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TrustEdu: A Blockchain-Based Framework for Secure Educational Document Verification

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Abstract: ***In today's digital world, the authenticity of educational documents is a critical issue faced by academic institutions, employers, and verification agencies. Traditional centralized verification systems are vulnerable to data tampering, document forgery, and unauthorized access. This paper presents TrustEdu, a blockchain-based decentralized framework designed to securely issue, store, and verify educational credentials. By leveraging smart contracts and IPFS (InterPlanetary File System), the system ensures transparency, immutability, and accessibility while eliminating the dependence on intermediaries. The proposed model enhances document security through cryptographic hashing and decentralized validation. Experimental results demonstrate that TrustEdu offers a reliable, tamper-proof, and efficient mechanism for document verification across academic and professional domains.***

Keywords: Blockchain, Smart Contracts, IPFS, Document Verification, Data Security, Decentralized Systems.

I. INTRODUCTION

Educational institutions globally are increasingly adopting digital processes for managing student records, degrees, and certificates. However, the authenticity and security of these digital documents remain a significant concern. Fraudulent activities such as certificate forgery, unauthorized duplication, and falsified records undermine the credibility of institutions and employers. Conventional systems rely on centralized databases, which are prone to single-point failures and data breaches. Blockchain technology offers a promising solution due to its decentralized, immutable, and transparent nature. TrustEdu leverages blockchain, smart contracts, and IPFS to design a secure document verification ecosystem that ensures authenticity, privacy, and accessibility of academic credentials.

II. LITERATURE REVIEW

Several researchers have proposed blockchain-based frameworks for academic certificate verification. Garima Sethia et al. implemented Hyperledger Fabric to create tamper-proof databases of student certificates. Gayathiri et al. explored blockchain's use in digitizing educational certificates for enhanced traceability. Pavitra Haveri et al. integrated Ethereum smart contracts and IPFS to prevent document forgery. However, these systems often suffer from scalability and implementation complexity. TrustEdu addresses these challenges by combining a lightweight consensus mechanism with smart contracts and decentralized IPFS storage to ensure secure, efficient, and low-cost verification.

III. PROPOSED SYSTEM: TRUSTEDU FRAMEWORK

The proposed TrustEdu framework introduces a decentralized, blockchain-based system to manage document issuance and verification. It consists of three main stakeholders: the issuing authority (educational institutions), the verifier (employers or universities), and the document owner (student). The system workflow includes the following steps:

1) The institution uploads a digital document to IPFS.
2) A hash of the document is generated and stored on the blockchain using a smart contract.
3) The student receives a QR code or a unique hash identifier linked to the blockchain record.
4) Verifiers scan the QR code to access the document's authenticity details via blockchain validation.

Smart contracts handle document issuance, access permissions, and validation requests autonomously. IPFS ensures decentralized storage, while the blockchain maintains immutable records of document hashes and transaction logs. This hybrid model provides both security and scalability.

IV. IMPLEMENTATION AND RESULTS

TrustEdu was implemented using Ethereum blockchain and IPFS integration. The front-end web interface was built using React.js, while the backend employed Node.js and Web3.js for smart contract interactions.

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Each document uploaded was encrypted and hashed using SHA-256. The verification latency was tested across multiple nodes, and the results confirmed that blockchain validation was completed within 2–3 seconds per transaction. This proves the efficiency and scalability of TrustEdu in real-world educational verification environments.

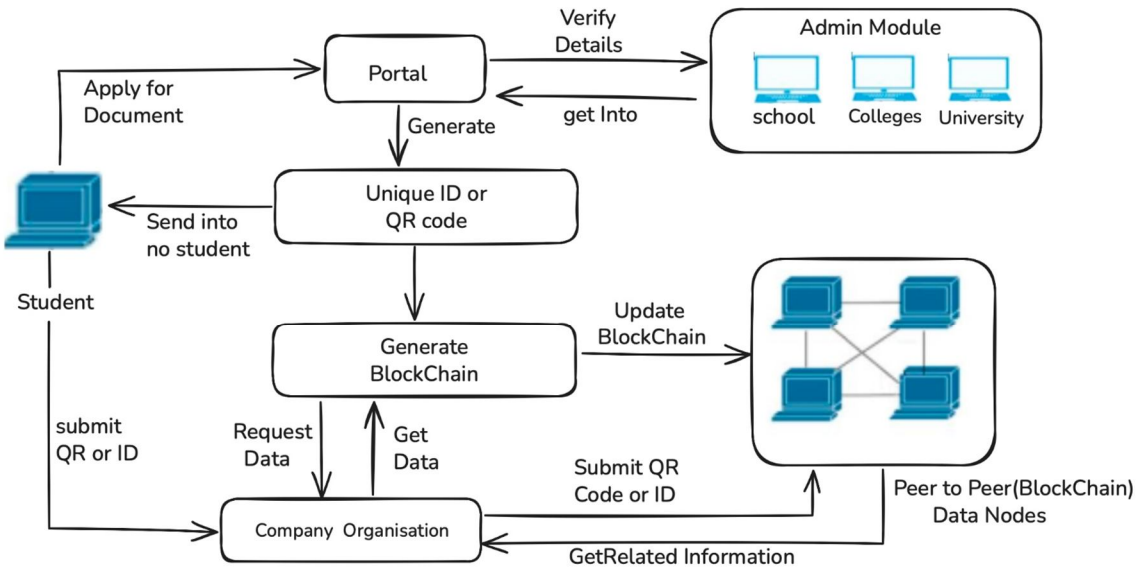
V. DISCUSSION

The TrustEdu framework enhances document security by removing the dependency on centralized authorities. The use of IPFS prevents data duplication and reduces storage costs. Smart contracts automate the verification process, ensuring transparency and eliminating human errors. Additionally, the system supports interoperability, allowing multiple institutions to participate in a shared blockchain network for inter-university verification. This model can be extended to government or corporate-level credential management.

