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Empowering Data Sovereignty: Decentralized Image Sharing through Blockchain and Interplanetary File System

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Abstract: The current digital environment poses challenges because of the widespread dependence on centralized systems, which create a single weak point and expose data to risks. The need for a central authority to manage data raises questions about data access, protection, and confidentiality. To address these challenges, our research presents an innovative paradigm—a meticulously architected decentralized image-sharing platform leveraging blockchain technology and the Interplanetary File System (IPFS). We use the IPFS protocol, backed by the reliable Pinata IPFS gateway, to ensure the integrity and availability of data and to store files securely and wisely. Our system is based on removing the need for a central authority to control content sharing and giving users full sovereignty over their data. Every transaction on the platform creates a unique hash, which is carefully stored in the blockchain's smart contract. Our research decentralizes the existing image-sharing model and leverages blockchain and IPFS features to enhance security, transparency, and privacy. This decentralized image-sharing platform marks a new era of content distribution and management, strengthening data protection and privacy and empowering users. The amalgamation of blockchain technology and IPFS imparts an avant-garde character to the platform, serving as an efficacious solution to exigent issues related to centralized data management, upholding sacrosanct principles of user privacy and data ownership.

Keywords: *Security, Blockchain Technology, Communication, Interplanetary File System (IPFS), Smart Contracts, Data Integrity*.

1. Introduction

The world of digital imagery has undergone a remarkable transformation with the advent of decentralization. Prior to this shift, centralized systems-imposed limitations on how we stored, shared, and accessed digital images. Centralized systems often limit our data sovereignty, expose us to security risks, and create accessibility issues. Decentralization offers a solution by spreading image data over a network of peers, removing single points of failure, and improving reliability.

A key innovation in this domain is the Interplanetary File System (IPFS). This system enables images to be stored on multiple nodes, making them immune to censorship and data loss. This decentralized method gives users more agency over their image content. Consequently, privacy is protected, and the dependence on centralized actors is diminished.

Additionally, blockchain technology has contributed by creating a secure and transparent ledger for managing image ownership and transactions. This development has enabled artists and photographers to directly monetize their work through digital art marketplaces, bypassing traditional middlemen.

The era of decentralization has also led to user-oriented social platforms, where individuals have more say over how their images are shared and accessed. This change reflects the increasing concerns about data privacy and security, allowing users to enjoy their moments without giving up control to big tech corporations.

1.1. Literature Review

In our quest to delve into the realm of Decentralized Image Sharing, we initiated a comprehensive literature review, anchoring our investigation in a multitude of reputable sources. Our primary focus was directed towards meticulously reviews. In our research paper, we have ensured the credibility of our sources by drawing upon a selection of peer-reviewed journals and esteemed publications presented at renowned national and international conferences, seminars, books, symposiums, and periodicals. Additionally, to maintain the utmost reliability in our referencing, we have consulted reputable repositories like Google Scholar and IEEE Xplore., along with publications sourced from eminent databases like IEEE and Springer.

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To pinpoint pertinent references and publications related to Decentralized Image Sharing and its integration with advanced language models, we meticulously employed keywords such as Decentralization, Blockchain, IPFS, Smart Contracts, and Image Sharing applications. In a meticulous screening process, we carefully assessed the titles of the retrieved articles, excluding any papers that did not meet our stringent criteria for quality and relevance. Subsequently, to maintain the same meaning while

Table 1. Comparative Analysis

Model	Compatibility	Security	Performance	Community Support	Year	Features	Input Type	Drawbacks
MAJOR Version	Represents significant changes that may not be backward-compatible with previous versions.	May address major security vulnerabilities and introduce significant security improvements.	Can bring major performance improvements or changes, sometimes with a risk of performance regressions.	May experience changes in community support, as major updates can sometimes lead to a shift in user and developer engagement.	2018	Introduces significant new features, architecture changes, or major updates.	Input typically includes major code changes or substantial new features.	Drawback includes potential compatibility issues with existing systems due to significant changes.
MINOR Version	Introduces new features or enhancements while maintaining backward compatibility.	Typically includes security updates and enhancements but maintains compatibility.	Usually includes performance enhancements while keeping overall stability.	Typically maintains or enhances community support, as new features attract continued interest and contributions.	2019	Adds new features, improvements, and enhancements without major overhauls.	Input involves adding new features or enhancements without major alterations.	Drawback may involve occasional introduction of new bugs or issues with added features
PATCH Version	Includes bug fixes and patches without adding new features, preserving compatibility.	Primarily focuses on fixing security issues and vulnerabilities, preserving compatibility.	Primarily focuses on fixing performance-related issues and maintaining stability.	Usually sustains strong community support, as it focuses on bug fixes and improvements without major disruptions.	2020	Focuses on bug fixes, security updates, and minor improvements, typically without introducing new features.	Input primarily consists of bug fixes, security patches, and minor improvements.	Drawback is limited, but over-dependence on patches can mask underlying problems or postpone necessary updates.

rephrasing the sentence. In our research paper, we thoroughly examined the abstracts of the remaining articles, closely analyzing their potential contributions to our study.

