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The Use of Audio Communication Technologies for Collaborative Music Production and Distance Learning

Hengrui Zhang [1], Fangxia Xu [2], Kexin Lyu [3], Dongkwon Seong [4*]
[1,2]Master Candidate, Department of X-Cultural Studies, Kookmin University, Seoul, Republic of Korea
[3]Ph. D. Candidate, Department of X-Cultural Studies, Kookmin University, Seoul, Republic of Korea
[4]Assistant Professor Dr., Department of X-Cultural Studies, Graduate School, Kookmin University, Seoul, Republic of Korea

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Abstract

Many people hold the view that music is one of the most ancient and complex forms of artistic expression. As audio communication technology has advanced, it has revolutionized the traditional methods of music composition, distribution, and playback and transmission. This inquiry begins with an executive description of the evolution and significant aspects of audio communication technology. Then, we'll go into the capabilities and features of HTML5, a mobile browser, and how they may be used to construct and implement a robust audio transmission system. This technology proves its reliability in transmitting audio by steadily increasing operational efficiency. Lastly, the paper explores how audio communication technology has influenced modern music, highlighting its crucial role in the creation and dissemination of contemporary tunes.

Author's Email id: dongkwonseong@kookmin.ac.kr*, z1254167800@gmail.com, 15689010481@163.com, karrtiny@gmail.com

Author's Orcid id: https://orcid.org/0009-0004-1037-9912, https://orcid.org/0009-0008-0884-241X, https://orcid.org/0009-0005-0246-409X, https://orcid.org/0000-0002-7607-1572

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Introduction

The music business in China has grown tremendously with the country's fast economic development and ongoing social change. A crucial area of study in music, digital audio technology is an integral part of music engineering and has been instrumental in pushing this progress.[1-3] Because of their adaptability—they are not limited to certain locations and provide easy ways to watch—computer-generated and online concerts are quickly becoming the industry standard. However, in order to guarantee continuous signal transmission, technological limits and constraints on network quality sometimes force the compression of audio and video data, which in turn causes data loss and irreparable distortion. Furthermore, users on the same virtual platform could experience different signal delays due to the absence of mandated synchronization for participants' speech gestures. As a result, there are obstacles in the music production process, such as poor communication between composers and performers and subpar audio quality that hinders the creative process. Although there are commercial audio transmission systems, many engineers and composers are looking for cheaper alternatives that nevertheless maintain signal integrity and transmit high-quality audio.

Researchers all across the world have dug deep into audio communication technology, which has led to a plethora of fresh ideas for improving this field. To illustrate the difficulties inherent in specialized audio transmission systems, Yao[4] constructed a model for digital piano audio transmission. A dual audio transmission system using WIFI modulation techniques was created and thoroughly evaluated by Ravi.[5] Lee et al.[6] examined the factors that cause delay and noise in the receipt

of Oracle Analytics Cloud (OAC) signals and introduced Anchor technology to enhance the efficiency of data packet processing. Using a Fabry-Perot interferometer, Chu et al.[7] created a passive audio pickup sensor that could be used in a four-channel parallel audio transmission system that used wavelength division multiplexing and bidirectional optical fiber. Modern audio transmission systems using Audio over IP (AoIP) and Unshielded Twisted Pair (UTP) cables were examined by Lee et al.,[8] who then proposed a more sophisticated audio network protocol. In order to reduce hardware costs and maximize resource efficiency for embedded devices, Yao and Ma[9] developed a framework for remote audio transmission that is based on embedded Ethernet. A similar embedded audio system based on the H.323 protocol was presented by Lu and Hu,[10] who also highlighted the system's efficacy in lowering power usage for audio conferencing. Yet, there are still significant gaps in the state of the art when it comes to research. In order to send audio files, many systems need extra plug-ins; others put compression efficiency ahead of audio quality; and still others aren't compatible with HTML5 standards. In addition, these systems' scalability and usefulness aren't always well-tested, and their use in the music business is still in its early stages, so there's room for improvement.

The history, features, and applications of digital audio communication technology in the context of music creation and remote cooperation are explored in this paper. It takes use of the portability and scalability of mobile browsers to construct and launch a robust audio transmission system on the HTML5 platform. It explores the impact of audio communication technologies on the development of the music industry and the creative process, going beyond just that.

