

# University strategies for preserving and innovating Uzbek musical arts using audio archiving technologies

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**Abstract:** *The preservation of Uzbek musical arts, particularly the Shashmaqom tradition and regional folk practices, has historically relied on oral transmission and memory. However, the twentieth century introduced analog recording technologies, and the twenty-first century has brought digital audio archiving, machine listening, and high-resolution signal processing into the domain of cultural heritage management. Universities in Uzbekistan and beyond are uniquely positioned to lead this transformation, not merely as repositories of historical recordings but as active laboratories for technological innovation that serves both preservation and pedagogy. This article examines university-led strategies for audio archiving of Uzbek music, focusing on three interconnected areas: the digitization and metadata standardization of Soviet-era reel-to-reel collections, the application of digital signal processing (DSP) for noise reduction and microtonal analysis of maqom performances, and the development of interactive student access systems that allow time-stretched, spectrogram-linked playback for aural training. Drawing on case studies from the State Conservatory of Uzbekistan and collaborative projects with technical universities in Europe and East Asia, the article argues that audio archiving technologies, when implemented through thoughtful university strategies, can achieve more than passive preservation. They can generate new scholarly insights into Uzbek ornamentation practices, support the revitalization of endangered regional variants, and create scalable pedagogical tools that extend the reach of master musicians beyond the traditional usta-shogird setting. Technical challenges including storage standards, format obsolescence, and the need for culturally informed metadata schemas are addressed alongside institutional recommendations for sustainable archiving workflows.*

**Keywords:** *audio archiving, digital signal processing, Uzbek maqom, music preservation, university heritage strategies, magnetic tape digitization*

## Introduction

Uzbekistan possesses a musical heritage of extraordinary richness and diversity. The Shashmaqom, recognized by UNESCO as an Intangible Cultural Heritage of Humanity, represents the pinnacle of Central Asian classical music, while the Fergana-Tashkent, Khorezm, and Bukhara regional styles offer distinct melodic and rhythmic vocabularies. Yet this heritage is fragile. Many of the greatest twentieth-century performers, including Yunus Rajabi, Turgun Alimatov, and Komiljon Otaniyozov, left their legacies primarily on magnetic tape, vinyl, and, in the earliest cases, wax cylinders. These physical media degrade. Playback equipment becomes scarce. Moreover, the traditional oral transmission system, while culturally vital, cannot alone sustain the full historical repertoire when the number of active masters dwindles. Universities have responded to similar challenges in other musical traditions by establishing audio archiving units that combine curatorial expertise with engineering infrastructure. For Uzbek music, the opportunity is particularly urgent because much of the most important archival material remains uncatalogued, under-digitized, or accessible only to a handful of senior researchers. This article proposes that Uzbek universities, in partnership with

international technical institutions, can implement audio archiving strategies that not only preserve these recordings but actively support musical innovation and pedagogical transformation.

#### The State of Uzbek Audio Archives and the University Role

Existing audio collections of Uzbek music are distributed across multiple institutions. The largest repository is the State Archive of Audio and Video Recordings in Tashkent, which holds thousands of hours of material dating from the 1930s to the 1990s. Additional collections reside at the Uzbek National Institute of Musical Art named after Yunus Rajabi, the State Conservatory of Uzbekistan, and the Institute of Art Studies of the Academy of Sciences. Each institution has its own storage conditions, cataloguing system, and preservation priorities. Most analog media are stored in non-climate-controlled environments, leading to binder degradation, magnetic shedding, and mold. Playback equipment for Soviet-era formats, such as the 4-track reel-to-reel recorders widely used in Tashkent recording studios, is no longer manufactured, and spare parts must be sourced from second-hand markets or custom-fabricated. Universities with engineering faculties are well positioned to address these technical challenges. A university can maintain a digitization laboratory with calibrated tape decks, analog-to-digital converters operating at 24-bit/96 kHz or higher, and standardized file formats such as Broadcast WAVE with embedded metadata. Unlike a traditional archive, a university can also integrate digitization into coursework, training students in both the cultural significance and the technical procedures of audio preservation. This dual mission of preservation and education creates a sustainable model. Students learn transferable skills in signal processing and digital archiving, while the archive benefits from a recurring workforce of supervised trainees.

A successful example is the pilot project initiated in 2019 between the State Conservatory of Uzbekistan and the Audio Engineering Department of a partner technical university in Budapest. Over three years, the project digitized approximately 1,500 hours of reel-to-reel recordings from the conservatory's basement archive, which had been inaccessible for nearly two decades. The project established a digitization chain beginning with physical inspection and baking of sticky tapes in a laboratory oven, followed by playback on restored Studer and Otari machines, conversion using RME audio interfaces, and final storage as both archival FLAC files and access MP3s. Critically, the project also produced a detailed technical log for each recording, noting tape speed, equalization curve, and any artifacts such as dropouts or print-through. Without a university framework that brought together musicologists, audio engineers, and student assistants, this material would likely have become unplayable within another decade. The same model can be replicated across other Uzbek institutions, provided that university leadership recognizes audio archiving not as a one-time grant activity but as an ongoing operational responsibility.

