DIGITAL ART OWNERSHIP AND AUTHENTICATION USING NFT'S

BACHELOR OF TECHNOLOGY

IN

COMPUTER SCIENCE AND ENGINEERING

Use Case Report

submitted by

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Kanuru, Vijayawada-520 007

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CERTIFICATE

This is to certify that the Use Case report entitled "**DIGITAL ART OWNERSHIP AND AUTHENTICATION USING NFT'S**" that is being submitted by **Maturi Mukhesh (22501A05A7)** as part of Assignment-1 and Assignment-2 for the Blockchain Technology(20CS4601C) course in 3-2 during the academic year 2024-25.

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1.Introduction

Blockchain technology has revolutionized various industries, and the digital art market is no exception. With the advent of Non-Fungible Tokens (NFTs), digital artists can now tokenize their creations, ensuring ownership, provenance, and monetization. NFTs provide a secure and immutable way to trade digital assets, eliminating fraud and unauthorized duplication.

Digital art, unlike traditional art, exists purely in a digital format, making it difficult to establish ownership and authenticity. The introduction of NFTs enables digital assets to have unique, verifiable ownership, solving key problems such as duplication and piracy. The blockchain-based system ensures that transactions are tamper-proof, creating a reliable marketplace for both artists and collectors.

One of the most significant advantages of blockchain-based digital art is that it allows for decentralization, meaning no central authority controls the buying, selling, or distribution of artwork. Instead, transactions are recorded on a distributed ledger, ensuring transparency and trust between buyers and sellers.

The NFT revolution is not only changing the way digital art is sold but also expanding the definition of digital ownership. With NFTs, artists can create limited edition pieces, prove authenticity, and even program royalties that ensure they receive a percentage of future resales. This level of control over digital assets was previously unattainable, making NFTs a groundbreaking innovation for creatives.

Blockchain technology has revolutionized various industries, and the digital art market is no exception. With the advent of Non-Fungible Tokens (NFTs), digital artists can now tokenize their creations, ensuring ownership, provenance, and monetization. NFTs provide a secure and immutable way to trade digital assets, eliminating fraud and unauthorized duplication.

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2.Background

2.1 Current Challenges in Digital Art

Despite the growing popularity of digital art, artists face several significant challenges that hinder their ability to monetize and protect their work effectively:

- Ownership & Provenance Issues: Digital files can be copied and shared endlessly, making it difficult for artists to prove ownership and originality.
- Monetization Barriers: Traditional online platforms impose high fees, limiting artists' earnings and providing no resale royalties.
- Market Accessibility: Emerging digital artists struggle to gain visibility and attract collectors in a competitive marketplace.
- Copyright Infringement: Digital art is frequently stolen, altered, or resold without the artist's consent, leading to widespread unauthorized reproduction.
- Lack of Transparency: Many platforms have unclear pricing structures and commission fees, reducing trust in digital art transactions.
- Security Concerns: Digital assets stored on centralized platforms are vulnerable to hacking, data breaches, or server failures.

2.2 How Blockchain solves these issues

Blockchain technology, particularly through NFTs, addresses these challenges by providing a secure, decentralized, and transparent system for managing digital art transactions:

- Immutable Ownership Records: Every NFT is recorded on the blockchain, ensuring a transparent and tamper-proof proof of ownership.
- Automated Smart Contracts: Smart contracts enable artists to receive royalties automatically on every resale.
- Global Marketplace Access: NFT platforms eliminate geographical barriers, allowing artists to reach international audiences.
- Enhanced Copyright Protection: Blockchain timestamps every transaction and artwork, reducing the risk of copyright disputes.
- Transparent Transactions: Blockchain records are publicly verifiable, ensuring fair pricing and ownership tracking.
- Decentralized Ecosystem: Unlike centralized platforms, blockchain allows artists greater control over pricing and distribution.
- Improved Security: The decentralized nature of blockchain significantly reduces the risk of data manipulation or hacking.

With these benefits, blockchain is transforming digital art into a more equitable and accessible market for artists worldwide.

