Construction of a Generative Artificial Intelligence-Based Personalized Clinical Therapeutic Music Management System Grounded in Traditional Chinese Medicine Five-Tone Therapy

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Abstract. Against the backdrop of refined healthcare management, traditional Chinese Medicine (TCM) Five-Tone Therapy faces limitations like insufficient personalization. This study aims to construct a personalized clinical therapeutic music management system integrating TCM Five-Tone Therapy with generative artificial intelligence technology and explore its application value and implementation pathways in enhancing patient satisfaction, alleviating anxiety, and improving pain management. Centered on the TCM theory linking the Five Tones ("Gong, Shang, Jue, Zhi, Yu") to the Five Zang Organs and Five Emotions, the system adopts a closed-loop architecture with multimodal data collection, Five-Tone feature mapping, personalized music generation, and feedback optimization, tailored to patients' clinical conditions, real-time emotional states, and musical preferences. It converts relevant indicators into quantifiable musical parameters aligned with Five-Tone Therapy principles, generating music precisely matching patients' physical and psychological needs. This system provides an innovative pathway for clinical emotional regulation, enhances hospital service quality, and shows significant potential in anxiety and pain management, deserving promotion in healthcare institutions.

Keywords: Traditional Chinese Medicine Five-Tone Therapy; Generative Artificial Intelligence; Personalized Therapeutic Music; Clinical Emotional Regulation; Pain Management.

1. Introduction

In the context of increasingly refined healthcare management, enhancing patient satisfaction and optimizing the effectiveness of emotional intervention and pain management have become key indicators for measuring a hospital's core competitiveness. Integrating traditional Chinese medicine's Five-Tone Therapy with generative AI technology to construct a personalized clinical therapeutic music management system not only aligns with modern medical concepts of "cooperative development of Chinese and Western medicine" and "mind-body harmony," but also provides innovative intervention tools for hospital management, holding significant clinical and practical value as well as academic research significance.

In the *Suwen* (The Classic of Internal Medicine), the chapter entitled *"Yin-Yang Yingxiang Dalun"* elucidates the correspondence between the Five Zang-Organs, the Five Tones, and the Five Sounds. It states: "[For] the Liver [Zang-Organ], its manifestation is in the color green-blue; its corresponding tone is Jue; its corresponding sound is shouting... [For] the Heart, the color is red; the tone is Zhi; the sound is laughter... [For] the Spleen, the color is yellow; the tone is Gong; the sound is singing... [For] the Lung, the color is white; the tone is Shang; the sound is weeping... [For] the Kidney, the color is black; the tone is Yu; the sound is groaning..." [1]This quotation establishes the core theoretical foundation for the Five-Tone Therapy system, which serves as a classic interventional tool in TCM for emotional regulation. Through the specific correspondences between the Five Tones (Gong, Shang, Jue, Zhi, Yu), the Five Zang-Organs (Spleen, Lung, Liver, Heart, Kidney), and the Five

Emotions (Pensiveness, Sadness, Anger, Joy, Fear), the Five Tones mediate dual physiological and psychological healing effects by means of "sound wave resonance and harmonization of Qi dynamics." Furthermore, modern evidence-based medical research has conclusively demonstrated that music therapy can effectively alleviate patient anxiety and lower pain perception thresholds through biological mechanisms such as regulating cortisol secretion levels and modulating brainwave activity patterns. It has already shown clear application value in clinical fields including cancer rehabilitation and palliative care.[2][3][4]However, current clinical practice faces limitations with traditional Five-Tone Therapy models, including insufficient personalization, delayed intervention responses, reliance on experiential transmission, and the absence of standardized efficacy evaluation systems and protocol optimization mechanisms. Breakthroughs in generative AI technology offer innovative solutions to these challenges. Multimodal generative models, exemplified by AnyGPT and Music Transformer, have achieved precise conversion from multi-source information (text, images, etc.) into musical content. Their real-time generation and dynamic optimization capabilities provide the technological foundation for modernizing the application of Five-Tone Therapy.

Based on this, this study aims to construct a generative AI-based personalized clinical therapeutic music management system grounded in Traditional Chinese Medicine's Five-Tone Therapy theory, clarifying the system's core architecture and operational mechanisms. The exploration focuses on three core aspects: First, the mechanism by which personalized therapeutic interventions enhance patient experience and satisfaction. Second, the clinical pathway for precisely addressing patient anxiety, reducing preoperative stress reactions, and alleviating anxiety associated with chronic diseases. Third, the application value in supporting pain management and reducing dependence on analgesic medications. Concurrently, this study proposes a standardized implementation pathway for the system within medical institutions, providing theoretical underpinnings and practical guidance for clinical adoption.

