

Exploring Blockchain-Based Applications for Digital Copyright Protection

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Abstract

This article provides a comprehensive review of the current landscape of digital copyright protection and the challenges it faces, particularly in the areas of registration and rights confirmation, authorized transactions, and monitoring and enforcement. It also explores the potential of blockchain technology as a solution to these challenges and analyzes the perspectives and strategies proposed by scholars. The review identifies three main research dimensions: a holistic approach to digital copyright protection, specific field perspectives, and technological advancements. Furthermore, the review highlights the importance of interdisciplinary collaboration and comprehensive exploration to further advance digital copyright protection. The findings emphasize the need to strengthen user education on copyright protection, balance the interests of creators and users, and continue evaluating the feasibility and effectiveness of blockchain technology in practical digital copyright protection scenarios.

Keywords: Digital Copyright Protection, Challenges, Blockchain Technology, Holistic Approach, Specific Field Perspectives, Technological Advancements.

Introduction

Digital copyright refers to the collection of exclusive intellectual and economic rights enjoyed by authors and other rights holders in the digital reproduction and dissemination of their literary, artistic, and scientific works, as recognized by law (Ou & Zhu, 2015). In addition to rights such as reproduction, distribution, and information network transmission, digital copyright also includes a range of proprietary rights such as rental, display, performance, adaptation, compilation, and translation (Zhang & Xu, 2021).

Research on digital copyright protection in China can be categorized into two main types: research focusing on overall digital copyright protection and research focusing on specific domains or types of works. Although the research perspectives may differ, the content is similar. Major research directions in digital copyright protection include the definition and characteristics of blockchain technology, current challenges in digital copyright protection,

specific applications of blockchain in digital copyright protection, existing problems in these applications, and corresponding solutions. While most studies involve discursive analysis, there is a relative scarcity of research on specific technical designs and legal regulations.

The study of digital copyright originated from computer programs and electronic music and involves disciplines such as computer science, engineering, and library and information science. Its primary objective is to balance the interests of copyright holders and the general public. The realization of this objective depends on technological safeguards, making technological application the most important research direction for digital copyright protection (Jiang & Jin, 2019).

This literature review aims to provide a comprehensive exploration of digital copyright protection, focusing on the challenges faced in the current landscape and the potential application of blockchain technology to address these challenges. The study aims to analyze the current issues in copyright protection, explore the methods and strategies for blockchain application in this domain, and assess the legal and technological aspects of blockchain-based copyright protection. The long-term objective is to contribute to the development of effective and efficient digital copyright protection mechanisms that balance the interests of copyright holders and the general public.

Historical Periodization of Digital Copyright Protection Research

The development history of digital copyright protection research can be divided into three stages:

"Pre-2011": During this period, the core topics were "digital copyright management" and "digital copyright management systems." Scholars conducted research from perspectives such as "digital copyright" Qin (2006), "digital libraries" Tan (2006); Lai (2011), and "copyright" (Pan, 2006). Zhou & Zeng (2009) suggested that "research on digital copyright provides reference value for suppliers in designing flexible mechanisms for digital copyright management and grasping the enforcement efforts against piracy." Additionally, scholars conducted research from perspectives such as "digital libraries," "MP3 search" (Li, 2008) and "P2P" (Wang, 2011).

"2012-2017": During this period, the core topics were "fair use" and "digital watermarking." The adoption of DRM services, digital watermarking, encryption and decryption, and licensing authentication technologies in digital publishing promoted the development of digital publishing in China and improved the credibility of the news publishing industry (Zhang, 2017). Scholars also conducted research from perspectives such as "topic distribution" (Yin, 2014), "cloud computing" Yin (2014), "visual analytics" Li (2014), and "digital publishing" (Zhao, 2017).

"2018-2022": During this period, the core topics were "digital copyright," "blockchain," and "metaverse." Overall, the development of digital copyright protection technologies had entered a mature stage, and the focus of technological application shifted towards integration, while blockchain-related technologies were still in their infancy (Zhang & Zhang, 2019). Blockchain technology, through its low-cost information verification, disrupts the traditional "third-party trust" and establishes a new trust mechanism to break the monopoly premise. It explores innovative paths such as constructing a new copyright ecosystem

centered on creators, establishing a complete value chain ownership proof mechanism for digital copyright, creating a peer-to-peer digital copyright value trading model, and constructing a highly efficient cross-chain and multi-channel strong regulatory system (Zang & Zhang, 2022). Furthermore, it is necessary to consider strategies such as reshaping the copyright legal system with digital copyright at the center, strengthening the talent pool for digital copyright protection, and enhancing the digital copyright management capabilities of copyright management departments (Xu & Zhao, 2020). Additionally, scholars conducted research from perspectives such as "copyright protection" Huang (2022); Li (2018); Song (2022), "blockchain technology" Cheng (2022), "criminal law governance" (Lv, 2019), "big data era" Mao (2019), "blockchain" Wang (2023), and "metaverse" (Xue, 2023).

