CHAPTER 1

INTRODUCTION

In the digital age, the proliferation of digital images has led to unprecedented challenges in protecting intellectual property rights. Copyright infringement and unauthorized usage of digital images have become rampant, posing significant challenges for content creators, publishers, and businesses across various industries. Traditional methods of image copyright protection often fall short in providing robust solutions that can effectively address these challenges.

In response to this growing need for secure and transparent copyright protection, blockchain technology has emerged as a promising solution. Blockchain, best known as the underlying technology behind cryptocurrencies like Bitcoin, offers a decentralized and immutable ledger that records transactions securely and transparently. When applied to image copyright protection, blockchain can provide a tamper-proof record of ownership and usage rights, enabling creators to assert their rights more effectively in the digital realm.

Additionally, zero-watermarking, a technique that embeds copyright information directly into digital images without altering their visual appearance, complements blockchain technology by preserving the aesthetic integrity of images while ensuring their copyright status remains intact.

In this paper, we will explore the application, benefits, challenges, and implications of blockchain-based image copyright protection with zero-watermarking across various industries. We will examine real-world use cases, discuss technical considerations, regulatory implications, and future prospects for this innovative approach to digital image copyright management.

1.1 BACKGROUND

The digital age has brought about challenges in protecting image copyrights. Traditional methods like watermarking lack effectiveness in the digital realm. Blockchain technology, known for its decentralized and immutable nature, offers a solution by securely recording ownership and usage rights. Zero-watermarking, an imperceptible technique, complements blockchain by embedding copyright data directly into images. This convergence promises to revolutionize image copyright protection, ensuring integrity and ownership transparency. However, challenges such as technical complexity and regulatory uncertainty remain.

Understanding these developments is crucial for navigating the evolving landscape of digital rights management in visual content.

1.2 BLOCKCHAIN

Blockchain technology is a decentralized, distributed ledger system that enables secure and transparent peer-to-peer transactions without the need for intermediaries. Each transaction is recorded as a block and linked together in a chronological chain, forming a tamper-resistant and immutable ledger. This decentralized nature of blockchain ensures that no single entity has control over the network, making it resistant to censorship and manipulation.

1.3 ZERO-WATERMARKING TECHNIQUES

Zero watermark technology is a specialized form of digital watermarking that embeds imperceptible identifiers directly into digital media, such as images or audio files, without altering the appearance or quality of the content. Unlike traditional visible watermarks, which overlay visible marks onto the media, zero watermarks are invisible and do not affect the visual or auditory experience for consumers. The term "zero watermark" refers to the fact that the embedded identifiers are imperceptible to human senses, making them virtually undetectable within the media content.

1.4 FEATURES

- **Decentralization**: Removes reliance on central authority, enhancing transparency and resilience against manipulation.
- **Immutability**: Ensures that once data is recorded on the blockchain, it cannot be altered, providing a tamper-resistant record of ownership.
- **Transparency**: All transactions and changes to ownership are publicly accessible on the blockchain, fostering trust and accountability.
- **Traceability**: Enables stakeholders to trace the lineage of an image and verify its ownership history, facilitating copyright enforcement.
- **Security**: Zero-watermarking techniques embed imperceptible digital fingerprints into images, enhancing resistance to removal or alteration.
- **Efficiency**: Automates copyright management processes through smart contracts and decentralized applications, streamlining registration, licensing, and enforcement.

CHAPTER 2

LITERATURE SURVEY

2.1 LITERATURE SURVEY

Blockchain Technology in Copyright Protection: Numerous studies have explored the potential of blockchain technology in revolutionizing copyright protection. Tapscott and Tapscott (2016) discuss the transformative impact of blockchain on various industries, including its implications for copyright management. Bhaskaran and Pandey (2018) analyze the applications and challenges of blockchain in copyright management, highlighting its potential to enhance transparency and accountability. Additionally, Kshetri (2017) explores the intersection of blockchain and the Internet of Things (IoT), suggesting potential synergies for strengthening copyright protection in interconnected digital ecosystems.