VI. CONCLUSION AND FUTURE SCOPE

TrustEdu demonstrates how blockchain and IPFS can transform document verification processes in the education sector. The decentralized nature of blockchain ensures data integrity, while IPFS provides scalable, distributed storage. In the future, AI-based verification mechanisms and zero-knowledge proof (ZKP) authentication can be incorporated to further enhance privacy and automation. TrustEdu can also be expanded to verify professional certifications, government-issued documents, and healthcare records, making it a universal document trust framework.

VII. ARCHITECTURE DIAGRAM



ARCHITECTURE DIAGRAM

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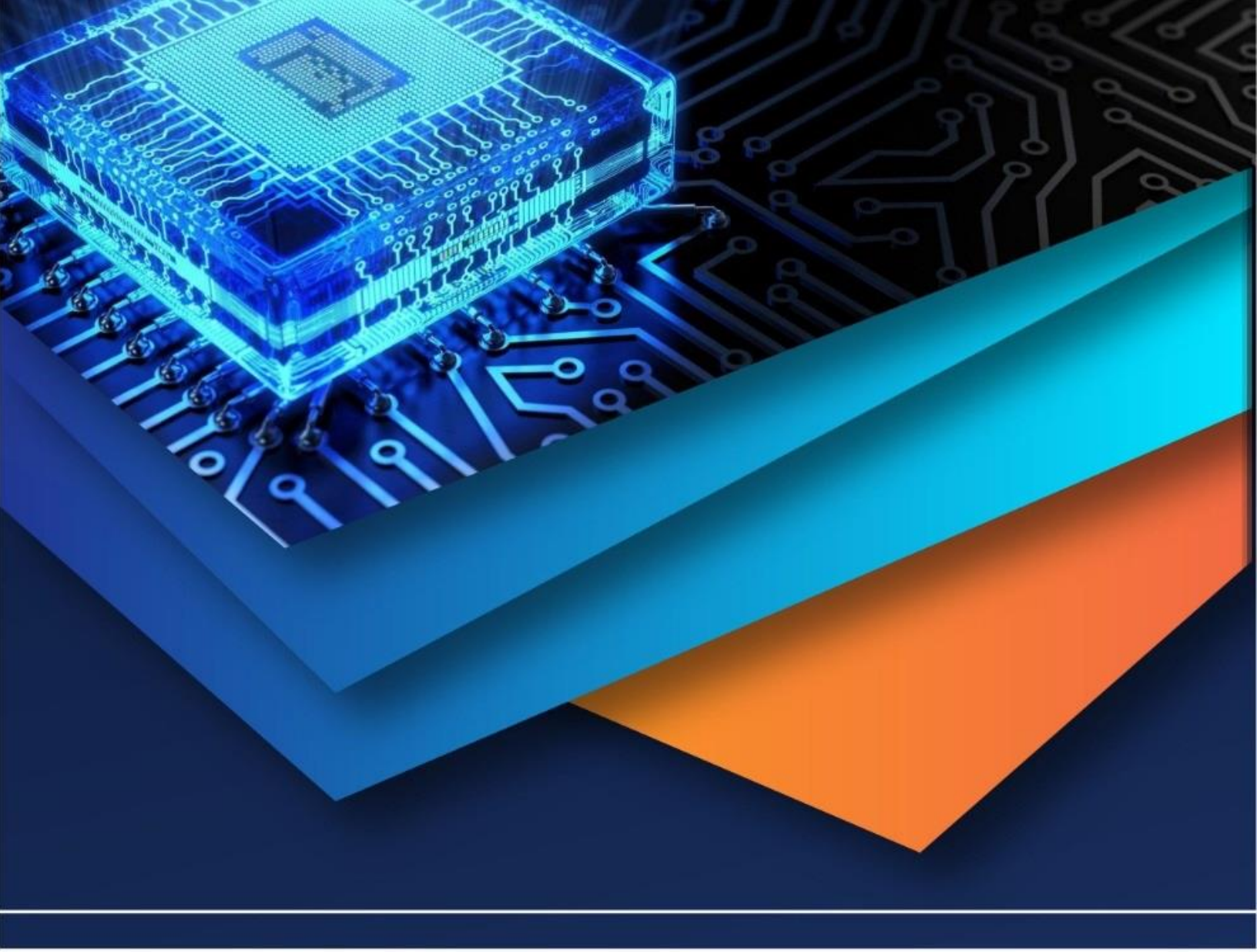

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