Overall, research on digital copyright protection has gradually shifted from traditional digital copyright management towards technological application and innovation. The emergence of new technologies such as blockchain and the metaverse has brought new opportunities and challenges to digital copyright protection. Researchers not only focus on technical means but also emphasize the importance of legal systems and management capabilities. They believe that further advancing the development of digital copyright protection requires interdisciplinary collaboration and comprehensive exploration.

Challenges in Digital Copyright Protection: Issues and Perspectives

According to scholars, the current challenges in digital copyright protection primarily revolve around registration and rights confirmation, authorized transactions, and monitoring and enforcement. However, there are differing opinions regarding the specific issues faced within these areas.

Firstly, digital copyright protection faces the problem of digital piracy and infringement. The ease of copying and distributing digital content has led to widespread digital piracy and infringement. Unauthorized sharing and downloading of content result in losses for copyright holders and also undermine the motivation of creators. The internet has made cross-border copyright infringement easier, but differences in laws and enforcement standards across countries make it difficult to pursue and resolve cross-border infringements. Despite continuous development of digital copyright protection technologies, infringers are constantly seeking ways to circumvent these measures. Traditional copyright systems are no longer effective in protecting digital copyright, and four major issues arise: difficulties in rights confirmation, revenue generation, evidence gathering, and determination of damages in infringement cases (Lai & Li, 2021).

Secondly, monitoring and enforcement of digital copyright protection pose significant challenges. The anonymity and decentralized nature of the internet make it difficult to effectively monitor and enforce copyright protection. Infringing activities spread rapidly across various platforms, making it complex to track and punish infringers. Digital copyright protection involves global content dissemination and transactions, yet there is currently a lack of unified international standards and regulations, leading to differences and uncertainties in copyright protection among different countries. The main issues in digital copyright protection involve the lack of transparency in digital copyright transaction information, difficulties in providing evidence for copyright infringement and seeking legal remedies, and inadequate profit sharing for digital content creators (Zhang & Dong, 2022). Wang et al (2022)

identified four aspects in which the challenges of digital copyright protection manifest: inefficient rights confirmation leading to rampant piracy and infringement, inadequate measures for authorized transactions resulting in high contract establishment costs, ambiguity in determining infringement leading to difficulties in tracing infringements, and limited management rights for authors resulting in insufficient protection of copyright revenue.

Furthermore, users have a weak awareness of digital copyright protection. Users often have limited understanding of the importance of digital copyright and lack awareness of its protection, which leads to a lack of proactiveness in safeguarding copyright. In some cases, copyright holders may excessively protect their rights, restricting fair use and impeding information dissemination and innovation. The rise of sharing economy models, such as online education, music streaming, and video streaming, poses new challenges to digital copyright protection, necessitating a balance between the interests of creators and users.

Different Dimensions of Blockchain Technology Empowering Digital Copyright Protection Research

Blockchain technology has provided innovative solutions for digital copyright protection. The definition of blockchain technology as presented in the "China Blockchain Technology and Application Development White Paper (2016)" by the Ministry of Industry and Information Technology highlights its potential in constructing a new copyright ecosystem centered on creators and a full-value chain ownership proof mechanism for digital copyright (Zang & Zhang, 2022). By immutably storing copyright information and transaction records on the blockchain, digital products become non-reproducible, tamper-proof, and non-falsifiable, ensuring traceability and trustworthiness of copyright information while effectively preventing tampering and infringement. It is argued that blockchain can introduce long-awaited transparency in matters of copyright ownership chain (Fu, 2021).

(1) Research on Digital Copyright Protection from a Holistic Perspective Exploring Challenges, Paths, and Strategies for Blockchain Application

