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Smart Contract-Driven Nft Trading Platform Using Ethereum And Decentralized Storage

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ABSTRACT
In the evolving landscape of digital ownership, Non-Fungible Tokens (NFTs) have emerged as a transformative medium for authenticating and trading unique digital assets. This paper presents ***Security Wizards****, a decentralized NFT marketplace built on the Ethereum blockchain, designed to empower creators and collectors through transparent, secure, and autonomous transactions. The platform enables users to mint, list, buy, and transfer NFTs while ensuring automatic royalty distribution to original creators on every resale. Leveraging smart contracts and decentralized storage via IPFS, the system eliminates intermediaries and enhances trust. The frontend, developed using React and integrated with MetaMask, offers a responsive and user-friendly interface. This work demonstrates the potential of blockchain technology in democratizing digital commerce and outlines future enhancements including multichain support, analytics, and AI-driven metadata generation.*

Keywords*: Decentralized, Smart contract, Security Wizards, NFT marketplace, MetaMask.*

1. INTRODUCTION
The digital era has witnessed a paradigm shift in how ownership and value are assigned to digital assets.
Non-Fungible Tokens (NFTs) have become solution to represent an enabling verifiable ownership, scarcity& provenance, unique digital items on the blockchain. Applications of NFT across diverse domains are gaming, virtual real estate, digital art & music, offering creators new avenues for audience engagement & monetization.
Existing NFT marketplaces operate on centralized platforms, with limitations such as restricted control for creators, lack of transparency and absence of automated royalty mechanisms. These trading platforms act as intermediaries, controlling access, fees, and data, which contradicts the decentralized nature of blockchain technology.
Security Wizards was introduced to address these challenges, a decentralized NFT marketplace built on the Ethereum blockchain. The platform is designed to empower creators and collectors by enabling direct peer-to-peer transactions, secure asset storage using IPFS, and automated royalty distribution through smart contracts., Security Wizards aims to create a transparent, fair, and resilient ecosystem by removing intermediaries and leveraging decentralized technologies for digital asset exchange.

1.1 Problem Statement
Even with the growing popularity of NFTs, most existing marketplaces are centralized, which introduces several limitations for creators and users alike. Centralized platforms often control the pricing, listing and resale of NFTs, reducing the limiting transparency in transactions and the autonomy of creators. Additionally, these platforms do not support depriving artists of recurring revenue from secondary sales and automated royalty mechanisms.

Another major concern is for storing digital assets and metadata on centralized servers , which makes them vulnerable to loss, tampering or downtime. This hinders the core principles of blockchain technology—decentralization, immutability and transparency.
The Security Wizards ensures that creators can mint and list NFTs independently, buyers can transact directly with sellers, and royalties are automatically distributed on every resale. It also addresses these challenges by developing a decentralized NFT marketplace on the Ethereum blockchain. In addition, by integrating IPFS for decentralized storage, the platform guarantees the security and permanence of digital assets.

2. THEORY AND CALCULATION

The development of the decentralized NFT Marketplace followed a structured methodology encompassing requirement analysis, system design, smart contract development, frontend integration, and testing. The approach ensured modularity, security, and scalability of the platform.

1. Requirement Analysis

The initial phase involved identifying the limitations of existing centralized marketplaces, particularly in terms of creator royalties, transparency, and asset ownership. Based on this analysis, the core requirements were defined:

- Decentralized minting and trading of NFTs.
- Automatic royalty distribution.
- Secure and persistent storage of digital assets.
- User-friendly interface with wallet integration.

2. Smart Contract Development

Two Solidity contracts were developed:

- Nft.sol: Handles NFT creation, metadata storage, and ownership tracking.
- NftMarketplace.sol: Manages listing, purchasing, and royalty distribution.

The contracts were written using Solidity and tested on the Sepholia Ethereum Testnet. Functions were rigorously tested using tools like Remix IDE and Hardhat to ensure correctness and security.

3. FRONTEND DEVELOPMENT

The frontend was built using React with Vite for fast development and hot module replacement. The UI was designed to be responsive and intuitive, supporting:

- NFT minting with metadata input.
- Marketplace browsing and purchasing.
- Wallet connection via MetaMask.

Figure 1: Wallet Connection Interface

4. DECENTRALIZED STORAGE INTEGRATION

To ensure the immutability and availability of NFT assets, IPFS was used via Pinata. Metadata and media files were uploaded to IPFS, and their hashes were stored on-chain to maintain a verifiable link between the NFT and its content.

