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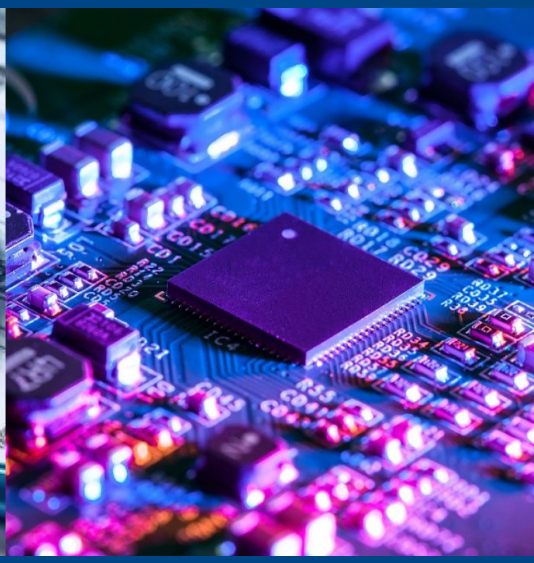

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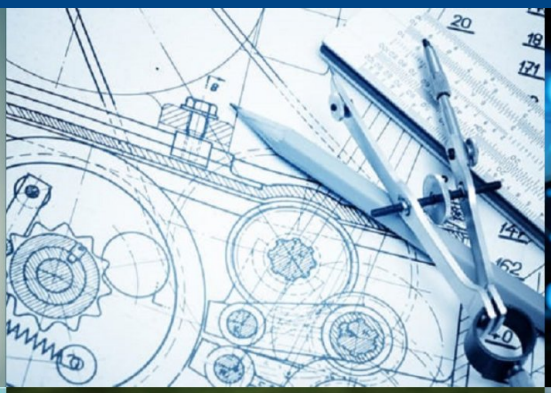

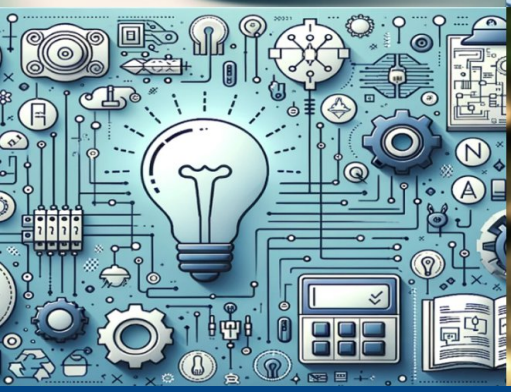

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Visual Refund Fraud Detection and Prevention System for Food Delivery Platforms

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ABSTRACT: This research presents the design and development of an Visual Refund Fraud Detection and Prevention System For Food Delivery Platform. With the rapid growth of online food delivery services, fraudulent refund requests using manipulated, edited, AI-generated, or reused food images have significantly increased. Many customers exploit image editing tools and generative AI models to fabricate evidence such as hair, insects, or spoiled food visuals in order to obtain refunds. Traditional refund verification systems rely heavily on manual review, which is time-consuming, inconsistent, and financially costly for food delivery platforms. The proposed system introduces a multi-layer intelligent verification architecture integrating computer vision, similarity detection, behavioral analytics, and explainable AI decision mechanisms. The system consists of six structured layers including image capture validation, visual forensics AI classification, image reuse detection, packaging and context validation, fraud behavior intelligence, and a final explainable risk decision engine. A balanced dataset containing real food images, edited fake images, AI-generated images, duplicate images, and behavioral data is collected and preprocessed for model training. Transfer learning using ResNet18 is applied for visual classification, while cosine similarity techniques are used for reuse detection. The platform also includes an AI assistant interface for real-time analysis and administrative monitoring. Experimental evaluation demonstrates reliable fraud detection performance and structured risk scoring. The proposed hybrid architecture enhances automation, transparency, and operational efficiency in food delivery refund management systems.