Matuszewski et al [7] conducted an analysis of user attitudes in the direction of the context of mobile peer-to-peer (P2P) content distribution applications, it is crucial to highlight the significance of these applications. The findings from their interviews revealed that a majority of users displayed a preference for using P2P applications briefly, particularly when sharing content with people they were familiar according to Heikkinen et al [8] Examined the Network data transmission using TCP/IP protocols from mobile P2P connections originating in GSM/UMTS networks operated by three well-known Finnish entities.

Telecommunications providers distinguished various P2P applications by scrutinizing the transport protocol port numbers. Interestingly, they did not observe direct P2P traffic but found 9-

18% unidentified traffic, possibly due to employing peer to peer(P2P) applications on mobile devices as Wi-Fi access points. They also conducted a panel study, which revealed that Fring was the mobile peer-to-peer (P2P) client software with substantial utilization rates across all participants. Nurminen et al [9] focused on the energy consumption aspect of mobile BitTorrent clients. They assessed the energy consumption of a mobile BitTorrent client and discovered it to be on par with that of mobile phone voice conversations. Nonetheless, it's important to acknowledge that these measurements were carried out in 2008, and mobile devices, as well as their power consumption have undergone substantial advancements since that time. Bori et al [10] assessed the dependability of the BitTorrent framework within a mobile context through the utilization of the mobile BitTorrent application named 'DrTorrent' which had a user base of 5000 active participants. Their findings indicated that BitTorrent exhibits overall reliability, underscoring the significance of client applications in effectively managing irregularities, such as unsuccessful TCP connections and data corruption. Ekler et al [11] proposed an innovative hybrid information exchange platform utilizing the BitTorrent framework, integrating BitTorrent functionality with central servers overseen by mobile operators. This approach caters to the needs of both mobile and PC clients, enhancing content distribution efficiency and reducing service provider costs. The authors also conducted an evaluation of the performance of BitTorrent client implementations, SymTorrent and MobTorrent, was assessed, and it was found that SymTorrent displayed superior capabilities on both 3G and WLAN networks, due to its inherent C++ implementation. Csorba et al [12] and Ekler et al [13] examined the content lifecycle and client usage in the BitTorrent network using data from the MobTorrent mobile application. Their analysis, based on 2 to 4 years of data, indicated that mobile BitTorrent usage has been steadily increasing. They also observed a higher prevalence of incomplete downloads compared to completed ones, largely attributed to concurrent downloads of identical content. The most frequently accessed torrent categories included videos, applications, and audio. Apart from BitTorrent, researchers have also investigated the energy consumption of other P2P protocols in mobile settings. Gurun et al [14] investigated the Chimera P2P protocol with an embedded device and deployed an energy-saving method that transitioned the wireless card into a low-power mode during periods of inactivity, resulting in power savings. This study demonstrated the feasibility of using P2P protocols on low-power embedded devices. Chowdhury et al [15] assessed the efficiency of Peer-to-peer overlays in mobile settings that rely on Distributed Hash Table (DHT) technology, involving Chord, Pastry, Kademlia, Broose, and EpiChord, they conducted measurements within a simulated environment and observed that Kademlia excelled under high churn conditions, achieving a remarkable 97% success rate in lookups while consuming only 316 bytes per second of bandwidth. Additionally, EpiChord exhibited strong performance, achieving a commendable 63% success rate. with minimal bandwidth consumption. Khan et al [16] developed a mobile-centric Peer-to-peer (P2P) network information storage system, which involved the organization of the Organizing a peer-to-peer (P2P) network into duplicate peer clusters. and implemented a gossip-based protocol for routing table updates. Their simulations revealed a notable 12-48% enhancement in lookup success rates when compared to MR-Chord and other peer-to-peer (P2P) systems built upon the Chord protocol. Additionally, their system demonstrated excellent churn and workload adaptation capabilities, distributing requests evenly.

