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Survey on Design of Smart Contract System Using Blockhchain Technology for NFT

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Abstract: ***Technology continues to simplify human activities, driving numerous innovations across various fields. One of the most prominent emerging technologies is blockchain, which plays a crucial role in business by enhancing data security and performance. Blockchain incorporates robust security measures such as cryptography, peer-to-peer networks, smart contracts, and consensus mechanisms "Reference[2]". Cryptocurrency which has gained significant attention after the rise of blockchain, as a new form of digital currency, influencing national economies "Reference[14]". Furthermore, digital currency has extended into the realm of digital art, leading to the emergence of NFTs unique digital assets with valuable use cases for businesses "Reference[5]". This paper explores the development and design of a simple NFT website, along with the process of minting and purchasing NFTs using the Ethereum test network/environment "Reference[9]".***
Keywords: NFT; Information System; Ethereum; Information Technology; Blockchain; Smart Contract; Web.

I. INTRODUCTION

The advancement of information technology enhances business efficiency, effectiveness, and competitiveness. According to Indrayani (2012), technology plays a crucial role in improving productivity, reducing costs, and simplifying processes. Before the emergence of NFTs, digital assets lacked proper ownership tracking, making them susceptible to unauthorized claims. Traditional systems relied on physical documents, increasing the risk of loss or damage. Blockchain technology, a distributed ledger, has transformed digital transactions by ensuring security and transparency. Initially introduced in 1991, blockchain gained prominence with Bitcoin's launch in 2009 by Satoshi Nakamoto. Bitcoin's decentralized nature attracted global attention, fueling interest in blockchain applications. Blockchain supports smart contracts—self-executing digital agreements used for transactions, particularly in cryptocurrency. These contracts store transaction details securely without intermediaries. Ethereum, Binance, and other crypto startups have expanded blockchain's ecosystem. NFTs, a notable blockchain innovation, represent digital assets with unique metadata. Each NFT is distinct, providing proof of ownership and authenticity. Transactions occur via cryptocurrency, with details permanently recorded on the blockchain. NFTs bridge traditional and digital transactions, offering economic opportunities in the Web 3.0 era. This study focuses on designing a smart contract NFT system using Ethereum blockchain technology. It explores Ethereum's relevance for NFT projects and examines key factors influencing blockchain adoption in NFT businesses.

Blockchain technology ensures transaction records are stored transparently and securely without third-party intervention, making it one of the most trusted systems for digital transactions "Reference[3]". As blockchain technology continues to grow, it has paved the way for innovations such as digital currency transactions, NFTs, and secure business systems for data protection. The cryptocurrency ecosystem has also expanded, leading to the emergence of various crypto startups like Ethereum, Binance, and many others "Reference[12]".

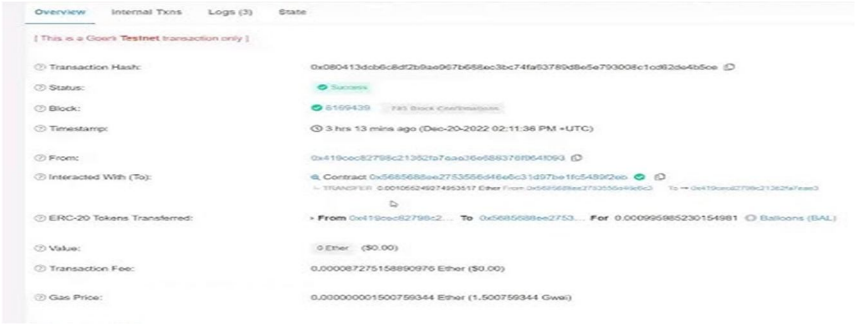


Figure 1.1

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Figure 1.1 presents an example of a smart contract on the Ethereum network. The smart contract contains a "transaction hash," which serves as a unique identifier (ID) for the transaction. It also includes the transaction status and the processing time. Additionally, the contract displays the digital wallet addresses of both the sender and recipient. Moreover, it shows the amount of ETH being transferred, along with the associated transaction processing fee, known as the gas fee.

