# BLOCKCHAIN SYSTEM FOR DIGITAL CONTENT TRADING

A PROJECT REPORT

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of

Bachelor of Technology

In

Computer Science and Engineering


**DEPT. OF COMPUTER SCIENCE & ENGINEERING**

COLLEGE OF ENGINEERING

TRIKARIPUR

APRIL 2024

## DECLARATION

I undersigned hereby declare that the project report BLOCKCHAIN SYSTEM FOR DIGITAL CONTENT TRADING, submitted for partial fulfillment of the requirements for the award of degree of Master of Technology of the APJ Abdul Kalam Technological University, Kerala is a bonafide work done by me under supervision of Mrs. REEJAMOL K J. This submission represents my ideas in my own words and where ideas or words of others have been included, I have adequately and accurately cited and referenced the original sources. I also declare that I have adhered to ethics of academic honesty and integrity and have not misrepresented or fabricated any data or idea or fact or source in my submission. I understand that any violation of the above will be a cause for disciplinary action by the institute and/or the University and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been obtained. This report has not been previously formed the basis for the award of any degree, diploma or similar title of any other University.

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**TRIKARIPUR**

**2023 - 2024**

## CERTIFICATE

This is to certify that the report entitled **BLOCKCHAIN SYSTEM FOR DIGITAL CONTENT TRADING** submitted by **AKSHAYA A,ANAMIKA M NAMBIAR,ANUSREE A,GAYATHRI GOVIND K**, to the APJ Abdul Kalam Technological University in partial fulfillment of the B.Tech degree in Computer Science & Engineering is a bonafide record of the project work carried out by him/her under my/our guidance and supervision. This report in any form has not been submitted to any other University or Institute for any purpose.

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## VISION

*(Institution)*

To be a premier institution in education and research for moulding technically competent and socially committed professionals.

## MISSION

*(Institution)*

(i) Promote interdisciplinary research and innovation so as to meet the current needs of industry and society.

(ii) Attract, nurture and retain the best faculty and technical manpower.

(iii) Provide state of art facility for quality technical education.

(iv) Develop personality and professional skills of the students through interaction with alumni academia and industry.

## VISION

*(Department)*

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(ii) To impart technical skills necessary to generate quality professional according to industry needs.

(iii) To develop human resource with the ability to apply the knowledge for the benefit of the society.

# ABSTRACT

*T*he digital age has transformed the way content is created, distributed, and consumed. However, traditional systems for digital content trading often face challenges related to copyright infringement, intermediary costs, security, and transparency. Blockchain technology offers a revolutionary approach to address these issues, providing a decentralized and transparent framework for trading digital content.

Through the use of smart contracts, blockchain enables automated, self-executing agreements that reduce the need for intermediaries, thereby lowering costs and increasing efficiency. Moreover, the immutable and transparent nature of blockchain ensures that the provenance of digital content is verifiable, offering robust protection against piracy and unauthorized use.

The off -chain aspect facilitates digital content trading through an authentication process,embedding digital fingerprints within the content for tracking in case of unauthorized leaks. Content is encrypted and traded , ensuring that only legimate users can access it,thereby safeguarding the income of content creators. The on chain network manages digital content licenses and employs a consensus algorithm for verification.Licensed users generate a secret block for their transactions,recorded on their ledger.This approach ensures privacy and network congestion during content uploads.

Finally,with consensus from all blockchain participants,a public block is created and recorded in the ledger,concluding the transaction securely.By leveraging smart contracts, decentralized networks, and immutable ledgers, blockchain can foster a fairer and more sustainable digital content ecosystem. The adoption of blockchain in this context could ultimately lead to a paradigm shift in how digital content is created, shared, and monetized.

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# Chapter 1

# INTRODUCTION

In today's digital age, the landscape of content creation, distribution, and consumption has undergone significant transformation. However, this shift has brought along various challenges for digital content trading, such as copyright infringement, intermediary costs, security, and transparency. Traditional models often struggle to address these issues effectively, leading to inefficiencies and revenue loss for content creators.

Blockchain technology offers a novel solution to these problems by providing a decentralized and transparent framework for digital content trading. Unlike traditional centralized systems, blockchain's distributed ledger system ensures that transactions are recorded immutably, enhancing trust and reducing the risk of unauthorized modifications. The application of smart contracts, which are automated, self-executing agreements, further streamlines the trading process, minimizing the need for intermediaries and thereby reducing costs.

A significant benefit of blockchain-based content trading is its ability to ensure the provenance of digital content. Through unique digital fingerprints embedded within the content, blockchain can track its source, making it easier to trace and address unauthorized use. The use of encryption and off-chain authentication processes adds an extra layer of security, allowing only legitimate users to access the content. This not only protects creators' intellectual property but also helps maintain their revenue streams by preventing

piracy.

Blockchain's on-chain component plays a crucial role in managing digital content licenses. The network employs a consensus algorithm for verifying transactions, and licensed users generate secret blocks for their activities. This approach ensures privacy and reduces network congestion during content uploads. Once consensus is reached among all blockchain participants, a public block is created and recorded in the ledger, securely concluding the transaction.

The adoption of blockchain technology in digital content trading represents a significant shift in how digital content is created, shared, and monetized. By fostering a fairer and more sustainable digital content ecosystem, blockchain opens up new possibilities for content creators and consumers alike. This introduction outlines the key aspects of blockchain's impact on digital content trading and sets the stage for a more detailed exploration of its potential benefits, challenges, and implications.

## 1.1 OBJECTIVES

The purpose of the project is to

- Identify the Blockchain platform to be used.
- Identity management using blockchain to verify and authenticate the identities of content creators and consumers.
- Integration with payment gateway.
- To identify and mitigate vulnerabilities, ensuring the integrity and safety of user transactions.
- To develop API's that allows easy transaction.

## 1.2 PROBLEM STATEMENT

In digital content trading the content is encrypted and traded and only the right user can use the digital contents , thus ensuring income for legitimate content author. In the digital content trading , a number of challenges exist.copyright infringement ,inequitable profit sharing, content forgery are the issues. Also existing blockchain systems exhibit constraints concerning storage capacity, inefficient resource utilization and privacy vulnerabilities. The problem here is to device an efficient solution to develop a secure digital content trading system.

## 1.3 SCOPE

In the current landscape, challenges such as illegal copying, leaking, profit distribution issues, forgery, and falsification hinder the growth of the digital content market. Conventional solutions like Digital Rights Management (DRM) and digital fingerprinting have proven insufficient. Recognizing the potential of blockchain in addressing these challenges, the SBBC system integrates innovative features to overcome existing limitations. The introduction of Secret Blocks (SBs) tackles storage space issues, especially concerning the upload of large digital content files like videos. By prioritizing transparency, data integrity, scalability, and efficiency, thIS system aims to usher in a new era for digital content trading, mitigating existing problems and fostering a more secure and robust marketplace. The implementation considerations and future implications of this system underscore its potential impact on industry dynamics and technological advancements.

# Chapter 2

# LITERATURE SURVEY

Gabin Heo ,et.al in [1] proposed efficient and secure for digital content trading using blockchain.The benefit of the system is that there is increased security and protection of personal information, as the secret block and consensus algorithm are designed to address the weakness of the existing blockchain system.Another benefit is the improved effieciency and scalability as, the secret block can help to reduce the amount of data that needs to be stored on blockchain network. Overall the paper suggests that the SBBC system has potential to provide a safe and reliable trading environments for digital content.

Anna Qureshi,et.al in [2] proposed blockchain based multemedia content protection system. The system is mainly used for content protection mechanism and performance criteria. Limitation of the system is scalability.Also complexity that is implementing it with existing copyright protection mechanisms can be complex and required tecnical expertise. Advantage is that there is reduced intermediaries that is there is direct interaction between copyright owners and consumers.This application empower content consumers. This application empower content owners to upload , manage and copyright options and receive payments for content wage.

