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AI-Based Smart Online Proctoring Exam Integrity Monitoring System

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Abstract: ***This project presents an AI-Based Smart Online Proctoring Exam Integrity Monitoring System designed to improve security and integrity during online examinations. The system combines multiple AI techniques for real-time monitoring and violation detection. The proposed system includes face detection and identity verification using YOLO and DeepFace, eye gaze tracking using Dlib and MediaPipe, unauthorized object detection using YOLOv8n, and behavioral analysis using an LSTM model. These modules work together to detect suspicious activities such as impersonation, mobile phone usage, multiple person detection, and gaze deviation during examinations. All detected violations are monitored through a Django-based web platform that provides real-time alerts, violation logs, and automated examination reports. The system is trained and tested on a custom dataset collected under different examination environments and lighting conditions,Experimental results show high accuracy in detecting examination violations, making the system reliable for remote examination monitoring. The proposed framework provides an efficient, automated, and browser-accessible online proctoring solution without requiring additional client-side software.***

Keywords : Artificial Intelligence, Computer Vision, YOLOv8, MiDaS, Online Proctoring, Deep Learning, Object Detection, Motion Detection, Face Verification, Exam Security, Real-time Monitoring, RBAC.

I. INTRODUCTION

Online examinations have become an important part of modern education and certification systems, especially after the rapid growth of remote learning platforms. During the COVID-19 period, educational institutions across the world shifted toward digital learning and online assessments, which increased the demand for reliable online examination systems. Although online exams provide flexibility and accessibility, they also introduce several challenges related to examination security and academic integrity. In remote environments, students may use unauthorized materials, receive external assistance, or attempt impersonation during examinations.

Conventional online proctoring methods mainly depend on human invigilators monitoring multiple webcam feeds or on periodic screenshot-based supervision. These approaches are often inefficient, difficult to scale, and unable to continuously monitor candidate behavior in real time. Managing large-scale examinations using manual monitoring also becomes costly and unreliable, particularly for competitive and university-level examinations involving thousands of candidates.

Recent developments in computer vision and deep learning have enabled automated monitoring systems capable of detecting suspicious activities through webcam analysis.

Object detection models such as YOLO provide fast and accurate real-time detection, while DeepFace can be used for identity verification. Similarly, Dlib and MediaPipe support gaze tracking and head movement analysis using standard webcams. Long Short-Term Memory (LSTM) networks are also effective in analyzing continuous behavioral patterns over time, helping to identify suspicious actions that may not be visible in a single frame.

This project presents an AI-Based Smart Online Proctoring Exam Integrity Monitoring System that combines multiple monitoring modules into a unified framework. The system integrates face detection and verification, gaze tracking, unauthorized object detection, and behavioral analysis within a Django-based web platform. The proposed framework provides real-time alerts, violation logging, and automated examination reports, offering an efficient and scalable solution for secure online examinations.

The remainder of this paper is organized as follows. Section II discusses the existing research and technologies related to online proctoring systems. Section III describes the architecture of the proposed system. Section IV explains the methodology and implementation of the different monitoring modules. Section V presents the experimental results and discussion. Section

VI outlines the limitations of the system along with possible future enhancements. Finally, Section VII concludes the paper by summarizing the overall work and contributions of the proposed system.

II. LITERATURE REVIEW

A. Online Proctoring Systems

Online proctoring systems are widely used to monitor students during remote examinations and reduce malpractice. Earlier systems mainly depended on human invigilators who monitored multiple webcam feeds at the same time. Although this method provides direct supervision, it becomes difficult to manage for large-scale examinations and may lead to inconsistent monitoring due to human error. Some systems also use screenshot capturing and browser monitoring, but these methods are unable to continuously observe student behavior in real time.

B. Face Detection and Recognition Techniques

Recent developments in computer vision have improved automated examination monitoring systems. Face detection and recognition methods are commonly used to verify candidate identity and prevent impersonation. YOLO-based object detection models are capable of detecting faces quickly and accurately in real-time environments. DeepFace is widely used for facial verification by comparing live webcam images with registered candidate data. These technologies help maintain the authenticity of online examinations.

C. Behavioral Analysis Using Deep Learning

Behavior analysis helps identify continuous suspicious activities during an examination session. Frame-by-frame monitoring alone may not accurately capture long-term cheating behavior. Deep learning models such as Long Short-Term Memory (LSTM) networks are effective for analyzing sequential behavioral patterns over time. LSTM models can detect repeated abnormal activities such as continuous gaze deviation, frequent movement, or screen absence, improving the reliability of automated proctoring systems.