Zero-Watermarking Techniques: Zero-watermarking has emerged as a promising alternative to traditional watermarking methods, offering robust copyright protection while preserving the visual quality of images. Xie and Jiang (2008) propose a zero-watermarking algorithm based on quantization index modulation, demonstrating its effectiveness in embedding imperceptible digital fingerprints into images. Similarly, Liu and Tan (2005) introduce a zero-watermarking technique based on discrete cosine transform (DCT) domain coefficients, which proves resilient to removal or alteration. Li et al. (2006) present a robust zero-watermarking scheme using the Harris corner detector, further expanding the repertoire of techniques for protecting image copyrights.

Blockchain and Copyright Management: The potential applications of blockchain in copyright management have garnered significant attention from researchers and practitioners. Kuo et al. (2017) explore the use of blockchain distributed ledger technologies in biomedical and healthcare applications, suggesting parallels with copyright management in terms of data integrity and security. Raval (2016) provides insights into decentralized applications (DApps) and their potential to disrupt traditional copyright management systems. Furthermore, Li et al. (2018) propose a blockchain-based framework for data sharing with fine-grained access control, offering insights into the intersection of blockchain and decentralized storage systems.

Applications of Blockchain in Copyright Protection: Several studies have examined specific applications of blockchain technology in copyright protection, particularly in the context of digital images. Bari et al. (2020) present a blockchain-based copyright management system tailored for digital images, highlighting its potential to enhance transparency and traceability in the image licensing process. Zyskind et al. (2015) explore the use of blockchain to protect personal data, suggesting implications for copyright management in safeguarding intellectual property rights. Additionally, Nofer et al. (2017) discuss the potential of blockchain in various industries, including copyright management, emphasizing its role in fostering trust and reducing transaction costs.

Challenges and Opportunities: Despite the potential benefits, the adoption of blockchain technology in copyright protection is not without challenges. Swan (2015) discusses the technical and regulatory hurdles facing blockchain adoption, suggesting the need for collaborative efforts to address these challenges. Zohar (2015) provides an in-depth analysis of Bitcoin, the first application of blockchain, shedding light on its underlying mechanisms and potential implications for copyright management. Vogelsteller and Buterin (2015) introduce Ethereum, a decentralized platform for building smart contracts, highlighting its potential to revolutionize copyright enforcement through automated processes.

Comparative Studies and Reviews: Comparative studies and reviews offer valuable insights into the strengths and limitations of blockchain technology in copyright protection. Tasca et al. (2017) provide a comprehensive overview of blockchain security, discussing its implications for copyright management and other domains. Ali and Clarke (2018) examine the maturity of blockchain technology in the insurance industry, drawing parallels with copyright management and suggesting areas for further research. Cachin (2016) presents an architectural overview of Hyperledger Fabric, a blockchain framework tailored for enterprise applications, offering insights into its potential applications in copyright management.

This literature survey provides a comprehensive overview of existing research and publications related to blockchain technology, zero-watermarking techniques, their applications in copyright protection, challenges, and opportunities in this domain.

CHAPTER 3

TECHNOLOGY USED

Protecting image copyright using blockchain and zero-watermarking involves a combination of technologies to ensure secure ownership verification and deter unauthorized use. Here's a breakdown of the technologies typically involved:

Blockchain: Blockchain technology is used to create an immutable, decentralized ledger of ownership rights for digital assets like images. Each image is assigned a unique digital signature, or hash, which is then recorded on the blockchain along with ownership information. This ensures that ownership of the image can be securely verified without the need for a central authority.

Smart Contracts: Smart contracts are self-executing contracts with the terms of the agreement directly written into code. In the context of image copyright protection, smart contracts can be used to automate the transfer of ownership rights between parties, enforce licensing agreements, and facilitate royalty payments.

Zero-watermarking: Traditional watermarking involves adding visible or invisible marks to an image to indicate ownership. Zero-watermarking, on the other hand, embeds ownership information directly into the image data itself in a way that is imperceptible to the human eye. This can be achieved using techniques such as digital signatures, steganography, or embedding metadata into the image file

Encryption: To further enhance security, encryption techniques can be used to protect the integrity and confidentiality of image data. This ensures that only authorized parties can access and view the image contents, reducing the risk of unauthorized distribution or reproduction.

Decentralized Storage: Storing images on decentralized or distributed storage platforms, such as IPFS (InterPlanetary File System) or Sia, enhances security and resilience by eliminating single points of failure and reducing the risk of data tampering or censorship.