Digital Audio Communication Technology: A History and Characteristics

Advancements in Digital Audio Communication Technology

Technology for conveying musical ideas has progressed in tandem with developments in information transmission, both of which are essential to the spiritual and cultural expression of humans. Over the years, music communication has come a long way from its primitive beginnings, reaching new heights with innovations like audio recording and transmission technologies. With each new technological development, not only has society advanced, but so has the availability and popularity of music. "Digital music" (a term including concepts like virtual concerts, MP3 formats, and digital audio workstations) is undergoing a time of rapid development and change, propelled by new regulations, improved technology, and increasing consumer demand. As a result of these changes, a worldwide service ecosystem with a growing number of potential customers has emerged. The driving force behind this change is digital audio technology, which is increasingly essential to audio communication in the modern day. The increasing number of people who listen to music online and the size of the Chinese market are two indicators of how important technological developments in digital audio are to the success of the "digital music" sector, as shown in Figure 1.

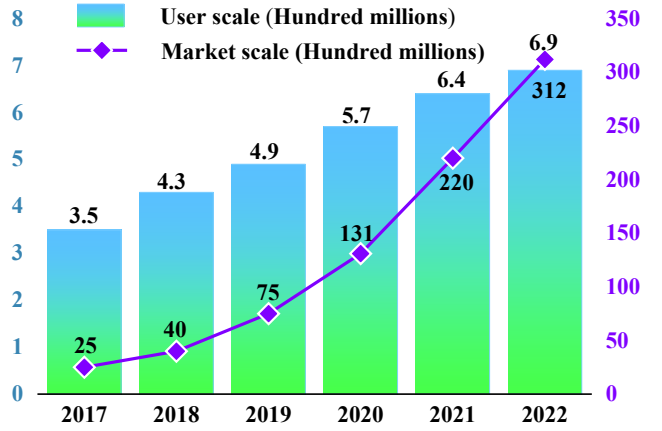

Fig. 1: Recent Developments and Future Outlook for China's Audio User and Market Scale

Audio effects may be significantly enhanced with the use of digital audio processing, which allows for the addition of several audio files to separate audio tracks before combining them for further processing. Computer hardware and digital audio software integration allows for more efficient handling of audio processing, storage, and transmission in batches. If any issues emerge when recording or processing the audio, the software's functionality makes it easy to fix them quickly. As a result, digital audio technology ensures that the music business consistently delivers high-quality sound and effects that meet or exceed customer expectations. Additionally, digital devices may be dynamically modified during client music software recording to adapt to real demands, thanks to the flexibility of digital audio technology. To ensure the best possible recording quality and clarity, it is possible to individually filter out weak interference signals. Maintaining excellent standards of audio recording, mobile audio tracks may also be increased depending on user needs. Despite the present media business boom, digital audio technology has been a lifesaver, cutting costs and increasing efficiency in the music industry's production processes without sacrificing usability.

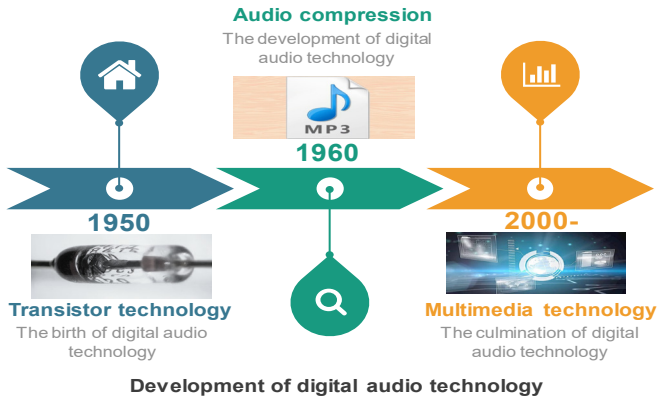

Figure 2. Modernizing Electronic Voice and Music Transmission

The advancement of digital audio technology is a key component in the expansion of China's music industry. Digital audio transmission systems, digital audio players, and digital mixers all support the Audio Engineering Society/European Broadcast Union (AES/EBU) interface protocol, making it one of the most utilized standards in the business. This protocol enables longer transmission lengths while operating in balanced mode. Many people are interested in finding real-world uses for digital audio technology due to its flexible operation, minimal transmission loss, and exceptional signal quality. One of the main pillars of China's music business is digitalization, which relies heavily on digital audio signals to ensure accurate reproduction of the original's input and output.

