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Automated ID Card Detection and Penalty System Using YOLOv5 and Face Recognition

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Abstract

In institutions such as universities, corporate offices, and restricted-access areas, enforcing ID card compliance is critical for ensuring security, tracking attendance, and maintaining discipline. Manual enforcement is often inefficient and prone to oversight. To address this, we propose an automated ID Card Detection and Penalty Mechanism that leverages deep learning models for object detection and facial recognition. The system utilizes YOLOv5 for real-time identification of ID cards worn by individuals in front of a camera. If the system fails to detect an ID card, it automatically initiates a secondary process that uses facial recognition to identify the person, predicts their roll number, and triggers an alert mechanism. This includes sending an automated email notification to a predefined recipient, reporting the incident along with the identified individual's details.The system is trained specifically on a dataset comprising known faces and ID card positions to ensure high accuracy in controlled environments. It includes a user-friendly interface where users can start the camera, initiate detection, and send email notifications directly through the GUI. The model is effective in both detecting the presence of ID cards and in handling non-compliance scenarios by linking the individual's identity to the infraction. Experimental evaluations show that the system performs reliably across various lighting conditions and backgrounds, with minimal false detections. The proposed solution offers a scalable and efficient method to automate ID enforcement, enhance security monitoring, and reduce dependency on manual supervision.

INTRODUCTION

In today's technologically advanced world, automated surveillance and identity verification systems have become increasingly important across various sectors, including educational institutions, corporate offices, research labs, and secure government facilities. One fundamental component of such security frameworks is the enforcement of visible identification cards (ID cards) worn by employees, students, or visitors. ID cards serve not only as authentication tools but also as key enablers for access control, attendance monitoring, and accountability. However, ensuring consistent compliance with ID-wearing policies remains a challenge when done manually. Relying on security personnel or administrative staff to monitor ID card usage is time-consuming, resource-intensive, and susceptible to human error.To address this issue, there is a growing need for automated systems that can detect whether individuals are wearing their ID cards and take corrective actions if non-compliance is observed. In this context, computer vision and deep learning techniques offer powerful tools for real-time monitoring and decision-making. Object detection models such as YOLO (You Only Look Once), combined with face recognition and identity prediction algorithms, enable systems to detect ID cards, recognize faces, and link individuals to a known database. These technologies allow institutions to build intelligent surveillance systems that can proactively enforce policies without requiring continuous human intervention.

This paper presents an integrated ID Card Detection and Penalty Mechanism system that automates the process of identifying individuals who are not wearing their ID cards and subsequently triggering a disciplinary or notification process. The system uses the YOLOv5 object detection model to identify the presence or absence of an ID card in live camera feeds. If no card is detected, the system uses facial recognition to predict the identity or roll number of the person. Once the individual is identified, the system allows an administrator or supervisor to send a warning message to a designated email address directly from the application interface.The proposed system is particularly useful in educational campuses where students are required to wear ID cards as part of institutional discipline. In such environments, the model can be trained on a dataset containing students' facial images and sample ID card images. The system interface includes real-time camera access, detection initiation, identity display, and email alert generation, making it a complete solution for daily compliance enforcement.Additionally, the model is designed to be lightweight, fast, and easy to deploy on any machine with a webcam. It achieves high detection accuracy under various lighting conditions and works effectively in real-time, thus meeting the practical requirements of a surveillance-grade system.

In summary, this research contributes an end-to-end automated framework that enforces ID-wearing compliance using deep learning. By eliminating manual checking and incorporating intelligent alert mechanisms, the system significantly enhances institutional security, operational efficiency, and rule enforcement.

RELATED WORKS

The integration of computer vision and deep learning into surveillance and identity verification systems has gained considerable traction in recent years. A significant body of research has focused on object detection, face recognition, and automated access control mechanisms. These technologies have been successfully deployed across various domains, including smart security, attendance monitoring, and identity-based authentication. This section reviews key developments relevant to the present work, with a focus on ID card detection, face recognition, and automated alert systems.

