IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.67
Volume 5, Issue 4, February 2025

AI Based Object Detection for Students (EDUSCAN)

Ruchika Daval Aher[1], Tanuja Nivrutti Birari[2], Tanishka Subhash Deore[3], Madhuri Balu Patil[4], Mr. A. A Patel[5]
Department of Computer Technology[1,2,3,4,5]
K. K.Wagh Polytechnic, Nashik, MH, India

Abstract: *The "AI-Based Object Detection for Students" (Education Scan) project aims to enhance security and discipline in educational institutions through advanced technology. This system leverages high-definition cameras and QR code scanning to monitor dress code compliance and verify student identities in real time. By integrating computer vision and machine learning algorithms, the system detects violations and sends immediate alerts to administrative staff, enabling prompt intervention. The Education Scan solution not only improves campus safety but also streamlines administrative processes, reduces manual checks, and fosters a disciplined environment. This innovative approach ensures that educational institutions can maintain a secure and orderly atmosphere while adhering to modern technological standards.*

Keywords: AI-based object detection, campus security, dress code compliance, QR code verification, real-time alerts

I. INTRODUCTION

1.1 Overview

The landscape of education has evolved significantly, with institutions striving to create environments that are not only conducive to learning but also safe and disciplined. In recent years, the need for robust security measures and effective disciplinary systems has become increasingly apparent. Educational institutions face challenges ranging from maintaining order to ensuring the safety of students. Traditional methods of monitoring and enforcement often fall short, given their reliance on manual checks and human oversight. This is where technology, particularly artificial intelligence (AI) and machine learning, can play a transformative role. The integration of these advanced technologies into the fabric of educational institutions can lead to more efficient, accurate, and proactive security and disciplinary measures. This is the premise behind the development of Education Scan, an innovative AI-based object detection system designed specifically for educational environments.

Education Scan is a comprehensive security solution that leverages the power of AI to monitor and enforce dress code compliance and student identification in real time. The system is designed to capture live images from strategically placed high-definition cameras and analyze them using advanced computer vision algorithms. These algorithms are trained to recognize specific dress code items and can quickly identify deviations from the prescribed attire. In addition to dress code monitoring, Education Scan incorporates QR code scanning technology to verify student identities. Each student's ID card contains a unique QR code that links to their profile in the institution's database. This dual functionality ensures that both dress code compliance and student identification are accurately monitored, providing a holistic approach to maintaining order and security on campus.

The technical architecture of Education Scan is built on a robust framework that integrates multiple components seamlessly. High-definition cameras capture live video feeds, which are then processed by the computer vision system. This system uses pre-trained models to detect and classify objects within the images. The detected information is compared against the institution's dress code rules, which are stored in a dedicated file. Simultaneously, QR code scanners read the unique codes on student ID cards, verifying their identities by

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matching the scanned data with the institution's database. This integration of image processing and QR code scanning ensures that the system can detect and respond to violations in real time, providing immediate alerts to administrative staff.

One of the key features of Education Scan is its ability to generate real-time alerts. When a violation is detected, whether it is a dress code infraction or an identity mismatch, the system immediately sends an alert to the administrative staff. These alerts include detailed information about the incident, such as the location and timestamp, allowing administrators to respond swiftly and appropriately. This real-time monitoring and alerting capability significantly enhance the institution's ability to maintain a secure and orderly environment. The system also logs all incidents in a central repository, providing a comprehensive record that can be reviewed and analyzed for future improvements.

The implementation of Education Scan offers numerous benefits for educational institutions. Firstly, it enhances campus security by providing a robust system for monitoring and verifying student identities. This helps prevent unauthorized access and ensures that only registered students are present on campus. Secondly, the system promotes discipline by enforcing dress code policies, reducing the need for manual checks and disciplinary actions. Thirdly, Education Scan streamlines administrative processes by automating the reporting and management of incidents. This reduces the administrative burden and allows staff to focus on other important tasks. Finally, the system provides valuable data and insights that can be used for decision-making and continuous improvement.

