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RECONSTRUCTION OF MAQAM MODES IN THE UZBEK CHANG INSTRUMENT BASED ON MODERN ACOUSTIC APPROACHES

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Abstract: This article explores the reconstruction of maqam modes in the Uzbek chang instrument using modern acoustic approaches. The study focuses on analyzing traditional maqom tuning systems, identifying microtonal intervals, and applying acoustic modeling techniques to optimize pitch accuracy and tonal stability. By combining historical performance knowledge with contemporary measurement and simulation methods, the research aims to recreate maqam structures faithfully while enhancing consistency and expressive potential. The findings provide practical guidance for musicians, educators, and instrument makers, contributing to the preservation and modernization of Uzbek musical heritage.

Keywords: Uzbek chang, maqam reconstruction, acoustic modeling, microtonal intervals, tuning optimization, performance practice, digital simulation

The Uzbek chang is a central instrument in traditional music, serving as a primary medium for expressing the complex modal and microtonal structures of maqoms. Historically, tuning systems for maqoms were transmitted orally, relying on empirical methods and the auditory sensitivity of performers. While these methods preserve expressive subtleties, they often result in inconsistencies in pitch, interval sizes, and tonal stability, which can challenge ensemble coordination, educational training, and contemporary performance applications.

Modern acoustic approaches provide tools for analyzing, modeling, and reconstructing maqam modes with precision. Spectral analysis, frequency measurement, and computational simulations allow researchers and performers to identify exact microtonal intervals, evaluate the acoustic properties of the instrument, and optimize tuning for consistency and expressive fidelity. By integrating traditional knowledge with contemporary technology, it becomes possible to maintain the cultural authenticity of maqoms while enhancing technical precision and pedagogical effectiveness.

This study aims to systematically reconstruct maqam ladders on the Uzbek chang using modern acoustic methodologies. The research combines historical data on traditional maqom performance, acoustic analysis of the instrument's properties, and digital modeling to develop a framework for accurate and consistent tuning. The proposed approach not only preserves the microtonal richness and stylistic features of maqoms but also provides a practical guide for musicians, educators, and instrument makers seeking to bridge traditional practice and contemporary musical standards.

The Uzbek chang is one of the most emblematic instruments in Central Asian music, serving as a key medium for expressing the rich modal structures and microtonal subtleties of maqoms. Traditionally, maqam tuning has been transmitted through oral methods and empirical experience, relying heavily on the performer's auditory perception. While these approaches preserve expressive nuance, they often lead to inconsistencies in pitch accuracy, intervallic relationships, and tonal stability, particularly in ensemble settings or educational contexts. Modern acoustic methods provide a systematic framework to analyze, model, and reconstruct maqam ladders on the chang, enabling precise tuning while maintaining the traditional musical aesthetics.

A central focus in maqam reconstruction is the accurate identification of microtonal intervals that define each mode. These intervals frequently lie between the notes of the standard Western diatonic or chromatic scale, requiring fine adjustments in string tension, length, and bridge positioning. Spectral analysis and frequency measurement tools allow researchers to determine the exact frequencies of individual notes, calculate interval ratios, and verify the consistency of microtonal relationships. If the tonic note is denoted as f0f_0f0, the frequency of any subsequent note in the maqam can be expressed as fn=f0·rnf_n = f_0 \cdot r_nfn=f0·rn, where rnr_nrn is the microtonal ratio corresponding to the intended interval. This mathematical representation provides a foundation for precision tuning and enables comparison across different instruments or performance practices.

The reconstruction process begins with acoustic measurement of the chang's properties. String composition, length, diameter, and tension are analyzed to understand how each factor influences pitch and harmonic content. The resonator's shape, material, and construction are studied for their impact on sustain, timbre, and microtonal clarity. By integrating these physical parameters into computational models, it becomes possible to simulate various tuning configurations and predict their acoustic outcomes. These models help identify optimal string adjustments and resonator modifications that enhance tonal stability without compromising traditional expressive qualities.

