

Media Safety Threshold for the Digital Protection and Inheritance of Dunhuang Culture

-- Take NFT Technology as an Example

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Abstract: This paper delves into the utilization of NFT (Non-Fungible Token) technology for safeguarding and perpetuating Dunhuang culture, with a focus on media safety. It proposes a research methodology aimed at constructing a digital resource library and management platform utilizing this innovative technology. Addressing the imperative requirements of safeguarding work copyrights and establishing robust transaction mechanisms, it introduces the unique features of NFTs, such as non-fungibility and smart contract transactions, in a novel manner. By digitizing cultural artifacts, this approach establishes clear copyright and ownership attributes, facilitating transparent transactions and seamless transfers of ownership. Moreover, the paper explores the integration of NFT technology into the online dissemination and preservation of Dunhuang cultural works, which encompasses the creation of digital exhibitions and online museums. Through collaborative efforts both domestically and internationally, the digital works of Dunhuang culture are poised to garner global exposure, thereby enhancing its international significance. By delving into the future potential of NFT technology for safeguarding and perpetuating Dunhuang culture, this paper seeks to foster better cultural dissemination strategies, ultimately contributing to the enhanced protection, inheritance, and promotion of Dunhuang culture on a global scale.

Keywords: Dunhuang Culture; Digitization; Blockchain; Media Safety; NFT Technology.

1. Introduction

1.1. The Current Status of Inheritance and Protection of Dunhuang Culture

For centuries, Dunhuang culture has held a significant position within Chinese cultural heritage, earning the esteemed title of the "Museum of All Nations." Its strategic location and rich cultural tapestry have made it a pivotal junction for the exchange between Eastern and Western civilizations, embodying and chronicling over two millennia of cultural amalgamation. However, with the rapid advancement of Internet and digital technologies in contemporary times, traditional models of cultural dissemination face both opportunities and imperatives for evolution.

As a beacon of national civilization and religious heritage, and a prominent participant in the "Belt and Road" initiative, Dunhuang culture seized upon the auspicious convergence of platforms and policies, initiating the Digital Dunhuang project in the 1980s. Subsequently, since the early 1990s, the digitization of Dunhuang culture has witnessed rapid strides domestically and internationally, propelled by the swift progression of digital technologies. This digitization endeavor has primarily centered on grotto art relics, literature, and comprehensive information, with extensive exploration into backgrounds, technologies, system architectures, goal orientation, and intellectual property rights. These efforts have yielded remarkable achievements, disseminated widely through various channels. Notably, significant advancements have been made in the digitization technology applied to grotto art relics, laying a robust theoretical groundwork for the trajectory of Dunhuang studies' digital evolution. The Digital Dunhuang project has flourished, yielding abundant fruits of labor.

Nevertheless, the burgeoning success of the Digital Dunhuang project has ushered in fresh challenges in terms of regulation and intellectual property rights, coinciding with the advent of the digital economy. The allure and enigmatic cultural charisma of ancient Dunhuang have engendered widespread public interest and awareness, while the ascent of smart cultural tourism has transcended traditional temporal and spatial constraints, broadening the patronage across diverse regions and demographics. This dynamic plays a pivotal role in the preservation and advancement of Dunhuang culture. However, the extensive digital dissemination has not been without its drawbacks; insufficient IP copyright protection has led to rampant replication and misuse of the "Digital Dunhuang" resource repository, spawning a proliferation of counterfeit products featuring Dunhuang motifs in local markets. This not only erodes the authenticity and scarcity of the original IP but also undermines the competitiveness and profitability of legitimate products. Thus, ensuring media integrity throughout the digitization process of Dunhuang culture, implementing stringent supervision and management of digital assets, and deploying pertinent technical control measures assume paramount importance.

2. Intervention of the NFT Media Security System

2.1. Media Security Threshold Theory

According to the latest cybercrime report released by Cybersecurity Ventures, by 2025, cybercrime is expected to cause \$10.5 trillion in losses, a qualitative increase from \$3 trillion in 2015. The "Overall Layout Plan for Digital China Construction" also clearly proposes to "build a trusted and controllable digital security barrier." 2024, as an important node marking the tenth anniversary of the overall national

security perspective proposed, the process of digital protection and inheritance of Dunhuang culture needs to ensure security of links and media security.