NFTs can contain various digital formats, such as images, music, and other media, though this discussion focuses specifically on NFT digital images. Each NFT has a unique token ID, ensuring its distinctiveness from others. These digital assets are typically generated through coding, which automatically assigns attributes, making each NFT image unique. An NFT asset has only one owner at a time, though it can be traded. However, ownership remains exclusive, as each NFT is a "one-of-a-kind" token. Once purchased, the asset belongs to the new owner, with ownership details verified and recorded on the blockchain. During the transaction process, NFTs are distributed randomly, along with their metadata, to interested buyers. Payments are made using cryptocurrency, and all transactions are permanently stored on the blockchain. NFTs provide digital proof of ownership, uniqueness, and rarity, making them valuable assets in the digital economy “Reference[13]”

II. LITERATURE REVIEW

We’ve studied total 10 systems; they are as follows:

A. System Design

System design involves creating a structured framework that outlines the operational steps required to develop a system, along with the procedures that support its functionality “Reference[4]”. It can also be defined as the process of analysing and designing a system to ensure efficient operation.

B. Information Systems

An information system is a system designed to provide valuable information for management decision-making and daily business operations. It integrates information technology with organizational procedures, processing collected data into a more useful and structured form “Reference[13]”.

C. Web-based understanding

A web-based application is a software application that can be accessed through a web browser via a network. It operates using browser technology and the HTTP protocol over TCP/IP. There are three primary web communication protocols: TCP, UDP, and ICMP. TCP/IP (Transmission Control Protocol/Internet Protocol) enables data communication by facilitating data exchange between computers over the internet.

It processes user requests to the server, which then responds with the required data. IP addresses play a crucial role in web communication, allowing computers to connect and exchange information over the internet. Thanks to this system, web-based applications can be accessed from anywhere. Search engines like Google.com serve as examples of web-based applications used to access websites. For developing an NFT web application, programming languages such as HTML, CSS, and React.js (JavaScript) are required.

D. Web 3.0

Web 3.0 is an internet that has been implemented by several web developers. This web-based application will be able to process information in an intelligent way through AI (Artificial Intelligence) technology with the help of machine learning. Besides that, Web 3.0 is also known as blockchain technology where there is a decentralized digital ledger. Examples of Web 3.0 are dapps (decentralized applications) and defi (decentralized finance) “Reference[10]”.

E. NFT

NFT, or Non-Fungible Token, refers to a unique digital asset that cannot be duplicated or replaced. Each NFT has a distinct digital signature, ensuring its uniqueness and differentiating it from others. NFTs typically represent digital assets such as images, videos, audio files, or other digital formats. For ex: comic books, sports collectibles, trading cards, games, artwork and more. Most NFTs are built using the ERC-721 token standard, which is commonly found on the Ethereum blockchain “Reference[8]”.

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F. Ethereum Network

The Ethereum (ETH) network is more than just a cryptocurrency or digital currency. Initially introduced in December 2013 by Vitalik Buterin and a group of fellow computer programmers and Bitcoin enthusiasts, Ethereum extends blockchain technology beyond financial transactions. It enables the development of decentralized computing on the blockchain, allowing transactions between digital assets though programming languages. This capability has played a key role in supporting and driving NFT systems. Ethereum was created to address scalability issues in Bitcoin-based applications, where high transaction volumes led to slow processing times. Unlike Bitcoin, Ethereum's blockchain can be used to develop various blockchain-based applications. Examples include platforms like OpenSea, MetaMask, and Uniswap. Entrepreneurs leverage Ethereum to build decentralized applications (DApps) and decentralized finance (DeFi) solutions, further expanding the blockchain ecosystem.