D. Eye Gaze Tracking Methods

Eye gaze tracking is an important feature in online proctoring because it helps identify suspicious behavior such as looking away from the screen frequently. Earlier eye-tracking systems required expensive hardware devices, which limited their practical use. Modern frameworks such as Dlib and MediaPipe allow gaze estimation and facial landmark tracking using standard webcams. These methods are cost-effective and suitable for real-time online examination systems.

E. Object Detection for Exam Monitoring

Object detection techniques are used in proctoring systems to identify unauthorized materials during examinations. Deep learning models such as YOLOv8n can detect objects like mobile phones, books, calculators, and additional persons within the webcam frame. These models provide fast and accurate detection performance even under different lighting conditions and webcam qualities, making them useful for online examination environments.

III. SYSTEM ARCHITECTURE

The proposed AI-Based Smart Online Proctoring Exam Integrity Monitoring System consists of multiple monitoring modules integrated into a single web-based platform. The system is designed to monitor students continuously during online examinations and detect suspicious activities in real time.The system first captures live video from the candidate’s webcam. In the first stage, YOLO and DeepFace are used for face detection and identity verification to prevent impersonation. In the second stage, Dlib and MediaPipe are used for eye gaze tracking and head movement analysis to identify look-away behavior. In the third stage, the YOLOv8n model detects unauthorized objects such as mobile phones, books, and additional persons in the examination environment. In the fourth stage, an LSTM-based behavioral analysis module examines activity patterns throughout the examination session to identify continuous suspicious behavior.

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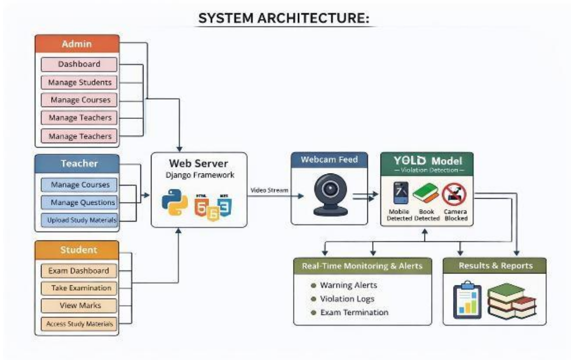

Fig. 1. System architecture of the AI-Based Smart Online Proctoring System showing Admin, Teacher, and Student modules connected to the Django web server, webcam monitoring, YOLO-based violation detection, and real-time alerts with report generation All detected violations are sent to a Django-based dashboard that provides real-time alerts, violation logs, and automated examination reports for administrators and faculty members. The system works through a web browser and does not require additional client-side software, making it suitable for large-scale online examinations.

IV. METHODOLOGY

A. STAGE 1: INPUT PREPROCESSING AND ENVIRONMENT ADAPTATION

1. Frame Quality Enhancement

Before webcam frames are processed by the AI models, the system first improves the image quality through a preprocessing stage. Each frame is analyzed based on brightness, contrast, and noise levels to determine its visibility quality. When lighting conditions are normal, only basic normalization is applied. In low-light or overly bright environments, enhancement techniques such as CLAHE (Contrast Limited Adaptive Histogram Equalization) are used to improve image clarity.

2. Real-Time Processing Optimization

To support real-time monitoring, preprocessing is executed on a separate CPU thread. This creates a buffer between webcam capture and AI model processing, helping the system maintain stable performance above 30 FPS. This approach improves reliability in practical examination environments where webcam quality, lighting conditions, and system performance may vary between users.

3. Performance Improvement

The preprocessing stage improves overall detection accuracy by enhancing frame quality before analysis. Experimental testing showed better performance under difficult lighting conditions and reduced detection errors compared to directly using raw webcam frames.

B. STAGE 2: FACE DETECTION AND POSE ESTIMATION

1. Face Detection

Face detection acts as the first security layer of the proposed system. Each webcam frame is processed using a YOLO-based model to detect faces in real time with high speed and accuracy. If no face is detected, the system assumes that the candidate has moved away from the screen or blocked the camera. Similarly, if multiple faces are detected, the system identifies it as a possible violation indicating the presence of another person during the examination. This helps ensure that only one candidate is present throughout the exam session.

