FAKE PRODUCT DETECTION SYSTEM USING BLOCKCHAIN

[1]Prof. S. P. Gunjal, [2]Sujal Chavan, [3]Sahil Vidhate, [4]Pranav Kute, [5]Jagdish Navpute

[1]Associate Prof. Student, Dept. of Computer Science SKN Sinhgad Institute of Technology & Science, Lonavala, Maharashtra

[2,3,4,5]Student, Dept. of Computer Science SKN Sinhgad Institute of Technology & Science, Lonavala, Maharashtra

Abstract: -The rising prevalence of counterfeit goods across pharmaceuticals, electronics, cosmetics, and luxury items undermines brand value, endanger consumers, and erodes trust in digital commerce. Traditional anti-counterfeit measures—holograms, serial numbers, and RFID—are vulnerable to duplication and fragmented record-keeping. This paper proposes a blockchain-backed fake product detection system that ensures end-to-end product provenance and tamper-evident auditability. Each item is registered on a permissioned ledger with a unique on-chain identifier and metadata issued by the manufacturer. Smart contracts govern lifecycle events (manufacture, transfer, sale, and recall), while a verification workflow exposes authenticity checks to consumers via QR/NFC. To strengthen detection beyond metadata integrity, an image-recognition module compares product/packaging images against canonical references to flag anomalies. We present a reference architecture built with a React front end and Solidity smart contracts, define data models and state transitions, and outline security and threat considerations (cloning, replay, and Sybil attacks). Experiments on a curated image set and simulated supply-chain events demonstrate low verification latency and robust tamper resistance. The approach shows promise for scalable, privacy-aware provenance in real-world supply chains.

Keywords: -Blockchain, Counterfeit Detection, Product Authentication, Smart Contracts, QR/NFC Verification, Supply Chain Provenance, Distributed Ledger, Image Recognition, Machine Learning, ReactJS, Solidity, Tamper Resistance.

I. INTRODUCTION

1. Background

Counterfeit products have become a systemic risk in global supply chains. Open marketplaces, long multi-party logistics chains, and opaque record-keeping create opportunities for product substitution and label cloning. Conventional defenses—security labels, barcodes, and RFID—offer limited trust because (i) artifacts can be copied, (ii) siloed databases can be altered, and (iii) verification often ends at the retail edge rather than tracing upstream provenance.

Blockchain technology provides a shared, append-only ledger where supply-chain actors (manufacturers, distributors, retailers, regulators) can record product events under a common trust fabric. The immutability of blocks, consensus-driven validation, and cryptographic linking of records make unauthorized edits detectable. Smart contracts encode rules for product state transitions (e.g., “manufactured → in-transit → retail → sold”) and can enforce checks such as single-use ownership transfers and time-bound recalls. Combined with consumer-facing QR/NFC tags, blockchain enables end users to query an item’s on-chain history at the point of purchase.

Fig 1: - Project Introduction Diagram

2. Motivation and Problem Statement

Despite advances in labeling and tracking, three pain points persist:

1. Data Integrity: Centralized databases allow privileged edits that can hide counterfeit insertion events.
2. End-User Verifiability: Consumers lack a trustworthy, low-friction way to verify authenticity and provenance.
3. Beyond-Metadata Detection: Even with correct identifiers, cloned packaging can pass basic checks without visual scrutiny.

Problem Statement: Design a system that (a) guarantees tamper-evident product lifecycle records across stakeholders, (b) enables instant consumer verification, and (c) augments metadata validation with machine-assisted visual checks.

Our Approach:

- Register each product with a unique, manufacturer-signed identifier anchored on a permissioned blockchain.
- Use smart contracts to control lifecycle events and prevent duplicate or out-of-order transitions.
- Expose a QR/NFC verification flow for consumers and field auditors.
- Integrate an image-recognition module to

compare packaging/product images with canonical templates and detect anomalies.

- Implement a reference stack (ReactJS front end, Solidity contracts), security controls against cloning, replay, and Sybil attacks.