#### Digital Signal Processing for Restoration and Analysis

Digitization alone is not preservation. Digital files on hard drives face their own risks, including bit rot, format obsolescence, and accidental deletion. More importantly, the intellectual content of a recording is not fully accessible if the audio is degraded by noise, distortion, or frequency loss. This is where digital signal processing becomes indispensable. Modern DSP techniques allow the restoration of recordings that would otherwise be unusable. For example, many Uzbek field recordings from the 1950s and 1960s contain pervasive hiss from magnetic tape, rumble from inadequately isolated recording environments, and intermittent crackles from damaged media. Adaptive noise reduction algorithms, such as those implemented in tools like iZotope RX or the open-source software Audacity with spectral editing plugins, can reduce these artifacts without removing significant musical information. The key is to apply these processes in a way that prioritizes musical intelligibility over superficial cleanliness. A Shashmaqom tanbur performance depends on

the subtle harmonics of the plucked string and the resonance of the soundbox. Over-aggressive noise reduction can erase these harmonics, leaving a sterile, hollow sound. University audio engineers working with Uzbek music must therefore be trained to make restoration decisions informed by musical content, not merely by signal-to-noise ratio measurements.

Beyond restoration, DSP enables new forms of musical analysis that were impossible in the analog era. The microtonal inflections characteristic of Uzbek singing and instrumental playing, including the neutral seconds and three-quarter tones that distinguish maqom intonation from Western equal temperament, can be measured precisely using pitch tracking algorithms. A student or researcher can open a digitized recording of Turgun Alimatov performing a Chorgoh tasnif in a spectrogram display that shows frequency over time, then zoom in on a single ornament to measure the exact cent deviation from a reference pitch. This capability transforms the study of Uzbek music from a descriptive to an analytical enterprise. Instead of saying that a performer uses "expressive microtonal slides," the researcher can document that a particular grace note consistently rises from 240 to 290 cents relative to a 261 Hz fundamental, a deviation that does not correspond to any Western interval. Over a large corpus of recordings, such measurements can reveal individual performer styles, historical changes in tuning practices, or regional differences in ornamentation. Universities with technical music programs are the natural homes for this research, as they can combine access to archival materials, expertise in DSP algorithms, and the scholarly framework necessary to interpret the results.

One ongoing university project at the Urgench State University, in collaboration with the Khorezm regional music archive, has used DSP to compare pre-Soviet wax cylinder recordings of Khorezmian tanbur players with late-Soviet reel-to-reel performances of the same maqom sections. Preliminary analysis suggests that the earlier recordings exhibited a wider range of microtonal flexibility, with ornamentation that varied freely between performances, while the later recordings showed a degree of pitch standardization that may reflect the influence of conservatory training. These findings are not merely historical curiosities. They have direct implications for how educators teach ornamentation today. If the earlier, more flexible style is considered an authentic heritage, then university curricula should emphasize variability and improvisation over fixed pitch templates. Conversely, if the later style is recognized as a legitimate evolution shaped by institutional conditions, then educators can teach it without a sense of loss. DSP analysis does not answer these cultural questions, but it provides evidence that can inform the conversation.

#### Interactive Access Systems for Student Learning

Preservation and analysis are incomplete without access. A digitized recording stored on a university server that only researchers can reach serves little educational purpose. The true innovation in university audio archiving strategies for Uzbek music lies in the development of interactive access systems tailored to the needs of student learners. Traditional oral transmission requires repetition. A student learning a difficult *usul* transition on the *dutar* may need to hear a master's performance twenty or thirty times at gradually increasing speeds. In the *usta-shogird* setting, the master could repeat a phrase manually, adjusting tempo as needed. In a university setting with large classes and limited contact hours, an audio access system can provide this same functionality. A purpose-built web interface linked to the archive can allow a student to select any recorded piece, then loop a user-defined segment, slow playback without altering pitch using phase vocoder algorithms, and overlay a spectrogram display that highlights the fundamental frequency contour. The student can also record themselves attempting the same phrase, align the two recordings in time, and play back both simultaneously or in rapid alternation. This turns passive listening into active, iterative practice. Several universities have implemented such systems for other musical traditions. The Indian Digital Heritage project at the Indian Institute of Technology Madras developed a similar tool for Hindustani

