NFT ArtHub - A Marketplace for Digital Art

SUBMITTED IN PARTIAL FULFILLMENT FOR THE REQUIREMENT OF THE AWARD OF DEGREE OF

BACHELOR OF TECHNOLOGY

IN

COMPUTER SCIENCE

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Session 2024-25

DEPARTMENT OF COMPUTER SCIENCE

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May 2025

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We hereby declare that this submission is our own work and that, to the best of our knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgment has been made in the text.

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This is to certify that Project Report entitled " NFT ArtHub - A Marketplace For Digital Art " which is submitted by Ankit Kumar Mishra, Aniket Singh, Annu, Ayush Mishra in partial fulfillment of the requirement for the award of degree B. Tech. in Department of Computer Science of Dr. A.P.J. Abdul Kalam Technical University, Lucknow is a record of the candidates own work carried out by them under my supervision. The matter embodied in this report is original and has not been submitted for the award of any other degree.

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ACKNOWLEDGEMENT

It gives us a great sense of pleasure to present the report of the B. Tech Project undertaken during B. Tech. Final Year. We owe special debt of gratitude to Professor Dr. Harsh Khatter, Department of Computer Science, KIET, Ghaziabad, for his constant support and guidance throughout the course of our work. His sincerity, thoroughness and perseverance have been a constant source of inspiration for us. It is only his cognizant efforts that our endeavors have seen light of the day.

We also take the opportunity to acknowledge the contribution of Dr. Ajay Kumar Srivastava, Head of the Department of Computer Science, KIET, Ghaziabad, for his full support and assistance during the development of the project. We also do not like to miss the opportunity to acknowledge the contribution of all the faculty members of the department for their kind assistance and cooperation during the development of our project.

Last but not the least, we acknowledge our friends for their contribution in the completion of the project.

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ABSTRACT

NFT ArtHub is a decentralized, all-encompassing platform that aims to change the manner in which digital art is developed, disseminated, and enjoyed in the contemporary world. Fundamentally, NFT ArtHub utilizes blockchain technology to facilitate artists to create their pieces as Non-Fungible Tokens (NFTs), allowing for verifiable authentication, irreversible records of ownership, and transparent, safe transactions on the blockchain. This not only secures intellectual property rights but also creates new sources of income for creators through instruments such as perpetual royalties using smart contracts.

The platform is a virtual ecosystem that encourages both new and established artists by providing portfolio-building tools, community interaction, and monetization opportunities. Collectors, meanwhile, experience a curated market that prioritizes artistic merit, uniqueness, and provable provenance. Powerful search and discovery mechanisms, community curation, and seamless compatibility with popular crypto wallets ensure a frictionless experience for all users.

Outside the market, NFT ArtHub seeks to create a lively social community where art and collaboration flourish. Artists may tell their stories, host virtual shows, and connect with collectors and fans in real-time. Knowledge libraries, artist features, and open feedback systems promote learning and trust among members.

In a time when digital content tends to be devalued and copied at will, NFT ArtHub is a revolutionary concept—enabling artists, compensating for authenticity, and changing the course of digital art ownership and cultural exchange.

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LIST OF ABBREVIATIONS

Abbreviation	Full form
NFT	Non-Fungible Tokens
IPFS	Interplanetary File System
EVM	Ethereum Virtual Machine
ETH	Ethereum Token
UI/UX	User Interface/User Experience
dApp	Decentralized Application
ERC-721	Ethereum Token Standard for Unique NFTs
ERC-1155	Ethereum Token Standard for Semi-Fungible NFTs
JWT	JSON Web Token

SDG MAPPING WITH JUSTIFICATION

SDG 8: Decent Work and Economic Growth

How it aligns:

- By enabling artists globally with direct access to a worldwide marketplace without middlemen, NFT ArtHub promotes inclusive economic opportunities and entrepreneurship.
- It reduces the barriers to entry for digital artists, allowing them to fairly and sustainably monetize their work.
- The platform facilitates creative industries and job creation in new sectors such as digital art, blockchain development, and NFT trading.

SDG 9: Industry, Innovation, and Infrastructure

How it aligns:

- NFT ArtHub makes use of advanced blockchain and decentralized storage technologies, which is an example of innovation in digital infrastructure.
- The use of smart contracts, Layer 2 solutions, and decentralized IPFS storage illustrates sustainable and scalable technological progress.
- The project promotes the development of creative industries through digital development and infrastructure.

SDG 10: Reduced Inequalities

How it aligns:

- Through eliminating conventional gatekeepers and middlemen in the art market, NFT ArtHub facilitates equal access and equitable opportunities for artists irrespective of geographic location or socio-economic status.

- The decentralized nature of the platform enables marginalized or underrepresented artists to present and financially benefit from their art globally.
- Low-fee and affordable transactions made possible by Layer 2 scaling solutions abate economic imbalances in participation.

SDG 12: Responsible Consumption and Production

How it aligns:

- NFT ArtHub enables digital ownership and provenance which de-incentivizes fake and unauthorized copies of digital art, encouraging responsible production.
- Digitalization of art sales and minimization of dependence on physical shipping and galleries aid the platform in lowering environmental prints in art business.
- Future scopes of the project involve embracing energy-saving Layer 2 and blockchain technologies to limit environmental effects.

SDG 17: Partnerships for the Goals

How it aligns

- The initiative promotes partnerships among developers, artists, and blockchain communities worldwide to create a sustainable digital arts environment.
- Partnerships with decentralized platforms, such as wallets including MetaMask, and storage networks like Pinata IPFS are classic examples of partnerships that enhance technological and creative infrastructure.
- NFT ArtHub is able to promote cross-domain partnerships such as art institutions, educational institutions, and environmental activities.

CHAPTER 1

INTRODUCTION

1.1 Introduction to Project

The "NFT ArtHub" project is a next gen NFT based e-commerce platform to help artists sell Their artworks have been sold as NFTs (Non-Fungible Tokens) on the Ethereum blockchain. This came into being alongside the increased desire of people wanting to trade and own digital art. A safe and transparent marketplace records transactions on the blockchain for authenticity and for traceability. One of the salient features of such a system is the use of smart contracts ensuring that all transactions are executed in an automated, safe, untraceable, and unhackable environment. These smart contracts are essentially self-executing agreements in which actions would be executed automatically when some predefined conditions are met, including disbursal of funds or transfer of ownership, a scenario that provides a safe platform for artists and buyers alike. The platform also goes in use of decentralized storage through Pinata IPFS (InterPlanetary File System).

From Digital technology's viewpoint, it has changed the way art is created, disseminated, and marketed. Art is now no longer displayed only in traditional art markets that depend on physical galleries and exhibitions. The era of digital transformation has brought in its wake an opportunity for artists to utilize digital platforms in showcasing their work worldwide. With the introduction of NFTs, they have further made this market big enough to allow an artist to create a unique, verifiable digital asset that holds market value and can be easily sold or traded without any interference from middlemen.

Reflecting this boom in digital art went the launch of "NFT ArtHub." It is the platform that allows artists to use the most advanced blockchain technology to showcase, market, and preserve their art. The platform ensures that every piece of digital art is not only uniquely registered but also safely recorded and traceable using Ethereum’s strong network so each artwork’s ownership and transaction history is transparent and verifiable.

In essence "NFT ArtHub" is a tool to empower artists and collectors in the fast growing digital art space not just an e-commerce website. It’s an environment where artists have full control over their creations from creation to retail and collectors can buy, own and exchange digital art with guarantees of authenticity. Every step of the process from minting an artwork as an NFT to the final transaction is made safe, efficient and transparent by the combination of smart con-

tracts and decentralized storage. This new way of buying, selling and trading digital art is changing the art world, a future where creators and collectors can thrive in a fully digital ecosystem.In short NFT ArtHub is the future of digital art, where blockchain meets artists and collectors. The platform is secure, transparent and friction less transactions, users have full control of their digital assets and an environment of trust and innovation.

1.2 Project Category

The project falls into NFT marketplace development and blockchain e-commerce. It takes decentralized storage, smart contracts, and blockchain technology to render a safe and easy-to-use marketplace for digital artists and collectors. The platform offers selling, buying, and exchange of artworks and digital art in an environment where security, transparency, and immutability hold these as advantages offered by the block-chain. NFTs, hence, confer an extra level of trust into online transactions by verifying the ownership and authenticity of digital art. By ensuring secure and verifiable transactions atop the Ethereum block-chain, the platform gives much-needed confidence to users in trading digital assets.

The project is particularly classified under block-chain-based e-commerce and NFT marketplace development. The platform provides every sale and purchase to be secured and transparent through automating and valid-into-smart-contract transaction procedures. Digital artworks get stored securely, are accessible, and are protected against any data loss or manipulation through the application of decentralized storage systems, e.g., Pinata IPFS. The combination of those technologies creates a trusted, efficient, and innovative market where artists make money out of their art and collectors buy digital assets with assurance of their worth and identity. This way, the platform creates a route for artists and buyers to conduct a digital art economy while maintain control and security over their assets.

1.3 Objectives

The project is driven by several clear and purposeful objectives:

- **To create a transparent and secure platform** that enables the buying and selling of digital art through NFTs.
- **To utilize Ethereum's blockchain infrastructure** for authenticating and recording all transactions in an immutable ledger.
- **To ensure the safety and permanence of digital artworks** by employing **Pinata IPFS**, a decentralized storage system.

- **To integrate Web3.js and Metamask**, simplifying the user's ability to interact with the blockchain without needing in-depth technical knowledge.
- **To enhance scalability and reduce costs** by using Layer 2 solutions like **Polygon**, ensuring transactions are both fast and affordable.
- **To ensure robust performance and reliability** through a combination of **manual testing** and **automated Selenium testing**, aiming for a smooth and error-free user experience.

1.4 Structure of Report

In order to provide readers with a comprehensive understanding of the project—from its conceptual foundation to its actual implementation—this report has been carefully structured. By providing both technical depth and user-oriented insight, each section is intended to build upon the one before it.

Section 1: Overview

This project will create a decentralized digital art market with NFT (Non-Fungible Token) technology, giving artists and collectors a secure, transparent, and tamper-proof setting for the creation, sale, and ownership of digital art. The aspiration is to empower artists by allowing them complete control and confirmed ownership of their work while allowing buyers to purchase one-of-a-kind digital content with verifiable provenance. The scope covers the integration of blockchain-based ownership validation, secure wallet authentication, decentralized storage through IPFS, and low-cost Layer 2 transaction capability. The aim of the platform is to tackle essential issues in the digital art environment—e.g., plagiarism, forgery, and inability to trust central marketplaces—by tapping into the inherent advantages of blockchain technology. This basis permits a more free, equal, and more effective art system responding to the needs of creators as well as collectors.

Section 2: Foundational Technologies

The platform is founded on a solid foundation of decentralized technologies working in concert to provide security, transparency, and reliability. Ethereum, one of the top blockchain platforms, acts as the basis for running and storing transactions via unalterable smart contracts. Those smart contracts implement essential features like NFT minting, ownership changes, and marketplace

transactions without the requirement for intermediaries and minimizing manipulation risks. IPFS (InterPlanetary File System) is employed to store NFT metadata and digital objects in a decentralized way so that content becomes accessible, tamper-evident, and resistant to single points of failure. All these technologies combined provide a completely decentralized digital artwork platform where trust is embedded in the system design, with users able to interact with confidence and security.

Section 3: Features of the Platform

The platform is built with a core set of fundamental features that augment both functionality and experience. To begin, it provides smooth transactional processes by incorporating Layer 2 solutions such as Polygon, thereby cutting down on gas fees and accelerating transaction speed. This enables users to purchase, sell, and transfer NFTs in an efficient and cost-effective manner. Second, decentralized digital asset storage is guaranteed by the use of IPFS through Pinata, which stores metadata and media assets in a network, safeguarding them against tampering and centralized failure. Finally, NFT minting functionality enables creators to monetize their digital content by tokenizing digital artwork and creating verifiable ownership on the Ethereum blockchain. All three features combine to create a secure, efficient, and artist-friendly platform.

Section 4: Methodologies and Outcomes of Testing

Explains how the platform's performance and dependability were examined. To find and address issues and guarantee a seamless user experience, both manual and Selenium-based automated testing were used.

Section 5: Conclusion and Prospects

The project was able to deliver a decentralized NFT art platform with secure ownership verification, smooth transactions through Layer 2 solutions, and decentralized storage through IPFS successfully. Key features such as NFT minting and wallet authentication performed smoothly in testing.

Future enhancements may involve AI-recommended content, artist analytics dashboards, and social aspects such as follow and share, further boosting engagement and user experience.

CHAPTER 2
LITERATURE REVIEW

2.1 Literature Review

The existing literature on blockchain development and its applications to virtual art offers credible insights for platforms such as NFT ArtHub.

An NFT, or a non-fungible token, is a blockchain-backed combination of digital and virtual art that assures secure and transparent transactions with respective ownership records.