The Ethereum (ETH) network goes beyond being just a cryptocurrency or digital currency. First introduced in December 2013 by Vitalik Buterin and a team of computer programmers and Bitcoin enthusiasts, Ethereum expands blockchain technology beyond financial transactions. It enables decentralized computing on the blockchain, facilitating digital asset transactions through programming languages. This functionality has been instrumental in the growth and development of NFT systems. Ethereum was designed to overcome scalability challenges in Bitcoin-based applications, where large transaction volumes led to slow processing times. Unlike Bitcoin, Ethereum’s blockchain supports the creation of diverse blockchain-based applications. Platforms such as OpenSea, MetaMask, and Uniswap are prime examples of its capabilities. Entrepreneurs utilize Ethereum to develop decentralized applications (DApps) and decentralized finance (DeFi) solutions, contributing to the continuous evolution of the blockchain ecosystem.

G. Smart Contract Ethereum

A smart contract is a program designed to implement blockchain technology by establishing agreements between multiple parties in a coded format. It functions as a logical system that enables interaction with the blockchain, serving as a solution to various challenges within blockchain technology. Smart contracts facilitate seamless communication between themselves and the blockchain. On the Ethereum network, smart contracts are developed using Solidity, a programming language specifically designed for building blockchain-based applications “Reference[2]”.

H. Blockchain

According to Maesa, D. D. F., Mori, P., & Ricci, L. (2019), blockchain is a digital ledger or database designed to be immutable, decentralized, constantly accessible, and secure. Data stored on the blockchain protected using cryptographic security methods, ensuring its integrity and safety “Reference[3]”. This technology plays a crucial role in various industries, enabling transparent and tamper-proof record keeping.

I. Cryptography

Cryptography is a security technique that involves encoding information using special characters, altering letters and symbols from their original form to conceal the message. According to Thahara, A., & Siregar, I. T. (2021), cryptography enables individuals to securely send messages using a coded system, preventing unauthorized access by third parties or malicious actors such as hackers. It serves as a safeguard against system attacks or disruptions. One common cryptographic method is the SHA-256 hashing algorithm (Secure Hash Algorithm), which is widely used in blockchain technology. A hashing algorithm transforms input data into a fixed-size output, ensuring data integrity and security. SHA-256 specifically converts input data into a 256-bit (64-character) hash, making it resistant to manipulation. The transformation process results in an irreversible and unique output, ensuring that any change in the original data produces a completely different hash “Reference[3]”.



Figure 2.1

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J. Waterfall Methods

The waterfall method is a structured development approach that follows a sequential process. It begins with requirements analysis, followed by system design, programming implementation, verification testing, and maintenance. This method is beneficial for system design as it emphasizes thorough documentation at each phase, ensuring that any changes are recorded. This structured approach allows for efficient development and timely project completion.

III. METHODOLOGY

A. Development of System

The system development method for designing the NFT system is an approach used to define system processes, methodologies, and tools. This design incorporates smart contract programming along with other languages such as React, HTML, and CSS. By implementing the waterfall method, the development process will follow a structured sequence, leading to the following outcomes:

B. Requirements

In the initial stage, all necessary requirements for system development must be identified. This helps in understanding the key aspects needed for the web application being developed “Reference[14]”.

C. Design

After identifying the requirements, the next step is designing the system. This involves preparing design plans for the web application, determining system needs, and outlining the overall system architecture “Reference[7]”.

D. Implementation

Once the system architecture is designed, the development process begins. At this stage, the design is translated into program code using appropriate programming languages, integrating it into the web application “Reference[5]”.

E. Verification

After implementation, the developed system undergoes testing to ensure functionality. This includes testing on the Ethereum network by executing transactions using Ether within a test environment or test-net, ensuring the smart contract functions correctly “Reference[11]”.

F. Maintenance

The final stage of the waterfall method involves regular system maintenance, even while still operating on a test-net rather than the main-net. If any errors or issues arise, they are promptly addressed and fixed to ensure system stability and performance “Reference[4]”.