and Carnatic vocal training. For Uzbek music, the technical requirements are comparable but the metadata structure must be different. An Uzbek maqom does not divide neatly into measures and beats in the Western sense. Instead, usul cycles often follow asymmetric patterns such as 5/8, 7/8, or 10/8, and the concept of a “downbeat” is less salient than the recognition of rhythmic pattern boundaries. An interactive access system for Uzbek music must therefore allow students to mark structural boundaries in terms of usul cycles, not bar lines. This is a metadata problem as much as a software engineering problem. The archive must store, for each recording, a timeline of usul changes and the performer’s own section labels. Building this metadata requires musicologists to annotate recordings painstakingly, but once completed, the system becomes a powerful pedagogical tool. A student studying the Sarakhbor section of Dugoh maqom can instantly navigate to any occurrence of a particular usul pattern, listen to how the master executes the pattern at different points in the piece, and then practice against a slowed, looped version.

A prototype of such a system was developed between 2021 and 2023 at the Tashkent University of Information Technologies named after Muhammad al-Khwarizmi, in partnership with the State Conservatory. The system, still in pilot testing, currently contains approximately 200 fully annotated recordings from the Fergana-Tashkent maqom tradition. Early feedback from student users indicates that the ability to slow playback without pitch distortion is the most valued feature, followed closely by the side-by-side recording comparison tool. Students report that they can learn ornamentation more accurately using the system than from live demonstration alone, because they can repeat the same recorded phrase dozens of times without imposing on the teacher. This finding challenges the assumption that technology is inherently inferior to live transmission. In fact, for certain learning objectives, especially those requiring fine detail discrimination and high repetition, an interactive digital system can exceed the capabilities of even an excellent live teacher. The university’s role is to ensure that such systems are designed with cultural specificity, not imported from Western music pedagogy without modification.

#### Institutional Recommendations for Sustainable Archiving

Implementing the strategies described above requires institutional commitment. No single grant or passionate individual can maintain an audio archive and interactive access system over decades. Based on the experiences of university projects in Uzbekistan, Europe, and East Asia, several recommendations emerge. First, universities should establish a permanent Audio Heritage Unit with dedicated staff positions, not just temporary project roles. This unit must include at least one audio engineer responsible for playback equipment maintenance and digitization standards, one cataloguer or librarian responsible for metadata creation and database management, and one musicologist responsible for verifying content descriptions and ensuring culturally appropriate access protocols. Second, universities must adopt a single, open metadata standard for describing Uzbek musical recordings. The Dublin Core standard is too generic. A specialized schema should include fields for maqom name, section name, usul, performer lineage, recording location, original media format, digitization parameters, and any restoration processes applied. Third, universities should establish redundant storage with offsite backups, using both spinning hard drives for active access and LTO magnetic tape for long-term archival copies. Cloud storage is convenient but raises legal questions about data sovereignty for culturally sensitive recordings. Fourth, universities should prioritize regional archives outside Tashkent. Khiva, Shakhrisabz, Termez, and Nukus each hold collections that are more endangered than those in the capital because they lack basic climate control. A mobile digitization unit operated by a central university can travel to these locations, digitize on site, and leave copies with the local institution.

Finally, universities must create clear policies for student and researcher access that balance openness with respect for cultural norms. Some recordings, particularly those of religious or ritual music (such as bakhshi performances of the dastan epic cycles), may have restricted access according to community protocols. A university archive cannot simply ignore these protocols in the name of open access. The technical solution is a tiered permission system embedded in the access interface, where recordings are classified as open, conditional (requiring a brief application explaining the research or educational purpose), or restricted (available only to community members or under specific conditions). This approach respects the music as living heritage, not merely as data.

### Conclusion

University strategies for preserving and innovating Uzbek musical arts using audio archiving technologies are not peripheral to the mission of higher education. They are central to it. A university that teaches Uzbek music without maintaining an active, technologically sophisticated audio archive is teaching from an impoverished base. The archive provides the evidence of past practice, the raw material for analysis, and the model recordings that students learn to emulate. Conversely, an archive without a pedagogical access system is a morgue, not a living resource. The technical strategies described in this article, including high-resolution digitization, DSP-based restoration and analysis, and interactive slowed-playback interfaces, are all achievable with current technology. What has been lacking is the institutional will to implement them systematically. The case studies from Uzbek and partner universities demonstrate that such implementation is feasible. What remains is to scale these successes, to train a new generation of audio engineers who also understand maqom aesthetics, and to ensure that the recordings of Yunus Rajabi, Turgun Alimatov, and their contemporaries remain audible not only to researchers but to every student who wishes to learn. That is the true measure of preservation. Not how many tapes are digitized, but how many young musicians can hear, understand, and continue the tradition. Audio archiving technologies, guided by thoughtful university strategies, make that hearing possible.

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