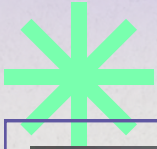


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Circuitry of Fate: An ESP-NOW Tarot System

"The Zoo" Project | SuSe 2025



Keywords: Interactive Installation, Magic, Tarot Cards, ESP-NOW, IoT, Physical Computing, RFID, Servo Motors, Networked Art, Divination, Tangible Interaction.

ABSTRACT Circuitry of Fate is a tangible interaction system developed as part of The Zoo, a collaborative project where nine devices were connected into a shared network. Each device had its own input and output mechanisms but communicated with others using the ESP-NOW protocol. The concept of Circuitry of Fate is based on a ritual of divination with tarot cards and a magical atmosphere. Users select cards representing the past, present, and future, and place them into a reading box with an RFID reader. Past cards decide which device in the network will receive a signal, and present cards define the intensity of that signal. When the present card is removed, the chosen device reacts according to the received intensity value. The future cards form the output of the system itself: one of eight cards is revealed with servo motors, while a glowing orb adds atmospheric lighting effects. The project focuses on themes of ritual, slowness, and materiality, creating a contemplative experience rather than an efficient one. Within the ecology of The Zoo, the system shows how simple signals can turn into poetic and unexpected connections between devices, contributing to ideas of ritual and contemplative computing.

1. INTRODUCTION

1.1. About the project

Tangible interaction is a growing area in Human-Computer Interaction that looks at how physical objects and gestures can serve as inputs and outputs in digital systems. Instead of focusing only on efficiency, it often emphasizes playfulness, ritual, and embodied experience, inviting users into interactions that feel both material and meaningful. The Zoo was developed as a collaborative project in which nine students each designed one device. Every device had its own input and output mechanisms, ranging from mechanical string-pulling to light or sound. All devices communicated with each other using the ESP-NOW protocol and the ZooUAR library [1]. Messages could be intentionally directed, but they could also be received unexpectedly, giving the network an atmosphere of both intentionality and mystery. The general challenge for each participant was to design a device that was technically feasible while also engaging through tangible interaction.

Circuitry of Fate is one of the devices in this ecology. Its interaction is based on divination rituals, using tarot cards, a

magic box, and a glowing orb. The specific challenge was to translate the act of choosing a tarot card into signals that could be shared across the network, while also producing a poetic output of its own. The interaction follows three stages: past cards decide which device will receive a signal, present cards define the intensity of that signal, and future cards reveal themselves as the output through servo movements and atmospheric lighting.

1.2 Why tarot cards?

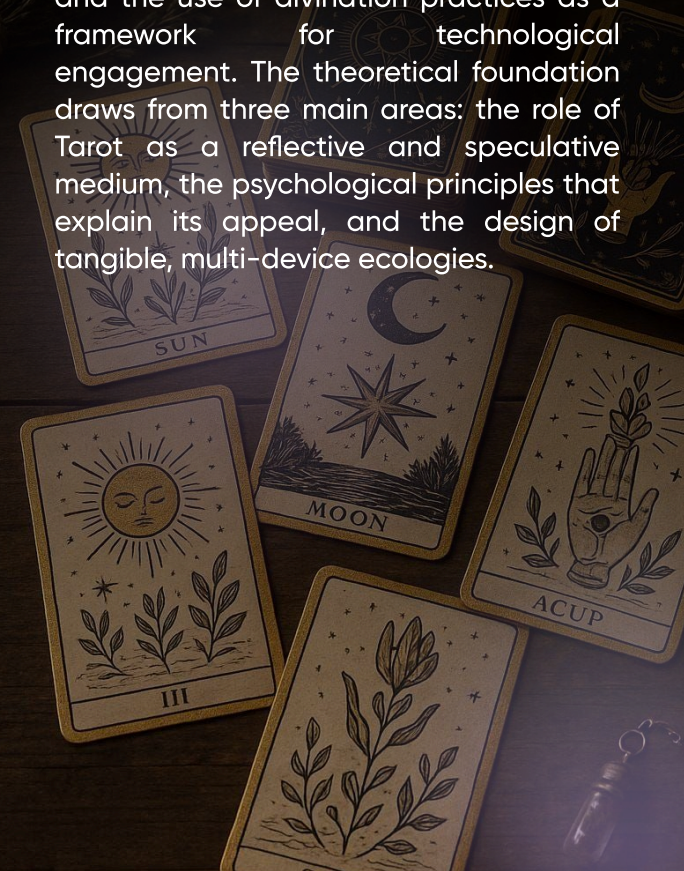
Several early concepts were explored but rejected due to technical limitations or the lack of tangible interaction. Tarot cards were chosen because they provided a clear way to combine input and output while also introducing unpredictability and curiosity. Since tarot is familiar to many people, it could draw users in and create an immediate connection. At the same time, it supported the project's overall focus on interaction and mystery, turning a technical process into a symbolic performance.