Digital Audio Communication Equipment Structures

Among the many functions offered by digital audio editing software, GoldWave stands out as a popular choice. With this program's sophisticated digital audio editing features, users may manipulate audio files by dragging and dropping waveforms into the program's user interface. The conversion of the auditory signals to graphical signals is much easier once they are represented visually. Perhaps one of the advantages of digital audio editing is the ability to put minute corrections to the specific sound since waveform display reveals all the details and nuances. Firstly, the audio file is examined in respect to the exact editing objectives. And then there is the editing strategy defined and the required level of edits to be made is decided. Further, using the graphical representation referred, called the waveform diagram, one can manage and view the audio. Finally, waveform is used so that exact places of edits can be identified and type of effect can be applied. This makes it possible that the audio files are as close to each other as possible, and optimally, enhances the quality of the audio files. It is rapid and accurate to manipulate digital audio to meet needs and customers' preference hence high quality.

Digital audio processing used virtually can join several audio files in one track and add effects to all tracks at once. Both numerical audio software and the computers as a hardware component allow the efficient processing, storage, and retransmission of large volumes of data. This provides a fast way of addressing all the challenges that may occur while recording or using software tools to process. Through this channel we can be assured that the final output will have the sound and effects anticipated by the audience. Furthermore, digital audio technology's adaptability allows for the versatile construction of digital equipment to fulfill unique needs during music recording. The ability to individually filter interference signals ensures crystal-clear recordings. It is also possible to add more mobile audio tracks later on if necessary, which keeps recording quality high. Thanks to digital audio technology's intuitive design, the music industry has been able to drastically reduce overall production costs while simultaneously enhancing manufacturing efficiency in today's media-driven, ever-growing demand environment.

The primary means of storing digital audio, which includes media like hard disks, is digitalization. Digital audio software is able to handle audio data effectively and methodically thanks to this methodology. Media workers may benefit from a simplified digital workspace that allows them to organize and label audio files for simple classification, modify or process them to meet specific demands, and synthesis varied audio recordings. With the development of IT came the distinct advantage of digital audio technology, which allowed for the exchange of audio over the Internet. This feature makes the process more efficient and user-friendly by enabling the remote usage of audio processing applications for audio enhancement and management. Audio comparison and watermarking are two elements of digital audio technology that make it stand out, make it more secure, and prevent frauds and unwanted spread. Consequently, the efficient transfer and storage of audio is made possible by digital audio technology. Its continuous improvement helps the music business expand in a sustainable and effective way, while also improving user experiences.

There was a time when traditional musicians could only assemble their sound effects from recorded sounds of nature or man-made instruments. But thanks to ever-improving audio communication gear, audio material accomplishment has jumped a huge notch in "quality" and "efficiency." Digital audio workstations increasingly include effect generators and virtual instrument plug-ins, so producers may easily find what they need online and use them to make or recreate content. Tube microphones,

preamps, compressors, and power loudspeakers are still used by certain professional recording studios today to generate a more analogue sound. Higher fidelity to the original analogue sound is achieved by digital audio technology's ability to convert audio data from analogue signals to digital signals, leading to greater audio quality. Many modern professional audio devices use digital interfaces built into tube gear to improve this conversion process and guarantee high-quality signal translation. Rather than displacing analog audio, the development of mathematical audio technology has created a symbiotic connection between the two, allowing them to live side by side and fuel each other's progress.

DESIGN AND IMPLEMENTATION OF AUDIO COMMUNICATION SYSTEM

Designing the Transmission Scheme and Building the Platform

Streaming media technology combines network technology with audio and visual coding and decoding. Transmission speeds are constrained by bandwidth limitations, and audio resources may only be sent in formats that are compatible with streaming media transmission. When compared to more recent video and audio coding methods, the format also has lower video resolution and less efficient compression. To get around these restrictions, this article uses audio tags to build a player that works in any web browser and allows audio to be sent across networks using the built-in UDP, RTCP, and RTSP protocols of streaming media technologies. Decoding and playing back audio is made possible by HTML5's audio coding elements. There are a lot of steps involved in implementing the audio communication system that this paper suggests (Figure 3). As a first step, the server has to determine an audio format that is compatible with the codecs that browsers support. Choosing the right procedure comes next. To activate the player, the next step is to choose a browser that supports HTML5 and audio components. Finally, the design and execution of the audio player are finished. This technically challenging step determines the quality of audio transmission and playback. Because it makes use of preexisting network protocols and hardware