Blockchain Fundamentals
According to Zheng et al. (2017), the three aspects that characterize blockchain are transparency, immutability, and decentralization. These are the key attributes that make a blockchain tamper-proof and perfect for transaction recording. Its immutability ensures there cannot be any alterations without undue permissions, whereas its lack of having a single database or storied library of information prevents such piracy and ownership issues from occurring on virtual works of art.

Impact of Digital Technology on Contemporary Art
The Effect of Digital Technology in Contemporary Art Chen, X., Dai, H., & Xie, S. (2019) discuss the influence of technical advancement on modern art, especially in digital and interactive mediums. They bring about the transformative nature of emerging technologies such as AI and blockchain on artistic expression. Blockchain integration ensures secure and transparent ownership of digital art, opening new avenues for artists for monetization.

Smart Contracts: From Bitcoin to Blockchain
Grishin, A., Yurchenko, A., & Alexeev, N. (2020) provide an in-depth analysis of the evolution of smart contracts. They trace their development from Bitcoin to their present-day applications within various blockchain platforms. Their work underlines the utility of smart contracts in automating and securing transactions in virtual art marketplaces, ensuring both artists and collectors are protected by transparent, self-executing agreements.

NFTs and the Digital Art Revolution
NFTs and the Digital Art RevolutionOf course, Lee, J., the co-author of "Digital art revolution through NFT" (2021), and Kim, Y. discuss the issuance of NFT in the digital art industry as a revolution. The NFTs, to their view, have brought a new order into the digital art world. The underlying blockchain technology is what materially enables verification and, at the same time, gives a platform for the digital art market to operate up through NFTs..

Bitcoin and Cryptocurrency Technologies

Bitcoin and Cryptocurrency TechnologiesSection one of Narayanan, A., Bonneau, J., Felten, E., Miller, A., & Goldfeder, S.'s book "Bitcoin and Cryptocurrency Technologies" (2016) acts as an elementary yet in-depth guide on Bitcoin and cryptocurrency. This is the fundamental work through which people will learn and understand decentralized technology including Bitcoin and Ethereum, which will make the processing of digital transactions cheaper, easier, and more reliable. This issue is of great value, especially in NFT platforms like NFT ArtHub, where irrefutable ownership and transaction records are important.

Digital Art Marketplaces: Trends, Challenges, and Opportunities

Rodriguez, J., & Patel, S. (2022) analyze the progress of the digital art markets, outlining negative elements such as copyright and market instability. They offer various steps, among them, are greater openness, and better artist compensation models that could be implemented with the help of blockchain platforms. This work is an essential one in terms of blockchain research providing insights into the ways blockchain can revolutionize the digital art market, promote fair NFT practices, and minimize the risk of transactional arbitration.

Legal and Ethical Considerations in NFT-Based Digital Art Transactions Transactionsharma, A., & Gupta, R. (2023) address and analyze the legal and ethical dilemmas surrounding NFT transactions, to explain these transactions that are of digital nature and fall within the domain of art. They explore topics such as exclusive rights, fraud, and the new law system that is emerging. Their work is indispensable for platforms like NFT ArtHub that deal with legal realities and transact in a fair, overt, and secure manner.

Digital Art: A Comprehensive Survey

Smith, P., Johnson, M., & Williams, L. (2018) give a detailed survey of digital art that covers the period from its history to the current day. The white paper analyzes the change in artistic methods dictated by digital tools and by means of depicting art in a different manner through the internet. Blockchain is presented as a major player in the revolution by delivering a secure system that allows artists to legit and share their works

Blockchain: Blueprint for a New Economy

Swan (2015) introduces blockchain technology and its potential apart from cryptocurrencies. The author refers to a situation, in which blockchain becomes not only a landmark for the financial world but also a game-changer for art, governance, data security, and many other fields of human activity. The writer argues in favor of the solution, claiming blockchain can, in fact, be an infrastructure necessary for exchanges in the digital art marketplaces like NFT ArtHub to be secure and transparent.

Ethereum: A Secure Decentralized Generalized Transaction Ledger
Wood (2014) introduces the Ethereum whitepaper that outlines the architecture and primary features of the platform as a self-executing contract platform. This magical technology is very much behind the so-called NFT art marketplaces, NFT ArtHub being one of them, through the process of NFT creation, sale, and transfer to be secure and transparent. The smart contract facility of Ethereum ensures that deals in the art world are automated through the blockchain.

Blockchain Technology: Principles and Applications
Zheng, S., Dai, H., Chen, X., & Wang, H. (2017) present a comprehensive review of the technology that supports cryptocurrency, the blockchain. They review the important aspects of security, scalability, and consensus mechanisms, which make blockchain the most suitable technology for NFTs, among others as an application. In the work, authors give a clear illustration of how the features of a blockchain can directly impact on various contexts, i.e. the issues of ownership, provenance, and market transparency in virtual art.

ArtProtect: Blockchain and NFC-Based Anti-Counterfeit System for Physical Art Tantowibowo, C. H., & Yau, W.-C. (2024) propose an anti-counterfeit system combining blockchain and NFC (Near Field Communication) technology. Although focused on physical art, their system ensures that artworks are securely authenticated and tracked using blockchain. The concept can be adapted to digital art platforms to prevent fraud and ensure the authenticity of virtual art.

NFT Market Size Statistics and Forecast Report, 2022 - 2032
Market Decipher (2022), offers a considerable amount of market research studying the growth and possibilities of the NFT sector. The report provides data on trends, investment opportunities and market forecasts, and discusses the information to provide data-based insights on the economic impact of NFTs in various industries. This provides strong research to understand the increasing relevance of NFT platforms such as NFT ArtHub in the digital economy.

2.2 Research Gaps

- **Scalability and High Transaction Costs in NFT Marketplaces**
  Scalability continues to present enormous challenges associated with network congestion, particularly related to June 2021 and Ethereum, which resulted in exorbitantly priced gas fees as high as $500 to mint or trade an NFT. Although Layer 2 solutions, including Polygon and Rollups, improve scalability and functionality, the issues of speed to market with NFT platforms is progressing considerably quicker than that of acceptance rate of L2 scalability solutions in the NFT community. Additionally, to have true scalability we need to accommodate interoperability across multiple

blockchains. NFTs have started to earn popularity, and minting and trading them is already costly, making accessibility for smaller creators challenging. This calls for research with regard to alternative consensus protocols; PoS and sharding as suggestions that could mitigate the overhead of scaling. Furthermore, hybrid models are research worthy, which include but are not limited to decentralized networks with cloud storages for scalability.

- **Legal and Regulatory Uncertainties Surrounding NFTs**
  sellers, vendors, Illegal tokenization of digital assets raises justice and intellectual property problems. There are still problems with taxation, classifications of securities, and anti-money laundering requirements, amongst others. Rug pullers continue to take the opportunity to take advantage of users because of the limited legal recourse. There are no standard NFT laws that are applied consistently and therefore they can falsely list whatever they want, deceiving buyers who have no recourse. There is ample research opportunity for a standardized legal framework that finds equilibrium in balancing decentralization and regulation.

- **Security Risks and Smart Contract Vulnerabilities**
  Many NFT smart contracts have vulnerabilities that allow bad actors to exploit them. Asset loss can include unauthorized access through wallet use and phishing attacks. There may also be risks to decentralized storage that could corrupt metadata and make NFTs unusable. Such decentralization leads to unregulated contracts being deployed because there is no standard auditing mechanism based on security. There is a need for research to develop automated tools that can secure smart contracts and detect vulnerabilities.

- **Environmental Impact and Sustainability Concerns**
  The excessive energy consumption exerted to mint an NFT on PoW blockchains instills concerns for the environment. Although such green alternatives exist, such as Layer 2 networks and PoS, these are rarely employed. There is also scarce investigation into green practices for blockchain, including carbon offsetting and green mining; very little research has been conducted toward integrating renewable energy into blockchain networks. Future avenues of research should explore the possibilities of decreasing the enviormental impact.

- **User Experience and Market Accessibility Issues**
  Technical complexities and on-boarding procedures restrain non-technical users' adoption of NFTs. Most marketplaces lack intuitive UI/UX, thus making it impossible for emerging users to navigate through. Costs and gas fees are barriers for smaller

creators to participate in the NFT ecosystem. Wallet integrations and cross-compatibility remain inconsistent. It is recommended that research focus on creating better accessibility, lowering cost, and improving overall user experience.

2.3 Problem Formulation

NFT marketplaces have revolutionized the nature of digital property ownership, granting the ability for artists, investors, and collectors to have the ability to securely buy, sell and trade their digital properties on blockchain-enabled platforms. Although an environment for exchange has been established within NFT marketplaces, there are still multiple challenges to overcome before it can be mainstream. First, there is the scalability issue, which represents high transaction fees and slow speed, especially on platforms like Ethereum, which represent cumbersome in-host transactions and created expenses for smaller buyers and creators. Second, there is the threat of security including the hacking and phishing that artist, and collectors face, and that attacks on smart contracts and decentralized storage represents a security issue that not only slows, and raises expenses in marketplaces but also creates barriers for smaller buyers and creators.

The third challenge is the uncertainty around the legal and regulatory framework, which creates confusions around ownership rights, taxation practices, and legislative compliance, for artists and creators. This issue could also lead to fraud and the unlawful tokenization of assets. In addition, there have been concerns with the environmental impact of minting NFTs on proof- of-work chains like Ethereum, which take an extremely high amount of energy to even mint and maintain proof of ownership using something like Ethereum, which presents sustainability challenges. Lastly, user experience within NFT marketplaces presents a challenge because of the process of onboarding.

CHAPTER 3

PROPOSED SYSTEM

3.1 Proposed System

Hybrid NFT-Based E-Commerce System presented here is a next-generation digital market that uses blockchain technology to revolutionize the experience of purchasing, selling, and owning digital art. The system is based on the Ethereum blockchain and uses Non-Fungible Tokens (NFTs) to deliver a decentralized, trustless platform where artists can tokenize their digital works and sell them directly to the end-users in a secure, verifiable way. At its core, the system employs smart contracts to enable automated transaction logic, creator royalties, and ownership authenticity enforcement without middlemen, thereby empowering artists and buyers in an open and self-sustaining ecosystem.

A key aspect of the system's design is its utilization of Pinata IPFS (Interplanetary File System) for decentralized storage. This makes sure that digital assets like images, animations, or videos are saved in a mountless and distributed manner—that is, the original artwork files are not saved in a centralized storage server, less susceptible to tampering, censorship, or loss of data. What IPFS does instead is give each digital asset an encoded cryptographic hash, and then include this in the NFT metadata in the blockchain. This hash-linking ensures immutability of data and simple verification of origin, thus promoting belief in the asset's origin and integrity.

Web3.js drives the platform's frontend, which acts as a liaison between the application for users and the Ethereum blockchain. With this integration, users are able to communicate with smart contracts from within their web browsers to execute crucial operations like minting NFTs, transferring ownership, or buying listed items. In conjunction, the MetaMask browser extension offers an easy and well-adopted wallet interface for conducting Ethereum transactions. MetaMask is both a key store and gateway to decentralized applications (dApps), enabling users to authenticate, handle funds, and sign transactions in a non-custodial fashion. The combination of these products provides an effortless and intuitive user experience that has very little technical overhead, driving wider adoption across digital creators and collectors.

In acknowledgment of Ethereum's scalability and price constraints—particularly the astronomically expensive gas prices of minting and transferring NFTs—the project seeks to incorporate Layer 2 scaling solutions, i.e., Polygon (previously Matic Network). Layer 2 chains run on top of the Ethereum mainnet and process transactions off-chain but maintain the security assur-

ances of the base Layer 1 blockchain. By handling the majority of transactions on Polygon and then re-anchoring end states to Ethereum, the platform helps immensely diminish transaction latency and gas fees, thus making NFT creation and exchange more available to users with small budgets or high-frequency requirements. This not only democratizes the availability of digital art markets but also creates a more sustainable and scalable framework for decentralized e-commerce.

From a system engineering and performance perspective, the development process laid major importance on quality assurance. To achieve a stable, user-friendly, and bug-free platform, the project utilizes manual testing and automated testing through Selenium. Manual testing replicates actual usage scenarios and human interactions with the system to test UI/UX flow, check edge cases, and identify inconsistencies in behavior on different devices and browsers. Selenium automated testing augments this by allowing continuous integration and regression testing. This guarantees that code changes do not create new bugs or render existing features dysfunctional in the long term. Selenium test scripts simulate user interactions—connect wallets, mint NFTs, and buy items—to confirm the entire workflow under iterated and scalable testing.

The platform vision is broader than mere NFT transactions. It is a proof-of-concept for the effective integration of decentralized technologies into conventional digital commerce. By disintermediating reliance on centralized middlemen, offering verifiable evidence of ownership, safeguarding artist royalties via programmable logic, and lowering entry barriers with inexpensive Layer 2 integrations, the system enables a more equitable, more open marketplace. This e-commerce hybrid model therefore sits at the nexus of art, technology, and money— opening up the horizon for a future where creators own the work they create, purchasers are guaranteed authenticity, and innovation continues to transform the digital economy.