The aim of Circuitry of Fate is to show how simple signals can be transformed into a ritualized interaction that feels

contemplative and poetic rather than purely functional. Key features include RFID-based card sensing, servo-controlled card reveals, atmospheric LED lighting, and integration within the multi-device ecology of The Zoo.

2. THEORETICAL BACKGROUND

This project lies at the intersection of tangible interaction, networked systems, and the use of divination practices as a framework for technological engagement. The theoretical foundation draws from three main areas: the role of Tarot as a reflective and speculative medium, the psychological principles that explain its appeal, and the design of tangible, multi-device ecologies.



2.1. Tarot as a Reflective and Speculative Technology

In Human-Computer Interaction (HCI), Tarot is increasingly studied not as a tool for fortune-telling, but as a medium for reflection and speculation. Wu [9] (as cited in [8]) describes Tarot as a “technology of care”—something people use to care for themselves and which, in turn, is maintained and cared for by its communities. This perspective moves the focus away from prediction and instead highlights introspection: the cards’ archetypal imagery prompts users to pause and consider different perspectives on their past, present, and future.

Recent design research builds on this understanding by using Tarot as a way to scaffold inquiry. Lustig and Rosner [7], for example, created a machine-learning-generated Tarot deck to explore the “unexplainable” in the design process, showing how the cards encouraged reflection on the roles and responsibilities of AI designers. Similarly, Artefact’s Tarot Cards of Tech [4] invite technology practitioners to reflect on unintended consequences of their projects. In these cases, drawing and interpreting a card becomes a ritualized moment that slows down interaction, making it particularly



relevant for a project like this one, which seeks to frame networked communication as a contemplative and even magical experience.

2.2. Psychological Engagement and the "Barnum Effect"

The appeal of Tarot can also be explained through psychology. The Barnum Effect describes how people tend to accept vague or general descriptions as uniquely accurate for themselves [3]. Tarot cards, especially those from the Major Arcana, rely on universal themes such as love, conflict, or transformation, which can be easily mapped onto a person’s life situation [6].

Beyond this, the ritual of a Tarot reading—shuffling, focusing on a question, selecting cards—creates space for self-reflection. Hofer’s study [5] found that many users employed Tarot not as a divination tool, but as a way to gain insight into their current situations. The cards often did not reveal new information but provided a shift in perspective, giving users a sense of order, control, or comfort in uncertain times. In this project, these mechanisms are central: choosing cards for the “past” and “present” makes the user an active participant, while the vague but universal idea of a “future” outcome (the activation of another device) taps into the Barnum Effect to make the experience feel personally meaningful.

2.3. Tangible Interaction and Networked Ecologies

The project also builds on the principles of tangible interaction, where physical objects and gestures act as a bridge to digital computation. Here, RFID-enabled cards are not only inputs but also ritualized objects that connect the user's tangible actions to responses in a larger digital system. This echoes Lustig and Rosner's [7] notion of "inspiriting design," which emphasizes creating interactions that feel mysterious and engaging rather than fully transparent.

Finally, Circuitry of Fate is part of a networked ecology of devices. Within The Zoo, multiple devices with unique inputs and outputs communicate using a shared protocol. Interactions are partly deliberate—since one can choose a target device—but also partly mysterious, as messages ripple through the network in unpredictable ways (Project Brief, 2025). A local ritual with the Tarot thus produces a distributed effect: the immediate outcome is visible in one place, but its full influence extends into unseen parts of the system. This reflects the core principle of ubiquitous computing, where multiple interconnected devices form experiences



greater than the sum of their individual parts [2].

3. DESIGN PROCESS

The design process began with initial sketches and presentations of individual visions, and gradually moved toward defining the technical details and components needed for realization. Materials were chosen with care, not only to address technical challenges but also to create a presentation that looked coherent and engaging.