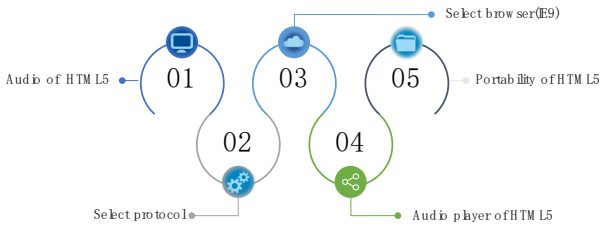

Fig. 3: A Framework for Audio Communication System Utilizing HTML5

infrastructure, the technical cost of the suggested audio communication system is mostly determined by the price of hardware.

When sending audio, the first thing to do is figure out what format would work best. For audio files, the MP3 format is still the de facto standard in the music business. Having said that, H.264 decoding technology is generally considered to have better compression and encoding performance than OGG decoding technology in HTML5, thanks to its enhanced capabilities and greater efficiency.[14-18] The coding layer and the network abstraction layer are the two primary components of the H.264 encoding structure, as shown in Figure 4. Audio and video encoding is handled by the coding layer, while the network abstraction layer breaks down the encoded data into smaller pieces and prepares them for external interface. In contrast to the basic stream, which consists only of audio data generated by the encoder, a T.S. stream incorporates extra protocol-required data into an audio stream. Audio PES is formed by independently packaging audio E.S. streams into PES in order to increase compatibility. In order to create T.S. packets, these PES groups go through a two-step packing procedure in the T.S. multiplexer. Another option is to have the program stream multiplexer process them and then produce P.S. packets. A comprehensive breakdown of the procedures required to package and manage audio data for transmission is shown in Figure 4, which also serves to demonstrate the process of creating transport streams.

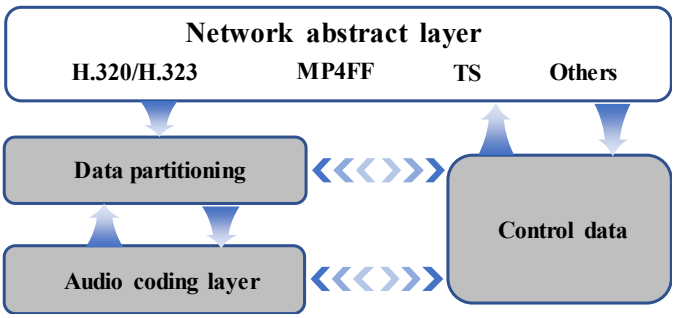

Fig. 4: H.264 Encoder Building

It is critical to choose the best transference procedure. Basic protocols that allow CPUs to communicate with one other include the Transmission Control Protocol (TCP) and the User Datagram Protocol (UDP).[19-24] In situations when data integrity, dependability, and controllability are paramount, such as when dealing with several data streams, TCP is usually the protocol of choice. On the other hand, UDP excels in situations that place a premium on transmission speed and performance. This study proposes an audio communication system that uses UDP as the network transport layer protocol to enhance

transmission speed. This protocol's full transmission procedure is shown in Figure 5.

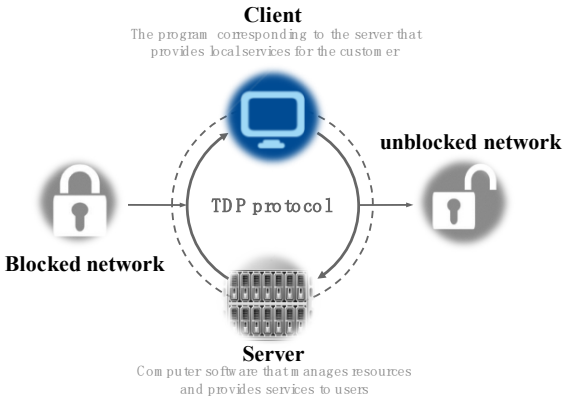

Fig. 5: Flow Diagram for the TDP Transport Protocol

For the audio entertainer's future growth, picking a browser that supports HTML5 is crucial for implementing the player and browser. This system utilizes state-of-the-art H.264 decoding technology, hence it is essential that the browser be IE9 or later. Moreover, by making use of JavaScript's local storage functionality, the player is able to load and save data locally. An appealing user interface and enhanced visual design for the player are achieved via the use of Cascading Style Sheets (CSS).[25-27] and [28]. The fundamental architecture of the HTML5-based music player is shown in Figure 6.

