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Blockchain-Powered Framework for Secure Tamper-Proof and Decentralized Communication in Social Media Platforms

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***Abstract*— The research leverages Ethereum blockchain to create a decentralized social media platform that enhances privacy and data security. Smart contract and DApp records users all actions like posting, liking and following on an immutable ledger guaranteeing transparent, secure as well as tamper proof user interaction within platform. The propose system uses blockchain to give users full control over their personal data ensuring privacy. Users engage with system via cryptographic wallets enabling secure authenticated transactions and interaction across decentralised network. The setup ensures privacy and restores data ownership to users empowering them to autonomously control, manage as well as protect user's digital identities on the platform. The proposed system resolves scalability challenges in decentralized networks while ensuring a responsive and intuitive user experience comparable to conventional social media platforms. The integration of technologies such as React and Django establishes a robust, scalable infrastructure capable of real-time data processing. This architecture ensures a seamless and responsive user interface, catering effectively to both beginner and experienced blockchain users**

***Index Terms*— Ethereum, Decentralise, Social Media Platform, Cryptographic Wallet, Scalability.**

I. INTRODUCTION

Social media refers to "digital platforms and tools" that allow users to create, share, and interact with content and connect with other users. These platforms typically enable individuals to post updates, share multimedia, comment, and engage with other users' content. Popular examples include "Facebook", "Instagram", "Twitter", and "LinkedIn". The main goal of social media is to facilitate communication and interaction, whether it's between friends, communities, brands, or public figures. Over time, it has become an essential part of daily life, influencing everything from personal relationships to business marketing and news dissemination. Social media serves several important needs, both for individuals and businesses, like publicity, marking, connectivity, community building, Education and Learning, Entertainment, Social Growth and awareness etc.

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The increase of fake and malicious news on various social media has significant societal implications. It ranges from defamation and interference to inciting violence. The AI era gives the benefits of text analysis as well the machine leaning techniques gave advance fake news detection but the problem of identifying the originators of such contents remain a critical challenge.

The time stamp is one of the crucial factor in proving originality of content. Content originators identification can be resolved using blockchain technology. The blockchain technology facilitates the content tampering and data transparency [1]. Blockchain uses cryptographic algorithm for ensuring data integrity and which make impossible to alter information once recorded.