2. Identity Verification

After face detection, the system performs identity verification using DeepFace with the ArcFace model. The largest detected face is selected as the primary candidate face and converted into a numerical representation called a facial embedding. This embedding is compared with the reference embedding stored during the student login process to verify identity.

3. Continuous Authentication

Identity verification is not limited to the beginning of the examination. The system repeats the verification process every 60 seconds to ensure continuous authentication during the session. If the similarity score exceeds a predefined threshold, the system flags it as a possible impersonation attempt. This approach improves reliability even when there are slight changes in lighting conditions or face orientation.

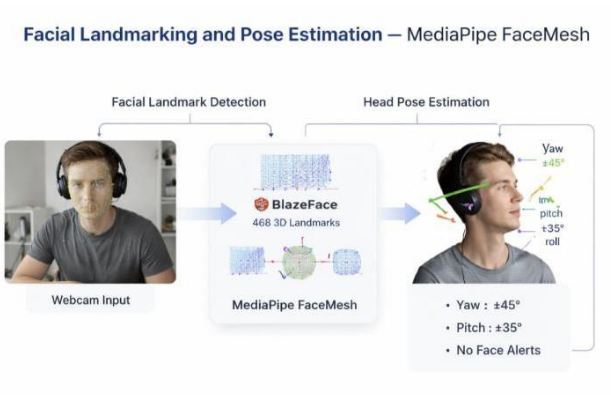

Fig. 2. Real-time facial landmark detection and head pose estimation using MediaPipe FaceMesh, illustrating 468 3D landmark mapping from webcam input.

.C. STAGE 3: GAZE TRACKING AND LOOK-AWAY DETECTION

1. Facial Landmark and Eye Tracking

Every graph node is shown using a 10-dimensional feature vector. The first three dimensions use one-hot encoding to mark the type of node such as actor, use case, or class. The next two dimensions stand for normalized in-degree and out-degree. Another dimension, the sixth one, shows the ratio of degrees. Dimensions seven and eight are reserved for potential centrality-related features. The ninth dimension indicates the normalized count of neighboring nodes. This vector explains both the type of the node and how it connects .

2. Gaze Zone Classification

After calibration, the system continuously tracks the student's eye movement and classifies the gaze into different zones such as center, left, right, up, and down. The center zone represents normal on-screen attention, while other directions indicate possible off-screen viewing. If the student continuously looks away from the screen for more than a few seconds, the system records it as a possible violation. Small and natural eye movements are ignored to reduce unnecessary alerts during reading or thinking

3. Stable Real-Time Monitoring

To improve stability, the system applies filtering methods that reduce noise and sudden fluctuations in gaze estimation. The module operates efficiently on standard CPU-based systems at nearly 28 FPS, making it suitable for regular student devices without requiring specialized hardware. This helps provide accurate and continuous monitoring throughout the examination session.

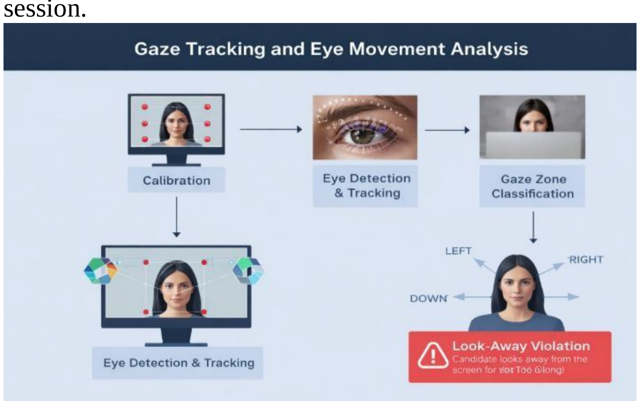

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Fig. 3. Multi-module system architecture pipeline — yolo+deepface identity • dlib+mediapipe gaze • yolov8n object detection • lstm

D. STAGE 4: UNAUTHORIZED OBJECT DETECTION

1. Object Detection Module

The system uses a fine-tuned YOLOv8n (nano) model to detect unauthorized objects during online examinations. The detection module identifies objects such as mobile phones, books or printed papers, additional persons, and camera obstruction attempts from live webcam frames. The lightweight YOLOv8n architecture provides fast and accurate real-time detection, making it suitable for both server-side and student-side systems.

2. Model Training and Dataset

The model was trained using a custom examination webcam dataset containing annotated images collected under different lighting conditions and webcam environments. Pretrained COCO weights were used as the initial model parameters, and the network was fine-tuned to improve detection performance for examination-related objects.