Digital Rights Management (DRM) Systems: DRM systems can be integrated with blockchain-based image copyright protection solutions to provide additional control over how images are accessed, shared, and used. This may include features such as access controls, usage tracking, and content expiration policies.

By combining these technologies, creators can establish a robust framework for protecting their image copyrights, ensuring that their work is properly attributed and compensated in an increasingly digital and interconnected world.

CHAPTER 4

SYSTEM ARCHITECTURE

In the system proposed in this paper, there are mainly two subjects, which are namely Image Owner and Image User.

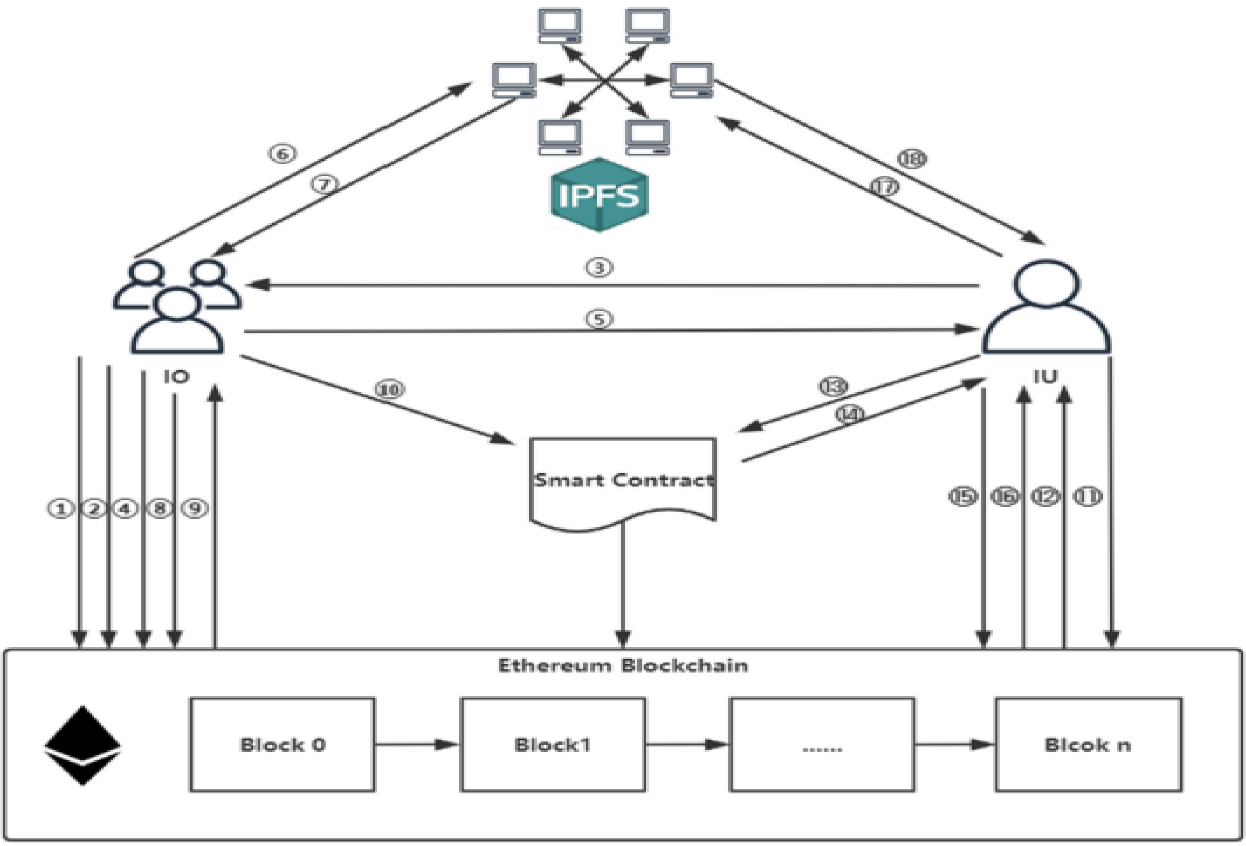

Figure 4.1 System architecture

In the system proposed in this paper, there are mainly two subjects, which are namely Image Owner and Image User.

1. IO starts the system and sets the default parameter.
2. IO deploy SC to Ethereum.
3. A registration request is sent to IO from IU.
4. After IO verifies IU's identity, then provides the query access (only W can be found through F, and the rest of the information cannot be obtained) to IU.