As a group, discussions focused on the potential technologies and processors required to bring the concepts to life. In the end, the ESP32 microcontroller was selected as the computational core, since it allowed flexibility while supporting wireless communication. The project relied on ESP-NOW, a low-power peer-to-peer communication protocol well-suited for multi-device ecosystems. Integration with the ZooUAR library [1] further enabled seamless message exchange between the devices in The Zoo.





Figure 1: Tarot card deck



Figure 2: Table rug



Figure 3: Decorative element



Figure 5: Wooden Box



Figure 4: Magic Ball

3.1. Material Choice

Each device in the network was designed to combine input and output mechanisms with tangible interactions. Outputs reflected the intensity of the inputs triggered by users, allowing signals to be shared across the group in a consistent way. For Circuitry of Fate, the materials included a tarot card deck [Figure 2] with predefined explanations and names, a magic ball [Figure 5] (later filled with polyester to diffuse light), a wooden box [Figure 6] and card stand, and additional decorative elements such as a table rug [Figure 3] and statues [Figure 4]. These choices supported both the technical requirements and the desired atmosphere of ritual and magic.

3.2. Technology and Sensor Choices

The device combines several hardware components and communication protocols to create an experience that feels both technical and magical. Its implementation can be understood through three main systems: input sensing, output actuation, and network communication.

3.2.1. Input System: RFID-Based Tarot Reading

The input system is built around Radio-Frequency Identification (RFID), which makes it possible to detect user interactions with the tarot cards. A MFRC522 RFID reader is placed inside a custom-built “magic box,” where users place their chosen cards. Each of the 16 cards—8 for the past and 8 for the present contains a unique RFID chip. This ensures that the system can reliably recognize which card is being used.

When a card is placed in the box, the reader captures its unique identifier and sorts it into one of two categories: past cards (which determine the target device to receive a signal) or present cards (which define the signal’s intensity, ranging between 10–90%). This makes the input process both tangible and intuitive, while also aligning with the ritual-like character of the tarot interaction.

3.2.2. Output Systems: Servo Mechanisms and Atmospheric Lighting

The output side of the system focuses on creating both physical and atmospheric effects. Behind the set of future cards, eight micro servos are arranged, each connected through a servo driver module. These servos allow one of the cards to be

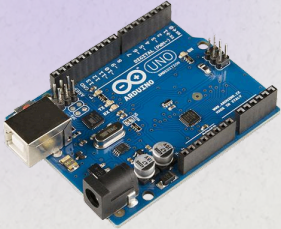
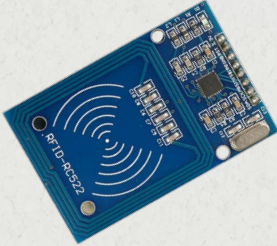
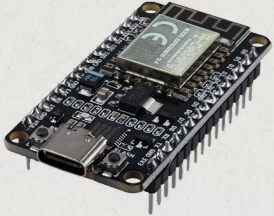
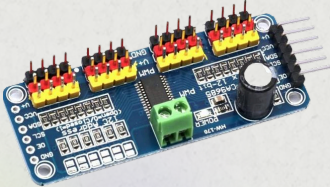
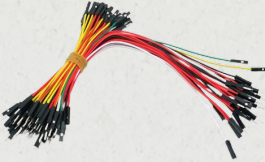
“magically” revealed depending on the intensity value received from another device. The smooth, controlled movements give the impression of a ritual unfolding rather than a mechanical action.

To support this, a dedicated power supply is used for the servos, ensuring that their higher current demands do not interfere with the rest of the electronics. This separation of power makes the actuation reliable even when several servos move at once.

In addition to the card reveal, a glowing magic ball enhances the atmosphere with light effects. Inside, an LED ring creates a soft “breathing” glow when idle and shifts colors in response to specific events such as card detection. These subtle lighting cues contribute to the sense of mystery and reinforce the theme of divination.

3.2.3. Network Communication: ESP-NOW Protocol

Communication between devices takes place using ESP-NOW, a lightweight protocol for peer-to-peer messaging. This makes it possible for the nine devices of The Zoo to exchange signals quickly

COMPONENT	DETAILS	COMPONENT	DETAILS
	ARDUINO UNO ATMEGA328P Main controller		MFRC522 13.56MHZ RFID Card detection
	ESP-NOW 2.4GHZ WIRELESS Inter-device comm.		NEOPIXEL LED RING 12X WS2812B RGB Ambient lighting
	DOLLATEK PCA9685 16-CHANNEL 12-BIT PWM Servo control		SG90 SERVOS 180° ROTATION, ANALOG Card revelation
	CLASSIC 1K RFID CHIPS 13.56MHZ, 1KB MEMORY Tarot card identification		JUMPER WIRES Interconnections

without relying on a standard Wi-Fi connection. The project uses the ZooUAR library [1] to format and transmit the data consistently across the network.

