META-BAZAAR
A Blockchain Based NFT Exchange

Submitted in partial fulfillment of the requirements of the degree

BACHELOR OF ENGINEERING IN **COMPUTER ENGINEERING**

By

1. Rohit Shahi (58)

2. Gaurav Mahadeshwar (43)

3. Umesh Tolani (64)

4. Gopal Vanjarani (66)

Name of the Mentor

Dr. Mrs. Nupur Giri (Dept. Hod)

Vivekanand Education Society's Institute of Technology,

An Autonomous Institute affiliated to University of Mumbai

HAMC, Collector's Colony, Chembur,

Mumbai-400074

University of Mumbai (AY 2024-25)

CERTIFICATE

This is to certify that the Mini Project entitled **"META-BAZAAR : A Blockchain Based NFT Exchange"** is a bonafide work of **Rohit Shahi (58), Gaurav Mahadeshwar (43), Umesh Tolani (64) & Gopal Vanjarani (66)** submitted to the University of Mumbai in partial fulfillment of the requirement for the award of the degree of **"Bachelor of Engineering"** in **"Computer Engineering" .**

Dr. Mrs. Nupur Giri (Dept. Hod)
Mentor

(Prof._____)
Head of Department

(Prof._____)
Principal

Mini Project Approval

This Mini Project entitled "**META-BAZAAR : A Blockchain Based NFT Exchange**" by **Rohit Shahi (58), Gaurav Mahadeshwar (43), Umesh Tolani (64) & Gopal Vanjarani (66)** is approved for the degree of **Bachelor of Engineering** in **Computer Engineering.**

Examiners

1……
(Internal Examiner Name & Sign)

2……
(External Examiner name & Sign)

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Abstract

This project, titled Meta-Bazaar : A Blockchain-Based NFT Exchange, aims to design and implement a decentralized marketplace for Non-Fungible Tokens (NFTs) using blockchain technology. The platform's core objective is to facilitate the secure, transparent, and efficient trading of digital assets while ensuring authenticity and ownership verification through blockchain's immutable ledger. By addressing the limitations of centralized NFT platforms such as high transaction fees, lack of transparency, and vulnerability to hacks, this project provides a decentralized solution that enhances security and reduces intermediaries in transactions. The marketplace will include features like minting, buying, selling, and auctioning NFTs. Smart contracts on the blockchain will manage transactions, and regular updates will ensure security, regulatory compliance, and continuous improvement.

Acknowledgments

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List of Abbreviations

- **NFT** : Non-Fungible Token
- **P2P** : Peer-to-Peer
- **UI/UX** : User Interface/User Experience
- **API** : Application Programming Interface
- **KYC** : Know Your Customer
- **AML** : Anti-Money Laundering
- **ERC-721** : Ethereum Request for Comments-721 (NFT Standard)
- **ERC-1155** : Ethereum Request for Comments-1155 (Multi-Token Standard)

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Introduction :

1.1 Introduction -

The rise of blockchain technology has revolutionized various industries, including finance, supply chain, and digital art. NFTs have emerged as a unique form of digital asset, allowing for the ownership and transfer of digital items. This project explores the creation of a decentralized NFT marketplace, providing users with a platform to trade these digital assets securely and transparently. Blockchain technology has disrupted many industries by enabling decentralized and transparent systems. NFTs, unique digital assets, have become popular for digital art and other virtual commodities. However, existing NFT marketplaces are mostly centralized, which results in high fees, vulnerability to hacks, and lack of transparency.

1.2 Motivation -

The growing popularity of NFTs, particularly in the art and entertainment sectors, has highlighted the need for more decentralized and transparent platforms. Traditional centralized marketplaces often charge high fees and require users to place their trust in a single entity, which introduces risks of data manipulation, fraud, and security breaches. Moreover, these platforms lack transparency in terms of fee structures and governance. Motivated by these challenges, we aim to create a decentralized NFT marketplace that addresses these limitations by leveraging the power of blockchain. By eliminating intermediaries, we aim to provide users with a more secure, transparent, and cost-effective platform for trading digital assets.

1.3 Problem Statement & Objectives -

Current NFT marketplaces, such as OpenSea and Rarible, operate on centralized models, which result in several significant drawbacks. These platforms often charge high fees for minting, buying, and selling NFTs, making transactions costly for users. Additionally, centralized servers pose security vulnerabilities, making them attractive targets for hackers, which can lead to potential data breaches and theft.