Fig. 6 The HTML5 Player's Structure Diagram

System Structure Design

As shown in Figure 7, the acoustic statement system developed for this article has a basic framework. Essential components of the system architecture include a web server, protocols for networks, a browser, an operating system, and a platform. There are three primary components to a web server: audio codec, protocol support and provisioning, and HTML5 audio files.

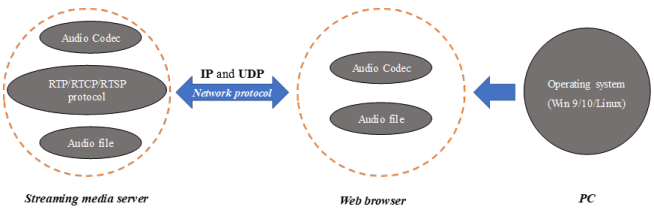

Fig. 7: Audio Communication Scheme's Structure Plan

An essential function of the audio codec is to encode and compress audio data received from external sources into transmission-optimal forms. Furthermore, it is the server's responsibility to establish audio resources using protocols that enable the transmission and management of streaming media. Examples of such protocols are RTP and RTSP, two of the most important standards for the secure and efficient transfer of audio information over the internet. Figure 8 shows the RTP protocol structure and Figure 9 shows the RTSP protocol structure. The RTP stands for "Real-Time Transport Control Protocol (RTCP)".[29-34]. The RTSP protocol structures are.[35-39] Internet Protocol (IP) is crucial because it separates TCP communications into packets, which the network infrastructure uses to deliver audio data. The client receives these packets and reassembles them after sending them over the Internet layer. A web page is a front-end interface from the client's perspective. A web browser will decode and play the audio file locally when you access it. Although the web page may include audio-related elements, the local browser is responsible for actually executing these functions. By including HTML5 audio tags, we guarantee that audio players may play back transmitted audio files without any hiccups.