In *Circuitry of Fate*, each interaction produces a packet with two key values: the target device ID (1–8, defined by the past card) and the intensity level (10–90%, defined by the present card). This packet is then broadcast to the chosen device, which responds in its own way. Because every device interprets and expresses signals differently, the results remain unpredictable, adding to the feeling of mystery within the collective network.

3.2.4. Integration and Power Management

The system was carefully designed to balance performance and stability. The separation of power domains ensures that demanding components such as the servos do not interfere with sensitive electronics like the RFID reader. Shared grounding keeps the system consistent across components.

On the software side, timing was handled using non-blocking methods, which means several processes—such as RFID polling, servo movements, LED animations, and network communication

—can run smoothly in parallel. This makes interactions feel seamless, so that each gesture by the user flows naturally into the magical responses of the system.

3.3. The design and Creative side

Apart from the technical considerations and sensor choices, an equally important aspect was making the device presentable and engaging enough to attract people's attention. For this reason, many parts of the device were handmade and carefully planned. The tarot cards contained RFID tags, but since the reader is highly sensitive, their thickness had to be adjusted precisely to avoid any detection issues. The box used for reading the cards was built from wood, ensuring both stability and reliable performance of the MFRC522 RFID reader. A logo element was added to create extra space and also function as a stand, contributing both to the design and the practicality of the setup [Figure 7].

The stand designed to hold the future cards was handmade from wood, using leftover pieces of cut timber. Since it also housed most of the controllers and functioned as the central structure of the device, it was important to ensure that everything was organized and securely



Figure 6: Wooden Box as a Reader

positioned. The stand was later painted black, with sparkles and decorative elements added to enhance the magical aesthetic. Each servo motor was carefully attached to the board so that, when activated, the cards would move and fall as intended—revealing the future. Logo components were also incorporated into the construction to provide additional stability and ensure the stand remained securely in place [Figure 8,9,10].

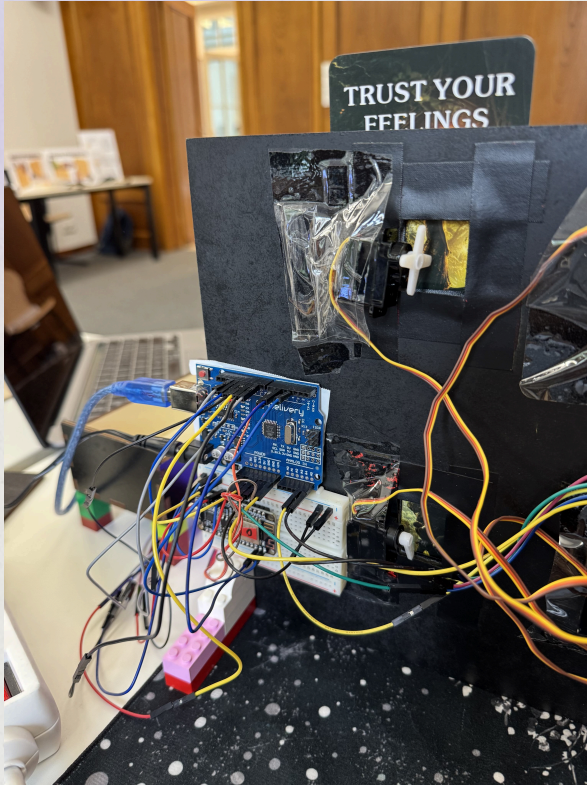


Figure 7: The configuration of the Arduino UNO board and ESP-NOW controller



Figure 8: The view of the setup from behind the stand



Figure 9: The stand view from front without the cards

The magic ball continuously changed colors and was positioned close to the device setup. The past and present cards were placed in front of the main wooden stand on the magical table rug. The cards were laid face down so that visitors could select them at random and then read them. Afterwards, the cards were placed into the box in sequence—first the past card, then the present card. Once both cards were entered, another device in the network responded, giving feedback according to its own output mechanism [Figure 10,11].