5. IO shares the contract address, the source code, and the contract ABI to IU by sending TXH1. This step is to reach an agreement on the contract content.
6. IO uses the zero-watermark algorithm for F and W to obtain K, F' , W' and ω, and stores the last three into IPFS.
7. IO notes the location LOCATION_ADDR of the image in the IPFS.
8. IO stores this information in the Ethereum transaction 2.
9. IO writes down the TXH2 returned after the transaction is approved.
10. IO calls SC to generate the index record.
11. IU reads TXH2 related transaction information from the Ethereum blockchain.
12. IU gets LOCATION_ADDR in the transaction data.
13. IU calls SC for a search.
14. SC searches and returns RESULT based on the information sent by IU.
15. IU reads RESULT from transaction data.
16. IU gets Key from RESULT.
17. IU downloads F0 , W0 , v from IPFS.
18. F and W are obtained by Key and validation part of zero-watermark algorithms.

The whole process of the system can be divided into five stages:

1) Initialization Stage: The zero-watermark algorithm used in the system runs with IO, and the contract is deployed in Ethereum blockchain by IO. It is responsible for storing the confidential scrambling parameter K and providing the search function to IU, corresponding to steps 1 and 2 in Fig. 4.1

2) Request Stage: When IU wants to verify image ownership or uses image, it needs to send a registration request to IO. After verification by IO, IO will provide it with an ownership query service. At this time, IU can query image ownership but cannot obtain the right to use the image. After IO verifies IU's identity (externally), IO adds IU's Ethereum account address to the authorized user collection of the contract and sends the contract information to IU via TXH. Corresponding steps 3, 4, 5, and 6 in Fig. 4.1

3) Watermark Generation Stage: Run zero-watermark algorithm by IO, take F and W as input, output zero-watermark graph v and a set of random scrambling parameters Key, store v, F' and W' into IPFS, and record the location of file LOCATION_ADDR, corresponding steps 8 and 9.

4) Retrieval Stage: Authorized IU calls SCs and takes LOCATION_ADDR as input to get the corresponding Key, where LOCATION_ADDR is read by IU from the Ethereum transaction stored by IO, and the corresponding Key is obtained by calling SCs. The search match is performed by SCs, which takes the input index as a parameter to search in the contract state and returns the corresponding RESULT if the match is successful. Corresponding steps 11, 12, 13, and 14 in Fig. 4.1

5) Use Stage: The verification part of zero watermarks is run by IU, which takes F0 , W0 , v, and Key as input and F as output. IU first gets Key according to the RESULT of the previous step, and gets encrypted F' , W' and v according to LOCATION_ADDR, and uses Key to correct F0 to get F. Corresponding steps 15, 16, 17, and 18 in Fig. 4.1.