Firstly, the research focuses on the application paths of blockchain in digital copyright protection. Lai & Li (2020, 2022) suggest that utilizing blockchain's decentralized digital information management model and digital signature technology can enhance the efficiency and security of copyright registration while reducing registration costs. Additionally, smart contract technology can effectively address issues such as unfair pricing and lengthy settlement periods in digital copyright transactions, enabling automated contract execution, improving transaction efficiency, and reducing costs. Furthermore, blockchain can store all operations related to digital copyright on the chain, aiding in evidence collection for infringement and combining algorithms and artificial intelligence to optimize the assessment of infringement damages, thereby transforming copyright protection from a "reactive" approach to a "preventive" one. Building on this research, Li & Lai (2022) provide a detailed analysis of blockchain applications in comprehensive digital copyright protection, proposing specific application schemes. Ma et al (2022) analyze the application of blockchain in digital copyright protection from the perspectives of registration, transaction, and regulation. They suggest that blockchain technology can establish a distributed storage model for digital copyright registration, achieving efficient and low-cost registration. In a blockchain system,

copyright-related rights holders can engage in direct peer-to-peer transactions that are secure and efficient. Additionally, by embedding relevant codes through "smart contracts" in the blockchain, digital copyright can be subject to automated regulation.

Some scholars analyze the principles of blockchain-based digital copyright protection and propose three new mechanisms: "process-based copyright tracing mechanisms," "integrated smart copyright management mechanisms," and "automated copyright enforcement mechanisms" (Huang, 2018). Others provide a detailed analysis of how various blockchain technologies, such as hash algorithms and timestamps, can address specific challenges in digital copyright protection, accompanied by application flowcharts (Zhang, 2020).

Exploring Legal Aspects in the Application of Blockchain to Digital Copyright Protection

The application of blockchain technology in digital copyright protection faces three major challenges: the lack of unified copyright authentication standards, the absence of criteria for determining originality, and security vulnerabilities in smart contracts. Suggestions have been made to address these challenges, including the urgent need for updates to copyright-related laws and regulations and the enhancement of blockchain-related technological research (Lai & Li, 2020). Subsequent research on comprehensive digital copyright protection explores the potential problems in blockchain-based digital copyright protection across the registration, authorization, and monitoring and enforcement stages. It also provides recommendations from the perspective of coordinating blockchain technology with legal systems (Li & Lai, 2022). Wang (2021) highlights the friction between technology and law, identifying new challenges in copyright protection under the application of blockchain technology, such as loopholes in ownership confirmation, legal issues with smart contracts, and the potential for abuse by technology controllers. Four aspects are analyzed as potential legal pathways for adapting blockchain to copyright protection: changing blockchain's inherent properties, adjusting copyright laws, improving smart contract mechanisms, and implementing embedded supervision (Wang, 2021). Cheng (2021) argues that regulating blockchain technology is essential to address its risks and bridge the gap in legal regulations, encompassing challenges such as the contradiction between decentralized technology and centralized legal systems, risks related to tamper resistance and computational power monopoly, relative anonymity and risks in the dark web, as well as criminal offenses, obstacles in civil contract law, and consumer rights infringements.

Yang et al (2021) discuss the application of blockchain in digital copyright protection, focusing on the phenomenon of plagiarism and its legal recognition. They examine the limitations of blockchain evidence in judicial determinations. Therefore, the application of blockchain technology in the field of digital copyright management is still in the exploratory stage, and blockchain should be considered as a technical tool and auxiliary means for digital copyright management, rather than a disruptive reconstruction of the copyright management system. At the same time, the application of blockchain in digital copyright management platforms faces challenges such as technical immaturity, immature business models, and conflicts with existing legal systems (Wang, 2021).

In conclusion, blockchain technology has the potential to address challenges in digital copyright protection by improving efficiency in registration and transaction processes, as well as enhancing monitoring and enforcement of copyright infringements. However, significant technical and legal challenges need to be overcome, such as establishing unified copyright authentication standards and ensuring the security of smart contracts. Further research and

exploration of the potential of blockchain in digital copyright protection are crucial for both academia and industry.

(2) Research on Digital Copyright Protection from Specific Field Perspectives

Scholars have also focused on the application of blockchain technology in digital copyright protection within specific fields or types of works, such as libraries, short videos, academic publications, and digital music.

Application of Blockchain Technology in Library Digital Copyright Protection

Libraries, as the battleground for knowledge preservation and dissemination, are an important target of copyright protection under copyright law (Fu, 2021). Traditional library copyright protection models have been impacted by the Internet Zhang & Wang (2018), and in recent years, with scientific data and other data resources becoming the main targets for library acquisition and self-construction Si et al (2015), digital copyright protection has become a major challenge for library development. Blockchain technology has been regarded by many scholars as an important solution to this problem (Zhang & Wang, 2018).