The objective of this project is to develop a decentralized NFT marketplace on the Ethereum blockchain to address these issues. By leveraging smart contracts, the platform aims to enable secure, transparent, and efficient transactions, reducing transaction fees and improving user control by eliminating intermediaries. Additionally, the marketplace will enhance user experience with features such as auctions, royalty distribution, and seamless wallet integration.

1.4 Organization of the Report -

The Introduction establishes the foundation for the report, starting with a general overview (1.1 Introduction) of the project topic. It is followed by Motivation (1.2), which explains the key reasons and driving factors behind the research or project. Next, the Problem Statement & Objectives (1.3) clearly define the issue being addressed and outline the specific goals to be achieved. Lastly, the Organization of the Report (1.4) provides a structured roadmap, detailing the sections and content that will be covered in the report.

The Literature Survey presents an overview of the existing systems and knowledge in the domain. It begins with a Survey of Existing Systems (2.1), offering insights into the current landscape. This is followed by a discussion on the Limitations of Existing Systems or Research Gaps (2.2), identifying areas where further work or improvements are required. The Mini Project Contribution (2.3) highlights how this project seeks to address those gaps and advance the current state of the subject.

The Proposed System introduces the core of the solution being developed. Starting with an Introduction (3.1), it provides a comprehensive overview of the proposed system. The Architecture/Framework (3.2) describes the structure and framework, while Algorithm and Process Design (3.3) explains the employed methodologies. The technological components are elaborated in Hardware & Software (3.5), followed by Conclusion and Future Work (3.8), which summarizes the outcomes and suggests future directions for research. Lastly, the References section compiles all the cited sources for readers to explore further.

Literature Survey :

2.1 Survey of Existing System -

In recent years, centralized NFT marketplaces like OpenSea, Rarible, and Foundation have gained significant popularity. These platforms allow users to mint, buy, sell, and trade NFTs, providing a marketplace for digital assets such as artwork, music, virtual land, and other unique digital content. Most of these platforms operate on the Ethereum blockchain, utilizing standards such as ERC-721 and ERC-1155 for the creation and management of NFTs. Centralized platforms, while offering ease of use and accessibility, depend heavily on a central authority for managing transactions, which introduces several challenges.

For instance, OpenSea is one of the largest NFT marketplaces, where users can create NFTs by paying a "gas fee" to cover the computational resources required on the Ethereum network. Despite the user-friendly interface and widespread adoption, platforms like OpenSea come with certain drawbacks that limit user control, increase transaction costs, and raise concerns about security. Similar platforms like Rarible provide community governance models using tokens, but they still operate on centralized infrastructures where users must trust the platform's ability to secure transactions and manage the marketplace effectively.

2.2 Limitation Existing system or Research gap -

Although centralized NFT marketplaces have played a key role in the growth of NFTs, they suffer from several limitations that hinder their effectiveness in the long term. These limitations include:

- **High Transaction Fees** : One of the most pressing issues with centralized NFT platforms is the high cost of transactions. For example, Ethereum's gas fees can spike during periods of network congestion, making it expensive for users to mint, trade, or transfer NFTs. This not only discourages small-scale creators but also increases the overall cost for buyers and sellers.
- **Lack of Transparency and Decentralization** : While these platforms are based on blockchain technology, their centralized nature means that a single entity manages the entire marketplace. This introduces concerns about transparency, as platform operators can potentially manipulate fees, alter terms of service, or impose

restrictions without user consent. Users are required to place trust in these central authorities, which undermines the decentralized ethos of blockchain technology.

- **Security Vulnerabilities** : Centralized servers are attractive targets for hackers. A single security breach can compromise user data, digital assets, and even the integrity of the marketplace. There have been multiple incidents where centralized platforms have been hacked, leading to the loss of user funds or NFTs.
- **Limited User Control** : Centralized platforms can impose restrictions on users, including how assets are listed, traded, and transferred. Users are dependent on platform policies, which may change over time, further restricting their freedom to operate within the ecosystem.
- **Royalties and Creator Compensation** : While some platforms provide mechanisms for creators to earn royalties on secondary sales, there is no universal standard for how royalties are enforced across platforms, leading to inconsistencies and dissatisfaction among creators.

Given these limitations, the need for a decentralized solution is evident. A decentralized marketplace would not only address these concerns but also align more closely with the principles of blockchain, which prioritize transparency, security, and user empowerment.

2.3 Mini Project Contribution -

The **Meta-Bazaar** project aims to address the limitations of centralized NFT platforms by developing a fully decentralized marketplace. Unlike traditional centralized platforms, Meta-Bazaar will leverage blockchain's inherent advantages, such as decentralization, transparency, and security, to create a more robust and user-driven marketplace. Key Contributions of the Project will be Decentralization, Reduction of Transaction Fees, Enhanced Security, Transparency, Royalties and Creator Compensation & User Empowerment and Autonomy. Meta-Bazaar will fill the gaps left by centralized NFT platforms by providing a secure, decentralized, and transparent solution. It aims to set a new standard for NFT marketplaces by ensuring user autonomy, reducing costs, and enhancing the overall user experience.