Jay kishigami ,et.al in [3] proposed a blockchain based digital content distribution system . The proposed system currently lacks an incentive mechanism for the mining calculations , meaning that there is no direct compensations for miners who perform the

resource incentive task of calculating hash values. There is enhanced trust and transparency in digital content distribution.The system offers more cost effective solution for content distribution ,making it attractive to content providers. Also easier for stakeholders to understand how it could be implemented.

Zehao Zhang et.al in [4] proposed a design of digital rights management system based on blockchain. This paper introduces a DRM mechanism based on blockchain technology, enhancing security and transparency by recording copyright transactions and licenses on the blockchain while using smart contracts. It acknowledges [potential limitations regarding the computational power required for high concurrency. The benefits include enhanced security and transparency for copyright under transactions simplified processes and reduced cost.

Haya R Haran et.al in [5] proposed a system for delivery of digital assets using blockchain and smart contracts. In this paper, a blockchain based solution and framework for the proof of delivery (P.D) of digital assets is presented. This solution is versatile and can be employed to manage the sale and distribution of various digital assets, including streamed video and audio. All transactions are interactions related to the sale and download of digital media are executed through Ethereum smart contracts. Limitation for this approach is it's scalability , when handling with large number of transactions . Benefits include security , reducing the risk of fraudulent activities. Also solutions to various NITN and replay attacks.

Umair Khan et.al [6] proposed a blockchain ethereum technology enabled digital content. Here the study investigates the "Digits" system which leverages smart contracts through ethereum blockchain technology. This technology is harnessed to established a robust review system allowing the seamless transfer of reputation data between platforms. Limitation for this approach is speed of technology. The energy intensive nature of blockchain network might raise concerns regarding sustainability and operability costs. Benefits of the systems is that they provide structured framework for understanding and classifying these applications, catering to diverse sectors . Incorporation of encryption algorithms ensures transparent and secure transactions , reducing the risk of data manipulation

and hacking.

The Major observations are summerized in the following table:

Table 2.1: Comparison study

| SI NO | TITLE | AUTHOR(YE | TECHNIQUE USED | HIGHLIGHTS | LIMITATIONS |
|---|---|---|---|---|---|
| 1 | Blockchain-based digital distribution system | Fujimura et al. (2015) | Blockchain | Decentralized content | Lack of incentives, scalability |
| 2 | A design of digital rights management mechanism based on blockchain technology | Zhang and Zhao (2018) | Blockchain | Smart contracts, flexible pricing | Resource demands, legal issues |
| 3 | Proof of delivery of digital assets using blockchain and smart contracts | Hasan and Salah (2018) | Ethereum, IPFS | Payment automation, IPFS | Scalability concerns, complexity |
| 4 | Blockchain Ethereum-based digital content | Khan et al. (2020) | Ethereum, blockchain | Smart contracts, encryption | Complexity, scalability issues |
| 5 | Blockchain-based Multimedia content protection:Review and open challenges | Qureshi and Jimenez (2020) | Blockchain | Control, transparency | Scalability, reliability |
| 6 | Efficient and Secure Blockchain system for Digital Content Trading | Heo et al. (2021) | Blockchain | Digital fingerprinting, encryption | Limited capacity for large content |

# Chapter 3

# SYSTEM DESIGN

## 3.1 BLOCK DIAGRAM

A block diagram is a drawing illustration of a system whose major parts or components are represented by blocks. These blocks are joined by lines to display the relationship between subsequent blocks.

We use block diagrams to visualize the functional view of a system. It uses blocks connected with lines to represent components of a system. With a block diagram, you can easily illustrate the essential parts of a software design or engineering system and depict the data flow in a process flow chart.

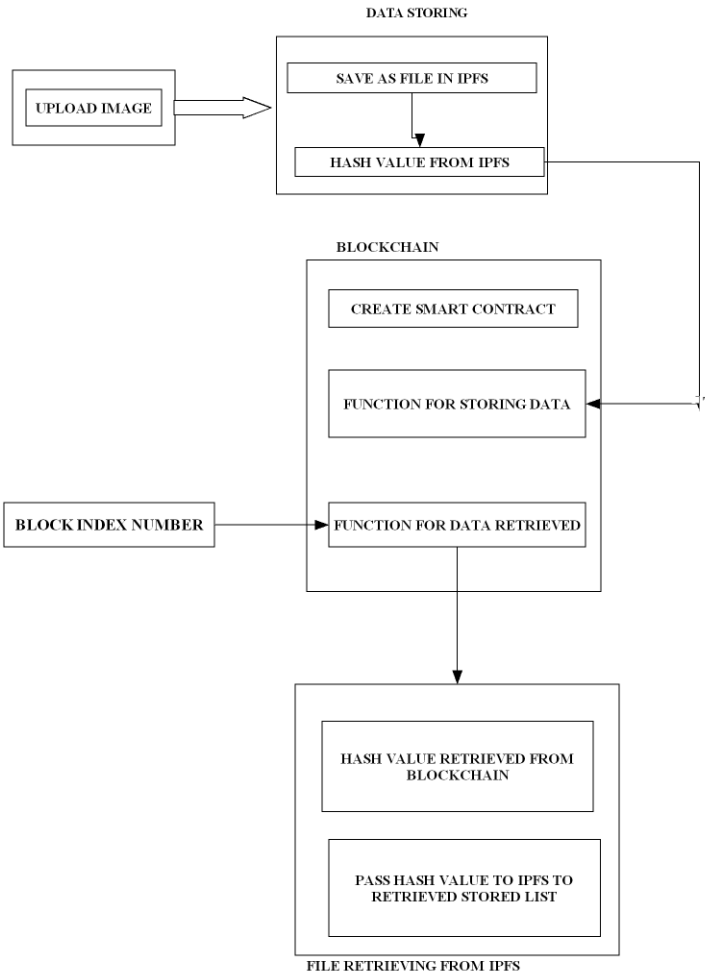


Figure 3.1: Block Diagram

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## 3.2 SYSTEM ARCHITECTURE

A system architecture is the conceptual model that defines the structure, behavior, and more views of a system. An architecture description is a formal description and representation of a system, organized in a way that supports reasoning about the structures and behaviors of the system.

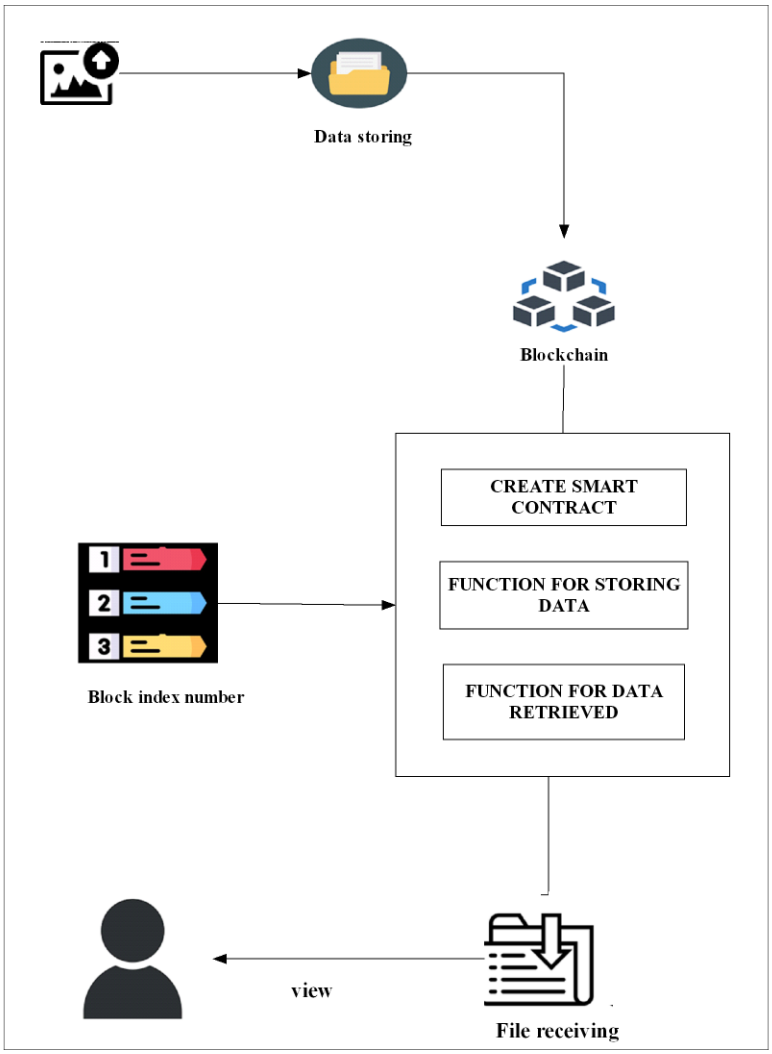


Figure 3.2: System Architecture

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## 3.3 DESIGN OF EACH MODULE

### 3.3.1 ADMIN

Within the intricate framework of a website, administrators, commonly known as admins, serve as the linchpin for ensuring its seamless operation and overall integrity. At the core of their responsibilities is the comprehensive management of the site, encompassing considerations like structure, design, and functionality. Admins wield authority over user

accounts, with the ability to create, modify, or deactivate them as necessary. This extends to overseeing user registrations, managing password-related issues, and defining account permissions, all contributing to the creation of a secure and user-friendly digital space.