3.Blockchain Basics

3.1 Blockchain Paradigms

Blockchain is a distributed, decentralized and cryptographic ledger characterized by blocks of immutable recorded transactions shared among multiple nodes linked in a P2P network. The main characteristics of blockchain are transparency, security, reliability, traceability and censorship-resistant. These characteristics, gives untrusted participants the possibility to communicate and send transaction between each other without any need of a trusted third party. The components that are usually included inside a blockchain and integrated inside a single software client are:

• "A P2P network connecting participants and propagating transactions and blocks of verified transactions"

• Messages as transactions.

• A consensus rule used to guarantee the validity of a transaction.

• A State machine that according to consensus rule defined, process the transaction.

• A Chain in which are constantly added and linked all the valid blocks.

• A consensus algorithm used to decentralize the control over the blockchain, by forcing participants to cooperate in the enforcement of the consensus rules.[3]

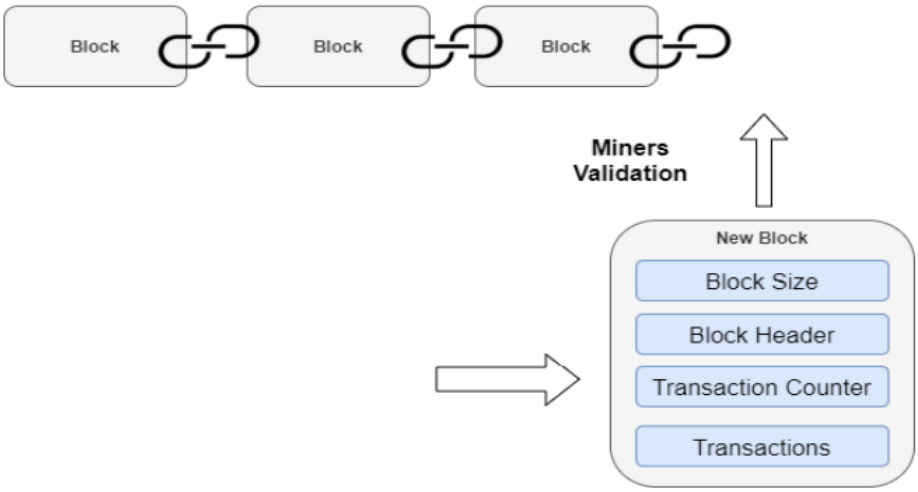

Fig 3.1: Block Structure

Courtesy: (https://www.politesi.polimi.it/retrieve/8794674c-fd5a-4ac3-bcf1-a7cfc2c8f5df/Davide_Clementi_Master_Thesis.pdf)

The Blockchain technology is made by units of blocks as shown in figure 3.1, each one is characterized by:

• The block size, representing the dimension of the block

• The block header will be described as shown in figure 3.2

• Transaction Counter is the number of transactions inside the block

• The version of the protocol used

• The timestamp which report the time in which the block has been mined

• The difficulty is an indicator of how challenging was the problem to solve for miner

• A pure numeric value named nonce

• A reference to the block that comes before the new one inserted. This connection has done including the previous block hash[4]

• the root hash of the Merkle tree, representing the way transactions are organized inside the block Bitcoin and Ethereum). Merkle tree is a tree data structure in which parent nodes have pointers to child nodes as reference and the leaves contain the hash of the transactions.[4]