1.2. Novelty and Contribution

This section introduces the innovative approach employed to enhance the efficiency of implementing a decentralized image system and presents a noteworthy contribution to the realm of distributed technologies. This venture encompasses several pivotal methodologies, each serving as a unique facet of the overarching innovation:

1.2.1. At the heart of novel approach relies on distributed storage, using advanced technologies such as the Interplanetary File System (IPFS). This approach breaks images into smaller pieces and spreads them over a network of connected nodes, ensuring both backup and constant availability, even if some nodes go offline.

1.2.2. This framework incorporates blockchain technology to provide a crucial layer of ownership and origin. Each image links to a unique token, which confirms its authenticity and creates a secure basis for transactions, licensing, and royalty management.

1.2.3. Creating a peer-to-peer network is Another innovative step is creating a peer-to-peer network, which allows users to exchange images directly. This reduces dependence on centralized servers and intermediaries, offering a faster and more secure sharing environment.

1.2.4. To improve identity management in this decentralized system, the use of Decentralized Identifiers (DIDs) has been identified as an inventive solution. DIDs act as the cornerstone of verifiable, self-sovereign digital identities, enabling users to easily manage their images and access controls. The use of smart contracts on blockchain platforms, such as Ethereum, automates various image-related processes, from licensing agreements to payments and access control, all driven by predefined terms.

1.2.5. The inventive application of content addressing methods, such as hash-based addressing, surpasses traditional URL-based identification. This immutability and simplicity of verification further strengthen the system's integrity.

1.2.6. Privacy and security are of utmost importance in this paradigm, and end-to-end encryption plays a key role. Only those who have the decryption key can access the images, reducing unauthorized viewing risks. Choosing the suitable consensus mechanisms is a strategic decision, whether it be Proof of Stake or Proof of Work. These mechanisms validate transactions and ensure network security.

1.2.7. Along with these technical innovations, user-friendly interfaces and applications have been carefully designed to simplify the user experience, thus expanding the system's appeal to a wider, non-technical audience.

The establishment of a decentralized governance model, where network participants agree on protocol upgrades, feature improvements, and rule changes, is essential for sustainable growth. Addressing scalability challenges is a fundamental component, with the exploration of layer 2 solutions and other techniques to accommodate the ever-increasing number of images and users. Moreover, educating users about the benefits of this decentralized system and helping them transition to it is vital. This educational effort highlights the enhanced security, control, and data ownership associated with the system.

2. Methodology

We have designed and developed a novel decentralized image sharing platform that integrates various components, using the latest technologies such as React.js, Solidity, IPFS, and Ethereum smart contracts. Our design philosophy is based on a user oriented React.js frontend, carefully designed to provide a lively and user-friendly interface, increasing user involvement and creating familiarity. The flexibility and speed of React.js enable a visually attractive and adaptive environment, ultimately enhancing the user experience. For image storage, we use the Interplanetary File System (IPFS), which provides a decentralized and peer-to-peer protocol for image storage and sharing, solving problems of centralization, data duplication, and permanence. IPFS stores images as unique cryptographic hashes, spreading them over multiple nodes, improving storage and ensuring immutability. Our system also employs Ethereum smart contracts to enable image-related transactions, adding an extra layer of immutability and transparency. These transactions and image references are safely stored within the Ethereum blockchain, ensuring continuous availability and reducing risks associated with centralized storage. Image retrieval is done through a dual mechanism: querying the IPFS network or using Ethereum smart contracts. All image-related transactions are recorded on the Ethereum blockchain for improved transparency and security. In summary, our decentralized image sharing platform combines React.js, Solidity, IPFS, and Ethereum smart contracts to offer a secure and user-focused experience, transforming image sharing through decentralization, transparency, and resilience.

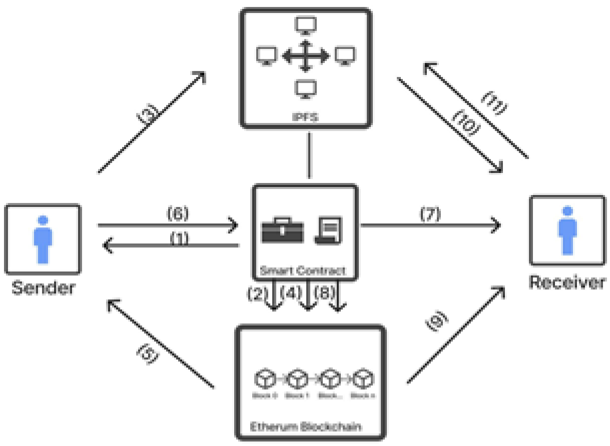

Fig. 1. Flowchart of Methodology

(1) The sender's identity is verified through a smart contract.