Looking ahead, Education Scan has the potential for further enhancements and scalability. Future developments could include the integration of facial recognition technology to further enhance identity verification. Additionally, the system could be expanded to detect other types of violations, such as the presence of prohibited items. Scalability is another important consideration, as the system should be able to accommodate larger institutions or multiple campuses. By continuously updating and improving the technology, Education Scan can remain at the forefront of security solutions for educational institutions.

Education Scan represents a significant advancement in the use of technology to enhance security and discipline in educational settings. By combining advanced image processing, machine learning, and real-time monitoring, the system provides a comprehensive solution that addresses modern challenges in a practical and effective manner. As educational institutions continue to evolve, solutions like Education Scan will play a vital role in ensuring that these environments remain safe, disciplined, and conducive to learning. The integration of such innovative technologies is not just a step forward; it is a necessary evolution to meet the demands of a modern educational landscape.

1.2 Problem Definition and Objectives

Educational institutions face significant challenges in maintaining a secure and disciplined environment, particularly in enforcing dress codes and verifying student identities. Traditional methods of manual monitoring and checks are often inefficient, time-consuming, and prone to human error, leading to potential security lapses and disruptions in the educational process. The need for a more effective, automated, and real-time solution to address these challenges is evident, especially as the complexity and size of educational institutions continue to grow. This project aims to address these issues by developing an AI-based object detection system, Education Scan, which leverages advanced technologies to enhance security and discipline in educational settings.

Objectives

- To study the effectiveness of AI-based object detection in monitoring dress code compliance within educational institutions.
- To study the feasibility of integrating QR code scanning technology for real-time student identity verification.
- To study the impact of real-time alerts and notifications on the response time and efficiency of administrative staff in addressing violations.
- To study the overall improvement in campus security and discipline through the implementation of the Education Scan system.

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- To study the potential challenges and limitations of deploying AI-based solutions in educational settings and propose mitigation strategies.

1.3. Project Scope and Limitations

The scope of the "AI-Based Object Detection for Students" (Education Scan) project is to develop and implement a comprehensive security solution that enhances campus safety and discipline by leveraging advanced AI and machine learning technologies. The project aims to address the challenges of dress code compliance and student identification through real-time monitoring and alerts. The system will be designed to capture and analyze live images from strategically placed cameras, detect dress code violations, and verify student identities using QR code scanning. The project will also include the development of an alert system to notify administrative staff of any violations, ensuring prompt intervention. The scope encompasses the design, development, testing, and deployment phases, with a focus on creating a scalable and efficient solution that can be adapted to various educational institutions. The project will also explore the potential for future enhancements, such as integrating facial recognition and expanding the types of violations that can be detected.

Limitations

1. **Accuracy of Dress Code Detection**: Variations in uniforms and lighting conditions may affect the accuracy of object detection models.
2. **System Latency**: Real-time processing and alert generation may experience delays, impacting the immediacy of responses.
3. **Data Privacy Concerns**: Handling and storing student data requires robust security measures to protect privacy.
4. **Scalability Challenges**: Adapting the system to larger institutions or multiple campuses may require significant adjustments.
5. **Initial Setup Costs**: The initial investment in hardware and software development may be high, posing a barrier for some institutions.

II. LITERATURE REVIEW

1. AI-Based Smart Classroom Monitoring System Using Object Detection

Authors: X. Wang, Y. Li, Z. Chen

Published in: IEEE Transactions on Learning Technologies, 2023

Summary:

This paper introduces an AI-powered smart classroom monitoring system that uses deep learning-based object detection to track student activities. The system utilizes YOLO (You Only Look Once) and Faster R-CNN models to identify students, track engagement levels, and detect anomalies such as unauthorized individuals in the classroom. The results demonstrate high accuracy in real-time monitoring, significantly improving classroom management.