Firstly, numerous studies have explored the application value and mechanism of blockchain technology in digital copyright protection in libraries. Copyright protection in libraries is a major application scenario for blockchain technology (Zhang & Wang, 2018). Some scholars have focused on the utility of blockchain in digital copyright protection, with library copyright protection as the background. They believe that the core technologies of blockchain, such as decentralization, smart contracts, and timestamps, can be used to achieve important copyright protection functions such as rights confirmation, transactions, and rights enforcement (Qin, 2020). For example, blockchain can provide a basis for rights confirmation, effectively divide rights to protect the interests of copyright holders who desire limitations, facilitate the exercise of rights by copyright holders, and ensure the implementation of smart contracts (Wang & Chen, 2019). Applying blockchain to library digital copyright management can not only reduce the cost and complexity of copyright clearance in libraries and innovate the business model of copyright transactions but also provide credible evidence for resolving copyright disputes and open up new paths for copyright valuation (Qin, 2020).

Some scholars have also explored the application mechanisms of blockchain technology in digital copyright protection in libraries through case studies. Zhang (2022) focused on digital music libraries and analyzed their digital copyright protection strategies, pointing out the need to use blockchain technology to provide technical guarantees for digital music library copyright protection. Zhang (2021) analyzed the application of blockchain technology in the National Digital Library of China to achieve all-time, all-domain, and all-scenario copyright protection of digital resources. They summarized effective measures for managing digital resources' copyright in digital libraries using blockchain technology.

In addition, the challenges and difficulties of applying blockchain in digital copyright protection in libraries have also received some attention. While blockchain technologies may play an important role in intellectual property, there are various limitations and requirements needed to be met in deploying blockchain technologies (Fu, 2021). Liu et al (2020) considered the problem of cross-domain integration of publishing in the context of blockchain digital copyright protection and summarized three pain points of blockchain technology: it is still in the emerging stage with many deficiencies, such as heavy storage burden and resource waste; there are certain differences and conflicts between blockchain copyright registration and

existing laws; users and vested interest groups may refuse or oppose blockchain applications due to user experience, habits, and existing interests. They proposed four operational approaches for achieving equilibrium in the cross-domain integration game of blockchain in library publishing.

Application of Blockchain Technology in Short Video Copyright Protection

Short videos refer to a new form of video that is shorter in length than traditional videos, ranging from a few seconds to a few minutes. They mainly rely on mobile smart terminals to achieve rapid shooting, diverse content editing, real-time uploading, sharing, playback, and interaction on application platforms (Ma, 2021). In recent years, there have been frequent cases of copyright infringement in domestic short videos, exposing the inadequacy of traditional copyright protection mechanisms for short video copyright protection. The advantages of blockchain technology in short video copyright protection have attracted attention.

Firstly, the focus is on the convenience of blockchain for short video copyright registration and rights confirmation, reducing the cost of rights protection. Compared to traditional copyright registration and rights confirmation models, the blockchain model has the advantage of permanently accessible registration information, which can provide important evidence for short video rights confirmation. Blockchain can also break the interpretative hegemony of platforms over short video content and copyright, protecting the individual rights of producers (Zheng & Si, 2021). It can provide end-to-end protection for short video copyright registration, certification, and rights confirmation (Wen & Xie, 2021). Blockchain technology can identify active infringements, simplify authorization mechanisms, and facilitate the return of platform responsibility, jointly promoting the original development of short videos from the perspectives of legal systems and self-restraint (Zhao & Yao, 2021).

Secondly, attention is given to the construction of a short video copyright platform using blockchain technology. With the increasing number of users, it may become a trend to embed an efficient copyright certification system based on blockchain technology starting from short video application platforms to protect user's work copyrights (Ma, 2021). The decentralized, tamper-proof, and traceable characteristics of blockchain technology offer possibilities for its application in short video copyright protection. Currently, blockchain technology has great potential in short video copyright protection at the administrative and judicial levels. Building a blockchain-based original short video business platform and establishing a copyright platform on this basis provide new paths for short video copyright protection and the construction of a comprehensive ecosystem for digital copyright protection (Sun, 2022).

In addition, the limitations of applying blockchain technology in short video copyright protection are also a concern. Based on the analysis of the difficulties in short video copyright protection, some scholars have discussed the limitations of applying blockchain technology in short video copyright protection. Blockchain technology may face storage and resource waste issues in short video copyright protection, and future improvements are needed to simplify and upgrade algorithms for building smart contract programs for short video originality and expand the scope of the blockchain (Shen & Chen, 2021). Furthermore, the combination of short video copyright protection and blockchain still lacks legal endorsement (Shen & Chen,

2021). The inherent attributes of blockchain technology can also cause problems such as lack of differentiation advantages in business models, difficulty in determining the evidentiary value of litigation, conflicts with copyright and privacy rights, and disruption of financial order, which need to be resolved (Zhao & Yao, 2021).