(2) After the user's authentication has been verified by the smart contract, a new user block is appended to the blockchain.

(3) The sender proceeds to upload a file onto the Interplanetary File System (IPFS).

(4) Upon successful storage of the file, IPFS generates a cryptographic hash key. This key is cross-referenced

with trusted sources before being added to the blockchain; this verification is carried out by the Smart Contract.

(5) The cryptographic hash key, representing the uploaded file, is now accessible to the sender via the blockchain.

(6) To initiate the file transmission process, the user provides the recipient's ether account address (public key).

(7) The smart contract verifies the authenticity of the specified recipient.

(8) The Smart Contract ensures the safe preservation of the cryptographic hash key within the recipient's designated blockchain block.

(9) Authenticated recipients receive the hash key, which has been transmitted by the sender.

(10) The recipient subsequently makes a request to IPFS for a specific file.

(11) Access to the file is granted solely to the recipient whose private key pair matches the public key employed to encrypt the file during its transmission.

2.1. User Interaction and React.js Frontend

The React.js frontend embodies our platform's user-centric design philosophy. As the first point of contact between users and the system, this part is essential. Its dynamic and user-friendly interface makes the user feel comfortable and at ease, which improves the user experience as a whole. We guarantee that users can access an environment that is both aesthetically pleasing and incredibly responsive by utilizing React.js's versatility and speed. This part serves as the vital link that connects users to the decentralized picture-sharing network.

2.2. Image Storage on IPFS

A Paradigm shift in the sharing and storing of images is brought about by the Interplanetary File System (IPFS) image storage procedure. It overcomes the problems with conventional centralization, data redundancy, and data permanence by utilizing a decentralized and peer-to-peer protocol. Within a distributed file system, IPFS creates a decentralized, content-addressable system for distributing hypermedia. It accomplishes this by employing a network of nodes, each of which holds versioned, hashed blocks that stand in for distinct files and data. A unique cryptographic hash (CID) is generated by content hashing, which is applied to images added to IPFS. The image is uniquely identified by this CID throughout the IPFS network. Images are divided into smaller pieces and distributed among several nodes in the decentralized storage system. To ensure redundancy and lower the risk of data loss, images are stored decentralized by being divided into smaller chunks and dispersed among several nodes within the IPFS network. IPFS uses deduplication techniques to store identical content only once, maximizing storage capacity and network bandwidth. Moreover, content on IPFS is treated as immutable, which means that once an image is added, it cannot be changed without creating a new hash. The preservation of historical data is guaranteed by this versioning system. Even in cases where node locations change, the IPFS network uses their cryptographic hashes to retrieve the relevant blocks when an image request is made. This guarantees picture retrieval without hiccups. IPFS basically fixes the shortcomings of image storage by making it a decentralized, safe, and extremely effective process.

2.3. Smart Contracts and Solidity

The core functionality of our platform is built upon Ethereum smart contracts. These self-executing contracts serve as middlemen for all image-related transactions and are driven by the Solidity programming language. They are essential to maintaining the system's dependability, security, and transparency. A distinct hash is created each time a user starts an image upload transaction. This hash is then stored on the Ethereum blockchain, providing an extra degree of immutability to image transactions, and it is closely connected to the uploaded image. Image sharing takes on a new dimension thanks to Ethereum smart contracts, which also improve security and transparency.

2.4. Decentralized Database and Ethereum Blockchain

Our platform leverages blockchain technology, especially the Ethereum blockchain, to achieve data immutability and accessibility. The Ethereum blockchain securely stores the IPFS hashes and the related metadata. This decentralized and distributed database design ensures that the image references are always available, minimizing the risks of centralized data storage and enabling easy retrieval. By combining IPFS and Ethereum, we create a harmonious environment where decentralized image storage and distributed, immutable databases coexist, ensuring image availability in the long run.

