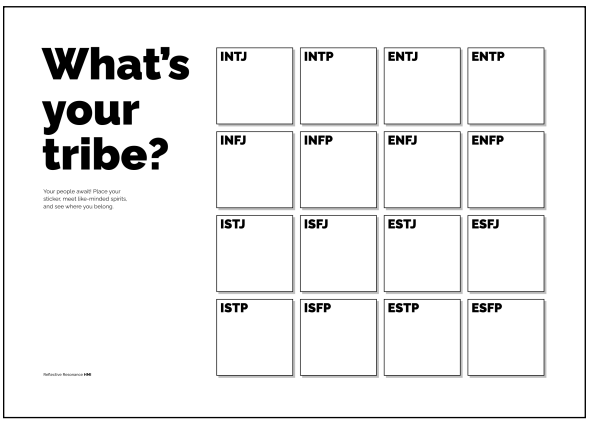


Fig. 15 *Exhibition Design, Self Branding and Interactive pieces for exhibition experience design*

Output

Fig. 16 *Human-Machine Interaction Model*

Message of Connection and Mindfulness

Interactive elements invite participants to become co-creators, highlighting the connection between the individual and the collective. Each movement or choice adds to a larger design, symbolizing how personal contributions shape a shared cultural tapestry.

Celebration of Cultural Heritage through Modern Technology

This experience combines Arduino and TouchDesigner with traditional Indian art, blending cultural heritage with modern technology. By reimagining a traditional form like rangoli digitally, it celebrates these ancient art forms as evolving expressions, bridging a sense of personal connection and honoring the centuries old tradition..

Customizable Patterns Reflecting Self-Discovery

Participants engage in a journey of self-exploration through an MBTI-inspired personality test. Each choice deepens their connection with their inner self, gradually forming a unique pattern that reflects their personality and identity.

Take-Home Experience

The experience concludes with a printed zine of each participant's creation, offering a tangible keepsake of their journey and a potential way to connect with like-minded individuals or "tribe."

Fig. 17 *Zine Station: Zines for the participants*

Fig. 18 *Visuals for Zines*

Socio-Cultural Impact

The interactive corner at IIT Kanpur provided a snapshot of the personality dynamics within the campus, revealing a predominance of INFJ and INTP participants, personality types known for their introspective and analytical qualities. This observation suggests a lean towards thoughtfulness and future-oriented thinking among the IIT Kanpur community. Notably, the absence of ESFJ participants hinted at a limited presence of extraverted, community-oriented traits, perhaps reflecting the social and cultural nuances of the campus environment. The project successfully

Fig. 19 *One of Three Interactive Corners*

brought together traditional Indian cultural heritage and modern technology. By reimagining rangoli, a centuries-old art form, through digital interaction, we offered participants a chance to connect with their cultural roots in a contemporary context. This approach not only revived interest in traditional motifs but also encouraged self-reflection, allowing participants to explore their identities within the framework of cultural symbols.

The space became a communal meeting point, where diverse perspectives and backgrounds could intersect through shared artistic experiences. It allowed participants to co-create, reinforcing the idea of individual contributions shaping a larger, collective narrative. By connecting with cultural symbols digitally, individuals saw themselves as part of a larger, evolving tradition, blending personal stories with collective heritage.

This experience illustrated the relevance of using technology to sustain cultural narratives, showing that digital platforms can offer a modern twist on tradition while preserving its essence. The exhibition encouraged meaningful dialogue around cultural appreciation, highlighting how adaptive interfaces can make heritage accessible, engaging, and personally resonant for today's generation.

Conclusion and Takeaways

Fig. 20 *Team Frieduino (Left to right: Roshan, Sumit, Lakshmi, Ishita, Prakriti, and Rahul Raj)*

Fig. 21 *A panoramic view of the curation*

Fig. 22 *Snapshots from exhibition*

The HMI project successfully demonstrated how traditional aesthetics and modern technology can intersect to foster a sense of connection and self-discovery. Participants not only engaged with cultural heritage through digital mediums but also reflected on their personal identities. The experiment confirmed that personality-driven and culturally adaptive interfaces can enhance inclusivity and resonance, offering both an educational and emotionally engaging experience. This project sets a precedent for how cultural traditions can evolve in the digital era, creating a bridge between the past and present while celebrating individuality and collective identity.

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