

ENHANCING CHAIN OF CUSTODY MANAGEMENT THROUGH BLOCKCHAIN TECHNOLOGY

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Introduction

1. This research focuses on a digital evidence management system* that uses blockchain to ensure a secure and unchangeable chain of custody for digital evidence.
2. It includes fuzzy hashing and cryptographic signatures to detect tampering and verify evidence authenticity in real time.
3. A role-based access control system with multi-factor authentication ensures that only authorized users can access evidence, with every action logged in detail.
4. The solution helps solve key problems in digital forensics by providing court-admissible records and automated tracking to ensure compliance with legal standards.



Problem Statement

1. Evolution of Digital Evidence

Digital evidence has transformed significantly—from paper records in the 1990s to CDs and now digital storage—making it increasingly challenging to *preserve integrity and authenticity* across diverse formats.

2. Lack of Standard Protocols in Traditional Systems

Existing traditional systems often lack standardized protocols for managing digital evidence, which can lead to corruption, breaches in the chain of custody, and *complications in legal validation*.

3. Vulnerabilities in Current Digital Storage Methods

Current digital storage methods are susceptible to unauthorized access and data tampering, and frequently lack adequate *verification mechanisms*, jeopardizing the credibility of evidence.

4. Security Challenges in Cloud Storage

While cloud storage enhances accessibility, it introduces security risks that demand robust tamper detection, strict access control, and mechanisms to ensure a legally defensible chain of custody.



Objectives



Blockchain-Based System

Develop a blockchain-based platform to guarantee complete data integrity and immutable custody records for digital evidence.



Fuzzy Hashing Integration

Incorporate fuzzy hashing techniques to facilitate intelligent verification and immediate tamper detection.



Secure Multi-User Platform

Create a secure, multi-user environment with granular access controls and comprehensive audit logging.

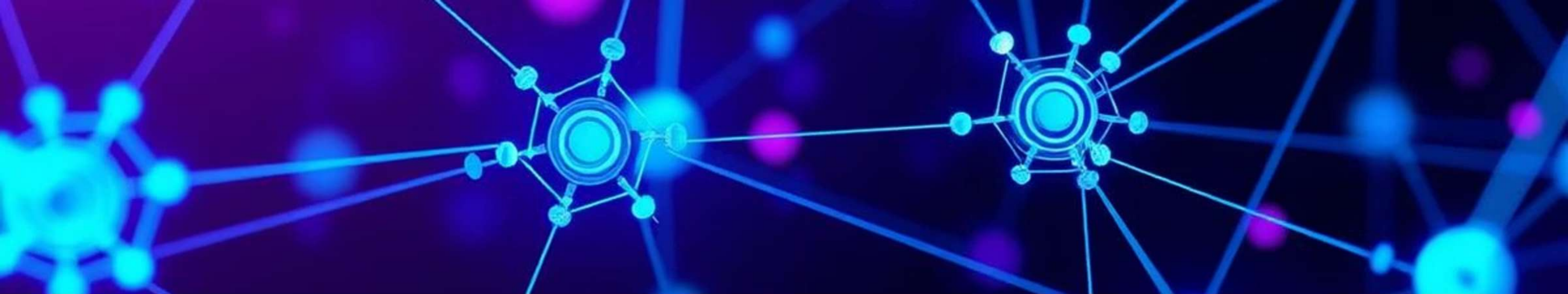


Standard Protocols

Implement protocols to ensure legal and forensic compliance.

Literature Insights

Author	Focus	Key Finding
Zhang et al. (2023)	Blockchain Framework	99.9% verification accuracy via smart contracts.
Kumar & Rodriguez (2022)	Hybrid Systems	60% faster verification with blockchain and fuzzy hashing.
Patel et al. (2021)	Cloud Forensics	MFA secures evidence access effectively.
Anderson & Lee (2022)	Access Control	Role-based + crypto validation supports court standards.
Wilson et al. (2023)	Tool Survey	Outlined best blockchain forensic legal compliance practices.



Technologies Behind the System

Backend Technologies

- Python (Flask)
- MySQL
- OpenCV, PIL, Hashlib

Frontend & UI

- HTML5, CSS3, JavaScript, Bootstrap, jQuery

Security Components

- Blockchain
- Fuzzy Hashing, Crypto Signatures

Additional Tools

- REST API
- Matplotlib, Pandas, JSON

Comprehensive System Architecture (FB-CoC)

Client Layer

Web interface with RBAC, multi-factor authentication, and dashboard.