3.2 Unique Features of the System

• Security aspects of Blockchain: It employs Ethereum smart contracts to act as mediators against digital art ownership and tamper-proofing. Trustless transactions are enabled through smart contracts, hence once it is marked as complete, it is fixed permanently with no other party (not even the platform) having the power to alter it.

• Storage is decentralized: NFT information and digital content (image, video, sound etc) assets are stored on the Pinata IPFS (Interplanetary File System). Decentralized storage gives assurances that digital data will be intact and is stored, regardless of whether a platform has issues or

shut down.

• Pinata IPFS, offering an IPFS solution that is scalable and strong for long-term and secure digital file storage, will store files linked to NFTs.

• Easy Minting: The platform is designed in a manner where all artists can mint NFTs, with no deep technical background and/or no prior knowledge of blockchain. With a simple user interface that assists the artist and tutorials, difficulty level is minimized to taking any type of art and creating it into an NFT. Making it accessible to artists of every discipline, who might or might not possess some level of blockchain knowledge.

• Smooth Transactions: Transactions are enabled via Web3.js and MetaMask for buying/selling NFTs via ETH (Ethereum). Web3.js is utilized by the platform to interact with the blockchain, and MetaMask enables our users to make payments in this cryptocurrency for security.

• Gas Fee Minimization: The platform was set up to reduce gas fees for individuals, and hence it does support second-layer protocols such as Polygon, which does transactions off-chain and then posts it to the Ethereum chain, which reduces gas fee and accelerates transaction time, which is crucial to both low-end users as well as content creators.

• Scalability: The system was built scalable and sustainable. It can develop sophisticated features pertaining to AI and other features (for instance, suggesting digital artworks for users based on user activity), and multi-chain support for the future when Ethereum ceases to be the largest blockchain.

• Trust and Transparency: This system is run on blockchain technology, thus all transactions are traceable, transparent, and verifiable. This will create trust among creators, collectors, and buyers. Also, all ownership history regarding each NFT, as well as reference to the original sale, is permanently stored on the blockchain.

• Global Reach: The platform allows users from anywhere on the globe to buy & sell & mint

NFTs. Although geographically restricted a traditional artistic marketplace offers, blockchain as technology polarizes and decentralizes this barrier to entry, enabling artists & buyers from around the world to enter the digital art marketplace.

• Marketplace: The NFT ArtHub marketplace provides a marketplace for those artists who wish to buy, sell, & auction NFTs. Every artist will have an optimal user experience when selling their artwork, and buyers can view, browse and purchase art. Marketplace filtering features like categories, trending, and limited-edition pieces are all available for browsing & bidding on.

• In short, the features of NFT ArtHub platform are not just secure and effective but also offer a friendly and scalable platform to all digital artists, art collectors, and NFT investors; but combined with the strength of blockchain technology, decentralized.

CHAPTER 4

REQUIREMENT ANALYSIS AND SYSTEM SPECIFICATION

4.1 Feasibility Study

Technical Feasibility

The platform uses a mix of established and innovative technologies to create a solid and scalable NFT platform. At its foundation, the Ethereum blockchain is used as the decentralized ledger, where all transactions and ownership information are recorded immutably, guaranteeing transparency and security. Business logic on the platform is coded in the form of smart contracts using Solidity, which carry out activities like NFT minting, transfer, and sales without go- betweens, lowering costs as well as increasing trust. Storage for NFT metadata and digital assets is facilitated by Pinata IPFS, a decentralized file storage network that ensures persistence and tamper-resistance of content through dispersal across different nodes around the world.

In order to make a connection between the front-end interface and the blockchain backend, Web3.js is utilized to provide transparent and secure communication with Ethereum nodes to enable wallet connections, transaction signing, and interactions with smart contracts. In regards to user experience, the front-end is developed with React.js, a contemporary and highly responsive JavaScript library that enables dynamic, efficient UI component rendering, increasing usability and accessibility across devices. The symbiosis of such technologies creates a scalable framework that can handle increasing user load while ensuring the utmost levels of security, transparency, and performance. Together, they constitute a strong foundation that can grow and evolve as the NFT space matures.

Economic Feasibility

The platform does away with intermediaries, thus considerably cutting down on operational costs unlike in conventional art markets that may come with galleries, agents, and auction houses. This efficiency reduces the entry cost for artists, who only pay gas fees for deploying smart contracts and minor server hosting charges. On the income side, the site collects fees on transactions of NFTs and provides premium services like showcased listings, advanced analytics, or marketing assistance to artists. The business model forms a cost-effective and sustainable ecosystem that is beneficial for both creators and collectors by creating an affordable and accessible digital art while ensuring the sustainability of the platform along with growth. On the income side, the platform is self-sustaining through a solid business model that levies reasonable transaction fees on NFT sale and resale. NFT ArtHub also provides a range of premium services aimed at promoting artists' work and visibility as well as its success.

Operational Feasibility

Our platform is centered around simplicity and ease of use. Artists are able to mint NFTs easily via a simple interface, while collectors enjoy a safe and streamlined trading experience, all driven by smooth integration with MetaMask wallets. To guarantee reliability and performance, the platform has also gone through heavy manual testing in addition to automated test suites, ensuring that each feature functions perfectly under different conditions. Particular emphasis has been placed on simplifying the onboarding process to make it easy and welcoming even for those without technical experience so that everybody can easily join the digital art market. As a whole, the platform aims to provide the optimal user experience through an innovative blockchain technology combined with an easy-to-use and refined interface.

Conclusion

The Overall, both technically, a strong business model, economically, with a healthy monthly revenue, and operationally, the NFT ArtHub platform is a fully viable project to launch. The combination of blockchain technology, decentralized storage of images, smart contracts, decentralization, and the overall function of the platform create a safe, reliable, cost-effective and user-friendly marketplace for artists and collectors alike. In addition to these benefits, this project has a robust business model which will ensure sustained growth and success to the NFT ArtHub platform within the ever-evolving digital ecosystem and digital art ecosystem.

4.2 Software Requirement Specification

4.2.1 Data Requirement

To effectively support platform functionality, the platform needs to retain and manage several data types:

- **User Data:** This comprises wallet addresses related to blockchain transactions, profile information such as username and biography, and details of transaction histories (previous purchases, sales, and transactions).
- **NFT Data:** Each NFT will have unique designations, like Token ID. The metadata associated with the NFT will need to be retained, consisting of attributes like title, description and artwork/media files. Ownership information will be tracked on the blockchain to maintain provenance while media files will remain on IPFS with links to the files.
- **Transaction Data:** This involves records related to smart contract interactions (minting NFTs, buying or selling NFTs), payment records detailing amounts and

confirmations of the transaction, and bidding records if the platform offers NFT sales in an auction-style.

4.2.2 Functional Requirement

The platform will include several essential features in order to ensure a seamless experience for users:

- User Authentication using Web3 wallets (i.e. MetaMask): Users will authenticate using MetaMask or a similar Web3 wallet solution to securely interact with the Ethereum Blockchain and facilitate the integration of wallets for payments and ownership.

- NFT Minting with metadata storage on Pinata IPFS: Artists will mint NFTs via uploading their digital artwork and the associated metadata for that artwork securely on Pinata IPFS, to ensure that their data remains decentralized and accessible.

- Buying, Selling, and Bidding Functionalities: The platform will assist users by allowing the ability to buy, sell, and bid on NFTs in a safe environment. All of the buy/sell/bidding processes will utilize smart contracts to automatically perform the transactions to ensure the proper transfer of assets.

- Smart Contracts will Guarantee Secure Transactions: All buying and selling will ultimately be in accordance with smart contracts, which will automatically execute the terms of that contract to ensure all parties are held accountable to fulfillment of the contract terms and prevent fraud.

- Admin Panel for Monitoring Marketplace Activities: It is important for an admin to have access to an admin panel, that will include monitoring of activities in the marketplace (e.g., access to active listings, total transactions, users, etc.) to allow for monitoring the activity surrounding the platform.

4.2.3 Performance Requirement

The platform must deliver high performance, particularly in handling a growing number of users and transactions:

Fast Transaction Processing with Layer 2 Scaling Solutions: To transcend the intrinsic constraints of the Ethereum mainnet—high gas charges, network overload, and delayed confirmations—this platform utilizes Layer 2 scaling technologies, namely Polygon (formerly Matic). Polygon is a companion protocol that is developed on top of Ethereum and enables the majority of transactions to be processed off-chain with greatly diminished charges and quicker

processing. Not only does this decrease gas charges, it also lowers confirmation latency, facilitating near-instant NFT-related operations like minting, transfer, and purchases.

Additionally, the use of Polygon's Proof-of-Stake consensus mechanism offers greater security with high throughput. Since it is EVM-compatible, developers can easily port Ethereum smart contracts onto the Polygon network without making drastic architectural overhauls. Consequently, the user experience is radically enhanced: collectors and artists can use the platform without the concern of prohibitively expensive transaction fees or performance delays, thus increasing adoption and user satisfaction.

Low-latency IPFS file retrieval: To accommodate the decentralized storage of NFT data, all digital assets and metadata thereof—such as images, videos, audio files, and description text—are hosted with Pinata, a user-friendly interface to the Interplanetary File System (IPFS). This way, the platform is immune to the flaws of centralized file storage in the form of single points of failure or censorship. With IPFS, all files are given a distinct cryptographic hash, and the system can bring back the files directly from the nearest or fastest node to hand over.

Pinata improves IPFS performance with specialty pinning services, which make content available in the long term and are not deleted as a result of garbage collection on IPFS nodes. In times of intense user demand, e.g., simultaneous NFT drops or large-scale events, this system ensures low-latency access to files—permitting users to display, validate, and engage with NFT content efficiently and consistently. In addition, this method delivers tamper resistance and enhanced data permanence, essential to establishing trust in NFT ownership.

High availability using a distributed architecture: Having continuous access and stable performance is a top concern of any major NFT platform. For this purpose, the system is designed on a distributed and redundant backend infrastructure. There are multiple application and database server nodes hosted across geographically distinct data centers or cloud regions through offerings like AWS, GCP, or Azure. The multi-region hosting ensures high availability, fault tolerance, and load balancing even during maximum user loads.

If a single server or data center becomes non-responsive because of hardware failure, network problems, or maintenance, traffic is automatically redirected to an alternate functioning node without impacting the end user. Moreover, containerization software such as Docker and orchestration software like Kubernetes are utilized to host scale-out microservices so that the process of rolling out updates, segregating failures, and handling system resources is simplified. This distributed architecture not only guarantees 99.9%+ uptime but also supports horizontal scaling, where additional servers are introduced to the pool on demand—granted elastic capacity as the platform user base expands.

4.2.4 Maintainability Requirement

In order to keep the platform functioning securely into the future, several maintainability practices will be employed:

- **Modular Smart Contract Design for Update Ease:** The smart contracts controlling the transaction and NFT minting are to be modular so that they can be easily updated or upgraded without any impact to the platform's continued operation. This supports flexibility around implementing new functionalities and upgrades.
- **Regular Audits to Improve Security and Performance:** Periodic security audits of the smart contracts will be done in order to find vulnerabilities and reduce risks. Audits will also look at the performance of the platform to ensure that it continues to operate efficiently as the underlying system grows.
- **Continuous Monitoring with Logging and Analytics to Assist Issue Resolution:** Continuous monitoring of the platform will be put into place so that administrators can monitor the performance of the platform in real time. Detailed logs and analytics will be available to identify resolution of issues that could delay the overall platform performance thereby improving the end user experience.

4.2.5 Security Requirement

Security is critical for the integrity of the platform and users' assets:

- **Blockchain-based Ownership Verification to Prevent Fraud:** The user interface uses the Ethereum blockchain to create an open and tamper-evident record of ownership of NFTs. The unique token ID of each NFT minted is linked directly to its creator and transaction history. This guarantees that ownership can be traced directly back to the source of creation. This makes forged or duplicate assets less concerning. The unalterable character of blockchain data guards against illegal changes and assists in establishing trust and combating fraud for collectibles and digital artwork.
- **Secure Wallet Authentication with Metamask:** Users Authentication happens via MetaMask or another Web3-compatible wallet, so that only the valid owner of the wallet can make interactions with the platform. It takes advantage of cryptographic signature authentication instead of passwords, offering a safe and user-owned access system. Because the private keys are never transmitted outside the device, theft of credentials is significantly minimized. It also facilitates safe NFT transactions straight from the wallet without displaying sensitive login credentials.
- **Smart Contract Audits to Mitigate Vulnerabilities:** To ensure security and preserve user trust, the platform will have ongoing smart contract audits by internal staff and/or third-party

security companies. These audits inspect the contract code for weaknesses such as reentrancy attacks, overflow bugs, and access control bugs. By actively discovering and correcting flaws, the platform can avoid exploitation and have confidence that smart contracts run securely and reliably in a production environment.