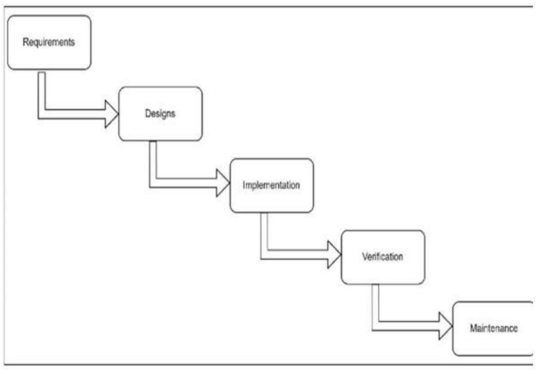


Figure 2.1

G. Collection of Data

Data collection is the process of gathering and analysing data to transform it into useful information. In this study, the data collection methods include:

- Observation: Data is gathered through direct observation of various Crypto and BlueChip NFT projects.
- Literature Review: Relevant data is collected from books, research papers, and online reference articles to support the study

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IV. RESULTS AND DISCUSSIONS

A. System Design and Plannin

The system being designed is a Web platform, where the website serves as the main interface for the NFT project. On the backend, a smart contract system is integrated, which activates when the user clicks the "Mint Now" button. Upon clicking, an external DApp wallet, such as MetaMask, will prompt the user to confirm the transaction using their ETH balance. Once the transaction is completed, the NFT is automatically transferred to the user's wallet. The website is built using frameworks like React.js and Hardhat.js, while the development utilizes programming languages such as HTML, CSS, JavaScript, and Solidity—the latter being used for smart contract interactions. Additionally, the system ensures secure and transparent transactions by leveraging blockchain technology, making NFT ownership verifiable and immutable. The integration of smart contracts eliminates intermediaries, allowing for a decentralized and automated minting process. Furthermore, the platform can be expanded to include additional functionalities such as NFT marketplaces, auctions, and metadata customization for a more dynamic user experience.

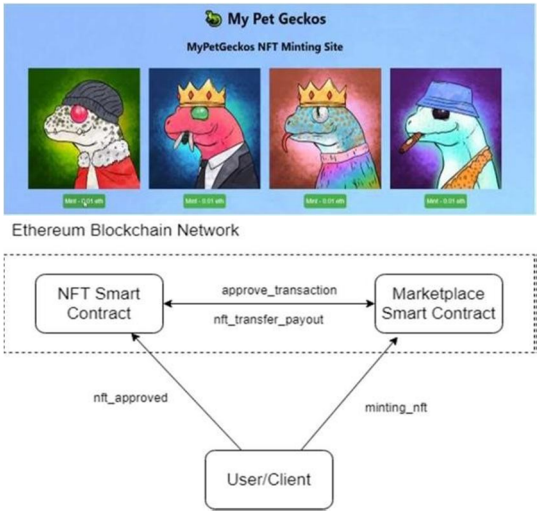


Figure 4.1

The purpose of this system is to simply the process of designing a smart contract system, allowing users to gain a clearer understanding of the NFT project “Reference[9]”.

V. CONCLUSIONS

A. Conclusions

Based on the discussion and design outlined in the previous chapters, the following conclusions can be drawn:

1) The system effectively provides information about digital assets and NFTs through various menus and features within the Web 3.0 platform, ensuring ease of use and accessibility for visitors “Reference[8]”.

2) The Ethereum blockchain serves as the foundational infrastructure, acting as a bridge for integrating cryptocurrency transactions with blockchain technology “Reference[1]”.

B. Suggestions

The development of this web and blockchain-based information system presents several areas for improvement in the NFT planning system. Here are some key suggestion

1) Enhancing the data security system to ensure better protection and reliability

2) Increasing promotional efforts, as the system is still in the environmental testing phase and has not yet reached a broader audience “Reference[13]”.