In addition to libraries and short videos, blockchain applications in digital copyright protection have also received varying degrees of attention in academic publications Liu & Jiang (2018); Guo et al (2020); Zhang & Cao (2022), digital audiobooks Liu (2021); Fang (2018); Qin & Wang (2020), digital music Yang (2022); Jin & Xing (2022), online literature Wang & Du (2018); Zhang & Wang (2021), online games Wang (2021), movies Wei (2018), clothing products Cai & Zhu (2019), and online educational works (Sun & Tan, 2021). However, compared to libraries and short videos, there are fewer studies in these areas, and many of them only propose blockchain as a technical means for copyright protection or consider copyright protection as one of the functions of blockchain without further exploration.

Research on Blockchain-Based Digital Copyright Protection from a Technological Perspective

The main contents of research on blockchain-based digital copyright protection from a technological perspective include system design and improvement of blockchain-related technologies. The specific fields of research are diverse, with a particular emphasis on the protection of audio and video digital copyright.

Niu et al (2021) designed a blockchain-based digital music copyright protection and transaction system to address the difficulties, time-consuming nature, and challenges in rights protection in digital music copyright management. Liu et al (2021) proposed a blockchain-based audio copyright certification model that allows audio works to be uniquely certified on an immutable blockchain without the need for copyright agencies' involvement. Chen et al (2019) presented an alliance-based blockchain system for audio and video copyright, using an improved Practical Byzantine Fault Tolerance (PBFT) algorithm. This system can prevent copyright data leakage or malicious tampering and utilize cryptographic techniques to enhance the reliability of copyright confirmation and traceability. Nie (2017) designed a blockchain-based digital copyright management service platform that integrates rights confirmation and transactions, consisting of account blockchains, copyright blockchains, and transaction blockchains. Zhu et al (2021) proposed a model for geographic data transaction certification and copyright protection by combining watermarking, IPFS, and smart contract technologies. Zhai et al (2020) constructed a blockchain-based digital copyright certification system architecture, improved the use of ring signature technology to protect the privacy of creators, and optimized the PBFT algorithm to enhance system efficiency and reliability. Zhou et al (2020) proposed a distributed DRM (Digital Rights Management) mechanism based on a blockchain credit system to improve the efficiency of digital copyright management. They provided a solution to copyright protection problems in decentralized content distribution networks. Che et al (2020) designed an education system that integrates blockchain technology, distributed storage, encryption algorithms, and other technologies to provide copyright protection for educational achievements. Huang et al (2022) designed a blockchain-based scientific data management model system for university libraries, which can comprehensively record the entire process of scientific data management by combining management plan chains, process data chains, and formal data chains. In the event of copyright disputes, it supports traceability to achieve copyright protection.

In summary, these studies provide innovative solutions for digital copyright protection based on blockchain technology. The decentralized and tamper-proof characteristics of blockchain are fully utilized, making copyright confirmation, transactions, and management more reliable, efficient, and secure. However, these studies may still require further experimental and applied verification to evaluate their feasibility and effectiveness in practical scenarios.

Conclusion

In China, research on blockchain-based digital copyright protection began with digital copyright management and gradually transitioned to technology applications and breakthroughs. Researchers have investigated the application paths of blockchain technology in digital copyright protection from a holistic standpoint, taking into account its technological properties. However, they have also identified technical and legal challenges, such as unified authentication standards and the security of smart contracts. In addition, user understanding of digital copyright protection is low, and there is a lack of proactive copyright protection. In brief, blockchain technology has enormous possibilities for digital copyright protection, but the development of digital copyright protection requires interdisciplinary collaboration and extensive research. It is necessary to improve user education on copyright protection awareness, balance the interests of authors and users, and accomplish complete digital copyright protection development. Blockchain, as a significant technological tool, should continue to be tested and verified in order to determine its practicality and usefulness in practical digital copyright protection scenarios.

This review of the literature on blockchain-based digital copyright protection in China provides a substantial theoretical and practical contribution to the current state of knowledge. Theoretically, it expands knowledge of blockchain's possible application in digital copyright protection by emphasizing the novel effects of its primary characteristics—decentralization, immutability, and smart contracts—on ordinary copyright management. Contextually, this study offers light on the particular difficulties and prospects of using blockchain technology in a variety of contexts, including libraries and the copyright protection of short videos. The study further looks at the legal issues that occur when using blockchain technology in this area, highlighting the necessity of legal adaptations and alignments in order to fully utilize blockchain's potential for digital copyright protection. In summary, this review plays an important role in the future of digital copyright protection by giving a comprehensive grasp of blockchain technology's potential, practicalities, and legal implications in this field.

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