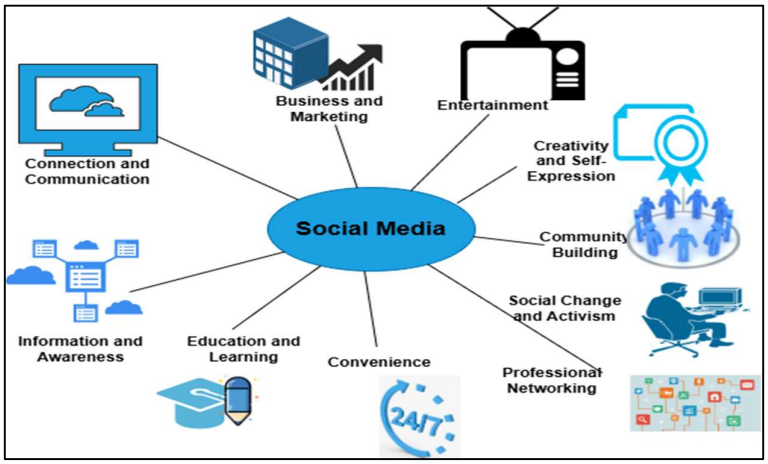

Figure1: Uses of Social Media

TABLE I: COMPARISON OF CENTRALISED SOCIAL MEDIA WITH DECENTRALISED SOCIAL MEDIA

Feature	Centralized Social Media	Decentralized Social Media
Data Ownership	Users cede ownership of their data to the platform.	Users own and control their data.
Data Security	Vulnerable to breaches and unauthorized access by the platform or third parties.	Blockchain technology offers enhanced security and immutability of data.
User Privacy	Limited control over user data and privacy settings.	Users have greater control over privacy settings and how their data is used.
Transparency & Trust	Platform algorithms and content moderation are opaque.	Transparent and verifiable due to the public nature of blockchain ledgers.
Content Moderation	Centralized control over content, potentially leading to censorship.	Community-driven or algorithmic moderation with more user control.
Financial Incentives	Limited options for users to monetize content or participation.	Potential for users to earn rewards through cryptocurrency or tokens.
Scalability	Highly scalable infrastructure managed by the platform.	Potential scalability challenges depending on the chosen blockchain technology.
User Engagement	Focus on user engagement metrics that may not necessarily benefit users.	Potential for increased user engagement due to a sense of community and ownership.

Blockchain enhances social media data security by offering decentralized, tamper-proof storage, ensuring data integrity and transparency. It allows users to control access and ownership through cryptographic protocols and smart contracts, mitigating data breaches and identity theft. This fosters a more secure, user-centric digital environment [2]. Privacy remain a serious concern when dealing with data on social media platforms, to address such issues recent research has advanced by integrating artificial intelligence with blockchain technology [3] this allows users to seamlessly connect their digital wallets and interact by posting text, audio clips, photos with greater assurance of data security and privacy. Every user interaction, including content sharing, commenting, liking as well as following is transparently processed and immutably recorded on blockchain. This research not only safeguard against data breaches but also fosters a transparent and equitable environment empowering users with full control over their personal data.

The motivation behind propose research start from the undeniable role social media plays in shaping global communication now a day. Platform has become integral to how people connect, share, and express themselves, their centralized nature raises continuous concerns around privacy, data security, and censorship. Centralized data storage creates single points of failure, making user information vulnerable to unauthorized access and

misuse. The growing public awareness of these risks, decentralized technologies particularly blockchain offers a timely and powerful alternative, shifting control from businesses to users, blockchain promotes “transparency”, “security”.

Propose research aims to explore how integrating blockchain into social media can create a more secure, privacy respecting as well as user-driven environment, where individuals can engage freely and safely, without sacrificing control over their personal data.

To carry out the research work following objectives has been finalised.

- Leverage blockchain's decentralization to safeguard user data against unauthorized access and breaches.
- Grant users complete control over their data and content, promoting autonomy and active participation within the platform.
- Ensure all transactions and interactions are transparently recorded on the blockchain, fostering accountability and trust.
- Facilitate a secure space for users to express themselves freely and engage in open dialogues without privacy concerns.

The research article has been organised as, Section-I gives the introduction and need of the research with motivation as well as objectives. Section-II discussed study of various existing systems with similar functionalities, identifying areas where improvements can be made. Section-III elaborate on the proposed system and outlines its implementation strategy. Section-IV is dedicated to the presentation and discussion of experimental results V and VI is about result discussion and observations respectively. The concluding remarks and key takeaways of the research are outlined in section VII.

II. Literature Review

In the realm of social media, the current landscape is dominated by centralized platforms. These platforms act as gatekeepers, controlling user data, content moderation, and user interactions. Their functionality and policies vary depending on their own internal structures and regional regulations.

The existing research reflect a wide scope of research the intersection of blockchain and decentralised social media. The authors in [4] and [5] proposed system using Ethereum and and smart contract for user interaction and IPFS for decentralized file storage, which addresses tamper proof data publishing. The latter offers a more modular architecture and extensibility, although it falls short on filtering fake or misleading contents.

In addition to infrastructure focused solution [6] and [7] explored the integration of artificial intelligence and blockchain technology to enhance the authenticity verification of social media content. These approach employed AI bases classifiers to identity misleading information and utilised blockchain ledger for securely anchor content validation. In spite of innovative methodology , the reliance on centralised moderation mechanism & the high computational demands pose significant challenges to achieve full decentralization. Pushing boundaries further the authors in [8] applied blockchain to trace deepfake contents which add another dimension to media integrity. This research highly relevant in visual misinformation, but it may suffer latency issues for real time social network.

