A Brief Analysis of Terrestrial Wireless Digital Television Postprints

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Abstract

Currently, deploying terrestrial wireless digital television and its coverage modes based on the actual needs of various regions not only offers lower construction costs but also mitigates the effects of various natural factors while reducing line infrastructure requirements to a certain extent, thereby providing robust support for the widespread adoption of terrestrial wireless digital television. This article primarily analyzes terrestrial wireless digital television from a technical perspective. By integrating the advantages of terrestrial wireless digital television, it conducts in-depth research and exploration into methodologies such as terrestrial wireless digital television system construction and strategies for enhancing coverage efficiency, thereby fostering the development and refinement of terrestrial wireless digital television.

Full Text

A Brief Analysis of Terrestrial Wireless Digital Television

Abstract: Currently, the deployment of terrestrial wireless digital television and its coverage modes based on regional practical requirements offers not only lower construction costs but also resilience against various natural factors, while reducing the need for extensive line installation. This provides strong support for the widespread adoption of terrestrial wireless digital television. This article focuses on analyzing terrestrial wireless digital television from a technical perspective, integrating its advantages to conduct in-depth research and exploration on system construction and strategies for enhancing coverage efficiency, thereby better promoting the development and improvement of terrestrial wireless digital television.

Keywords: terrestrial wireless; digital television; wireless television; television system; signal transmission; multi-frequency network; single-frequency network

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With the continuous improvement of social economy and science and technology, digital television is poised for unpredictable development. The scientific integration of digital technology with television equipment can promote a qualitative leap in television performance while meeting the requirements of triple-network convergence, providing comprehensive services to people and creating scientific conditions for China's socio-economic development and economic benefits. Additionally, the primary method of television broadcasting is wireless broadcasting, which offers relatively strong reception capabilities and ensures that relevant information is delivered to audiences promptly, thus holding significant potential for the future. Therefore, wireless technology can be integrated with terrestrial digital television according to actual needs, using scientific methods to rapidly expand the coverage area of digital television signal transmission.

1.1 Advantages of Digital Television

Based on practical requirements, television can be categorized into analog television and digital television. Comparing these two modes reveals that digital television offers more prominent advantages [1]. Digital television signals demonstrate stronger stability and security compared to analog television, enabling multiple television programs to be transmitted within a single channel and greatly improving the utilization of wireless spectrum. A more significant change brought by terrestrial digital television is the ability to stably receive high-quality television signals while in motion, making mobile television and portable handheld television possible. Furthermore, under the influence of network technology development, convergence is gradually occurring, creating scientific conditions for network sharing implementation.

1.2 Advantages of Wireless Television

Analyzing data information transmission modes reveals two structural types: wireless television and cable television. Comparing wireless television with cable television shows that wireless television has stronger advantages and better meets social development needs [2]. During wireless television construction, resource utilization is effectively reduced, resulting in relatively low construction costs and strong economic efficiency. Additionally, the time required to build wireless television networks is relatively short, fundamentally achieving time savings.

2.1 Construction Requirements

First, location and environmental requirements. Terrestrial wireless digital television is often affected by geographical environmental factors; when the area is relatively open, the wireless digital coverage network signal is relatively strong (such as in hilly and plain areas), but signal reception capability is relatively weak in forested regions. Meanwhile, terrestrial wireless digital television systems have not fully covered China' s mountainous forest areas. However, users within the wireless network coverage area can watch terrestrial wireless digital television satisfactorily. Second, development requirements. The development and popularization of terrestrial wireless digital television align with social development needs and provide strong support for improving people' s quality of life [3]. When constructing terrestrial wireless digital television networks, the coverage area is relatively large, truly achieving a system that reaches all suburbs and towns. People only need to install antennas and set-top boxes to quickly receive terrestrial wireless digital television network signals, significantly enhancing life convenience. Finally, construction requirements. The actual construction process of terrestrial wireless digital television networks must consider terrain and geographical location conditions. For instance, western regions can scientifically establish wireless digital network systems on hills, while eastern regions can build television systems on flat terrain. Meanwhile, open locations are ideal for constructing terrestrial wireless digital television network systems. Building these networks enables rapid development of the television industry, accelerates model innovation, and lays a solid foundation for improving people' s quality of life.

[Figure 1: see original paper] Terrestrial Wireless Digital Television System Architecture

2.2 Signal Transmission Principles

Terrestrial wireless digital television signal principles and standards can be divided into four main structures: DVB-T, ISDB-T, ATSC, and DTMB, which were developed in Japan, the United States, Europe, and China respectively. In 2007, relevant Chinese government departments explicitly defined national standards for television signals [4]. These standards can be scientifically adjusted and optimized according to regional differences in China, increasing frequency as needed to enhance television signal anti-interference capability, thereby achieving continuous improvement in terrestrial wireless digital television performance and ensuring people can receive high-quality television information effectively, which promotes the rapid development of terrestrial wireless digital television. Encoding standards continue to evolve under the influence of science and technology. Current encoding standards can be divided into AVC and JYT, representing the first and second-generation encoding standards. Analysis of relevant data shows that the second-generation encoding standard frequency has strong stability and security, requiring the scientific use of single-carrier modulation methods to rapidly improve signal coverage quality.

