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Original Article

Online Exam Fraud Detection Using Machine Learning and Computer Vision: Real-Time Monitoring and Risk Assessment

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Keywords

Online Exam Monitoring, Machine Learning, Computer Vision, YOLO, MediaPipe, Fraud Detection, Real-Time Monitoring, Proctoring System, AI Security.

Abstract

This paper presents the design and development of an Online Exam Fraud Detection System using machine learning and computer vision techniques to ensure fairness and integrity in digital examinations. The system is developed using Python and Streamlit, integrating YOLO-based object detection and MediaPipe facial landmark tracking to monitor student behavior in real time. It detects suspicious activities such as multiple faces, unauthorized devices, and abnormal head or eye movements. The system includes modules for authentication, fraud detection, and admin monitoring with real-time alerts and evidence storage. Experimental evaluation demonstrates that the proposed system improves accuracy, reduces manual invigilation effort, and provides a scalable solution for secure online assessments.

Introduction

The rapid adoption of online education has increased the use of digital examinations, creating challenges in maintaining academic integrity. Traditional proctoring methods rely on human invigilators, which are inefficient, error-prone, and difficult to scale for large numbers of students.

To overcome these issues, an intelligent Online Exam Fraud Detection System is proposed using machine learning and computer vision. The system analyzes real-time webcam input to detect suspicious behaviors such as multiple faces, use of electronic devices, and abnormal eye or head movements.

The system follows a modular architecture that separates detection, processing, and interface components, improving scalability and maintainability. By automating exam monitoring, the system enhances transparency, reduces cheating, and ensures a fair evaluation process.

Background

With the advancement of AI, online proctoring systems have evolved from manual monitoring to intelligent automated systems. Technologies such as YOLO for object detection and MediaPipe for facial tracking enable real-time behavioral analysis.

Previous research has explored gaze tracking, face recognition, and deep learning models for detecting suspicious activities. These approaches improve detection accuracy and reduce dependency on human supervision.

Problem Statement

The problem statement defines the issues in current online exam systems. Existing systems lack intelligent monitoring and depend heavily on human invigilators, making them inefficient and difficult to scale. Detecting cheating behaviors such as looking away, using mobile devices, or having multiple people in the frame is challenging. There is also a lack of real-time alert systems and automated evidence collection. Therefore, a smart and automated solution is required to detect fraud effectively and ensure secure online examinations.

Literature Survey

Sharma et al., (2021): Implemented an AI-based online exam proctoring system using com-puter vision and machine learning techniques to monitor student behavior during online ex-aminations. The system analyzed real-time webcam data to detect suspicious activities such as unusual movements and presence anomalies. It reduced dependency on human invigilators and improved monitoring efficiency.

Algorithms used: Image Processing, Machine Learning.

Zhang et al., (2021): Developed a face recognition-based authentication system to verify student identity during online exams. The system used deep learning models to match live facial data with stored records, preventing impersonation. Continuous verification ensured that the same candidate remained present throughout the exam.

Algorithms used: FaceNet, ArcFace (Deep

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Learning)

Nguyen et al., (2020): Proposed an eye gaze tracking system to monitor student attention during online exams. The system used computer vision techniques to analyze eye movement and head direction to detect suspicious behavior such as looking away frequently. It helped identify potential cheating patterns effectively.

Algorithms used: Computer Vision, Gaze Tracking.

Singh et al., (2022): Developed an object detection-based cheating detection system using deep learning. The system used YOLO to detect unauthorized objects such as mobile phones and laptops in real time during exams. It generated alerts whenever restricted items were identified.

Algorithms used: YOLO (You Only Look Once).

Santos et al., (2022): Studied ethical considerations in AI-based online proctoring systems, focusing on privacy, fairness, and data security. The research highlighted the need for secure data handling, transparency, and user consent while implementing AI monitoring systems. It emphasized balancing exam integrity with student privacy.