### 3.3.2 USER

Users play a pivotal role in shaping the dynamics and functionality of the online platform. At its core, users serve as active consumers, visiting the site to access and absorb diverse content, ranging from articles and videos to other multimedia offerings. Beyond passive consumption, users contribute significantly to the interactive and engaging nature of a website. This involvement can manifest through activities such as leaving comments, participating in discussions, and sharing content across various social media platforms. In essence, user interaction fosters a sense of community and enriches the overall user experience.Admins may be responsible for handling technical aspects, ensuring the website's proper functioning, implementing updates, and addressing any technical issues that may arise. Their behind-the-scenes efforts contribute significantly to the overall success and sustainability of the website.

### 3.3.3 DATABASE

The database is a crucial element that enhances the system's capabilities,providing a structured way to store, organize, and analyze data for the benefit of users and the overall functionality of the electric vehicle system.

## 3.4 DATA FLOW DIAGRAM

A data flow diagram (DFD) maps out the flow of information for any process or system. It uses defined symbols like rectangles, circles and arrows, plus short text labels, to show data inputs, outputs, storage points and the routes between each destination. Data flowcharts can range from simple, even hand-drawn process overviews, to in-depth, multi-level DFDs that dig progressively deeper into how the data is handled.

### 3.4.1 Data Flow Diagram Level 0


Figure 3.3: DFD Level 0

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### 3.4.2 Data Flow Diagram Level 1

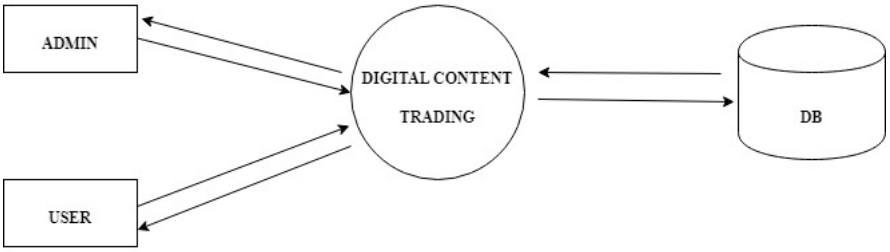


Figure 3.4: DFD Level 1.1

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### 3.4.3 Data Flow Diagram Level 1.1

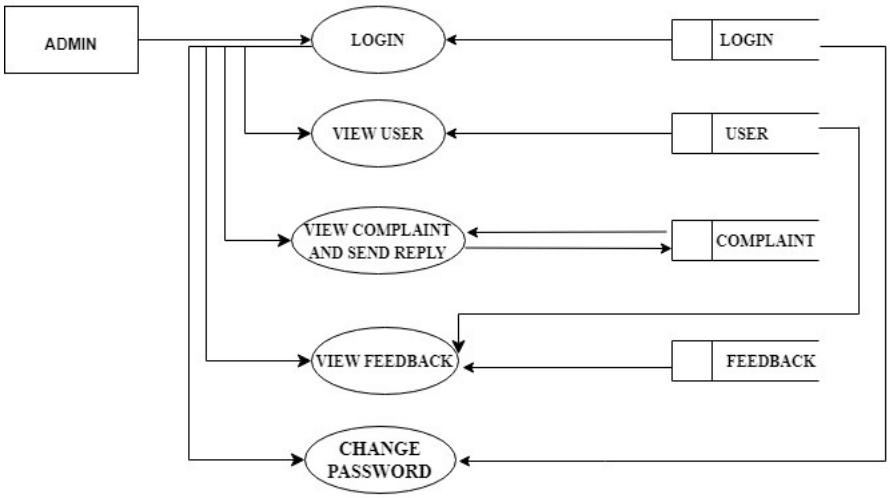


Figure 3.5: DFD Level 1.1

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### 3.4.4 Data Flow Diagram Level 1.2

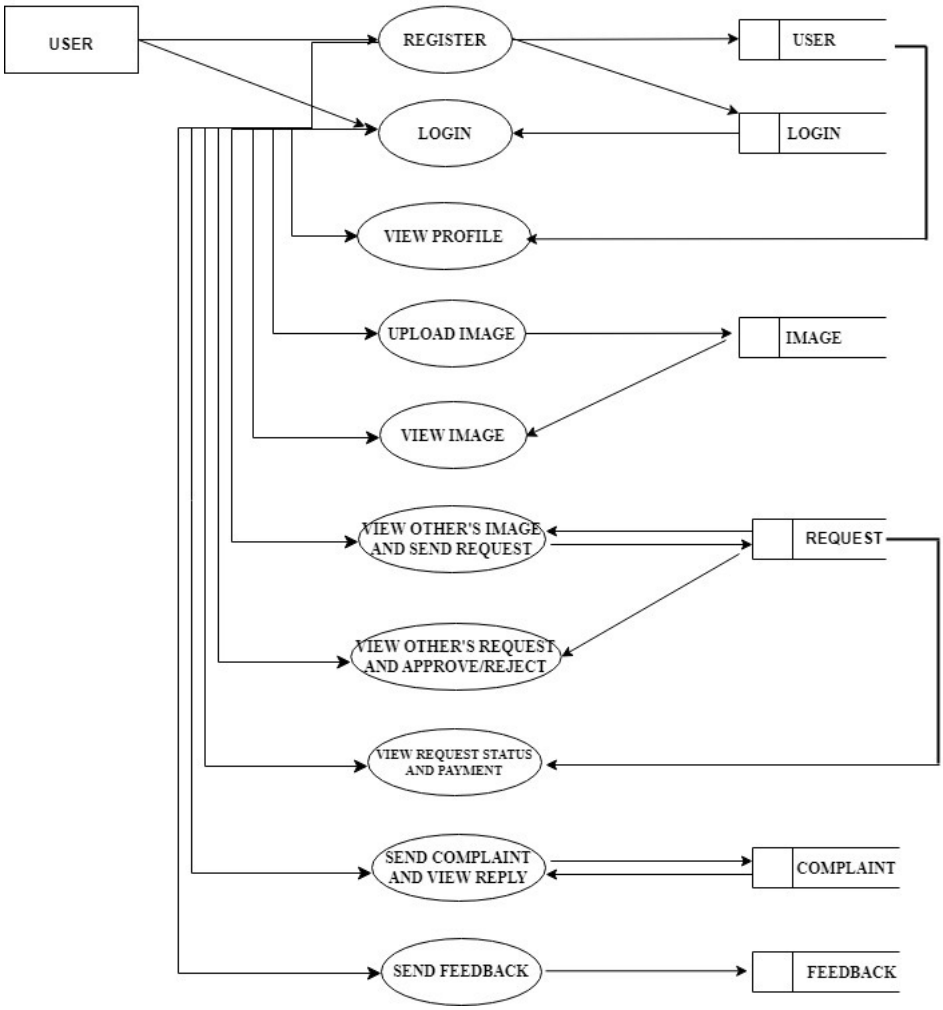


Figure 3.6: DFD Level 1.2

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## 3.5 USE CASE DIAGRAM

It is a graphical depiction of a user's possible interactions with a system. A use cases diagram shows various use cases and different types of users the system has and will often be accompanied by other types of diagrams as well. The use cases are represented by either circle or ellipses. The actors are often shown as stick figures. While a use case itself might drill into a lot of detail about every possibility, a use case diagram can help provide a higher-level view of the system. It has been said before that use case diagrams are blueprints of our system.

