

The “Rule Cop”

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Abstract - This work presents Rule Cop, an AI-powered surveillance system designed to automate discipline monitoring in educational campuses. Traditional manual supervision suffers from inconsistency, human bias, and limited monitoring coverage. To overcome these challenges, the proposed system integrates YOLOv8 object detection, OpenCV-based video analytics, face recognition, and an SQL database to detect violations such as missing ID cards, dress-code breaches, loitering, and unauthorized entry. The system processes live CCTV feeds, identifies individuals with high accuracy, and stores violation logs with timestamps, snapshots, and location metadata. A dashboard interface enables authorities to review real-time alerts and historical data. Experimental evaluation demonstrates an overall detection accuracy of approximately 92%, validating the system’s ability to deliver scalable, unbiased, and automated monitoring across large campus environments. The approach also provides a foundation for future extensions including automated attendance, anomaly detection, and cloud-integrated analytics

I. INTRODUCTION

Discipline, safety, and structured movement are essential components of an effective educational environment. However, traditional monitoring methods rely heavily on human security staff, making them vulnerable to inconsistency, human error, and limited coverage. Manual supervision is time-consuming, difficult to scale, and lacks digital traceability, resulting in unrecorded violations and reduced operational efficiency.

Advancements in artificial intelligence and computer vision allow institutions to automate surveillance and eliminate many shortcomings of manual monitoring. Modern deep-learning models such as YOLOv8 offer high-speed, high-accuracy detection capable of processing real-time video streams. When combined with OpenCV and advanced face recognition

algorithms, AI systems can detect rule violations objectively and consistently.

This project introduces Rule Cop, a multi-module smart monitoring system that autonomously identifies missing ID cards, dress-code violations, loitering, and unauthorized entries within campus premises. The system integrates detection algorithms, rule-based decision-making, and database logging to create an end-to-end monitoring workflow. Through this automation, staff workload is reduced while enhancing safety, transparency, and institutional discipline.

Rule Cop aims to modernize campus monitoring, provide real-time digital evidence, and extend toward future applications such as automated attendance, behavioral analytics, and anomaly detection.

II. MATERIALS AND METHODS

A. System Architecture

The Rule Cop system is composed of five primary modules that together enable automated rule enforcement:

1. Video Input Module – Captures live CCTV feeds or pre-recorded campus footage.
2. Detection Module – Utilizes YOLOv8 and OpenCV to identify persons, ID cards, clothing attributes, and movement patterns.
3. Face Recognition Module – Verifies identities and flags unauthorized individuals.
4. Rule Engine – Applies predefined institutional rules to classify violations.
5. Database and Dashboard – Stores violation logs and displays data to administrators.

B. Tools and Technologies

1. YOLOv8: Used for detecting persons, ID cards, dress attributes, and loitering behavior.

2. OpenCV: Employed for frame pre-processing, object tracking, and geometric transformations.
3. Face Recognition Models (such as FaceNet or LBPH): Used to recognize individuals and detect unknown faces.
4. Python: The primary programming language for model development, data processing, and server logic.
5. SQL Database: Stores structured records including image snapshots, timestamps, violation types, and location metadata.
6. Flask or Streamlit: Used for creating dashboards and APIs for real-time monitoring and historical log retrieval.
7. CCTV Cameras and GPU Systems: Provide video input and enable high-speed model execution.

C. Dataset Preparation

A custom dataset was developed using CCTV images and campus footage captured from various locations. Additional publicly available datasets were used for dress-code classification, ID-card detection, and face recognition. All images were manually annotated using the YOLO format:

```
class x_center y_center width height
```

Dataset augmentation techniques such as rotation, brightness adjustment, and cropping were used to increase model robustness.

D. Model Training and Detection Pipeline

1. YOLOv8 Training

The YOLOv8 model was trained for multiple classes including person, ID card, improper dress, and loitering behavior. Transfer learning was used for fast convergence. The model reached an accuracy of nearly 92% after fine-tuning on augmented datasets.

2. Face Recognition

Deep-learning-based encodings were generated for each registered student. The system matches faces in real-time and flags unauthorized individuals whose embeddings do not match database entries.

3. Rule Engine

Rules are defined as follows:

- If ID card is not detected → ID violation

- If dress code mismatch occurs → Dress-code violation
- If a person stays too long in a restricted area → Loitering
- If face not registered → Unauthorized entry

4. Database Logging

Each violation is stored with:

- Snapshot image
- Timestamp
- Location
- Violation type
- Student ID or Unknown

The dashboard retrieves this data for analysis.

III. RESULTS AND DISCUSSION

The Rule Cop system was evaluated using multiple CCTV samples from different campus environments. The results indicate the system can reliably detect and classify various rule violations.