Proposed System :

3.1 Introduction -

We propose developing a decentralized NFT marketplace on a blockchain network. This platform will allow users to mint, buy, sell, and trade NFTs without a central authority, leveraging smart contracts to automate and secure transactions. The decentralized architecture ensures peer-to-peer interactions, reducing costs and enhancing security. Users will enjoy a user-friendly interface for creating and trading NFTs, seamless wallet integration, and support for various NFT standards. Additional features like auctions, royalty distribution, and advanced search options will enhance the user experience. Regular updates, security audits, and regulatory compliance will ensure the platform's integrity and continuous improvement.

3.2 Architectural Framework / Conceptual Design -

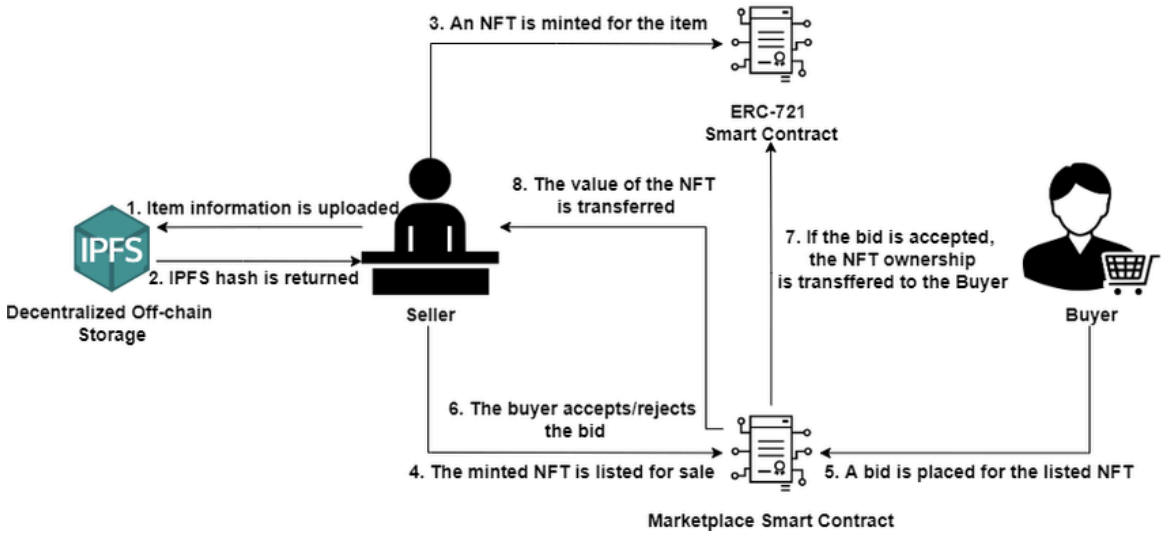

Figure 1

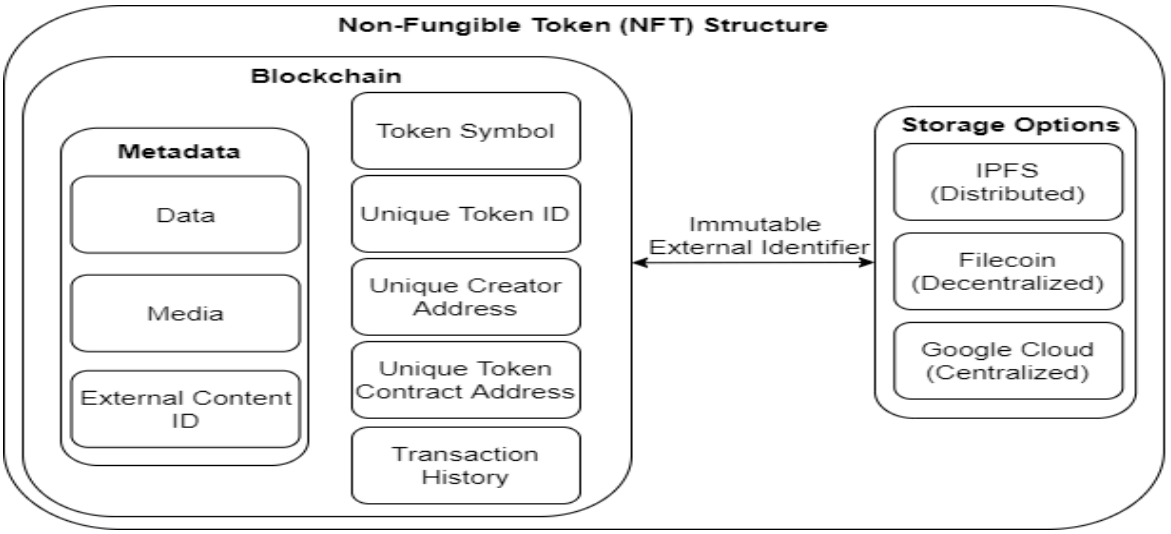

Figure 2

3.3 Algorithm and Process Design -

The **Algorithm and Process Design** section outlines the methodologies implemented in the Meta-Bazaar decentralized marketplace, focusing on minting NFTs, handling transactions, and facilitating auctions to ensure a seamless user experience while maintaining security and transparency.

1. NFT Minting Process :

Users begin by providing metadata (title, description, file upload) for their NFTs. The system interacts with a smart contract to mint the NFT based on ERC-721 or ERC-1155 standards. Upon validation, a unique token ID is generated, and the minting transaction is recorded on the Ethereum blockchain, ensuring ownership and authenticity.

2. Buying and Selling Process :

Sellers can list their NFTs by specifying the price and listing duration. Buyers can view available NFTs and initiate purchases by sending transactions to the smart contract, which updates ownership and transfers the NFT to the buyer's wallet, crediting the seller's balance.

3. Security Measures :

Smart contracts will undergo thorough audits to identify potential vulnerabilities, and user authentication will be managed through wallet integrations (e.g., MetaMask), ensuring secure access.

4. User Experience Enhancements :

The front-end interface will be intuitive, facilitating easy navigation for users to create and trade NFTs. Feedback mechanisms will be in place to gather user input for continuous improvement.

By implementing these algorithms and processes, Meta-Bazaar aims to provide a robust, user-friendly, and secure platform for NFT trading, addressing the shortcomings of centralized systems while enhancing user autonomy and satisfaction.