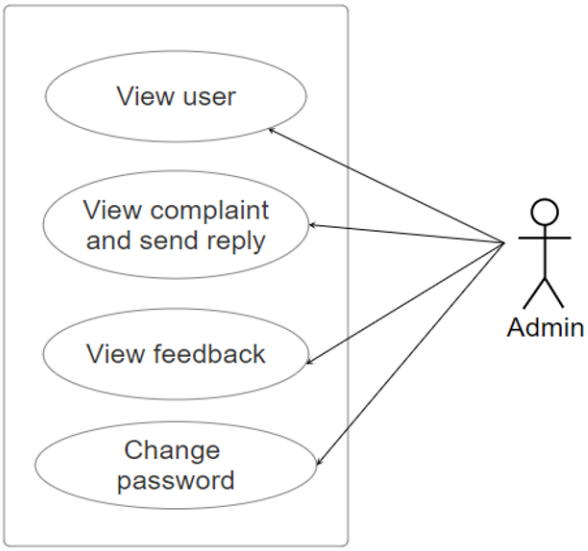


Figure 3.7: Usecase Diagram(admin)

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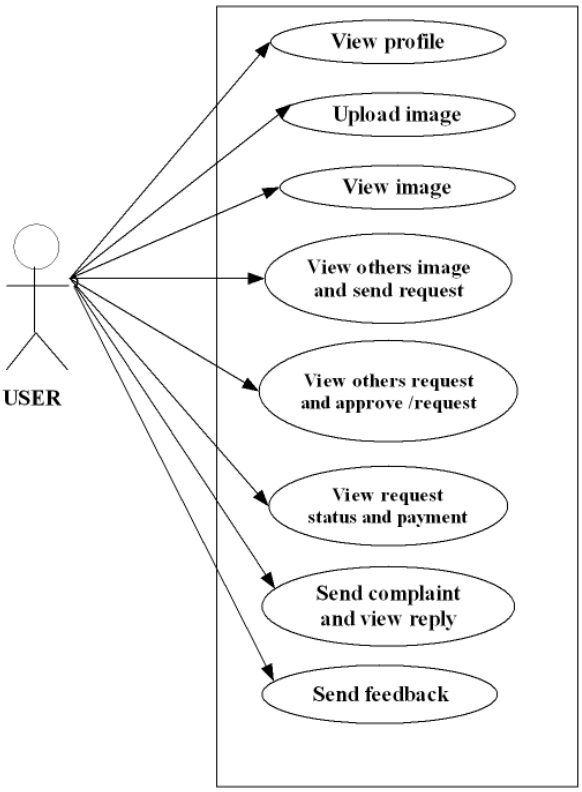


Figure 3.8: Usecase Diagram(user)

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## 3.6 SEQUENCE DIAGRAM

A sequence diagram is a type of interaction diagram because it describes how—and in what order—a group of objects works together. These diagrams are used by software developers and business professionals to understand requirements for a new system or to document an existing process.

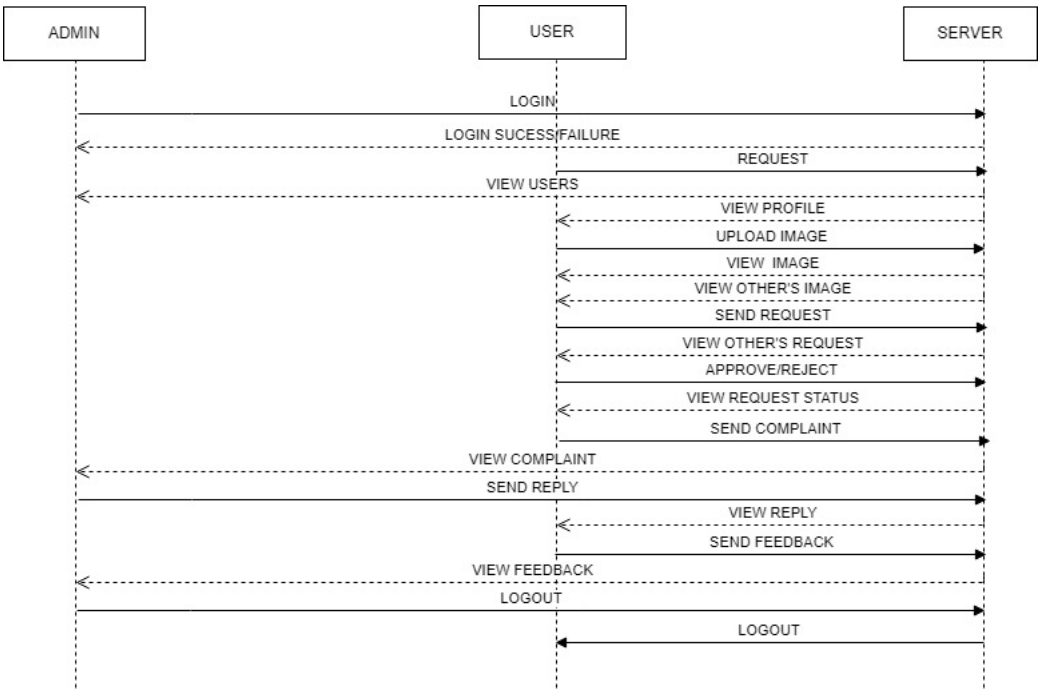


Figure 3.9: Sequence Diagram

.

## 3.7 ACTIVITY DIAGRAM

Activity diagrams are graphical representations of workflows of stepwise activities and actions with support for choice, iteration and concurrency.

## 3.8 CLASS DIAGRAM

Class diagrams are the main building block of any object-oriented solution. It shows the classes in a system, attributes, and operations of each class and the relationship between each class.