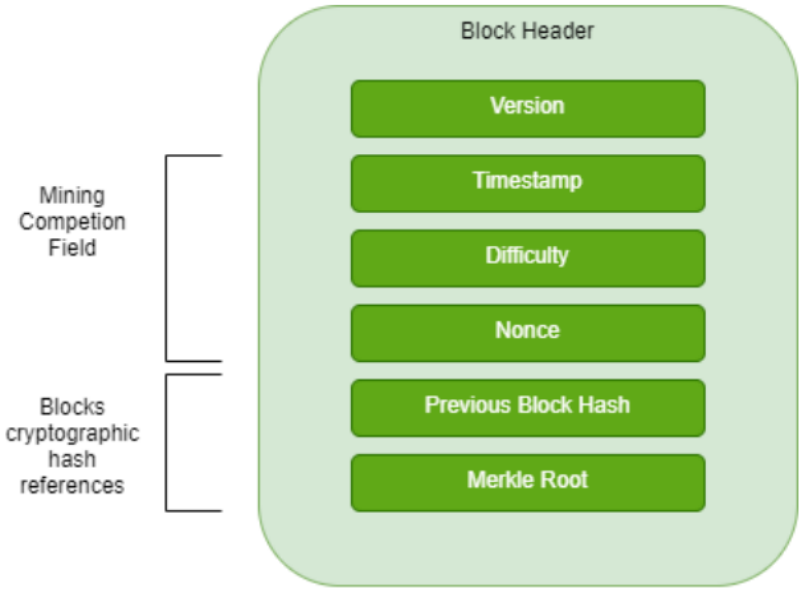

Fig 3.2: Block Header

Courtesy: (https://www.politesi.polimi.it/retrieve/8794674c-fd5a-4ac3-bcf1-a7cfc2c8f5df/Davide_Clementi_Master_Thesis.pdf)

3.2 Consensus Algorithm

Consensus algorithm has a crucial importance inside the blockchain ecosystem. The two kinds of consensus algorithm which are currently widely used are

• Proof-of-work where the participants in order to mine and validate a block are required to solve a computational problem of increasingly difficulty. Each participants proportionally with its effort is then rewarded with an amount of coins specific to the blockchain. The algo12 rithm can be defined as function of the number of participants and the difficulty of the computational problem to solve.

• Proof-of-stake is intrinsically linked to stake or in better word the currency holding. The higher is the stake the higher is the credibility and assurance that the node will not try to tamper the ledger. The algorithm gives a proportional weight to each node according to its stake. [5]

3.3 Smart Contracts

Smart contracts represent program that operates inside the blockchain, their development is useful to automatize and customize transactions according to the different needs. Their main characteristics are to mirror the main functionalities of the real contract without the need of a third-party certification authority. Smart contract as a real-world contract represents a binding agreement between two or more parties. The smart contract is automatically executed once the terms of an agreement of the specified conditions are met. The absence of a third party is justified by the distributed and verified code execution among the network nodes that are inside the blockchain network. Smart contracts need to consume gas to make the transaction works, this cost of execution belongs to the fact that the transaction is executed on multiple nodes and each one need a reward for the usage of their computational power. Another important characteristic is that as a real-world contract smart contract are immutable and not censorable. The range of Smart contract application is very wide, some of the many cases of usage can be smart propriety, e-commerce, real-estate, business process and even digital/musical property.

3.4 NFT

NFTs (Non-Fungible Token) differently from the fungible token are not interchangeable since they have to represent unique assets. This kind of token is linked to the need of representing digital, copyright property of collectible object that for their nature must be unique. Another important property is the indivisibility, the fact that this kind of token represent unique and not interchangeable object make it unfeasible and unreasonable to consider the possibility to fractionize it. Another important point is that even if the data to which the NFT refers may have other copies, each single NFT creation is considered as unique. In better word if we got a unique digital asset, we might create different NFT from it but each one will be distinguishable from the other one since each one will have a different hash identifier. For example, we can say that even if someone create another token from the same art work the identifier associated to it will be different and distinguishable from what was the real owner identifier; consequently, we can say who is the real owner of the original asset. For each mint is possible to track all the asset property movement from an owner address to another and everything got a timestamp where all the passages are visible to everyone. One of the most famous implementations of this interface is in 2017 with “criptokitties” a game created on top of Ethereum, the popularity of this project paved the way for the usage of NFT in also other fields. In particular this new token was really suitable to keep track of what can be named as intellectual property especially the digital one. Recently at the end of 2020 and 2021 NFT start to become very used among digital content creator, artists and brand that want to sold their unique product[17]. The standard used by Ethereum to manage the NFT is ERC721. One of 15 the main difference between this kind of interface and the ERC20 standard is different management of the address and in particular the link between the addresses and the token. In ERC20 the necessity was to create a link between the address and the token, in the ERC721 there are an association between an address and multiple token since each one may be unique.[2]

