Design and Practice of an Internet Live-Streaming Information Management System Based on Intelligent Services (postprint)

Authors: Wang Kejia

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

Abstract

With the rapid and ever-changing development of information technology and mobile internet technology, the ecology of public opinion, media landscape, and communication modes have all undergone profound transformations. In particular, the live streaming business format under the trend of media convergence has posed tremendous challenges to the traditional broadcasting and television model, making comprehensive IP-based migration an inevitable trend. Against this backdrop, how to better comprehend the current state of business resources to cope with the continuously expanding business scale and the demands for ultra-high-definition reporting such as 4K/8K and VR, and to achieve efficient business management and information sharing, is an issue that must be directly addressed. Simultaneously, increasingly mature intelligent services can enable further extraction of effective information from live streaming content and deep value mining, which also provides greater impetus for facilitating full-process tracking, expanding statistical analysis dimensions, conveniently realizing distribution and sharing, and deeply empowering integrated media production collaboration. This paper will, based on the aforementioned concepts, center on issues such as how to design and construct an internet live streaming information management system based on intelligent services, as well as how to achieve deep mining and sharing of live streaming resource content, and present further discussions.

Full Text

Preamble

Title: Design and Practice of an Internet Live Broadcast Information Management System Based on Intelligent Services

Author: Xinhua News Agency Communication Technology Bureau, Beijing 100803

Abstract: With the rapid evolution of information technology and mobile internet technology, today' s public opinion ecosystem, media landscape, and communication methods have undergone profound changes. In particular, the video live broadcast industry under the trend of media convergence poses significant challenges to traditional broadcasting models, making comprehensive IP-based transformation an inevitable trend. In this context, a critical challenge is how to better grasp the status of business resources to cope with continuously expanding business scales and the demands of ultra-high-definition reporting such as 4K/8K and VR, while achieving efficient business management and information sharing. Meanwhile, increasingly mature intelligent services can enable further extraction of effective information from live content and deep value mining, providing greater support for assisting full-process tracking, expanding statistical analysis dimensions, facilitating distribution and sharing, and deeply empowering converged media production collaboration. This paper discusses the design and construction of an internet live broadcast information management system based on intelligent services, as well as how to achieve deep mining and sharing of live broadcast resources and content.

Keywords: mobile internet technology; intelligent services; live broadcast information management; data collection; data mining
Classification: TN93
Document Code: A
Article ID: 1671-0134(2021)09-135-03
DOI: 10.19483/j.cnki.11-4653/n.2021.09.043
Citation Format: Wang Kejia. Design and Practice of an Internet Live Broadcast Information Management System Based on Intelligent Services [J]. China Media Technology, 2021(09): 135-136, 67.

In recent years, Xinhua News Agency has established an IP-based high-definition video live broadcast transmission and scheduling network, supporting simultaneous access of over 64 video signals and multi-channel distribution, which has strongly supported the rapid development of the agency' s video production and live broadcast reporting business. However, under the broader trend of media convergence, the scale of live broadcast reporting continues to expand, with increasing demands for ultra-high-definition, high-bandwidth reporting such as 4K/8K and VR. Limited resources struggle to meet these unlimited growth needs. To more intuitively grasp the status of live broadcast reporting operations and available resources, and to more rationally plan reporting schedules and technical implementation solutions, there is a need for dynamic management and real-time tracking of resources such as broadcast time, content, transmission paths, personnel, studios, encoding/decoding equipment, transmission backpacks, and camera equipment, as well as the status of each link in the live broadcast workflow. At the same time, Xinhua News Agency now completes an average of nearly one hundred live broadcasts per month. Key concerns for

the reporting business include: how effective is the dissemination of this content, does it have value for reuse or reproduction, and how can content sharing be achieved more efficiently? The goal is to mine more reference-worthy data information at a relatively low labor cost to provide decision-making basis for future reporting organization.

1. Design Principles

To address these core requirements, Xinhua News Agency designed an internet live broadcast information management system based on intelligent services and completed the basic functional design and first-phase independent development by the end of 2020. This platform provides stronger support for full-process live broadcast business management and lays a solid foundation for subsequent code iteration and functional upgrades. The system adheres to the following design principles.

1.2 Efficiency

In addition to distributing live signals to multi-channel media users in real time, the live broadcast support team members also need to be deeply involved in live reporting operations, monitoring the status of live streams and transmission paths, and coordinating the allocation of reporting resources such as studios, equipment, and personnel. Furthermore, big data monitoring platforms need to display live signals on a daily basis, while reporting scheduling systems need to display multiple real-time return feeds during major coverage events. This requires the system to dynamically obtain and present resource occupancy status in real time, and to introduce more efficient streaming media transmission protocols and data exchange mechanisms to serve the sharing needs of more users and upstream/downstream display terminals for live signals.

1.3 Intelligence

The system aims to build intelligent service modules that automatically generate daily live broadcast previews and briefings, conduct deep mining of live reporting content, assist in multi-channel data collection and statistical data aggregation, and reduce manual labor costs in full-process business management—all while minimizing human effort and cost expenditure.