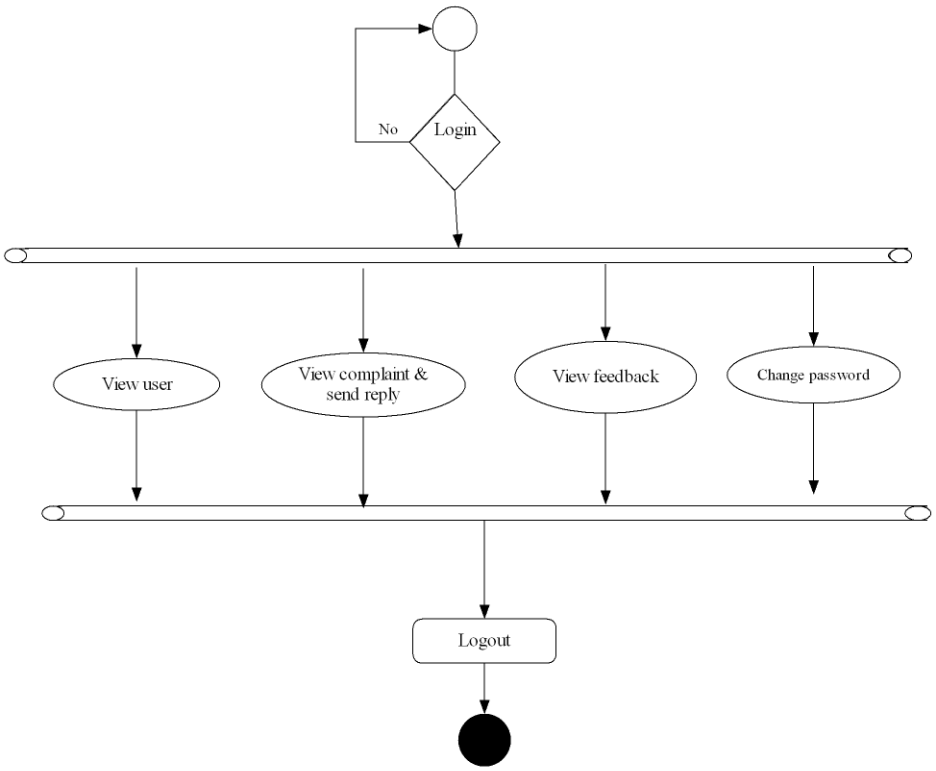


Figure 3.10: Admin Activity Diagram

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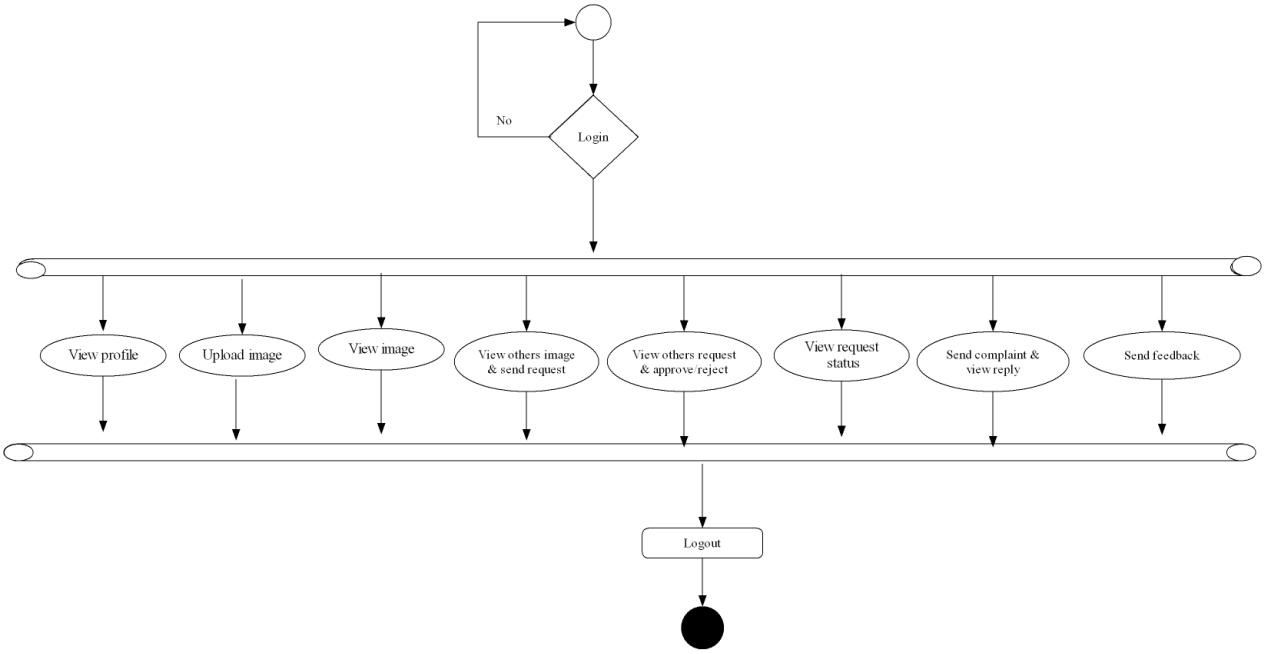


Figure 3.11: User Activity Diagram

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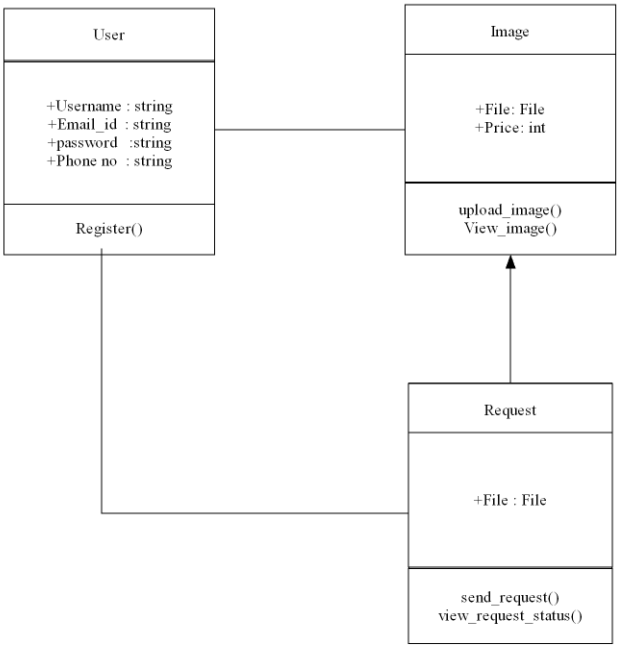


Figure 3.12: Class Diagram

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# Chapter 4

# TOOLS

### 4.0.1 PYTHON

PyCharm is a powerful Integrated Development Environment (IDE) developed by JetBrains specifically for Python programming. It offers a wide range of features to enhance productivity, including intelligent code completion, syntax highlighting, and code inspections. PyCharm also provides advanced debugging capabilities, version control integration, and support for various frameworks such as Django and Flask. Its intuitive interface and customizable settings make it suitable for both beginners and experienced developers. PyCharm is available in both free and paid versions, catering to different needs and preferences within the Python development community, making it a popular choice for Python programmers worldwide.

### 4.0.2 NODE JS

Node.js is an open source, cross-platform runtime environment for developing server-side and networking applications. Node.js applications are written in JavaScript, and can be run within the Node.js runtime on OS X, Microsoft Windows, and Linux.Node.js also provides a rich library of various JavaScript modules which simplifies the development of web applications using Node.js to a great extent.

### 4.0.3 GANACHE

Ganache is a local blockchain emulator designed for Ethereum development, providing a safe and efficient environment for testing smart contracts and decentralized applications (dApps). It allows developers to create a personal Ethereum network on their local machine, offering fast transaction processing, customizable parameters, and the ability to reset the blockchain as needed. Ganache supports various development frameworks like Truffle and Hardhat, making it easier to build and test Ethereum-based projects. It features both a graphical user interface (GUI) and a command-line interface (CLI), catering to different user preferences. Ideal for development, automated testing, and learning, Ganache helps developers experiment without risking real Ether or affecting the public Ethereum network.

### 4.0.4 WEB3

Web3, or Web 3.0, is the future of the internet, centered around decentralization, blockchain technology, and user ownership. Unlike traditional web platforms that rely on central servers, Web3 uses decentralized networks, enabling applications (dApps) to run without a single point of control. This approach provides greater security, transparency, and autonomy, allowing users to have direct ownership of their data, digital assets, and online identities. With smart contracts and blockchain-based technologies like Ethereum, Web3 creates a peer-to-peer ecosystem where cryptocurrencies and tokens play a central role, reshaping how we interact, transact, and build online communities.

# Chapter 5

# IMPLEMENTATION

Our proposed system aims to provide a comprehensive traceability scheme for digital content trading from origin to end users. The system introduces a secure mechanism for trading and delivery of digital content among various entities in the content distribution network.The proposed model follows a layered architecture and is categorized into three layers. The system is designed using a layered architecture comprising three distinct layers.The first layer is the data layer which handles interactions between different entities involved in digital content trading.The data layer also supports verification processes to ensure the integrity and origin of the content being traded. The second layer is the blockchain layer that handles the transactional data of the trading.o optimize storage and reduce the blockchain's size, this layer only stores the hashes of the data, with the actual data stored in the storage layer. The blockchain layer enforces strict access control strategies to prevent unauthorized reads and writes to the storage layer. The third layer is responsible for securely storing transaction and event data from the blockchain on the InterPlanetary File System (IPFS), a decentralized storage medium. The blockchain layer enforces strict access control to prevent unauthorized access to the stored data. IPFS allows the system to maintain high throughput, low latency, and scalability due to its distributed nature.