- **Data Integrity with Pinata IPFS Decentralization:** NFT metadata and linked files are archived with Pinata's IPFS gateway, facilitating content-addressed and decentralized storage. IPFS takes a different approach from traditional centralized servers, utilizing a network of distributed nodes, so that files are always accessible and verifiable in the future. This distributed storage solution avoids single points of failure, guards against tampering of data, and guarantees digital assets are always available and corruption-resistant even when nodes are lost.

4.3 SDLC Model Used

A second sprint was established to code the backend with functionality for user accounts, NFT metadata, and transactional logic. The above-mentioned sprint also included the creation and deployment of smart contracts with Solidity and MetaMask and Web3.js for wallet integration so that users can interact safely with the blockchain.

Secondly, Pinata IPFS was incorporated for decentralized NFT metadata and digital asset storage. Thirdly, Layer 2 solution integrations such as Polygon were carried out to enhance performance and reduce gas charges. Last but not least, manual testing was carried out using Selenium tests on functionality, security, and usability to enable seamless user interaction.

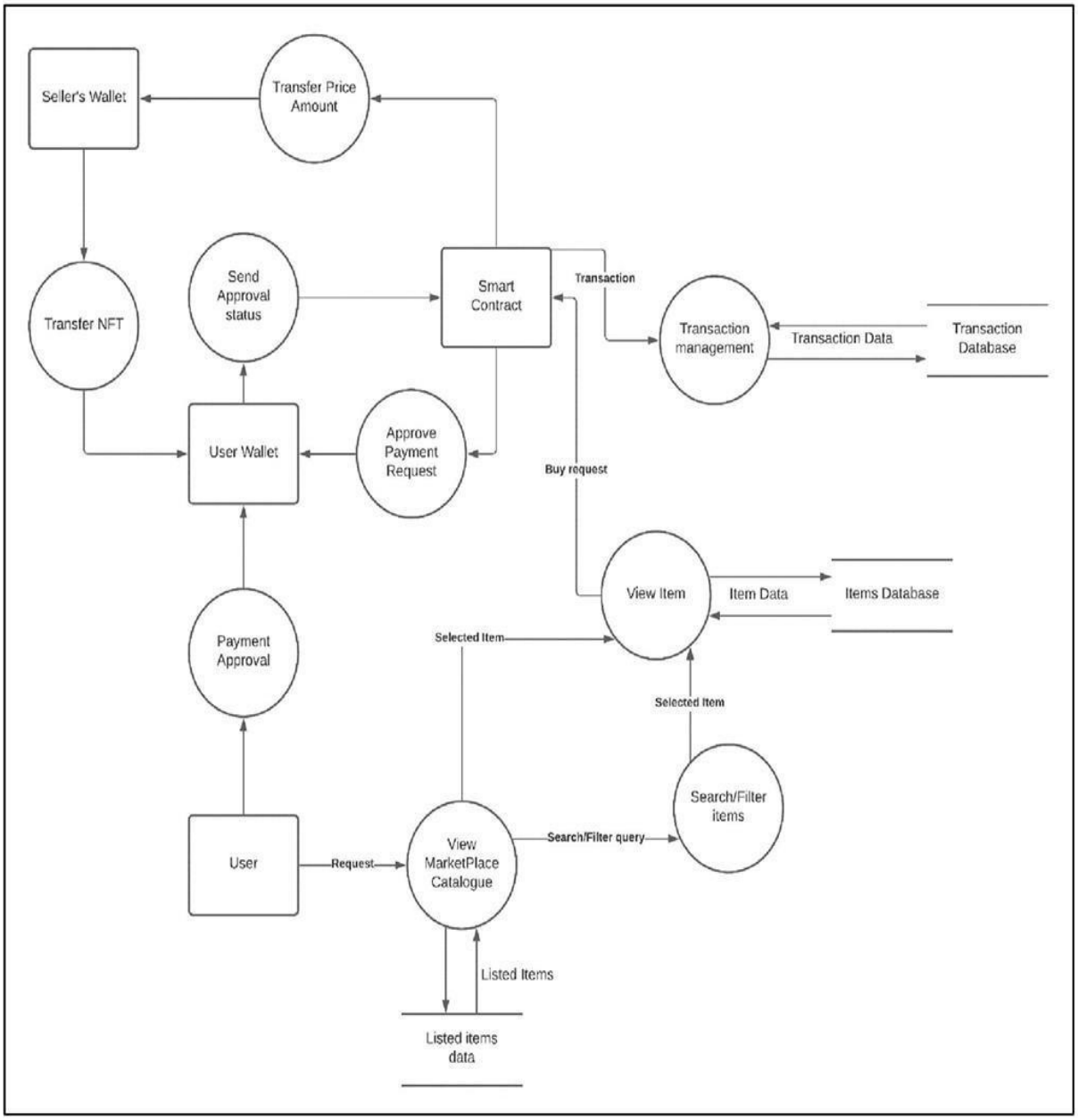
Concurrently, an API layer was built to ensure smooth interaction between the frontend and blockchain infrastructure. RESTful services were used to retrieve NFT data, manage user profiles, and process transaction history in a scalable fashion. Token-based authentication mechanisms were also implemented to provide an added layer of security for user sessions. Logging and error-handling systems were implemented to enable debugging and monitoring in production. These features combined to make the platform maintainable and reliable.

To enhance interaction further, UI/UX improvements were implemented based on responsive design concepts and user feedback loops. Functions such as real-time wallet connection status, dynamic NFT galleries, and immediate transaction alerts were added for enhanced usability. Accessibility enhancements were also factored to make the platform accessible to everyone. Version control was maintained continuously with Git that enabled orderly collaboration and rollback functionality. These steps in turn strengthened the iterative development process, finally resulting in a feature-rich, scalable, and user-friendly NFT marketplace.