KEYWORDS: Food Delivery Fraud Detection, Computer Vision, Image Forensics, Similarity Detection, Behavioral Analytics, Deep Learning, Transfer Learning, Explainable AI, Risk Scoring, Web Application Security

I. INTRODUCTION

Recent research work carried out between 2022 and 2026 has investigated the application of artificial intelligence in fraud analysis, digital image forensics, and risk modeling. Computer vision methods such as Convolutional Neural Networks, ResNet models, Efficient Net models, and Vision Transformers have been extensively used for image authenticity analysis and the detection of AI-generated images. Research work on AI- generated image detection has shown that deep learning models can be used to detect pixel-level inconsistencies and artifacts in the frequency domain introduced by generative models .Research work on similarity detection highlights the importance of embedding extraction

techniques using pre-trained models like ResNet and CLIP, and then compare using cosine similarity or FAISS indexing for large-scale image retrieval systems. Such methods are very useful for duplicate or near-duplicate image detection. Behavioral fraud detection systems usually employ anomaly detection models like Isolation Forest, Random Forest, and ensemble risk scoring for anomaly detection. Although such methods are proven to be effective separately, very few methods combine visual authenticity verification, duplicate image verification, contextual packaging validation, and behavioral intelligence into a single enterprise solution for food delivery refund fraud. This problem statement thus calls for the design of a six-layer AI-powered verification system specifically for food delivery services .literature review

Recent research work carried out between 2022 and 2026 has focused on artificial intelligence applications in fraud analysis, digital image forensics, and behavioral risk modeling. Computer vision methods such as Convolutional Neural Networks (CNN), ResNet models, EfficientNet models, and Vision Transformers have been extensively used for image authenticity verification and AI-generated image detection. Research work in AI- generated image detection has shown

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that deep learning models can be used to detect pixel-level inconsistencies and frequency domain artifacts added by generative models. Research in similarity detection highlights the use of embedding extraction techniques based on pretrained models such as ResNet and CLIP, followed by cosine similarity comparison or FAISS indexing for large-scale retrieval systems. These methods have been shown to be effective in detecting similar or duplicate images. Fraud analysis systems typically employ anomaly detection models such as Isolation Forest, Random Forest, and ensemble risk scoring models to detect unusual user behavior. While these methods have been shown to be effective separately, there is limited research work in combining visual authenticity detection, duplicate image verification, and behavioral fraud detection models., The integration of contextual packaging validation and behavioral intelligence into a unified enterprise framework for food delivery refund fraud. This leads to the need for a six-layer AI-based verification architecture designed for food delivery systems.

II. PROBLEM DEFINITION

The food delivery services are experiencing growing financial losses due to fraudulent refund claims that are supported by altered or artificially created images of food. Customers can alter the images to appear contaminated, reuse old images, or create artificial images to request compensation. The traditional manual review process is slow, inconsistent, and non-scalable with the growth of the platforms. The current automated systems do not have multi-stage validation and explainability tools. This implies that there is a need for a smart and organized system that combines visual authenticity verification, duplicate detection, contextual validation, behavioral analysis, and explainable risk scoring. The system should promote accurate fraud detection with low false positives against genuine customer complaints.

III. PROPOSED SYSTEM

The proposed system is a multi-layer fraud detection and prevention system designed to detect and prevent fraudulent visual refund claims in food delivery services. The system combines computer vision algorithms, similarity detection algorithms, behavioral analysis, and a decision-making engine to offer a reliable and automated refund verification system. The proposed system has the following major components:User Query Input Module

- Image Capture Validation Module
- Visual Forensics Classification Module
- Image Reuse and Similarity Detection Module
- Packaging and Context Validation Module
- Fraud Behavior Intelligence Module
- Explainable Risk Decision and Reporting Module

The system starts by accepting customer-submitted images of food for refund. The Image Capture Validation Module validates the image integrity by checking the file format, resolution, corruption, and size. The image is then passed to the Visual Forensics Classification Module, where a deep learning algorithm using transfer learning is applied to classify the image into one of the three categories: real food image, edited fake image, or AI-generated image.

The defined risk categories include:

1. Genuine Claim
2. Edited Image Manipulation
3. AI-Generated Image Fraud
4. Reused or Duplicate Image
5. Staged Packaging Manipulation
6. Behavioral Abuse Pattern

These categories focus on structured fraud intelligence rather than simple image verification, providing a scalable and enterprise-ready solution for modern food delivery refund management systems.