5. WALLET AND BLOCKCHAIN INTERACTION

MetaMask was integrated to facilitate secure user authentication and transaction signing. All blockchain interactions, including minting, listing, and purchasing, were executed through MetaMask, ensuring a trustless and decentralized experience.

3. Testing and Validation

The system was tested across multiple scenarios:

- Minting NFTs with various metadata.
- Listing and purchasing NFTs with royalty enforcement.
- Withdrawing and transferring NFTs.
- Verifying IPFS asset availability.

Testing was conducted on the Sepholia Testnet to simulate real-world blockchain behavior without incurring gas costs.

4. System Architecture

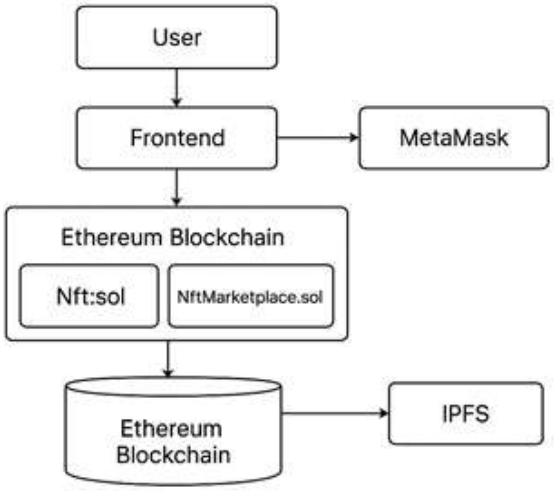

Figure 2: System Architecture

The architecture of the decentralized NFT Marketplace is designed to ensure transparency, security, and scalability by leveraging blockchain technology and decentralized storage. The system comprises multiple layers, each responsible for distinct functionalities, working in tandem to deliver a seamless user experience.

1. User Interface Layer

The frontend is developed using React with Vite for optimized performance and rapid development. It provides users with intuitive interfaces for minting NFTs, browsing marketplace listings, and executing transactions. Integration with MetaMask enables secure wallet authentication and blockchain interaction, allowing users to sign and submit transactions directly from their browser.

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Figure 3: Main dashboard of the NFT Marketplace displaying wallet connectivity and core functionalities, including minting, listing, purchasing, withdrawing, and transferring NFTs

2. Smart Contract Layer

This layer consists of two Solidity-based contracts deployed on the Ethereum (Sepholia Testnet):

- Nft.sol: Defines the structure and behavior of NFTs, including metadata, ownership, and royalty parameters. It includes core functions such as mintNFT, transferNFT, and ownerOf..
- NftMarketplace.sol: Extends the functionality of Nft.sol to support marketplace operations. It manages listing, purchasing, royalty distribution, and withdrawal of NFTs. Key functions include listNft, buyNft, withdrawNft, and getAllListings.

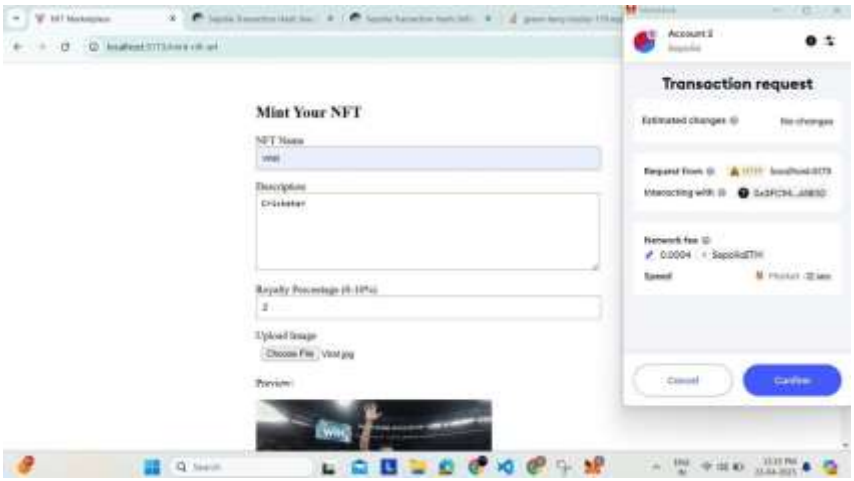

Figure 4: NFT Minting Interface

Figure 5: NFT Minting Confirmation

These contracts ensure immutability and enforce business logic directly on the blockchain, eliminating the need for intermediaries.

3. Blockchain Layer
The Ethereum blockchain serves as the backbone of the system, maintaining a tamper-proof ledger of all transactions. It guarantees decentralized execution of smart contracts, secure ownership tracking, and automated royalty payments.