Table 2. System Comparative Analysis

Section	Component	Description	Key Benefits
Proposed Methodology	Technologies Used	Utilizes React.js, Solidity, IPFS, and Ethereum smart contracts for a decentralized image-sharing platform.	Integration of modern, robust technologies.
React.js Frontend	User Interface	Offers dynamic and intuitive interface for user engagement and familiarity. Improved user experience, responsiveness, and visual appeal.	User-Centric Design
Image Storage on IPFS	Decentralized Storage	Utilizes IPFS for decentralized, content-addressable image storage. Addresses centralization, redundancy, and permanence issues.	Distributed and secure image storage, data optimization, and immutability.
Smart Contracts and Solidity	Intermediary for Transactions	Employs Ethereum smart contracts to facilitate image-related transactions. Ensures transparency and security.	Enhanced security and transparency in image transactions.
Decentralized Database and Ethereum Blockchain	Data Immutability and Accessibility	Embeds IPFS hashes and metadata securely within the Ethereum blockchain. Ensures perpetual image reference availability and mitigates centralized storage risks.	Immutable data storage and long-term image availability.
Dual Image Retrieval Mechanisms	Flexible Retrieval Options	Offers two retrieval methods: direct IPFS query and Ethereum smart contracts. Provides user flexibility.	Diverse image retrieval options for user convenience.
Transaction Logging on Ethereum Blockchain	Transparency and Accountability	Logs all image-related transactions on the Ethereum blockchain. Enhances trust and accountability.	Traceable and tamper-proof transaction history.

3. Simulation Framework

Decentralized Image Sharing Simulation Framework: We have developed a specialized simulation framework to perform a comprehensive analysis and evaluation of the proposed decentralized image sharing platform. This simulation framework uses advanced technologies and software tools to simulate the decentralized environment and its interactions. The main components of this simulation setup are: Blockchain Simulation: We use blockchain simulation software to mimic the blockchain network's operations and functions. This allows us to assess the platform's performance, scalability, and consensus mechanisms under various conditions and network loads.

IPFS Emulation: We use an IPFS emulation tool to simulate the Interplanetary File System's behaviour. This enables us to examine how image data is distributed, stored, and retrieved across the simulated decentralized network.

Smart Contract Testing: We use smart contract testing frameworks to test the functionality and security of the Ethereum smart contracts used within the platform. This helps us to verify the integrity and reliability of the image-related processes controlled by these contracts.

User Interaction Simulation: We use user behaviour modeling and simulation tools to measure user experience and interaction. This component helps us to understand how users interact with the platform, including image uploads, retrievals, and sharing.

Scalability Analysis: We use load testing and scaling tools to measure the platform's capacity to handle a growing number of users and images. This helps us to identify potential bottlenecks and scalability issues.

Latency and Speed Evaluation: We use network simulation tools to measure the latency and speed of image uploads and retrievals. This enables us to analyze the impact of consensus mechanisms on the platform's performance.

Energy Consumption Assessment: We use energy consumption models to estimate the environmental impact of the platform, considering different consensus mechanisms and network configurations.

User Experience and Adoption Testing: We conduct user testing and surveys to evaluate the platform's user-friendliness and adoption potential. This feedback is essential for improving the user interface and accessibility.

Security and Privacy Analysis: We use specialized security assessment tools to identify vulnerabilities and assess the platform's resilience to potential attacks, ensuring robust data privacy and protection.

4. Result and Analysis

The results and analysis of our research reveal a transformative approach that extends well beyond traditional image management. We embark on a pioneering journey to reshape the digital image landscape through decentralized technologies like blockchain and IPFS, ushering in a new era within the field.

Our innovation finds substantial application in the realm of digital art, empowering artists and creators to assert their ownership rights, protect their digital creations, and efficiently manage royalties. With the use of blockchain-based provenance, our contribution extends to the domains of digital art and intellectual property, promising significant advancements in safeguarding creative expressions.