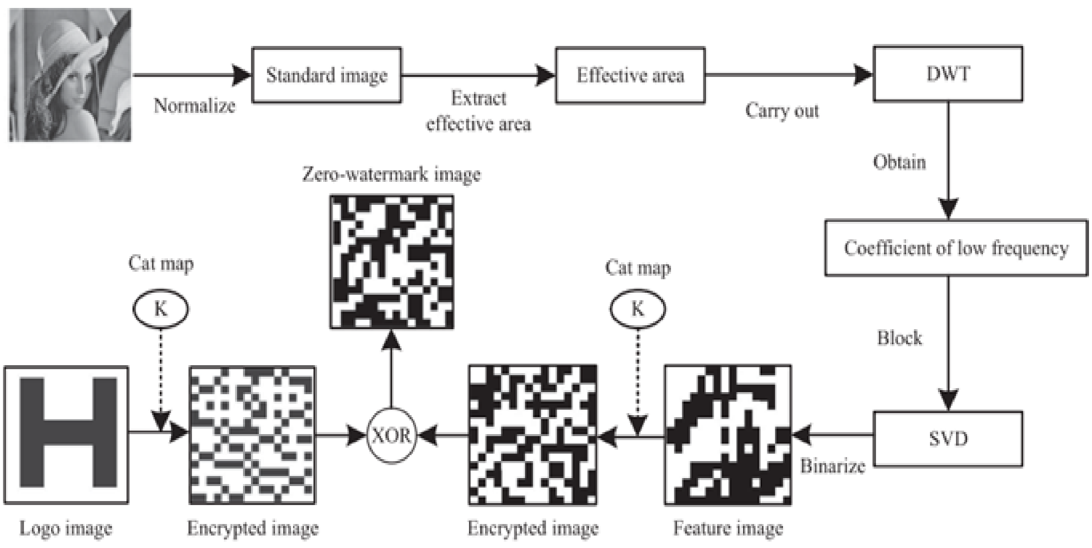

Figure 4.2 Zero-watermark generation flowchart

CHAPTER 5

IMPLEMENTATION AND RESULTS

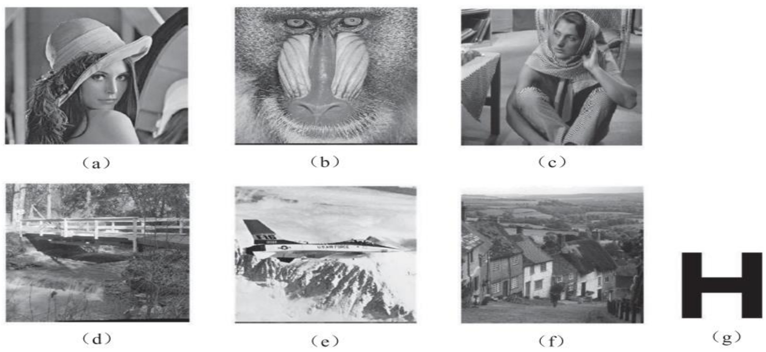

Figure 5.1 Seven figures for experiment

(a)Lena, (b) Baboon, (c) Barbara, (d) Bridge, (e) Airplane, (f) Goldhill, (g) Logo