3.4 Methodology Applied -

- **Blockchain Selection -**
  - **Research and Compare** : Evaluate different blockchain networks (e.g., Ethereum, Binance Smart Chain, Polygon) based on factors like transaction fees, scalability, security, and developer community support.
  - **Decision** : Choose the blockchain that best fits the project requirements. For this project, Ethereum is a strong candidate due to its robust smart contract capabilities and widespread adoption in the NFT space.
- **Smart Contract Development -**
  - **Define Requirements** : Identify the functionalities needed in the smart contracts, such as minting NFTs, transferring ownership, and handling transactions.
  - **Design Smart Contracts** : Use Solidity (or Vyper) to write the smart contracts. Key components include -
    - **ERC-721/ERC-1155 Standards** : Implement these standards for creating NFTs.
    - **Marketplace Logic** : Develop functions for listing NFTs, buying, selling, and auction mechanisms.
  - **Security Best Practices** : Ensure the smart contracts follow best practices to prevent common vulnerabilities (e.g., reentrancy attacks, integer overflow).

❖ **Frontend Development -**

- **Design UI/UX** : Create wireframes and prototypes to design a user-friendly interface. Consider ease of navigation, responsiveness, and accessibility.
- **Framework Selection** : Choose a frontend framework (React or Vue) for building the user interface.
- **Integration with Blockchain** : Use libraries like Web3.js or Ethers.js to connect the frontend with the blockchain. Ensure users can interact with smart contracts seamlessly.

❖ **Backend Development -**

- **Server Setup** : Set up a backend server using Node.js and Express to handle off-chain data and support the frontend.
- **Database Management** : Implement a database (e.g., MongoDB) to store off-chain data such as user profiles, transaction history, and NFT metadata.
- **API Development** : Create RESTful APIs to enable communication between the frontend and backend.

❖ **Integration -**

- **Smart Contract Deployment** : Deploy the smart contracts to the selected blockchain network. Use development tools like Truffle or Hardhat to manage the deployment process.
- **Frontend-Backend Sync** : Ensure the frontend and backend are properly integrated. Validate that all interactions (e.g., minting an NFT, purchasing an NFT) are functioning correctly.
- **Wallet Integration** : Integrate cryptocurrency wallets (e.g., MetaMask) to facilitate user authentication and transaction signing.