Detection Accuracy

- Overall accuracy: ~92%
- High performance in detecting ID cards and recognizing faces
- Moderate sensitivity for dress-code detection due to clothing variations
- Loitering detection performed well using motion tracking and time thresholds

System Performance

The system successfully:

- Identified ID-card absences in real-time
- Detected dress-code mismatches even in crowded environments
- Recognized unknown individuals entering restricted zones
- Logged violations with complete metadata for administrative review

Observed Challenges

- Low lighting affects face recognition accuracy
- Densely crowded scenes reduce the visibility of ID cards

- Dress classification requires more domain-specific images to improve accuracy

Overall Assessment

The evaluation demonstrates that AI-based monitoring can significantly reduce the burden on campus staff and ensure fair, unbiased enforcement of institutional rules. The modular architecture also allows seamless upgrades, including automated attendance and anomaly detection.

IV. HELPFUL HINTS

- **Ensure High-Resolution Video Input:**
CCTV cameras should provide at least 720p clarity to reliably detect ID cards, dress-code violations, and faces.
- **Maintain Consistent Lighting Conditions:**
Detection accuracy drops in dim or uneven lighting; place cameras where lighting is stable and predictable.
- **Use a Diverse and Well-Annotated Dataset:**
Include multiple angles, lighting variations, clothing patterns, and ID-card positions to improve YOLOv8 robustness.
- **Optimize Camera Positioning:**
Mount cameras slightly above chest level to ensure visibility of ID cards and improve dress detection.
- **Use Frame Skipping for Real-Time Efficiency:**
Processing every frame is unnecessary; analyzing 5–10 FPS maintains accuracy while reducing computational load.
- **Combine YOLOv8 with Motion Tracking:**
Use OpenCV trackers (KCF, CSRT) to monitor movement over time, improving loitering and unauthorized entry detection.
- **Calibrate Face Recognition Thresholds Carefully:**
Adjust similarity thresholds to avoid both false positives and false negatives in identifying individuals.
- **Define Restricted Areas Using Region-Based Rules:**

Create digital boundaries on camera frames so that loitering is detected only inside predefined zones.

- **Periodically Retrain the Model:**
Update training data when new batches of students arrive, uniforms change, or ID card designs are updated.
- **Compress and Optimize Database Storage:**
Store violation snapshots at reduced resolution (e.g., 480p) to save space while preserving evidence quality.
- **Implement Duplicate Alert Control:**
Introduce a cool-down period (30–60 seconds) to avoid repeated alerts for the same individual and same violation.
- **Secure Dashboard Access:**
Use login authentication and role-based permissions to prevent unauthorized viewing or misuse of sensitive data.
- **Monitor and Reduce System Latency:**
Processing delay must remain under one second to ensure real-time responsiveness and reliable rule enforcement.
- **Evaluate the System in Real-World Scenarios:**
Test the system in crowded halls, entrances, staircases, and low-light areas to validate its performance outside controlled environments

V. CONCLUSION

The Rule Cop system demonstrates the practical potential of integrating modern deep-learning algorithms with real-time video analytics to automate campus rule enforcement. By leveraging YOLOv8 for object detection, OpenCV for video processing, and advanced face recognition techniques, the system successfully identifies major discipline-related violations such as missing ID cards, improper dress code, loitering in restricted zones, and unauthorized entry. The results show that AI can provide a level of consistency, speed, and accuracy that is difficult to achieve through manual supervision. The achieved accuracy of approximately 92% validates the reliability of the detection pipeline and highlights the

effectiveness of the training strategy, dataset preparation, and rule-engine design. The system's ability to generate and store violation logs—including timestamps, snapshots, and identity details—in an SQL database ensures strong traceability and accountability for administrative processes. This creates a transparent ecosystem where data-driven decisions can be made regarding campus safety and student behavior trends. The deployment of Rule Cop reduces dependency on human surveillance staff, minimizes bias in rule enforcement, and ensures continuous monitoring across multiple campus locations. Its modular design also enables easy scaling, allowing institutions to expand the system to new buildings or integrate additional monitoring zones without restructuring the core architecture. Furthermore, the system lays the groundwork for a wide range of future enhancements. Potential upgrades include automated attendance systems, behavior analytics, anomaly detection, and cloud-based central monitoring dashboards. With advancements in GPU computing and improved campus-wide CCTV quality, the Rule Cop system can evolve into a complete smart-campus surveillance solution. Overall, Rule Cop represents a significant step toward modernizing campus discipline management by merging artificial intelligence, computer vision, and data-driven decision-making. Its impact can extend beyond educational institutions to other domains such as corporate security, public safety, and restricted-area monitoring, making it a versatile and powerful solution for automated surveillance.

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