

The Design of Mandala and Chinese Medicine Five Tone Somatic Healing System Based on TouchDesigner and Comfy UI

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Abstract. A body-sensing interactive healing system based on TouchDesigner and Comfy UI has been designed and implemented. By integrating traditional Chinese medicine's five-tone therapy, mandala pattern generation, Kinect body-sensing interaction, and heart rate monitoring technology, a multimodal sensory interaction platform for mental health intervention has been constructed. The system allows users to dynamically customize mandala patterns through the Comfy UI API, and then utilizes TouchDesigner to achieve real-time generation and three-dimensional particleization of the mandala patterns. It combines the audio features of traditional Chinese medicine's five tones with heart rate data to realize dynamic mapping of sound and images and physiological feedback regulation. The Kinect V2 sensor captures users' body-sensing movements, employing a "one-euro filter" to optimize joint-point acceleration detection, enhancing interaction accuracy. Research results indicate that the system uses dynamic mapping of mandala patterns and the five tones of traditional Chinese medicine, along with quantifying the healing effects through heart rate variability, providing a reusable technical framework for mental health intervention.

Keywords: TouchDesigner; Comfy UI; Somatosensory Interaction; Chinese Five Sound Therapy; Heart Rate Visualization

1. Introduction

Art therapy, originating in the West, has been extensively applied in Europe and the United States since the mid-20th century to treat mental illnesses like schizophrenia, autism, depression, and PTSD. In China, traditional Chinese medicine (TCM) employs the five tones (Gong, Shang, Jue, Zhi, Yu) to correspond with the Five Elements, regulating emotions through music and sound waves to achieve spiritual healing. This method is commonly used to address psychosocial diseases[1]. Additionally, mandala patterns serve as both ancient art forms and effective tools for psychotherapy and personal growth. Drawing mandalas allows individuals to express inner conflicts, integrate fragmented emotions, and achieve self-healing[2]. Kinect somatosensory detection technology is also utilized in medical rehabilitation, such as in psychological catharsis systems, to help patients vent emotions through somatosensory sensors. This study integrates TCM's five tones therapy, heart rate monitoring, and Kinect technology using Touch Designer to create a comprehensive psychological healing system, offering new solutions for mental health promotion. The study achieved the following objectives:

(1) It combined the sound elements of TCM's five tones therapy with the pattern elements of mandala therapy, constructing a visual interaction system for sight and sound. Somatic interaction instructions enhanced the researchers' ability to manipulate the interactive process of sound and image.

(2) The study realized real-time generation of mandala patterns based on audience choices using Comfy UI. The 2D mandala patterns were transformed into 3D point cloud models, with particles moving according to audio input to enrich visual effects.

(3) A feasible solution for quantitatively assessing art healing effects was proposed by detecting physiological indicators in real time and visualizing emotions through arithmetic operations, providing a basis for quantifying healing effects.

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2. Current Research in Somatic Interactive Healing

In recent years, somatosensory interaction technology has been applied in medical rehabilitation. It integrates game design, VR, and AI to provide multi-sensory stimulation and immersive experiences, improving cognitive, emotional, and motor functions. For children with special needs (e.g., autism), physiological signals (e.g., blood volume pulse, skin conductance) are monitored, and machine learning algorithms (e.g., random forest) support personalized therapy [3]. Moreover, somatosensory games combined with art therapy enhance concentration, coordination, and social skills in autistic children [4].

Music therapy combined with somatosensory technology has been explored in both Eastern and Western medicine. Clinical studies show that somatosensory sound wave therapy can reduce fatigue and improve immune function in chronic fatigue syndrome patients [5]. For stroke patients, somatosensory music therapy with dietary intervention can improve emotional state, independent living ability, and quality of life [6].

XR technologies provide immersive environments for somatosensory therapy. Kinect-based serious games use supportive learning therapy to enhance learning for children with learning disabilities [7]. Studies also show that gesture interaction in VR natural environments is more effective for stress relief than traditional handles, supported by physiological and emotional assessments [8].

3. TouchDesigner-based Audio-visual somatosensory interactive system

3.1. System Design Objectives and Functions

The Touch Designer-based somatosensory healing system integrating mandala patterns and TCM five-tone theory addresses two primary design objectives: First, enabling users to experience measurable therapeutic effects during interaction; Second providing researchers with a scientific and efficient evaluation tool to quantify and analyze therapeutic outcomes.