II. METHODOLOGY

The proposed Fake Product Detection System adopts a hybrid approach that integrates blockchain technology with machine-learning–based image analysis to ensure end-to-end authenticity verification. The methodology begins with the creation of a permissioned blockchain network consisting of major supply-chain participants such as manufacturers, distributors, retailers, and regulatory authorities. Each stakeholder is assigned a unique digital identity, allowing only verified participants to record transactions on the ledger. A smart contract is deployed within this network to define rules for product registration, ownership transfer, and verification events. This ensures that every interaction with product information is validated, traceable, and permanently stored in an immutable structure.

During production, each product is registered on the blockchain through the Product Registration Module. The manufacturer generates a unique product identifier (UPID), which is hashed and stored along with details such as batch number, production date, and manufacturer credentials. A QR code or NFC tag is then assigned to the product, linking the physical item to its digital blockchain record. This process creates a secure bridge between the physical and digital worlds and ensures that any attempt to duplicate identifiers is immediately detectable through the blockchain's consensus mechanism.

The Verification Module is activated whenever a consumer or supply-chain participant scans the product's QR code. The system retrieves the corresponding blockchain entry and validates the authenticity of the product by matching the UPID, metadata, and transfer history. The smart contract logic checks whether the product identifier already exists, whether it has been tampered with, and whether unauthorized transactions have been recorded. If the verified metadata aligns with the original on-chain entry, the system confirms the product as genuine; otherwise, it flags the product as counterfeit.

To strengthen detection beyond metadata verification, the system incorporates an Image Recognition Module. Users may upload product or packaging images, which are analyzed using a machine-learning model trained on genuine product images. Features such as logo alignment, color correctness, font accuracy, and packaging layout are compared with reference images stored securely. If deviations exceed predefined thresholds, the system identifies the product as potentially counterfeit. This dual-layer methodology—blockchain verification combined with visual inspection—offers significantly higher reliability than traditional single-layer authentication techniques.

All interactions are facilitated through a React-based user interface designed to provide seamless scanning, result display, and counterfeit reporting. The interface communicates with smart contracts via Web3 components, ensuring real-time verification while maintaining data integrity. The overall methodology ensures transparency, tamper resistance, and enhanced consumer trust through a combination of decentralized data storage, automated smart contract validation, and intelligent visual analysis.

III. LITERATURE SURVEY

The rising demand for secure and reliable product authentication systems has encouraged extensive research in blockchain-based anti-counterfeiting frameworks. Thilina et al. (2021) proposed a blockchain-IoT integrated system for tracking products across supply chains. Their work demonstrated how immutable records combined with IoT sensors can detect unauthorized product movement, particularly within pharmaceutical supply chains. The study highlighted blockchain's capability to eliminate data manipulation but focused primarily on tracking rather than consumer-side verification.

Zhang et al. (2020) introduced a blockchain-enabled counterfeit detection mechanism specifically for online marketplaces. Their system utilized machine learning to analyze product descriptions and images, coupled with blockchain to maintain secure authentication records. The results showed significant improvement in identifying counterfeit listings; however, the approach heavily relied on textual and visual data and offered limited real-world physical product verification.

In the luxury goods domain, Kim et al. (2021) presented a blockchain-based anti-counterfeiting solution incorporating NFC technology. Each product was embedded with an NFC chip containing a unique encrypted identifier recorded on the blockchain. Consumers could scan the chip to validate authenticity, and the study demonstrated successful deployment in a luxury handbag supply chain. Nevertheless, the cost of integrating NFC chips has restricted scalability for low-cost consumer goods.

Jin et al. (2020) proposed a blockchain-backed QR-code authentication mechanism that supported low-budget product verification. Their research showed that QR-code–driven blockchain authentication was effective and economical; however, QR codes remained susceptible to cloning, as cloned labels could still bypass simple metadata checks if not paired with additional verification layers.

Zhang et al. (2019) conducted an empirical study on blockchain-enabled supply chain management to examine transparency and security in high-value electronics goods. Their findings indicated that

blockchain technology significantly reduced opportunities for counterfeit insertion by making every product movement traceable. Yet, the study did not address consumer-level validation or the use of computer vision to detect packaging-level counterfeiting.