### 5.0.1 SMART CONTRACT

Smart contract is a piece of executable code that is responsible to facilitate digital transactions and provide security in terms of authen-ticity, credibility and immutability. Once a smart contract is deployed on the blockchain then it cannot be modified and executed as it is. If its code is vulnerable, it seriously affects the security of a blockchain.All transactions are recorded and stored in the blockchain's immutable ledger with links to a decentralized file system (IPFS)and thus providing to all a high level of transparency and traceability into the supply chain ecosystem in a secure, trusted, reliable, and efficient manner.All transactions are written to blockchain which ultimately uploads the data to Interplanetary File Storage System (IPFS).

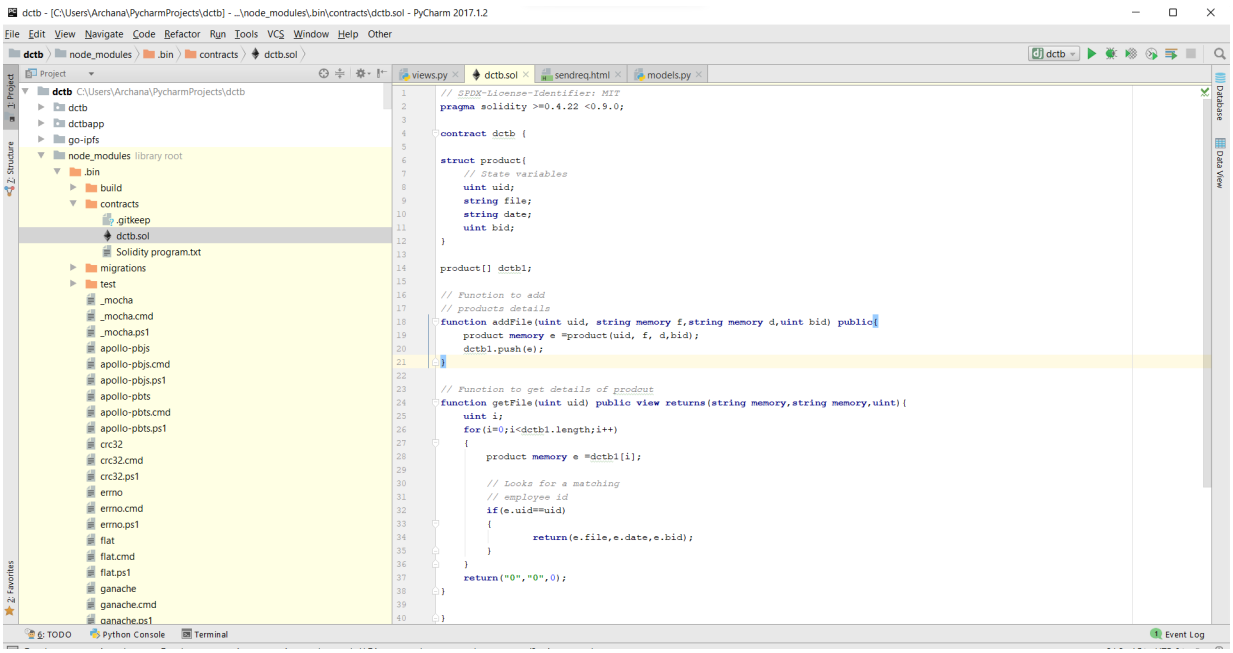


Figure 5.1: Smart cntract

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### 5.0.2 ETHEREUM

Ethereum is a programmable blockchain platform that has the ability to govern business logic including interactions, sequence of events, and access control to enforce the required

work- ow and execute agreed-on business logic among supply chain participants. The Ethereum Virtual Machine (EVM)is the runtime environment for Ethereum computations on which the user programs are executed. A smart contract is a protocol that is intended to digitally verify and carry out credible transactions that are traceable and irreversible, with- out third party intervention.

### 5.0.3 USER INTERFACE

The interface is designed with a focus on user-friendly interaction and functionality.

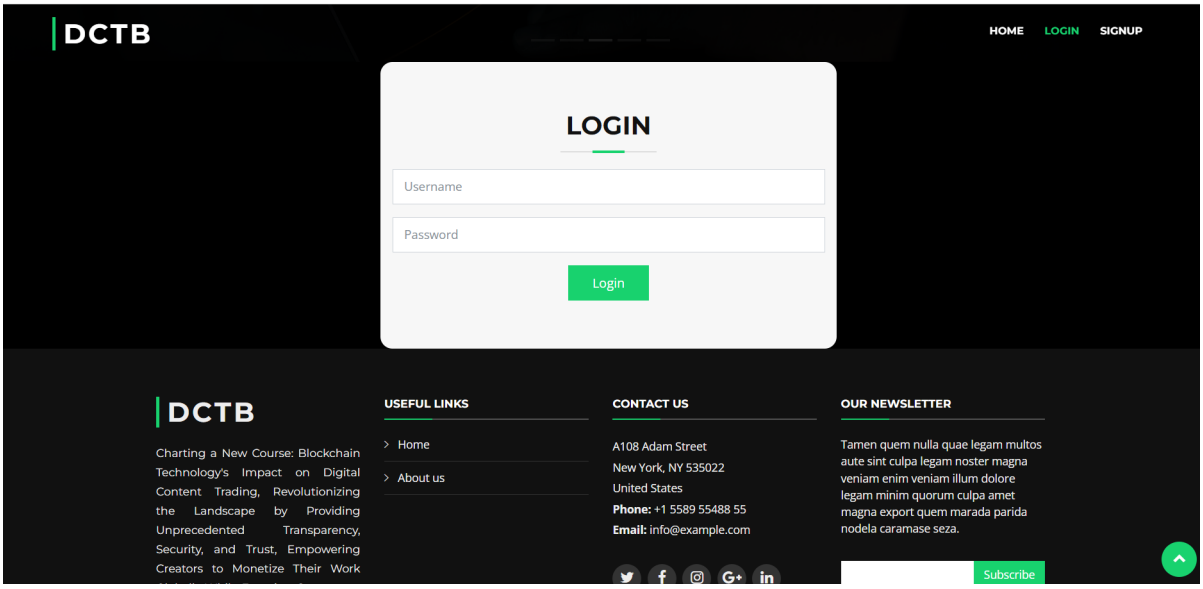


Figure 5.2: Login page

.

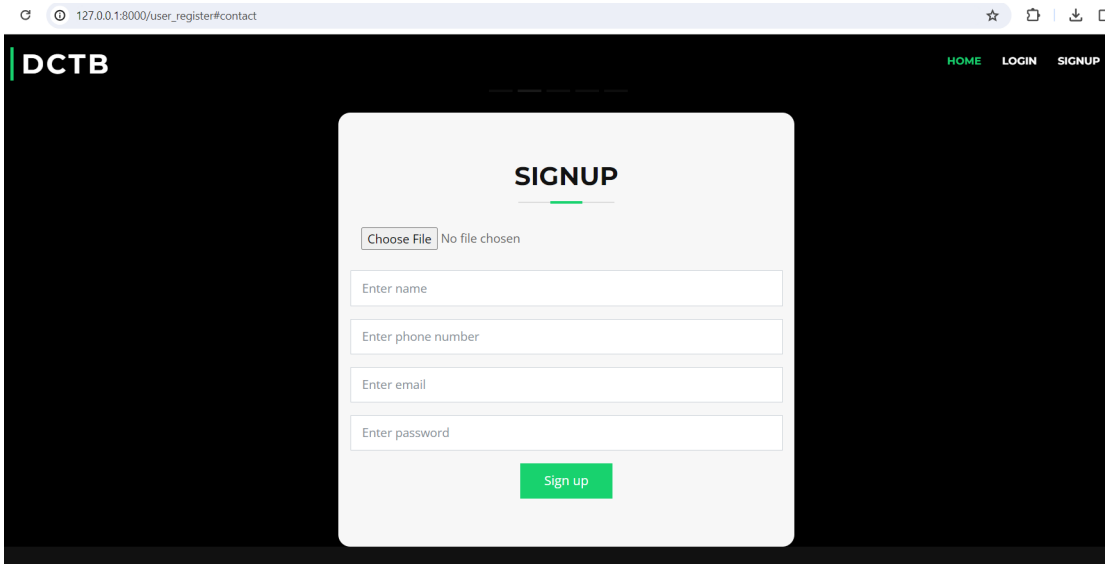


Figure 5.3: Signup page

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### 5.0.4 UPLOADING FILES

Uploading files to a blockchain involves storing data on a distributed and decentralized ledger, typically in the form of transactions or smart contracts. Since blockchains are designed to maintain a secure and immutable record of information, adding large files to a blockchain can be challenging due to size limitations and the cost of storing data on-chain. A common approach is to use the blockchain to store a cryptographic hash or reference to an off-chain storage location, such as the InterPlanetary File System (IPFS). .

