My Virtual Land: Build an Immersive Visual and Auditory Experience

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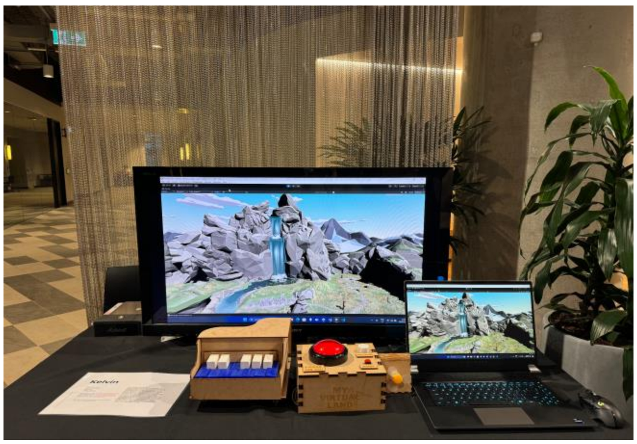

Figure 1: The My Virtual Land Interactive Device

ABSTRACT

Stress and anxiety have been shown to be greatly reduced by yoga and meditation. “My Virtual Land" is an interactive device that is intended to improve the quality of yoga and meditation sessions by incorporating visual and auditory technologies, thereby establishing a more immersive and natural environment. The system processes user inputs from sensors using an ESP32 microcontroller, which allows for real-time auditory feedback and personalised interaction with virtual scenes through Unity. High levels of satisfaction with the system's interactivity and functionality have been reported by users, underscoring its efficacy in alleviating anxiety. Future improvements will concentrate on the optimisation of the natural element distribution algorithm and the enhancement of data transmission stability between Unity and ESP32.

KEYWORDS

Stress Reduction, Unity, Visual-Auditory-Sensory interaction

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1 INTRODUCTION

Stress is increasingly becoming one of the major factors affecting health. Previous studies have indicated that practicing yoga and meditation once a week can drastically reduce stress and anxiety levels[8]. With the growing prevalence of virtual scenarios in everyday life, research has explored the use of virtual reality headsets for meditation to alleviate pre-test anxiety in students. T-test analyses have shown that the relief effect of meditation using virtual reality was significantly higher than that of meditation using videos[7]. However, these findings were limited to successful performance in meditation classes. Wearing headgear in yoga classes poses a safety risk by affecting balance and reducing awareness of one's surroundings. Additionally, yoga and meditation classes often use natural sounds to energize and pace movements, with instructors frequently using words to help participants visualize being in nature. While indoor environments allow for greater control, they also make it difficult for people to feel connected to nature in an artificially constructed setting. Therefore, through the design of the “My Virtual Land” interactive installation, we aim to explore how visual and auditory technologies can enhance yoga and meditation classes, bridging the gap between unnatural studios and nature.

2 RELATED WORKS

Music is an essential element in yoga and meditation classes. Numerous studies have shown that listening to music can effectively relieve stress levels, but as [2] noted, "one person's noise may be another person's music," indicating that perceptions of relaxing sounds are subjective. In healthy individuals, the level of stress relief varies depending on the type of music, its tempo, and the person selecting it[1]. Similarly, studies suggest that when music is used as a therapeutic medium, interventions for stress are more effective with active creative music rather than receptive music[5]. Therefore, personalisation in My Virtual Land is crucial, allowing users to create harmonious music combinations during the interaction process.

Additionally, we sought to explore how auditory experiences could be combined with visual experiences in a fun and interactive way. Research has been conducted to create multiple interactive scenarios by combining audio, mobile technologies, and locations[4]. For example, [6] developed a musical interactive landscape in a park in the UK, where visitors transitioning from one physical area to another were greeted by harmonious tuning and the introduction of new music. Similarly, numerous multi-sensory interactive installations exist, such as Lume in South Wharf, Victoria, Australia, which created an immersive art exhibition experience by projecting large-scale artworks onto walls and floors to facilitate classes like Yin Yoga[9]. Another example is Ben Heim's idea of playing the piano in reality or painting on a digital canvas using DJ equipment[3].

These interaction concepts inspired the conception of “My Virtual Land”, which aims to provide a new experience for users by integrating auditory, visual, and sensory aspects, with a focus on creative control during the interaction. This contrasts with the more binary interactions (i.e., visual-auditory, somatosensory-auditory) emphasized in previously mentioned devices. As illustrated in the sketch (see Figure 2), we use a piano as the interaction device, allowing users to create personalised natural landscapes and auditory experiences in the virtual scene by playing the piano.