A review of these studies reveals that while blockchain provides strong immutability, traceability, and decentralized trust, most existing systems rely solely on metadata and transaction history for verification. Few integrate visual inspection techniques, and even fewer combine both approaches into a unified counterfeit detection mechanism. This observation underscores the need for a comprehensive solution that incorporates both blockchain's tamper-proof nature and machine-learning–based visual analysis to address counterfeit detection more holistically and effectively. The proposed methodology in this paper is motivated by these research gaps and aims to provide a robust, scalable system suitable for diverse product categories.

IV. PROPOSED SYSTEM

The proposed system introduces a blockchain-driven framework designed to authenticate products throughout their entire life cycle and identify counterfeit items with high accuracy. The system operates within a permissioned blockchain environment where manufacturers, distributors, retailers, and consumers interact with a unified and transparent ledger. At the point of production, manufacturers register every product using a unique product identifier (UPID) that is cryptographically signed and stored on the blockchain. This record includes essential metadata such as batch details, manufacturing date, and ownership information. Once registered, the system generates a QR/NFC code that links the physical product to its immutable on-chain record.

When a product enters the supply chain, each transfer of custody is recorded as a blockchain transaction, ensuring that the complete provenance of the product is visible and auditable. The verification module allows consumers to scan the product upon purchase, automatically retrieving the corresponding blockchain record. A smart contract validates the integrity of the identifier, checks for duplication or unauthorized changes, and confirms whether the product follows a legitimate chain of custody.

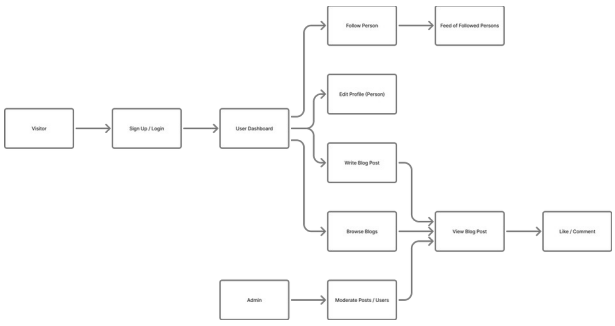

Fig 1: - Proposed system Architecture

To further enhance reliability, the system integrates an image-recognition layer capable of analyzing product packaging and physical characteristics. The uploaded image is compared to reference templates stored in the system, enabling detection of subtle inconsistencies often present in counterfeit goods. By combining immutable blockchain records with machine-learning–based visual analysis, the system provides a comprehensive, multi-layered authentication process that is highly resistant to tampering, replication, and data manipulation.

V. EXPECTED OUTCOME

The expected outcome of this work is the development of a secure and reliable counterfeit product detection mechanism that significantly minimizes the presence of fake goods in the marketplace. The system aims to produce a tamper-proof, transparent, and decentralized platform where each product can be verified easily by both supply-chain participants and end consumers. Through blockchain immutability, the system will ensure that all product records remain consistent and resistant to malicious alterations, while smart contracts automate verification processes without requiring third-party intervention.

Additionally, the incorporation of machine-learning–based image recognition is expected to increase detection accuracy beyond traditional label-based checks. The system is anticipated to reduce false positives and identify counterfeit items even when packaging identifiers are cloned. Consumers will benefit from instant verification, gaining trust in the authenticity of purchased goods. Manufacturers and distributors will gain enhanced traceability, helping to prevent unauthorized distribution and leakage. Overall, the system is expected to contribute toward a safer market environment with improved supply-chain transparency and reduced economic losses due to counterfeiting.

VI. CONCLUSION

The increasing prevalence of counterfeit goods across industries highlights the urgent need for robust and reliable product authentication mechanisms. Traditional methods of verification, such as holograms or serial numbers, are no longer sufficient due to their susceptibility to duplication and manipulation. The proposed blockchain-based counterfeit detection system addresses these limitations by providing an immutable, transparent, and decentralized infrastructure in which every product's lifecycle can be securely recorded and verified.

By combining blockchain technology with smart contracts, the system ensures automated, tamper-proof verification of product authenticity. The addition of an image recognition module further strengthens detection capabilities by identifying visual inconsistencies in packaging and product design. Together, these

components create a multi-layered solution that enhances consumer trust, improves supply-chain accountability, and reduces the circulation of fake goods. Future work may focus on scalability optimization, interoperability with global supply-chain standards, and the integration of more advanced AI models to further enhance accuracy and performance.

VII. REFERENCES

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