

Exploration of Technical Solutions for HD Upgrade of Broadcast Television Studio Systems - Postprint

Authors: Zhang Zhaijun

Date: 2023-10-08T00:00:00+00:00

Abstract

Broadcasting and television constitute information exchange media that have emerged within the context of modern social development. The advent of high-definition digital television has introduced revolutionary new experiences to media communication in both social production and daily life, rapidly becoming a key focus and objective in the current innovation and development of broadcasting and television. This paper first provides a brief introduction to the primary technologies and related standards of high-definition digital television, subsequently elaborates on the design principles and fundamental technical requirements for high-definition production and broadcasting systems, and finally examines in detail the specific equipment selection and system construction, aiming to offer valuable reference for the high-definition technical transformation of production and broadcasting systems in China's radio and television stations.

Full Text

Abstract

High-definition (HD) digital television represents a revolutionary information exchange medium in modern society, delivering transformative viewing experiences that have become a focal point for innovation in broadcast television. This paper introduces the key technologies and standards of HD digital television, outlines the design principles and fundamental technical requirements for HD production and broadcasting systems, and discusses specific equipment selection and system implementation, aiming to provide valuable insights for HD technical renovation of broadcast television production systems in China.

Keywords: broadcast television; high-definition; strategy analysis

Introduction

HD broadcast production systems have been designated as a major national research project and a key high-tech construction initiative during China's "Tenth Five-Year Plan" period [2]. However, prefecture-level television stations face additional constraints due to budget limitations. The construction of a 190m² HD studio at Yongzhou Broadcasting Television Station serves as an important case study in studio HD renovation, offering valuable lessons for similar projects across China. A typical broadcast television studio system operates as a hybrid HD/SD compatible production and broadcasting system, which simultaneously meets the requirements for HD program recording, broadcasting, storage, and development while maintaining SD production capabilities for special circumstances. [Figure 1: see original paper] illustrates the workflow of such a hybrid HD production and broadcasting system.

When producing HD programs in the studio, HD signals first enter through the video input terminal, then pass through subtitle overlay and special effects processing before being distributed via an HD video distributor to hard disk storage devices and the broadcast transmission system.

1. Technical Indicators and Standards for HD Digital Television

The CCIR standard defines HD digital television as a system where viewers positioned at a distance greater than three times the screen height can still perceive image quality comparable to viewing the original scene or performance [3]. Achieving this "high-definition" benchmark requires increasing the scanning rate and pixel transmission capacity of the production system to enhance information throughput, adjusting the display aspect ratio to better align with human visual characteristics, and implementing 5.1-channel surround sound to enrich the immersive experience.

The primary technical characteristics of studio production and broadcasting systems include line frequency, field frequency, scanning method, and aspect ratio—parameters that directly determine the content quality and effectiveness of television media communication. Based on resolution levels, studio production formats can be categorized into three types: 720p (1280×720p), 1080/60i/50i (1920×1080i), and 1080/24p/25p/30p (1920×1080p). Among these, 1920×1080/i represents the highest clarity standard (p: progressive scanning; i: interlaced scanning) [4]. In August 2000, China's State Administration of Radio, Film, and Television issued the GY/T155-2000 standard for HD television program production and exchange video parameters, which explicitly designated 1080/50i as the HD television signal source standard. This format facilitates efficient up/down conversion with existing standard-definition signals, providing a foundation and direction for studio HD technical renovation.

2. Key Aspects of Broadcast Television Studio HD Technical Renovation

Signal source transmission and conversion constitute the core of HD technical renovation in broadcast television studios, with high clarity and fidelity serving as the primary objectives. Consequently, HD technical renovation focuses on optimizing and controlling signal transmission and conversion to achieve high-definition information delivery.

3. Principles and Implementation of HD Production System Technical Renovation

3.1 Basic Principles

The overall design for Yongzhou Broadcasting Television Station's studio system renovation aims to create a multi-scene, all-media studio that integrates technology with artistry, tradition with innovation, and static with dynamic elements. The following principles should guide the HD production system technical renovation:

3.1.1 Meeting Diverse Program Production Requirements Yongzhou Broadcasting Television Station plans to reconfigure its existing facilities—two 100m² physical studios and a 42m² control room—into a 200m² panoramic studio, a 50m² control room, and a 20m² equipment room to accommodate multi-channel news program recording and live broadcasting. The renovation must fully consider the studio's functional positioning to determine the appropriate system scale and required functional modules, thereby maximizing the economic value of the HD production system upgrade.

