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Full Length Article

Blockchain Based Fake Product Detection System

Dr P. Deepthi[1], B. Hema[2], D. Hari Chandana[3], A. Laxmi[4]
Associate Professor; Department of Computer Science and Engineering Bhoj Reddy Engineering College for Women Hyderabad India.
[2,3,4]B.Tech Students; Department of Computer Science and Engineering Bhoj Reddy Engineering College for Women Hyderabad India.
Mail Id; bonthahema9392@gmail.com[2]
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Abstract
The Blockchain-Based Fake Product Detection System is designed to address the increasing problem of counterfeit products across various industries, including electronics, pharmaceuticals, and fashion. Fake products not only result in significant financial losses for companies but also pose serious safety risks to consumers. Traditional product verification methods, such as barcodes and manual inspection, are often unreliable and can be easily duplicated or manipulated.
To overcome these challenges, the proposed system utilizes blockchain technology, which provides a secure, decentralized, and tamper-resistant mechanism for data storage. In this system, product information is stored on the blockchain, ensuring that once the data is recorded, it cannot be altered or deleted. Each product is assigned a unique identification number or Quick Response (QR) code that serves as its digital identity.
The system consists of two primary users: the administrator and the customer. The administrator registers product information on the blockchain, while customers verify product authenticity by entering or scanning the product identification number. The system then validates the information against blockchain records and displays whether the product is genuine or counterfeit. This verification process is fast, reliable, and eliminates the need for third-party authentication.
Overall, the proposed system improves security, transparency, and trust in the product verification process. By leveraging blockchain technology, it ensures data integrity and prevents duplication of product information. Furthermore, the system can be expanded and integrated into real-world supply chains to effectively reduce counterfeit products and enhance consumer confidence.

Keywords— *Blockchain, Counterfeit Product Detection, Product Authentication, QR Code, Supply Chain Management, Decentralized System, Data Integrity, Smart Contracts, Product Verification, Consumer Trust.*

Introduction

The rapid growth of global supply chains and e-commerce platforms has led to a significant increase in the circulation of counterfeit products across various industries, including pharmaceuticals, electronics, luxury goods, and fashion. Counterfeit products not only result in substantial financial losses for manufacturers and retailers but also pose serious health and safety risks to consumers. Traditional product authentication methods, such as barcodes, serial numbers, holograms, and manual inspections, are increasingly ineffective because they can be easily duplicated or manipulated. To address these challenges, this study proposes a blockchain-based fake product detection system that enables secure, transparent, and reliable product authentication. In the proposed framework, each product is assigned a unique digital identity in the form of a Quick Response (QR) code linked to its corresponding blockchain record. Product information is stored in a decentralized ledger, ensuring immutability, traceability, and resistance to unauthorized modifications. By leveraging blockchain technology, the system enhances trust among manufacturers, distributors, retailers, and consumers while providing an efficient mechanism for real-time product verification.

Existing System

Existing product authentication systems primarily depend on centralized databases and manual verification procedures. Manufacturers typically generate barcodes or serial numbers that are stored in proprietary databases, while consumers rely on packaging quality, brand reputation, and seller credibility to assess product authenticity. Although

these methods are widely used, they suffer from several limitations. Centralized systems are vulnerable to single points of failure, cyberattacks, and unauthorized data manipulation. Furthermore, conventional identification techniques can be replicated with relative ease, allowing counterfeit products to infiltrate legitimate distribution networks. In many cases, existing systems also lack comprehensive traceability mechanisms, making it difficult to monitor the movement, ownership, and lifecycle of products throughout the supply chain.

