A Preliminary Study of Digital Audio Processing Technology in Radio Program Production (Post-print)

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Abstract

With the rapid development of information technology, traditional radio programs are facing increasingly significant impact and influence in market competition. To enhance the overall production quality of radio programs and improve the dissemination effectiveness of audio, it is imperative to actively employ digital audio processing technology. This paper first conducts an in-depth analysis of the principal advantages of digital audio processing technology in radio program production, clarifies the importance and application stages of utilizing digital audio processing technology in radio program production, and provides a detailed introduction to the practical application of specific recording equipment and digital audio processing technology, thereby strengthening the transmission effectiveness of radio programs.

Full Text

A Preliminary Study on Digital Audio Processing Technology in Radio Program Production

Abstract: With the rapid development of information technology, traditional radio programs face increasingly severe market competition. To enhance overall production quality and improve audio transmission effectiveness, it is essential to actively adopt digital audio processing technology. This paper first analyzes the main advantages of digital audio processing technology in radio program production, clarifying its importance and application stages. It then provides a detailed introduction to the practical application of recording equipment and digital audio processing techniques to strengthen broadcast transmission effects.

Keywords: radio program production; digital audio processing; technology exploration

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With the rapid advancement of modern science and technology, digital technology has been widely applied across various industries, profoundly transforming people' s production and lifestyles. The application of digital audio technology in radio station program production and broadcasting can effectively promote the rapid development of the broadcasting industry and align with contemporary trends. Only by correctly mastering digital audio processing technology can we ensure the digital transformation of radio stations and meet the actual needs of audiences.

1. The Main Development Process of Digital Audio Technology

In modern society, digital products are ubiquitous—digital cameras, optical discs, and digital television all enrich our lives. Similarly, audio digitization represents an inevitable requirement for the future development of audio technology. Digital audio technology primarily involves using digital means to record, store, and playback sound. It is closely related to the development of computer multimedia technology, information processing technology, and computer technology, all of which can effectively improve sound processing quality.

The key technical indicators in digital audio technology include sampling rate, compression rate, and bit rate. The sampling rate refers to the number of sound samples a computer can obtain per minute, which determines the sound file' s quality, pitch, and overall standard. Higher sampling frequencies with shorter intervals produce more accurate waveform representation and more pleasant sound. Compression rate refers to the ratio between file sizes before and after compression, reflecting the efficiency of digital audio compression. Bit rate, measured in bits per second (bps), indicates data transmission speed; in audio, it represents the unit for converting analog signals to digital signals and serves as a criterion for audio quality. Quantization level refers to the binary data used for sound processing, typically measured in bits (e.g., 16-bit and 24-bit), representing 16-bit and 24-bit binary numbers respectively. Quantization level is a crucial reference standard for sound quality, with 24-bit/48kHz sampling being commonly used to describe audio quality in everyday contexts.

Since Edison invented the phonograph, audio technology has undergone over a century of development, though most of this history involved analog audio technology. In 1953, Japan and other countries began developing digital tape recorders, but it took another two decades to achieve practical digital recording. After more than 30 years of continuous development and refinement, digital

audio technology has significantly improved and found widespread application in digital cinemas, digital audio broadcasting, and other fields.

2. Main Advantages of Digital Audio Technology in Radio Program Production

Digital audio technology offers unique advantages in radio program production. For instance, it can effectively improve overall production efficiency and quality by enabling rapid audio acquisition, playback, and storage. It can also be directly integrated into audio tracks, significantly enhancing production outcomes. During recording, digital audio technology employs multi-track recording, capable of simulating 64-track or 128-track digital recordings. If obvious deviations occur during audio recording, techniques such as track shifting and layering can be used, and reasonable utilization of analog audio tracks can substantially improve audio quality.

Digital audio technology also enhances accuracy. By using high-resolution displays, editors can ensure more meticulous digital audio processing effects and meet specific graphical representation requirements. As editors become more proficient, they can perform digital audio editing based on visual waveforms, significantly improving editing effectiveness and production efficiency. The rapid popularization of digital audio technology also lays a solid foundation for establishing digital audio databases. Due to its high efficiency and large-capacity information advantages, digital audio technology can effectively reduce storage space and strengthen management.

Since analog audio signals are highly susceptible to external interference during transmission—for example, lightning phenomena in nature can easily cause transmission interruptions, and electromagnetic signals from factory transformers, electrical sparks, and household appliances can also interfere with analog signal transmission—analog audio signals experience excessive attenuation during transmission. Even after amplification and equalization, the original amplitude cannot be recovered, resulting in significant noise problems. After adopting digital audio signals, lost and interfered signals can be effectively corrected and compensated, ensuring the original audio signal is restored and improving overall digital signal transmission quality.

3. Specific Workflow of Digital Audio Technology in Radio Program Production

Radio program production mainly includes four stages: sound recording, editing, synthesis, and transmission. The application of digital processing technology can continuously optimize this workflow. During sound recording, selecting appropriate sound sensors, microphones, and other audio acquisition tools can improve recording quality. Sensors with higher signal-to-noise ratios and sensitivity should be chosen to meet on-site recording requirements. Effective coor-

dination among various sound sensors must be strengthened to ensure optimal sound collection.

After sound collection is completed, audio editing work begins. During editing, audio materials should be appropriately clipped to ensure processing quality. Data transmission must also be enhanced. Since broadcast program signals are based on current and voltage values, digital transmission signals can be reasonably analyzed to improve transmission quality. During data transmission, lines with strong anti-interference capabilities must be selected to reduce signal processing difficulty.