The system consists of three main components: User Interface (UI), Scene System, and Interaction Events. First, the UI, which includes the initial interface, the instrument selection interface, the music switching interface, the experience interface, the healing effect evaluation interface and all the UI elements in the system. Second is the Scene System. This involves using Touch Designer software to access the Comfy UI via an API interface to generate mandala patterns in real time and uses Geometry COMP node to realize two-dimensional image three-dimensional particleization into point cloud model and then follow the movement of music data input. In addition, during the experience of the work, the audience can also independently choose the instrument they want to experience among Pipa, Sheng, Erhu, Guzheng, Chimes, and Hulusi. Third are the Interaction Events, whose functional goal is to enable users to precisely control the work, while also providing an immersive audio-visual experience and achieving beneficial healing effects.

3.2. Components of the Somatic Healing Interaction Control Framework

The virtual visualization interaction framework (see Fig.1) with four core modules:

(1) Comfy UI Integration

TouchDesigner's Python scripts invoke Comfy UI's RESTful API for real-time mandala pattern generation. Upon selecting "Wu Yin" (Five Tones), the system synthesizes Five-Element-compliant mandalas using a pre-trained GAN model, integrated with TCM tonal attributes (e.g., Gong tone-yellow, Shang tone-white).

(2) Audiovisual Interaction

The TCM music library is algorithmically deconstructed to extract volume, frequency, and drumbeat intensity, which are mapped to Geometry COMP-instantiated mandala point-cloud models, driving particle dynamics through audiovisual parameter coupling.

(3) Somatosensory Interaction Control

Kinect captures user motion data, transmitted via Kinect SDK to TouchDesigner, where algorithms decode action intent and trigger corresponding functional operations.

(4) Heart Rate Visualization

Real-time physiological monitoring modulates mandala particle motion, with post-experience quantitative analysis evaluating therapeutic efficacy.

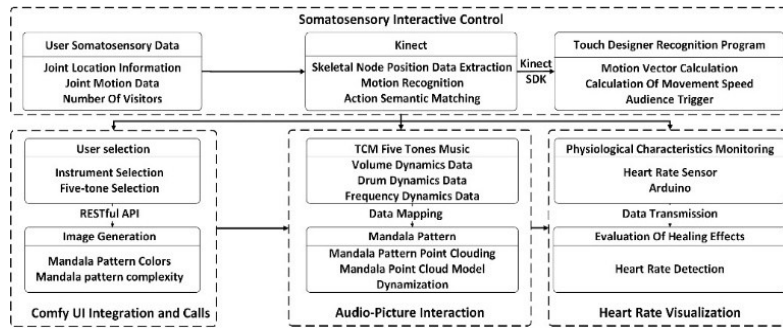


Fig. 1: Interaction control framework

4. Technology Realization Path

4.1. API-based Data Interaction Architecture Design

This study proposes a cross-modal data processing framework based on the deep integration of TouchDesigner and Comfy UI, comprising three core technical phases, as shown in Fig.2.

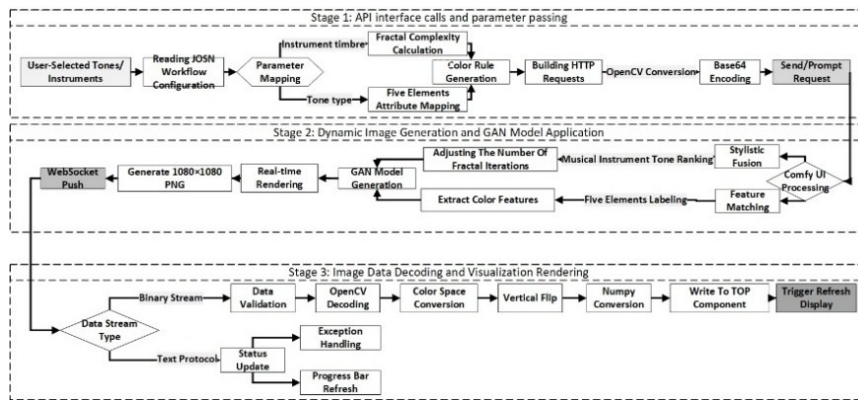


Fig. 2: TouchDesigner and Comfy UI Data Interaction Diagram

(1) API interface call and parameter passing

TouchDesigner invokes Comfy UI's RESTful API via Python scripting to construct a JSON-based multimodal parameter system. When users select specific tonal parameters (e.g., "Gong tone"), the system retrieves workflow configurations from the null1 DAT component, encapsulating tonal types, Five-Element color mappings (e.g., Gong tone → "Earth" element/yellow hues), and instrument timbre sequencing into structured requests. Finally, the WebClient DAT initiates a POST request to the `http://localhost:8188/generate` endpoint.

(2) Dynamic Image Generation with GAN Modeling Applications

Comfy UI leverages a pre-trained Generative Adversarial Network (trained on 500 Five-Element instrument timbre datasets) for multimodal synthesis. For example, with a "Gong tone" chime request:

- Feature Matching:** Extract "Gong tone" attributes (Earth element, yellow palette);
- Timbre Fusion:** Adjust generation parameters based on instrument timbre sequencing (Chimes-Sheng-Pipa-Guzheng-Erhu-Hulusi), where bright/cold timbres (e.g., Chimes) correspond to low-iteration fractal structures;
- Real-Time Output:** Generate PNG images returned to TouchDesigner via JSON packets.