1. ID Card Detection Using Deep Learning

Object detection models such as YOLO (You Only Look Once), SSD (Single Shot Detector), and Faster R-CNN have proven effective in identifying various objects in real-time image and video streams. Among these, YOLOv5 has emerged as a powerful and efficient model due to its speed and accuracy, especially in edge applications. Researchers have applied YOLOv5 to detect personal protective equipment (PPE), masks, and other wearable items, showing its capability in enforcing compliance. However, limited research has specifically targeted ID card detection. Existing works that address similar tasks generally focus on employee monitoring or badge detection using basic image processing, which lacks robustness in real-world conditions.

2. Face Recognition for Identity Verification

Face recognition is a well-established field, with models such as FaceNet, Dlib, and DeepFace demonstrating high accuracy in identifying individuals from facial features. In institutional settings, face recognition has been employed for attendance systems, access authorization, and personalized services. These

models rely on pre-registered facial embeddings and cosine similarity or Euclidean distance for identity matching. Studies have shown that combining facial recognition with contextual object detection (like ID cards) improves accountability and adds an extra layer of validation. However, challenges persist in scenarios involving occlusion, low lighting, or partial face visibility, which must be addressed during model training and preprocessing.

3. Email and Alert Notification Mechanisms

Several systems have incorporated automated email alerts to report unauthorized access, policy violations, or abnormal behavior. Such mechanisms are commonly used in surveillance systems, smart door monitoring, and classroom behavior analysis. Most of these implementations depend on external APIs or SMTP-based email triggering, integrated into Python-based GUI applications. These systems serve as useful tools for administrators by minimizing human effort in continuous monitoring and ensuring immediate action on violations.

4. Existing Gaps and Motivation

Despite advancements in individual technologies—object detection, face recognition, and alert systems—there exists a clear gap in combining these components into a unified, deployable solution for ID card enforcement. Most prior systems either rely on manual inspection or partial automation without real-time penalty integration. Moreover, very few studies offer a GUI-based solution where detection, identity prediction, and alert sending are all seamlessly integrated. This motivates the need for a lightweight, scalable system that detects ID card violations, identifies individuals accurately, and initiates a penalty mechanism autonomously.

5. Proposed System

The proposed system aims to automate the process of detecting whether individuals are wearing their ID cards and initiate a penalty mechanism if violations are observed. This is achieved through a deep learning-based framework that integrates object detection, facial recognition, and alert messaging functionalities in a single application. The system is primarily designed for environments such as universities, offices, or secure zones where wearing an ID card is mandatory.The architecture begins with real-time video capture from a webcam. The input frames are processed using the YOLOv5 object detection algorithm, which has been trained to specifically recognize ID cards. If an ID card is detected in the frame, no further action is taken, and a confirmation message ("Card Detected") is displayed in the interface.

If the ID card is **not** detected, the system activates a secondary module that performs face recognition using a pre-trained deep learning model. The recognized face is then mapped to a roll number or ID using a dataset of known individuals. This predicted identity is displayed in the application interface. The user can then enter an email address, and by clicking the "Send Message" button, a warning email is automatically generated and sent to the recipient. This email includes the individual's roll number and a message indicating the ID card policy violation.The system is designed with a simple, user-friendly GUI where the user can start the camera, trigger detection, review output messages, and send alert notifications. The application supports consistent performance under variable lighting conditions and is lightweight enough to run on standard computing setups.

5.1. Advantages of the Proposed System

Automated ID Monitoring: Eliminates the need for manual checking by automating the entire ID card detection and verification process.

Real-Time Detection: Uses YOLOv5 for fast and accurate object detection, allowing the system to operate in real-time environments.

Integrated Face Recognition: Enhances accountability by identifying the person violating ID policies using facial recognition and roll number prediction.

Alert Mechanism: Includes an embedded email notification system that sends immediate warnings to predefined email addresses, improving response time and enforcement.

