

Visual Audit Framework for Preventing E-Commerce Delivery and Return Fraud

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ABSTRACT: Product delivery and return fraud is a growing issue in e-commerce, where products are replaced, tampered with, or returned with missing components. These incidents create disputes between customers and sellers and result in financial loss, mistrust, and poor customer experience. Most current delivery and return processes do not maintain reliable visual proof of the product across its lifecycle. There is no proper way to confirm what was packed, what was actually delivered to the customer, and what was later returned. Manual verification is time-consuming, prone to human error, and often fails to clearly identify where fraud or tampering occurred. To address this problem, this project introduces a visual verification framework that continuously records and analyses three key checkpoints in the product lifecycle: the packing video, the delivery video, and the return video. Each video acts as digital proof of the product's condition, contents, and authenticity at different stages of the logistics process. The system applies YOLOv9 to detect and verify all visible items such as the main product and its accessories at each stage. A Siamese Network is then used to compare the product across these videos and confirm whether it is the same item throughout its journey. This deep-learning model is capable of handling variations in camera angle, lighting, and orientation, while still identifying subtle differences caused by product substitution or tampering. By performing pairwise comparisons—packing vs delivery, delivery vs return, and packing vs return—the system can accurately detect missing accessories, swapped items, or fraudulent return attempts. More importantly, it can pinpoint the exact stage where the discrepancy occurred, whether at the seller's end, during courier handling, or by the customer. The proposed approach reduces disputes, protects both customers and sellers, and creates a transparent audit trail throughout the delivery and return process. It improves accountability, enhances fraud detection accuracy, and helps resolve product return claims fairly.

I. INTRODUCTION

E-commerce has become an indispensable part of modern trade, transforming how consumers and businesses interact globally. However, the rapid growth of online retail has been accompanied by a significant increase in delivery and return fraud. Products are frequently tampered with, replaced with counterfeit items, or returned with missing accessories, causing financial and reputational damage to both sellers and platforms.

Traditional verification methods such as barcode scanning, signature collection, and manual inspection are insufficient to detect sophisticated fraud. They do not capture the visual state of products across the packing, delivery, and return stages, leaving all parties without reliable evidence during disputes.

This project proposes Visual Audit Framework, a system that records and links videos at each stage of the delivery lifecycle. Using deep learning techniques including YOLOv9 object detection and Siamese Networks for image similarity, the system automatically verifies product integrity and generates reliable evidence for dispute resolution.

II. PROBLEM DEFINITION

Existing e-commerce platforms lack robust mechanisms to detect fraud during delivery and return processes. The key problems include:

- Products are tampered with, replaced, or returned with missing parts.
- Both customers and sellers doubt each other due to lack of visual evidence.
- Manual inspection and barcode systems cannot detect physical tampering.
- Proof of delivery photos do not capture the internal product condition.
- Disputes are resolved inconsistently without proper audit trails.

III. PROPOSED SYSTEM

The proposed system introduces a continuous visual proof chain across packing, delivery, and return stages. Each video is recorded and linked to a unique order ID, enabling systematic comparison of product state throughout the lifecycle.

Working Process:

- Customer places an order; system generates a unique Order ID.
- Packing team records a video while sealing the product.
- Delivery agent records a video at the customer's doorstep before handover.
- Return team records a video while opening the returned package.
- Key frames are extracted from each video for analysis.
- YOLOv9 detects and counts products and accessories at each stage.
- Siamese Network compares product images across stages using similarity scores.
- Visual Evidence Fusion combines detection counts and similarity scores.
- Decision Engine classifies the case as genuine, partially fraudulent, or fraudulent.
- Alerts are sent and reports are stored for dispute resolution.

Technologies Used:

YOLOv9 – Object Detection

- Siamese Network – Product Similarity Comparison
- Python, Flask – Web Application Development
- MySQL – Database Storage
- OpenCV – Video Frame Extraction
- TensorFlow, Karas – Deep Learning Framework

IV. EXISTING SYSTEM

Current e-commerce fraud prevention methods include:

- Manual Inspection and Verification – warehouse staff manually check products before dispatch and during returns.
- Barcode and Serial Number Tracking – products are labelled and scanned at dispatch and return to verify identity.
- Proof of Delivery (POD) Photos and Signatures – delivery agents collect signatures or photographs as proof of handover.
- Policy-Based Return Verification – return policies and manual checks applied at the return centre.

Limitations:

- No complete visual proof of internal product condition.
- Tampering and missing parts are difficult to detect.
- Manual checking is unreliable and inconsistent.
- Disputes lack solid evidence and lead to unresolved claims.
- Serial tracking cannot verify the physical condition of a product.
- Delivery proof does not show accessories or internal items.