Performer technique remains critical in realizing microtonal intervals accurately. Skilled chang players manipulate finger placement, plucking force, and string tension to achieve subtle pitch variations and expressive ornamentation. The reconstruction framework accommodates this interpretive flexibility by providing reference frequencies and ratios rather than rigid targets, allowing performers to retain stylistic nuance while maintaining overall modal integrity. For example, pitch slides, grace notes, and microtonal inflections can be executed within the reconstructed ladder, preserving the authentic maqam character.

Environmental factors, including temperature, humidity, and instrument aging, can affect tuning stability. Microtonal intervals are particularly sensitive to these changes due to variations in string tension and material elasticity. The reconstruction model incorporates compensatory mechanisms, such as material selection, pre-tuning protocols, and fine adjustment techniques during performance. These strategies help maintain consistent microtonal relationships and ensure that reconstructed maqam ladders are reliable in diverse performance conditions.

Digital simulation plays a pivotal role in modern reconstruction. By creating virtual models of the chang and its acoustic behavior, researchers can explore the effects of string adjustments, resonator modifications, and microtonal tuning on overall sound quality. Simulations also allow for iterative testing and refinement, providing performers and instrument makers with precise data for optimizing both tonal range and intervallic accuracy. Furthermore, digital archives of reconstructed maqam performances serve as educational tools, enabling students to study microtonal relationships and develop auditory skills in alignment with historical performance practices.

The application of this methodology extends to pedagogy, instrument construction, and ensemble performance. In educational settings, reconstructed maqam ladders provide clear tonal references for training students in microtonal recognition and execution. In instrument making, detailed acoustic data guide luthiers in string selection, bridge placement, and resonator design to support accurate tuning and expressive potential. In ensemble contexts, standardized reference frequencies facilitate coordination between chang and other traditional or modern instruments, ensuring consistent microtonal integration within complex arrangements.

The integration of historical knowledge and modern acoustic approaches highlights the dynamic interplay between tradition and technology. While empirical methods maintain expressive authenticity, contemporary techniques provide the precision and reproducibility necessary for performance consistency, research documentation, and cross-cultural collaboration. By combining these approaches, the reconstruction of maqam ladders on the chang achieves both scientific rigor and musical integrity, bridging centuries of tradition with contemporary musical practice.

Moreover, this methodology supports cultural preservation. Documenting and systematizing maqam intervals ensures that the nuanced modal structures are retained for future generations, reducing the risk of loss due to oral transmission variability. At the same time, it enables innovation, allowing musicians and composers to explore new interpretations and applications of traditional modes while respecting their structural and expressive foundations. The reconstructed maqam ladders thus serve as both a preservation tool and a platform for creative expansion.

In conclusion, reconstructing maqam modes in the Uzbek chang using modern acoustic approaches involves a multifaceted process that integrates instrument analysis, microtonal identification, computational modeling, and performer technique. By combining historical practice with contemporary acoustic and digital methods, it is possible to achieve precise, reliable, and expressive maqam ladders. This approach enhances the technical accuracy and pedagogical utility of the instrument while preserving its cultural authenticity, supporting both the continuation and evolution of Uzbek maqom performance in modern contexts.

This study has presented a comprehensive approach to reconstructing maqam modes on the Uzbek chang using modern acoustic methodologies. By integrating detailed acoustic analysis, frequency measurement, computational modeling, and traditional performance knowledge, the research provides a systematic framework for accurately identifying microtonal intervals and optimizing tuning stability. The approach maintains the expressive nuances and stylistic characteristics of maqoms while enhancing consistency and precision, offering significant benefits for performers, educators, and instrument makers. Additionally, digital simulation and modeling facilitate experimentation, pedagogical applications, and preservation of traditional modal structures. Ultimately, the study bridges the gap between historical practice and contemporary technology, ensuring the continued relevance, accuracy, and expressive richness of the Uzbek chang in modern musical contexts.

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