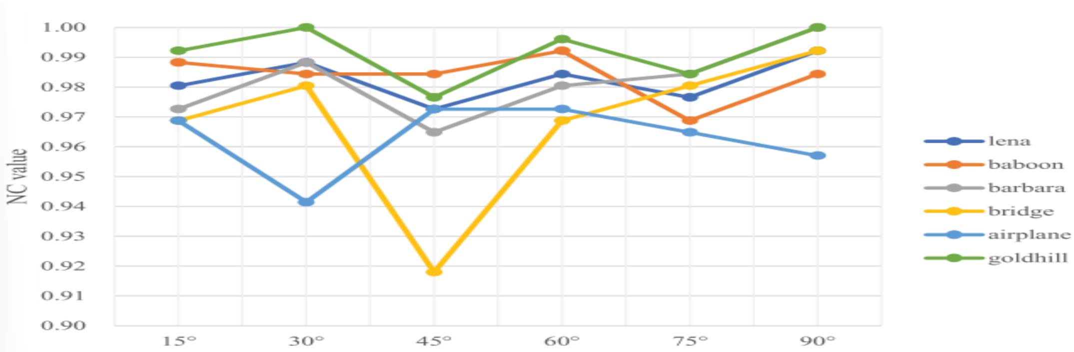

Figure 5.1.1 Rotation angle

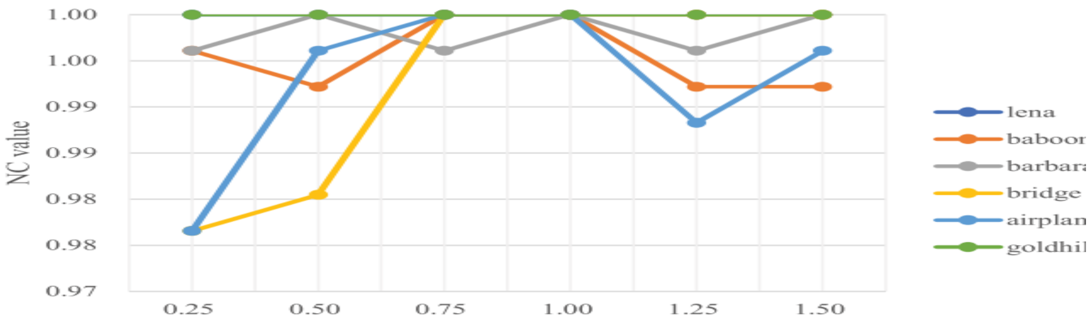

Figure 5.1.2 Scale multiple

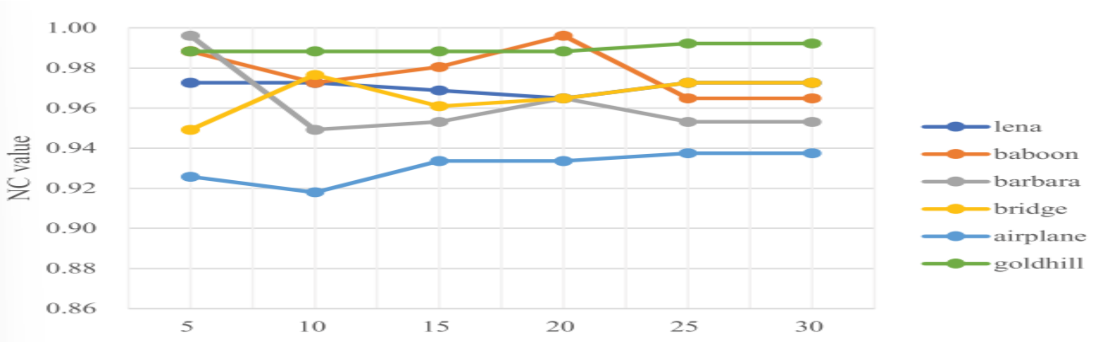

Figure 5.1.3 Number of transaction pixels

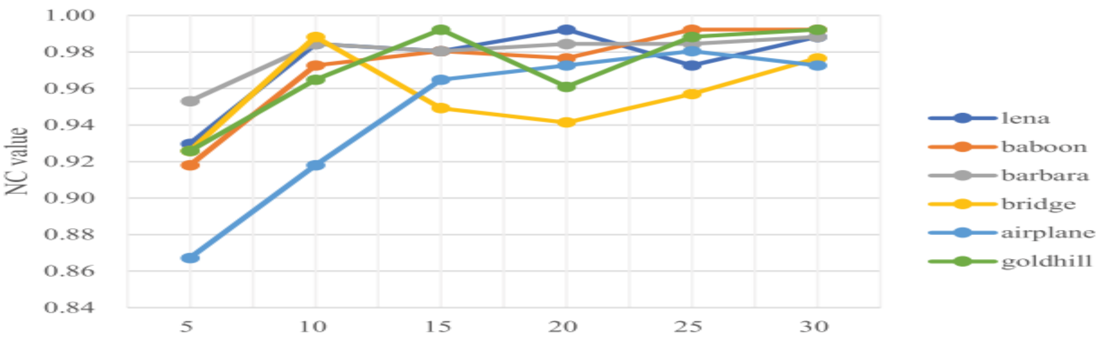

Figure 5.1.4 JPEG compression quality factor

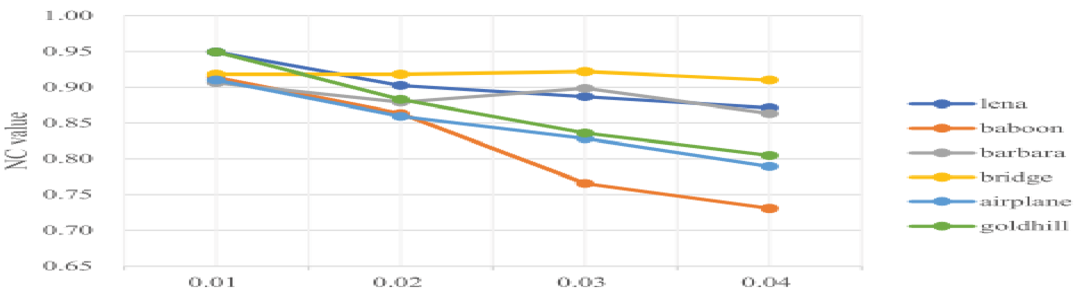

Figure 5.1.5 Gaussian noise variance

CHAPTER 6

PROS AND CONS

6.1 PROS

1. Immutable Ownership Records: Blockchain provides an immutable ledger of ownership records, ensuring that once copyright details are recorded, they cannot be tampered with or disputed easily.

2. Transparency and Trust: The transparent nature of blockchain technology fosters trust among stakeholders by providing a clear and verifiable record of ownership and usage rights.