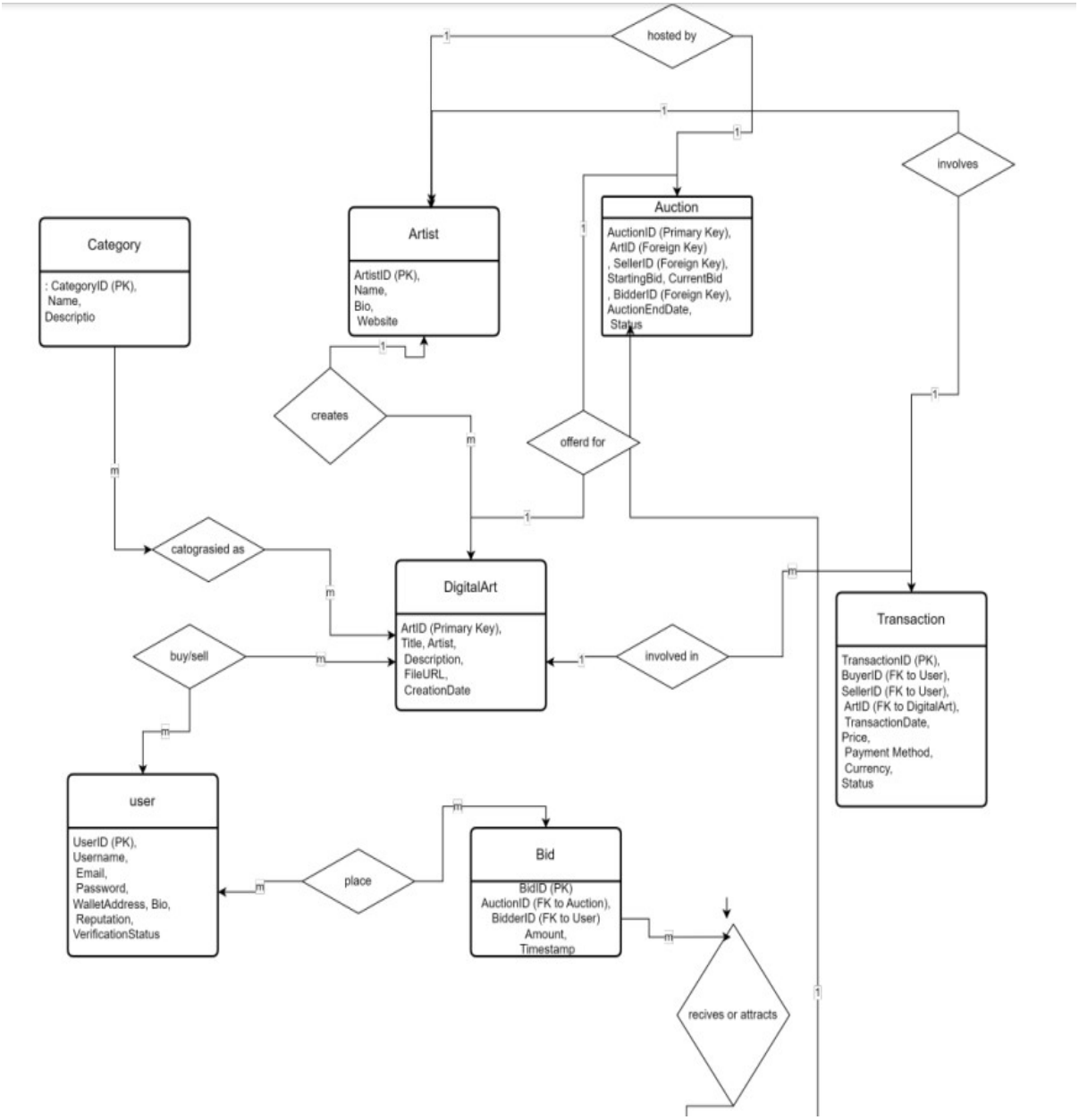
4.3 System Design

4.4.1 Data Flow Diagrams (DFD)

- **Figure 1 –**



- **Figure 2 –**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Category
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AuctionID (Primary Key),
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, SellerID (Foreign Key),
StartingBid, CurrentBid
, BidderID (Foreign Key),
AuctionEndDate,
Status
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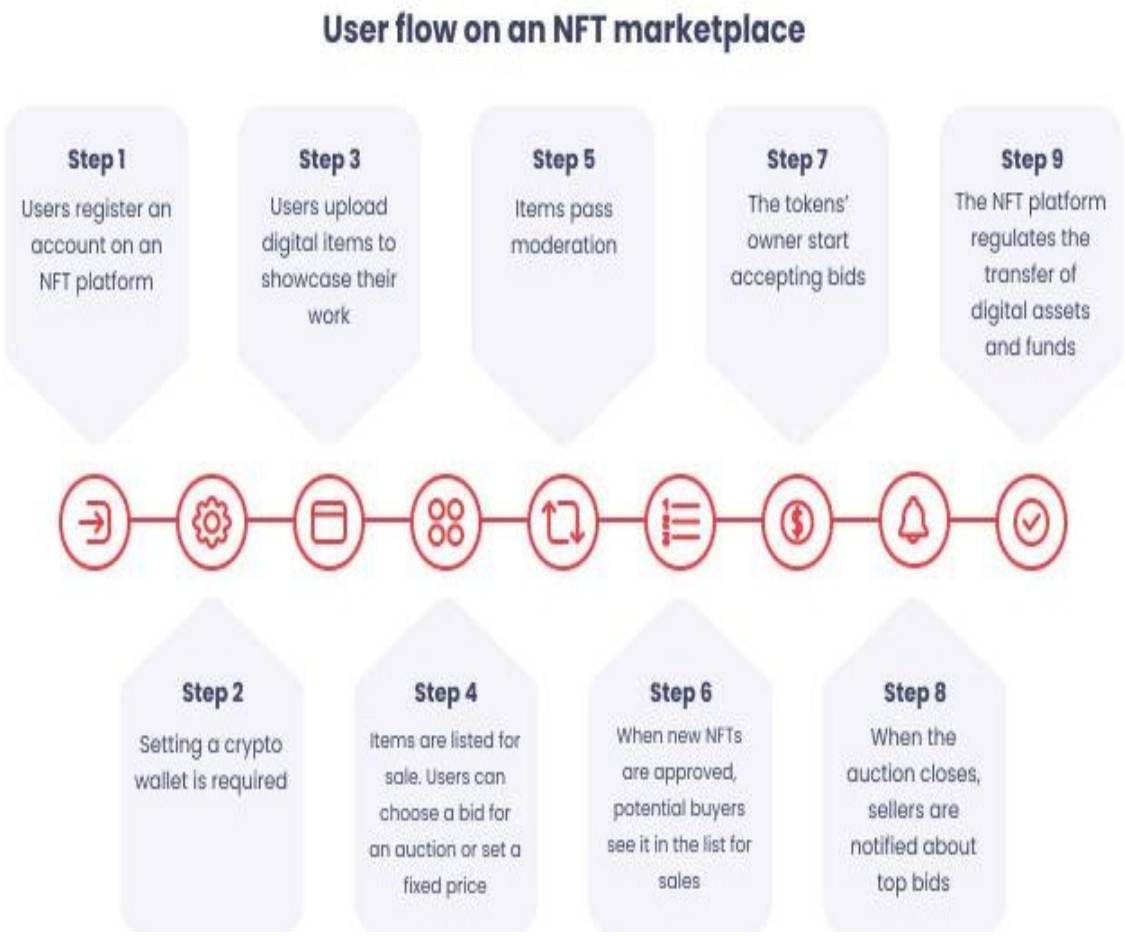
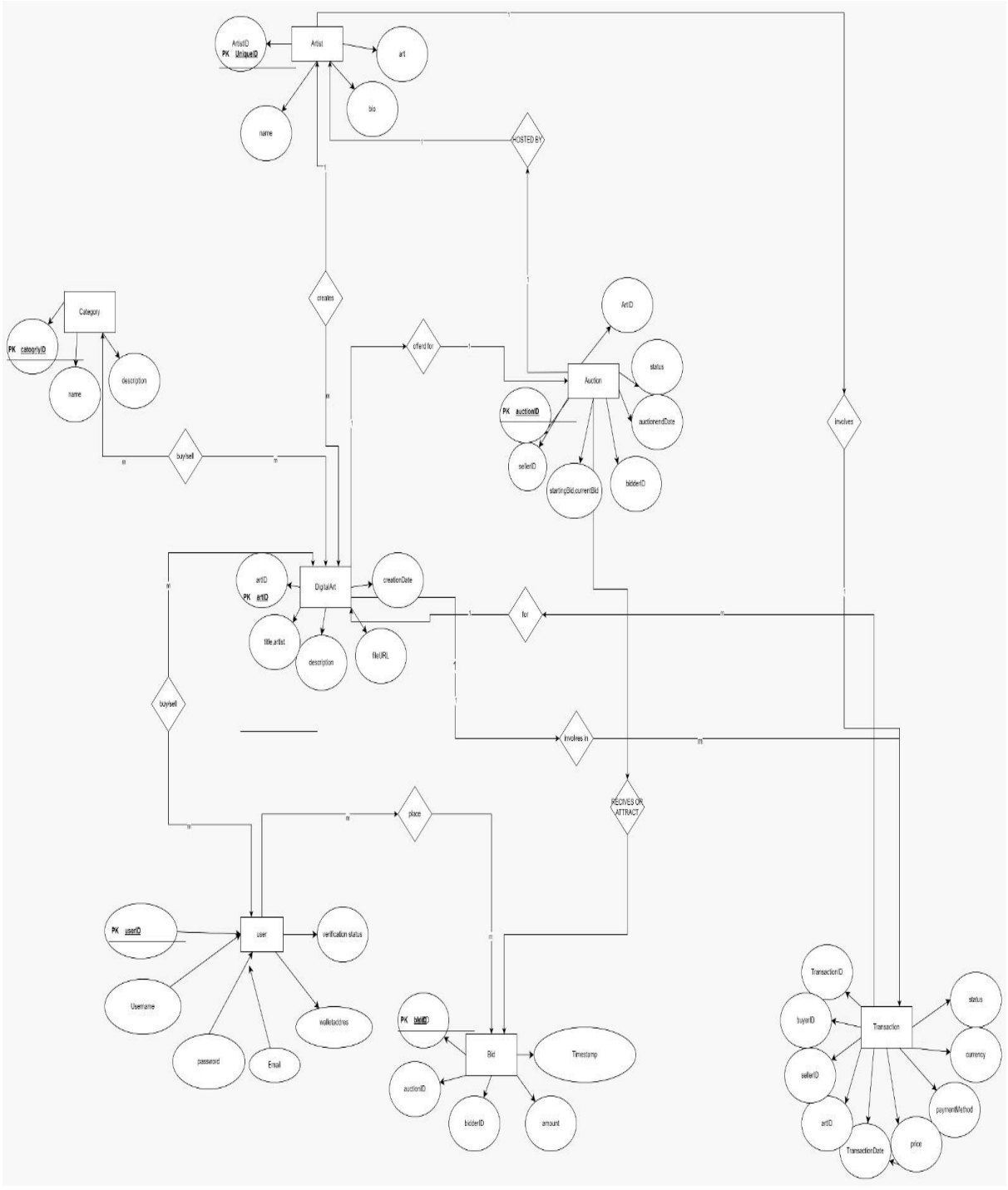
DigitalArt
ArtID (Primary Key),
Title, Artist,
Description,
FileURL,
CreationDate
buy/sell
involved in
Transaction
TransactionID (PK),
BuyerID (FK to User),
SellerID (FK to User),
ArtID (FK to DigitalArt),
TransactionDate,
Price,
Payment Method,
Currency,
Status
user
UserID (PK),
Username,
Email,
Password,
WalletAddress, Bio,
Reputation,
VerificationStatus
place
Bid
BidID (PK)
AuctionID (FK to Auction),
BidderID (FK to User)
Amount,
Timestamp
recives or attracts

4.4.1 User Flow Diagram



4.5 Database Design



CHAPTER 5

IMPLEMENTATION

5.1 Introduction Tools and Technologies Used

- **Next.js:** According to the documentation, Next.js is a React framework that enables server-side rendering (SSR) and static site generation (SSG). Next.js generally increases page performance with pre-rendering, and also gets the SEO benefits through pre- rendering. According to the documentation, Next.js also allows effortless and automatic code splitting on your pages.

- **React.js:** React was the front-end JavaScript library used by Facebook for designing dynamic and interactive user interfaces. One advantage React derives from its component system. Using a component system-based library like React allows a modular specification for code repositories, consequently being imported and reused, thus improving speed and maintainability.

Blockchain Integration:

- **Polygon:** Polygon (previously Matic) is a layer-2 scaling solution for the Ethereum blockchain. Polygon applies to the Marketplace for quickly, cheaply, and securely deploying blockchain transactions. Since Polygon chain is an Ethereum 1:1 it allows for easy, seamless interaction with decentralized applications (dApps) and smart contracts.

- **Solidity:** Solidity is the programming language used to produce smart contracts that conducts the transaction work on the blockchain. Your contracts are deployed on the

Polygon network, preventing transaction issues with users and ensuring transparency, reliability, and security in the Marketplace for all users transactions.

- **Hardhat:** Hardhat is a development framework for Ethereum-based applications; in this project Hardhat allows you to compile, deploy and test your Solidity smart contracts. Hardhat provides you your Ethereum instance to deploy your contract to the Polygon blockchain, an easy reliable method of testing your contract and ensuring reliability in blockchain operations.

Development Tools and Workflow:

- **VS Code:** Visual Studio Code (VS Code) is used as the primary Integrated Development Environment (IDE) for writing code, with various extensions for enhanced productivity, including Solidity syntax support and React/Next.js integrations.

- **Git:** Git is used for version control, collaborative development, and hosting the project repository.

Deployment and Hosting:

- **Vercel (for Next.js):** The frontend of the marketplace is deployed using Vercel, which provides seamless hosting for Next.js applications with automatic scaling and server-side rendering. **The Web URL used is https://nft-arthub.vercel.app/**

- **GitHub:** Continuous updates, issue tracking, and code reviews were maintained directly through the GitHub repository.

CHAPTER 6

TESTING AND MAINTENANCE

6.1 Testing Techniques and Test Cases Used

A structured Agile-based testing approach was to be adopted so as to provide the highest level of user experience and secure operations on the platform of NFT ArtHub. This meant testing each component of the solution—smart contracts, backend API, frontend UI—at different testing levels to confirm performance, security, and usability.

Agile Testing Approach:

Sprints: Testing work items were conducted within two-week sprints based on feature deliveries, such as NFT minting, NFT listing, or connecting a wallet.

Continuous Feedback Loop: After Manual test results were considered with the development team after every sprint to allow for faster iterations and fixes.

Bug Tracking using MantisBT: All reported bugs and test results were monitored within MantisBT; this service then allowed us to track any issues identified and monitor their resolutions through the development life cycle.

Test Levels Executed

1. Unit Testing

Components Tested

- React UI components (buttons, forms, modals).
- Smart contract functions (e.g., mintNFT, transferNFT, getTokenURI) written in Solidity.

Tools & Methods

- Manual unit testing using Development Tools from the browser for client-side UI.
- To test smart contracts, I ran them on my local blockchain (by hand) as a means of validating that the function outputs and emissions fired correctly.

File Upload Verification by Size (Boundary Value Analysis)

• Description: This table validates the file size limits for uploads to ensure only files within the acceptable range (1 MB to 100 MB) are processed.

• Method **Used**: **Boundary Value Analysis** tests the edge cases of minimum, maximum, and beyond the limits.

Test Case	Condition	Input File Size	Expected Output	Actual Output	Status
1	Below minimum size	0 MB	Rejected with "Size too small"	Rejected with "Size too small"	Pass
2	Minimum boundary	1 MB	File is successfully uploaded	File is successfully uploaded	Pass
3	Maximum valid size	100 MB	File is successfully uploaded	File is successfully uploaded	Pass
4	Above maximum size	101 MB	Rejected with "Size exceeds limit"	Rejected with "Size exceeds limit"	Pass

Table - 1

2. Integration Testing

Focus Areas:

- Integration of React frontend with Node.js backend for metadata.Interaction with smart contracts using Web3.js and MetaMask wallet. Upload to Pinata/IPFS for metadata and linking to NFT tokens.

Test Cases Included:

- Verify that yellow Poke Form is posting form data to the backend and posting to Pinata.
- MetaMask is triggering and validating transaction(s) on Polygon Mumbai Testnet.

NFT Creation Workflow (Equivalence Class Partitioning)

- Description: This table certifies the NFT creation process by ensuring metadata completeness, file format compatibility, and file size restrictions.
- Method Used: Equivalence Class Partitioning categorizes valid and invalid inputs for concentrated testing.
- Test Coverage: Positive test cases (complete fields, supported file formats) and negative test cases (incomplete fields, unsupported file formats, large files) are included.
- Validation Criteria: Verifies metadata fields such as title, description, and creator ID are not blank; validates file types against supported MIME types (e.g., image/png, image/jpeg).
- Boundary Testing: Size limits for the file are tested on minimum, maximum, and just-beyond boundaries to make sure there's strict compliance with size restrictions.
- Expected Outcome: System must accept only well-formed inputs and give informative error messages for ill-formed ones.
- Automation: Selenium or Postman may be used to automate test cases for API-based validation of NFT submission endpoints.
- Error Handling: Ensures that the system fails elegantly for invalid input without crashing and logs errors properly.
- User Feedback: Ensures that users get immediate and explicit feedback upon failure of submissions to validate.

Test Case	Metadata Input	File Type	File Size	Expected Output	Actual Output	Result	Status
1	Valid title	desc.	.mp3	50 MB	NFT is successfully created	NFT is successfully created	Pass
2	Missing title	.mp4	50 MB	Metadata error: "Title is required"	Metadata error: "Title is required"	Pass	Pass
3	Valid title	desc.	.pdf	50 MB	File is rejected (unsupported type)	File is rejected (unsupported type)	Pass
4	Valid title	desc.	.jpg	101 MB	File is rejected ("Size exceeds limit")	File is rejected ("Size exceeds limit")	Pass

Table – 2

3. System Testing

Environment:

- Deployed a staging version of the app. Simulated real use and self-serve experience.
- Launched a beta version of the platform to replicate real-world usage and enable user-driven testing.

Test Flow:

- User connects domain account MetaMask → uploads digital avatar art → fills out mint form → mints NFT → views NFT on Marketplace.

Objective:

- Validate that all modules within the platform connect coherently from start to finish.

4. User Acceptance Testing (UAT)

Participants:

- Team members and a small group of sample users.

Feedback Focus:

- Ease of use related to wallet integration and interaction with the app.
- How responsive and/or clear the UI parts of the app was to intended purposes.

Outcome:

- Feedback was used to fine-tune the layout, error prompts, and confirmation alerts.

5. Performance Testing

What Was Tested:

- Page load times, particularly for the NFT listing grid and IPFS image retrieval.
- System behavior under multiple simultaneous minting or listing attempts.

Simulated Tools:

- Manual browser-based load testing with multiple sessions.

Result:

- The app maintained responsiveness for up to 20 concurrent sessions.

6. Security Testing

Primary Areas:

- Validation of **MetaMask authentication** and prevention of unauthorized actions
- Ensuring **Solidity smart contracts** are resistant to reentrancy and double-minting attacks.
- Verifying **JWT-based session handling** for protected user actions.

Manual Reviews Included:

- Smart contract code audits.
- URL and form field tampering attempts.

7. Regression Testing

Scope:

- Re-tested previous features such as NFT minting, listing, and viewing after updates to the UI or contract logic.

Key Checks:

- Wallet connectivity.
- Image rendering from IPFS.
- Smart contract function executions via Web3.js.