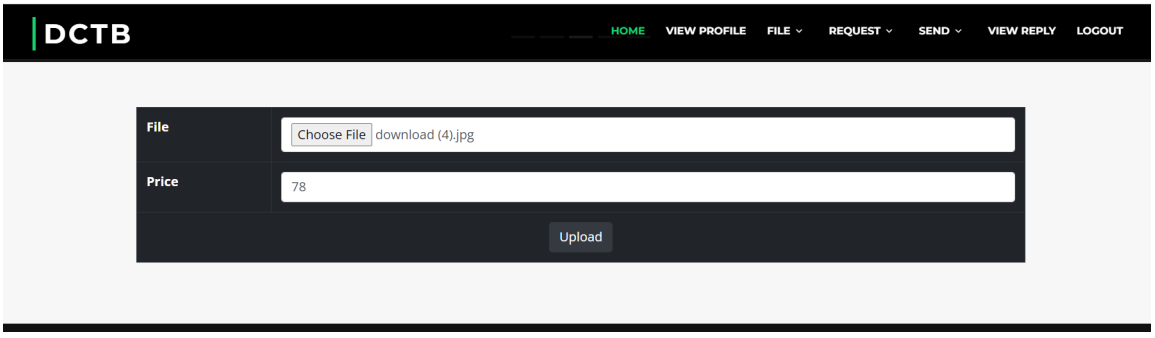


Figure 5.4: Uploading files

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Once the file has been uploaded to blockchain,the block number will be updated.It is shown in Ganache.

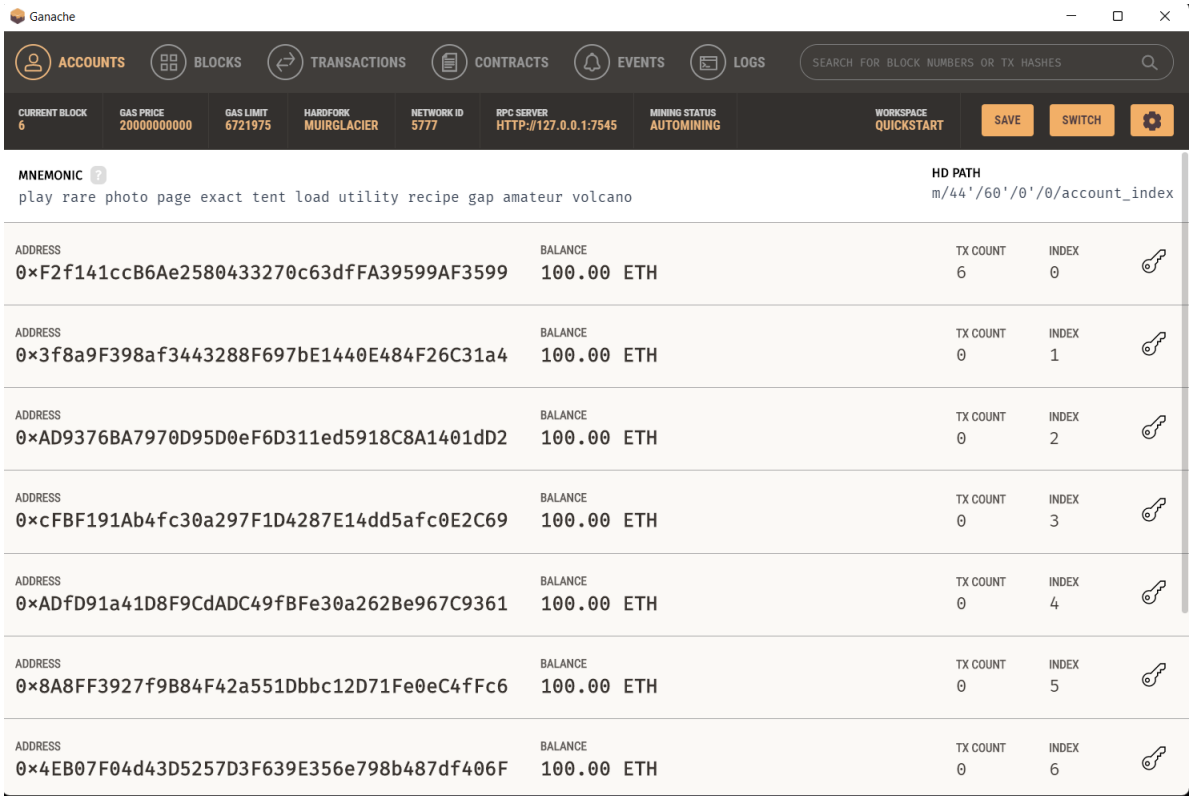


Figure 5.5: Updation of block number

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### 5.0.5 ALERT MESSAGE

When implementing a system where file uploads are handled via blockchain or other storage mechanisms, it is critical to prevent duplicate uploads.When a user attempts to upload a file, the system first calculates a unique identifier for the file, typically a cryptographic hash. If a file that is already stored is uploaded again, the system can send an alert message to notify the user or administrator. This serves to maintain data integrity and avoid unnecessary duplication, which can lead to increased storage costs and operational complexity.

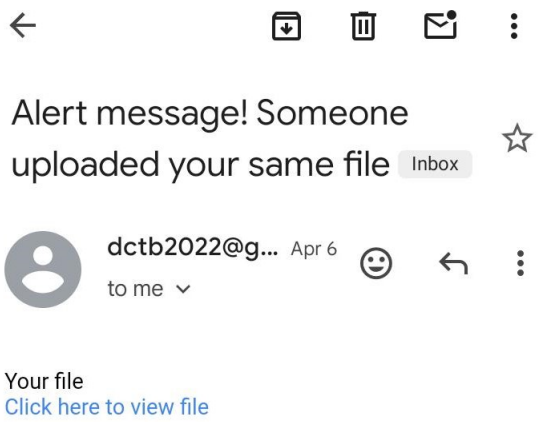


Figure 5.6: Alert message

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### 5.0.6 SENDING REQUEST

When a user likes an image, this action can be recorded on the blockchain through a smart contract.The smart contract might first check if the content is available for purchase and if the user has the necessary permissions to buy it. If all conditions are met, the smart contract can send a request to the user to confirm the purchase.

