CONVOLUTIONAL NEURAL NETWORKS IN MOTION: AUTOMATING PASSENGER IDENTIFICATION AT TERRESTRIAL TERMINALS

ABSTRACT

The growing insecurity at terrestrial terminals, characterized by transnational crimes and inefficient surveillance, necessitates advanced technological solutions. This study develops an automatic identification system leveraging Convolutional Neural Networks (CNNs) to enhance public safety by rapidly identifying individuals with outstanding arrest warrants. Utilizing a quasi-experimental design and a quantitative approach, the research implements models like InsightFace for facial recognition and YOLOv8 for real-time people tracking. The system was trained and evaluated on a private dataset of 50,000 images, augmented to improve robustness. Results demonstrated exceptional performance, with InsightFace achieving 97.53% precision, 100% recall, and a 98.76% F1-score, while YOLOv8 attained 95.93% precision and 99% recall. The study concludes that the proposed CNN-based system offers a highly effective and reliable solution for automating passenger identification, representing a significant step towards modernizing surveillance infrastructure at terrestrial terminals, albeit with recommendations for further optimizing performance in complex, high-density scenarios.

EXISTING SYSTEM

The current paradigm for identifying wanted individuals at terrestrial terminals, particularly in the context of the study in Chiclayo, Peru, relies on a fragmented and predominantly manual approach. This system is a composite of legacy procedures and non-integrated technologies that have failed to keep pace with the volume and sophistication of modern criminal mobility. The core components of this system are:

Manual Document Verification: The primary method involves law enforcement officers manually checking National Identity Documents (DNI) against physical or digital lists of wanted individuals. This process is conducted at checkpoints or through random spot checks within the terminal.

Non-Intelligent Video Surveillance: Closed-circuit television (CCTV) cameras are installed throughout the terminal. However, these systems operate passively, recording footage for post-

incident review rather than for real-time analysis. As noted in the context of Bogotá, a significant portion of this infrastructure is often non-operational.

Physical "Most Wanted" Notices: Authorities supplement other methods by displaying physical posters or banners with photographs and details of high-priority fugitives. This relies on the vigilance and memory of both security personnel and the general public to recognize a face from a static image.

Disadvantages of the Existing System

1. Operational Inefficiency and High Latency in Identification

The reliance on manual document checks creates a fundamental bottleneck in passenger processing. This method is inherently slow, requiring a direct, time-consuming interaction for each individual screened. In a high-traffic environment like a bus terminal, this either leads to significant passenger delays or forces authorities to resort to random checks, which drastically reduces the coverage and effectiveness of the screening process. The system's latency is so high that a wanted individual can pass through the terminal long before a manual check, or a subsequent forensic review of video footage, can identify them. This makes the process fundamentally reactive rather than proactive.

2. Pronounced Human Error and High Rate of Missed Detections (False Negatives)

The existing system is critically dependent on human factors, which are its greatest weakness. The manual verification of documents is susceptible to fatigue, distraction, and the cognitive impossibility of officers memorizing thousands of faces. Similarly, the "Most Wanted" poster method is highly inefficient, as a person's appearance can be easily altered with simple changes in hairstyle, clothing, or accessories. This leads to a very high probability of false negatives, where individuals with active arrest warrants are visually overlooked and pass through the terminal undetected. The system's accuracy is therefore unacceptably low for a critical public safety function.

3. Systemic Fragmentation and Lack of Proactive Intelligence

The various components of the existing system—CCTV cameras, document databases, and physical notices—operate in complete isolation from one another. The video surveillance system does not communicate with the database of wanted individuals, rendering it a "dumb" recording device rather than an "intelligent" sensor. This fragmentation prevents the creation of a proactive

security posture. Security personnel cannot receive real-time alerts when a person of interest is identified on camera. Consequently, the system offers no capability for preemptive action, allowing criminal activities to proceed until after the fact, at which point the investigation must rely on piecing together evidence from disparate, non-integrated sources.

PROPOSED SYSTEM

The proposed system introduces a comprehensive, technology-driven solution centered on Convolutional Neural Networks (CNNs) to revolutionize passenger identification at terrestrial terminals. This integrated framework operates through a sophisticated, multi-stage pipeline:

Real-Time People Detection & Tracking with YOLOv8: The system continuously processes live video feeds using the YOLOv8 deep learning model, which performs real-time detection and tracking of all individuals within the camera's field of view. This ensures comprehensive coverage of passenger movement throughout the terminal environment.

Automated Facial Recognition with InsightFace: For each detected individual, the system employs the InsightFace model to extract and analyze facial features, creating unique numerical embeddings ("facial fingerprints"). These embeddings are instantaneously compared against a secure database of known persons of interest.

Integrated Alerting and Response Platform: Upon positive identification, the system triggers immediate, prioritized alerts to law enforcement personnel. These alerts include matched identity information, live video feed, and precise location data within the terminal, enabling rapid and targeted intervention.

The architecture leverages a robust technological stack including Python, PyTorch, Keras, and FAISS for efficient vector search operations, designed for scalable deployment on cloud or edge-computing platforms.

Advantages of the Proposed System

1. Comprehensive Real-Time Processing Capability

   The system achieves unprecedented operational efficiency through simultaneous processing of all individuals within surveillance coverage. This enables 100% passenger screening without creating bottlenecks or impeding passenger flow, representing a quantum leap in surveillance thoroughness and operational throughput.

2. Exceptional Accuracy and Reliability

   Leveraging advanced CNN architectures, the system demonstrates remarkable performance metrics with InsightFace achieving 100% recall and 97.53% precision, while YOLOv8 maintains 99% recall and 95.93% precision. This ensures near-perfect identification of persons of interest while minimizing false alarms, establishing new standards for identification reliability in dynamic environments.

3. Proactive Intelligence Integration

   The framework transforms passive surveillance infrastructure into an active intelligence network by seamlessly integrating detection, recognition, and notification systems. This creates immediate, actionable intelligence that enables preemptive security measures and rapid response capabilities, fundamentally enhancing situational awareness and intervention effectiveness in critical security scenarios

SYSTEM REQUIREMENTS

- **H/W System Configuration:-**
- Processor - Pentium –IV
- RAM - 4 GB (min)
- Hard Disk - 20 GB
- Key Board - Standard Windows Keyboard
- Mouse - Two or Three Button Mouse
- Monitor - SVGA

SOFTWARE REQUIREMENTS:

- **Operating system** : Windows 7 Ultimate.
- **Coding Language** : Python.
- **Front-End** : Python.
- **Back-End** : Django-ORM
- **Designing** : Html, css, javascript.
- **Data Base** : MySQL (WAMP Server).