3.4. Challenges

Everything appeared to work smoothly when tested individually, but challenges emerged once all nine devices were running together. Each device had its own mechanism and specific code, and the ZooUAR library [1] was used to ensure communication and synchronization across the network. However, in practice, the system was not flawless. For Circuitry of Fate, one of the main issues concerned the servo motors, which were responsible for tilting the future cards when receiving signals from other devices. The cards had to be positioned very precisely for the servo movement to succeed in making them fall; otherwise, visitors assumed that

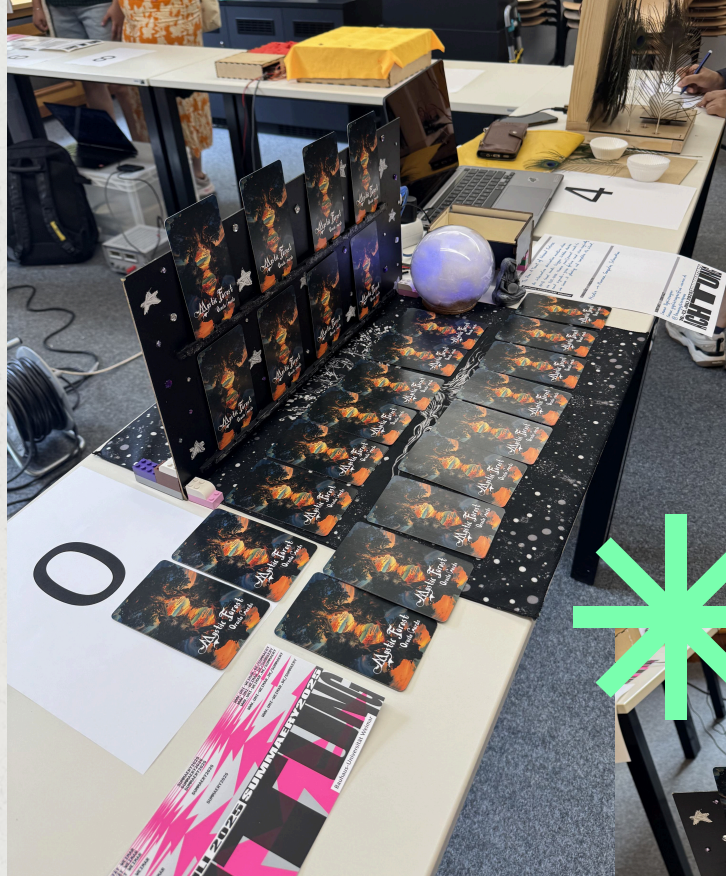


Figure 10: The device setup view 1

the device was not functioning. At times, the device also received multiple signals simultaneously, which resulted in several future cards being revealed at once. Another challenge was the Magic Box, particularly the clarity of the interaction sequence. Visitors often expected an immediate response after inserting the

past card, without realizing that the process required placing the present card afterwards. This sometimes led to confusion until the interaction was explained. Additionally, the system occasionally required the code to be restarted in order to continue functioning as intended.



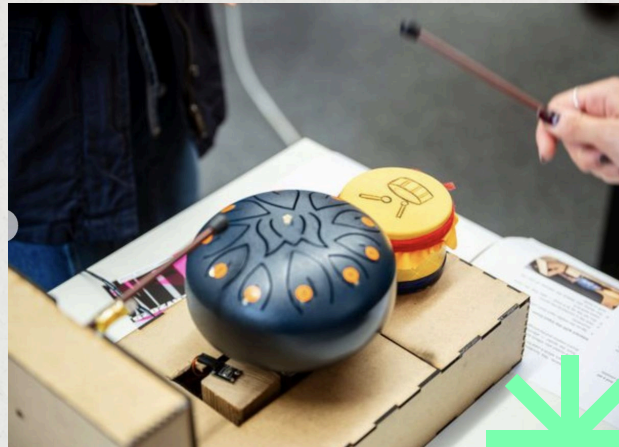
Figure 11: The device setup view 2

3.5. Presenting as a team

The most exciting stage of the project was presenting the final outcome to visitors and witnessing the results of several months of work. All nine devices were arranged on stands in a circular formation, allowing visitors to easily observe the chain of interactions and feedback between them. The diverse materials, forms, and mechanisms of the devices immediately attracted attention and curiosity. The overall aim of the project—to evoke engagement and curiosity through tangibility and technology—was successfully achieved, as visitors enthusiastically interacted with the devices. The installation created the impression of “toys for grown-ups,” where each device invited a different kind of touch, response, or reaction. The exhibition also highlighted the importance of teamwork and coordination, as every member needed to be prepared to answer questions about other devices and to resolve any technical issues smoothly when they arose.