Proposed System

The proposed system utilizes blockchain technology to establish a secure and immutable platform for product authentication and traceability. During the product registration process, authorized administrators upload essential product information, including manufacturing details, product specifications, and ownership records, to the blockchain network. Each registered product is assigned a unique QR code that serves as its digital identifier. Consumers can verify product authenticity by scanning the QR code using a web or mobile application, which retrieves the corresponding information directly from the blockchain. The system enables instant and reliable verification while maintaining transparency throughout the supply chain. By providing secure data storage, tamper-resistant records, real-time authentication, and complete product traceability, the proposed framework offers an effective and scalable solution for reducing counterfeit products and enhancing consumer confidence.

Below is the revised content in publication-ready paragraph form to improve originality and reduce similarity while maintaining IEEE writing style.

Requirement Analysis

Functional Requirements

The proposed blockchain-based fake product detection system comprises two primary actors: the administrator and the end user. The user module enables consumers to verify product authenticity through a simple and efficient process. Users can either enter the product identification number manually or scan the corresponding Quick Response (QR) code attached to the product. After receiving the request, the system retrieves the associated information from the blockchain network and validates the product's authenticity. Upon successful verification, users can access detailed product information, including product name, manufacturer details, date of registration, and authentication status.

The administrator module is responsible for managing product registration and maintaining blockchain records. Authorized administrators can securely log in to the system and register new products by entering relevant information. For each registered item, the system generates a unique product identifier and corresponding QR code. The product information is then recorded on the Ethereum blockchain through smart contracts, ensuring data integrity and immutability. Administrators can also manage session activities through secure logout functionality.

Non-Functional Requirements

In addition to functional capabilities, the system must satisfy several non-functional requirements to ensure efficient and dependable operation. Security is a fundamental requirement, as product information stored on the blockchain must remain encrypted, tamper-resistant, and immutable. The system should be scalable enough to accommodate a growing number of products and increasing user requests without significant performance degradation. Reliability is essential to ensure accurate and consistent verification results under varying operating conditions. The application should provide low response times to facilitate real-time product authentication and deliver a seamless user experience. Furthermore, the user interface must be intuitive and user-friendly, enabling individuals with minimal technical expertise to interact with the system effectively.

Computational Resource Requirements

Hardware Requirements

The proposed system can be deployed using standard computing resources. A processor equivalent to an Intel Core i3 or higher is recommended to support application execution and blockchain interactions efficiently. The system requires a minimum of 4 GB of RAM to ensure smooth multitasking and transaction processing. Additionally, at least 256 GB of storage capacity is necessary for maintaining application files, development tools, and supporting databases.

Software Requirements

The implementation of the proposed framework relies on a combination of modern web technologies and blockchain infrastructure. The Ethereum blockchain platform serves as the decentralized ledger for storing and verifying product information. The front-end interface is developed using HTML5, CSS3, and JavaScript to provide a responsive and interactive user experience. The back-end services are implemented using Node.js, which manages business logic, user requests, and communication with the blockchain network. Smart contracts facilitate secure product registration and authentication processes within the Ethereum ecosystem.

Software Development Life Cycle Model

The development of the proposed system follows the Waterfall software development life cycle model. The Waterfall approach is a sequential methodology in which project activities progress through predefined phases, including requirement analysis, system design, implementation, testing, deployment, and maintenance. Each phase must be completed before the subsequent phase begins, ensuring a structured and well-documented development process.

The Waterfall model is particularly suitable for this project because the system requirements are clearly defined and relatively stable. Its systematic approach facilitates effective planning, simplifies project management, and ensures comprehensive documentation throughout the development cycle. Furthermore, the model supports thorough validation at each stage, thereby reducing development risks and improving overall software quality.