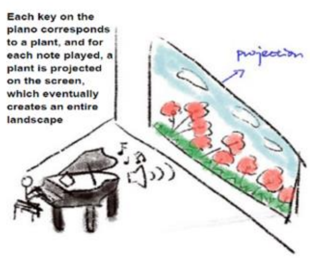

Figure 2: Initial design sketch

3 DESIGN AND IMPLEMENTATION

3.1 System Design

The system is designed to interface user inputs with various outputs using an ESP32. The design comprises three main components: Input, Processing, and Output.

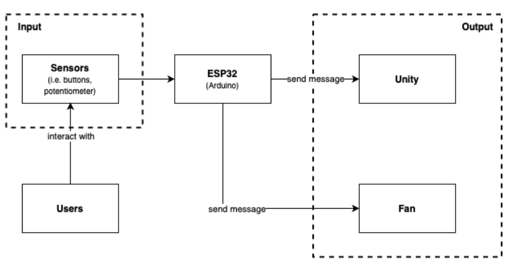

Figure 3: Illustration of Input and Output

Input: Users interact with the product through sensors. These sensors capture user actions and convert them into electrical signals, which can be processed and received by the ESP32 microcontroller.

Processing: The ESP32 (Arduino) microcontroller serves as the central processing unit of the system. It receives messages from hardware sensors and processes them to unity to generate appropriate responses.

Output: The processed signals are sent to two types of output:

Unity: a game development platform, which is used to simulate the forest environment for this product.

Fan: a hardware device that can be controlled by ESP32.

Hardware components are connected to the ESP32 microcontroller. They all have one terminal to GND, one to power, and another connected with the pins on ESP32.

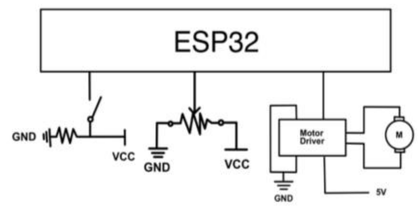

Figure 4: Illustration of Hardware Connection

3.2 Hardware Implementation

The circuit was simulated using a breadboard. After confirming the correctness, the buttons used for piano were soldered to a circuit board to enhance the connection stability and reduce occupied space.

3.3 Software Implementation

ESP32 is programmed to receive incoming messages from sensors (i.e. buttons and potentiometer), and send messages to unity and fan. The ESP32 sends messages to the fan based on the sensor inputs, and the fan can be turned on and off in response to the sensor data.

The communication between ESP32 and unity is achieved via serial port connection. When the unity scene is active, it initiates a connection by calling new SerialPort (port_name, speed). Once the communication is successfully set up, unity will use ReadLine() to continuously listen to the incoming message sent from ESP32. This method will read messages line by line, ensuring that complete messages are received and processed.

```
void Start()
{
    //Open the serial stream
    data_stream = new SerialPort("/dev/cu.usbserial-56E40389571", 9600);
    data_stream.Open();
    data_stream.WriteLine("1");
    StartCoroutine(Incoming());
}

1 个引用
IEnumerator Incoming()
{
    while(true) {
        string message = data_stream.ReadLine(); // Read a line of data
        Debug.Log("Message from Arduino: " + message);
        // responses to received messages

        yield return null;
    }
}
```

Figure 5: Communication between ESP32 and Unity

Upon receiving a message, Unity processes it and executes corresponding actions within the scene. For example, when a white key on the piano is pressed, unity will generate a tree at a random position according to pre-scripted functions.

3.4 External Fabrication Design

Figure 6: Demonstration of External Fabrication Design

The design of the "My Virtual Land" external interactive fabrication consists of three primary components: a piano device that creates the landscape and music of the virtual scene, a console that adjusts the parameters of the virtual scene, and a fan that contributes to building the sensory experience.

Piano Functionality: The blue keys of the piano plant trees at random locations in the scene, with seven keys corresponding to seven different types of trees. The five white keys generate five different sounds, allowing users to create harmonious music through various combinations.

Piano Construction: The overall appearance of the piano was designed using Fusion 360, and it was assembled from four main parts:

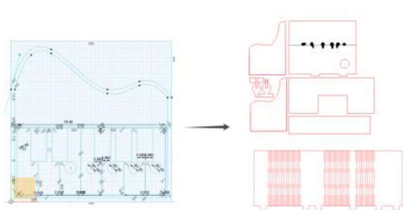

Figure 7: Design Sketches

Piano shell designed through Coreldraw and laser cut using 3mm MDF material and utilised Kerf bending technique to form curves. This technique involves creating a section filled with dense vertical lines to make the section flexible.