(3) Image Data Decoding and Visualization Rendering. Binary stream parsing is implemented using the `imgToNumpy()` method:

- Verify data integrity through the `struct` module;
- Convert PNG stream to numpy array based on OpenCV's `imdecode()`;
- Perform color space conversion to fit the TouchDesigner texture coordinate system;
- Write the processed matrix to the target TOP component via `scriptOp.copyNumpyArray()` to complete the visualization rendering.

4.2. Audio-Visual Dynamic Mapping Implementation

This study develops a sound visualization system in TouchDesigner, transforming TCM's Wu Yin into dynamic mandala point-cloud particles. The framework comprises two modules:

(1) Audio Management & Playback

- a) SSFile Handling: Folder DAT scans external directories, Select DAT extracts metadata, and Switch DAT enables Somatosensory -controlled music switching via Index parameters;
- b) Audio Loading: Audio File In CHOP loads files using path binding (op('null16')[1,'path']), capturing stereo waveform data.

(2) Audio Analysis

- a) Data Processing: AudioAnalyze CHOP performs channel merging, feature extraction, delay operations, and resampling to decode frequency, amplitude, and drum intensity;
- b) Waveform Generation: Outputs frequency/time-domain graphs for visual mapping.

(3) Mandala Visualization Parameters

- a) Color: Dynamically mapped from 2D image RGB channels;
- b) Shape: Generated from pixel arrangement in mandala images;
- c) Voxel Density: Determined by 2D image resolution.

The node-based architecture achieves audiovisual synchronization, offering a scalable model for multimodal generative art, as shown in Fig.3.

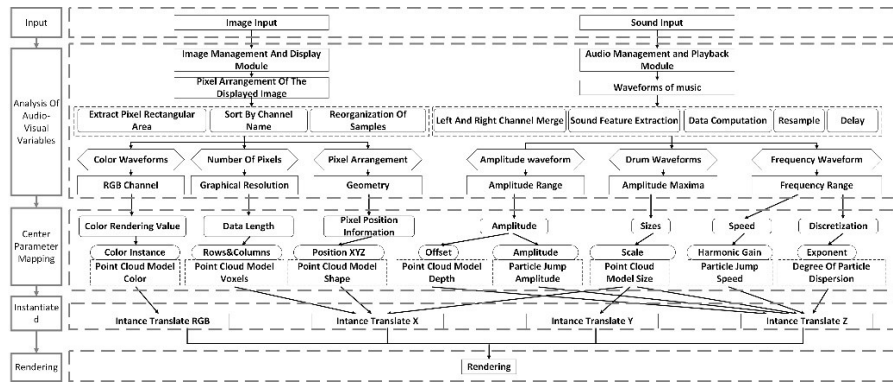


Fig. 3: Mapping of sounds, pictures to point cloud models

The sound information of the five tones of Chinese medicine and the image information of the mandala are processed to obtain the physical parameters to establish the mapping between the color waveform, number of pixels, pixel arrangement, music amplitude, drum beat, and music frequency and the color, voxel, shape, 3D graphic depth, particle jumping amplitude, 3D image size, particle jumping speed, and particle discrete degree of the mandala point cloud model, as shown in Fig. 4.

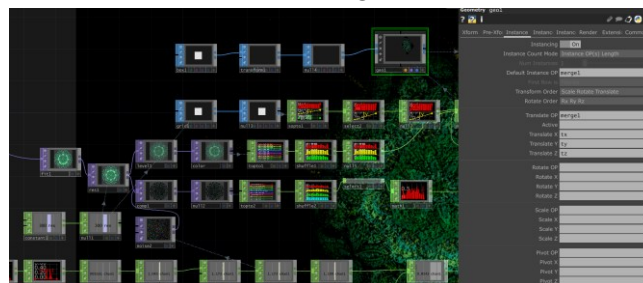


Fig. 4: Numerically Controlled Mandala Pattern Point Clouding in TouchDesigner

4.3. Kinect-based Somatosensory Interaction Logic Optimization

One of the goals of constructing a somatic healing system based on mandala and the five tones of Chinese medicine is to solve the interaction uncertainty caused by differences in users' height, location and behavioral habits, which is divided into the following two parts:

- (1) Interaction design: take the acceleration of user's hands in X/Y-axis as the judgment benchmark (see Table 1), to avoid the interference of invalid movements;

(2) Process optimization: Implemented in three phases, trigger recognition, gesture and position mapping, and joint acceleration optimization, balancing operation naturalness and precision.