Result:

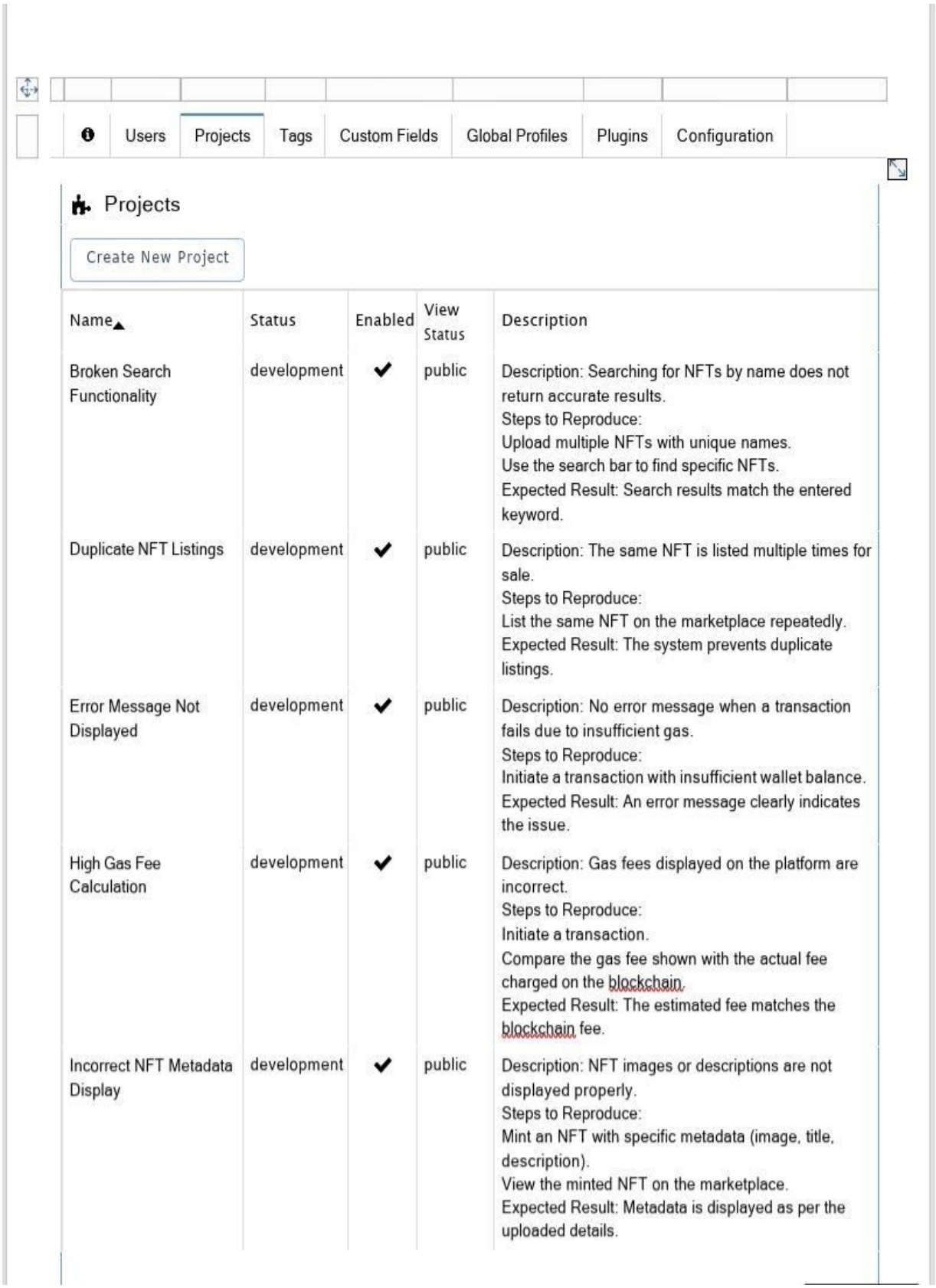
- No critical functionality was broken during iterative development

Bug Reports using MantisBT

MantisBT (Mantis Bug Tracker) MantisBT (Mantis Bug Tracker) is a robust, open-source issue tracking system to aid teams in the handling of software development and testing through a centralized platform for recording and fixing bugs. With its easy-to-use, web-based interface, MantisBT allows for effortless communication and collaboration between developers, testers, and project managers. It makes the bug life cycle—from detection and reporting at first instance to resolution and verification as simple as possible—so that no bug remains unnoticed or unresolved.

One of the greatest strengths of MantisBT is its comprehensive bug prioritization and classification system, enabling teams to assign levels of severity, status, and custom labels to every issue. This means high-priority bugs are dealt with quickly while having visibility of lower-priority items. The system facilitates customizable workflows, which fit the specific development practices of different teams, be it Agile, Scrum, or Waterfall. With role-based access control, administrators can establish user permissions so that sensitive information is accessible only to authorized staff.

MantisBT also supports integration with a variety of third-party tools such as version control systems (like Git, Subversion), CI/CD pipelines, and communication platforms like Slack or mail clients, to provide automated updates and notifications. Moreover, MantisBT provides rich reporting and analytics capabilities, such as charts and timelines, to give insights into project health, team performance, and bug fixing trends. Its open-source nature guarantees active community support and flexibility for customization, which makes it an effective and scalable solution for projects of various sizes. Essentially, MantisBT improves quality assurance and project accountability while reducing the friction normally involved in bug tracking.


Users
Projects
Tags
Custom Fields
Global Profiles
Plugins
Configuration
Projects
Create New Project
Name
Status
Enabled
View Status
Description
Broken Search Functionality
development
public
Description: Searching for NFTs by name does not return accurate results.
Steps to Reproduce:
Upload multiple NFTs with unique names.
Use the search bar to find specific NFTs.
Expected Result: Search results match the entered keyword.
Duplicate NFT Listings
development
public
Description: The same NFT is listed multiple times for sale.
Steps to Reproduce:
List the same NFT on the marketplace repeatedly.
Expected Result: The system prevents duplicate listings.
Error Message Not Displayed
development
public
Description: No error message when a transaction fails due to insufficient gas.
Steps to Reproduce:
Initiate a transaction with insufficient wallet balance.
Expected Result: An error message clearly indicates the issue.
High Gas Fee Calculation
development
public
Description: Gas fees displayed on the platform are incorrect.
Steps to Reproduce:
Initiate a transaction.
Compare the gas fee shown with the actual fee charged on the blockchain.
Expected Result: The estimated fee matches the blockchain fee.
Incorrect NFT Metadata Display
development
public
Description: NFT images or descriptions are not displayed properly.
Steps to Reproduce:
Mint an NFT with specific metadata (image, title, description).
View the minted NFT on the marketplace.
Expected Result: Metadata is displayed as per the uploaded details.

Projects

Create New Project

Name	Status	Enabled	View Status	Description
Broken Search Functionality	development	✔	public	Description: Searching for NFTs by name does not return accurate results. Steps to Reproduce: Upload multiple NFTs with unique names. Use the search bar to find specific NFTs. Expected Result: Search results match the entered keyword.
Duplicate NFT Listings	development	✔	public	Description: The same NFT is listed multiple times for sale. Steps to Reproduce: List the same NFT on the marketplace repeatedly. Expected Result: The system prevents duplicate listings.
Error Message Not Displayed	development	✔	public	Description: No error message when a transaction fails due to insufficient gas. Steps to Reproduce: Initiate a transaction with insufficient wallet balance. Expected Result: An error message clearly indicates the issue.
High Gas Fee Calculation	development	✔	public	Description: Gas fees displayed on the platform are incorrect. Steps to Reproduce: Initiate a transaction. Compare the gas fee shown with the actual fee charged on the blockchain. Expected Result: The estimated fee matches the blockchain fee.
Incorrect NFT Metadata Display	development	✔	public	Description: NFT images or descriptions are not displayed properly. Steps to Reproduce: Mint an NFT with specific metadata (image, title, description). View the minted NFT on the marketplace. Expected Result: Metadata is displayed as per the uploaded details.

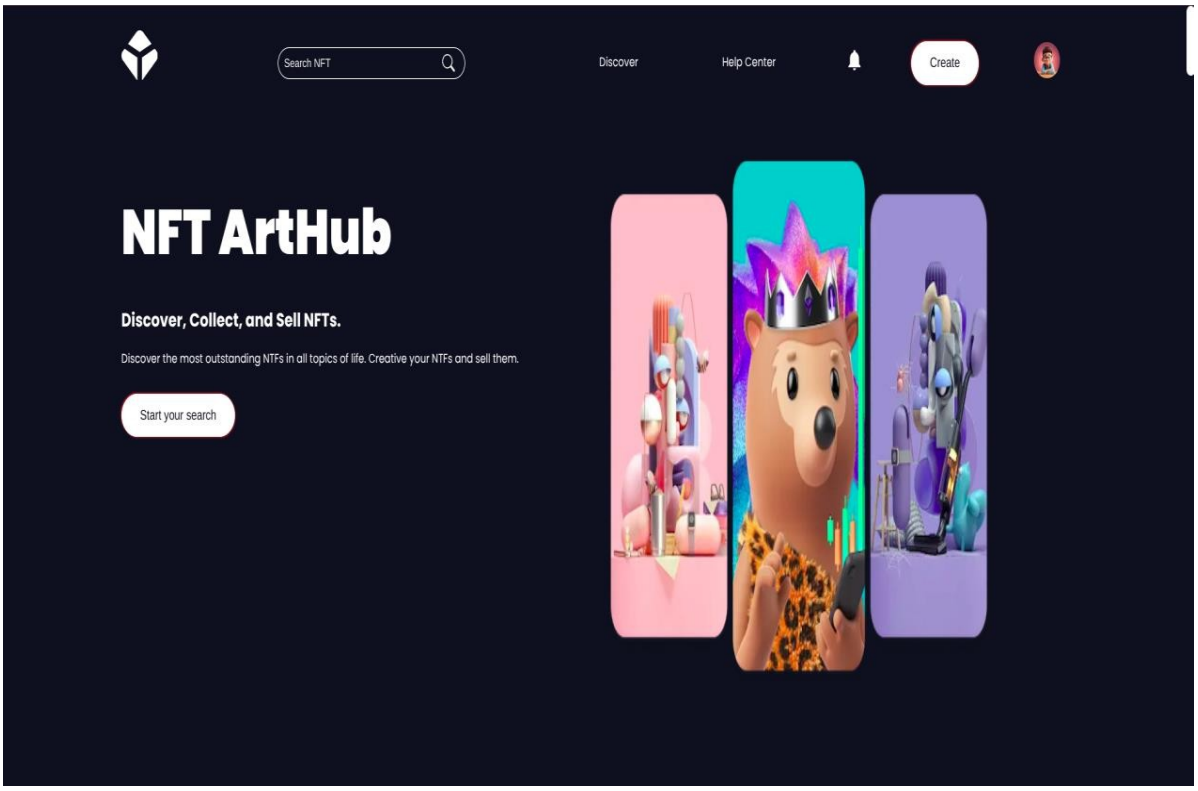
CHAPTER 7

RESULTS AND DISCUSSIONS

7.1 Description of Modules with Screenshots

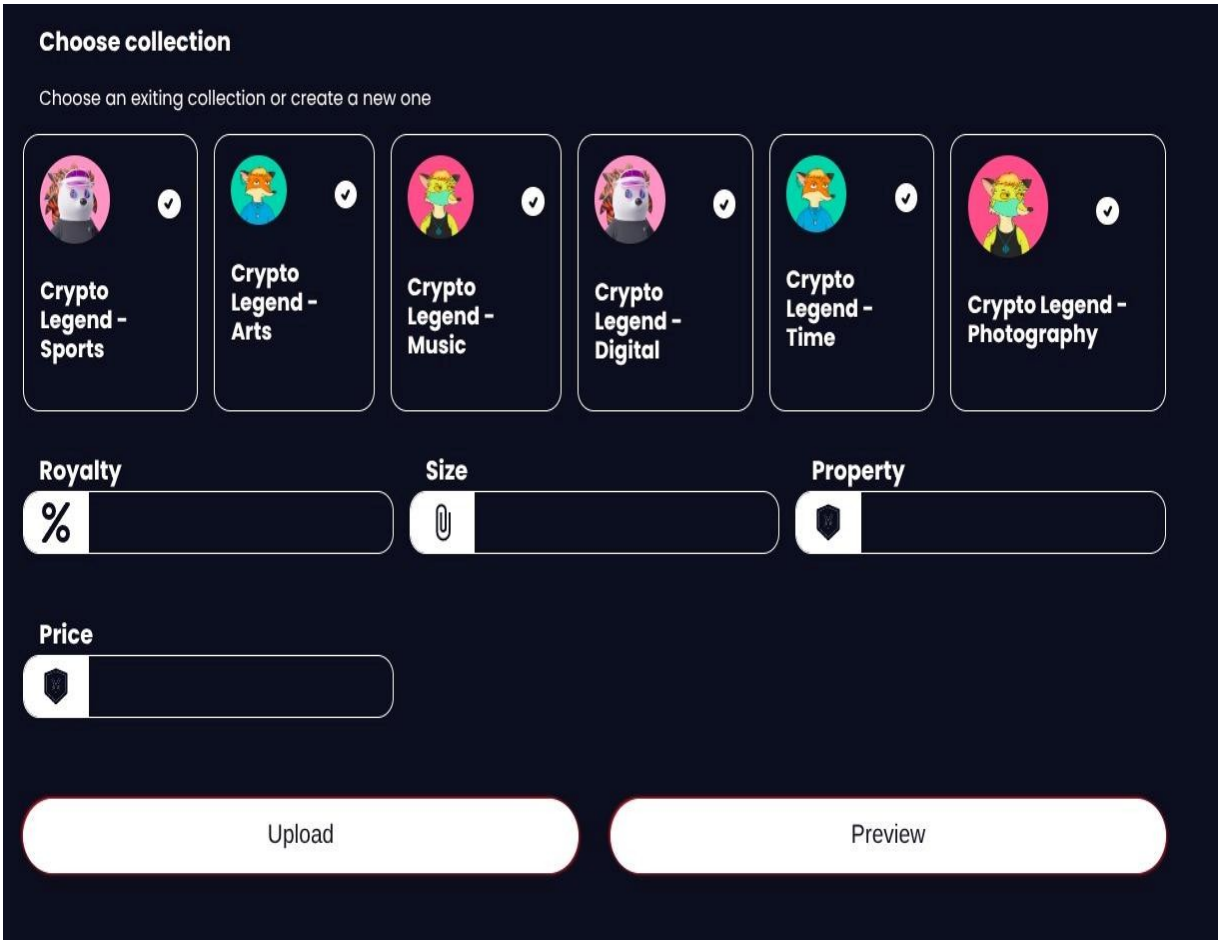
7.1.1 UI Rendering

NFT ArtHub's frontend UI is crafted with new-age web technologies for a smooth and responsive feel. The users get a neat interface to upload, display, and maintain their NFTs. The UI updates dynamically upon user input and blockchain feedback. Aesthetics of design aim at functionality and simplicity.