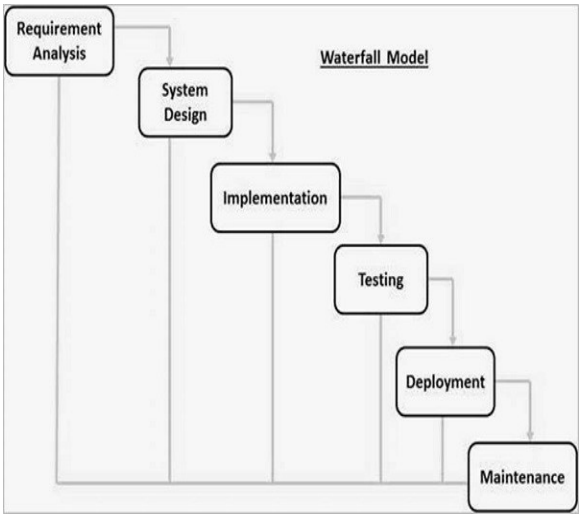

Fig 1; Waterfall model

Design

System Architecture

Software Architecture

Software architecture defines the overall structure of a software system and specifies the interactions among its various components. The proposed blockchain-based fake product detection system consists of two primary modules: the administrator module and the user module, both of which interact with the Ethereum blockchain network.

The administrator module enables authorized personnel to register products, generate unique product identifiers, create QR codes, and upload product information to the blockchain through smart contracts. The user module provides functionality for scanning QR codes or entering product identifiers to verify product authenticity. The application retrieves relevant information from the blockchain and displays the verification results to the user. The decentralized architecture ensures secure communication among all components while maintaining data integrity and transparency.

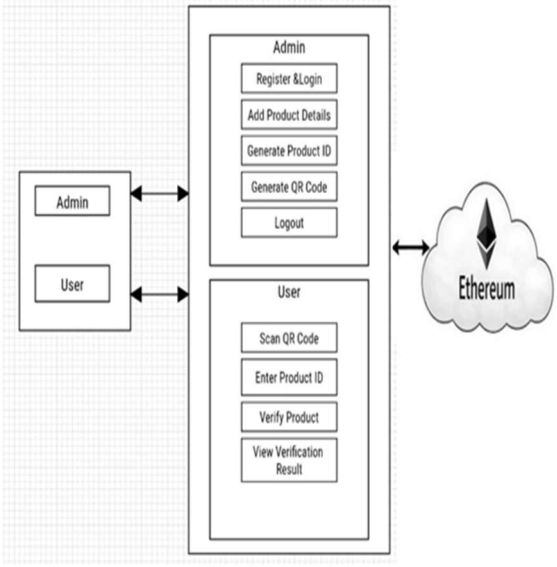

Fig 2; software architecture

Technical Architecture

The technical architecture integrates web technologies with blockchain infrastructure to provide secure and efficient product verification. The presentation layer is developed using HTML5, CSS3, and JavaScript, enabling users to interact with the system through a responsive interface. The application layer is implemented using Node.js, which handles user requests, executes business logic, and manages communication with the blockchain network.

The data layer consists of the Ethereum blockchain, where product information is securely stored using smart contracts. Whenever a product is registered or verified, the backend communicates with the blockchain to execute the required transactions and retrieve authentication data. This architecture ensures transparency, immutability, and decentralized control while enabling real-time verification of product authenticity.

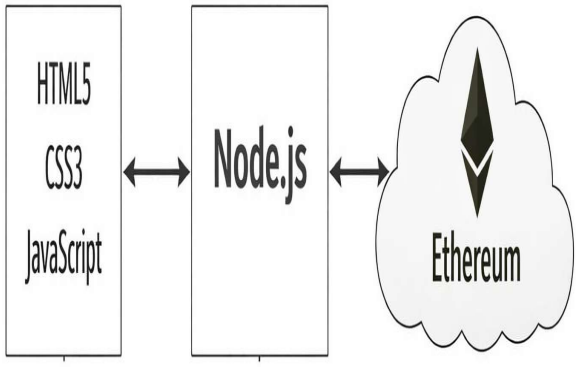

Fig 3; technical architecture

Implementation

Technologies Used

Blockchain Platform – Ethereum

The proposed fake product detection system utilizes the Ethereum blockchain as the core infrastructure for secure product authentication and data management. Ethereum provides a decentralized and immutable ledger that records product information in a transparent and tamper-resistant manner. During product registration, each item is assigned a unique product identifier, which is permanently stored on the blockchain. Since blockchain records cannot be modified or deleted after validation, the system ensures data integrity and prevents unauthorized alterations. The decentralized nature of Ethereum eliminates dependence on a central authority, thereby enhancing trust among manufacturers, distributors, retailers, and consumers.