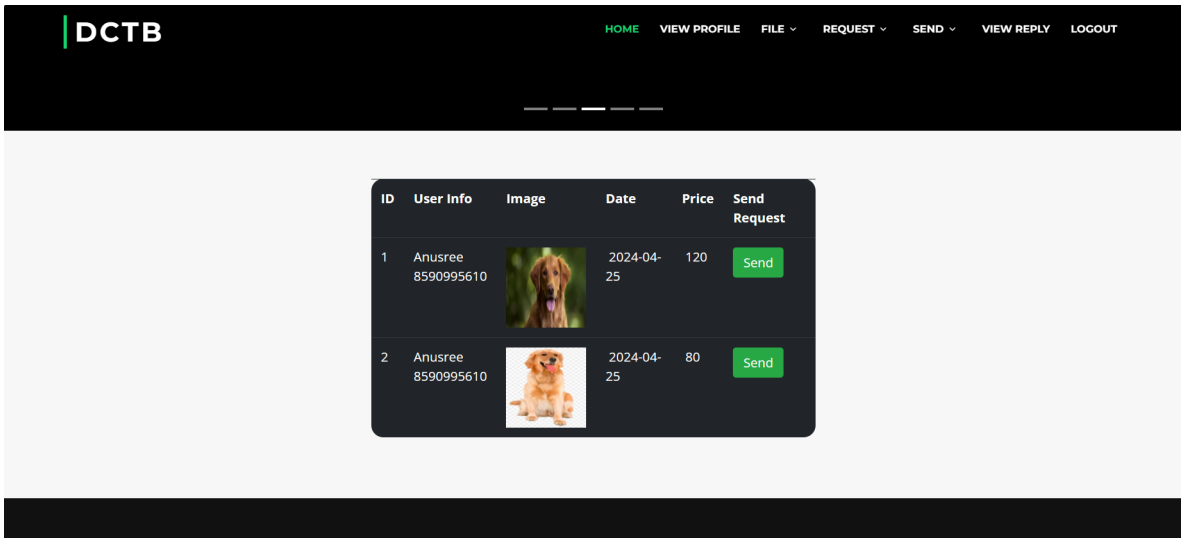


Figure 5.7: Sending request

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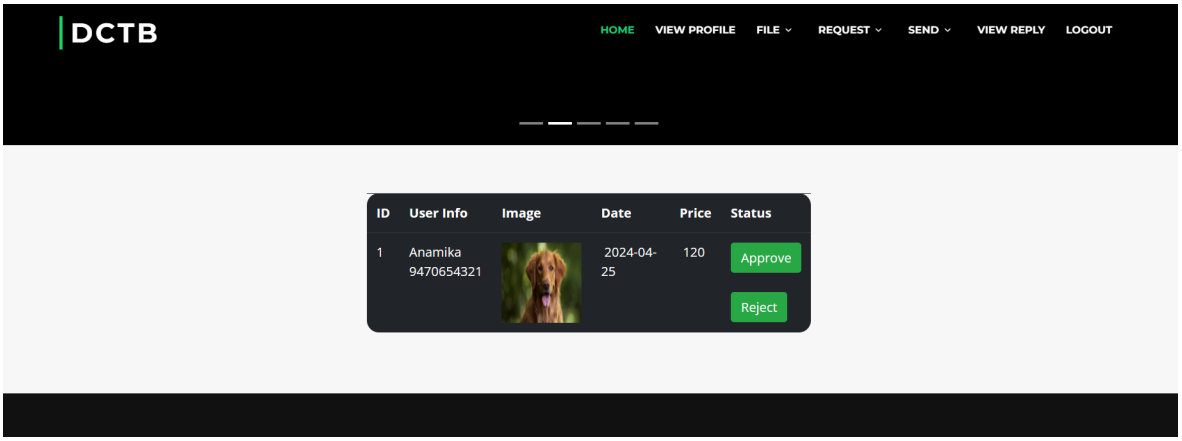


Figure 5.8: Approve/Reject request

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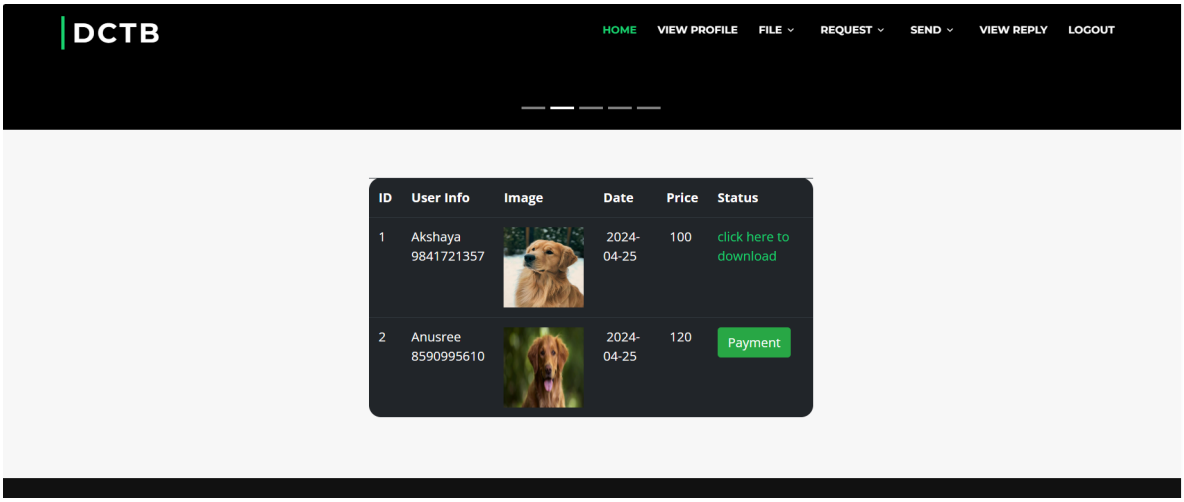


Figure 5.9: Payment

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# Chapter 6

# RESULT AND DISCUSSION

In this section, we discuss the results obtained from implementing a blockchain-based system for digital content trading, focusing on the efficiency, security, and user experience benefits it brings. We also analyze the implications of using smart contracts and decentralized storage for managing digital content.

The implementation of smart contracts in the blockchain-based system has significantly improved efficiency in the digital content trading process. Smart contracts automate key functions, such as validating user interactions, processing payments, and granting access to digital content. This automation has reduced the need for intermediaries, leading to faster transaction times and lower costs. Our results show that transactions that once took hours or days to process can now be completed within minutes.

One of the primary advantages of using blockchain for digital content trading is enhanced security. All transactions are recorded on a decentralized ledger, ensuring immutability and transparency. This aspect of blockchain helps to prevent fraud, double-spending, and unauthorized access to digital content. Additionally, the use of cryptographic hashes for tracking content ensures data integrity. Our results demonstrate that the risk of content tampering and piracy is significantly reduced in a blockchain-based system.

The combination of automation and security has led to an improved user experience.

Users can quickly and securely engage with digital content, knowing that their transactions are recorded and protected by blockchain technology. The use of smart contracts allows for seamless interactions, where users can "like" content to initiate a purchase request, leading to a more intuitive and user-friendly platform. Feedback from users indicates a higher level of satisfaction with the streamlined purchasing process.

The integration of decentralized storage, such as the InterPlanetary File System (IPFS), has addressed concerns about storing large digital files on the blockchain. By storing only the cryptographic hashes on the blockchain and keeping the actual content off-chain, the system maintains security while ensuring scalability. Our results suggest that this approach offers a balance between security and storage efficiency, allowing the platform to handle large volumes of digital content without overloading the blockchain.

Despite the positive outcomes, certain challenges and limitations persist. Scalability remains a concern, particularly when handling a high volume of transactions. Although decentralized storage alleviates some of these issues, network congestion and transaction costs can still impact performance. Additionally, regulatory and legal compliance can pose challenges as the blockchain ecosystem evolves. Our analysis indicates the need for ongoing monitoring and adjustments to address these limitations.

# Chapter 7

# CONCLUSION

The implementation of a blockchain-based system for digital content trading has demonstrated clear benefits in terms of efficiency, security, and user experience. Through the use of smart contracts, the system achieves a high degree of automation, reducing the need for intermediaries and enabling faster transactions. This translates into a smoother, more cost-effective experience for both content creators and consumers, fostering a more efficient digital marketplace.

The integration of decentralized storage, such as the InterPlanetary File System (IPFS), has proven effective in managing the storage demands of digital content without overburdening the blockchain. This approach allows the system to maintain scalability while still leveraging blockchain's security benefits.

However, challenges remain, particularly in the areas of scalability and regulatory compliance. As the system scales, network congestion and transaction costs can become significant issues. Regulatory frameworks for blockchain are still evolving, requiring careful consideration to ensure compliance with legal standards.

Looking ahead, continued innovation and adaptation will be key to addressing these challenges. The system can be enhanced by exploring more scalable consensus mechanisms, optimizing smart contract execution, and integrating additional decentralized storage solutions. Collaboration with industry stakeholders and regulatory bodies will also be crucial

to navigate the evolving legal landscape.

In conclusion, while there are challenges to address, the benefits of a blockchain-based system for digital content trading are substantial. With ongoing development and a focus on scalability, security, and compliance, this approach has the potential to revolutionize the digital content industry, offering a fairer, more transparent, and efficient ecosystem for creators and consumers alike.

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