2. Core Theory and Technological Foundations

2.1 Core Principles of Traditional Chinese Medicine's Five-Tone Therapy Theory

TCM Five-Tone Therapy is a theoretical system that dynamically interconnects "tones, zang-organs, and emotions," using the Five-Phase (Wu Xing) theory as its core logical link. As recorded in the *Ling Shu: Xie Ke Pian*: "Heaven has the Five Tones, humankind has the Five Zang-Organs; Heaven has the six pitch-pipes, humankind has the Six Fu-Organs." [5]This establishes the foundational concept of cosmic-human correspondence. The text further states that music regulates physiological and psychological states by "invigorating the blood vessels" and "harmonizing the heart-mind." Similarly, *the Records of the Grand Historian*: *Treatise on Music* reiterates this view.[6]This concept was later affirmed by the Yuan Dynasty physician Zhu Zhenheng's assertion in *Danxi's Essential Methods* that "music is also a form of medicine".[7]The therapy defines specific correspondences: the steady Gong tone corresponds to the Spleen-Earth system, primarily regulating emotional imbalance caused by overthinking; the clear Shang tone to the Lung-Metal system, addressing grief and depression; the uplifting Jue tone to the Liver-Wood system, for disorders arising from liver qi stagnation; the joyful Zhi tone to the Heart-Fire system, targeting states of low spirits; and the profound Yu tone to the Kidney-Water system, primarily modulating fear and anxiety. This "tone-zang-organ-emotion" system is not a rigid mapping but is grounded in principles such as "music and medicine share a common origin" (Yue Yao Tong Yuan) and "resonance between energies of the same nature" (Tong Qi Xiang Qiu). It aims to achieve holistic effects through sonic resonance with organ functions, thereby "harmonizing qi and blood, and balancing yin and yang."

A key advantage of this Therapy lies in its principle of "pattern-based music treatment" (Bian Zheng Shi Le), which emphasizes individualized interventions tailored to the patient's constitution, disease pattern, and emotional state. This personalized approach, documented in historical cases such as Zhang Congzheng's use of "using joy to overcome sorrow" (Yi Xi Sheng Bei) in Ru Men Shi

Qin[8], showcases a flexibility that aligns with modern precision medicine and provides a robust theoretical foundation for AI-driven personalization.

2.2 Current State of Generative AI Music Technology

Generative AI music technology utilizes deep learning models to learn core musical features such as melodic structure, rhythm, and harmony, enabling automated generation of musical content from input conditions. Current mainstream technical approaches primarily fall into two categories. One category comprises sequence generation models based on the Transformer architecture, as exemplified by *Music Transformer*. These models employ self-attention mechanisms to capture long-range dependencies within musical sequences, thereby generating coherent and logical melodic content. The other comprises multimodal generative models, such as *AnyGPT*, which accept diverse input data, including textual descriptions, visual information, and audio signals, to achieve cross-modal music generation. This capability provides more comprehensive technical support for personalized therapeutic needs.

Compared with traditional music production, generative AI technology offers three core advantages: First, real-time capability enables music generation and parameter adjustment within seconds, meeting the demand for immediate clinical intervention. Second, personalization allows flexible matching of musical styles, emotional tones, and rhythmic characteristics through precise parameter control. Third, explainability is achieved by establishing clear correspondences between the music generation process and therapeutic objectives via feature mapping. These technical properties make generative AI an ideal vehicle for integrating Five-Tone Therapy, paving the way for modernizing traditional therapeutic approaches.

3. Development of a Personalized Clinical Therapeutic Music Management System

3.1 System Design Principles

The system's development strictly adheres to three core principles. First, the TCM-oriented principle: all music generation parameters must be based on the Five-Tone Therapy theory to ensure the accuracy and standardization of the therapeutic connotation, preventing technical applications from deviating from the theoretical foundation. Second, the clinical adaptability principle: data collection methods and operational workflows are designed to seamlessly integrate with hospital environments, reducing the learning curve and operational barriers for medical staff while enhancing clinical applicability. Third, the dynamic optimization principle: a closed-loop feedback mechanism based on patient feedback data is established, enabling continuous iteration through "generation-evaluation-optimization" to improve the system's interventional effectiveness.

