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Comparison and Introduction of Old and New Automated Monitoring and Control Systems at Henan Radio and Television Transmission Station (Postprint)

Authors: Wang Ran

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Abstract

With the successful relocation of Henan Radio and Television Transmission Station, this paper, based on actual working conditions, compares and describes the broadcasting and monitoring systems of the station's old and new transmitter rooms from both hardware and software perspectives. It primarily provides an overview of audio-video signal emergency switching, as well as the design and practice of transmitter automated monitoring and control systems, from the perspectives of the audio-video signal front-end system, technical requirements for transmitter automated monitoring systems, main functions, and operational process control of monitoring points.

Full Text

Abstract

Following the successful relocation of the Henan Radio and Television Transmission Station, this paper compares and describes the broadcasting and monitoring systems of the station's old and new transmitter rooms from both hardware and software perspectives, based on practical operational experience. The overview covers emergency video and audio signal switching, design and implementation of transmitter automation monitoring systems, focusing on the video/audio signal front-end system, technical requirements for transmitter automation monitoring, primary functions, and operational flow control at monitoring points.

Keywords: video and audio signals; transmitter monitoring and control; comparison of old and new systems

Introduction

The transmission room of the Henan Radio and Television Transmission Tower bears the critical responsibility of ensuring the broadcast of five analog television programs: CCTV-1, HNTV-1, HNTV-2, HNTV-4, and HNTV-5. To continuously strengthen information infrastructure construction, comprehensively advance the informatization development process, and ensure the safe and reliable operation of the transmission system, it is essential to help operators promptly detect and resolve issues in video/audio signal sources and transmission systems throughout the broadcast chain. By examining the monitoring characteristics of each transmission link in the new facility with its new equipment, this analysis compares the two generations of automated monitoring and alarm control systems in the old and new transmitter rooms, focusing on video/audio signal front-end equipment, transmitters, equipment environment monitoring, and computer software systems. The comparison covers automatic fault diagnosis, localization, alerting, logging, statistical analysis, and the workflow for timely operator notification. This has effectively reduced human-caused accidents, shortened incident duration, improved safe broadcasting efficiency, enabled centralized monitoring and unified management of broadcast networks, transformed traditional manual monitoring and inspection patterns into real-time computer-based monitoring, reduced operator workload, and enhanced the station's comprehensive management capabilities.

1.1 Main Equipment in the New Transmitter Room Automation Monitoring System

The primary equipment includes five digital all-solid-state transmitters (CCTV-1, HNTV-4, and HNTV-5 use 10kW imported water-cooled transmitters; HNTV-1 and HNTV-2 use 5kW domestic air-cooled transmitters). The signal source front-end employs products from Beijing Huanluwang, including SDH network adapters (TL303), ASI switching matrices (SS100), decoders (DE100), and stream distributors (AS150), along with Beijing Bohui's off-air receiving systems and multi-screen video/audio processing systems (digital), analog video/audio switchers, 8-channel analog TV demodulators, Canare 24-channel video patch panels, Advantech industrial PCs for transmitter parameter acquisition, 6-inch intelligent high-speed dome cameras, 1-to-8 analog video/audio distributors, embedded DVR Ethernet switches, temperature and humidity transmitters, and Emerson UPS power supplies.

1.2.1 Signal Source Monitoring and Intelligent Switching System

The new transmitter room currently utilizes four signal sources (CCTV fiber, provincial station fiber, CCTV microwave, and provincial station microwave) with four signal outputs. Both fiber and microwave signals are SDH digital signals using identical packaging methods, requiring network adapters to convert DS3 to ASI signals, which are then distributed through an ASI distribution network to dedicated ASI decoders for each program to extract analog video

and audio signals. Given that the old transmitter room experienced incidents where the signal source front-end, during the process of converting optical signals to digital and then to analog signals, suffered from transmission equipment failures or stream errors causing broadcast screen freezing or blackouts that were difficult to troubleshoot, an ASI stream monitoring subsystem has been added between the provincial station's fiber and microwave adapters. This independent subsystem monitors ASI content without affecting downstream signal transmission.

A 3\$×\$1 ASI automatic switcher has been installed between the adapters and decoders to monitor PID upper and lower limits, as well as the lower bit rate limit for PIDs within the specified range. Configuration enables monitoring of ASI system bit rate, effective bit rate, individual PID bit rate, and detection of signal loss, sync loss, PID loss, and program descrambling failures. In automatic mode, when the main stream experiences interruption or abnormalities—including signal loss, sync loss, PID loss, descrambling failure, or prolonged empty packet PSI/SI table changes—the system provides log alerts, message notifications, and audible alarms. If the bit rate of monitored PIDs falls below the configured threshold, the system automatically switches from the main to the backup signal path, and automatically reverts to the main path when it returns to normal. Manual mode allows forced switching, and the switcher features a main-path power-off bypass function.

The stream distributor can split a single ASI/SDI digital signal into multiple identical output streams for applications such as EPG distribution, stream backup, and monitoring in digital television environments. It supports 8-way stream distribution with signal conditioning and equalization amplification capabilities.