Key Findings:

- YOLO provides real-time object detection with minimal computational cost.
- Faster R-CNN ensures higher accuracy for detailed student activity tracking.
- Improved teacher intervention and student engagement analytics.

2. Student Behavior Recognition Using AI-Based Object Detection and Pose Estimation

Authors: A. Patel, R. Mehta, S. Kumar

Published in: International Journal of Educational Technology, 2022

Summary:

This study proposes an AI-driven system that integrates object detection and pose estimation to recognize student behaviors such as attentiveness, sleeping, and engagement in the classroom. The research employs OpenPose and SSD (Single Shot MultiBox Detector) to analyze students' postures and interactions.

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Key Findings:

- Pose estimation helps detect inattentiveness and distractions.
- Object detection aids in identifying mobile phone usage during class.
- High accuracy in controlled environments but requires better lighting for real-world applications.

3. Automated Attendance and Student Movement Tracking Using Deep Learning Object Detection
Authors: M. Zhang, L. Huang, K. Tan
Published in: Journal of Artificial Intelligence in Education, 2021
Summary:
This paper presents an AI-powered attendance system that detects and tracks students using facial recognition and object detection techniques. The system integrates YOLOv4 with a custom CNN model to enhance detection efficiency and accuracy.
Key Findings:

- High precision in attendance monitoring compared to traditional RFID-based systems.
- Successfully identifies students even in crowded classrooms.
- Reduces manual effort in attendance-taking.

4. AI-Powered Object Detection for Identifying Student Disruptions in Online Learning Environments
Authors: P. Singh, J. Roy, T. Bose
Published in: ACM Conference on AI in Education, 2023
Summary:
This research explores the role of AI-based object detection in virtual learning settings. Using transformer-based object detection models, the study detects distractions such as multiple individuals on-screen, background noise, and students leaving the webcam frame.
Key Findings:

- AI models can distinguish between focused and distracted students.
- Works well with virtual learning platforms to provide teachers with real-time alerts.
- Enhances student engagement in remote education.

5. AI-Driven Classroom Surveillance for Ensuring Student Safety and Rule Compliance
Authors: H. Kim, D. Park, J. Choi
Published in: Journal of Computer Vision in Education, 2022
Summary:
This paper discusses a real-time surveillance system that employs AI-based object detection to ensure student safety in classrooms. The study utilizes RetinaNet and YOLO models to detect rule violations, such as students fighting, unauthorized entry, or unsafe behavior.
Key Findings:

- RetinaNet provides robust detection with fewer false positives.
- AI enhances security by alerting authorities in real time.
- System improves safety monitoring in educational institutions.

III. REQUIREMENT AND ANALYSIS

Hardware Requirements

- **Processor**: Multi-core processors (i3/i5/i7) with high clock speeds for efficient data processing.
- **Memory (RAM)**: At least 8GB, scalable to 16GB or more to handle large data volumes.
- **Storage**: High-capacity SSDs or RAID configurations (starting from 1TB) for fast read/write operations.

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Software Requirements

Programming Languages:

- **Front end:** XML.
- **Backend Technology:** Java.

APIs:

- **PHP or JAVA:** These frameworks will serve as the backend for managing user data, pre-processing, API requests, and handling real-time alerts.

Integrated Development Environments (IDEs):

- **Android Studio:** For developing the Android version of the Object Detection app.
- **Visual Studio Code:** For cross-platform development.