Approach used: Ethical AI Framework.

Proposed System

The proposed system is an intelligent online exam monitoring solution that uses machine learning and computer vision to detect fraudulent activities. It captures real-time video from the student's webcam and analyzes it using advanced algorithms. The system detects multiple faces, identifies electronic devices, and tracks eye and head movements. It calculates a fraud probability score and generates alerts if suspicious activity is detected. The system also provides an admin dashboard for monitoring and reviewing recorded evidence.

Modules Used

- **User Module:** This module allows students to log in and attend exams. It continuously captures webcam data and sends it for analysis.
- **Admin Module:** The admin module provides a dashboard for monitoring student activities, reviewing alerts, and analyzing reports.
- **Authentication Module:** This module ensures secure login and verifies the identity of users, preventing unauthorized access.
- **Fraud Detection Module:** This is the core module that analyzes video data using machine learning algorithms to detect suspicious behaviour.
- **Database Module:** This module stores user information, exam data, alerts, and evidence for future verification and analysis.

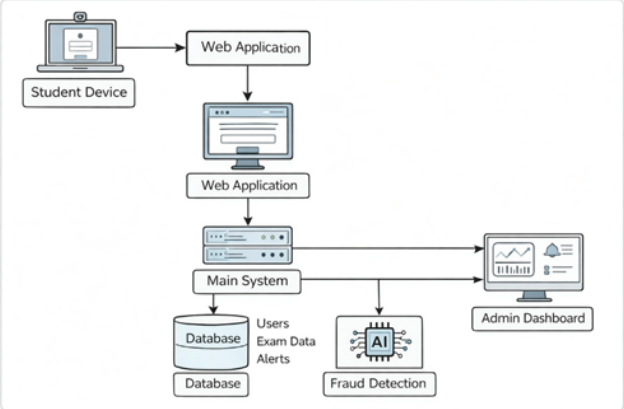
Technologies Used

- **Computer Vision Techniques:** YOLO, MediaPipe
- **Image & Video Processing:** OpenCV
- **Frontend Framework:** Streamlit
- **Backend Processing:** Python-based processing
- **Database:** SQLite / MySQL
- **Web Technologies:** HTML, CSS, JavaScript
- **Data Processing Libraries:** NumPy, Pandas
- **Deep Learning Framework:** Ultralytics YOLOv8
- **Model Storage:** Local Storage / Pickle
- **Visualization Tools:** Streamlit Dashboard

Advantages of proposed system

- **Automated Monitoring:** Eliminates the need for manual invigilators by using machine learning and computer vision to monitor students automatically during exams.
- **High Accuracy Detection:** Uses advanced models like YOLO and MediaPipe to accurately detect suspicious activities such as multiple faces, device usage, and abnormal movements.
- **Real-Time Fraud Detection:** Identifies and alerts suspicious behavior instantly, allowing immediate action during the examination.
- **Reduced Human Error:** Minimizes mistakes caused by fatigue or inattention in manual monitoring systems.
- **Scalability:** Can monitor a large number of students simultaneously, making it suitable for large-scale online examinations.
- **Improved Exam Integrity:** Ensures fairness and transparency in online examinations by preventing cheating and malpractice.
- **Cost Effective:** Reduces the need for hiring multiple invigilators, lowering operational costs for institutions.
- **Evidence Recording:** Captures images, logs, and activity data as proof of suspicious behavior for further verification.
- **Flexible Deployment:** Can be deployed on local systems or cloud platforms depending on institutional requirements.
- **Enhanced Security:** Prevents impersonation and unauthorized access through authentication and monitoring mechanisms.