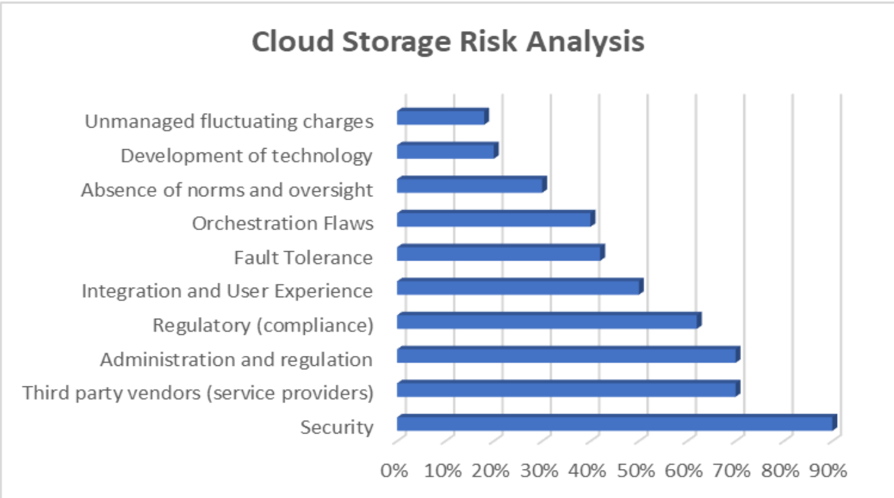

Fig. 2. Volume Sharing Data on Centralized and Decentralized

Table 3. Ability and Data of Sharing

Ability	Data	
Degree of information sharing	Detailed	Limited
Communication overload	High	Low
Association	Possible	Possible
Unfair decision	No	Possible
Transparency	Low	High
Reliability	Low	High
Scalability	Low	High
Complement confusion	Low	High

Table 4. Acceptance Result on Transformation

Image	HASH (Hexadecimal)	Hamming Distance	Dissimilarity (NHD)	Acceptance result
image.png	a938f9fad3120d0d	-	-	Accepted
image rot5.png	363cfaad3220d14	12	0.158	Rejected
image rot25.png	347476faf2da2608	26	0.374	Rejected
image rot90.png	cb1f3f37ceff078b8	32	0.466	Accepted
image exp-50.png	a938f9fad3120d0d	0	0	Rejected
image sat+50.png	e938f9da93160d0d	2	0.031	Rejected

Table 5. Different Instances

Instances	Minutes	Maximums	Averages
Recently generated content	0.366	348	54.4
Cached content	0.0845	0.549	0.114
inaccessible content identifier	92	342	276

Table 6. Protocols

Data storage system	Informatio n structure	Network protocol suite	Identifier	Address compositio n	Application s	Similarity to IPFS	Hashing method
Distributed file-sharing protocols	Merkle Directed Acyclic Graph (DAG)	Transmission Control Protocol/Intern et Protocol	Peer-to-peer file distributio n file	filename + SHA-1	Data exchange	Inferior	SHA-256
Distributed data disseminatio n	Merkle Directed Acyclic Graph (DAG)	User Datagram Protocol	Cipher identifier	Cipher identifier	decentralize d data sharing	intermediar y	SHA-256
Revision management	Revision chronicle	Transmission Control Protocol/Intern et Protocol	Version control hash	Version control hash	Revision control hash	intermediar y	SHA-1, SHA-256
Distributed social networking platform	Immutable transaction log	Scuttlebutt Communicatio n Protocol	Content stream identifier	Content stream identifier	Distributed social network	Elevated	SHA-256