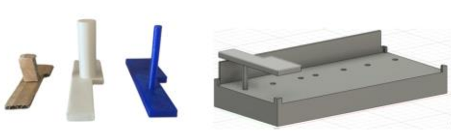

Figure 8: Iteration of Key and Piano Base

Piano keys and piano base required precise measurements for easy assembly. We used 3D printing techniques to embed the traditional white keys (blue keys in the final presentation) into the piano base, ensuring stability while leaving space for key presses. After initial prototypes in a cardboard box, we found PLA to be too hard, resulting in a lack of flexibility and inadequate space for sensors. Therefore, we used TPU material for the keys, redesigned the cylinder to be further back and thinner, and made the keys themselves thinner. A shorter layer height (0.1mm) and higher print density (40%) were used to achieve flexibility and toughness.

Sensors: Different sensors were selected based on key characteristics. Black keys (white keys in the final presentation) use a tactile switch button, while white keys use a snap-action switch with a bump lever to ensure they press and bounce back effectively.

Console and Fan: The main parts of the console and fan were designed using Coreldraw, laser cut, and assembled with Kerf bending techniques for the pattern design. The console includes a large push button (swift day and night mode), a small red button (reset the scene), and a potentiometer (adjust the sound volume).

4 SYSTEM EVALUATION

4.1 Theoretical Evaluation

To verify the accuracy and efficiency of the whole system, a comprehensive evaluation has been generated and tested.

Hypothesis:

When the white keys on the piano are pressed, trees should be generated randomly in the given areas (10*10). Each white key should create a different type of tree.

When the black keys on the piano are pressed, sound effects should be turned on or off based on its current status. Each black key should control different sound effects.

When the unity scene is on raining mode, the fan should start working. Meanwhile, the UI for raining mode should be active.

When the huge red button is pressed, the unity scene should change between day and night.

All the circuit should be correct, ESP32 should receive all the messages sent from sensors and sent to unity.

Result: Based on daily tests and final functionality test, these hypotheses have been proved and passed. Overall, each component cooperates with others effectively, and provide a great user experience.

4.2 User Evaluation

We conducted a short questionnaire survey with six users who experienced the interactive equipment. The Likert scale data indicated high user satisfaction with the uniqueness (6.5/7), interactivity (6.5/7), and functionality (6.4/7). However, users suggested that the commercialization potential (5/7) could be improved with more refined functionalities.

5 DISCUSSION

General discussion: Despite the efficiency of our interactive device in presenting a natural visual-auditory-sensory experience, user feedback highlighted several areas for enhancement:

Sound Design: The current design uses the white keys for sound inputs, allowing automatic control of sound. All users suggested that it would be more interesting if the piano could emit its original sound. To balance the natural sound design with user preferences, future designs could include a switch between "natural sound" and "piano sound" modes, providing a different auditory experience.

Scenario Design: The current scenario only allows users to plant trees and provides a single viewpoint. User feedback suggested that future designs could incorporate more natural elements and scene types, as well as allow the same scene to exhibit seasonal changes, thereby enhancing the overall experience. Additionally, users recommended the installation of pressure sensors under the keys. When pressed with varying intensity, these sensors could trigger changes in the scene, such as planting larger trees or increasing wind intensity. Furthermore, somatosensory elements, such as the fan, could be adjusted accordingly to enhance the immersive experience.

limitations: Due to lack of experience, improper soldering resulted in plenty of short circuits, causing system malfunction. This issue impacted the stability of the system and a significant amount of time was spent verifying the correctness of the circuitry.

Future direction: The algorithm for generating trees at random position should be improved to ensure a more natural distribution of trees. Meanwhile, the communication between ESP32 and unity should be advanced to ensure faster and stable data transmission. VR technology can also be integrated to enhance user experience.

6 CONCLUSION

"My Virtual Land" successfully bridges the gap between artificial studio settings and natural environments through innovative integration of visual, auditory, and sensory technologies. User feedback highlights the effectiveness of this approach in creating an immersive, stress-relieving experience. The system's design, involving user input via piano keys and sensors processed by an ESP32 microcontroller, facilitates personalized interaction with the virtual environment, enhancing the overall experience. Despite the positive reception, improvements in sound design, scenario variety, and system stability are necessary for further development. Future directions include refining the algorithm for natural element distribution, enhancing data transmission stability between the ESP32 and Unity, and incorporating VR technology to deepen the immersive experience. These advancements hold promise for broadening the application and impact of virtual environments in stress reduction and wellness practices.

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