[10]



4. DISCUSSION

This project connects to the field of tangible interaction but approaches it from a more reflective and poetic side. Instead of focusing on efficiency or performance, *Circuitry of Fate* explores ritual, mystery, and the slower side of interaction. It shares ideas with other HCI projects that use Tarot as a reflective or speculative tool [7],[8], showing how technology can also be emotional and symbolic. The physical act of selecting and placing cards turns interaction into a kind of ritual, while the servo movements and light effects create a magical response that feels more like an experience than a function.

This idea connects closely to Wu's description of Tarot as a "technology of care" ([9] as cited in [8]). It is not about prediction, but about reflection – about using a system to think, pause, and care for oneself. The project also draws from psychological explanations, like the Barnum Effect [3], which shows why people find personal meaning in something general. The categories of "past," "present," and "future" are open enough that visitors could relate them to their own experiences. Even when the

system did not work perfectly, people still found meaning in what happened, which made the interaction feel personal and alive.

The networked setting of *The Zoo* also played an important role. Having nine devices connected together created an ecology that was never completely predictable. Sometimes devices reacted unexpectedly or at the same time, which at first seemed like a problem, but later felt like part of the charm. It showed that interactions between devices don't always need to be seamless – sometimes a bit of mystery makes them more interesting. This unpredictability gave life to the system and made each interaction feel slightly different, confirming that small imperfections can also create wonder.

4.1. Lessons learned

During the exhibition and testing process, a few important lessons became clear. One of them was that people are often more fascinated by what they do not fully understand. Visitors were most engaged when they could sense that something was happening but could not completely explain it. This feeling of uncertainty gave the system its magic – people enjoyed



wondering what would happen next. Another lesson came from the unexpected moments when the technology failed. When the servos didn't move due to technical issues, sometimes the wind made one of the future cards fall on its own. People immediately reacted with excitement, believing that their action had caused it. It became a moment of shared surprise – everyone laughed, pointed, and connected over it. What could have been seen as a mistake actually made the experience more magical. It showed that in projects like this, even technical errors can add to the story if they feel natural and fit the atmosphere.

It was also interesting to see how fragile the illusion of magic can be. When the sequence of actions wasn't clear, or something didn't respond as expected, the sense of mystery quickly faded. This made it clear how important it is to balance reliability with playfulness – to make sure the system works smoothly while keeping space for unexpected and open-ended moments.

Finally, working as part of The Zoo showed the beauty of collaboration. Even though each device was built by a different person, once everything came

together, they started to “speak” to each other in ways no one could plan. The unpredictable signals, mixed responses, and shared space created a collective rhythm that felt alive. It reminded that not everything has to be perfectly synchronized for something meaningful to happen – sometimes, unpredictability is what makes it human.



4.2. Limitations and future work

Of course, the project also had its limitations. The servo motors were sensitive and required the cards to be placed very precisely, which sometimes caused small failures in movement. The order of interaction with the Magic Box – placing the past card first and then the present card – was not always clear to visitors and sometimes needed explanation. There were also moments when the device received several signals at once, which caused multiple cards to fall or required restarting the system.

Future versions could focus on improving the interaction sequence to make it more intuitive, perhaps by giving small visual or sound cues that guide the user through the process. Technically, better handling of incoming messages could reduce overlapping signals. On a conceptual level, future work could also experiment more with unpredictability – maybe letting several “futures” appear at once or intentionally including environmental effects like wind and light as part of the experience. These elements could make the interaction feel even more alive, continuing the idea of blending technology, ritual, and coincidence.

5. CONCLUSION

The aim of Circuitry of Fate was to explore how technology can become part of a ritual – something slow, reflective, and mysterious rather than purely functional. Created within The Zoo, a network of nine interconnected devices, it combined RFID tarot cards, servo movements, and atmospheric lighting to form a tangible experience that felt alive and unpredictable.

The project showed that tangible interaction can be emotional and poetic, not just precise. Even technical imperfections, like cards falling by accident or multiple signals appearing, became part of the story and added to the sense of magic. Through this, Circuitry of Fate turns simple gestures into meaningful connections, reminding that technology can inspire curiosity and reflection when it allows space for uncertainty and imagination.

6. ACKNOWLEDGEMENTS

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