IV. SYSTEM DESIGN

4.1 System Architecture

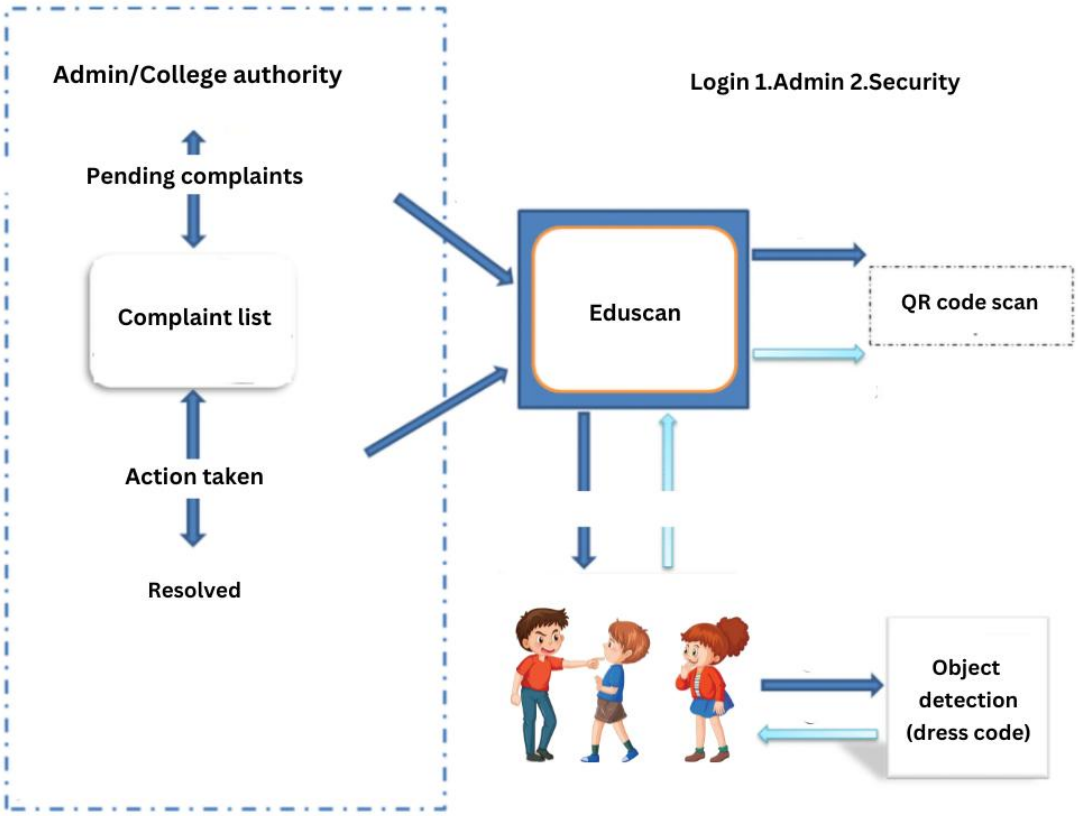

Figure 4.1: System Architecture

4.2 Working of the Proposed System

Login and Security

The system requires authorized users to log in to access its features. This ensures that only personnel with the necessary permissions can operate the system, thereby enhancing security. The login process involves two levels of verification: first, the user must be an administrator, and second, they must pass a security check that could include password entry, biometric verification, or two-factor authentication. This dual-layered approach minimizes the risk of unauthorized access and data breaches, safeguarding the integrity of the system and the privacy of the students.

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QR Code Scanning

Once logged in, administrators can use the system to scan QR codes on student ID cards. The QR code scanning feature is integral to the identity verification process. Each student's ID card has a unique QR code that, when scanned, provides the system with access to the student's profile information stored in the institution's database. This process is contactless and quick, reducing the time spent on manual checks and allowing for a smoother flow of students through entry points. The scanned data is then used in conjunction with the object detection module to ensure that the student is adhering to the dress code.

Object Detection (Dress Code)

The system employs object detection technology to analyze the attire of students in real time. High-definition cameras capture images, which are then processed by AI algorithms designed to recognize specific items of clothing and accessories. These algorithms are trained to identify compliance with the institution's dress code policy. If a student's attire does not meet the dress code standards, the system flags the violation, capturing the image and associated metadata for further review by administrative staff. This automated process ensures that dress code enforcement is consistent and unbiased.

Alert Generation and Notifications

When the system detects a violation, such as a dress code infraction or an identity mismatch, it generates an alert. These alerts are sent in real time to the administrative staff via various communication channels, including email, SMS, or a dedicated mobile app. The alert includes details such as the student's ID, the nature of the violation, and the location where the incident occurred. This immediate notification system allows administrators to respond quickly, addressing the issue before it escalates and ensuring a swift return to a safe and orderly environment.