4.Use Case Overview

4.1 Objectives

The primary objective of this use case is to leverage blockchain technology to revolutionize the digital art industry by ensuring authenticity, ownership, and secure transactions for artists and collectors. The specific objectives include:

- Providing a Secure Marketplace: A decentralized NFT marketplace where artists can tokenize their artwork, ensuring that each piece is unique and verified on the blockchain.
- Enabling Transparent Transactions: All transactions related to NFT sales and resales are recorded immutably on the blockchain, ensuring trust and accountability.
- Automating Royalty Payments: Smart contracts enable artists to receive automatic royalties on secondary sales without intermediaries.
- Ensuring Ownership Verification: Blockchain technology ensures verifiable ownership records, reducing fraud and unauthorized duplication.
- Reducing Dependence on Intermediaries: Unlike traditional art markets, where auction houses and galleries control pricing and access, NFT platforms allow direct artist-to-buyer interactions.
- Increasing Global Market Access: Digital artists worldwide can list their artwork on NFT marketplaces without restrictions, reaching a broader audience.
- Enhancing Copyright Protection: Timestamped blockchain records act as immutable proof of creation, preventing unauthorized reproduction.

4.2 Scope

This use case applies to digital artists, collectors, investors, and NFT marketplaces. The implementation involves various stakeholders, including:

- Digital Artists: Individuals creating digital art who want to sell or license their work through NFTs.

- Buyers/Collectors: Individuals or institutions purchasing NFTs for personal collection, investment, or commercial purposes.
- NFT Marketplaces: Platforms like OpenSea, Rarible, and SuperRare that facilitate the minting, buying, and selling of NFTs.
- Blockchain Networks: Public blockchains like Ethereum, Solana, and Tezos that store and verify NFT ownership records.
- Smart Contracts: Deployed on the blockchain to automate transactions, enforce royalty payments, and manage NFT transfers securely.
- Cryptocurrency Wallets: Digital wallets such as MetaMask and Trust Wallet, used to store and manage NFT assets and payments.

The use case does not cover physical artworks or non-blockchain digital art markets. It focuses exclusively on tokenized digital art assets managed through blockchain infrastructure.