Application Layer

Backend processing with blockchain, fuzzy hashing, and audit logging.

Security Layer

Authentication, encryption, tamper-proofing, and attack mitigation.

Data Layer

Secure storage combining MySQL, encrypted files, and blockchain ledger.



Core Algorithms Powering the System

Blockchain Algorithms

SHA-256 guarantees data integrity, **Merkle Trees** enable fast verification.

1

2

Fuzzy Hashing

CTPH(Context Triggered Piecewise Hashing) and **ssdeep** detect partial file modifications for tamper detection.

Consensus Mechanism

Proof of Authority(PoA) ensures energy-efficient, trusted block validation.

3

System Modules Overview

- Authentication Module for secure user access
- Evidence Management for uploading and handling digital evidence
- Blockchain Module managing ledger and immutability
- Security Module enforcing cryptography and tamper proofing
- Case Management tracking investigations and evidence flow
- System Administration overseeing configuration and maintenance

Working principles

Evidence Handling

Uploads secure with unique IDs, timestamps, fuzzy hashes, and metadata.

Blockchain Ledger

Records immutable blocks with cryptographic signatures and timestamping.

Access Control

Role-based permissions with MFA and real-time integrity checks.

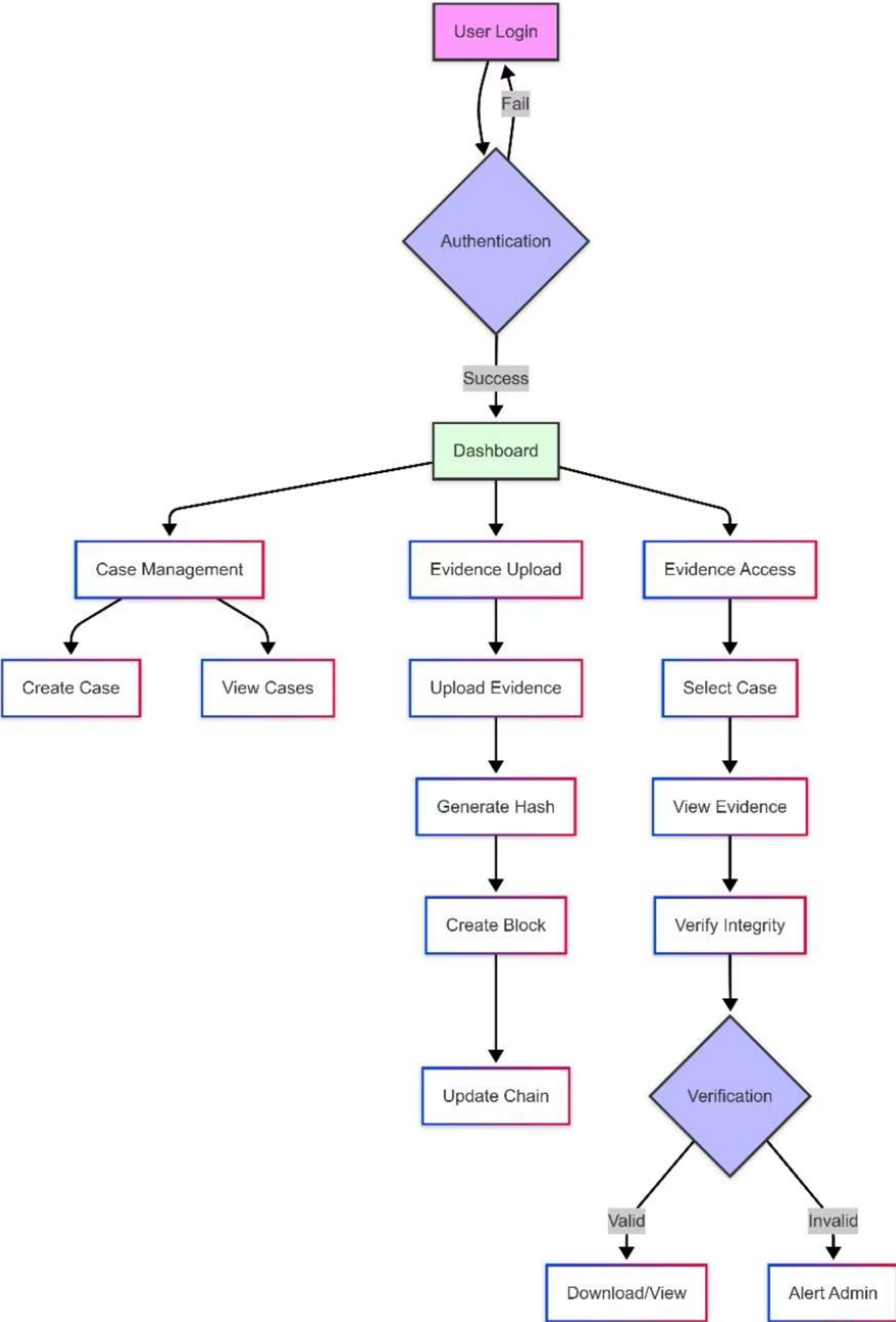
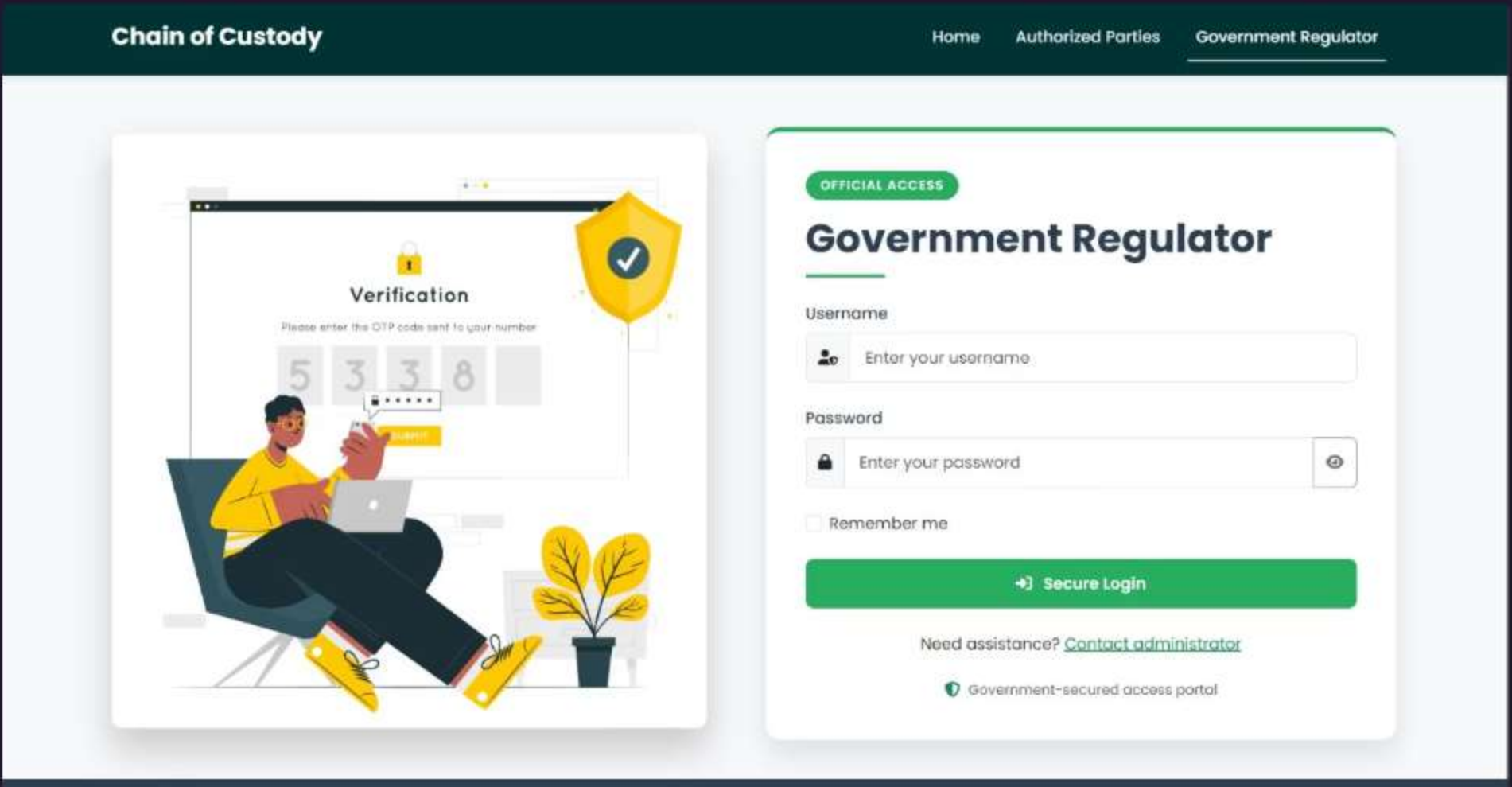
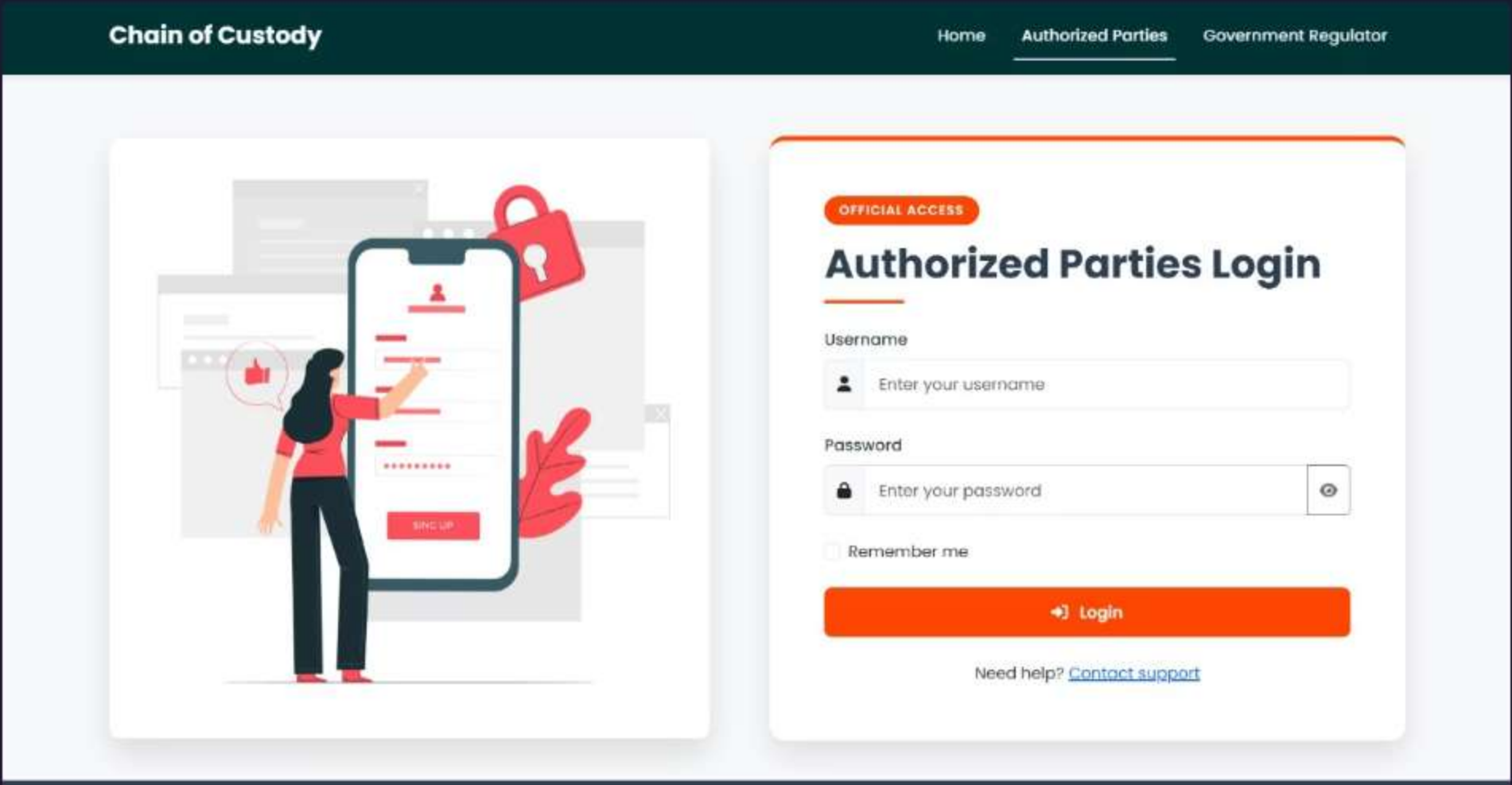
Chain of Custody