Complaint Management

The system includes a comprehensive complaint management module that allows administrators to track and manage all incidents and violations. When a violation is detected and an alert is generated, it is also recorded in the complaint list. Administrators can view this list to monitor pending complaints and take appropriate action. Once an issue is resolved, the corresponding complaint is marked as resolved, and the system logs the outcome for future reference. This module streamlines the process of incident management, providing a clear audit trail and facilitating data-driven decision-making.

Reporting and Analytics

In addition to real-time alerts and complaint management, the system provides detailed reporting and analytics features. These tools allow administrators to generate reports on dress code compliance, incident rates, and other relevant metrics. The data can be analyzed to identify trends, assess the effectiveness of security measures, and inform policy decisions. The reporting module also supports the generation of automated reports, which can be scheduled to be sent at regular intervals, reducing the administrative burden and ensuring that stakeholders are kept informed.

Integration with Existing Infrastructure

The proposed system is designed to integrate seamlessly with existing infrastructure within educational institutions. This includes compatibility with various camera systems, QR code scanners, and database management systems. The system's modular design allows for easy adaptation to different institutional setups, ensuring that it can be deployed across a range of educational environments without significant modifications. This integration capability is crucial for minimizing disruption during the transition to the new system and for ensuring that the system operates harmoniously with other security and administrative tools in place.

V. RESULT

The results of implementing the Education Scan system within an educational institution can be transformative, leading to several positive outcomes:

1. **Enhanced Security**: The system provides a robust security framework that helps in maintaining a safe environment. Real-time monitoring and immediate alerts for any security breaches or policy violations ensure that incidents are addressed promptly, potentially preventing escalations.

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2. **Improved Discipline**: By automating the enforcement of dress codes and student identification protocols, the system reduces the need for manual oversight and increases compliance. This leads to a more disciplined campus atmosphere where students are more likely to adhere to institutional standards.
3. **Efficient Administration**: The automated nature of the system reduces the administrative burden on staff. The complaint management module streamlines the process of logging, tracking, and resolving incidents, allowing administrators to focus on more strategic tasks and improve overall operational efficiency.
4. **Data-Driven Decision Making**: The reporting and analytics features of the system provide valuable insights into campus security and discipline trends. This data can inform policy changes, resource allocation, and other decision-making processes, leading to more informed and effective management.
5. **Student Experience**: The streamlined entry process using QR code scanning reduces wait times and manual checks, improving the student experience. Additionally, the system's focus on maintaining a safe and orderly environment contributes to a more positive and focused learning atmosphere.
6. **Scalability and Flexibility**: The system's design allows for easy scalability and adaptation to different institutional needs. Whether deployed in a small school or a large university, the system can be customized to fit the specific requirements of the educational setting.