3.2 Overall System Architecture

The system adopts a layered architecture design pattern, structured top-down into three functional tiers: Application Layer, Core Engine Layer, and Data Layer. Each tier interacts through standardized API interfaces to ensure data exchange and functional coordination, ensuring system stability and scalability. The specific architecture design is as follows:

3.2.1 Data Layer: Multimodal Data Collection and Standardization

As the core foundation for personalized music generation, the data layer primarily handles the collection, cleansing, and standardization of multidimensional patient data. Key data types include the following three categories:

3.2.1.1 Clinical Condition Data

Through standardized interfaces with hospital HIS and EMR systems, this layer automatically acquires objective data such as patient diagnoses, medical history, and key physiological indicators

(e.g., heart rate, blood pressure, blood oxygen saturation).These data are standardized using both ICD-11 disease codes and Traditional Chinese Medicine (TCM) syndrome codes to construct a "disease-syndrome" correspondence database.For instance, "primary hypertension" is linked to TCM syndromes like "liver yang hyperactivity" and "kidney yin deficiency," providing an objective basis for the precise selection of Five-Tone modalities.

3.2.1.2 Emotional State Data

A hybrid collection model combining "subjective scale assessments + objective physiological signal monitoring" is employed.For subjective assessment, the system integrates the SAS Anxiety Self-Rating Scale, SDS Depression Self-Rating Scale, and TCM Emotional Assessment Scale, enabling patients to complete evaluations conveniently via mobile terminals. For objective monitoring, physiological signals such as heart rate variability (HRV) and galvanic skin response (GSR) are collected using medical wearable devices. Machine learning algorithms are employed to build emotion recognition models, enhancing the accuracy and objectivity of emotional state assessment.

3.2.1.3 Music Preference Data

Through a combination of structured questionnaires and dynamic feedback, the system collects subjective information on patients' music style preferences (e.g., classical, ethnic, light music), instrument preferences (e.g., guqin, erhu, piano), and rhythm tempo preferences (e.g., soothing, steady, upbeat). This data is used to build personalized music preference models, enhancing patient acceptance of generated music and improving intervention compliance.

All collected data is transmitted and stored using end-to-end encryption technology, strictly adhering to the Personal Information Protection Law of the People's Republic of China and relevant medical data security regulations to ensure the security and controllability of patient privacy information and medical data.

3.2.2 Core Engine Layer: Five-Tone Feature Mapping and AI Generation

As the functional core of the system, the core engine layer is responsible for converting multimodal data into personalized therapeutic music.It primarily comprises two core submodules: the feature mapping module and the AI generation module.

3.2.2.1 Five-Tone Feature Mapping Module

This module serves as the critical link between TCM theory and AI technology. Its core function is to construct a standardized mapping rule library that links "patient state" to "five-tone parameters". The implementation process involves: First, based on TCM syndrome differentiation and treatment principles, the patient's three-dimensional assessment results of "disease diagnosis, syndrome classification, and emotional state" are mapped into core five-tone type combinations. For example, patients with liver yang hyperactivity hypertension typically exhibit irritability and anger, corresponding to a modality combination dominated by the Jue tone and supplemented by the Zhi tone. Second, physiological indicators and emotional characteristics are quantified into musical parameters. For instance, patients with slower heart rates are assigned a relaxed tempo of 60-70 beats per minute, while those with higher anxiety scores receive parameters with increased low-register dominance and simplified harmonic structures. Finally, musical preference data is integrated, blending the patient's preferred instrument types and stylistic characteristics with the Five-Tone modalities to form a complete set of music generation parameters.

3.2.2.2 AI Generation Module

This module employs a dual-model collaborative architecture combining "*Music Transformer* and multimodal optimization." First, the Music Transformermodel generates foundational melodies and harmonic frameworks based on the parameter set output by the feature mapping module, ensuring musical coherence and professionalism. Second, the *AnyGPT* multimodal model is introduced to process patients' subjective emotional descriptions (e.g., "feeling chest tightness and low mood,"

"palpitations and anxiety") as supplementary input, refining emotional nuances and optimizing details within the foundational musical content to enhance its alignment with the patient's emotional state. Throughout the generation process, the system outputs real-time key parameters, including Five-Tone modality ratios, rhythmic characteristics, and frequency ranges, ensuring the interpretability and traceability of the generation process.

3.2.3 Application Layer: Clinical Applications and Feedback Optimization

The application layer provides targeted functional services for three core user groups: medical staff, patients, and hospital administrators. It primarily includes the following modules.