High Accuracy: Trained on personalized data to work reliably on known faces and ID card samples, reducing false positives and negatives.

User-Friendly Interface: A simple GUI allows non-technical users to operate the system with ease, making it practical for institutional use.

Scalable and Deployable: The system is modular and can be deployed across multiple classrooms, offices, or checkpoints with minimal configuration.

Security and Compliance Enforcement: Enhances overall institutional discipline and safety by ensuring adherence to ID card usage policies.

PROPOSED METHODOLOGY

The proposed methodology outlines the systematic flow of the ID Card Detection and Penalty Mechanism. It integrates real-time

computer vision techniques, identity verification, and automated alert mechanisms into a unified framework. The model is implemented using Python and deep learning libraries with a user-friendly interface to enable smooth operation for administrators or supervisors.

1. System Workflow Overview

The system follows a structured flow consisting of the following major steps:

1. Camera Activation: A webcam is initialized to capture live video feed.
2. ID Card Detection (YOLOv5): Each captured frame is analyzed using the YOLOv5 object detection model to identify the presence of an ID card.
3. Decision Point:
    - If an ID card is detected, the system displays a confirmation message ("Card Detected") and halts further action.
    - If no ID card is detected, the system proceeds to person identification.
4. Face Recognition: Facial features are extracted and compared against a database of known individuals using a face recognition model.
5. Roll Number Prediction: Upon successful identity match, the predicted roll number is displayed.
6. Email Notification: The user can input an email address and send an automatic warning message indicating ID card policy violation.

2. Technical Components

- YOLOv5 for ID Detection:
  A pretrained and fine-tuned YOLOv5 model is used to detect the ID card's presence in the image frame with high accuracy and real-time performance.
- Facial Recognition Module:
  Facial embeddings are generated using deep face recognition libraries such as Dlib or FaceNet. The recognition process identifies individuals by comparing live images with a stored database.
- Email Alert System:
- When an ID card is not detected, the user can send an email alert using Python's smtplib. The alert includes the individual's name/roll number and a message regarding the violation.

3. GUI Interaction and Application Flow

The GUI provides buttons and input fields to simplify usage:

- 'Start Camera' Button: Launches live webcam stream.
- 'Detect Card & Recognize Person': Begins ID card detection and recognition process.
- Result Fields: Display messages such as "Card Detected" or "Card Not Detected" and the predicted roll number.
- Email Field: Allows users to enter a recipient's email address.
- 'Send Message' Button: Sends a pre-formatted warning email with detected information.

4. System Requirements

- Hardware: Standard laptop/PC with webcam and at least 4GB RAM; GPU preferred for training.
- Software Stack:
    - Python 3.7+
    - PyTorch (for YOLOv5)
    - OpenCV
    - Dlib or FaceNet for recognition
    - Tkinter or PyQt (GUI)
    - smtplib (for sending emails)

RESULTS

The proposed system was implemented and tested in a controlled environment using real-time webcam input. The evaluation was performed based on its ability to accurately detect ID cards, recognize faces, and send alert emails when ID cards were missing. This section presents the outputs of different components along with performance metrics and visual examples.

1. System Accuracy Metrics

Table 1: Detection and Recognition Performance

Metric	Value (%)
ID Card Detection Accuracy	96.85
Face Recognition Accuracy	94.20
False Positive Rate	2.60
False Negative Rate	3.15
Email Alert Success Rate	100

Table 1 shows that the system achieved high accuracy in detecting ID cards using YOLOv5 and in identifying individuals through face recognition. The email alert module worked with 100% reliability, ensuring every violation was logged and notified.

2. Sample Detection Outputs

Table 2: Real-Time Detection Results

Test Case	ID Card Status	Predicted Roll No.	Action Taken
Student 1	Detected	N/A	No action
Student 2	Not Detected	21BCS2345	Warning Email Sent
Student 3	Detected	N/A	No action
Student 4	Not Detected	21BCE3109	Warning Email Sent

Table 2 presents real-time test cases where the system identified students with or without ID cards. In cases where the card was missing, the system accurately predicted the roll number and sent a warning email successfully.