The authors in [9] provided a structured framework which benchmarks blockchain based social media DApps across multiple dimensions whereas [10] contributed insights on platform selection , revealing that while NEAR may be cheaper. Ethereum still dominated adoption due to ecosystem maturity. The authors in [11] proposed a novel social network which is built on blockchain offering secure and transparent environment for online interaction. This also offers various future direction for development like creation of more efficient consensus algorithm, privacy enhancing technology.

Gap Identified:

- User Accessibility and Engagement: One significant gap in existing decentralized social media platforms is the complexity of their user interfaces and interaction models, which often deter less tech-savvy users.
- Real-Time Performance and Scalability: Another critical gap is the limited scalability and slower transaction times commonly associated with blockchain applications.

III. Proposed Modelling

Propose system represents a ground breaking step forward in the evolution of social media, harnessing the power of decentralized technology to significantly enhance user privacy and security. Social media platforms have changed the way people talk to each other and share information in big ways. These platforms have some good points, but their centralised structure makes them inherently flawed and puts users' privacy and security at risk,

because they serve as single points of failure, centralised servers are vulnerable to illegal data access and cyberattacks. Additionally, platform providers may abuse user data and violate privacy rights due to this centralised control. In centralised platforms there is lack of transparency in data and contents management which further complicates issues leading to biased content moderation and censorship.
The propose system addresses these challenges by using blockchain technology for decentralised data management, enhancing the user trust and protection digital rights in a more equitable and secure digital environment.
The propose system presents a novel system intended to address the issues of user accessibility, real-time performance, and comprehensive privacy control in response to the gaps found in the current context of decentralised social media platforms. propose system makes use of state-of-the-art blockchain technology to develop a decentralised platform that is user friendly and scalable and guaranteeing strong security and privacy while preserving usability on par with conventional social media platforms. The architecture creates a smooth and interesting user experience by integrating "Ethereum Blockchain," Hardhat for setting up a local blockchain environment, Django for backend functions, and React for a dynamic frontend.
The architecture, technology stack, and functional capabilities of the system that work together to create a more secure, responsive, and inclusive social media environment will be covered in detail in this section.