The concept of media security aims to consider the use and impact of media from the perspectives of maintenance and guarantee, focusing on the potential threats and risks of media to personal, social and national security. Its relationship and influence in the digitization of Dunhuang culture and art trading dissemination can be understood from the following aspects:

Firstly, ensure the information security of digital resources and trading platforms to prevent computer viruses, hacker attacks and other network behaviors, and protect the security of digital resources and transaction data. For example, in the process of digitization of Dunhuang culture, digitized relic pictures and materials need effective protection against malicious theft, tampering or sales. For art trading platforms, ensuring confidentiality and integrity of transaction data is also a primary task. Identity verification mechanism should also be implemented to prevent fake or quasi transaction entities from participating in transactions and causing risks. In art transactions, ensuring the authenticity and reliability of the identities of buyers and sellers can reduce transaction risks and fraud. Preventing network fraud requires effective monitoring and identification of network fraud to avoid fraudulent activities that damage the interests of transaction entities during transactions.

Protect intellectual property rights to prevent illegal dissemination and plagiarism of digital resource contents, and maintain the interests of content creators and resource owners. In the digitization of Dunhuang culture, protecting the intellectual property rights of digital resources such as Dunhuang murals and cultural relic research achievements is extremely important, with key points in strengthening copyright protection for digital resources and preventing piracy. In addition, strengthen supervision of transaction market order, standardize irregular transaction behaviors such as manipulation and insider trading to promote fair competition in transactions. This can prevent fraudulent advertising, price manipulation and other improper behaviors to maintain the fairness and transparency of transactions.

Meanwhile, the role of new technologies needs to be given full play to encourage improving network security protection

capabilities. Blockchain and non-fungible token (NFT) technologies can be used to ensure the traceability, uniqueness and anti-counterfeiting of works of art, thereby improving the safety and credibility of art transaction [3].

Finally, media security aims to improve the orientation of public opinion on the internet and guide correct propagation of cultural values in online dissemination to promote cultural exchange. In the digitization of Dunhuang culture and dissemination of art transactions, suppressing the spread of false information and promoting the truthful and accurate communication of cultural values and artworks information can improve the quality and reliability of public opinion online.

2.2. The Application Adaptability of Blockchain Technology in Dunhuang Culture

The rise of emerging art markets and the enhanced purchasing power in Asia, the Middle East and other regions have driven rapid growth in the art market. Online auctions and art exhibitions have also expanded market boundaries, making art transactions more widely participated. According to a research analysis report on the Chinese art market, in 2021, the number of art auctions in China reached 63,400, up 59.84% year-on-year. The industry warmed up rapidly. By 2023, the domestic art auction market scale will increase sharply year-on-year, with 220,000 lots (sets) put up for auction, 135,000 lots (sets) sold, and a total turnover of RMB 40.7 billion, up 31% year-on-year. Due to the needs of copyright control and market regulation, some high-tech technologies have been privately applied to a certain scope of market management and gradually promoted, through which blockchain has gradually entered the public view.

By definition, blockchain is a new application pattern combining distributed data storage, encryption algorithms, consensus mechanisms and peer-to-peer transmission technologies. It has characteristics of decentralization, traceability, tamper-proof and public transparency. NFTs have uniqueness and can bind users' unique assets to digitally abstract tangible items and turn them into "digital assets" owned by owners.

```
pragma solidity ^0.4.20;

interface ERC721 /* is ERC165 */ {

    event Transfer(address indexed _from, address indexed _to, uint256 _tokenId);
    event Approval(address indexed _owner, address indexed _approved, uint256 _tokenId);
    event ApprovalForAll(address indexed _owner, address indexed _operator, bool _approved);

    function balanceOf(address _owner) external view returns (uint256);
    function ownerOf(uint256 _tokenId) external view returns (address);

    function safeTransferFrom(address _from, address _to, uint256 _tokenId, bytes data) external payable;
    function transferFrom(address _from, address _to, uint256 _tokenId) external payable;

    function approve(address _approved, uint256 _tokenId) external payable;
    function setApprovalForAll(address _operator, bool _approved) external;
    function getApproved(uint256 _tokenId) external view returns (address);
    function isApprovedForAll(address _owner, address _operator) external view returns (bool);
}
```