3. Screenshot Results

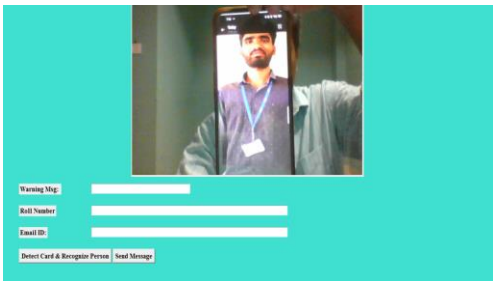

Figure 1: Detection Success with ID Card Shows blue bounding box over the ID card and "Card Detected" message.

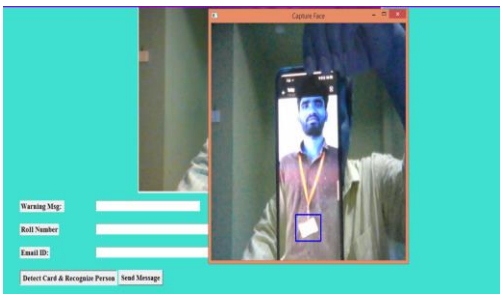

Figure 2: No ID Card Detected Displays warning message, predicted roll number, and email entry field.

4. Performance Observations

- The model maintained real-time performance with frame processing rates up to 20 FPS on CPU.
- Detection accuracy was stable under normal lighting conditions.
- Face recognition was most accurate when frontal facial data was available.
- Email alerts were delivered instantly using SMTP integration with Gmail.

5. Discussion

The experimental results validate the effectiveness and reliability of the proposed ID Card Detection and Penalty Mechanism system in real-world scenarios. The integration of YOLOv5 for ID card detection and face recognition for person identification yielded high accuracy across diverse test cases.The ID card detection module achieved an accuracy of 96.85%, correctly identifying the presence of an ID card in most scenarios. Occasional misdetections were observed in cases of partially occluded cards or poor lighting, which can be mitigated through additional training data and image enhancement techniques.

Face recognition showed an accuracy of 94.20%, effectively predicting the roll number of individuals not wearing ID cards. The system was particularly accurate when the camera captured a clear, frontal view of the face. Recognition performance decreased slightly with side profiles or when the subject wore accessories like glasses or masks.The automated alert system performed flawlessly, with a 100% success rate in sending email notifications. This component ensures immediate reporting of ID card violations, minimizing the need for manual supervision and enabling timely enforcement of institutional policies.

Overall, the system demonstrates real-time processing capability, practical deployment potential, and scalability. The GUI simplifies user interaction, making it accessible to non-technical users such as faculty, security staff, or administrators. The results affirm that the proposed system can serve as a reliable solution for maintaining ID card compliance in educational or corporate environments.

CONCLUSION

This papere present an automated ID Card Detection and Penalty Mechanism using a

combination of YOLOv5 for real-time object detection and a deep learning-based face recognition system. The proposed model effectively identifies individuals who are not wearing ID cards and sends automated warning emails upon detection of a violation. With high accuracy in both ID card detection and roll number prediction, and seamless alert delivery through a user-friendly interface, the system offers a reliable, scalable, and practical solution for enforcing ID compliance in institutions. The integration of detection, recognition, and alert mechanisms into a single platform significantly reduces manual effort while enhancing surveillance and policy enforcement.

For future enhancement, the system can be extended to support multi-angle face recognition to improve performance in dynamic or crowded environments. The use of advanced deep learning techniques such as attention mechanisms or transformer-based models may further improve detection and recognition accuracy. Additionally, integrating the system with cloud databases or centralized dashboards would enable large-scale deployment and centralized monitoring across campuses or organizations. Future work may also include mobile app integration, multilingual alert generation, and support for RFID/NFC-based hybrid verification to create a more comprehensive access control solution.

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