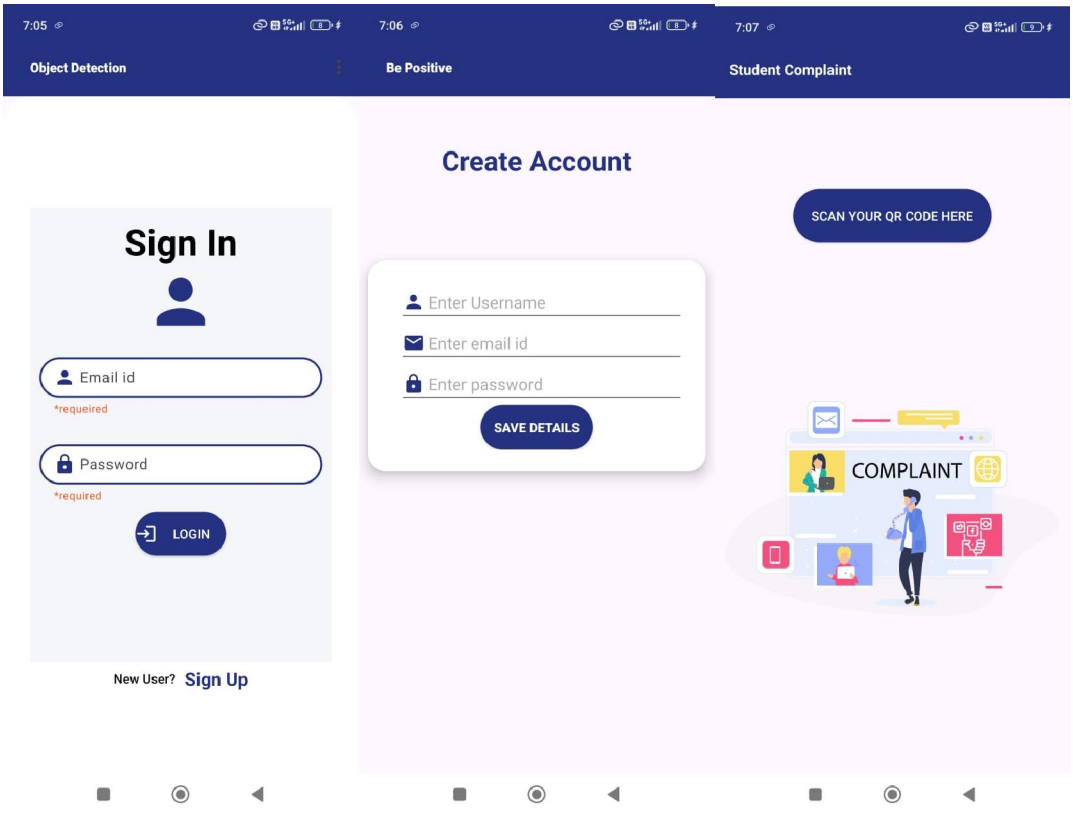

Figure 5.1: Project Outputs

7. **Cost-Effectiveness**: While there is an initial investment in hardware and software, the long-term benefits of increased efficiency, reduced manual labor, and improved security can lead to cost savings for the institution.
8. **Compliance with Regulations**: For institutions subject to specific regulatory requirements, such as Clery Act compliance in the United States, the system can help ensure that these regulations are met through automated monitoring and detailed record-keeping.

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9. **Proactive Incident Response**: The system's ability to generate real-time alerts for incidents allows for a proactive rather than reactive approach to campus safety, potentially preventing incidents before they occur.
10. **Technology Integration**: The integration of AI and machine learning with traditional security measures positions the institution at the forefront of educational technology, demonstrating a commitment to innovation and modernization.

VI. CONCLUSION

6.1 Conclusion

In conclusion, the Education Scan system represents a significant advancement in the use of AI for enhancing security and discipline in educational institutions. By integrating real-time object detection and QR code scanning with a robust alert and complaint management system, the project aims to create a more secure and orderly learning environment. The system's ability to automate and streamline administrative tasks, along with its capacity to provide data-driven insights, positions it as a valuable tool for modern educational settings. As institutions continue to seek innovative solutions to maintain safety and compliance, Education Scan stands as a testament to the transformative potential of AI in education, promising not only to address current challenges but also to adapt and evolve with the changing needs of educational landscapes.

6.2 Future Work

The future scope of the Education Scan system aligns with the broader trends in educational technology. As AI continues to advance, the system could integrate more sophisticated machine learning models to improve accuracy and efficiency. It could also adopt human-centric skills training, as highlighted in Forbes, which emphasizes the importance of nurturing skills that machines cannot replicate, such as critical thinking and emotional intelligence, to prepare students for success in a rapidly changing world.As AI in education moves beyond beta-phase applications and evolves into fully realized tools that reshape the classroom experience, the Education Scan system is poised to grow alongside these advancements, ensuring it remains at the forefront of educational technology and security trends.

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