Fig 1. Programming protocol for NTF: ERC721 standard

In the field of NFT art, NFT tokens are often closely combined with digital art and performance art, thus deriving a new form of art - crypto art. Crypto art has very clear characteristics determined by the "decentralization" of blockchain technology, widespread transactions beyond national boundaries and geography, and various forms of art. After artworks become NFTs, "authentication of authenticity" will no longer exist, and the blockchain will record every transaction and every owner on record, allowing anyone to clearly query who the owner of an NFT is. Therefore, NFT has its unique advantages in copyright protection. Through blockchain, art transactions become faster and more convenient, greatly reducing the cost of authentication, making art transactions safer.

Currently, the domestic NFT market is still immature, but its development potential has still attracted the attention of relevant departments. The "13th Five-Year Plan" issued by the State Council proposed to strengthen strategic emerging technologies such as blockchain and advance planning. The Ministry of Industry and Information Technology has also released a white paper stating that early formulation of standards for the core technologies of blockchain development process is needed. Against this backdrop, closely combining blockchain technology with the art transaction market can help promote the development and optimization of art transaction models. Therefore, using NFT as an entry point to study its effects on the digital management and control of Dunhuang culture has certain representativeness and can provide examples for the digital protection and dissemination of China's traditional cultural heritage.

2.3. Working Principles of NFT Technology and Mechanism for Protecting Digital Works

In the realm of industry operations, blockchain technology

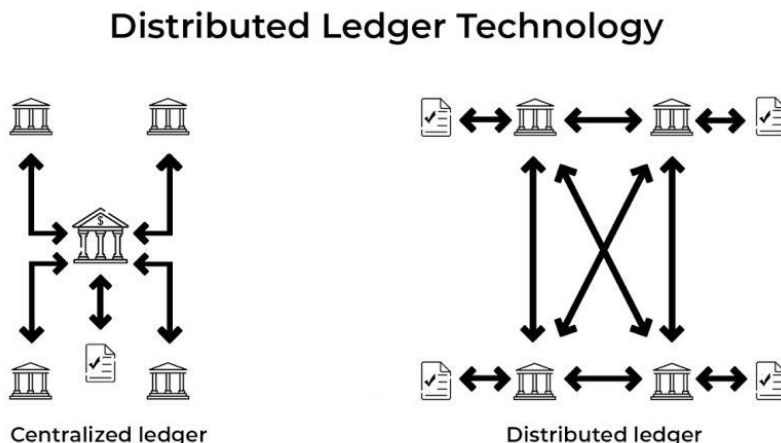


Fig 2. Distributed ledger technology schematic

For example, when a digitized Dunhuang mural image is uploaded to the network for dissemination and transactions, media security measures can include encrypting and watermarking the image to prevent unauthorized copying and dissemination. At the same time, establish a secure trading platform, adopt identity authentication mechanisms and transaction oversight measures to ensure the authenticity and reliability of transaction entities and prevent fraudulent activities. In addition, blockchain technology can be used to record the transaction history and ownership information of

offers the capability to construct robust data modules grounded in continuously amassed authentic data, thereby fostering the standardization of the art industry and safeguarding its sustained growth. The genesis of blockchain can be traced back to Satoshi Nakamoto's seminal paper, "Bitcoin: A Peer-to-Peer Electronic Cash System," published in 2008. Nakamoto delineated blockchain as a distributed ledger framework facilitating value exchange via Bitcoin or other trusted instruments, underpinned by cryptographic protocols ensuring the immutability of transaction records. The advent of Bitcoin stands as one of the pioneering demonstrations of blockchain technology's efficacy.