4. Decentralized Storage Layer
To store NFT assets and metadata, the system integrates IPFS (InterPlanetary File System) via Pinata. This ensures that digital assets remain accessible and tamper-resistant, even in the absence of centralized servers. IPFS hashes are embedded in the smart contracts to link NFTs with their corresponding assets.

5. Wallet Integration
The platform supports MetaMask for wallet connectivity, enabling users to interact with the blockchain securely. This integration facilitates transaction signing, account management, and real-time balance updates.

6. Optional Backend Services (Future Scope)
While the current implementation is fully decentralized, future enhancements may include backend services for analytics, user profiles, and off-chain data caching. Technologies such as Node.js or Firebase could be employed to support these features without compromising decentralization.

5. Blockchain Implementation Details

The core functionality of the NFT Marketplace is powered by smart contracts deployed on the Ethereum blockchain. These contracts govern the creation, ownership, trading, and royalty distribution of NFTs in a decentralized and trustless manner.

1. Smart Contract Architecture
The system comprises two primary smart contracts written in Solidity:

A. Nft.sol
This contract defines the structure and behavior of individual NFTs. Key features include:
- NFT Structure: Each token includes an ID, creator address, current owner, token URI, name, description, and royalty percentage.
- Minting Functionality: Creators can mint NFTs with a royalty cap to prevent excessive fees.
- Ownership Tracking: Functions such as ownerOf and balanceOf allow querying of ownership and balances.
- Core Functions: Includes mintNft, getNft, transferNft, and others to manage NFT lifecycle.

B. NftMarketplace.sol
This contract extends the functionality of Nft.sol to enable marketplace operations. Key features include:
- Listing Mechanism: NFTs can be listed for sale by their owners.
- Purchase Flow: Buyers can purchase listed NFTs, triggering automatic royalty distribution.
- Withdrawal Functionality: Creators or owners can withdraw their listings.
- Marketplace Queries: Functions like getAllListings provide visibility into active listings.

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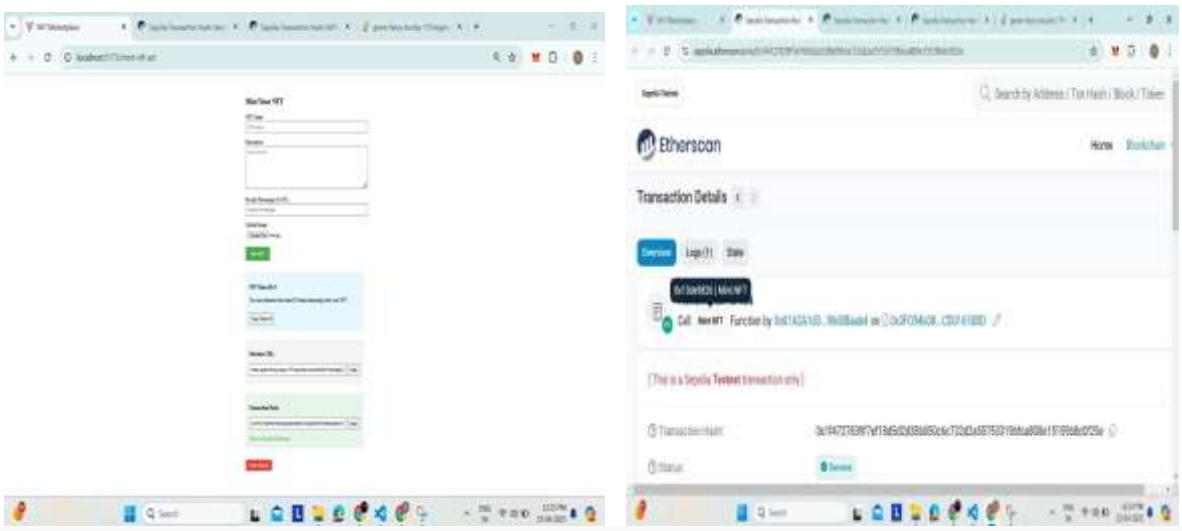

Figure 6: Sepholia Block

Royalties are enforced at the smart contract level. During each resale transaction:

- A predefined percentage of the sale price is automatically transferred to the original creator.
- This is implemented using Solidity's transfer method, ensuring fairness and recurring income for artists.