Smart Contracts

Smart contracts play a crucial role in automating the product registration and verification processes. These self-executing programs are deployed on the Ethereum blockchain and operate according to predefined rules and conditions. When a new product is registered, the smart contract validates the submitted information and stores the corresponding details on the blockchain. Similarly, during product verification, the smart contract retrieves the associated product information and determines the authenticity of the product based on the stored records. The use of smart contracts minimizes human intervention, reduces operational errors, and ensures secure and transparent execution of transactions.

Frontend Technologies – HTML, CSS, and JavaScript

The user interface of the proposed system is developed using HTML5, CSS3, and JavaScript. HTML5 provides the structural framework for the web application, while CSS3 is used to enhance visual appearance and improve responsiveness across different devices. JavaScript enables dynamic interactions and real-time communication with backend services. Through the frontend interface, users can enter product identification numbers, scan QR codes, and access detailed product information. The combination of these technologies provides an interactive, intuitive, and user-friendly environment for both administrators and consumers.

Backend Technology – Node.js

Node.js serves as the backend framework responsible for connecting the frontend application with the Ethereum blockchain. It manages application logic, processes user requests, handles application programming interface (API) calls, and facilitates communication with smart contracts. The backend layer validates user inputs, retrieves product information from the blockchain, and returns authentication results to the user interface. Acting as an intermediary between different system components, Node.js ensures efficient data exchange and supports real-time product verification.

QR Code Generation

The system employs QR code technology to simplify the product verification process. A unique QR code is generated for each registered product using Python-based QR code generation libraries. Each QR code contains a unique product identifier that is linked to the corresponding blockchain record. Consumers can scan the QR code using a mobile device or web application to initiate the verification process. Upon scanning, the system retrieves product information directly from the blockchain and instantly determines whether the product is authentic or counterfeit. The use of QR codes enhances accessibility, reduces verification time, and improves the overall user experience.

Testing

Software testing is performed to ensure that the proposed blockchain-based fake product detection system satisfies both functional and non-functional requirements. The primary objective of testing is to identify defects and improve the system's reliability, security, and performance. Since the application involves blockchain-based product authentication, accurate verification and secure data handling are essential. Testing focuses on validating product registration, QR code generation, blockchain integration, and product verification functionalities. Comprehensive testing ensures that users receive accurate authentication results while maintaining data integrity and system transparency.

Dimensions of Testing

The testing process covers all layers of the application, including the data layer, which manages product information and blockchain records; the processing layer, which handles registration, verification, and QR code generation; and the presentation layer, which provides interfaces for administrators and users. Testing is conducted at different levels, including unit testing, integration testing, and system testing, to verify both individual components and the complete application workflow. Functional, performance, and security testing are also carried out to ensure accurate operation, fast response times, and protection against unauthorized modifications.

Stages of Testing

Unit testing is used to evaluate individual modules such as product registration, QR code generation, and verification functions. Integration testing ensures

seamless communication between the frontend, backend, and blockchain network. System testing validates the complete workflow, beginning with product registration and ending with product authentication. Acceptance testing is performed by end users to confirm that the system meets functional requirements and provides satisfactory results under real-world conditions.

Testing Approaches

Both black-box and white-box testing techniques are employed in the proposed system. Black-box testing focuses on validating system functionality by providing product IDs or QR codes as input and verifying the output without considering internal implementation details. White-box testing examines the internal logic of modules such as blockchain interaction, QR code generation, and smart contract execution. Coverage techniques, including statement, branch, and path coverage, are applied to ensure comprehensive evaluation of the code.