Leveraging the distributed ledger architecture of blockchain, a transparent and open ecosystem for the entire lifecycle of artworks can be established. This model disperses data storage across multiple nodes, adhering to principles of decentralization, consensus mechanisms, encryption protocols, immutability, data replication, synchronization, scalability, and performance. Consequently, all nodes equally engage in ledger management, including the verification and validation of art transactions. The consensus mechanism guarantees alignment among nodes regarding the status and transactions of artworks, while encryption fortifies data security and transaction authenticity. Essentially, pertinent files and transaction details of artworks are permanently archived, with every transactional event being meticulously recorded on the blockchain. Moreover, the data replication and synchronization mechanisms ensure ledger consistency across nodes, thereby ensuring the integrity, transparency, and reliability of the system. This framework enables stringent oversight of on-chain information by tax authorities and artists worldwide, fostering data authenticity and enabling identification and rights confirmation grounded in circulation records.

artworks to ensure their authenticity and anti-counterfeiting, improving transaction security. These media security measures help protect the safe dissemination of digitized Dunhuang cultural resources and artworks, maintain the interests of transaction entities, and promote the sustainable development of digital cultural content.[5]

3. Application of NFT in Digital Protection of Dunhuang Culture

3.1. Construction of NFT Digital Resource Library and Management Platform

In the process of applying NFT technology to the digital protection of Dunhuang culture, standards need to be formulated first for different types of digitized Dunhuang cultural resources, such as literature, artworks pictures, etc. These standards should include metadata of digital resources, copyright attribution and traceability information. By combining such standards with unique NFT digital tokens, the uniqueness and authenticity of digital resources can be ensured.[6]

Given the intrinsic value and confidentiality of cultural digital resources, the trading process of all materials data must rely on standardized platforms as carriers. This requires using blockchain technology to establish an NFT platform dedicated to Dunhuang cultural digital resources. The platform can record and manage the NFT tokens of each digital resource to ensure their immutability and transparency. A core resource database should also be established for Dunhuang cultural digital resources. Classify, annotate and manage various digitized resources that have been scanned and compiled to provide a basis for resource uploading and NFT token generation. Such a database can facilitate the management and maintenance of integrity and accuracy of Dunhuang cultural digital resources. By generating immutable NFT tokens for each digital resource, the uniqueness of digital identity of each resource can be ensured. This verification mechanism can prevent theft and tampering of digital resources and protect copyright and authenticity of Dunhuang cultural digital resources. An authorization management mechanism should be established to support various authorization models, such as setting different field usage authorizations for Dunhuang cultural digital resources, including dissemination, exhibition, research, etc. The authorization management mechanism can ensure the legitimate use of digital resources and facilitate cooperation and communication of resources.

In addition to legitimate use, reasonable utilization of digital resources and value creation require establishing trading and communication modules to support online viewing, trading and business cooperation of digital resources. Such modules can promote circulation and value realization of Dunhuang cultural digital resources to support development of the digital cultural industry. Multi-business around resources: In addition to storage and management functions, the NFT digital resource platform can also carry out diversified businesses around Dunhuang cultural digital resources. For example, establish digital galleries, virtual environments and e-commerce platforms to exhibit and promote Dunhuang culture through digitization and expand the value and influence of resources. On this basis, to ensure sustainable and efficient management of the platform and resources, it is necessary to establish a mechanism for continuous improvement and updating. Regularly update and maintain the platform, fix bugs, improve functions to adapt to changing digital protection and communication needs.

3.2. Realizing Copyright Protection and Transaction Mechanism for Works

Through “NFTization”, the copyright attribution and

ownership attributes of each digital work can be clarified, providing legal protection and recognition of interests for artists and cultural institutions. This requires strengthening identity authentication and copyright confirmation to ensure that each NFT work is closely associated with its creator and copyright information and includes relevant information and digital signatures in the metadata. Secondly, formulating specifications and protective measures for smart contracts to ensure their legality and compliance, and clarify the interests of creators such as copyrights, usage rights and revenue sharing.