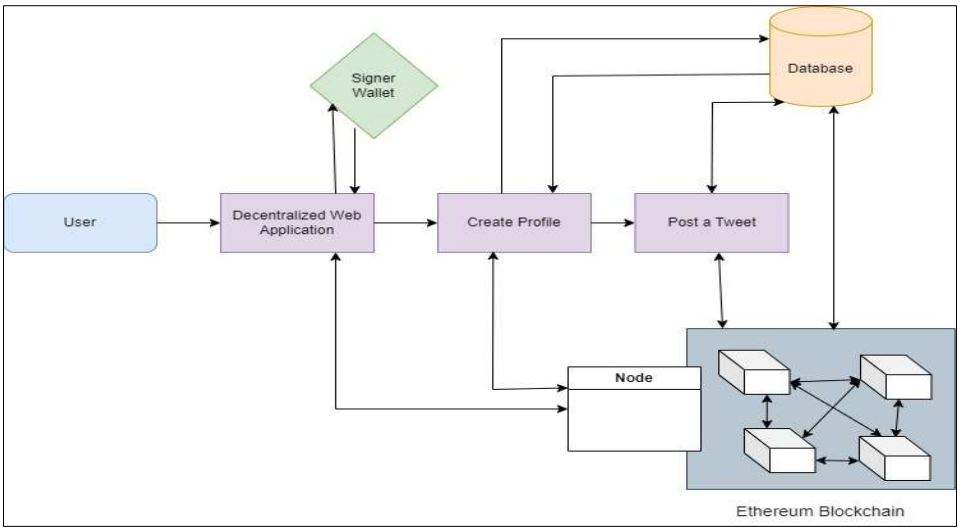

Figure 2. Propose System Architecture

The propose system architecture is built to make the most of decentralised technologies while also making sure that security, user control, scalability are all very strong. This architecture fetches organized different parts that work together flawlessly to make blockchain social media safe and easy to use. The “Ethereum blockchain” is at the heart of architecture. It works with a complex front-end decentralised web application and a back-end database system to make sure that all operations are clear, unchangeable, and safe.
Proposed system workflow:
User “Ceates a Profile” via the “Decentralised Web Application”, the proposed system's workflow starts. In order to safely record the user's information, this action uses the “Signer Wallet” to start a transaction on the “Ethereum Blockchain”. Users can “Post Tweets” transactions signed by their wallets and recorded on the blockchain after registering, guaranteeing that all posts are permanently stored and impenetrable.
Every interaction a user has with the platform whether it be liking posts, leaving comments on existing ones, or creating new tweets is handled as a transaction on the Ethereum blockchain. In addition to protecting user data, this maintains an open and verifiable log of all platform activity.
In order to overcome the drawbacks of conventional social media platforms, this architecture prioritises user privacy, data integrity, and decentralisation while guaranteeing an efficient operation.

IV. Implementation Details

The various components of propose system are discussing in this section

A. Components

- Ethereum Blockchain: The Ethereum blockchain, which forms the foundation of the platform controls all important user interactions and data transactions. It guarantees the application's decentralisation, security and data integrity.
- Signer Wallet: Users engage with the proposed system platform through their personal digital wallets which act as secure blockchain signatures for interactions and transactions, guaranteeing non-repudiation aa well as authenticity.
- Database: To improve performance and lower transaction costs, non-blockchain data, like user preferences and cached content is stored in a dedicated database offering a compromise between decentralised and conventional web technologies.
- User Nodes: Providing a distributed and robust network structure, every user on the platform functions as a node with the ability to send and receive data straight from the blockchain.
- 5)Decentralized Web Application: React was used in the development of the front-end application, which offers a dynamic and responsive user interface that communicates with the Ethereum blockchain through Web3.js. With this configuration, users can easily interact with one another, post tweets, and create profiles.
- Smart Contracts: The Ethereum blockchain's smart contracts handle the main data interactions and transactions. Because of the immutability of blockchain technology, these contracts guarantee data security and integrity by storing crucial transaction data like timestamps, interactions with users, and content references.
- Storage:
  Blockchain-based Storage:
  Ethereum Blockchain: The Ethereum blockchain stores transaction logs, post metadata, and user profile data directly. In addition to offering security and transparency, this method makes data verifiable and impenetrable, which are essential components of a decentralised social media platform.
  Decentralized File Storage:
  IPFS (InterPlanetary File System): Using IPFS for decentralised file storage is necessary because large files, like pictures and videos, must be stored effectively. Large data blocks can be safely stored and addressed thanks to IPFS, which is incorporated into the platform's architecture. By using distinct hashes to refer to files stored on IPFS in the Ethereum blockchain, the content is distributed and accessible from any network node, improving availability and redundancy.

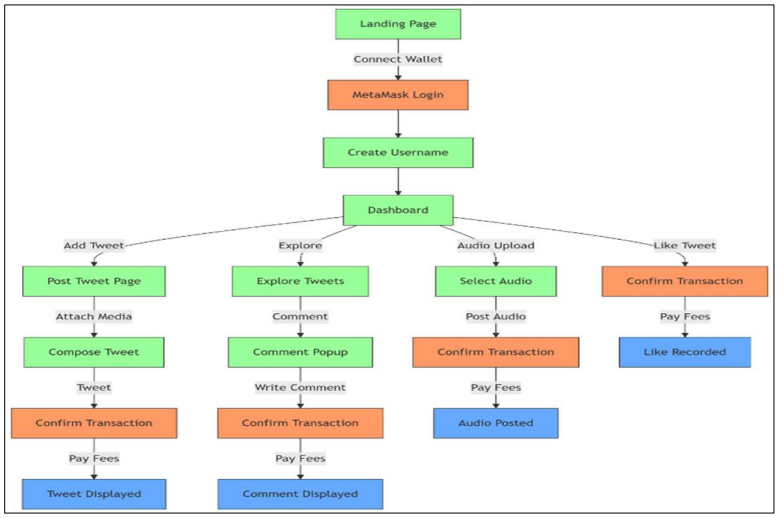

Figure 3: Implementation of propose system.

