



RESTORING ARCHIVAL FOLKLORE RECORDINGS USING MODERN AI TECHNOLOGIES AND THEIR APPLICATION IN EDUCATION

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ABSTRACT This article explores the application of modern artificial intelligence (AI) technologies in the restoration of rare folklore works, specifically Karakalpak epics (dastans) and bakhshi performances recorded on magnetic tapes during the mid-to-late 20th century. It analyzes technical algorithms for eliminating audio defects—such as tape hiss, mechanical clicks, background noise, and high-frequency loss—using spectral editing software like iZotope RX and neural network-based tools. Furthermore, the study scientifically grounds the pedagogical efficacy of integrating these digitized and restored folklore samples into the academic curricula of "Folklore and Ethnography" and "Technogenic Art" programs in higher educational institutions.

Keywords: audio restoration, artificial intelligence, folklore, Karakalpak bakhshi art, iZotope RX, spectral editing, technogenic art, music education, magnetic tape.

INTRODUCTION

Folklore and traditional music heritage are essential factors that define the spiritual identity of any nation. Throughout the 20th century, the performances of great bakhshis, jirovs, and folk singers who lived in the territories of Uzbekistan and Karakalpakstan were documented on various analog media, predominantly magnetic tapes. These archival materials serve as an invaluable scientific and cultural resource for folkloristics. However, over time, the physical degradation of analog carriers—such as the shedding of magnetic layers and tape deformation caused by fluctuations in humidity and temperature—has led to a drastic deterioration in audio quality.



Today, simply digitizing archival recordings into modern formats is insufficient. It is crucial to restore them to an audible and study-ready condition, preserving the performer's breathing nuances, diction, and the unique timbral characteristics of national instruments, such as the Karakalpak *ala moynaq* dutar and the qobyz. Traditional noise reduction methods using standard equalizers and compressors often result in the loss of useful signals, particularly high-frequency overtones. At this juncture, modern AI-driven audio restoration technologies offer a revolutionary solution. The primary objective of this research is to analyze the technological application of AI tools on archival folklore recordings and to develop a methodology for utilizing these restored materials as primary educational resources within the higher education system.

METHODOLOGY AND MATERIALS

During the research process, folklore recordings dating back to the 1970s and 1990s, preserved in the archives of the Nukus Branch of the Uzbekistan State Institute of Arts and Culture as well as in various private collections, were subjected to analysis. The core methodological approach consists of two integrated phases: first, technical restoration based on audio engineering and spectral analysis methods; second, a pedagogical evaluation determining the suitability of the restored materials for academic syllabi.

The restoration process was carried out in several continuous stages rather than automated batch processing. Initially, the analog signals were converted into a high-resolution digital format (24-bit/96 kHz) to capture the maximum remaining sonic detail. Following this, a visual diagnosis of the audio files was conducted using spectrogram analysis to identify specific frequency anomalies. Advanced AI-driven machine learning algorithms were then employed to extract precise noise profiles, allowing for the independent processing and separation of vocal and instrumental tracks using neural network stem-separation technologies.

AI-ASSISTED AUDIO RESTORATION PROCESS

Restoring folklore recordings fundamentally differs from cleaning standard commercial music. In epics and traditional chants, isolating the performer's emotional delivery, raspy vocal textures, or the specific resonant "cry" (*nola*) of the qobyz from background noise poses a highly complex challenge for computing systems.

Addressing tape hiss and static noise requires precision. Utilizing classic low-pass filters to eliminate tape hiss usually suppresses the bakhshi's diction and muffles the recording. Instead, AI-based spectral de-noise plugins learn the specific noise profile through neural networks. By



analyzing the overlapping frequencies of the human voice and static noise, the algorithm dynamically reduces only the unwanted hiss, thereby fully preserving the natural overtones of the vocal performance.

Mechanical damages and artifacts must also be meticulously cleaned. Defects frequently found in old recordings, such as crackling, vinyl-like clicks, and microphone wind noise, are automatically detected using AI-driven de-click and de-rustle functions. Because these artificial intelligence models have been trained on thousands of hours of archival audio, they can accurately distinguish between a useful musical transient—such as the sharp pluck of a dutar string—and the physical crackle of a degraded magnetic tape.

One of the most significant breakthroughs in this research was the application of AI-powered voice isolation technologies for cleaning field recordings. Many storytellers were originally recorded in open environments, such as village weddings or outdoor gatherings. AI dialogue isolation algorithms successfully separate the human voice and instrumental sounds from complex environmental interference, including crowd chatter, wind, and rain. As a result, historically compromised field recordings can be brought surprisingly close to modern studio quality.

Furthermore, recreating the lost frequency spectrum is vital for a natural listening experience. Magnetic tapes inherently lose their high frequencies (above 8-10 kHz) over decades, resulting in a dull, muffled sound. Modern AI spectral recovery tools possess the capability to synthesize these lost frequencies. By analyzing the harmonics present in the surviving lower and mid-range frequencies, the neural network logically predicts and reconstructs the missing upper spectrum, returning a natural brightness and presence to the historical audio.

INTEGRATION OF RESTORED AUDIO INTO EDUCATIONAL CURRICULA

Creating an integrated educational environment between the "Technogenic Art" (Sound Engineering) and "Folklore and Ethnography" departments is a modern academic necessity. The restored archival recordings serve as a unique, shared educational platform for students in both disciplines, bridging the gap between cultural preservation and digital technology.

For students studying "Folklore and Ethnography," having access to high-quality recordings of renowned bakhshis and jirovs from the last century provides an unprecedented opportunity to master unique performance styles, complex melismas, and traditional vocal ornamentations. When listening to outdated, noisy tapes, students often struggle to decipher the lyrics correctly or



distinguish the tuning of the instrument. Once the audio is restored, young performers can clearly perceive every note, breathing technique, and traditional dialectal articulation. This ensures that indigenous epic-telling schools are transmitted to the next generation in their purest form.

For students of "Technogenic Art," these archival materials function as a ready-made practical laboratory. Students work with the raw, degraded versions of the recordings, independently applying AI plugins to clean interferences and adjusting parameters to achieve the optimal balance. This hands-on process not only enhances their software proficiency with industry-standard neural network tools like iZotope and stem-separation platforms but also fosters a deep sense of respect and responsibility toward their national heritage. They learn global audio standards while working directly with local cultural content.

Additionally, these cleaned audio files open new creative avenues. They can be utilized by students to compose high-quality soundtracks for modern films, theatrical productions, and podcasts. The restored samples also provide a foundation for producing ethno-electronic or world music projects aimed at an international audience, effectively blending ancient traditions with contemporary multimedia arts.

CONCLUSION

This research demonstrates that restoring archival folklore recordings using artificial intelligence is not merely a technical procedure, but a crucial strategic mechanism for translating cultural memory into the future. AI technologies have yielded results previously deemed impossible in traditional audio engineering, allowing for the meticulous removal of noise without damaging the intricate nuances of folk instruments and vocals.

The integration of these materials into the educational process has established a strong digital foundation for "Folklore and Ethnography" students to continue the master-apprentice (ustoz-shogird) tradition. The clear audibility of texts and musical intonations has drastically improved the quality of learning. Simultaneously, these restoration projects serve as practical, real-world objectives for "Technogenic Art" students, preparing them to become specialists who meet global industry standards. In the future, the establishment of a "Digital Folklore Archive" at the Nukus Branch and the integration of this audio database into public educational portals will further expand the scope of both scientific research and cultural preservation.

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