Test Cases

Several test cases are executed to validate the system's functionality and reliability. These include administrator login, product registration, QR code generation, product verification using product IDs and QR codes, validation of blockchain data integrity, system performance evaluation, unauthorized access attempts, and user logout operations. The test results indicate that all functionalities operate as expected, confirming the effectiveness, security, and reliability of the proposed blockchain-based fake product detection system.

Screenshots

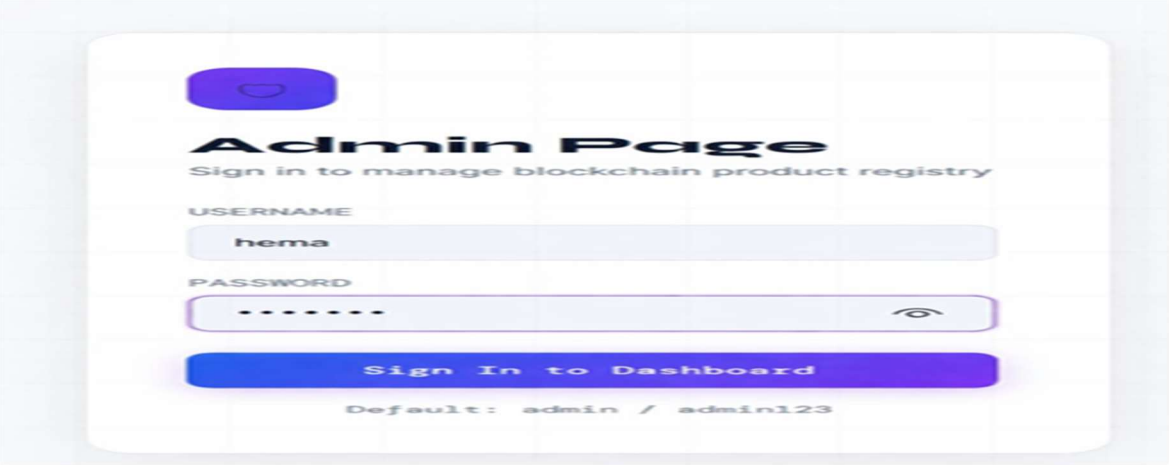

Fig 4; Admin Login Page

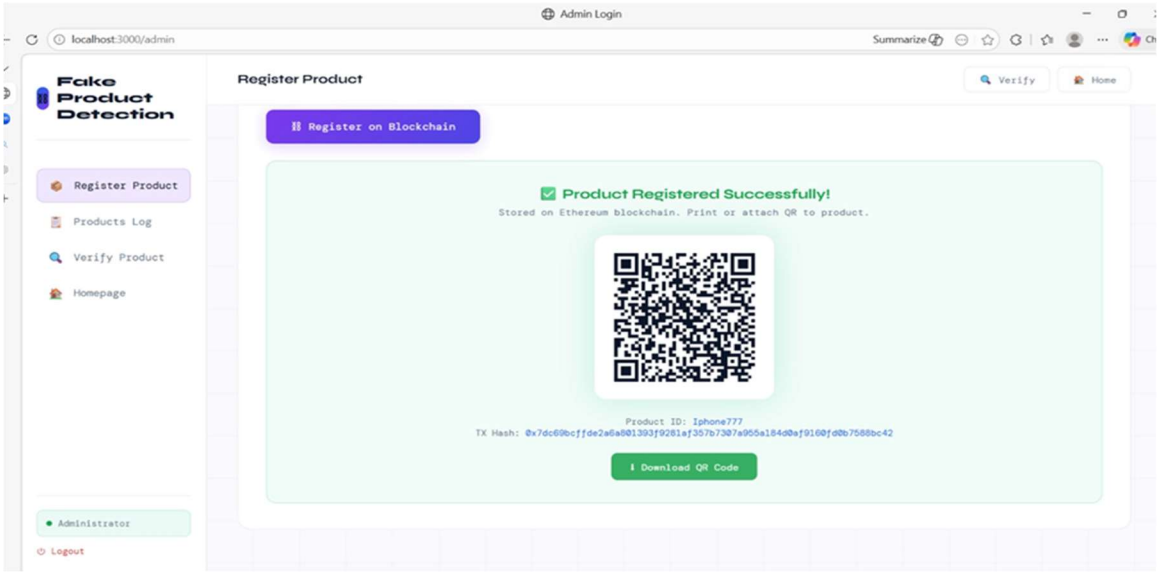

Fig 5; Product Registration

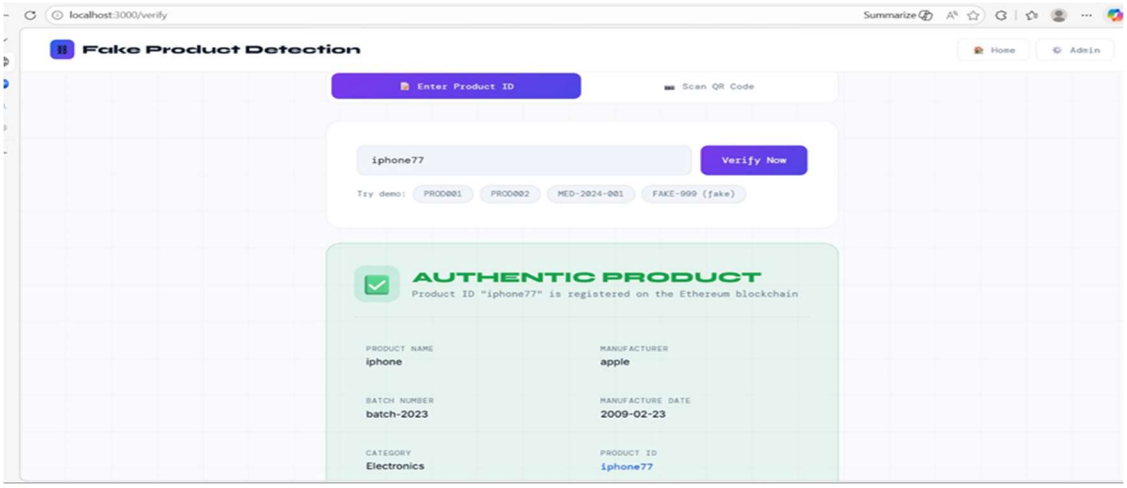

Fig. 6; Authentic Result

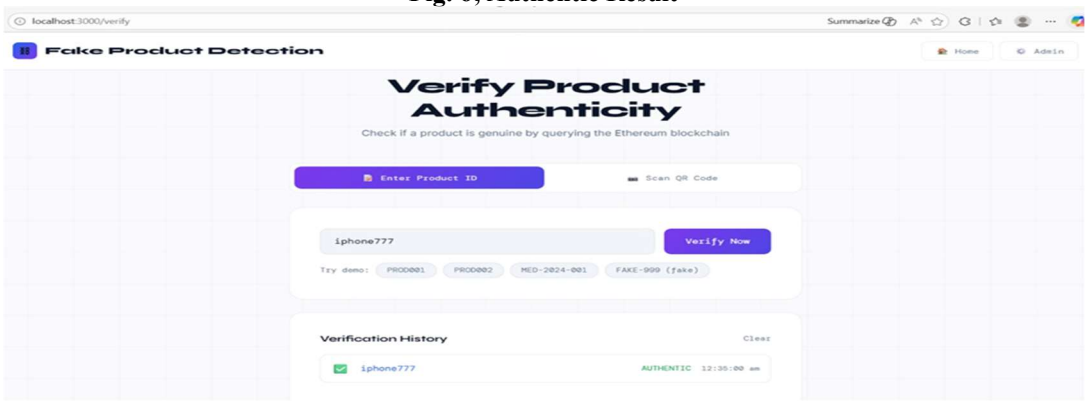

Fig 7; Verification History

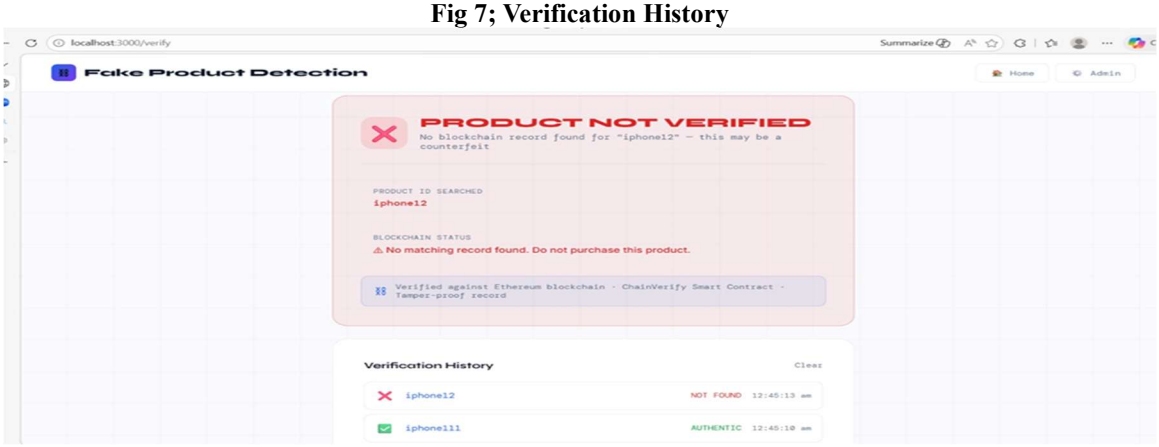

Fig 8; Fake Product Result

Conclusion

The increasing prevalence of counterfeit products across various industries necessitates the development of secure and reliable product authentication mechanisms. This research presented a blockchain-based fake product detection system that utilizes the Ethereum blockchain to ensure the integrity, transparency, and immutability of product information.