3.2.3.1 Physician Workstation

Healthcare professionals can use this module to view patients' comprehensive assessment reports and system-generated music therapy plans. They can adjust music parameters based on clinical experience; for example, increasing the proportion of Yu tones for postoperative pain patients can enhance sedative and analgesic effects. The module also supports batch generation of standardized music plans for patients with similar conditions, improving clinical efficiency.

3.2.3.2 Patient Terminal

Patients access personalized therapeutic music through bedside smart terminals or mobile apps, which support basic operations such as pause, loop playback, and volume adjustment. Real-time feedback on auditory experiences (e.g., "too soothing," "uncomfortable instrument tones") and physical or mental changes (e.g., "anxiety symptoms alleviated," "pain intensity reduced") is provided through a combination of ratings and text input. Feedback is automatically synchronized to the core engine layer via encrypted channels.

3.2.3.3 Management Backend

Hospital administrators use this module to monitor core system metrics, including patient usage rates, satisfaction scores for therapeutic programs, and quantitative indicators of emotional and pain improvement. This provides data-driven insights and decision support for optimizing hospital service quality.

3.2.3.4 Feedback Optimization Module

Based on real-time patient feedback and long-term efficacy evaluations, reinforcement learning algorithms iteratively optimize the feature mapping rule library and AI generation model parameters. This progressively enhances the matching accuracy of music therapy programs with increasing usage frequency, enabling the system's adaptive self-improvement.

4. Application Value of the System in Hospital Management

4.1 Enhancing Patient Satisfaction and Optimizing Healthcare Service Experience

Patient satisfaction has become a core evaluation metric in modern hospital management systems. Anxiety and physical or mental discomfort during the healthcare journey are significant factors contributing to reduced satisfaction. Traditional music therapy models often lack sufficient personalization, resulting in inconsistent patient acceptance and intervention compliance. This system achieves precise matching of therapeutic solutions through multidimensional data integration, significantly enhancing the acceptance and effectiveness of therapeutic music interventions.

From the perspective of hospital operational management, the clinical application of this system offers dual value. First, it addresses the industry-wide shortage of professional music therapists by delivering standardized yet personalized therapy, thereby reducing reliance on specialized personnel and associated labor costs. Second, it creates a distinctive competitive advantage through the innovative integration of TCM therapies with AI technology, thereby enhancing the hospital's core competitiveness. For instance, when deployed in departments with high emotional intervention needs,

such as obstetrics and pediatrics, the system can effectively alleviate patient anxiety through warm and soothing personalized music, contributing to the establishment of a humanistic healthcare service brand.

4.2 Precise Intervention for Anxiety to Reduce Clinical Stress Responses

Anxiety is the most prevalent psychological issue among clinical patients. Preoperative anxiety and anxiety accompanying chronic diseases not only diminish patients' quality of life but may also lead to adverse outcomes such as increased surgical risks and reduced treatment compliance. TCM Five-Tone Therapy regulates visceral qi mechanisms to intervene in emotional states. Modern clinical studies confirm that patients with liver qi stagnation and spleen qi deficiency benefit from this therapy in alleviating anxiety and depression while relieving clinical symptoms. Gong-tone music demonstrates significant efficacy in improving postoperative anxiety[9][10].

The core advantages of this system in anxiety intervention lie in its precision and real-time responsiveness: It monitors patients' emotional fluctuations in real time through physiological signals like HRV. When anxiety levels exceed thresholds, the system automatically triggers adjustments to musical parameters, such as increasing the proportion of Jue tones and moderately accelerating rhythms to achieve liver-soothing and qi-regulating effects. When deployed in preoperative preparation rooms, this system can partially replace traditional sedative premedication protocols, reducing risk of adverse drug reactions. In oncology chemotherapy departments, continuous emotional intervention enhances treatment adherence and decreases interruptions caused by anxiety. From a hospital management perspective, effective anxiety intervention shortens patient hospital stays, reduces resource consumption, and improves healthcare resource utilization efficiency.

4.3 Adjunctive Pain Management and Reduced Dependence on Analgesic Medications

Pain management is fundamental to clinical care. Long-term opioid use carries risks of dependence and adverse effects. Music therapy, as a non-pharmacological intervention, can reduce pain perception by activating the brain's limbic system and reward pathways. In TCM Five-Tone Therapy, the Yu tone's low-frequency vibrations are believed to influence the Kidney Meridian, exerting calming and analgesic effects, while the Shang tone helps alleviate sharp pain by regulating qi flow. Modern evidence shows that personalized music interventions lower both pain scores and analgesic requirements.[11] These effects reduce medication-related risks and costs, thereby improving healthcare resource allocation efficiency.