(1) Identify work triggers

To address accidental triggering of audience works, the Kinect sensor's critical distance for switching trigger states is set at 1 to 2 meters and clear signs on the ground guide operators to optimize interaction experience. During operations, standing 1 to 2 meters from the sensor triggers the state, while exceeding 2 meters or being within 1 meter results in a non-triggered state.

Let: d be the distance between the audience and the sensor; T represents the trigger state ($T=1$ indicates triggered, $T=0$ indicates not triggered). P indicates whether there are people in the identified area ($P=1$ means Kinect detects the presence of a person; $P=0$ means Kinect does not detect a person.)

Thus, the complete trigger state logic can be written as:

$$T = P \cdot 1_{[1m,2m]}(d) \quad (1)$$

(2) Character position gesture mapping

This system is based on the TouchDesigner software development platform for somatosensory interaction devices, and the Kinect coordinate system is very similar to the TouchDesigner coordinate system. No additional adjustments were needed in this study and the data mapping can be done directly.

(3) Joint motion acceleration algorithms and optimization

In view of the differences in users' height and exercise habits, this study uses joint acceleration as the trigger condition for somatosensory interaction, balancing the interaction quality and ease of use:

- a) Data Acquisition: Acquire depth and bone data through Kinect CHOP component, Slope CHOP calculates joint x-axis acceleration;
- b) Jitter suppression: One Euro Filter algorithm is used to suppress low-speed jitter and transient fluctuations to ensure real-time interactive accuracy;
- c) Experience Optimization: Reduce the complexity of operations to avoid additional burden in treatment scenarios.

4.4. Heart Rate Monitoring Integrated with Physiological Feedback Visualization

(1) Relationship between heart rate and the healing system

In this study, we monitor the participants' heart rate in real time through the MAX30102 heart rate sensor, and establish a dynamic coupling mechanism between physiological data and the motion of mandala point cloud particles:

- a) Heart rate variability (HRV), as a key indicator of physiological response, can be quantitatively assessed to assess the relaxation effect or emotion regulation produced by the mandala pattern combined with the five tones of Chinese medicine on the participants.
- b) Once the viewer begins the experience, the viewer's heart rate data is combined with the input music data, which can deepen the viewer's emotional engagement and immersion.

(2) Introduction of MAX30102 Heart Rate Module

According to the design ideas of this system, the MAX30102 sensor is used to implement photoelectric volumetric profiling (PPG, Photoplethysmography), and heart rate and oxygen saturation data are synchronously collected through the I²C protocol. It has the advantages of non-invasive detection, accurate infrared optical signal resolution and low-power hardware compatibility.

(3) Heart rate monitoring technology realization

Hardware: MAX30102 connects to Arduino UNO R3 via I²C (SDA-A4, SCL-A5, VIN-3.3V).

Software workflow:

- a) Sensor initialization using Wire and MAX30105 libraries;
- b) Infrared data processed by *checkForBeat()* to detect intervals and compute BPM;
- c) Serial output for data validation, key code in Fig. 5.

```

1 float beatsPerMinute = 0; // Variable to store the calculated heart rate
2 long lastBeat = 0; // Timestamp of the last detected heartbeat
3
4 void loop() {
5     long irValue = particleSensor.getIR(); // Get the infrared light data from the sensor
6     if (checkForBeat(irValue)) { // Check if a heartbeat is detected
7         long delta = millis() - lastBeat; // Calculate the time interval between beats
8         lastBeat = millis(); // Update the timestamp of the last beat
9         beatsPerMinute = 60 / (delta / 1000.0); // Calculate beats per minute (BPM)
10    }
11    Serial.print("BPM: "); // Print the calculated heart rate
12    Serial.println(beatsPerMinute);
13 }

```

Fig. 5: Key Code Snippet for Heart Rate Monitoring

(4) Heart rate visualization technology implementation

After burning the driver code in the Arduino development board, firstly, receive the data with Serial DAT component in TouchDesigner, and keep the data port and bit rate settings consistent with those in Arduino IDE. Secondly, create Constant CHOP component to reference the value in Serial DAT component to convert the textual heart rate into data.

5. Summary

This paper presents a multi-sensory healing system integrating Chinese medicine's five-tone therapy and mandala therapy, using Somatosensory interaction and heart rate monitoring. The system enriches art healing forms and offers new mental health intervention methods. It achieves real-time user interaction with mandala patterns and five tones via TouchDesigner and Kinect V2, while monitoring heart rate changes to visualize and evaluate healing effects. The system balances interaction accuracy and naturalness, optimizes joint motion detection algorithms to reduce user fatigue, and provides a quantifiable way to assess healing effects. Future work will focus on technology integration, function expansion, and user experience optimization to maximize its potential in mental health promotion.

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7. References

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