IV. SYSTEM ARCHITECTURE

The architecture follows a layered design:

- Presentation Layer**:** Flask-based web interface for image upload, refund submission, and fraud monitoring

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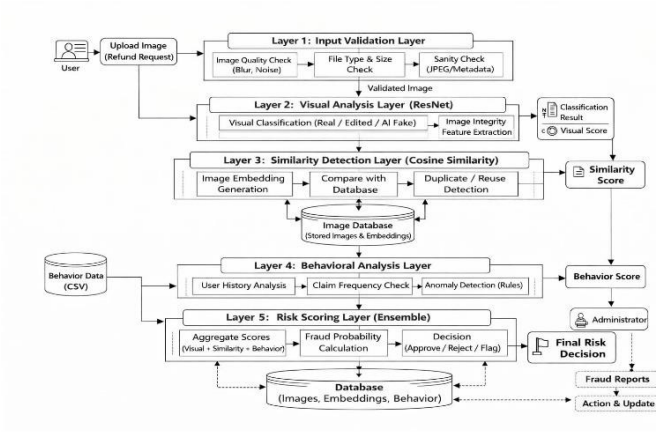
dashboard.

- Application Layer**:** Handles image validation, visual classification, similarity detection, behavioral analysis, and risk decision processing..

AI Analytics Layer**:** Implements ResNet-based classification, embedding similarity comparison, and anomaly detection models

Data Layer: Stores user claims, image embeddings, behavioral logs, risk scores, and trained model files.. This layered architecture separates user interface,
processing logic, AI models, and data storage, ensuring scalability, maintainability, and future system enhancement.



V. METHODOLOGY

The system follows a structured processing pipeline:

Data Collection

A labeled dataset containing real food images, edited fake images, AI-generated images, duplicate image variations, packaging images, and behavioral claim data is collected for model training and validation.

Preprocessing

A labeled dataset containing real food images, edited fake images, AI-generated images, duplicate image variations, packaging images, and behavioral claim data is collected for model training and validation.

Feature Extraction

Deep features are extracted using a pretrained ResNet model for visual classification. Image embeddings are generated for similarity comparison using cosine similarity. Behavioral features are structured for anomaly scoring.

Classification

Deep features are extracted using a pretrained ResNet model for visual classification. Image embeddings are generated for similarity comparison using cosine similarity. Behavioral features are structured for anomaly scoring.

Decision Engine

A risk scoring mechanism aggregates outputs from all layers and assigns a fraud probability score. Based on defined thresholds, the system decides to approve, flag, or reject the refund claim.

Reporting

Fraud analysis results, risk scores, claim history, and detection categories are displayed through an administrative dashboard with structured monitoring insigh

ALGORITHM

This section describes the core algorithms used in the proposed system for detecting fraudulent visual refund claims. The system integrates deep learning-based image classification, embedding similarity detection, behavioral anomaly scoring, and a structured risk decision engine to ensure accurate, transparent, and scalable fraud verification.

Residual Neural Network (ResNet18) Based Visual Classification Algorithm

ResNet (Residual Network) is a deep convolutional neural network architecture designed to address the vanishing gradient problem in deep networks through residual learning. It introduces shortcut connections that allow gradients to

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flow directly across layers, enabling effective training of deep models.

In the proposed system, a pretrained ResNet18 model is used through transfer learning for image classification. The model is fine-tuned using a labeled dataset containing real food images, edited fake images, and AI-generated food images. During preprocessing, input images are resized to a fixed dimension and normalized before being passed into the network.

The model extracts hierarchical visual features such as texture patterns, color inconsistencies, synthetic artifacts, and edge distortions that may not be visible to the human eye. The final fully connected layer produces probability scores for each class. The class with the highest probability is selected as the predicted category. This probability score is also used as a confidence measure in the final fraud risk evaluation.

ResNet is chosen due to its high accuracy, strong generalization capability, and suitability for visual authenticity detection tasks.

Cosine Similarity-Based Image Reuse Detection Algorithm
Cosine Similarity is a vector-based similarity measurement technique used to determine the similarity between two feature embeddings. It calculates the cosine of the angle between two vectors in a high-dimensional feature space.

In the proposed system, deep feature embeddings are extracted from food images using the pretrained ResNet model. These embeddings represent compact numerical representations of image characteristics. The embeddings of uploaded refund claim images are compared with stored embeddings of original food images using cosine similarity.

The similarity score ranges between -1 and 1, where values closer to 1 indicate high similarity. If the similarity score exceeds a predefined threshold, the image is identified as a reused or duplicate image. This mechanism helps detect customers who attempt to reuse previously submitted images to claim multiple refunds.