4.3Architecture

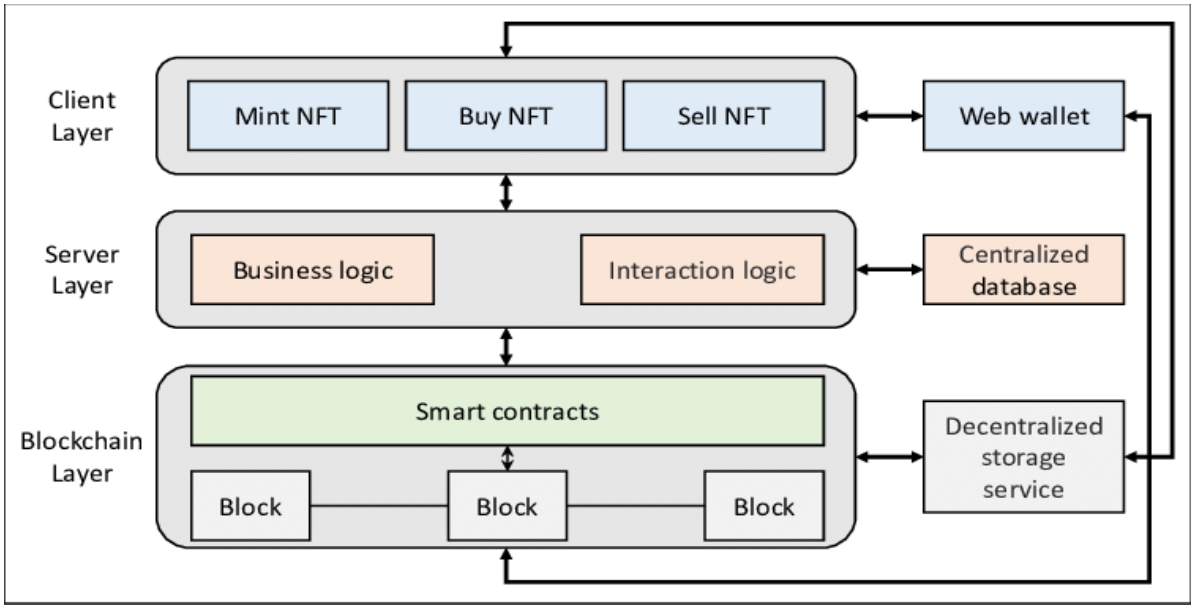

Fig 4.1: three Layer NFT Architecture

Courtesy:
(https://www.researchgate.net/publication/363080792/figure/fig2/AS:11431281081494833@1661822456520/Traditional-three-layer-NFT-architecture.png)

The architecture diagram for the Digital Art NFT Ecosystem consists of three primary layers as shown in figure 4.1:

1. Client Layer (User Interface)
2. Server Layer (Business and Interaction Logic)
3. Blockchain Layer (Decentralized Ledger and Smart Contracts)

Each layer plays a crucial role in the lifecycle of an NFT.

4.3.1. Client Layer

This layer represents the user-facing components where artists, collectors, and investors interact with the NFT ecosystem.

- Mint NFT – Artists create and upload digital artwork to tokenize it as an NFT.
- Buy NFT – Collectors purchase NFTs through the marketplace using cryptocurrency.
- Sell NFT – Owners of NFTs can resell them on secondary markets.
- Web Wallet – Digital wallets like MetaMask and Trust Wallet store NFTs and cryptocurrencies for transactions.

This layer facilitates seamless interaction between users and the NFT ecosystem.

4.3.2. Server Layer

The server layer manages the business logic and interaction logic between the front end and blockchain.

- Business Logic – Handles NFT marketplace operations, such as listing, bidding, and transaction management.
- Interaction Logic – Manages communication between the client interface and blockchain.
- Centralized Database – Some platforms use centralized storage for metadata (e.g., images, descriptions) to enhance efficiency.

While NFTs are stored on the blockchain, metadata can be stored in a hybrid fashion, combining both centralized and decentralized storage.

4.3.3. Blockchain Layer

This is the decentralized and immutable backbone of the system, ensuring trust, security, and transparency.

- Smart Contracts – Automate NFT minting, transactions, royalties, and ownership transfers.
- Blocks (Ledger) – Transactions and NFT ownership records are stored permanently on the blockchain.

- Decentralized Storage Service – Since storing large files directly on a blockchain is expensive, decentralized storage solutions like IPFS (InterPlanetary File System) or Arweave are used to store artwork.

End-to-End Process Flow

1. Minting – Artists upload artwork and create an NFT.
2. Transaction Execution – Buyers purchase NFTs, and transactions are recorded on the blockchain.
3. Ownership & Royalties – When NFTs are resold, smart contracts ensure artists receive royalties automatically.
4. Decentralized Storage – Digital artwork is stored securely on IPFS or another decentralized solution, ensuring permanent access.

5.Implementation

5.1 Choosing a Blockchain Network

NFTs rely on blockchain for immutability, security, and decentralization. Choosing the right blockchain is crucial for efficiency, cost, and scalability. For this use case Public blockchain is better choice because of

- Decentralization: No single entity controls the NFT marketplace.
- Interoperability: NFTs can be traded across different marketplaces.
- Security: Public validation prevents unauthorized modifications.
- Smart Contracts: Automate NFT transfers and royalty distribution.[7]

5.2 Smart Contract Development

NFT transactions are executed via smart contracts, which define rules for minting, buying, selling, and royalty payments.

Smart Contract Standards:

- ERC-721: Unique, non-fungible tokens (1:1 ownership).
- Solidity (Ethereum's smart contract programming language).[6]

Key Functionalities of the Smart Contracts are

1. Minting NFTs
    - Artists upload their digital artwork.
    - Metadata (title, creator name, description, etc.) is stored on IPFS.
    - The smart contract assigns a unique NFT ID.
2. Buying & Selling NFTs
    - Buyers send cryptocurrency (ETH, MATIC) to the smart contract.
    - Ownership is transferred automatically via the blockchain.
    - Transaction details are recorded immutably.
3. Royalty Payments
    - Smart contracts ensure that artists receive royalties on secondary sales.
    - Example: If an NFT is resold, 10% of the price goes to the original artist.
4. Ownership Verification
    - The blockchain ledger maintains records of NFT ownership.
    - Users can verify authenticity via blockchain explorers.