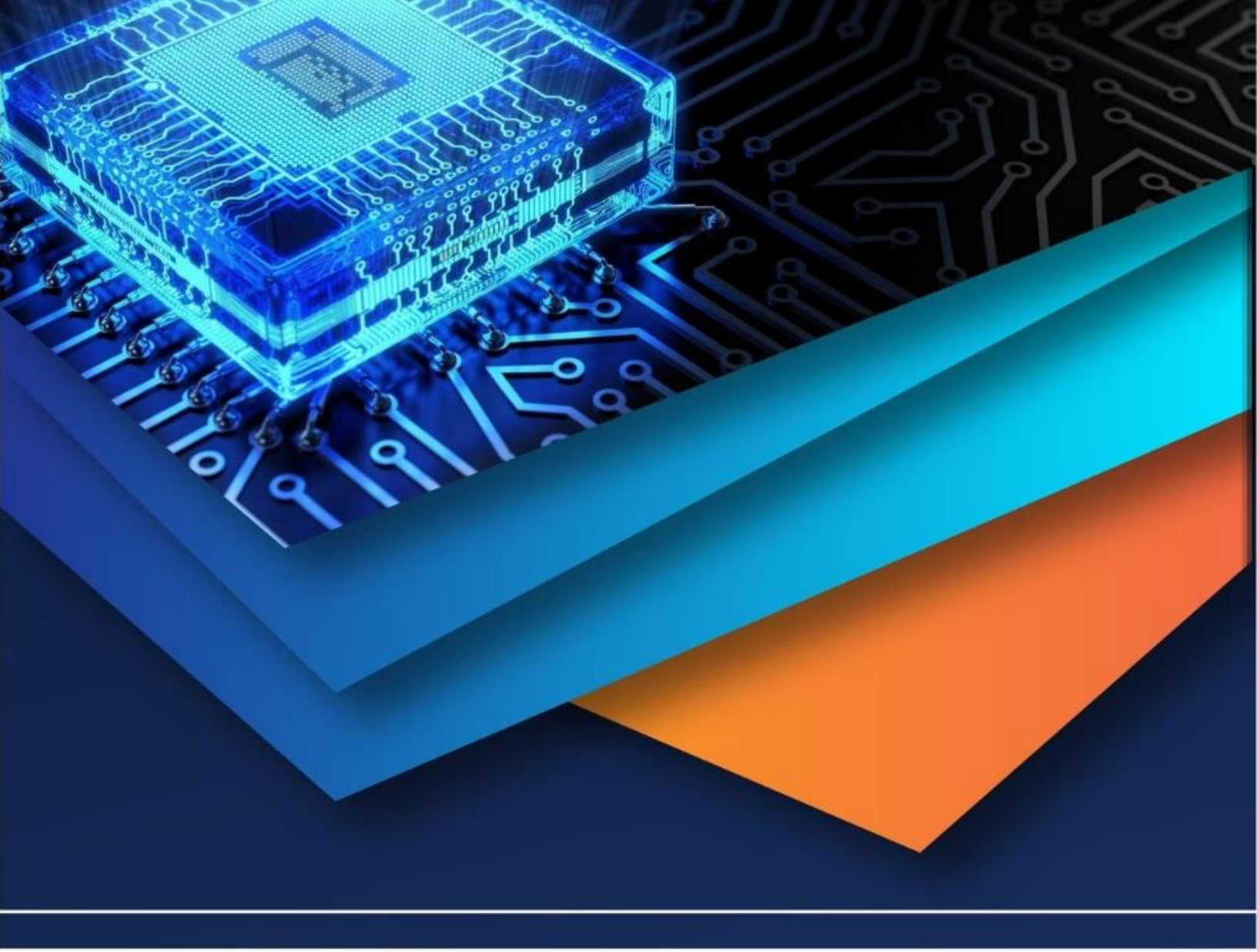
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