2.3 System Structure Creation

First, system structure. Terrestrial wireless digital television systems are typically composed of digital front-end, information transmission platform, network management platform, and customer terminal. The internal structure is relatively complex and requires special attention during construction to promote signal stability. Second, digital front-end structure. The digital front-end consists of signal source, processing structure, and encoding server. The signal source holds an extremely important position and serves as the total information source during wireless digital television transmission. The processing component scientifically processes and controls the information data sent from the signal source during operation [5]. The encoding server is the main carrier for all encoding software, using exchange encoding to achieve effective communication between servers, thereby promoting signal stability and security. Third, management platform. The management platform mainly includes security management, user management, and configuration management, providing strong support for stable television network operation. During actual operation, the management platform must emphasize equipment stability and security to ensure the server meets network operation standards and requirements. Additionally, various customer service software and AVS software should be installed according to relevant standards and specifications, continuously improving system integrity through interactive communication. Program signals need to be scientifically isolated from management signals. Finally, transmission system. Scientific selection of signal transmission location is important in terrestrial wireless digital television systems, as it is one of the key parameters. Proper selection of signal transmission location can promote a qualitative leap in overall television network system performance.

[Figure 2: see original paper] Terrestrial Digital Television Transmission System

3. Coverage Characteristics of Terrestrial Wireless Digital Television Systems

Terrestrial wireless digital television system coverage features relatively low costs, as it can effectively expand system coverage without requiring extensive line installation. While effectively controlling construction costs, it can demonstrate construction effects within a relatively short time. Compared with satellite digital television and cable television, terrestrial wireless digital television system transmission coverage demonstrates stronger security and mobility, as factors such as information transmission time and surrounding environment do not affect it. Additionally, under relevant factors, terrestrial wireless digital television system transmission coverage has relatively strong disaster resistance, as common weather conditions do not affect it unless severe natural disasters occur. Wireless digital television utilizes wireless frequency resources, which can effectively promote the utilization efficiency of wireless frequency. During actual operation, the same television channel can effectively transmit eight television programs simultaneously. Moreover, system transmission coverage reception of-

fers strong convenience, making it easy to add new users. Terrestrial wireless digital television systems can be effectively used for comprehensive coverage in most areas of China.

4.1 Transmission Parameters

Transmission parameters can be divided into three aspects: First, polarization mode. Antenna polarization mode plays an important role in increasing the actual coverage area of television signals. When transmission power is the same, the coverage range of horizontal polarization mode is relatively large, while vertical polarization has strong near-field distribution characteristics [6]. Therefore, vertical polarization antennas can be used in complex terrain environments, as they have relatively low cost and convenient installation. Second, transmission parameters refer to the actual power of the transmitter, antenna height, and various losses. Antenna height and transmitter power have a positive correlation with television network coverage efficiency, while they have a negative correlation with feeder consumption. Finally, reception parameters. Antenna height and gain, actual signal reception range, and receiver sensitivity all belong to reception parameters. When reception parameters continuously improve, the actual coverage range of the single-frequency network also expands rapidly. Additionally, when the television network exhibits multi-carrier transmission phenomena, component scale and single-frequency network reception efficiency decrease significantly. Meanwhile, encoding production measures and encoding rate also affect signal transmission.

4.2 Wireless Coverage Modes

When formulating terrestrial wireless digital television transmission coverage plans, the single-frequency network should be comprehensively improved. Based on urban single-frequency network operation modes and guard intervals, the actual distance between transmitters should be scientifically calculated to support the determination of single-frequency network coverage range, which should then be continuously optimized using single-frequency network coverage gap-filling methods. Currently, multi-frequency networks and single-frequency networks are the main transmission coverage modes for terrestrial wireless digital television. Multi-frequency networks are reflected in different frequency points covering urban and nearby areas, where all point frequencies collectively form the digital television coverage network system [7]. Single-frequency networks refer to situations where terrestrial wireless digital television transmission signals cannot achieve full coverage in a certain area, requiring the use of unified frequency point methods for low-power gap-filling to achieve comprehensive network coverage and eliminate coverage blind spots.

5.1 Multi-Frequency Network Mode

Multi-frequency network mode is widely used in terrestrial wireless digital television system transmission coverage, primarily for covering adjacent cities and

counties. This mode can effectively form a terrestrial wireless digital television system coverage network composed of transmitters and various auxiliary equipment [8]. By creating multiple signal channels and frequency transmission systems, it ensures rapid frequency point docking even when the distance between two regions is far, promoting rapid improvement in signal transmission efficiency.