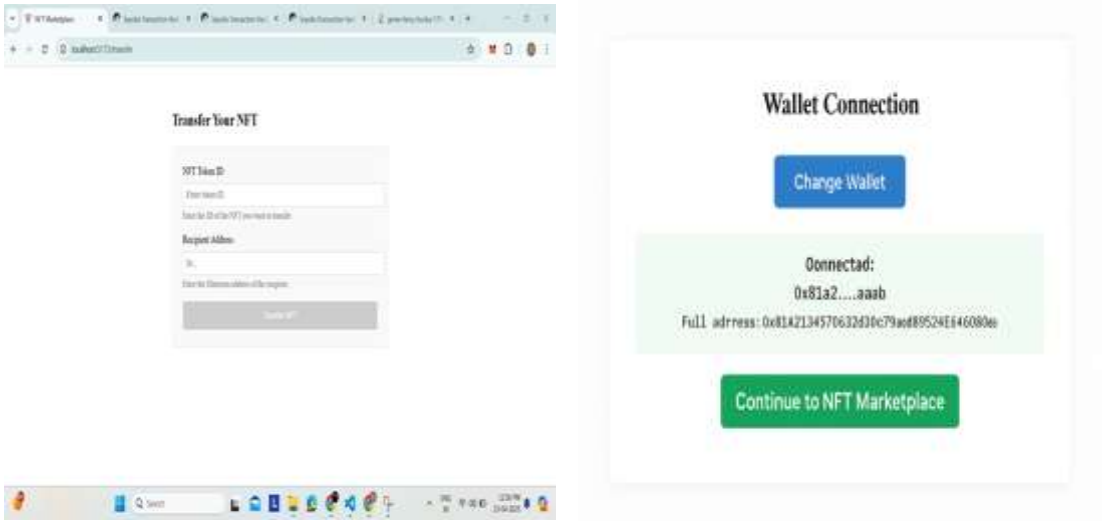

Figure 7: Wallet Connection Interface

The contracts were deployed on the Sepholia Ethereum Testnet, allowing for secure and cost-effective testing. Tools such as Remix IDE, Hardhat, and MetaMask were used to simulate real-world interactions and validate contract behavior.

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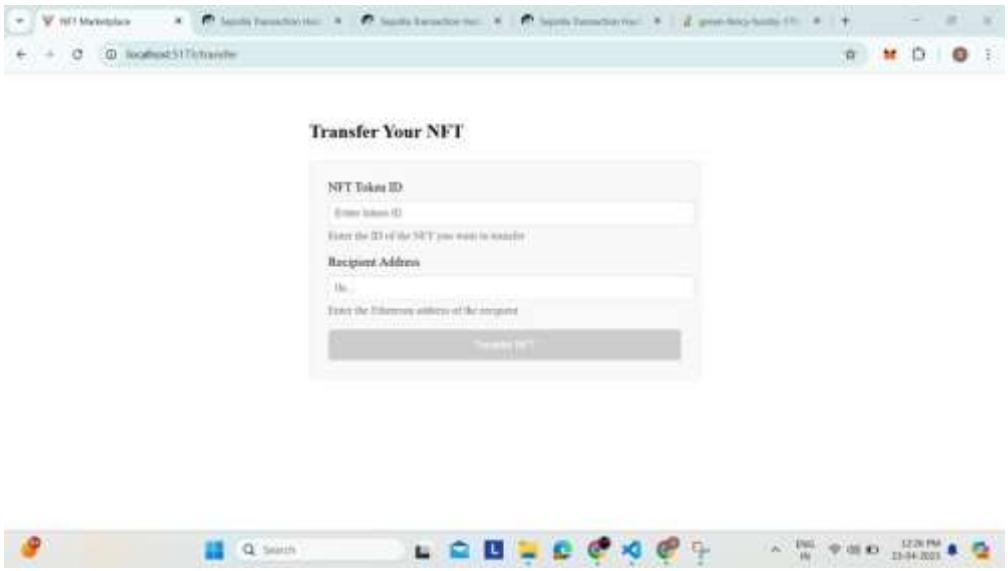

Figure 8: Transfer NFT

FUTURE ENHANCEMENT

- **Wallet Integration**: Support for multiple wallet providers (e.g., WalletConnect, Coinbase Wallet).
- **Analytics Dashboard**: Track sales, royalty revenue, and view trends.
- **Multichain Support**: Extend support to chains like BSC, Avalanche, and Solana.
- **Creator Profiles & Ratings**: Social layer for creators and buyers.
- **AI Tagging:** Automatic metadata generation for NFTs using AI.

CONCLUSION

The NFT Marketplace showcases the power of decentralized applications in democratizing digital ownership. By combining Ethereum smart contracts with decentralized storage and a responsive frontend, the platform delivers transparency, fair compensation, and user autonomy. With further development, it can evolve into a fully-featured NFT ecosystem serving creators and collectors alike

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