System Architecture



Results

The results of the proposed project demonstrate that the Online Exam Fraud Detection System effectively improves security, transparency, and efficiency in monitoring student activities during online examinations. By utilizing machine learning and computer vision techniques, the system ensures continuous and reliable analysis of real-time video data captured from the student's webcam. This significantly reduces the chances of cheating and enhances the integrity of online assessments. The integration of YOLO-based object detection minimizes the risk of unauthorized device usage by accurately identifying objects such as mobile phones and laptops. MediaPipe-based facial landmark detection enables precise tracking of head and

eye movements, helping in identifying suspicious behaviour patterns. The use of machine learning classification techniques ensures accurate identification of fraudulent activities, while real-time processing allows instant alert generation. Experimental evaluation using real-time webcam data shows that the system achieves high detection accuracy, reduced false alerts, and reliable identification of suspicious activities such as multiple faces, abnormal movements, and gadget usage. The admin dashboard provides effective monitoring and evidence tracking, ensuring secure exam supervision. Overall, the results confirm that the proposed system provides a scalable, accurate, and intelligent solution for maintaining fairness in online examinations.

Table 1: *Accuracy Comparision*

Model	Accuracy
Manual Monitoring	75.2%
Rule-Based System	82.6%
Basic ML Model	88.4%
Proposed System (YOLO + MediaPipe)	94.1%

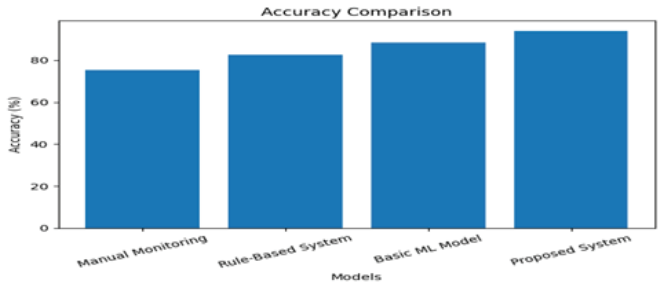


Figure 1. *Graph for Accuracy comparison*

Table 2: *F1 Score Comparison*

Model	F1 Score
Manual Monitoring	0.72
Rule-Based System	0.81
Basic ML Model	0.86
Proposed System (YOLO+MediaPipe)	0.93

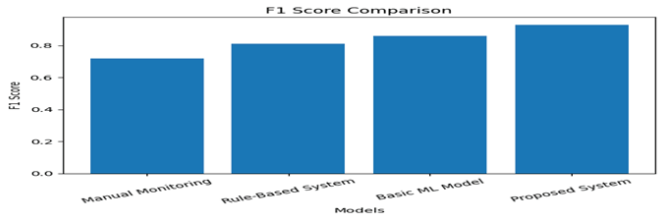


Figure 2. *Graph for F1 Score comparison*

Conclusion

The Online Exam Fraud Detection System provides an effective solution for maintaining fairness in online examinations. By integrating machine learning and computer vision, the system automates the monitoring process and detects suspicious activities in real time. It reduces human effort, improves accuracy, and enhances the credibility of online exams. The system demonstrates the potential of AI in solving real-world problems in education..

Future scope

- **Integration with Advanced Monitoring Systems:** Future versions of the system can integrate multi-camera setups and screen monitoring to provide a more comprehensive view of the student's environment, improving fraud detection accuracy.
- **Deep Learning Enhancement:** Advanced deep learning models such as CNN, RNN, and transformer-based architectures can be implemented to improve detection of subtle behaviors like micro-expressions, lip movement, and gesture analysis.
- **Mobile Application Development:** A mobile-based version of the system can be developed to allow students to attend exams and be monitored directly through smartphones with real-time fraud detection and alerts.
- **Cloud-Based Deployment:** The system can be integrated with cloud platforms to support large-scale examinations with better performance, scalability, and centralized monitoring.
- **Voice Detection and NLP Integration:** Future systems can include voice recognition and natural language processing to detect unauthorized communication or conversations during exams.
- **Multilingual and Adaptive AI Support:** The system can be enhanced to support multiple languages and adaptive AI models that learn and improve fraud detection patterns over time for better accuracy.

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