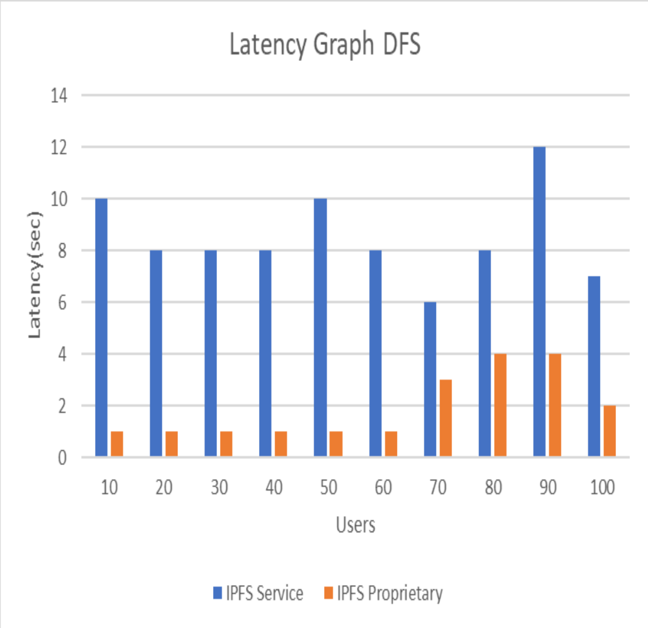

Fig. 8. Latency on Decentralized File Storage

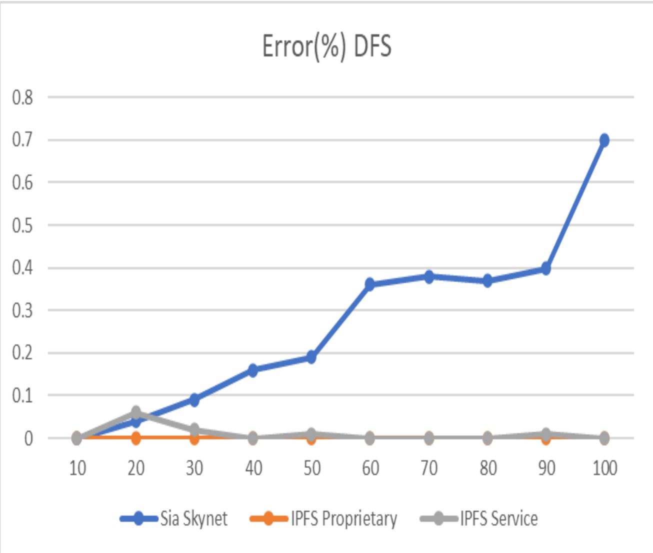

Fig. 9. Error Graph DFS

In our decentralized platform offers a ray of hope for regions where severe censorship limits content access. Our impact goes beyond traditional content distribution, making a substantial contribution to the domains of content freedom and censorship resistance.

We equip photographers, artists, and creators with direct monetization opportunities, transforming the landscape of content monetization. This endeavour reshapes the digital content monetization sphere, providing a new model for those who create and share their work in the digital realm.

Our platform crosses boundaries to become a global collaboration hub, enabling trust-less and borderless creative collaborations. By creating an environment that facilitates cross-border sharing and collaborative work, we redefine international collaboration within the field, fostering innovation and creativity on a global scale.

We embrace decentralized distribution with the paramount goal of preserving cultural heritage. We play a crucial role in protecting historical and cultural images, making a significant contribution to the preservation and accessibility of priceless visual records, enriching the field of cultural preservation.

We introduce a privacy-centric alternative in the realm of social media, redefining user data privacy and influencing the direction of social media practices. Our innovative approach within this field ensures users enhanced data privacy and control, changing the course of social media practices for the better.

We act as an innovation catalyst, encouraging developers to explore new territories, creating novel applications, tools, and marketplaces within our ecosystem. This pioneering spirit redefines the landscape of decentralized image sharing, placing us at the forefront of innovation within the field.

Our platform leverages blockchain's inherent qualities to ensure transparency and verifiability, which are at the core of our platform. Our platform ensures the authenticity of images, reducing vulnerability to counterfeit or manipulated visuals. This groundbreaking advancement enhances the field's capabilities in image authenticity and verification.

We embark on the mission of challenging the dominance of centralized tech giants by offering user-centric alternatives. Our efforts redefine the digital landscape, prioritizing individual rights and needs, making a significant impact within the field of digital technology governance. In essence, our research ventures into uncharted territories within the field of decentralized image sharing, addressing key challenges and unlocking new opportunities. We leave a profound impact on various facets, including digital art, content freedom, monetization, cross-border collaboration, cultural preservation, data privacy, innovation, image authenticity, and digital governance, ushering in a new era of possibilities and potential within the field.

4.1. Limitation

4.1.1. Scalability: Blockchain technology, while providing the advantages of decentralization, faces challenges in scaling to meet the growing needs of users and their storage demands. As more users join the network, the processing and storage requirements for maintaining the blockchain may increase significantly. Addressing these scalability issues will be crucial to ensure that the platform remains available and efficient for a wider audience of users.

4.1.2. Speed and Latency: Blockchains inherently require consensus mechanisms that can cause latency, affecting the speed of file uploads, accesses, and shares. This latency can be a significant disadvantage when compared to centralized cloud storage solutions that offer faster data transfers. To improve the user experience and competitiveness of the platform, addressing speed and latency issues will be very important.

4.1.3. Energy Consumption: The energy-intensive nature of many blockchain networks, especially those that rely on proof-of-work consensus, raises concerns about their environmental impact. The computational requirements for mining and network maintenance lead to high energy consumption. As sustainability becomes an increasingly important consideration, reducing the energy footprint of the Decentralize Image Sharing project should be a priority for future development.

4.1.4. User Experience: The inherent complexity of blockchain technology may present a significant learning curve, especially for users who are not familiar with its workings. This learning curve could potentially hinder adoption, especially among non-technical users who may find the platform less intuitive. Streamlining the user experience and simplifying interactions with blockchain elements will be key in expanding the project's user base and accessibility.