Cosine similarity is selected due to its computational efficiency and effectiveness in detecting near-duplicate visual patterns.

Behavioral Anomaly Detection Algorithm
Behavioral anomaly detection is used to identify suspicious refund claim patterns based on user activity history. The system analyzes structured behavioral features such as number of previous refund claims, claim frequency, account age, average claim interval, and past fraud flags.

A machine learning-based anomaly scoring approach or rule-based weighted scoring mechanism is applied to compute a behavioral risk score. If the computed **score**

exceeds a predefined threshold, the user behavior is classified as suspicious. This module enhances fraud detection by combining visual analysis with user activity intelligence.

Behavioral anomaly detection strengthens the system by identifying fraud attempts even when visual manipulation is minimal.

Ensemble Risk Scoring Decision Algorithm
The final decision engine integrates outputs from visual classification, similarity detection, packaging validation, and behavioral analysis. Each module contributes a weighted risk score to the overall fraud probability.
The system aggregates these scores using an ensemble risk scoring strategy and categorizes the claim into predefined classes such as genuine claim, suspicious claim, or fraudulent claim. Threshold-based decision logic determines whether the refund request is automatically approved, flagged for manual review, or rejected.
This structured decision mechanism ensures transparency, explainability, and consistent fraud management across the platform.

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VI.IMPLEMENTATION

The proposed system is implemented using Python as the primary programming language due to its flexibility, extensive library ecosystem, and seamless integration with deep learning frameworks. The web application is developed using the Flask framework, which enables dynamic interfaces for image upload, refund claim processing, and administrative fraud monitoring dashboards.

Image preprocessing and augmentation are performed using OpenCV, PIL, NumPy, and Torchvision libraries. These tools support resizing, normalization, rotation, brightness adjustment, noise addition, and compression- based transformations required for model robustness. Deep learning models are implemented using PyTorch and Torchvision, where a pretrained ResNet18 model is fine-tuned for visual classification of real, edited, and AI- generated food images.

For similarity detection, deep feature embeddings are extracted from the trained ResNet model, and cosine

similarity comparison is applied to detect reused or duplicate images. Behavioral fraud analysis is implemented using structured CSV datasets processed with Pandas, enabling anomaly scoring based on user refund patterns.

The trained classification model is saved using PyTorch model serialization for deployment. The backend integrates all six processing layers into a structured inference pipeline, where outputs from visual classification, similarity detection, packaging validation, and behavioral scoring are aggregated within a risk decision engine.

VII. EXPERIMENTAL RESULTS

Experiments were conducted using a balanced labeled dataset consisting of real food images, edited fake images, and AI-generated food images. Each category contained an equal number of samples to ensure unbiased model training and evaluation. The dataset was divided into training and testing sets using an 80:20 split to validate model performance objectively. The ResNet18- based visual classification model achieved strong performance in distinguishing between real, edited, and AI-generated images. The overall validation accuracy demonstrated consistent improvement after dataset balancing and augmentation. Performance metrics such as precision, recall, and F1-score were evaluated to measure class-wise reliability. The results indicate that the model effectively detects visual manipulation artifacts and synthetic image characteristics.

For image reuse detection, cosine similarity comparison between stored embeddings and uploaded claim images successfully identified duplicate and near- duplicate submissions. Similarity threshold tuning improved detection sensitivity while minimizing false positives. Behavioral anomaly detection experiments were conducted using structured refund claim data, including historical claim frequency and account activity patterns. The anomaly scoring mechanism effectively flagged suspicious claim behavior that deviated from normal usage patterns. The ensemble risk scoring engine integrated outputs from visual classification, similarity detection, and behavioral analysis to generate final fraud probability scores. The multi-layer integration improved overall fraud detection robustness compared to single- layer evaluation.

VIII. DISCUSSION

The proposed multi-layer fraud detection system successfully integrates visual classification, similarity detection, behavioral analysis, and structured risk scoring to automate refund verification in food delivery platforms. Unlike traditional manual review processes, the system emphasizes layered validation and data-driven decision-making to improve fraud detection accuracy and consistency. The modular architecture allows independent optimization of visual forensics, reuse detection, behavioral intelligence, and decision engine components. This structured design enhances scalability, simplifies maintenance, and supports future integration of advanced detection models or cloud-based deployment.