1.4 Connectivity

The system provides better connectivity and scalability, utilizing universal service interfaces to flexibly integrate with multiple upstream and downstream systems such as the live broadcast scheduling system and the audio-video content aggregation and distribution platform [1], establishing efficient intra-LAN transmission mechanisms to facilitate convenient distribution and sharing of video content and metadata.

1.5 Maintainability

The system is stable and reliable, employing virtualized deployment for application software and middleware, with comprehensive data backup and snapshot mechanisms. It introduces service-oriented start/stop and log monitoring mechanisms for application operation, achieving easy management, maintenance, and high availability.

2. Overall Architecture

Based on the above concepts, the architecture of the internet live broadcast information management system based on intelligent services is designed as shown in Figure 1 [Figure 1: see original paper].

The system adopts a technical route centered on virtualization, componentization, and intelligence. It builds web servers, intelligent engines, and other essential infrastructure on a virtualization platform to support the implementation of upper-layer components, modules, and services. Specifically, it establishes an HTTP server using the open-source Python Django web application framework to achieve templated, loosely coupled, and easily extensible web functions and service encapsulation. The system introduces a multi-level storage structure composed of object storage, MySQL relational databases, and Redis in-memory databases to fundamentally improve full-process data storage management efficiency and provide underlying support for data collection and statistical analysis functions. The system also deploys a message queue service cluster to achieve distribution and real-time scheduling of business and statistical data, and builds intelligent engines such as TensorFlow and PaddlePaddle to create the foundational environment for implementing core module functions of intelligent services and application logic at the user service layer.

Above the infrastructure layer, the system also designs a basic component layer and a core module layer. It introduces componentized data collection services to track the adoption and dissemination of Xinhua News Agency' s live reports through multiple channels; builds an intelligent service module to implement functions such as OCR (Optical Character Recognition) and video content object detection, deeply extracting and mining video and text information from live reports; designs a universal data exchange service to provide docking standards and sharing support for live streams, video files, and metadata exchange between upstream and downstream systems; and constructs a highly available streaming media service component that introduces low-bandwidth, low-latency video streaming transmission protocols suitable for LAN scenarios to enhance efficiency for real-time live stream monitoring and multi-terminal display.

Simultaneously, the system designs a user service layer to provide relatively complete live broadcast information management services for users. This includes implementing live broadcast information management services that support live stream and metadata information management and live calendar display functions; designing live equipment management services that enable query, reser-

vation, warehousing, lending, return, and audit management operations for live reporting equipment such as video encoders/decoders, transmission backpacks, cameras, and VR cameras; designing studio reservation management services that support query, reservation, allocation, and audit management functions for critical resources such as studios and transmission fibers; and designing live personnel management services that support management functions for live business production and technical team members. The system also provides personnel permission and shift management, live previews, SMS notifications, live briefing generation, and online live stream monitoring functions.

3. Core Functions

Based on componentized services such as intelligent services, data collection services, and highly available streaming media services, the system implements core functions including live broadcast business management, live broadcast adoption analysis, and live broadcast signal monitoring and sharing.

3.1 Live Broadcast Business Management

The system implements a live broadcast information management service that supports live stream and metadata information management functions. In addition to manual management of relevant information, the system fully utilizes intelligent services to simplify user operations and further strengthen content mining. The system supports one-click live information entry, using intelligent OCR (image text recognition) services to automatically recognize text in business application forms and convert them to electronic format, and using intelligent natural language processing services to extract key information such as time, location, and personnel from application forms, thereby completing structured archiving of live information and providing strong support for full-process live broadcast business management and deep content value mining. Additionally, the system supports the extraction of effective information from video content using third-party services such as intelligent speech transcription, intelligent video classification, and image object detection.

3.2 Live Broadcast Adoption Analysis

Through componentized data collection services, the system regularly tracks adoption information and influence data of Xinhua News Agency' s live reports from multiple channels both internally and externally. The system collects basic data of Xinhua News Agency' s live reports from internet user platforms, as well as dissemination effectiveness indicators such as click volume, playback volume, user comments, and likes. The collected data is deduplicated using an in-memory database cluster and written into a distributed logging system for asynchronous archiving and distribution.

Based on the collected influence data, the system provides analysis reports to users, summarizing the monthly quantity and geographical distribution of live

reports. By leveraging functions such as content correlation detection and comment sentiment analysis in intelligent services, the system establishes a dissemination influence data model, quantifies dissemination effectiveness, generates reports, and provides decision-making basis for future reporting planning.

3.3 Live Broadcast Monitoring and Sharing

The system builds an open-source streaming media service component that, in addition to supporting mainstream video live/on-demand protocols such as HTTP, RTMP, HLS, and WEB RTC, introduces SRT and NDI protocols with characteristics of low bandwidth, high reliability, and low latency to create a more efficient live/on-demand video distribution framework suitable for LAN scenarios, as shown in Figure 2 [Figure 2: see original paper].

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