Fig 4: Unauthorized Object Detection Pipeline — yolov8n • Multi-Class Detection (Phone, Book, Person, Camera) • CSP Backbone • Real-Time Alert System

3. Real-Time Detection Performance

The trained YOLOv8n model performs real-time inference efficiently on both GPU and CPU devices. A confidence threshold is used to balance detection accuracy and false alerts across all object categories. This module helps the system continuously monitor the examination environment and quickly identify suspicious objects or activities during the exam session.

E. STAGE 5: BEHAVIORAL SEQUENCE ANALYSIS

1. Temporal Behavior Monitoring

Single-frame detection methods may fail to identify continuous suspicious behavior during online examinations. For example, repeated gaze deviation or frequent off-screen viewing over time may indicate cheating behavior that cannot be detected from a single frame alone. To address this issue, the system uses a bidirectional LSTM (Long Short-Term Memory) network to analyze behavioral patterns across multiple frames continuously.

2. Proposed Algorithm

The LSTM model processes a rolling sequence of webcam frames using extracted behavioral features. Each frame contributes features such as face count, gaze direction, mobile phone detection, book detection, and head movement information. These features are normalized and passed to the LSTM network, which learns temporal activity patterns and predicts whether the behavior is normal or suspicious.

3. Training and Performance Improvement

The model was trained using annotated examination session data containing both normal student behavior and simulated cheating activities. Before the examination begins, the system performs a short calibration phase to understand the candidate’s normal behavior pattern. This helps reduce false alerts caused by natural head movements or wider gaze ranges.

Experimental results showed that the LSTM-based sequence analysis significantly reduced false-positive detections compared to basic frame-by-frame monitoring methods.

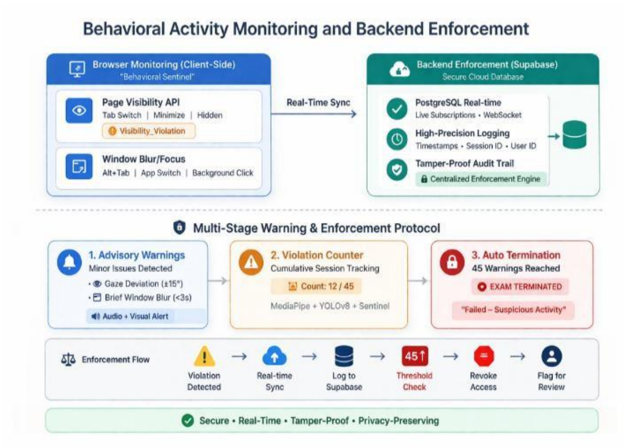

Fig 5: YOLOv10n + ByteTrack Vehicle Speed Estimation Pipeline — Detection • Association • Ground-Plane Projection • Filtering • Violation Flag

F. DJANGO EXAMINATION PLATFORM AND ANALYTICS DASHBOARD

1. Web-Based Examination Platform

The proposed system is developed using the Django web framework, which provides a secure and role-based environment for administrators, teachers, and students. Authentication and session management are handled securely using session tokens and CSRF protection. When the examination begins, the webcam monitoring pipeline starts automatically, and all AI monitoring modules run in the background for continuous real-time analysis.

2. Real-Time Monitoring Dashboard

The platform includes a real-time analytics dashboard that displays detected violations along with timestamps and annotated webcam frames. The dashboard also calculates an integrity score for each candidate based on the type and number of violations detected during the examination. Examination-wide statistics and violation summaries are presented using charts and reports for easier monitoring by faculty members

3. Report Generation and Data Management

The system generates downloadable examination integrity reports for each candidate after the exam session. Separate access controls ensure that students can only view their own examination status, while teachers and administrators can monitor all candidates. Django's ORM is used for storing violation records and managing the database efficiently in both development and production environments.