V. RESULTS AND DISCUSSION

- User Empowerment & Data Control: The proposed system gives users ownership and control over their data, in contrast to centralised platforms. This promotes privacy and gives users control over how their data is used.

- Enhanced Security & Transparency: The proposed system is strengthened by blockchain technology, which provides an unchangeable and transparent ledger for user interactions. By reducing data breaches and guaranteeing information authenticity, this improves security.
- Community Building & Engagement: A greater sense of community can be fostered by decentralisation. In addition to having more influence over content moderation, users might gain from a more cooperative setting.
- Monetization Opportunities: Allow users to earn rewards or cryptocurrency for their content or contributions, potentially creating new revenue streams for users.
- Reduce Censorship and Free Speech: Compared to centralised platforms, the decentralised nature of the suggested system may result in less censorship. While effective content moderation solutions might still be required, this could result in a more diverse and open online environment.
- Resistance to Takedowns and Downtime: Content removal and outages are possible on centralised platforms. The suggested system, which is based on a decentralised network, may be more resilient to outages and takedowns, guaranteeing increased accessibility and user control over the lifespan of content.
- Algorithmic Transparency and Fairness: Content feeds are curated by centralised platforms using "opaque" algorithms, which may introduce bias. A more equitable and user-driven content experience could be promoted by the proposed system's exploration of transparent or user-customizable algorithms.

TABLE III: COMPARISON OF PROPOSED SYSTEM WITH EXISTING SYSTEM

Sr. No.	Parameters	Propose System	Existing System
1	User Accessibility & UI/UX	React-based frontend with Django backend offering seamless user experience, targets non-tech-savvy users.	Many systems lack mainstream-ready UI or require deep tech knowledge [1],[2]
2	Content Integrity and Timestamping	Includes time-stamping for every interaction, aiding origin tracing and verifying authorship essential for combating misinformation.	Mentioned conceptually in [3] but not practically integrated.
3	Hybrid Architecture	Combines blockchain for security and off-chain DB for scalability (e.g., preferences, cache). Balances decentralization and performance.	Others often store everything on-chain or IPFS, causing latency and cost issues [4], [5]
4	Full Decentralization and Data Control	Users are nodes; all actions signed via MetaMask (wallet). True self-sovereignty over data and identity.	Systems like [1],[1] often use central moderators or private blockchains, compromising decentralization.
5	End-to-End Features Integration	Integrated tweeting, commenting, liking, media upload, and blockchain interactions tested end-to-end.	Others usually focus on specific components like posting or commenting only [5]
6	AI & Misinformation Handling	Conceptually discusses future integration with AI-based filtering and blockchain validation.	Focused on this but lacks UI integration or user-side control.
7	Transparent Smart Contract Ledger	All actions immutable and verifiable on-chain; interactions are logged and trustless.	Partial support in limited logging.
8	Academic & Practical Fusion	Combines strong theoretical foundation with a real, working prototype suitable for research, education, or deployment.	Several papers stay conceptual or only prototype one layer (only benchmarks fees).

VI. OBSERVATIONS

Forming a decentralised social media platform has numerous benefits.

- Potential for Increased Efficiency and Scalability: Automated Content Moderation: Content moderation activities, such as removing spam or enforcing community rules, can be automated with smart contracts. This simplifies the procedure and lessens the need for human moderators.
  Decentralised Data Storage: While core data for verification (like account ownership) may be kept on the blockchain for scalability and security, user data and content that needs frequent access may be kept off-chain.
- Enhanced Security and Transparency: Immutable Content Record: Blockchain guarantees that user posts and interactions are unchangeable. By keeping historical data from being censored or altered, this promotes trust.
  Secure Communication Channels: The suggested system can use group chats or direct messaging via secure communication channels made possible by smart contracts. This reduces the likelihood of a data breach and safeguards user privacy.
- Challenges in Balancing Privacy and Accessibility: Off-chain vs. On-Chain Data Management: It's critical to find a balance between off-chain and on-chain data storage. Large user profiles must be stored off-chain

due to storage constraints, even though on-chain data provides immutability. To protect this data, strong encryption and access controls are necessary.

