Blockchain-Based NFT Marketplace for Secure Minting and Ownership

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Abstract— **The rising demand for secure digital ownership and authenticity has accelerated the adoption of Non-Fungible Tokens (NFTs). This project presents a Blockchain-Based NFT Marketplace that enables creators and collectors to securely mint, list, and trade digital assets in a decentralized environment. Built on the Ethereum blockchain, the platform leverages smart contracts to ensure tamper-proof, transparent, and automated transactions. Users can authenticate through Clerk for identity management and connect their MetaMask wallet for blockchain transactions. Creators can mint NFTs by storing metadata and digital files securely on Pinata (IPFS), ensuring decentralized and permanent storage. After minting, NFTs can be listed for sale at a fixed price or through an auction with customizable end times (minutes, hours, or days). Creators also have the ability to manage their listings by viewing bids, relisting tokens with updated prices, and enabling or disabling bidding options. The marketplace integrates a real-time bidding system, secure wallet authentication, and a responsive React-based interface for browsing, buying, and selling NFTs. Smart contracts are developed in Solidity and deployed/tested using Hardhat, ensuring a reliable and transparent transaction flow. All payments are conducted in Ethereum (ETH), enabling a trustless, global exchange of digital assets. By combining Clerk authentication, MetaMask integration, Pinata IPFS storage, and Ethereum smart contracts, this project delivers a scalable, secure, and user-friendly NFT marketplace that eliminates intermediaries, reduces fraud, and empowers users with complete control over their digital property.**

Keywords— Blockchain; Non-Fungible Tokens (NFTs); Smart Contracts; Ethereum; IPFS; Hardhat; MetaMask; Decentralized Marketplace; React.js; Pinata; Clerk Authentication.

I. INTRODUCTION

In today's rapidly advancing digital ecosystem, the demand for verifiable ownership and authenticity of digital assets has become increasingly vital. The emergence of blockchain technology has introduced Non-Fungible Tokens (NFTs) as a transformative mechanism that enables creators to tokenize digital content and establish immutable proof of ownership. This study presents a Blockchain-Based NFT Marketplace designed to facilitate the minting, listing, and exchange of NFTs within a decentralized and transparent framework. The platform is built upon the Ethereum blockchain to guarantee integrity, security, and traceability of transactions. Through MetaMask integration, users can securely authenticate and interact with the system using their Ethereum wallets. Once authenticated, users are able to mint digital assets into NFTs, attach metadata, and list them for either fixed-price or auction-based sales. Ownership transfer and payment processes are automated through Solidity smart contracts, ensuring trustless, efficient, and intermediary-free execution. The proposed system incorporates Hardhat for smart contract testing and deployment, React and TypeScript for an interactive and responsive frontend, and Pinata (InterPlanetary File System) for decentralized metadata storage. Together, these technologies create a scalable, robust, and user-centric ecosystem for both creators and collectors. Emphasizing accessibility and usability, the platform features a clean, intuitive interface that simplifies the entire lifecycle of NFT creation, listing, and trading. With integrated wallet functionality, users can easily manage their assets and monitor transactions in real time. This focus on simplicity ensures that both

experienced blockchain users and newcomers can confidently participate in digital commerce. Ultimately, the Blockchain-Based NFT Marketplace bridges the gap between digital creation and verified ownership by providing a secure, transparent, and efficient platform for NFT management. It empowers artists and collectors alike to safeguard intellectual property, engage in decentralized trade, and contribute to a more trustworthy digital economy.

II. LITERATURE SURVEY

Das et al. [1] investigate the security flaws in NFT ecosystems, identifying phishing attacks, contract bugs, and fraudulent minting as major risks. They stress the need for improved contract auditing, wallet security, and marketplace verification mechanisms.

Taherdoost [2] presents a systematic review covering NFT foundations, market behavior, and applications, outlining both benefits and challenges such as high gas fees and environmental impact. This review informs key design considerations for NFT platforms.

Wang et al. [3] propose a blockchain marketplace for art trading, ensuring provenance and authenticity through smart contracts. Their model highlights how blockchain eliminates forgery and enhances transparency in digital asset exchange.

Alizadeh et al. [4] perform a network analysis of NFT markets, revealing creator dominance and clustering behavior that drive speculative bubbles. Their findings support fair ranking and discovery mechanisms in NFT marketplaces.

Bao [5] provides a comprehensive review of NFT evolution, focusing on standards, governance, and interoperability. The paper identifies gaps like regulatory uncertainty and metadata permanence, guiding sustainable marketplace development.

Borri, Liu, and Tsyvinski [6] study NFT economics, showing that investor sentiment and rarity traits heavily influence pricing. Their results emphasize transparency and anti-manipulation tools for stable marketplace operations.

Tian et al. [7] examine NFT-related frauds such as rug pulls and wash trading, highlighting weak marketplace moderation as a major cause. They recommend better governance and verification systems to improve platform trust.