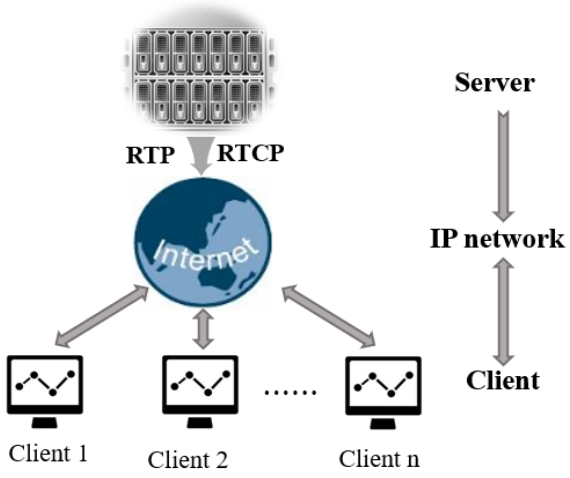

Fig. 8 Protocol Framework for RTP/RTCP

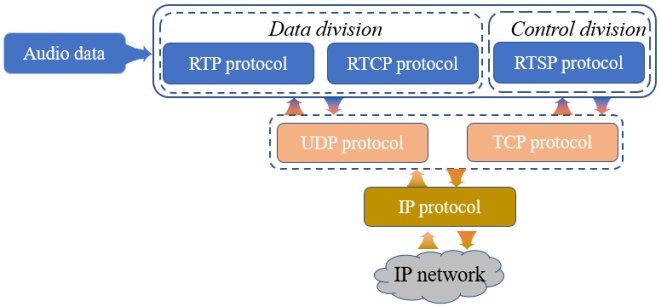

Fig. 9: RTSP Protocol Establishment

System Function Design

To transform audio data sent by front-end devices into a suitable format, the streaming media server employs H.264 technology. The next step in preparing the encoded data for transmission is to utilize the RTP protocol to bundle it. Before data is sent, a communication handle called a SOCKET is used. The acronym stands for the address and port that permit the transmission service. A communication connection is established by the SOCKET using the RTCP procedure, which involves creating an RTCP thread. This thread utilizes reaction data to dynamically alter the transmission rate. By doing so, we can guarantee the free flow of information without interruption while avoiding congestive state at certain points in the network. The overall premises of the packet structure in the RTP protocol are also maintained throughout the packing method. As part of this procedure, you must set the 12-byte RTP packet header, which contains the synchronisation source, timestamp, version, flag, and serial number. The server places the audio data in RTP format and portions it to make sending smoother for them to reach the client. The RTSP module on the server also enables the client's web browser to manage the session as long as it is interactive. When the body of the HTML5 audio player encapsulates a data payload with an IP header in the Internet layer and a UDP header in the transport layer, the server quickly deciphered the data and delivers the session request over the network. This system's design is to have a better user experience, lower latency and better synchronization. The server also supports HSS, which permits it to dynamically alter its streaming rate via alteration in the network through put to match constant audio quality. It also ensures the stability in playing and transmission of stream to its end users.

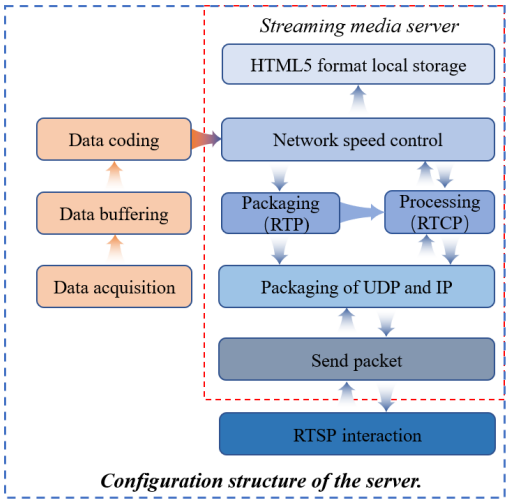

Fig. 10: Formation Building of the Server

The primary responsibility of the server, which is doing the broadcasting is to use RTP to encase the media stream and forward it to the client with the end view to further processing. A number of essential functional modules on the server are responsible for this, including the following: RTSP collaborating, RTP packing and transmission, RTCP dispensation, and HTML5 format local storage. All of these parts are interdependent and contribute to the smooth transfer of material. Figure 10 shows the server's configuration structure with these important components integrated.

System Test Results and Analysis

A high-quality local audio file, of 24 MB in size, was selected as the test object to conduct a comprehensive evaluation of the performance and efficacy of the proposed audio communication system. For this test, as the suggested audio communication technology, we employed more than network streaming media solutions to compress and send out the audio file. The client side used the similar process in order to uncompress the file. To prove the effectiveness of the system, important performance characteristics are investigated, such as the size of the compressed file and the operation with cookies and JS files. In Figure 11, the performance of the suggested method is compared with that of the FLV format which is used due to its high compression characteristics and for streaming the videos. The results based on the format of the suggested system are as follows A resource size of 21 MB for the same audio resource Within the same circumstances the FLV format only used 18 MB. The MP3 format employed within the framework of this research was quite versatile, the difference in the compression capacities of which did not differ greatly from the compared format - FLV being slightly more efficient. Furthermore, the proposed procedure proved to provide better network resilience and superior while assuring faster throughput rates for the ultimate

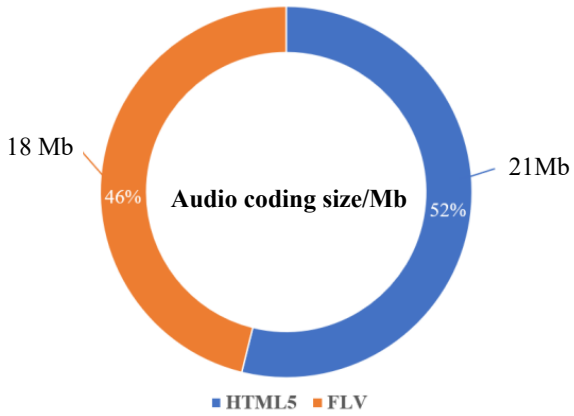

Fig. 11: Audio Training Size Judgment Results

delivery of high-quality sound. Further, the system was relatively flexible and streamlined in transferring large files with the identical performance rate. With these facts in mind, the offered audio communication method can be considered as a quite suitable replacement for the traditional streaming media when it is necessary to transmit the audio.