5.3 Metadata and Decentralized Storage

NFTs need metadata to store digital art details securely.

Decentralized Storage

To ensure long-term preservation and decentralization, NFT metadata is often stored using decentralized file storage solutions like IPFS (InterPlanetary File System) and Arweave.

- IPFS (InterPlanetary File System): A peer-to-peer file-sharing protocol that ensures permanent access to NFT metadata by distributing it across multiple nodes.
- Arweave: A blockchain-based permanent storage network designed to securely store large digital files for long-term access.

5.4 NFT Marketplace Development

A marketplace enables users to mint, buy, and sell NFTs.

Features of the NFT Marketplace:

1. User Authentication
    - Users connect their MetaMask or WalletConnect wallets.
    - Blockchain authentication eliminates username-password logins.
2. NFT Minting
    - Artists can upload digital files (JPEG, PNG, GIF, MP4, etc.).
    - Smart contract mints an NFT and links it to IPFS metadata.
3. Listing & Bidding
    - Users list NFTs with fixed-price or auction-based sales.
    - Buyers place bids, and smart contracts process transactions automatically.
4. Transaction Processing
    - Payments are made in ETH/MATIC.
    - Gas fees are calculated dynamically.
5. Royalty Enforcement
    - Smart contracts ensure automatic payouts for artists.
    - Artists continue earning from secondary sales.
6. Search & Filtering
    - Users can search for NFTs by categories, price range, and creator.

6.Benefits

6.1 Ownership and Authenticity

NFTs provide artists with immutable proof of ownership and authenticity. Unlike traditional digital files that can be easily copied, blockchain technology ensures that each NFT is unique, with ownership records permanently stored on a decentralized ledger. This prevents forgery and unauthorized duplication.

6.2 Secure and Transparent Transactions

Blockchain-based NFT marketplaces facilitate secure and transparent transactions without intermediaries. Every sale and resale of an NFT is recorded immutably, ensuring accountability and reducing fraud risks. Smart contracts handle transactions automatically, eliminating manual processing.

6.3 Direct Monetization and Royalties

Artists can sell their digital artwork directly to buyers, bypassing galleries and auction houses. More importantly, smart contracts enable automatic royalty payments on secondary sales, ensuring that artists continue to earn revenue whenever their work is resold.

6.4 Global Reach and Accessibility

NFTs operate on decentralized platforms, allowing artists from any part of the world to showcase and sell their work without geographical restrictions. Buyers can easily purchase NFTs using cryptocurrencies, eliminating traditional financial barriers like currency conversion fees.

6.5 Digital Permanence and Storage

Unlike physical artwork that can degrade over time, NFTs are permanently recorded on the blockchain. Decentralized storage solutions like IPFS (InterPlanetary File System) ensure that digital artwork remains accessible and preserved indefinitely.

6.6 Community Engagement and Exclusivity

NFTs allow artists to build stronger connections with their audience by offering exclusive digital assets, limited editions, or special perks such as early access to new artwork. Collectors benefit from proven scarcity, enhancing the value of digital art.

7.Challenges

7.1 High Transaction Costs (Gas Fees)

Most NFT transactions occur on blockchain networks like Ethereum, where gas fees can be expensive, especially during network congestion. This increases the cost of minting, buying, and transferring NFTs, making it less accessible for small artists.

7.2 Environmental Concerns

Proof-of-Work (PoW) blockchains, such as Ethereum (before the Merge), consume a large amount of energy. This has raised environmental concerns regarding the sustainability of NFTs. Although newer blockchains like Solana and Ethereum 2.0 use Proof-of-Stake (PoS) to reduce energy consumption, the impact remains a topic of debate.

7.3 Market Volatility

NFT values fluctuate based on demand and speculation. Prices can skyrocket or crash rapidly, making NFT investments risky. Many collectors and investors experience financial losses due to unpredictable market trends.