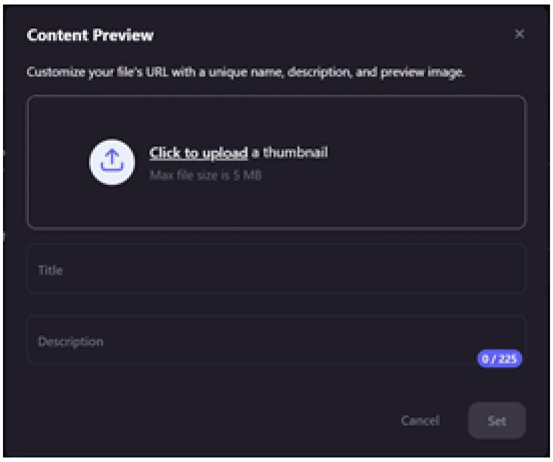

Fig. 10. Content Preview

Fig. 11. Stored Image

4.2. Case Study

A possible case study could involve a group of photographers who want to use the Decentralize Image Sharing platform to store and share their high-resolution images securely. They appreciate the decentralized nature of the research, which ensures that their creative works remain under their control. However, they may also face slower upload times and occasional delays when accessing their files, especially during times of high network congestion.

5. Conclusion and Future Scope

The Decentralize Image Sharing Project offers a promising solution for users seeking greater control and security over their cloud storage. By leveraging blockchain technology, it decentralizes the storage network, reducing the reliance on a single provider and enhancing data privacy. However, certain limitations, such as scalability and energy consumption, should be carefully addressed to ensure a seamless user experience and wider adoption.

Table 7. Research Directions

Application	Education	Healthcare	Industry	Agriculture	Travel and Transport	Commerce
Purpose	The purpose of education in decentralized image sharing is to empower individuals with the knowledge and skills to participate in peer-to-peer networks securely and ethically, fostering user autonomy and data sovereignty.	The purpose of healthcare in decentralized image sharing is to ensure the privacy, security, and interoperability of medical images within decentralized networks, facilitating efficient and patient-centered healthcare delivery.	The purpose of industry in decentralized image sharing is to leverage blockchain and decentralized technologies to streamline image management, enhance data integrity, and foster collaboration across diverse sectors, including healthcare, media, and beyond.	The purpose of agriculture in decentralized image sharing is to enable farmers to efficiently share and access agricultural imagery and data for informed decision-making and sustainable practices.	The purpose of travel and transport in decentralized image sharing is to enhance the transparency and efficiency of logistics and passenger services through decentralized networks, improving safety, tracking, and customer experience.	The purpose of Ecommerce (Transactional Commerce) in decentralized image sharing is to enable seamless, trust less, and secure image-related transactions, such as image licensing, purchasing, and trading, within a decentralized ecosystem.
Challenges	Ensuring content quality, privacy, and moderation in a decentralized image-sharing platform poses significant challenges.	Interoperability and data security concerns in decentralized image sharing in healthcare.	One challenge of decentralized image sharing is ensuring data privacy and security while maintaining efficient access and distribution.	Challenges of Agriculture in Decentralized Image Sharing: Ensuring data privacy and security while maintaining accessibility and usability.	Ensuring efficient and secure image sharing across decentralized networks while maintaining user privacy and data integrity.	Ensuring content ownership and copyright protection in decentralized image sharing.
Research Opportunities	Research opportunities in decentralized image sharing in education include investigating the impact on student collaboration, privacy, and data ownership within distributed networks.	Research opportunities in decentralized image sharing in healthcare include optimizing security, privacy, and interoperability to enhance collaborative diagnostics and patient care.	Exploring blockchain-based solutions for secure and transparent decentralized image sharing in the photography and media industry.	Exploring the potential of decentralized image sharing platforms to enhance agricultural research and knowledge dissemination.	Research opportunities in decentralized image sharing could focus on optimizing data transmission, privacy preservation, and network efficiency for a more sustainable and user-centric travel and transport experience.	Exploring blockchain technology for secure and transparent copyright management in decentralized image sharing platforms.

Scalability	The scalability of education in decentralized image sharing relies on efficient peer-to-peer networks and decentralized storage solutions to accommodate a growing user base.	Scalability of healthcare in decentralized image sharing enhances data accessibility and collaboration across a growing network of providers and patients.	The scalability of decentralized image sharing relies on distributed networks to efficiently handle increasing user activity and data volume.	Scalability of agriculture in decentralized image sharing can enhance knowledge dissemination and collaboration among farmers.	The scalability of travel and transport in decentralized image sharing depends on the efficiency of distributed networks and infrastructure.	The scalability of commerce in decentralized image sharing relies on efficient blockchain technology and decentralized storage solutions to handle a growing user base and transaction volume.

Conflicts of interest

The authors declare no conflicts of interest.

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