V. ADVANTAGES

- Significantly reduces delivery and return fraud.
- Provides clear visual proof for dispute resolution.
- Builds trust among customers, delivery agents, and sellers.
- Prevents losses caused by missing or swapped products.
- Saves time by automating fraud detection and evidence generation.
- Improves transparency and accountability in e-commerce logistics.
- Identifies the exact stage where fraud occurred.
- Supports fair refund and return decisions.
- Enhances overall customer satisfaction and service quality.

VI. DISADVANTAGES

- Requires consistent video recording at all three stages.
- Storage requirements increase with order volume.
- Poor video quality may reduce detection accuracy.
- Deep learning models require significant computational resources.
- Implementation complexity is higher than traditional barcode systems.

VII. SYSTEM ARCHITECTURE

The system architecture consists of the following key components working in a sequential pipeline:

- Video Capture Module – records packing, delivery, and return videos linked to Order ID.
- Frame Extraction Module – extracts key frames from each video for analysis.
- Object Detection Module (YOLOv9) – detects and counts products and accessories in each frame.
- Similarity Comparison Module (Siamese Network) – compares product images across stages.
- Visual Evidence Fusion Module – combines detection and similarity results.
- Decision Engine – classifies each case and generates audit records.
- Alerts and Notifications Module – informs users of fraud or verification results.
- Evidence Storage and Reporting Module – stores all records indexed by Order ID.

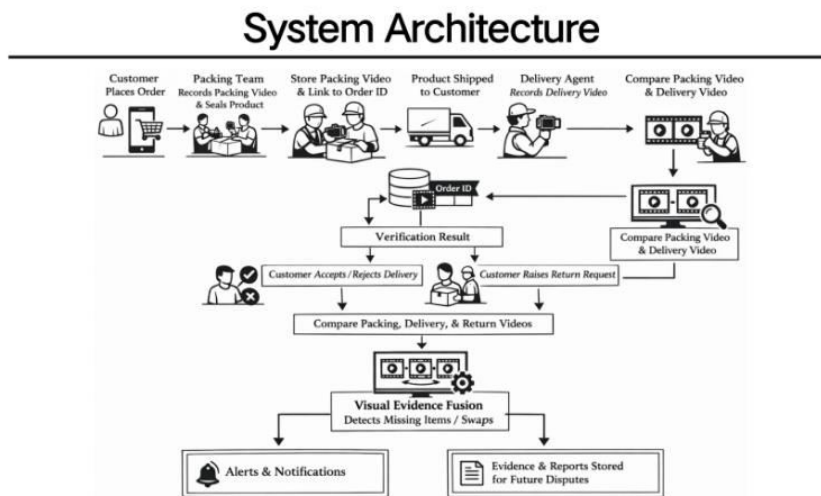


Fig. 1: System Architecture – Visual Audit Framework

VIII. RESULTS

The implementation of the Visual Audit Framework demonstrates that automated video-based verification can significantly improve fraud detection and resolution in e-commerce systems.

Observed Results:

- Accurate detection of tampered, swapped, and missing products across delivery stages.
- Reduced unauthorized return approvals and fraudulent delivery claims.
- Improved dispute resolution with clear, timestamped visual evidence.
- Faster verification compared to manual inspection processes.
- Better identification of the exact stage at which fraud occurred.

The system successfully verifies genuine orders while accurately detecting and flagging fraud attempts, improving accountability for all parties involved.

IX. CONCLUSION

The Visual Audit Framework provides a reliable and transparent solution for detecting delivery and return fraud in e-commerce systems. Traditional authentication methods are increasingly insufficient against modern fraud techniques. By integrating YOLOv9 object detection and Siamese Network similarity comparison with a continuous video evidence chain, the proposed system enhances accountability, reduces disputes, and improves user trust in online transactions. Although challenges such as storage requirements and video quality exist, the system proves to be an effective and scalable modern fraud prevention solution.

X. FUTURE ENHANCEMENTS

Possible future improvements include:

- Legal and Insurance Integration – automated generation of insurance claims or legal records from verified fraud reports.
- Multi-Camera and 360° Product Recording – capturing all angles to eliminate blind spots.
- AI-Based Decision Explanation – providing human-readable summaries such as ‘Missing accessory: charger count reduced at delivery stage’.
- Real-Time Fraud Alerting – instant notifications during suspicious events.
- Mobile Application Implementation – enabling agents to record and upload videos from mobile devices.
- Cloud-Based Evidence Storage – scalable, secure storage for large order volumes.
- Multilingual Dashboard Support – making the system accessible across regions.