The system is clinically applied in pain management through three main approaches: First, for postoperative pain, it generates personalized music protocols tailored to surgical types such as orthopedics and general surgery, primarily using the Yu tone supplemented by the Shang tone. These protocols work synergistically with analgesics to reduce dosage requirements. Secord, in chronic pain management, the system provides long-term home-based therapy for conditions including arthritis and neuropathic pain, supported by a mobile platform for remote monitoring and follow-up reduction. Third, for hospice care, it delivers non-invasive pain relief to enhance the quality of life for end-stage patients. This integrated strategy lowers risk of adverse drug reactions, optimizes medication costs, and improves healthcare economic efficiency.

5. System Implementation Pathway and Safeguard Measures

5.1 Phased Implementation Pathway

The system will be implemented in healthcare institutions following a "pilot first, phased expansion, and continuous optimization" approach across three sequential phases.

The initial pilot stage (1–3 months) will select high-need departments such as Anesthesiology, Oncology, and Obstetrics as pilot units. This phase involves integrating the system with the Hospital Information System (HIS), training medical staff, and establishing a standardized workflow covering assessment, generation, feedback, and optimization. Core patient data on satisfaction, anxiety, and

pain will be collected to guide initial system calibration. During the subsequent promotion stage (4–6 months), building on validated pilot outcomes, the system will be extended to all clinical departments. Customized adaptations will be developed, such as child-friendly interfaces for Pediatrics and non-intrusive music for the ICU and a dedicated operations team will be formed to oversee data security, technical support, and system maintenance. In the final deepening stage (7–12 months), the system will be integrated with chronic disease management and telemedicine platforms to support long-term follow-up and home-based therapy. Multicenter clinical studies will be conducted with academic partners to evaluate long-term efficacy, aiming to establish standardized, transferable industry guidelines.

5.2 Safeguard Measures

5.2.1 Technical Safeguards

A dual-deployment architecture combining cloud and on-premises infrastructure will be implemented. Cloud nodes will handle model training and data storage, while local terminals will maintain core system functionality during network outages. Blockchain technology will be used to encrypt patient privacy data and create immutable records, ensuring full compliance with healthcare data security regulations. A regular system upgrade mechanism will integrate the latest AI technologies and Five-Tone Therapy research findings, sustaining the system's technical advancement.

5.2.2 Ethical Safeguards

An interdisciplinary ethics committee will oversee all system applications, reviewing data collection scope and risk control measures. Patient data collection will be based on informed consent, with clear disclosure of data usage, storage practices, and privacy safeguards. All system-generated music protocols must be clearly labeled as "adjunctive therapy." Any exaggeration of therapeutic outcomes is strictly prohibited to avoid replacing standard clinical treatments.

5.2.3 Workforce Development

A comprehensive training program integrating TCM theory, AI technology, and clinical practice will be established to ensure healthcare staff master both Five-Tone Therapy fundamentals and system operation skills. Partnerships with professional music therapy institutions will be formed to create clinical training bases, systematically cultivating specialists with dual expertise in TCM and music therapy to provide sustainable talent support for the system's long-term operation.

5.2.4 Policy Support

Alignment with the National Administration of Traditional Chinese Medicine's policy on TCM modernization will be pursued, and specialized research projects will be sought for funding support. System utilization outcomes will be integrated into hospital performance assessments, with incentive mechanisms established to encourage adoption by healthcare staff. These measures collectively form a promotion model combining policy guidance with market-driven engagement.

6. Summary

This study develops an AI-driven personalized music therapy system that integrates TCM Five-Tone theory with artificial intelligence. Its key innovations include: a standardized disease condition, emotional state, and Five-Tone modality mapping framework that addresses the limitations of traditional experience-based practice; real-time music personalization through multimodal generation; and a closed-loop clinical-management optimization pathway.

Current limitations include the need for larger clinical validation of tone-mapping accuracy, the relatively limited artistic quality of AI-generated music, and the requirement for better adaptation to varied patient preferences.

Future efforts will focus on multi-center trials to refine model parameters, integration of GANs to enhance musical quality, and development of culturally adaptive multilingual versions.

As AI and TCM modernization progress, such systems are expected to become standard clinical tools—advancing both therapeutic practice and global dissemination of Five-Tone theory, while contributing innovative solutions to global health systems.

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