Establish a decentralized trading platform to ensure transaction transparency, fairness and security, using smart contracts to execute transactions and provide an effective dispute resolution mechanism. Record the process of replacement transactions and changes of property rights for each work on the trading platform. Ensure the transparency and traceability of the transaction process of works and support secondary trading legally. Support limited digital releases to give limited edition digital works scarcity.

In addition, enhance regulatory and compliance measures - regulatory agencies should strengthen supervision of the NFT market, formulate a compliance framework to guarantee copyright protection, anti-money laundering and investor protection. At the same time, provide relevant training and guidance through education and awareness raising to enhance creators, trading platforms and users' understanding of NFT technology and copyright protection.

Finally, within the maximum possible scope, strengthen international cooperation and standard formulation to promote the establishment of international standards and cooperation mechanisms to ensure consistency and interoperability of copyright protection and transaction mechanisms globally. By comprehensively applying these measures, the copyright protection and transaction mechanism for NFT works can be improved to provide creators and transaction participants with a safe, fair and transparent trading environment.

3.3. Promoting Online Dissemination and Inheritance of Digital Works

To promote the dissemination and inheritance of digital works online, the gap between audiences and works needs to be minimized as much as possible by creating an intuitive access system. Firstly, establish digital platforms and online exhibitions to provide convenient access and sharing functions, and archive digital artwork collections to create permanent digital records. Highly faithful digitization of artworks ensures their long-term preservation and widespread dissemination. The platforms should support online display of digital artworks. By utilizing online display functions provided by the platform combined with augmented reality (AR), virtual reality (VR) and other technologies, users can be provided with a more immersive artistic experience to widely exhibit Dunhuang cultural digital artworks and create a rich and diverse multimedia display and interactive experience. Technological means can be used to enhance the audience's sense of immersion. Cross-border cooperation and cross-cultural exchanges will create new forms and experiences of digital artworks.

Secondly, actively promote and publicize digital artworks through social media and online communities to enhance participation. Guide netizens to participate in interactive discussions such as comments, likes and shares to enhance

users' sense of participation and identification with cultural works. Deeply integrate with social platforms such as WeChat and Weibo to strengthen dissemination effects, enabling one-click sharing and promotion of artworks and expanding their scope of influence. Competition or educational and training activities related to Dunhuang culture can be organized on the platform to raise public awareness and understanding of digital artworks. Strengthen international cooperation and exchanges to promote the dissemination and inheritance of digital artworks globally.

4. Operation Construction and Future Prospects

4.1. Future Feasibility Research of NFT

As a new generation of Internet technology, NFT has huge development potential and shows broad feasibility in protecting and inheriting Dunhuang culture. It will become an important model for digital art products and cultural products.

Through blockchain technology, NFT can ensure the copyright uniqueness of Dunhuang cultural works, affix a unique immutable digital signature to each digital cultural product, and solve the problem of copyright confirmation. Realizing digital identity authentication of cultural relics can annotate cultural relic resources with metadata and tokenize assets, and create immutable ownership certificates and digital copyright documents on the blockchain to effectively protect the uniqueness and interests of cultural relics. NFT technology also brings innovative copyright transaction models and supports online trading, transfer and collection of digital cultural products, injecting new impetus into Dunhuang cultural undertakings. Establishing a special NFT platform can digitally archive and preserve Dunhuang relics and artworks in the long run to ensure the security of cultural resources.

At the same time, NFT technology also helps enhance

copyright protection by developing story-based digital content with regional characteristics or personalized themes, forming personalized and cross-media content industries, and promoting dissemination and interaction of Dunhuang cultural content on social media platforms to increase social influence.

Therefore, NFT technology provides many potential opportunities and innovative ways for the protection and inheritance of Dunhuang culture. It can ensure the independence of works, promote cultural transactions and dissemination, and endow new digital identities and values to Dunhuang cultural works. From this perspective, the application of NFT technology can realize digitized preservation, widespread dissemination and innovative development of Dunhuang culture.

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