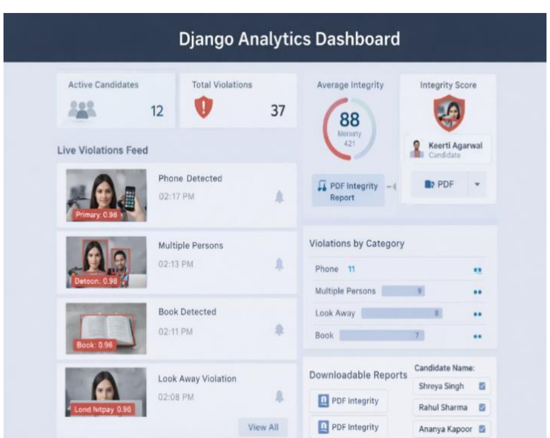

Fig 6: django analytics dashboard — metric cards • live violation feed • integrity score • category charts • downloadable reports

V. DISCUSSION

A. Significance of Results

1. Experimental Evaluation

The proposed system was tested using multiple simulated online examination sessions conducted under different lighting conditions, webcam qualities, and user environments. The evaluation included common examination violations such as mobile phone usage, gaze deviation, multiple-person presence, screen absence, and impersonation attempts. The system successfully monitored candidate activities in real time and generated automated violation reports during the examination process.

2. Summary of System Performance

Experimental results showed strong performance across all monitoring modules. The YOLO and DeepFace-based face verification module accurately identified candidates and detected impersonation attempts. The Dlib and MediaPipe gaze tracking module effectively monitored student attention and identified continuous look-away behavior. The YOLOv8n object detection model successfully detected unauthorized objects such as mobile phones and books under different environmental conditions. The LSTM-based behavioral analysis module improved overall monitoring reliability by analyzing continuous activity patterns instead of depending only on single-frame detection. This reduced false alerts caused by natural student movements and improved the accuracy of suspicious behavior detection. Overall, the proposed framework demonstrated efficient real-time performance and reliable violation detection, making it suitable for secure and scalable online examination monitoring systems.

B. Case Study — PMC Tech College Examination Pilot

To evaluate the proposed system, a pilot online examination was conducted at PMC Tech College involving 120 students across three examination halls during an end-semester assessment. The system continuously monitored all candidates throughout the 3-hour examination session using webcam-based analysis, while faculty members observed activities through the Django monitoring dashboard.

During the examination, the system detected different types of violations, including gaze deviation, mobile phone usage, multiple-person presence, screen absence, and identity mismatch events. After manual verification by the monitoring staff, most of the detected violations were confirmed to be genuine, showing that the system achieved reliable real-time monitoring with a low false-alert rate.

The analysis also showed that suspicious activities were more common during the early stages of the examination and during difficult sections of the test. Mobile phone usage was identified as one of the most frequent malpractice activities. The integrity score generated by the system closely matched the results of manual review, demonstrating that the scoring mechanism can effectively help faculty identify high-risk candidates quickly and efficiently.

C. Limitations and future work

1. Limitations

The proposed system has a few practical limitations. The gaze tracking module based on Dlib and MediaPipe requires a short calibration process before the examination begins, which slightly increases the setup time. Gaze estimation accuracy may also reduce for candidates wearing glasses with reflections or under poor lighting conditions.

The YOLOv8n object detection model performs well for most unauthorized objects, but detection accuracy decreases when objects such as mobile phones are partially hidden or placed outside the webcam view. Similarly, face verification accuracy may reduce when multiple users have very similar facial features or when webcam quality is low.

The LSTM behavioral analysis module requires a short observation period to learn the candidate’s normal behavior pattern. This additional calibration phase may increase the initial examination setup time for large-scale examinations.

2. Future Work

Future improvements can focus on increasing detection accuracy and reducing setup complexity. The system can be extended with advanced gaze estimation methods that require less calibration time and perform better under challenging lighting conditions.

The object detection module can be improved by training on larger examination datasets containing more hidden-object scenarios and different webcam environments. Additional biometric verification methods such as voice recognition or keystroke analysis may also be integrated to improve identity authentication.

Future versions of the platform can support cloud-based scalability, mobile-device compatibility, and integration with Learning Management Systems (LMS) for automated examination management. Further optimization of the behavioral analysis module may also help reduce false alerts and improve real-time performance for large-scale online examinations.

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VI. CONCLUSION

This project presented an AI-Based Smart Online Proctoring Exam Integrity Monitoring System for secure and reliable online examinations. The system combines multiple AI techniques, including YOLO and DeepFace for face verification, Dlib and MediaPipe for gaze tracking, YOLOv8n for unauthorized object detection, and an LSTM model for behavioral analysis. By integrating these modules into a single framework, the system improves examination monitoring accuracy and reduces false alerts compared to traditional online proctoring methods.

The proposed Django-based platform supports real-time monitoring, violation detection, and automated report generation for administrators and faculty members.Experimental testing demonstrated effective detection of violations such as impersonation, gaze deviation, mobile phone usage, and multiple-person presence under different examination conditions.

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