1.2.2 Transmitter Monitoring and Control System

To prevent single-point failures from affecting the entire transmitter control system, the transmitters employ a distributed control architecture with host and field computers. The host computer uses high-performance data servers, while field computers utilize mature, widely-used general-purpose electronic devices requiring high stability, scalability, and environmental friendliness. Field computers can flexibly install and uninstall any software, enabling resource reuse during upgrades. Transmitters provide RS232 or RS485 communication interfaces, with field computers performing data acquisition, status display, and control functions. The server serves as a local remote control terminal; even when the server fails or disconnects from the LAN, field computers can maintain automatic transmitter control, ensuring normal system operation. Fault alarms are issued through audio-visual alerts in both the transmitter room and control room. Monitored faults include: complete machine faults (phase loss protection, temperature alarms, power supply overheating, over/under voltage); power amplifier faults (over-excitation, overload, overheating); exciter faults (no video, high VSWR, local oscillator unlock, abnormal small amplifier current); antenna

and dummy load control; automatic and manual coaxial switch switching; remote dummy load on/off control with status monitoring and water shortage alarms; and operation logging.

The transmitter automation monitoring system has been operational in the new facility for over five years, significantly improving the working environment and integrating daily operations into an automated, informatized, and networked process. This has freed operators from heavy inspection duties, allowing them to focus on technical maintenance and research, thereby improving operational standards. The system has fundamentally resolved the previous situation where transmission stations could broadcast without knowing the actual broadcast quality, effectively reducing human-caused accidents, shortening incident duration, and improving safe broadcasting efficiency while standardizing station management. Currently, remote transmitter monitoring technologies remain immature, with incomplete hardware and software compatibility even among products from the same manufacturer, preventing the formation of unified standards and fully autonomous operation. However, the introduction of new technologies indicates promising development prospects for wireless transmission technology, and a new generation of universal transmitters and remote monitoring systems is imminent.

1.2.3 Television Multi-Screen Real-Time Monitoring and Alarm System

The new transmitter room's multi-screen monitoring system represents a significant advancement over the old facility's single off-air signal monitoring system, which could only detect black screens and video/audio loss due to its early design. The new system monitors and listens to 25 signals, including primary and backup decoder signals, video/audio distributors, post-transmission RF signals, and off-air signals for all five broadcast programs. Built around a high-performance industrial control computer and employing a B/S architecture, the system supports both local and remote network monitoring. Using high-speed video/audio acquisition and encoding technology with H.264 compression, it supports up to 36 video/audio (AV) inputs. The current system supports AV, ASI, and analog RF signal inputs with mixed display, with future scalability for SDI, HD-SDI, IP, DVB-C, DVB-S, DVB-S2, CTTB/DTMB, CMMB, ABS-S, AM/FM, analog mono/stereo audio, and AES/EBU interfaces. It supports MPEG-2, H.264, AVS and other high-definition/standard-definition video decoding, and MP2, MP3, AC3, AAC, Dolby 5.1 audio decoding with stereo/mono distinction. Monitoring capabilities include color format display and anomaly alarms, specific image alarms, closed-caption monitoring, black field detection, freeze frame detection (combined with audio analysis), audio loss, and volume level monitoring. The system supports dual-screen display standard (expandable to triple-screen or more), future support for various encrypted signal descrambling, and multi-screen transcoding recording with OSD overlay of program names, signal sources, time, etc. It supports both original

stream and transcoded recording for post-incident analysis.

1.2.4 Equipment Room Environmental Monitoring and Alarm System

Environmental monitoring primarily tracks temperature, humidity, and smoke in the transmitter room, integrating environmental parameters into the monitoring system through acquisition devices. This allows direct identification of alarm sources from the monitoring interface while providing 24-hour video recording with playback capability. In the old facility, temperature and humidity monitoring relied entirely on operator inspection rounds. During summer, air conditioning had to run 24 hours without guaranteed transmitter environmental conditions, increasing accident risks.

2. Centralized Network Management Monitoring System

The system features a Simplified Chinese interface with topology diagram drawing capabilities. The software creates system link topology diagrams for all monitored devices, visually indicating current primary or backup line status during transmission. The topology drawing software is simple to operate, with straightforward binding between devices and parameters that can be easily adjusted when system connections change or devices are added/removed. The system software can configure broadcast time slots for each program with automatic power on/off functionality. For temporary broadcast tasks, duration can be extended or shortened without normal schedule constraints, supporting multiple daily broadcast task configurations. The user interface is friendly, with all controlled devices (transmitters, exciters, audio signal sources) accessible through graphical interfaces. Real-time data can be displayed in both list and graphical formats, showing both centralized core equipment status and program video/audio passing through each device. The system supports flexible alarm level modification and intelligent fault consolidation, accurately identifying fault locations through internal and cross-monitoring point logical comparison and consolidation, combined with equipment status to generate intelligent alarms while filtering interference. The monitoring system software can disable remote operation terminal functions for transmitter control.

References

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(Author' s affiliation: Henan Radio and Television Transmission Station)

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