Automated tracking using smart contracts for court-admissible proofs.

Security Practices

End-to-end encryption, tamper detection, secure storage, and audits.

Work flow-chart



Benefits

1. Enhanced Evidence Integrity – Leveraging blockchain technology for tamper-proof records, cryptographic hashing, and a comprehensive audit trail.
2. Streamlined Chain of Custody – Automated tracking with real-time status updates and legally admissible documentation.
3. Improved Security & Access Control – Role-based permissions, multi-factor authentication, and detailed activity logging.


Government Regulator

HomeCase Management ▾Verify Evidence IntegrityLogout

Authorized Parties

View and manage all authorized parties who have access to the Chain of Custody system

ID: AT1



Ramkumar

Role: Junior Advocate

Mobile: 8896377412

Email: ramkumar@gmail.com


Aadhar No: 432156784321

Location: FF Nagar, Salem

Edit

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ID: AT2



Dharun

Role: Police

Mobile: 8875644231

Email: dharun@gmail.com


Aadhar No: 256344848454

Location: DG Road, Karur

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ID: AT3



Balaji

Role: Police

Mobile: 9345469758

Email: joseph32@gmail.com

Aadhar No: 76543864332

Location: chennai, chennai

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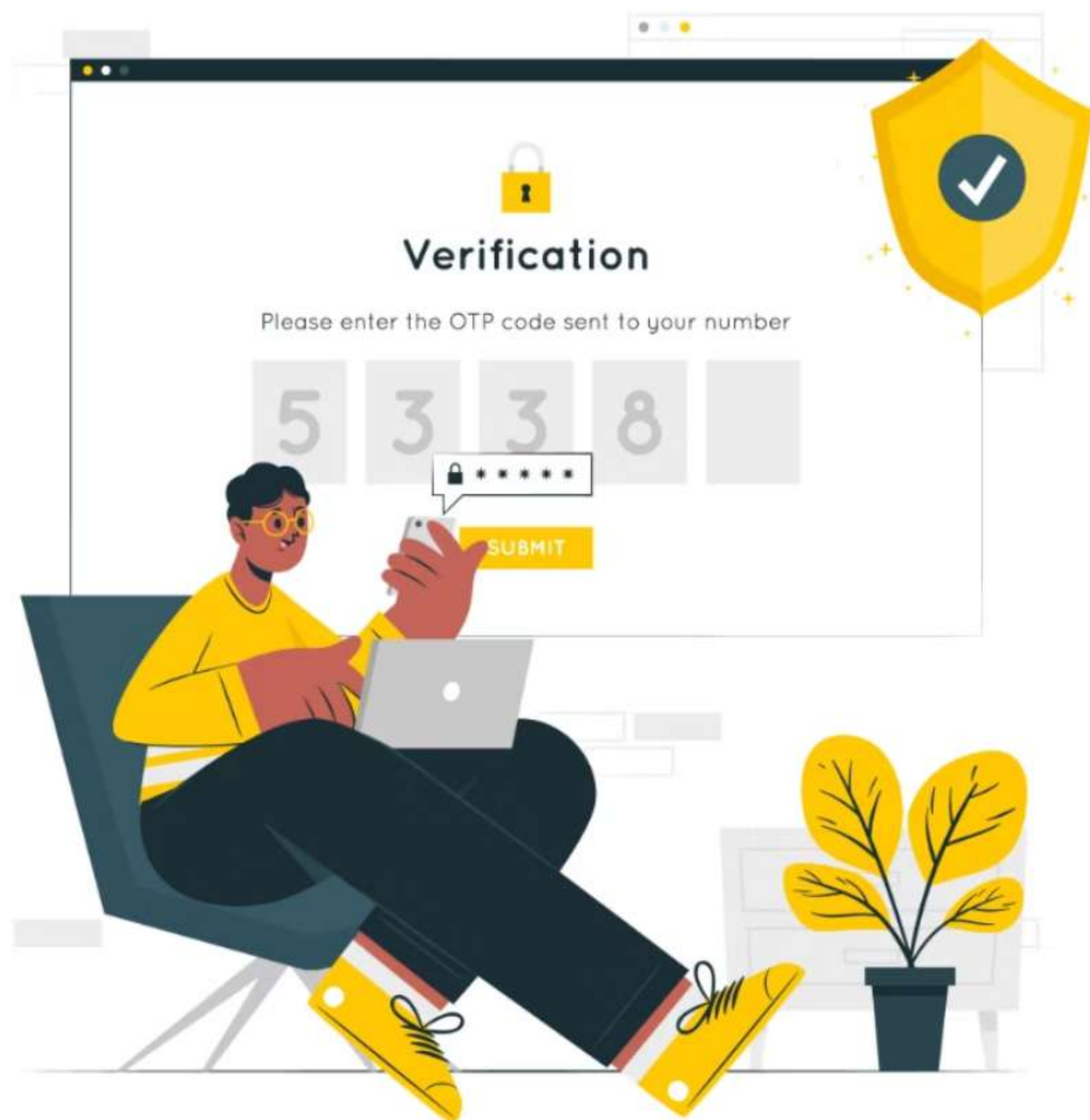
Challenges