7.4 Legal and Copyright Issues

Despite blockchain's ability to prove ownership, copyright enforcement remains a challenge. Some individuals steal and tokenize digital art without the creator's permission. Legal frameworks for NFT ownership and intellectual property rights are still evolving, leading to disputes.

7.5 Security Risks and Scams

Phishing attacks, fake NFT projects, and rug-pulls are common in the NFT space. Malicious actors trick users into revealing private keys or conducting transactions on fraudulent platforms, leading to financial losses. Smart contract vulnerabilities also pose risks of exploitation.

8.Conclusion

The integration of blockchain technology in digital arts through NFTs has transformed the way artists create, monetize, and protect their work. By providing immutable ownership records, transparent transactions, and automated royalty mechanisms, NFTs have empowered artists with direct market access while eliminating traditional intermediaries.

This case study has explored the architecture, implementation, benefits, challenges, and SDGs addressed by Digital Arts NFTs. The use of public and private blockchains, coupled with smart contracts, ensures a secure, decentralized, and scalable solution for digital art trading. However, challenges such as environmental concerns, regulatory uncertainty, and market volatility need to be addressed through eco-friendly blockchain solutions and standardized legal frameworks.

Despite these challenges, the adoption of NFTs continues to grow, opening new economic opportunities and reshaping digital asset ownership. With ongoing innovations and responsible implementation, NFTs can foster sustainable growth, support artistic creativity, and contribute to the broader adoption of decentralized technologies.

The future of Digital Arts NFTs depends on balancing technological advancements with ethical considerations, ensuring that blockchain-driven art ecosystems remain inclusive, sustainable, and beneficial to artists and collectors worldwide.

9.SDG'S Addressed

9.1 SDG 8: Decent Work and Economic Growth

Justification:

Digital Arts NFTs empower artists by providing them with a global marketplace to monetize their work without intermediaries.

The NFT industry fosters new job opportunities in digital design, blockchain development, and decentralized finance (DeFi).

Automated royalty payments through smart contracts ensure artists receive fair compensation for secondary sales.

9.2 SDG 9: Industry, Innovation, and Infrastructure

Justification:

NFTs leverage blockchain technology, which enhances transparency, security, and efficiency in digital asset transactions.

The use of smart contracts revolutionizes the digital art industry by ensuring ownership verification and fraud prevention.

Blockchain-based NFT platforms contribute to technological infrastructure development, enabling decentralized finance and digital asset management.

9.3 SDG 12: Responsible Consumption and Production

Justification:

NFTs reduce the need for physical art production, printing, and shipping, lowering the carbon footprint associated with traditional art markets.

Emerging eco-friendly blockchains (e.g., Ethereum 2.0, Tezos, and Flow) use energy-efficient consensus mechanisms to minimize environmental impact.

The adoption of green NFTs and carbon offsetting initiatives helps promote sustainable digital asset practices.

10.References

1. selling digital art for millions -a qualitative analysis of nft art marketplaces, Thirtieth European Conference on Information Systems (ECIS 2022),by Ferdinand Thies.

2. https://www.politesi.polimi.it/retrieve/8794674c-fd5a-4ac3-bcf1-a7cfc2c8f5df/Davide_Clementi_Master_Thesis.pdf , [12-15] by Davide Clementi 2021

3. Andreas Antonopoulos and Gavin Wood. Mastering Ethereum. O'Reilly

Media, 2019.

4.Merkle tree. https://en.wikipedia.org/wiki/Merkle tree. last visited on 12-3-2025

5.P. Rajitha Nair and Dr. D. Ramya Dorai. Evaluation of performance

and security of proof of work and proof of stake using blockchain. 2021.

6. https://eips.ethereum.org/EIPS/eip-1155 last visited on 12-3-2025

7. https://docs.polygon.technology/ last visited on 12-3-2025

11.Appendix A

URL:

https://drive.google.com/drive/folders/1wttjUAHrXMPsj25hDpXdCclN3GLT6SKI?usp=sharing

QR Code: