Design and Implementation of Television Broadcast Monitoring System Postprint

Authors: Ma Biao

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

Abstract

In recent years, as television stations nationwide have undertaken high-definition digital upgrades, the broadcast quality of television programs has been substantially improved. However, compared with traditional broadcasting models, the new broadcasting models exhibit exponential growth in the types and quantities of signal sources, as well as in the complexity of signal chains, thereby imposing more stringent quality requirements on broadcast signals. Consequently, how to achieve rapid fault localization and consistently ensure broadcast signal quality has become a critical issue requiring focused consideration and research by television stations across the country. This paper addresses this challenge by attempting to design a broadcast monitoring system that enables real-time monitoring of signal sources, timely and accurate analysis and processing of various broadcast incidents, and effectively safeguards secure and high-quality broadcasting for television stations.

Full Text

Design and Implementation of a TV Broadcast Monitoring System

Abstract: In recent years, as television stations across China have undertaken high-definition digital transformation, broadcast quality has improved significantly. However, compared with traditional broadcasting models, the new paradigm has seen geometric growth in both the types and quantities of signal sources and the complexity of transmission chains, necessitating higher broadcast signal quality. Consequently, rapid fault localization and continuous quality assurance have become critical challenges requiring urgent attention. This paper proposes a broadcast monitoring system designed to achieve real-time signal source monitoring, timely and accurate analysis of broadcast incidents, and effective safeguarding of secure, high-quality television broadcasting.

Keywords: monitoring system; high-definition digitalization; transmission system; broadcast television; media technology
Classification Number: TP277
Document Code: A
Article ID: 1671-0134(2019)06-105-03
DOI: 10.19483/j.cnki.11-4653/n.2019.06.031
By Ma Biao

With the continuous development of television broadcasting, the scale of broadcast, transmission, and emission facilities has expanded considerably. Increasingly sophisticated technologies, equipment, and methodologies have been deployed to ensure and enhance signal quality, rendering modern broadcast systems far more complex than their predecessors and imposing more stringent requirements on monitoring technologies. Therefore, research into broadcast monitoring system design holds particularly significant importance.

1.1 Overall Design Principles

This design adheres to the principle of "comprehensive planning with unified standards; safety assurance through phased implementation; development promotion for public benefit" to construct an integrated monitoring system that combines security with reliability. The system ensures real-time, reliable, and secure acquisition of monitoring data while enabling intelligent content recognition, quality assessment, and security monitoring of broadcast signals. Specifically, the system follows several key construction principles: strict compliance with national laws, regulations, and technical standards, as well as industry-specific benchmarks [1]; adoption of mainstream, widely-recognized products and equipment with advanced, mature technologies to meet operational requirements and ensure long-term viability; accurate monitoring metrics with rapid information reporting and processing capabilities, maintaining stable operation over extended periods without shutdown; implementation of open software architecture, network protocols, and operating systems [2] to ensure interoperability and full resource sharing; scalability to accommodate evolving business needs and technological advancements; and a network management platform with control functions capable of unified device management and real-time display of system parameters and operational status.

1.2 Overall Design Objectives

The proposed TV broadcast monitoring system enables centralized management of monitoring signals, television signals, and associated data processing while ensuring secure data and signal transmission. This contributes to reduced maintenance costs for television transmission networks, improved equipment utilization efficiency, enhanced management and maintenance capabilities, and timely response to emergencies. Specific design objectives include: achieving seamless integration with all existing IP network monitoring information platforms based on IP technology [3] to optimize network configuration and bandwidth resources,

thereby maximizing monitoring capabilities across all stages and fully leveraging existing transmission link bandwidth; real-time transmission of equipment environmental data and peripheral machine room conditions to the central control room for early detection of potential incidents, thereby improving emergency monitoring, management, and response capabilities, as well as command dispatch and alarm issuance functions; supporting monitoring, alarm, and storage capabilities for 48 channels of high-definition (or standard-definition) SDI node signals; enabling remote network monitoring of television stations to achieve unattended operation with centralized oversight; and facilitating data transmission and aggregation through real-time monitoring functions to enable comprehensive quantitative assessment of signal transmission performance.

1.3 Overall System Architecture

Based on IP technology, the broadcast monitoring system employs a hybrid B/S and C/S architecture [4] and utilizes distributed multimedia management scheduling technology [5] to constitute a distributed monitoring network. The system integrates various existing audio-visual resources to enable IP-based multi-source audio-visual streams, which are transmitted via multicast through a dedicated network to achieve converged monitoring information. The system also enables intelligent scheduling of different signal sources and displays performance metrics for multiple television channels in a multi-screen mosaic format on multiple displays through monitoring hosts, achieving frame-accurate synchronization and recording alarm events and broadcast content to ensure normal signal transmission throughout the television transmission chain.

[Figure 1: see original paper] TV Broadcast Monitoring System Architecture Diagram

2.1 Signal Monitoring and Alarm Function

The monitoring and alarm system enables real-time multi-channel, multi-parameter monitoring with automatic detection of common signal faults, issuing audio-visual alarms to capture subtle anomalies that might escape human attention and overcome human error and fatigue. To meet the demands of high-quality, uninterrupted broadcasting, the system performs qualitative monitoring of PGM signals for anomalies including video loss, static frames, black screens, and audio silence, low volume, or excessive volume. Monitoring these technical parameters is particularly critical for broadcast signals, allowing operators to continuously assess on-air signal status and respond promptly to broadcast incidents. The C/S-based signal monitoring and alarm system employs SNMP protocol for information transmission [6]. Broadcast PGM signals are first captured in real-time by signal acquisition cards, after which the collected information is aggregated and analyzed at the signal detection server before being published to monitoring terminals. Fault levels are distinguished by different colors to facilitate timely operator response.

[Figure 2: see original paper] Signal Monitoring Alarm Terminal Display

2.2 Peripheral Equipment Monitoring and Alarm Function

Utilizing the television station' s internal LAN, the monitoring software and peripheral equipment monitoring system connect various devices to form a complete network monitoring system. SNMP network management protocol is fully leveraged to ensure real-time, comprehensive, and accurate information. The peripheral equipment monitoring system operates through two primary workflows: periodic polling by the system server to collect status information at intervals, and proactive transmission of exception reports by peripheral devices themselves. This dual approach helps personnel detect anomalies promptly, rapidly identify and locate fault points, and minimize incident response time. Monitoring devices are displayed graphically on the monitoring interface, including equipment topology and status lists, with diverse alarm displays based on selected graphics. When equipment malfunctions or operates abnormally, the peripheral equipment monitoring system issues audio-visual warnings, enabling personnel to analyze fault information promptly, quickly determine the fault area and severity, and implement appropriate countermeasures.

[Figure 3: see original paper] Signal Node Monitoring Alarm Diagram
[Figure 4: see original paper] Abnormal Signal Node Properties Dialog

2.3 Dynamic Environment Monitoring Function

The broadcast machine room dynamic environment monitoring system, based on a comprehensive network cabling infrastructure, centrally monitors various subsystems through dedicated monitoring software [7]. The system monitors all power equipment including batteries, DC power systems, UPS, distribution cabinets, low-voltage and high-voltage power distribution. Temperature and humidity data from these power devices are collected via sensors and displayed intuitively within the monitoring system. When anomalies occur, the system issues alerts to operators through SMS, voice, and audio-visual alarms while logging alarm events and historical data. Upon receiving abnormal alerts, operators can enter equipment rooms to inspect and resolve issues promptly, preventing broadcast incidents caused by power interruptions.

2.4 Real-Time Audio-Video Monitoring and Recording Function

From a practical management perspective, completely avoiding broadcast incidents is impossible. To establish clear accountability, strengthen supervision of broadcast content, properly handle potential advertising disputes, and accurately define and rapidly determine responsibility for broadcast incidents, all daily programs must be tracked and recorded throughout their entire duration, with relevant information stored for post-incident inquiry. The real-time audio-video monitoring and recording function enables this comprehensive tracking and archiving. Additionally, as the system is based on a B/S architecture [8], it

provides simplified functions for query, parameter configuration, and playback, significantly facilitating client deployment.