Adherence to Regulations: The suggested system must comply with local data privacy laws. The platform's architecture must guarantee adherence to the legal frameworks controlling online content and user data.

- Importance of Building User Trust and Awareness:

  User Education and Transparency: To establish trust, extensive user education is essential. User adoption requires openness about user control systems, content moderation guidelines, and data security.

  Resolving Algorithmic Bias: The suggested system may investigate transparent or user-adaptable content curation algorithms. This aids in addressing possible biases found in centralised platforms' opaque algorithms.
- Vulnerability Analysis: The smart contract is the subject of the vulnerability analysis.

  Three main categories are established: 1. Logical bugs: This includes missing checks and unbalanced braces. 2. Security concerns: it addresses the absence of access control 3. Inefficiencies in gas and storage: it includes redundant data structures

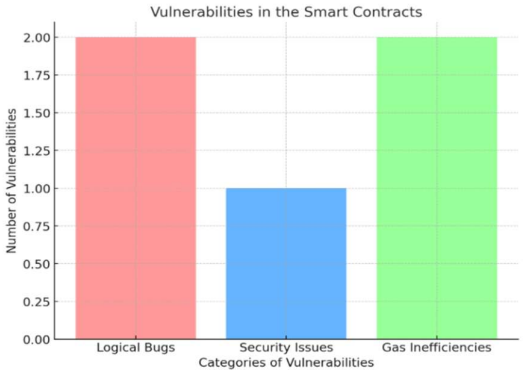

Figure 4: Vulnerabilities in the smart contract

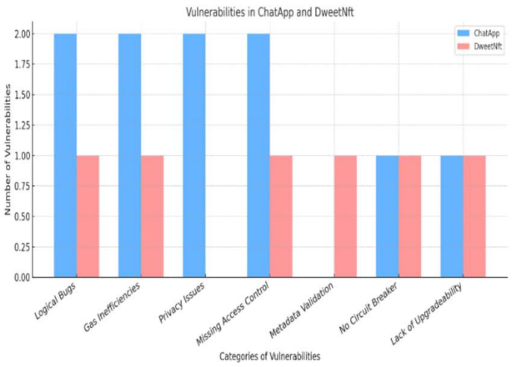

Figure 5: Vulnerability in to "chatApp"and "DweetNft" smart contracts

The figure 4, shows vulnerabilities in the smart contract and Figure 5, shows comparison of the vulnerabilities in the "ChatApp" and "DweetNft" contracts across various categories.

VII. Conclusion

The impact of the proposed system could extend well beyond social media. It acts as a lighthouse showing the way to an online future that is more focused on the user. It can ignite a revolution where users not corporations are in control by showcasing the potential of decentralised technologies. This might result in a social media environment that encourages moral behaviour and gives people authority over their information and online experiences. Its success can also serve as a powerful stimulant for innovation in the technology sector. It may encourage a new generation of developers to explore the enormous possibilities of decentralisation and blockchain technology. This could open the door to a more user-controlled, transparent, and safe internet ecosystem where privacy and data ownership are central to the development of applications. The suggested system might have effects that go well beyond social media. Users are likely to expect comparable degrees of openness, security, and user empowerment from other digital services they frequently use as they become used to the freedom and control it provides.This could trigger a domino effect, pushing the entire industry towards a more decentralized and privacy-focused future. In essence, propose system transcends its role as a social media platform, it stands as a potential turning point for the internet itself. By placing users back at the center of their online experience and empowering them with control over their data, it paves the way for a more secure and empowering digital future for all.

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