4. Specific Applications of Digital Audio Technology

4.1 Application of Digital Audio Embedding Technology

As current digital program production primarily adopts component serial interfaces and digital audio embedding technology for rapid processing and production, it is essential to thoroughly understand digital component serial technology and digital audio embedding technology to comprehensively enhance broadcast program production quality. Due to structural differences between digital and analog signals, their conversion processes also differ. After digital acquisition, data transmission can be divided into serial and parallel methods, both sharing common components. During the blanking periods of video digital signals, the extra space can be used to carry digital information. In this space, digital audio and auxiliary data can be embedded according to specified positions, a technique known as digital embedding technology. The commonly used SDI signal belongs to this category, capable of directly inserting digital audio signals into video signals for synchronized transmission with video content.

This transmission method can greatly enhance signal transmission efficiency, optimize internal system wiring, and effectively avoid signal failures during transmission. If separate audio processing is unnecessary, embedded audio can be transmitted together with video to ensure audio-video synchronization. By transmitting SDI digital signals in this manner, overall transmission efficiency can be significantly improved. When converting digital signals, positions can be pre-arranged to ensure effective digital information analysis and conversion. When information is transmitted in two separate parts, there is no need to clip audio and video or perform on-site processing, effectively eliminating unnecessary sampling procedures and making audio information secondary, thereby substantially improving transmission efficiency.

4.2 Application of Dolby Digital Technology

Dolby Digital technology, as a commercial standard widely used in DVDs and laser discs, has received recognition from standard organizations. During program production, it can directly synchronize and compress independent-channel PCM signals with video. Audio signals as MD and Dolby metadata must use

this signal during editing, and during production, MD and Dolby decoding must be applied to ensure independent-channel PCM signals are sent to AC3 audio encoders.

4.3 Practical Application of Digital Mixing Consoles in Radio Stations

The application of digital mixing consoles in radio stations can optimize and upgrade traditional mixing console functions, such as noise, crosstalk, and distortion. To ensure different operation methods and functions adapt to various environments, multiple control surfaces can be synchronized in various styles. Digital mixing consoles are compact yet offer more channels with obvious processing effects. They feature multiple forms of inputs and outputs, including multi-channel digital I/O and multi-channel analog I/O, enabling both digital and analog audio output to ensure overall mixing console performance.

Digital mixing consoles feature virtual channel application software to control audio functions without requiring physical interface control. As broadcasting equipment, they adopt integrated modular designs that comprehensively enhance all input and output signals. During installation, all signal sources can be connected to the mixing console without external connection boxes. Each module supports hot-swapping, including inputs and outputs, ensuring overall usability is comprehensively enhanced.

4.4 Specific Advantages of Digital Audio in Radio Stations

With the rapid development of electronic information technology, China's broadcasting industry has entered the digital age. Digital audio workstations enable effective digital editing and multi-track digital hard disk recording. Digital audio workstations include various modules such as broadcast audio workstations, recording audio workstations, advertising management workstations, and program management workstations, which can properly handle related functions. Compared with traditional production and broadcasting systems, digital audio workstations ensure more precise cutting and allow sound to be visually displayed as waveforms during editing, with audio also represented graphically as waveforms.

Digital audio workstations can also perform multi-track digital hard disk recording, featuring 64 tracks that enable rapid track shifting for music and language programs during recording, ensuring multi-track usage with wireless digital signal processing capabilities and effectively reducing real-time sampling rate delays. As computer digital storage devices, they can also store master tapes synchronously with video signal transmission. During information transmission, they enable rapid audio-video splitting, ensuring embedded audio reduces matrix requirements and can process large amounts of data information, including audio program data allocation, for quick access at any time.

5. Main Functions of Digital Audio Processing Technology in Radio Program Production

In modern digital multimedia production and transmission, digital component serial interfaces and digital audio embedding technology can be effectively adopted to ensure more scientific overall design concepts for digital radio and television programs, requiring in-depth research into digital component serial interfaces. During multimedia digital transmission, since both serial and parallel forms must be used consistently after digital determination, related information must be properly handled during audio-video transmission. Similarly, data information transmission in other contexts employs different methods, and other data information cannot be quickly transmitted using this approach.

Computer digital processing technology can comprehensively process audio programs. Operations must strictly follow established workflows, with each step performed according to specific standards and procedures to improve overall digital audio processing effectiveness and provide important references for audio signal processing quality. For example, during sound pickup, to ensure improved audio efficiency, sound sensor equipment should be properly handled to guarantee high quality. Through comprehensive analysis of microphones, headsets, and other devices, operations can be performed according to specific standard requirements. During actual recording, appropriate sensors must be used, with careful selection of sensor directionality and signal-to-noise ratio to meet audio quality requirements.

During audio production, different directional sound sensors should be reasonably configured to ensure comprehensive audio information collection from various directions. Before radio and television program recording, collected information should be pre-processed, connection equipment correctly selected, and data lines properly configured to ensure accurate sound signal transmission. To guarantee recording quality, transmission standards should be evaluated during actual recording. For reasonable control of signal noise, sound signals should be properly handled. If digital audio is too harsh, noise reduction processing can be applied according to actual recording requirements.

In summary, as radio program production levels continue to develop, we must break through traditional limitations and actively embrace new technologies, concepts, and ideas to ensure broadcasting engineering development meets user needs. Digital audio processing technology can significantly improve the overall quality of radio and television signal transmission, providing important references for future broadcasting engineering development.

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Note: Figure translations are in progress. See original paper for figures.