The use of probability-based confidence scores and ensemble risk evaluation improves transparency in automated fraud decisions. Administrative dashboards provide structured insights into fraud categories, claim patterns, and risk trends, enhancing monitoring and operational efficiency. However, system performance depends on dataset diversity, image quality variations, and evolving AI-based image generation techniques. Continuous dataset expansion and periodic

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model retraining are required to maintain detection robustness. Despite these challenges, the system demonstrates strong potential for practical deployment in modern food delivery refund management systems.

ADVANTAGES

The proposed system offers several important advantages:

- Provides automated and intelligent detection of fraudulent visual refund claims
- Reduces dependency on manual refund verification processes
- Integrates multi-layer validation including visual, similarity, and behavioral analysis
- Generates structured and explainable fraud risk scores
- Detects AI-generated, edited, and reused food images
- Identifies abnormal refund claim patterns through behavioral intelligence
- Improves transparency using probability-based risk evaluation
- Modular and scalable enterprise architecture
- Supports administrative dashboard with fraud analytics and monitoring
- Enables efficient deployment through a web-based interface

These advantages make the system suitable for practical fraud prevention in modern food delivery platforms, improving operational efficiency and reducing financial losses.

IX. LIMITATIONS

Despite its effectiveness, the proposed system has certain limitations:

- Performance depends on the quality, diversity, and balance of the visual and behavioral datasets
- Requires riodic retraining to maintain robustness against evolving image manipulation and AI generation techniques
- Similarity detection accuracy depends on predefined threshold tuning
- Confidence estimation may vary for borderline visual cases
- Computational complexity increases with large-scale image embedding storage
- Real-time large-scale deployment may require higher computational resources and optimized infrastructure
- Behavioral rule thresholds may require updates as user These limitations indicate the need for continuous dataset expansion, model refinement, and infrastructure optimization to maintain long-term fraud detection performance.

X. FUTURE ENHANCEMENT

Several future enhancements are planned to improve system functionality and scalability:

- Integration of real-time fraud monitoring with live refund processing systems
- Deployment on secure cloud-based infrastructure for large- scale enterprise use
- Implementation of advanced deep learning models for improved AI-generated image detection
- Integration of large-scale embedding indexing systems such as FAISS for faster similarity search
- Development of mobile administrative applications for fraud monitoring
- Real-time alert notifications for high-risk refund claims
- Enhancement of behavioral analytics using advanced anomaly detection techniques
- Large-scale validation using diverse real-world food delivery datasets

These enhancements will strengthen fraud detection accuracy, improve scalability, and support enterprise-level deployment in modern food delivery platforms.

XI. CONCLUSION

This research presents a multi-layer fraud detection and prevention system designed to address fraudulent visual refund claims in food delivery platforms. The proposed framework integrates visual classification, image reuse detection, behavioral anomaly analysis, and an ensemble risk decision engine to provide structured and automated refund verification. By combining deep learning-based image forensics with similarity detection and user behavior intelligence, the system ensures accurate identification of manipulated, AI-generated, and reused food images.

Unlike traditional manual refund review processes, the proposed architecture emphasizes multi-stage validation and probability-based risk scoring to enhance transparency and consistency in decision-making. The integration of embedding similarity comparison strengthens duplicate image detection, while behavioral analytics provide additional

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fraud context beyond visual evidence. The administrative dashboard offers structured insights into fraud categories, risk distribution, and claim patterns, improving operational monitoring and decision support.

The Parent Dashboard provides visual analytics including search history logs, risk distribution charts, category breakdown analysis, and activity monitoring. These insights help parents understand behavioral patterns and identify potential risks at an early stage. The system not only blocks harmful content but also supports informed parental intervention and responsible internet usage guidance.

Experimental evaluation demonstrates reliable classification performance and effective reuse detection across balanced datasets. The modular layered architecture ensures scalability, maintainability, and ease of future enhancement. With continuous dataset expansion and adaptive model refinement, the system can effectively respond to evolving fraud strategies and emerging image manipulation techniques.

Overall, the proposed fraud detection framework establishes a practical and intelligent solution for food delivery refund management. It bridges the gap between visual forensics, behavioral intelligence, and automated decision systems, contributing to improved operational efficiency, reduced financial losses, and enhanced trust in digital food delivery ecosystems.

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