XI. TABLE

Test Cases – Unit Testing

TC ID	Input	Expected Result	Actual Result	Status
UT01	Valid order details	Order ID generated	Order ID generated successfully	Pass
UT02	Upload packing video	Video saved with Order ID	Video linked correctly	Pass
UT03	Extract frames from video	Key frames extracted	Frames extracted properly	Pass
UT04	Run object detection on frame	Objects detected with labels	Objects labeled correctly	Pass
UT05	Compare two product images	Similarity score generated	Score calculated correctly	Pass

Test Cases – Security Testing

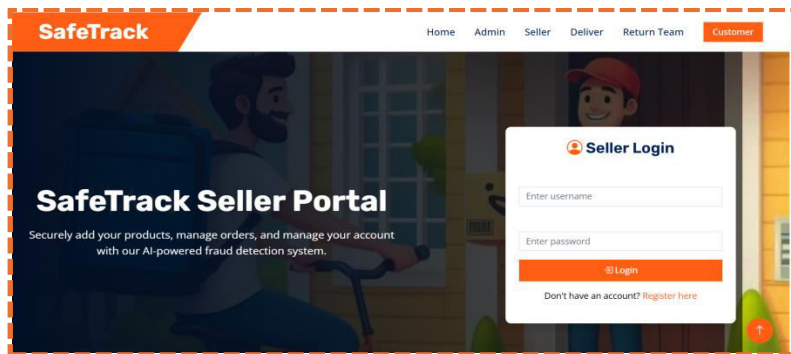
TCID	Input	Expected Result	Actual Result	Status
ST01	Invalid login credentials	Access denied	Access denied	Pass
ST02	Unauthorized admin access attempt	Restricted access	Access blocked	Pass
ST03	Direct URL access to video file	Access denied without permission	Blocked successfully	Pass
ST04	SQL injection attempt	Input rejected	Protected successfully	Pass
ST05	Multiple failed login attempts	Account temporarily locked	Lock applied	Pass

Product Table

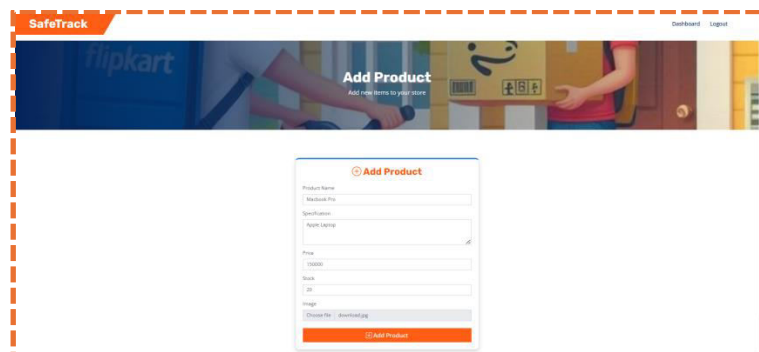
Field Name	Data Type (Size)	Constraints	Description
Product Id	Varchar(20)	Primary Key, Not Null	Unique product ID
Seller Id	Varchar(20)	Foreign Key, Not Null	Linked seller
Product Name	Varchar(150)	Not Null	Product title

Product Description	Text	Not Null	Product details
Price	Decimal(10,2)	Not Null	Product price
Stock Quantity	Int	Not Null	Available stock

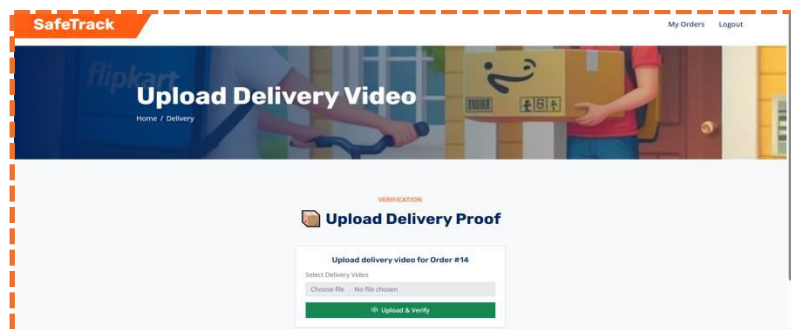
XII. SCREENSHOT



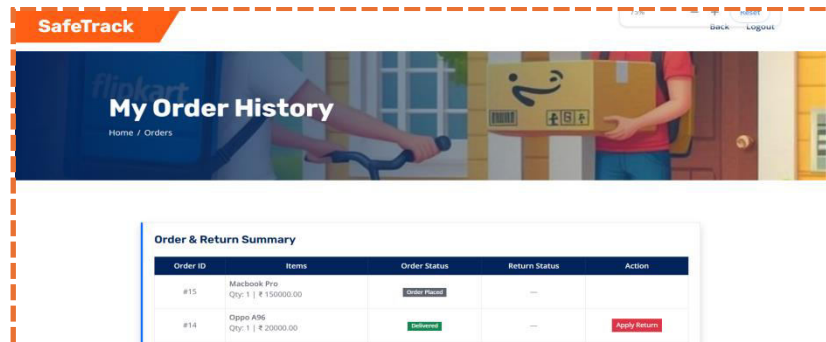
Seller Login



Add Products



Accept and Upload Delivery Video



Apply Return

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