3.1.2 Innovative Design Philosophy Innovation serves as the vital source of technical renovation and development. The HD production system technical renovation should embrace innovative design concepts to preserve the authenticity and clarity of signal sources while maintaining optimal audiovisual quality and technological advancement. The system should establish a signal scheduling architecture centered on a routing matrix, with a 2 M/E main HD switcher as the production core to achieve high-definition audiovisual reception. Notably, the system design should integrate live broadcasting, playback, recording, and replay functions to enrich information dissemination and storage capabilities, thereby extending the visual communication lifespan of television media.

3.1.3 Principles of Conservation and Economy Conservation in HD technical renovation involves avoiding resource waste and maximizing the utility of existing broadcast station resources. Economy refers to generating direct economic benefits or achieving indirect economic gains through resource savings. In summary, technical renovation should prioritize conservation and economic

efficiency as fundamental principles to maximize the benefits of HD production technology.

3.1.4 Feasibility and Developmental Principles Feasibility is an essential requirement for technical renovation and a prerequisite for reliable system operation—any renovation lacking feasibility is meaningless. Developmental principles demand forward-looking vision and scalability, leaving appropriate technical margins for future system coordination, improvement, and upgrades when introducing new technologies and concepts.

3.2 Technical Implementation Details

3.2.1 Studio Space Planning The studio can be functionally divided into a large screen area, multi-screen standing broadcast area, green box area, and backup physical news studio area, with the basic layout shown in [Figure 2: see original paper]. This integrated design combines virtual and news studios into a comprehensive, full-function HD studio capable of meeting all program production needs. The various zones should not be simply partitioned but rather form an interactive whole where seamless communication is possible. As anchors move between standing and sitting positions, the background remains perfectly composed, enabling smooth interaction between sitting broadcast, interview, and standing broadcast areas.

For instance, the anchor area features a P1.9 full-color LED background screen (minimum 17m²) that serves as a news backdrop, capable of simultaneously displaying multiple video conversation windows and integrating content from online video platforms, Weibo, WeChat, and other sources, enabling anchors to interact with multiple remote online correspondents. Additionally, the sitting broadcast area's irregular anchor desk should accommodate multiple angles to meet the shooting requirements for three-person television news interview programs.

3.2.2 Three-Channel Audio-Video System The audio-video equipment and online packaging system design employs an HD kernel architecture, utilizing HD cameras and other high-clarity signal input devices to preserve signal authenticity and clarity. The system establishes signal scheduling centered on a routing matrix, with a 2 M/E main HD switcher as the production core to achieve high-definition audiovisual reception. The system design incorporates live broadcasting, playback, recording, and replay functions to diversify information broadcasting and storage methods, thereby extending the visual communication vitality of television media.

3.2.3 Studio Lighting Lighting design should adjust the overall regional illumination ratio while meeting the basic luminance requirements for cameras. The lighting system can achieve independent zone control through DMX512

protocol. The lighting approach combines regional circular lighting with broad-area basic illumination, using panel soft lights for general area lighting and spotlights for key zones to emphasize anchor contour modeling and enhance three-dimensionality. Specific areas receive reinforced illumination based on three-point lighting concepts.

3.2.4 Studio Air Conditioning Air conditioning units should be distributed according to the actual needs of each studio zone to maintain appropriate ambient temperature, thereby ensuring the operational safety of HD production equipment. For quality assurance, domestically well-known brands should be selected to guarantee overall service quality.

Conclusion

The development of HD renovation technology for broadcast television studio systems can deliver superior audiovisual experiences to audiences, representing a key factor driving its emergence as a research hotspot in China's scientific and technological development. However, current HD renovation practices for broadcast television studios lack systematic theoretical frameworks and require substantial theoretical research data and accumulated practical experience for further advancement.

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

Source: ChinaXiv — Machine translation. Verify with original.