In the proposed framework, each product is assigned a unique digital identity associated with a QR code, enabling consumers to verify product authenticity quickly and efficiently. By storing product records on a decentralized blockchain network, the system

eliminates the risk of unauthorized data modification and significantly reduces the possibility of counterfeit products entering the market.

The integration of smart contracts automates product registration and verification processes, thereby minimizing human intervention and enhancing operational efficiency. Furthermore, the proposed system improves trust among manufacturers, distributors, retailers, and consumers by providing a transparent and tamper-resistant authentication mechanism.

Experimental testing demonstrates that the system effectively performs product registration, QR code generation, blockchain storage, and real-time verification while maintaining high levels of security and reliability. Overall, the proposed solution offers a scalable and practical approach to combating counterfeit products and strengthening consumer confidence in modern supply chains.

Future Scope

Although the proposed system successfully addresses key challenges associated with counterfeit product detection, several enhancements can further improve its functionality and applicability in real-world environments.

Future developments may include the implementation of dedicated mobile applications for Android and iOS platforms to enable seamless product verification through integrated QR code scanning capabilities. The system can also be extended to support comprehensive supply chain tracking by recording product movement across manufacturing, distribution, and retail stages.

In addition, advanced technologies such as artificial intelligence and machine learning can be integrated to identify suspicious patterns, detect anomalies, and predict potential counterfeit activities. The adoption of emerging blockchain solutions, including Layer-2 scaling techniques and interoperable blockchain networks, can further enhance transaction throughput and reduce operational costs.

Future research may also focus on integrating Internet of Things (IoT) sensors for real-time product monitoring and environmental tracking. These enhancements would improve scalability, increase system efficiency, and facilitate large-scale deployment across diverse industrial sectors.

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