The comparison of sizes of the two players' Cookie and J.S files is illustrated in figure 12 below. The FLV format currently used for streaming video can contain only roughly 150 KB of data, so the capabilities of the HTML5 player are significantly beyond this. This is well illustrated by the fact that HTML5 player is relatively more efficient than the rest in terms of storage. Additionally it can also be seen from the comparism of J.S. files of the two players that the HTML5 player runs the files more effectively and loads the files even more faster, and manages the resources more efficiently thus validating the technological advancement of the HTML5 player. This HTML5 player has better controls on storage and resources, supports new technologies, and is much more scalable than its predecessors, so it can fit into most platforms with ease. They raise its general adaptability and make for it adequate for most functions of purpose. HTML5 player can be created to be faster and more responsive and it can utilize complex possibilities such as the usage of local storage and efficient loading of the media resources. On the other side, as multimedia technology advances, the format of the FLV could not be adequate due to the constrain in terms of storage and resource management. The study's suggested audio communication system, which uses the HTML5 player, outperforms popular streaming media players in terms of efficiency, usefulness, and flexibility. All things considered, it seems like a good bet for meeting the demands of contemporary audio transmission and storage.

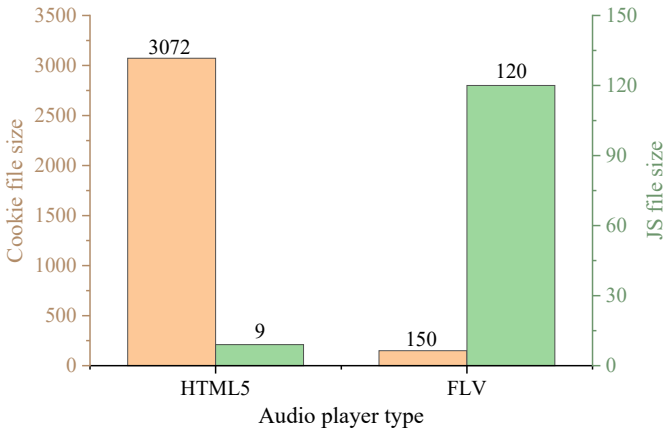

Fig. 12: Cookie and J.S. Folder Scope Contrast Outcomes

Aural Communication Systems' Impact on Recording and Distribution of Musical Works

With the fast development of audio communication technology, it is now possible to create auditory worlds with pinpoint accuracy and recreate virtual places. Music producers may now easily manage massive volumes of audio content, freed from the limitations imposed by the number of tracks. Producers may liberate practitioners from monotonous repetitive work by accomplishing complex and thorough outputs with less time and simplified procedures. An improvement in the realism of the creative process has resulted in an overall improvement in production quality. Although there are many benefits to audio communication technology, there are also many obstacles that musicians must overcome when making music. For example, digital workstations' ease of use encourages over-reliance on technology, and planned processes have the potential to limit musicians' ability to be creative and inspired. Furthermore, it is evident that audio communication technology has a negative impact on artistic musical expression due to the abundance of plagiarised and inappropriate material in online music.

The potential of digital audio communication technology must be fairly evaluated. The field of music sociology posits that modern music culture—as a spiritual product—has become more and more interdependent on the industrial production process. The digital revolution has changed the way people live their lives and the way music is made. It has made music more accessible than ever before and has changed the way people listen to and enjoy music. Since audio communication technology has far-reaching effects on the music industry, this section explores those effects further by looking at how it is used in the creation and distribution of music.