3. Enhanced Security: Blockchain's decentralized architecture and cryptographic techniques enhance security, reducing the risk of copyright infringement and unauthorized usage of digital images.

4. Fair Compensation for Creators: By enabling transparent tracking of image usage and ownership, blockchain facilitates fair compensation for content creators, ensuring that they receive royalties for their work.

5. Preservation of Image Integrity: Zero-watermarking allows copyright information to be embedded in digital images without altering their visual appearance, preserving their aesthetic quality and market value.

6. Global Accessibility: Blockchain-based copyright protection can be accessed globally, making it easier for creators to protect their intellectual property rights across international borders.

6.2 CONS

1.Complex Implementation: Integrating blockchain technology and zero-watermarking into existing systems can be complex and costly, requiring specialized technical expertise and infrastructure.

2. Scalability Challenges: Blockchain networks may face scalability challenges, especially during periods of high transaction volume, which could affect the efficiency and responsiveness of copyright management systems.

3. User Adoption Hurdles: Users may face challenges in understanding and adopting blockchain-based copyright protection solutions, especially if they are not familiar with blockchain technology or its applications.

4. Regulatory Uncertainty: The regulatory environment surrounding blockchain and copyright law is still evolving, leading to uncertainty regarding legal standards and compliance requirements.

5. Potential Privacy Concerns: Storing copyright information on a public blockchain may raise privacy concerns, as sensitive data related to image ownership could be accessible to anyone with access to the blockchain network.

6. Risk of Centralization: Despite blockchain's decentralized architecture, there is a risk that certain entities or organizations could gain significant control over blockchain networks, potentially undermining their security and integrity.

CHAPTER 7

APPLICATION

Blockchain-based image copyright protection with zero-watermarking has significant applications in various industries where digital images are valuable intellectual property. Here's how it can be applied:

1. Photography Industry: Photographers can register their images on a blockchain platform, which records ownership and copyright details immutably. Zero-watermarking ensures that the visual integrity of the image remains intact, enhancing its aesthetic appeal and market value.

2. Stock Photography Platforms: Platforms offering stock images can utilize blockchain to authenticate the ownership of images in their database. This helps in preventing unauthorized usage and ensures that content creators receive fair compensation for their work.

3. Art Market: Artists and creators can protect their digital artworks using blockchain and zero-watermarking. This can prevent unauthorized reproduction and distribution of digital art pieces, ensuring that artists retain control over their creations and receive proper recognition and compensation.

4. Publishing Industry: Publishers can employ blockchain to manage copyright permissions for images used in books, magazines, and online articles. Zero-watermarking allows publishers to embed copyright information without altering the visual content, maintaining the image's quality and integrity.

5. E-commerce: Online retailers can use blockchain to verify the authenticity and ownership of product images. This can help in combating counterfeit products and ensuring that customers receive genuine merchandise.

6. Digital Advertising: Advertisers and marketers can protect their visual advertisements from unauthorized usage by leveraging blockchain technology. Zero-watermarking allows advertisers to embed copyright information discreetly, without detracting from the advertisement's effectiveness.

CONCLUSION

In conclusion, blockchain-based image copyright protection with zero-watermarking holds great promise for revolutionizing how digital images are managed, shared, and monetized. By leveraging the immutability and transparency of blockchain technology alongside the aesthetic integrity of zero-watermarking, this approach offers a robust solution for addressing the challenges of copyright infringement and unauthorized usage in various industries.

However, while the benefits are significant, it's essential to acknowledge the complexities and potential drawbacks associated with implementing such systems. Challenges such as technical complexity, scalability limitations, regulatory uncertainty, and user adoption hurdles must be carefully navigated to realize the full potential of blockchain-based copyright protection.

Despite these challenges, the potential advantages, including immutable ownership records, enhanced security, fair compensation for creators, and preservation of image integrity, make blockchain-based image copyright protection with zero-watermarking a compelling solution for safeguarding digital intellectual property rights.

Moving forward, collaborative efforts between technology developers, legal experts, content creators, and industry stakeholders will be crucial for overcoming these challenges and establishing robust frameworks for blockchain-based image copyright protection. With careful consideration of these factors, blockchain technology has the potential to revolutionize the way digital images are protected, valued, and shared in the digital age.

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