Image Forensics & Sentiment Analysis System

Progress Report

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Executive Summary

This Image Analysis Application is a comprehensive platform that unifies digital image forensic analysis with AI-powered sentiment detection. The application is designed to detect tampering, authenticate image sources, and analyze facial expressions for emotional context. The backend, developed using FastAPI and Python, integrates advanced image processing and machine learning techniques including Error Level Analysis (ELA), PRNU fingerprinting, copy-move forgery detection, object detection using YOLOv8, and emotion analysis using DeepFace. The frontend, built with React, provides an intuitive interface for users to upload images, view results, and download forensic reports.

Key achievements include a unified JSON schema for image analysis results, integration of multiple forensic pipelines, and a responsive web interface. This tool can be applied in domains such as digital forensics, journalism, cybersecurity, and academic research. Future extensions include expanding to video analysis and cloud-based scalability.

1. Introduction & Objectives

With the widespread availability of editing software, ensuring the authenticity of digital images has become an urgent requirement. Tampered images can spread misinformation, compromise evidence in forensic investigations, and mislead in journalism. To address these challenges, this project develops an Image Analysis Application combining forensic and AI techniques.

Objectives:

- Detect image manipulations including splicing, copy-move, morphing, and lighting inconsistencies.
- Extract detailed image metadata and JPEG structural information.
- Apply PRNU fingerprinting to identify camera sources and validate authenticity.
- Perform emotion detection using DeepFace for facial expression analysis.
- Use YOLOv8 for real-time object detection within images.
- Provide a web-based frontend for intuitive user interaction and results visualization.

2. System Overview & Key Features

The system follows a client-server architecture. The backend (FastAPI) executes forensic and AI modules, while the frontend (React) handles image uploads, previews, and result visualization. The application integrates multiple forensic techniques into a single pipeline, ensuring that each uploaded image undergoes a holistic analysis.

Key Features:

- Metadata extraction: PIL, ExifRead, Piexif, Hachoir
- Error Level Analysis (ELA) and splicing detection
- Lighting inconsistency analysis with heatmaps
- Noise visualization and regional variance detection
- Copy-move forgery detection using ResNet18 and cosine similarity
- Camera model identification and thumbnail extraction
- CFA artifact detection
- PRNU fingerprint estimation, localization, and matching
- Face morphing detection via Mediapipe facial landmarks
- Emotion analysis with DeepFace
- YOLOv8 object detection
- Digest info and cryptographic/perceptual hashing
- Dashboard endpoints for statistics and recent uploads

3. Methodology (Detailed per Module)

Each uploaded image is subjected to a series of analysis modules implemented in the backend:

- Metadata Analysis: Uses multiple libraries (PIL, ExifRead, Piexif, Hachoir) for redundancy.
- Error Level Analysis (ELA): Detects compression inconsistencies by recompressing images.
- Lighting Analysis: Computes local variance and brightness histograms with heatmaps.
- Noise Analysis: Gaussian filtering and variance calculations to reveal anomalies.
- Copy-Move Forgery Detection: Extracts deep features from patches
- Splicing: To detect manipulation
- PRNU Analysis: Implements wavelet denoising, residual extraction, NCC/PCE for matching, and localization maps.
- Camera Model Identification: Extracts Make and Model via EXIF parsing.
- Thumbnail Comparison: Uses perceptual hashing to verify integrity of embedded thumbnails.
- CFA Artifact Detection: Detects frequency artifacts from Color Filter Array patterns.
- Face Morphing Analysis: Landmark asymmetry and blending artifact detection via Mediapipe.
- Emotion Analysis: DeepFace library for emotion classification and dominant emotion detection.
- Object Detection: YOLOv8 lightweight model identifies objects with confidence scores.

4. Flow

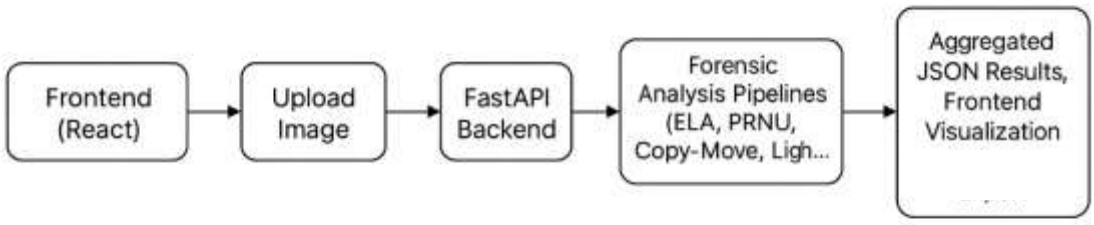

Figure 1: Flow of System

5. Work Completed

The following major tasks were successfully completed:

- Developed FastAPI backend with modular forensic analysis pipelines.
- Integrated YOLOv8 for efficient object detection.
- Implemented PRNU fingerprinting for camera verification.
- Enabled face morphing detection and emotion recognition.
- Built React frontend with upload, preview, and result visualization.
- Connected frontend to backend endpoints via REST API.
- Designed dashboard APIs for recent uploads and analyzed statistics.
- Unified JSON schema for consolidating all analysis outputs

6. Conclusion

The Image Analysis Application integrates advanced forensic techniques with AI-driven analysis to deliver a robust tool for detecting manipulations, authenticating image sources, and analyzing emotional content. Its modular backend allows extensibility, while the React frontend ensures user friendliness. This project demonstrates the feasibility of combining PRNU fingerprinting, ELA, copy-move detection, and sentiment analysis into a single coherent tool.

Future enhancements include extending analysis to video, integrating cloud storage and distributed processing, and refining forgery detection accuracy with advanced machine learning approaches.

References

- FastAPI Documentation
- Ultralytics YOLOv8 Docs
- OpenCV Library
- DeepFace Library
- Relevant research papers (PRNU, Image Forensics, ELA, etc.)

Appendix

- Backend API schemas (sample JSON responses)
- Screenshots of frontend UI (upload card, preview, results page)
- Flow diagrams & extra charts