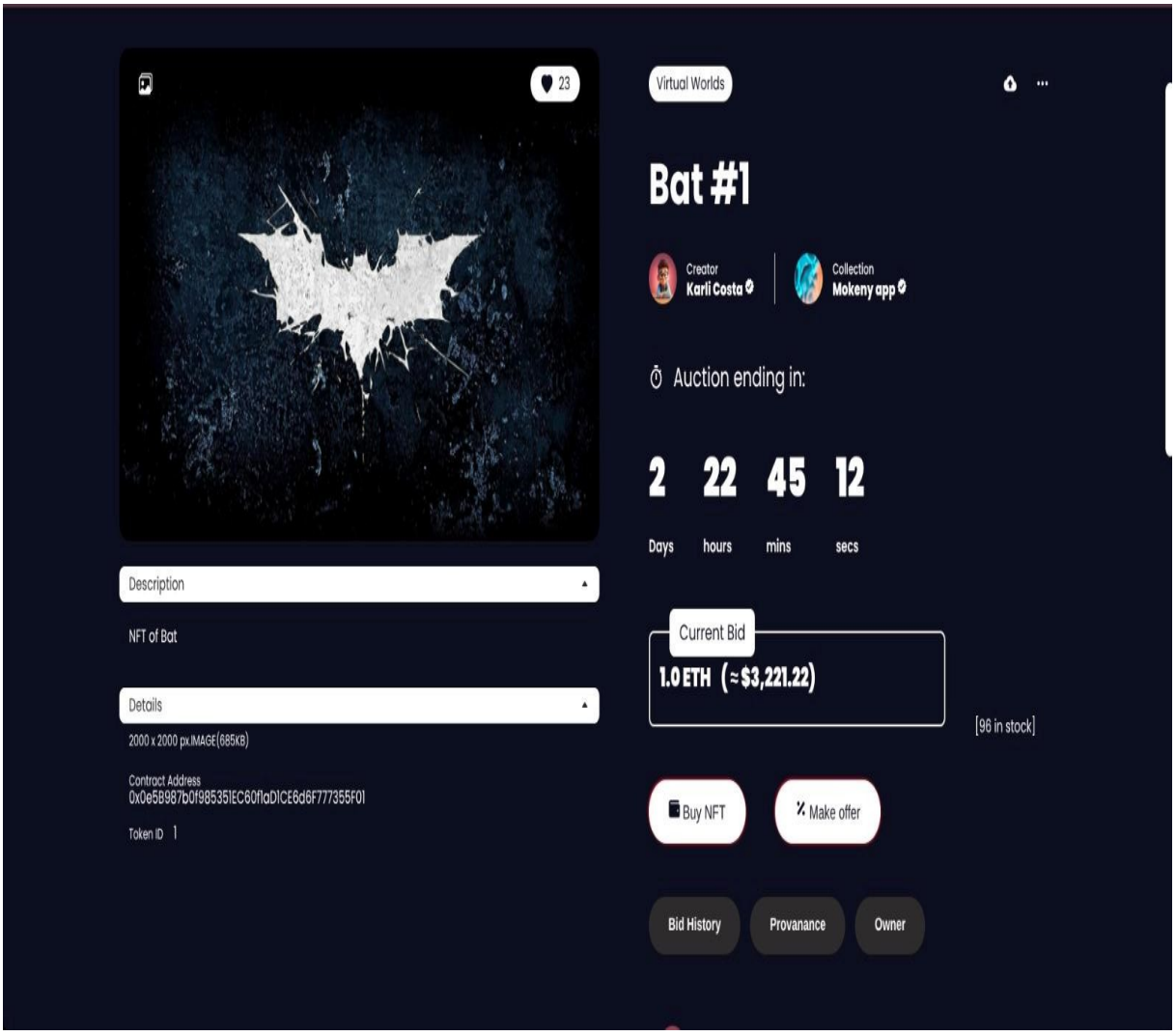
7.1.2 Creating NFT

Artists can upload their digital pieces using an easy-to-use form. The artwork is deposited onto IPFS or an equivalent decentralized storage platform, which provides immutability and availability. Metadata such as title, description, and creator information is appended to the upload. A preview is shown prior to minting to verify submission.



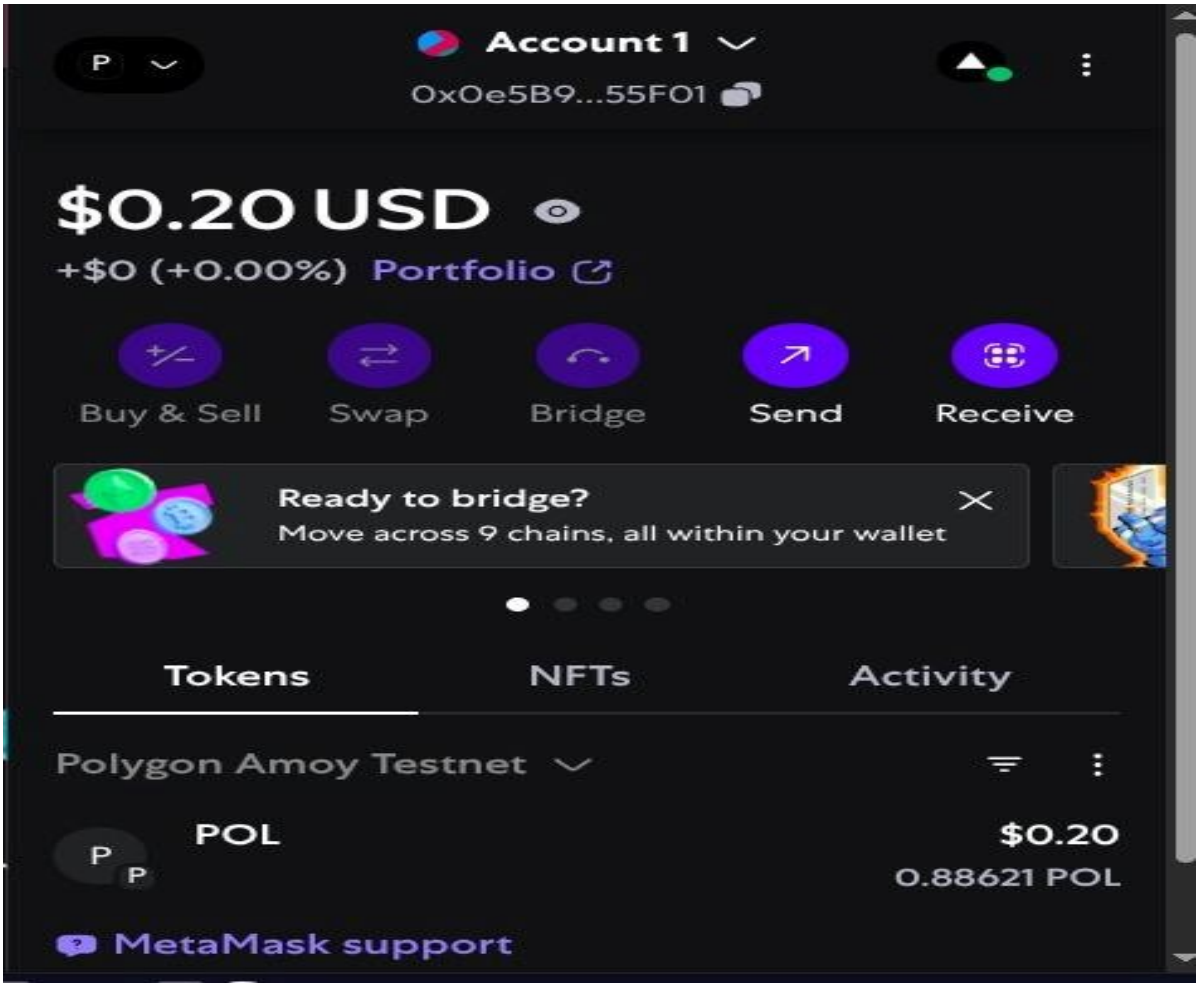
7.1.3 Uploaded NFT

Once the NFT is uploaded successfully and minted, it becomes visible on the user's own gallery. Ownership and token information are read live from the blockchain. Details such as token ID, transaction hash, and storage URL can be viewed by users. This also allows for resale or transfer capability in the future



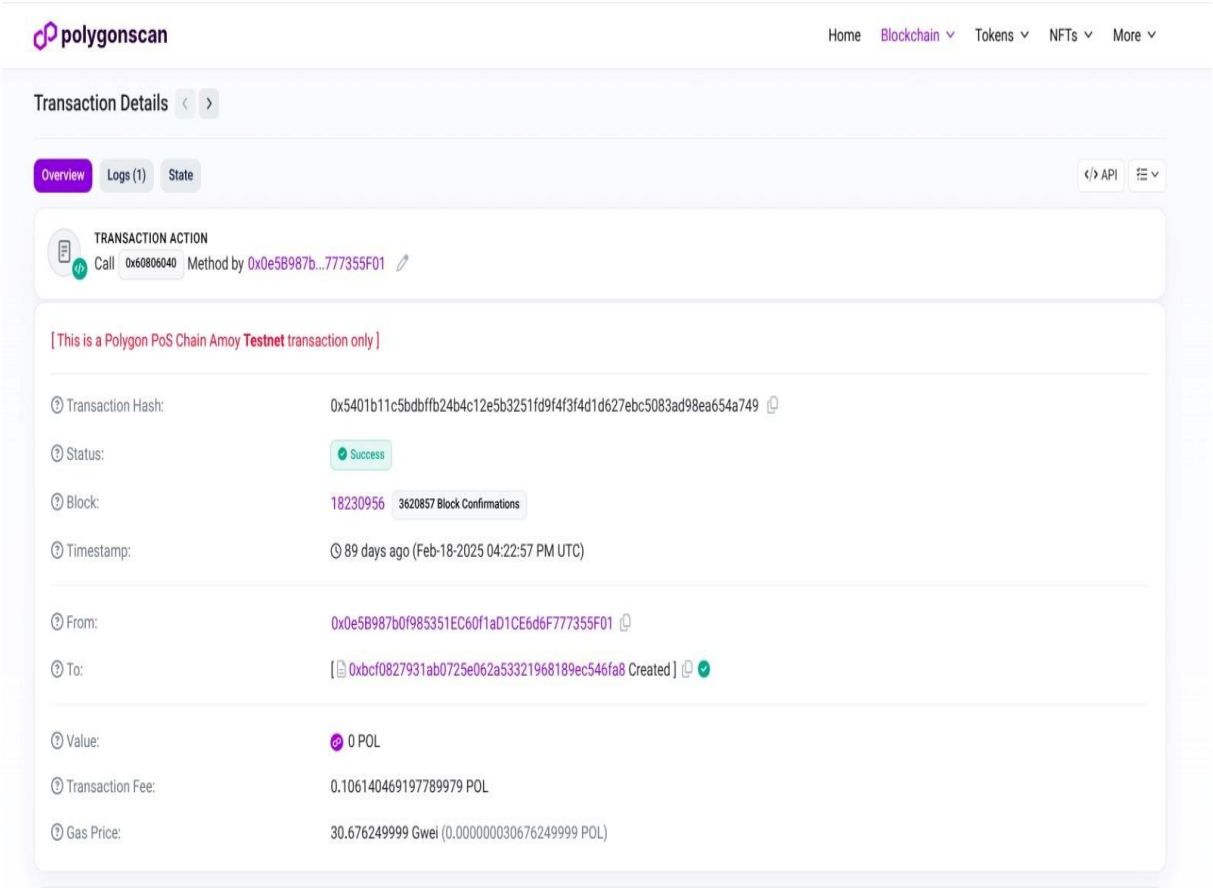
7.1.4 MetaMask Connection

MetaMask integration provides secure and effortless wallet connection to users. It allows transaction signing such as minting or transferring NFTs straight from the browser. Wallet verification handles the authentication, eliminating the need for conventional login methods. The state of the connection is mirrored in the UI in real time.