❖ **Testing -**

- **Unit Testing** : Write unit tests for individual components of the smart contracts, frontend, and backend to ensure they work as expected.
- **Integration Testing** : Test the entire system to validate the interaction between different components. Check for issues related to smart contract interactions and data flow.
- **Security Audits** : Conduct thorough security audits of the smart contracts and the overall platform. Consider engaging third-party security experts to identify and mitigate potential vulnerabilities.
- **User Testing** : Gather feedback from a group of test users to identify usability issues and gather insights for improvements.

❖ **Deployment and Launch -**

- **Final Preparations** : Ensure all components are tested, debugged, and ready for production. Prepare documentation for users and developers.
- **Mainnet Deployment** : Deploy the smart contracts and backend services to the mainnet. Update the frontend to point to the mainnet endpoints.

❖ **Maintenance and Updates -**

- **Monitoring** : Continuously monitor the platform for any issues or anomalies. Use analytics tools to track performance and user activity.
- **User Support** : Provide support channels (e.g., helpdesk, FAQs) to assist users with any problems or questions.
- **Regular Updates** : Release updates to fix bugs, improve performance, and add new features based on user feedback and technological advancements.

3.5 Hardware & Software Specifications -

❖ **Hardware Requirements -**

- **Standard Development Computers** : Computers with adequate processing power, memory, and storage to handle software development tasks, including compiling code and running development environments.
- **Internet Access** : Reliable internet connection for accessing online resources, blockchain networks, and cloud services.
- **Server Hardware** : Dedicated servers or cloud-based instances for hosting the backend and supporting blockchain nodes.

❖ **Software Requirements -**

- **Node.js** : JavaScript runtime environment for building the backend.
- **Next.js** : React framework for building server-rendered and static web applications.
- **MongoDB** : NoSQL database for storing off-chain data such as user profiles, transaction history, and NFT metadata.
- **Solidity/Vyper** : Programming languages for writing smart contracts on the Ethereum blockchain.
- **Web3.js/Ethers.js** : JavaScript libraries for interacting with the Ethereum blockchain and smart contracts.
- **React/Vue** : Frontend frameworks for building the user interface of the application.

- **Truffle/Hardhat** : Development environments and testing frameworks for Ethereum smart contracts.
- **IPFS (InterPlanetary File System)** : Decentralized storage solution for storing NFT metadata and assets.

❖ **Tools Requirements -**

- **MetaMask (or other wallet)** : Cryptocurrency wallet for user authentication and transaction signing.
- **Ganache** : Local blockchain emulator for testing smart contracts in a controlled environment.
- **Visual Studio Code (or other IDE)** : Integrated development environment for coding and debugging.
- **Postman** : API development and testing tool to ensure proper communication between frontend and backend services.
- **Git** : Version control system for managing code changes and collaboration.
- **GitHub/GitLab** : Platforms for hosting code repositories and facilitating team collaboration.

3.6 Experiment and Results for Validation and Verification -

Multiple tests were conducted to validate smart contract execution, transaction speed, and security audits. Results show significant reductions in transaction fees compared to centralized marketplaces. To validate the Meta-Bazaar platform's reliability and functionality, a series of experiments and tests were conducted :

1. Unit Testing :

Individual components of the smart contracts, frontend, and backend were tested to ensure proper functionality, confirming successful NFT minting, transferring, and listing.

2. Integration Testing :

Tests verified seamless interaction between the frontend and backend, as well as communication with smart contracts on the blockchain, ensuring accurate transaction processing.

3. Performance Testing :

The platform was evaluated under various load conditions, demonstrating its ability to handle multiple concurrent transactions without significant delays.

3.7 Result Analysis and Discussion -

The analysis of the validation and verification results provides valuable insights into the NFTBazaar platform :

1. Functionality - Core features like minting, trading, and auctioning were successfully implemented.

2. Performance - The system maintained low response times during peak load conditions, ensuring a smooth user experience.

Meta-Bazaar effectively addresses the shortcomings of centralized platforms, providing a secure and user-friendly NFT trading environment.

3.8 Conclusion and Future Work -

The **Meta-Bazaar** decentralized marketplace represents a significant advancement in NFT trading by leveraging blockchain technology for secure, transparent, and efficient transactions. The successful implementation of core functionalities underscore the platform's effectiveness.

Future work will focus on :

1. **Cross-Chain Compatibility** - Enabling NFT trading across multiple blockchain networks.
2. **Enhanced User Features** - Adding advanced search filters and social sharing options.
3. **Mobile Application Development** - Improving accessibility for users on mobile devices.
4. **Community Governance** - Allowing user participation in platform decisions.

In summary, Meta-Bazaar is poised to revolutionize the NFT marketplace, fostering a more inclusive and equitable environment for creators and collectors.

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