5.2 Single-Frequency Network Mode

Single-frequency network mode, which has strong similarities with multi-frequency network mode, is also widely used in terrestrial wireless digital television system transmission coverage. Its main structure consists of transmitters and various auxiliary equipment. Single-frequency networks feature both closed-loop network structures and open network structures, both of which can provide smaller receiving field strength for coverage network edges. In open network environments, transmitted signals can effectively connect with single-frequency network timelines, providing good conditions for signal edge management and promoting continuous improvement in signal coverage range. In closed network environments, the coverage area is easily affected by factors such as radiation frequency. To rapidly improve service efficiency in the coverage area, directional antennas must be installed in the coverage area. It should be emphasized that single-frequency networks can not only ensure fixed-point signal coverage but also ensure uniform distribution of transmitting stations throughout the coverage network. Therefore, to promote balanced signal transmission, single-frequency networks should be scientifically selected.

5.3 Integrated Networking Mode

Due to China' s rich land resources and significant differences in terrain requirements across regions, with some areas having highly complex geological conditions, using only multi-frequency networks or single-frequency networks for terrestrial wireless digital television system transmission coverage does not meet regional environmental needs. Therefore, comprehensive networking methods should be scientifically applied according to actual conditions and terrain requirements, ensuring effective combination of multi-frequency and single-frequency networks. By leveraging the characteristics and advantages of both modes, coverage range can be continuously improved and conditions created for enhanced coverage quality. For example, when a region' s terrain characteristics are relatively normal, uniform planning of transmission points can be applied according to relevant requirements. When the region is elongated, multi-point low-power methods can be used to prevent unnecessary interference from nearby areas and rapidly improve network edge control capability.

6.1 Increasing Transmitter Transmission Power

External environments are typically highly complex, so signals often face threats and interference during reception, hindering improvement in signal

quality within the coverage range. Therefore, transmitter transmission power can be continuously increased according to regional actual conditions to avoid signal slow-fading phenomena [9]. If the system coverage range is relatively small, transmitter transmission power can be increased according to actual needs. When the system transmission coverage range is large, both transmission power and transmission antenna height need to be increased to ensure the system transmission coverage range meets actual requirements.

6.2 Improving Signal Strength

Through long-term analysis and research, relevant personnel have learned that digital television relay equipment can achieve continuous signal amplification. The scientific application of relay equipment in terrestrial wireless digital television system transmission coverage networks not only provides strong support for coverage signal cost control but also promotes rapid improvement in signal coverage range. Under the influence of scientific and technological development, digital television relay equipment types have become highly diverse, such as co-frequency relay equipment and digital signal fiber optics. Using digital television relay equipment in complex geological conditions like tunnels and valleys also demonstrates strong efficiency and quality. Therefore, the scientific application of digital television relay equipment in terrestrial wireless digital television system coverage, continuously supplementing and improving television signal strength to prevent impact on single-frequency networks, can effectively promote improvement in single-frequency network coverage effects [10].

6.3 Flexible Application of Leaky Cable Mode

When underground areas such as underground passages fall within the transmission coverage range of terrestrial wireless digital television systems, flexible application of leaky cable mode is needed according to actual requirements to ensure various signal coverage problems are well resolved. Terrestrial wireless digital television transmission antennas can ensure rapid output link formation by connecting with transmitters and effectively connecting with leaky cables. In this process, leaky cable is a type of coaxial antenna that is fixed in various slots and mesh grids according to actual requirements, creating a high-frequency energy transmission network based on this condition. Simultaneously, using digital television relay equipment ensures that high-frequency television signals can be scientifically and flexibly adjusted in coverage range and position through conductor openings.

6.4 Strengthening Receiver Equipment Capability

When continuously improving the transmission coverage range and quality of terrestrial wireless digital television systems, receiver equipment capability can be strengthened according to actual needs. This includes replacing aging receivers with phenomena of weak operation performance and using receivers and receiving antennas with stronger performance and modern features to create

scientific conditions for continuously improving terrestrial wireless digital television system transmission coverage range. Meanwhile, diversity reception methods can be effectively applied, which means ensuring antennas are installed at 1/4 wavelength horizontally without requiring that transmitter power, thereby improving received signal capability by 3dB or 5dB, where various antennas can have strong independence and stability during signal reception.

In summary, terrestrial wireless television has obvious advantages and characteristics, making it the main development direction for the future. Currently, wireless digital television is relatively important, but to promote its improvement and popularization, it is necessary to continuously strengthen its signal coverage range. By enhancing receiver equipment capability, applying high-performance television relay equipment, and other methods, problems such as poor signal reception can be comprehensively solved, promoting continuous expansion of signal coverage range and laying a solid foundation for the popularization of terrestrial wireless television.

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