

Audio Signal Comparison System Postprint

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Abstract

This paper introduces an audio signal comparison system, covering its implemented functions, interface, software architecture, and module functionalities. It can assist broadcasting and television industry personnel in monitoring signal interference and provide a basis for querying illegal signal injection, and is available for study and research by relevant personnel.

Full Text

Abstract

This paper introduces an audio signal comparison system, detailing its functions, interface, software architecture, and module capabilities. The system provides broadcasting professionals with tools to monitor signal interference and detect unauthorized signal injection, serving as a valuable reference for technical personnel learning and researching this system.

Keywords: Audio signal comparison system; Web; Monitoring; Alarm log; App; MySQL database

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1. Introduction

Currently, many radio stations have established relatively comprehensive broadcast production and transmission link monitoring systems that can accurately locate faults in transmission chains and enable rapid response. However, these systems cannot monitor or compare audio signal quality differences between various nodes, particularly between signals received from transmitters and those within the station's internal chain. Comparing audio quality and content from

different signal sources is highly valuable for quickly identifying and comprehensively understanding issues across broadcast audio transmission links. Specifically, comparing transmitter-received signals with master control final-stage output signals can reveal interference without real-time listening and help technicians detect potential unauthorized signal access at transmission endpoints. Consequently, research into multi-source audio signal comparison system technology has become essential. This research was jointly completed by our station's technical staff and engineers from Hangzhou Lianhui Technology.

2. Audio Signal Comparison System Overview

The ACA (Audio Consistency Analyzer) audio signal comparison system employs a 3U rack-mount design, with each device supporting up to four frequency pairs (i.e., four pairs of audio signal detection). The system rear panel is shown in [Figure 1: see original paper].

The system features eight analog stereo inputs and eight AES stereo outputs, utilizing PCI interfaces (PCIe also available). Unused rear-panel XLR connectors are covered with blanking plates. The multi-source audio comparison technology can be applied in broadcast master control rooms, transmission stations, and monitoring centers. In master control, it verifies consistency between final-stage output signals and mixing console outputs, as well as between final-stage signals and transmitter-received signals. Transmission stations can compare received signals with optical terminal and microwave output signals. Monitoring centers can determine whether broadcast signals have been interfered with or intruded upon. The system performs consistency comparisons on all signals, including mute, noise, and overload detection, with optional phase inversion detection (noise detection is not mandatory) [1]. When parameters exceed configured thresholds, the device's buzzer sounds and software interface alarm lights activate. Alarms can be manually silenced, with all events logged for review and export. The system automatically cleans logs periodically, and logs can be integrated into centralized log management systems. Alarm information is output via network to master control, transmission stations, or monitoring centers using configurable protocols. The software achieves high accuracy in consistency alarming and records user login, logout, and parameter modification activities. The system supports both manual monitoring and automatic patrol listening for any channel, with customizable channel and frequency names displayed in the interface.

The host is Linux-based, providing web services compatible with Firefox, IE, and Google Chrome browsers. The system can automatically detect delays between primary and backup signal pairs and automatically locate signal starting points. Embedded HTML-based online help is included. The web interface, accessible directly through browsers, is shown in [Figure 2: see original paper] and includes real-time status queries, alarm log queries, operation log queries, detection parameter settings, and system configuration.

2.1 Host Functions

2.1.1 Real-Time Query The real-time query interface (main access interface) shown in [Figure 2: see original paper] allows configuration of channel and frequency names without modifying volume bars. Users can select listening modes: manual or automatic. When manual mode is selected, automatic patrol and time interval settings become disabled, and vice versa. The time interval can be manually input in seconds, with a range of 5–60 seconds. During alarms, corresponding channel indicator lights illuminate and alarm buttons turn red, with alarm information output via network. For false alarms or maintenance periods, alarms can be dismissed by clicking and will reactivate upon the next fault. If some channels have no input, volume bars display no input and all indicator lights remain gray.