2.5 Large Screen Display Function

The monitoring system features a powerful, advanced audio-video data processing and management platform supporting import, export, backup, and restoration of all configuration information. Through the monitoring large screen, the system enables playback of multiple audio-video signals, supports arbitrary multi-screen layout arrangements, and allows free adjustment of display proportions and sizes. It supports combined display of standard-definition and high-definition digital television programs, with program names displayed in each window, and supports OSD character overlay [9] to display monitoring and fault alarm information on-screen.

3. Advantages of the Designed System

The TV broadcast monitoring system proposed in this paper offers numerous advantages due to its advanced IP-based, B/S, and C/S architecture, excellent portability and interoperability, and integration of various monitoring resources. These include: flexible display configurations with arbitrary screen segmentation, multiple 55-inch screens each supporting 1920$×$1080 resolution, simultaneous display of different program content with program names, left/right audio level meters, and video images; precise audio-video content monitoring with frame-accurate audio monitoring to avoid false and missed alarms, specialized settings for particular programs, suppression functions for static frames and color format anomalies, and PID interruption monitoring for audio loss caused by line contact issues; clear voice alarm prompts through advanced voice alarm software enabling categorized display of different alarm information, with automatic generation of voice alarm files from text without requiring additional recording; comprehensive and accurate alarm systems featuring equipment fault transmission parameter change alarms, cyclic audio-visual alarms, high-quality stable audio-video monitoring services, fault screen magnification, schedule management, manual alarm suspension, and fault confirmation functions; high stability and security through an all-embedded platform [10] where environment, processes, and software/hardware monitoring management form independent modules with low coupling and high independence, supporting power-failure restart and effective virus prevention; and simple management, convenient expansion, and easy maintenance through a unified configuration interface, scalable monitoring equipment addition, and embedded devices facilitating operational status monitoring and fault maintenance.

[Figure 5: see original paper] Large Screen Display Function Schematic

References

[1] Qiu Baogu, Chen Guang, Lin Bi, et al. Integrated TV Monitoring Management System [J]. China Cable Television, 2010(2): 182-185.

[2] Zhou Xi' an. Design of Quanzhou TV Monitoring Center System [J]. Video Engineering, 2011, 35(12): 64-67.
[3] Chen Na, Bai Liang, Liang Bo. Analysis on How to Strengthen TV Monitoring to Improve Safe Broadcasting Level [J]. TV Information, 2015(3): 108-110.
[4] Gong Haijun. Design and Implementation of Jiangxi TV Monitoring Network System [D]. Nanchang University, 2014.
[5] Huang Xiang. Discussion on Problems and Optimization Strategies in TV Monitoring Technology [J]. New Media Research, 2016, 2(4): 23-24.
[6] Li Jiangtao. Research on Assessment and Evaluation for TV Safe Broadcast Monitoring [J]. TV Information, 2017(5): 33-37.
[7] Gao Qi. Thoughts on How to Strengthen TV Monitoring and Improve Safe Broadcasting Standards [J]. China New Telecommunications, 2017, 19(11): 81-83.
[8] Shao Weihua. Design and Implementation of Digital TV Signal Monitoring System [J]. Public Communication of Science & Technology, 2018, 10(2): 60-61.
[9] Wang Rui, Feng Xiaodong. Effectively Strengthening TV Monitoring to Enhance Safe Broadcasting Level [J]. West China Broadcasting TV, 2018(2): 202, 206.
[10] Duan Yongliang, Bu Yanbin. Design of Automatic TV Signal Monitoring System [J]. Computer Measurement & Control, 2018, 26(4): 32-34, 38.

(Author Affiliation: Huaibei Radio and Television Station)

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