1. Technical Complexity – Integration of multiple protocols, blockchain scalability issues, and ensuring cross-platform reliability
2. Regulatory Compliance – Meeting legal admissibility standards, adhering to forensic requirements, and navigating jurisdiction-specific regulations
3. User Adoption & Training – Upskilling staff, overcoming resistance to change, and enforcing proper evidence handling practices

Applications of Blockchain-Based Chain of Custody System

1. *Law Enforcement* – Criminal evidence, forensics, crime scene docs, case tracking
2. *Healthcare* – Clinical trials, medical samples, patient records, drug development
3. *Military* – Classified docs, weapons inventory, intel security, asset tracking
4. *Agriculture* – Food supply chain, farm-to-table, safety compliance, authenticity
5. *R&D* – Scientific data, experiment logs, IP protection, research tracking
6. *Finance* – Transaction audits, fraud prevention, compliance docs
7. *Manufacturing* – Product lifecycle, quality control, supply chain traceability
8. *Education* – Credential verification, research integrity, student records

Chain of Custody

[Home](#)[Authorized Parties](#)[Government Regulator](#)

Welcome To Chain of Custody

Chain of custody is a critical process used to track the movement and control of digital evidence throughout its lifecycle. Our system documents each person and organization who handles the evidence, the date/time it was collected or transferred, and the purpose of the transfer.

Using advanced blockchain technology and fuzzy hashing algorithms, our FB-CoC system ensures that digital evidence remains tamper-proof and verifiable, meeting the highest standards required for legal proceedings and forensic investigations.

[Learn More](#)

Future Potential

1. Real-Time Notifications – Immediate alerts for evidence updates, tampering attempts, and role-based push, SMS, or email notifications.
2. Mobile Application – A secure, cross-platform app (iOS/Android) featuring biometric authentication, offline synchronization, and comprehensive case management.
3. AI-Powered Analysis – Automated classification, pattern and anomaly detection, predictive analytics, and intelligent tamper alerts.
4. Enhanced Integrations – Robust APIs for law enforcement systems, cloud compatibility, cross-jurisdiction data sharing, and automated reporting.

Conclusion

The FB-CoC (Fuzzy Hash Blockchain Chain of Custody) system represents a major breakthrough in digital evidence management by seamlessly combining blockchain technology with fuzzy hashing algorithms.

This project effectively addresses key challenges in digital evidence management, while establishing a scalable framework for future enhancements and widespread adoption across industries requiring secure chain of custody implementations.

References

Blockchain-Based Digital Evidence & Chain of Custody

1. **Zhang & Anderson (2023)**

IEEE Transactions on Information Forensics and Security.

A blockchain framework ensuring the integrity of digital evidence through immutable ledgers and decentralized consensus mechanisms, providing enhanced tamper-evidence and auditability.

2. **Kumar & Rodriguez (2023)**

Digital Investigation

Integration of fuzzy hashing with blockchain technology for enhanced verification, enabling robust detection of subtle changes in digital evidence and improving forensic accuracy.

3. **Wilson & Thompson (2022)**

Forensic Science International: Digital Investigation

Application of smart contracts to automate custody tracking, reducing human error and increasing transparency in the handling of digital evidence.

4. **Chen & Martinez (2022)**

Journal of Digital Forensics

Implementation of role-based access control within blockchain systems, ensuring that only authorized personnel can access or modify chain of custody records.

5. **Park & Lee (2021)**

Computers & Security

Development of security protocols for evidence handling, addressing vulnerabilities in digital evidence transmission and storage.

6. **Brown & Smith (2021)**

IEEE Access

Fuzzy hashing combined with cryptographic verification techniques to strengthen data integrity checks and prevent evidence tampering in forensic applications.

Thank You!

We sincerely appreciate your time and thoughtful review of our blockchain-based system.

Please feel free to contact us with any questions or to explore collaboration opportunities.