Sibanda et al. [8] explore NFTs in healthcare for securing medical records and imaging data. Their work demonstrates blockchain's potential for traceable and trustworthy handling of sensitive information.

III. PROPOSED SYSTEM

The Blockchain-Based NFT Marketplace is a decentralized web application that allows users to mint, list, buy, and sell digital assets securely using Ethereum smart contracts. By integrating MetaMask, users can connect their wallets to interact with the platform, mint NFTs from digital files (images, videos, or audio), and store metadata on IPFS via Pinata for decentralized and permanent access. Each NFT carries immutable proof of ownership and authenticity, eliminating intermediaries and ensuring transparency. The system uses React.js for the frontend and Node.js/Express.js for the backend to manage communication with the blockchain, transaction monitoring, and user activity. Users can browse, trade, or manage collections in real time, with transaction statuses displayed on the interface. Clerk Authentication handles user sessions, while smart contracts—developed in Solidity and tested through Hardhat—manage minting, listing, and transfers. The marketplace provides a secure, scalable, and user-friendly environment for creators to monetize their work and collectors to own verified digital assets.

IV. FLOW CHART OF THE SYSTEM

The system supports a fully decentralized workflow that allows creators to mint NFTs, collectors to purchase them, and administrators to manage platform operations. It integrates blockchain smart contracts, decentralized storage, Web3 authentication, and a modern frontend–backend architecture to ensure secure, transparent, and efficient NFT trading. The following sections describe the complete system methodology.
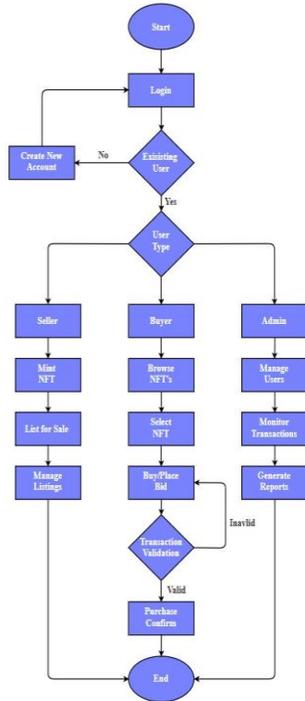
Fig. 1: Flow Chart of the System

A. Smart Contract & NFT Minting Logic

The core of the system is built using Solidity-based smart contracts, deployed on the Ethereum blockchain through the Hardhat development framework. These contracts define essential NFT operations such as token creation, metadata assignment, ownership verification, marketplace listing, and auction management. Each NFT is assigned a unique token ID, mapped to its metadata URI stored on IPFS. The minting logic follows the ERC-721 standard, ensuring interoperability with existing NFT wallets and platforms.

B. Decentralized Storage using IPFS & Pinata Integration

To ensure immutability and permanent access to digital assets, the system uses InterPlanetary File System (IPFS) via Pinata. When a creator uploads an artwork, the file and metadata (name, description, attributes, and image reference) are pinned to IPFS. Pinata returns a Content Identifier (CID), which becomes the metadata URI stored on-chain inside the smart contract. Since IPFS uses content-addressing, the data cannot be altered without changing the CID, ensuring strong integrity and tamper resistance.

C. Web3 Authentication, Blockchain Interaction and Transaction Handling

The system integrates MetaMask for Web3 wallet authentication, allowing users to securely connect their Ethereum accounts to the application. Once authenticated, users can initiate blockchain transactions such as minting, listing, approving, or purchasing NFTs. The frontend communicates with the smart contract using Ethers.js, converting user actions into signed blockchain transactions. Each transaction is sent to the network, mined, and confirmed. Real-time updates are displayed to users, showing the status of minting, approval, gas consumption, block confirmations, and completed ownership transfers.

D. Web Application Development

A responsive and intuitive user interface is built using React.js, providing seamless interaction between users and the blockchain. The interface allows creators to upload digital assets, enter metadata, and mint NFTs with a single click. Collectors can browse the marketplace, view NFT details, participate in auctions, and complete purchases through secure wallet interactions. Live transaction progress, wallet balance, NFT listing history, and ownership status are displayed dynamically to enhance user transparency. The drag-and-drop asset upload system and structured forms ensure a simple and accessible user experience even for non-technical users.

V. RESULT

In the proposed NFT Marketplace system, users can seamlessly mint, list, and trade NFTs on a decentralized blockchain network. The platform integrates smart contracts, IPFS storage, and Web3 wallet authentication to ensure secure ownership, transparency, and trustless transactions. During testing, the system demonstrated stable and reliable performance, successfully executing core operations such as wallet authentication, metadata upload, minting, approval, listing, and buying. The marketplace effectively bridges the gap between creators and collectors by enabling transparent, real-time asset exchange. Overall, the system provides a scalable foundation for future integration of advanced features such as multi-chain support and AI-driven NFT recommendations.