2.1.2 Alarm Log Query Alarm log queries are accessed via the second item on the left menu in [Figure 2: see original paper]. Search criteria include fault type, channel, frequency, and date. Fault types include: all, mute, overload, inconsistency, and phase inversion. Channels range from all to specific inputs (IN1–IN8). Frequencies correspond to configured values. Date selection uses an embedded calendar control. Results can be exported, and the system automatically cleans records periodically while supporting integration with centralized log systems.

2.1.3 Operation Log Query Operation log queries are accessed via the third item on the left menu in [Figure 2: see original paper]. Administrators can search by date and review all critical operations, including login, logout, password changes, and alarm parameter modifications. Query results can be exported, with the system performing periodic log cleanup and supporting log center integration.

2.1.4 Detection Parameter Settings The detection parameter settings interface is accessed via the fourth item on the left menu in [Figure 2: see original paper]. Parameters for inconsistency detection can be configured based on actual requirements. Mute, overload, and phase inversion modules must be enabled before their status displays. Detection parameter settings are saved after configuration.

2.1.5 System Settings System settings are accessed via the fifth item on the left menu in [Figure 2: see original paper], allowing configuration of network parameters, log settings, port settings, master control alarm output settings, and password management. After modifying the device IP address, users must exit and re-access the web interface. Two user levels exist: administrators (admin/admin) who can modify all system parameters and passwords with full permissions, and regular users (user/user) who can only access real-time status viewing pages.

2.2 APP Functions

The dedicated APP is designed for large-screen display, communicating with the host via network. Developed for Windows, it supports Windows 7 and 8 systems with resolutions of 1440×900 , 1920×1080 , and 1366×768 . The interface uses a skin-based design with configurable channel quantities, allowing free combination of frequencies from different devices. When parameters exceed thresholds, software interface alarm lights activate and can be manually dismissed. The APP supports both manual monitoring and automatic patrol listening for any channel. It includes a main interface, device management interface, and group screen settings interface, all in windowed mode.

The main interface offers two listening modes: manual and automatic. Selecting manual mode disables automatic patrol and time interval editing, and vice versa. The time interval can be manually input in seconds, with a default range of 5–60 seconds. During alarms, corresponding channel indicator lights illuminate and alarm buttons turn red. For false alarms or maintenance, clicking can dismiss alarms until the next fault occurs. Manual listening allows switching channels by clicking any VU meter bar. The device management interface adds devices by IP address and port number, with a “connect” button to verify network connectivity and retrieve channel information. The group screen settings interface configures layout patterns and adds frequencies (names must match web configurations), allowing drag-and-drop positioning.

3. Audio Signal Comparison System Implementation

Technical personnel developed the system using the ACASStation.Web site, ModuleACAServer.dll server, and ACAWatch.exe client with Visual Studio 2010 and MySQL database [2]. The software architecture is shown in [Figure 3: see original paper], and the relationship between module functions and program structure is detailed in .

The system parameter configuration is shown in . Channel parameters include channel name, equipment, detection item switches, detection thresholds, detection duration, and analog ESM-8 device port settings. After configuration completion, the system prompts for service restart to apply changes, either manually or via web command. The listening function utilizes a dedicated DLL (Delay-locked loop, DLL), widely used in timing applications. Database design and software execution scripts are omitted due to company confidentiality.

All detection items have three threshold levels: the first for notification, the second for early warning, and the third for alarm. By default, mute and overload only support the first threshold, while consistency detection supports all three. System operation logs can be configured to output at three levels: 0 (no output), 1 (output values outside threshold ranges), or 2 (output all detection values). Different alarm types generate separate log files containing timestamp, input channel (primary output or transmitter-received), detection value, and

threshold. Log output elements include time, input channel, detection value, and alarm threshold.

Through research on audio signal comparison system technology, this work can be widely applied in future broadcasting operations, particularly for in-depth analysis of Xi'an Radio and Television Station's audio link transmission technology. The system enables rapid fault judgment and resolution in practical work, with multi-channel audio comparison achieving practical accuracy requirements for long-term use in the broadcasting industry. Special thanks to colleagues at our station and Hangzhou Lianchuang Technology for their persistent support.

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

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