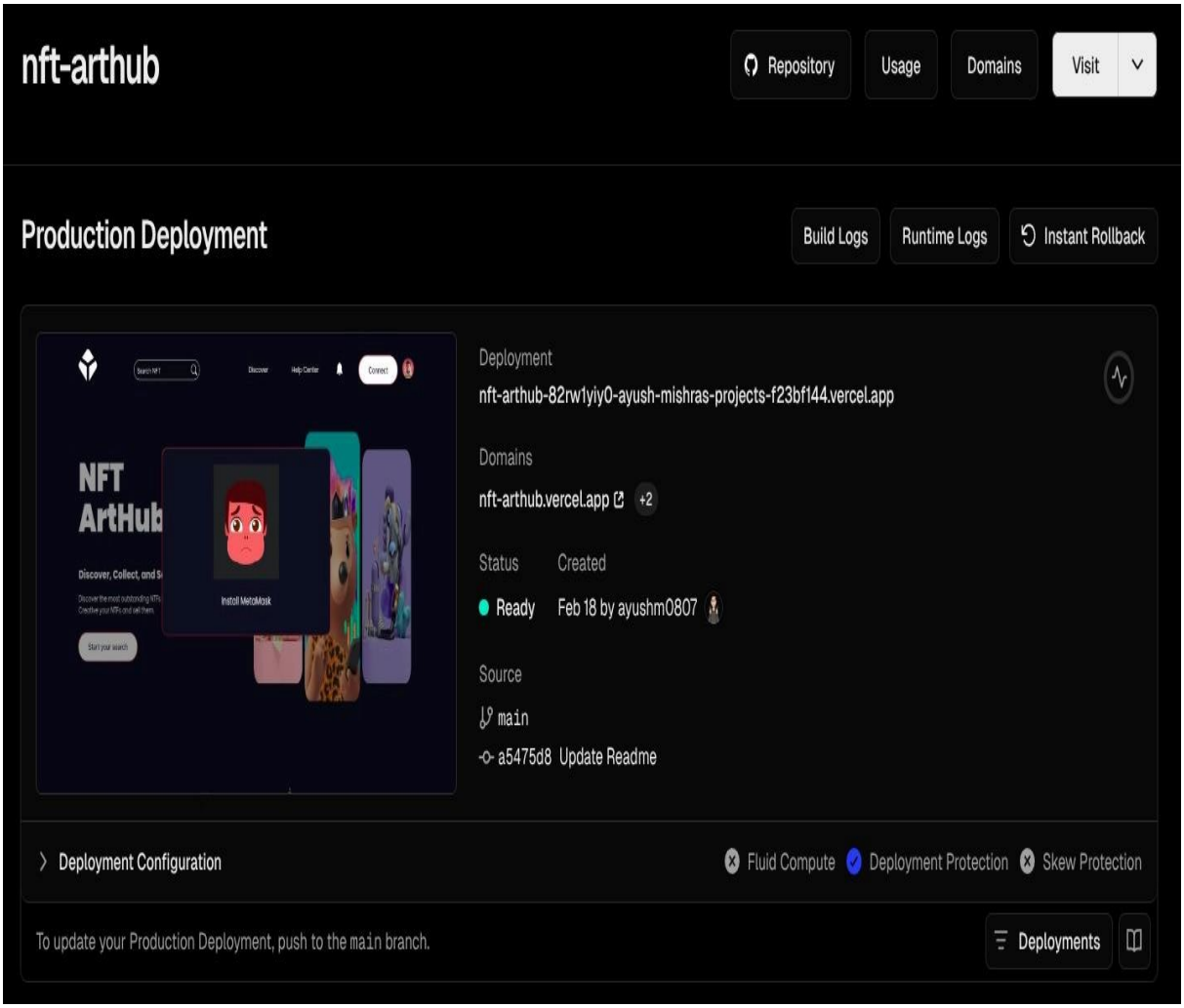
7.1.5 Smart Contract Deployed in Polygon

The main NFT logic is managed by a smart contract running on the Polygon blockchain. Polygon was selected due to low gas costs and quick transaction finality. The contract has minting, owner tracking, and metadata fetch functionality. It adheres to the ERC-721 standard for maximum compatibility.



7.1.5 Deployed in Vercel

The frontend of NFT ArtHub is hosted on Vercel, offering rapid and worldwide content delivery. The deployment is continuous so that any updates pushed to the codebase are reflected online immediately. Performance optimization, SSL, and CDN are handled by Vercel out of the box. This allows for high uptime and great user experience.



7.2 Key findings of the Project

1. Seamless Interoperability with Web3 Tools –

   The integration of MetaMask and calling smart contracts through Web3.js or Ethers.js facilitated seamless user-wallet interaction, making authentication and transaction signing easier.

2. Economical and Scalable Deployment through Polygon –

   Smart contract deployment on the Polygon network cut gas expenses drastically without compromising on Ethereum compatibility, allowing NFT minting to be fast, economical, and scalable.

3. Scalable Frontend Deployment with Vercel –

   Frontend hosting with IPFS accelerated performance, global CDN, and continuous deployment, which resulted in an improved user experience and less downtime.

4. Decentralized Storage Resilicates Ownership –

   Leveraging decentralized storage such as IPFS made sure that NFTs and metadata are tamper-resistant and persistent, resiliating the notion of digital ownership and provenance.

5. User-Centric UI Increases Engagement –

   A neat, responsive UI with live feedback (uploading, minted state, etc.) enhanced usability and accessibility for both Web3-knowers and strangers

CHAPTER 8

CONCLUSION AND FUTURE SCOPE

Conclusion

The NFT ArtHub project effectively creates a decentralized, secure, and effective digital art market based on blockchain technology. Through the use of the Ethereum blockchain, smart contracts, and decentralized storage using IPFS, the platform solves top concerns with traditional digital art markets, such as authenticating authenticity, displaying clear ownership, and very high transactional fees.

Throughout the development process, the project concentrated on providing an artist- and collector-focused solution that enables artists and collectors. Artists are presented with an easy minting process that converts their online creations into NFTs that are verifiable, creating definitive provenance and ownership. Collectors are assured by unalterable transaction histories and secure wallet-based authentication, mainly through MetaMask, and their assets cannot be counterfeit transferred or replicated. The integration of Layer 2 scaling solutions, e.g., Polygon, effectively addresses the gas fee problem of Ethereum, rendering transactions faster and cheaper, hence optimizing platform usability and accessibility.

In addition, the selection of Pinata IPFS for decentralized storage ensures metadata and media file integrity and availability, thereby ensuring concern for centralized server failure or content manipulation. Combined with thorough manual and automated testing, these technologies create a robust and scalable infrastructure ready to handle growing user adoption and changing industry standards.

The business model, which aims to cut out middlemen and lower operating expenses, forms a sustainable art economy for collectors and artists alike, providing a fair and transparent arena

that disrupts the inefficiencies of traditional art markets. Premium services and transaction fees generate revenue streams that fund platform upkeep and future expansion, reinforcing long-term sustainability.

The success of this project is not just in its technical achievements but also in its vision towards democratizing access to digital art and building greater trust between buyers and creators. Through innovation entwined with accessibility, NFT ArtHub is a solid groundwork for the future of digital art trade that spans technologies, creativity, and community.

Future Scopes

Although the present deployment of NFT ArtHub is solid in foundation, there are a number of areas for improvement and extension that would enhance user experience, platform functionality, and ecosystem development further. These future horizons include technological enhancements, feature creation, and community outreach programs.

1. AI-Driven Personalized Recommendations

Having Artificial Intelligence (AI) and Machine Learning (ML) as part of the platform would be instrumental in significantly enhancing user interaction and discovery. Through observations of user behavior, collection history, and interaction patterns, AI algorithms might offer customized NFT suggestions based on individual preferences. This would make artists more visible to the right audience and help collectors find new and appropriate art. For instance, collaborative filtering or content-based filtering methods might be used to compile tailored feeds or recommend emerging NFTs based on user interest.

Aside from advice, AI applications may aid artists with inspirational ideas—e.g., style advice or trend forecasting—enabling them to produce more saleable digital art. Moreover, image recognition powered by AI may create automatic metadata, enhancing searchability and cataloging.

2. Advanced Analytics and Dashboard Tools

Implementing in-depth analytics dashboards for artists and collectors can provide rich insights into activity on the site. Artists may follow metrics such as views, bids, sales trends, and audience demographics to have a better knowledge of their market outreach and refine their sales strategy. Collectors may examine portfolio performance, track asset valuations, and be alerted to price fluctuations or imminent auctions.

These data-driven interfaces would not only render the platform more transparent but also generate trust and create a more enlightened user base. Combining visual analytics with user-friendly UI/UX design will ensure that these insights reach even non-technical users, further demystifying access to the platform.

3. Social and Community Features

Converting NFT ArtHub into a lively community center from a marketplace can tremendously boost user retention and engagement. Implementing social elements like profiles for artists, follower/following systems, comments, likes, and share buttons would foster communication and cooperation. Users might discuss art trends, join events hosted by the community, or even co-create NFTs via collaborative minting.

Social verification systems deployed would also increase trust through confirmation of the identity of well-known artists or collectors, eliminating fake accounts. Community governance attributes such as voting for updates to the platform or curation would democratize development and invest users in the future of the ecosystem.

4. Cross-Chain and Multi-Blockchain Support

Although the platform is currently based on Ethereum and Polygon, having support for multiple blockchains would allow for increased market penetration and flexibility. Newer blockchains

such as Solana, Binance Smart Chain, and Flow have varying trade-offs in terms of speed, cost, and scalability. To provide cross-chain NFT minting, trading, and bridging capabilities would enable users to harness the best of each ecosystem, creating a more cohesive and diverse platform.

Establishing interoperability protocols and standards like the Inter-Blockchain Communication (IBC) protocol would allow for frictionless asset transfers and shared liquidity among blockchains, making NFT ArtHub a leader in blockchain technology.

5. Virtual and Augmented Reality Integration

The future of digital art is increasingly a convergence of blockchain and immersive technologies. Blending Virtual Reality (VR) and Augmented Reality (AR) experiences into NFT ArtHub could provide users with the capability to exhibit, engage with, and consume digital art in three-dimensional or mixed-reality spaces.

For artists, it would unlock new possibility for creative design of interactive or spatial artworks. For enthusiasts and collectors, virtual galleries, shows, and events would enhance the user experience over static 2D presentation. Collaboration with VR platforms or creation of native VR environments could be considered as a part of long-term expansion.

6. Enhanced Security and Privacy Features

As the platform grows, sustaining security focus is important. The future may involve smart contract auditing with formal verification techniques to mathematically establish the correctness of contracts and cut out vulnerabilities. Furthermore, the inclusion of multi-factor authentication (MFA) features outside of wallet signatures could provide additional user account security.

Privacy-protective technologies, including zero-knowledge proofs or confidential transactions, may also be examined in order to enable users to verify ownership or conduct transactions

without exposing sensitive information publicly on the blockchain, finding a balance between transparency and user confidentiality.

7. Educational Resources and Onboarding Support

To enhance access, particularly for non-technical users, the site could create extensive learning materials and onboarding tutorials. These might include blockchain fundamentals, wallet usage such as MetaMask, NFT minting procedures, and marketplace exploration. Interactive tutorials, videos, and FAQs would serve to lower user friction and promote more extensive engagement.

Collaborations with art schools, digital artists, and blockchain instructors would allow for workshops or webinars to be conducted, expanding community expansion and literacy within decentralized technologies.

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Paper ID: 116

Paper Title: Decentralized Marketplace for Digital Art Creativity using Blockchain

Abstract:
Blockchain technology and digital art collided to give rise to Non-Fungible Tokens (NFTs), the new era for digital assets creation, valuation, and trading. NFTs serve like the unique digital certificate of ownership over a new piece of art making it possible for an artist to prevent their creation from being pirated or copied without due permissions. In this work we present NFT ArtHub, a decentralised platform that uses the immutability of blockchains and the decentralised storage capabilities of InterPlanetary File System (IPFS) and Pinata. This integration creates an additional layer of security and a de-centralised database to provide a secure marketplace for artists to tokenise their work and showcase it on a global scale.
One of the things that makes NFT ArtHub so special is that artists are paid by way of smart contracts automatically, whenever their artwork sells or gets sold. This mechanism provides the benefits of traditional systems without their inefficiencies and enhances trust and transparency. It also highlights the platform's solutions for scalability, gas high fees that users on Ethereum are facing and more importantly user adoption emphasizing its position as an enabler of creators while redefining ownership in the creative economy.

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