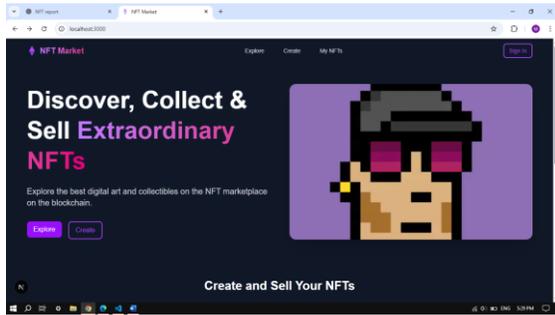The below Fig. 2 shows the home page of the NFT Marketplace.

Fig. 2: NFT Marketplace Home Page

The below Fig 3 displays the NFT creation page where creators upload digital artwork.
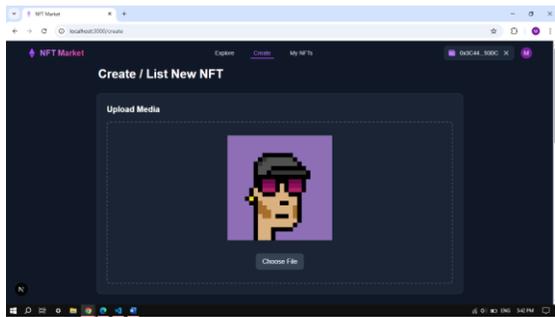

Fig 3: NFT Minting Interface

The below Fig 4 shows the transaction execution panel that tracks the status of Ethereum blockchain operations simulated using hardhat.
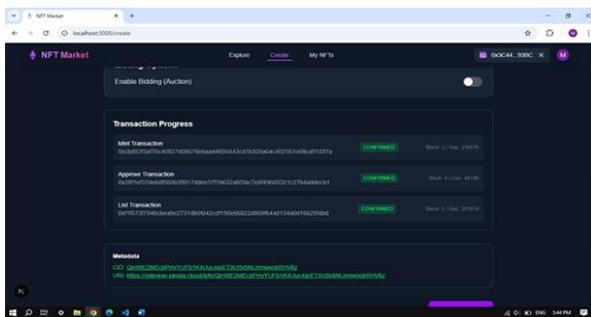

Fig 4: Transaction Progress

Figure 5 shows the Marketplace page, which displays all NFTs currently listed for sale. The page also includes a filter option that allows users to sort NFTs by category such as music, photos, and videos, as well as by price range—from high to low or low to high—for easier browsing and selection.
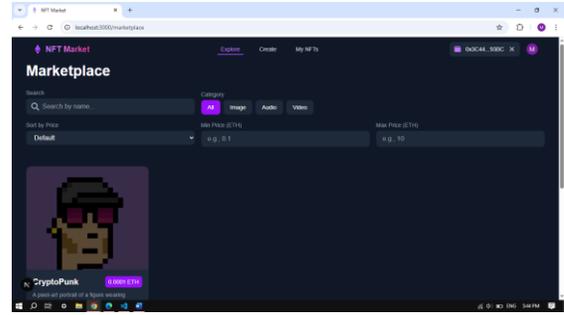

Fig 5: Marketplace Interface

Figure 6 displays the detailed view of an individual NFT, showcasing the full-size artwork along with the creator's address, metadata, price, ownership history, and transaction options such as Buy or Place Bid. It also illustrates the final purchase confirmation stage, where the blockchain transaction is processed and verified. Upon completion, the system displays the transaction hash and a confirmation message, ensuring that the NFT ownership transfer has been successfully recorded on the blockchain.
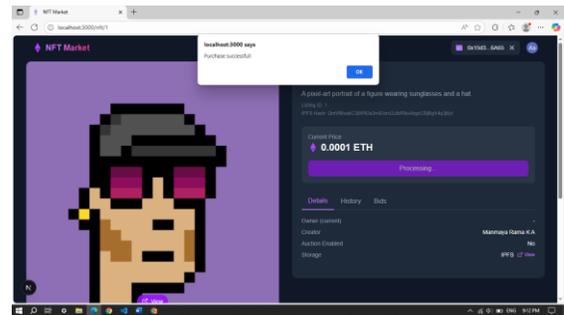

Fig 6: Purchase Confirmation Interface

VI. CONCLUSION

The Blockchain-Based NFT Marketplace is a decentralized platform that enables secure creation, listing, and trading of digital assets using Ethereum smart contracts, IPFS storage, and MetaMask wallet authentication. It ensures transparency, immutability, and trustless ownership transfer while providing a smooth user experience through a React-based frontend. The system automates minting, approval, and listing processes, allowing creators to monetize their digital works directly without intermediaries. By leveraging smart contracts for fair and secure transactions and IPFS for decentralized storage, the marketplace guarantees authenticity, permanence, and protection of digital assets. Its modular, scalable design supports advanced features like royalties,

multi-chain compatibility, analytics dashboards, and metaverse NFT galleries. Overall, the project demonstrates the real-world potential of Web3 technologies to redefine digital ownership and modernize online marketplaces through an intuitive and accessible decentralized framework.

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