Technological Advancements in Audio Communication and Their Impact on Musical Genre

The final result of music production is the musical composition conveyed via sound, as music is fundamentally related to the art of sound and its aural presentation. As a result, the process of making music includes not only arranging the pieces but also performing or singing them. Additionally, it encompasses a wide range of techniques for making completed musical sounds utilizing digital technology, mostly computer-based procedures. Both the methods and the instruments used in traditional music composition have been utterly altered by the advent of digital technology's incorporation into the industry. This shift has brought to fresh ways of thinking about music that are apart from traditional compositional methods, as well as novel

creative conceptions. Popular music, film and television soundtracks, and other commercially viable forms of popular music have all benefited from the expansion of computer-assisted music production into more experimental electronic music and more serious works of expert music. Digital audio transmission technology has had a tremendous impact on every genre, irrespective of its intention. Accuracy, flexibility, and accessibility are three hallmarks of digital music production that this technology imparts to musical works. Composers and producers now have more leeway than ever before to try out unheard-of structures, sounds, and approaches thanks to digital technologies. Plus, with the advent of digital audio transmission technology, the production process has been simplified, allowing more people to easily create music. Not only has it revolutionized technological aspects of music, but it has also reshaped cultural and artistic paradigms, paving the way for a merging of classical craftsmanship with cutting-edge innovation. The way music is imagined, produced, and enjoyed in the digital era has been greatly affected by this change.

The Impact of Modern Audio Communication Methods on the Transmission of Musical Works

This paper therefore agrees with the assertion that the digital revolution has dynamically impacted the transmission of music, because of the availability of state of the art technology that has improved the quality of the program medium. It was impossible to transfer of digital audio over the networks without the digital audio compression standards like MP3 files. This format guarantees that too much of undiluted 'digital music information' is not hampered by negative production parameters such as time, space or capacity among others. Real-time efficiency, high quality and nearly infinite capacity of digital music transmission makes most known restrictions and weaknesses of conventional music distribution mechanisms irrelevant. As an intangible good, digital music is completely indifferent to physical channels of distribution that where other forms of music depended upon. The need and relevance of audio correspondence in music delivery has been increased with the help of this copy-pitable nature and infinite storable feature of digital music products mater and ease of transmission. This alters not only the way people listen to music but also makes music trip the world at large or in the large world. Such an opportunity helps musicians avoid geographical and logistic limitation of the previous formats of music distribution and share their pieces with people from all over the world. Moreover, it became integrated into streaming services and internet platforms, which make it even more approachable and elastic, let customers browse through music assortments at any time they wish. Other than enhancing the aspects of propagation, this transformation of music transmission has also positively affected the culture or mode by which people listen; enjoy; and share music in their current society as they continue to embrace digital technology advancement.

The Impact of Modern Audiovisual Tools on Musical Evolution

Blessed by great advancements in audio communication technology, other modes of media such as video shops, television, sound terminal machines are no longer necessary for delivering music. The transmission of music is now more accessible, quicker, and cost-effective since it can now take place completely inside computer networks, including production, dissemination, and discussion. Because of this shift, the music business has flourished, and our nation's cultural heritage has been better preserved and promoted. Thanks to the rapid development of audio transmission technology, music is currently used in internet-based information exchange more and more often. Because it is so simple for consumers to upload, download, and share music, there is an environment where artists have a lot more room to grow. Because of this, the number of independent artists in China who use the internet to disseminate their music has increased, contributing to the phenomenal growth of the country's music industry. Shows like "I Am a Singer" and "The Voice of China" that use popular music as a gift have maintained continuously strong ratings, indicating that the audience enjoys music entertainment. Despite problems like falling viewership and plagiarism, these programs definitely demonstrate the influence of digital media's new technical developments. While they haven't solved all of the problems associated with protecting and promoting Chinese music, they have helped the country's music business thrive. There are now fewer geographical and cultural constraints for musicians because to advancements in digital audio technology. Localization has occurred in many American musical genres, including jazz, rock, and others, allowing for the incorporation of varied musical topics and styles into distinctive expressions that speak to local audiences.

Conclusion

As with other forms of art, music has been shaped and sustained by technological developments; in this case, the rapid progress of audio transmission technology. Audio statement technology is defined and its historical progression are examined in this article. Using this as a springboard, it delves further into the revolutionary effects of audio communication

technology on the music industry, including the introduction of an HTML5-based audio program system and an examination of the distribution and creation of music. There has been a sea change in how people listen to and enjoy musical works. The intangible nature of music goods is becoming more important in the digital era, since it allows for more accessibility and flexibility. This change is critical in promoting and safeguarding our national culture, making sure it lives on in the information age and continues to build the music business.

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