



Athena Proctor - Smart Proctoring System for Online Exam

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Abstract—

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Online examinations provide flexibility and accessibility for students and educational institutions, but maintaining academic integrity in remote assessment environments remains a major challenge due to limited direct supervision. Traditional examination methods may not effectively identify impersonation, unauthorized materials, suspicious movements, or attempts to access external resources during an examination. To address these challenges, this paper presents a Smart Proctoring System for Online Examinations that integrates Artificial Intelligence (AI), Machine Learning (ML), computer vision, audio monitoring, and web technologies to support automated examination supervision.

The proposed system verifies student identity using facial recognition before the examination and monitors the candidate throughout the examination session using a webcam and microphone. Computer vision techniques are used to identify suspicious conditions such as face absence, the presence of multiple faces, unusual eye and head movements, and mobile phones or other prohibited objects. Audio monitoring supports the identification of predefined suspicious audio activities, while browser activity monitoring records unauthorized actions such as switching between tabs or leaving the examination window. These monitoring mechanisms help identify potential examination The system maintains examination records, including timestamps,

screenshots, violation details, and activity logs, to support transparency and post-examination review. It aims to reduce dependence on manual invigilation and improve the efficiency of online examination monitoring. By combining automated detection with human review, the system provides supporting evidence for investigating suspicious activities and ensures that alerts are verified before any final decision is made.

Keywords— Online Examination; Artificial Intelligence; Smart Proctoring; Computer Vision; Face Verification; Object Detection; Audio Monitoring; Browser Activity Monitoring; Academic Integrity.



I. INTRODUCTION

The rapid development of digital education has increased the use of online examinations in educational institutions. Although online examinations offer flexibility and convenience, ensuring academic integrity and preventing malpractice remain important challenges. Issues such as impersonation, unauthorized materials, suspicious activities, and switching to external browser resources can affect the fairness of examinations. Traditional online examination systems often rely on manual supervision, making continuous monitoring difficult.

The proposed Smart Proctoring System for Online Examinations uses Artificial Intelligence (AI), Machine Learning (ML), computer vision, and web technologies to improve examination security. The system verifies student identity using facial recognition and monitors suspicious activities through face detection, gaze and head-pose analysis, mobile-phone detection, audio monitoring, and tab-switch tracking.

An administrator dashboard allows authorized staff to monitor examination sessions, review alerts, and access screenshots, activity logs, and violation reports. By integrating multiple monitoring techniques, the system aims to improve monitoring efficiency, support academic integrity, and provide evidence for human review before making decisions about potential violations.

Furthermore, the system is designed to provide a structured and transparent examination monitoring process. It records detected incidents with timestamps and relevant evidence, helping administrators investigate suspicious activities after an examination. The integration of web technologies and AI-based detection services also supports centralized data management and efficient communication between system components. Overall, the proposed system aims to make online examinations more secure, reliable, and manageable while reducing the workload of human invigilators.

II. LITERATURE REVIEW

Earlier online proctoring research has explored facial recognition, gaze detection, audio monitoring, and automated identification of suspicious activities. However, these systems may generate false alerts due to natural student movements, poor lighting, camera quality, and network connectivity. Continuous recording may also raise privacy concerns, while deep-learning approaches can require significant computational resources and bandwidth. These limitations highlight the need for a reliable system that combines multiple monitoring techniques and supports human verification.

Computer vision and machine learning techniques have been widely explored for detecting suspicious examination behaviors. Facial analysis and head-pose estimation help identify unusual movements, while object detection techniques can recognize prohibited items such as mobile phones. Audio-based monitoring and browser activity tracking provide additional information about possible violations. However, the accuracy of these techniques can be affected by environmental conditions, and individual detection methods may not identify every form of examination malpractice.

Recent approaches emphasize multimodal proctoring systems that combine visual, audio, and behavioral information to improve monitoring capabilities. Maintaining examination logs, screenshots, and timestamps can also support the investigation of detected incidents. Nevertheless, balancing detection accuracy, computational requirements, student privacy, and system reliability remains an important challenge in online examination environments.

The proposed Smart Proctoring System for Online Examinations integrates facial authentication, face detection, gaze and head-pose analysis, mobile-phone detection, multiple-person detection, tab-switch monitoring, and audio analysis. It also provides real-time alerts, screenshots, activity logs, and a centralized administrator dashboard for reviewing examination violations. By combining multiple monitoring mechanisms, the



system aims to improve detection efficiency, maintain transparency, and reduce dependence on a single detection technique while supporting human review of suspicious activities.

III. METHODOLOGY

The proposed Athena Smart Proctoring System for Online Examinations follows a modular, AI-based approach that integrates facial recognition, computer vision, audio monitoring, browser activity tracking, and web technologies. The system verifies student identity, monitors examination activities, detects potential violations, and maintains records for further investigation. It follows a client-server architecture in which the frontend collects examination inputs, the backend manages authentication and records, and AI services analyze facial images and detect prohibited objects.

The methodology begins with student registration and facial enrollment. Facial images are captured through a webcam and processed to generate facial feature representations. Technologies such as InsightFace and ArcFace compare the candidate's facial features with the enrolled identity during authentication. Computer vision techniques, including OpenCV and YOLO-based object detection, help monitor face absence, multiple faces, unusual head movements, and prohibited objects such as mobile phones. Audio monitoring and browser activity tracking record suspicious sound patterns, tab switching, and loss of browser focus. The system uses React, Node.js, Express.js, Python, FastAPI, and MongoDB Atlas to manage examination activities and store relevant records. An administrator dashboard enables authorized staff to review alerts and recorded incidents. System performance can be evaluated using accuracy, precision, recall, F1-score, and response time. Student data must be protected, and automated alerts should be reviewed by authorized staff before any disciplinary decision is made.

IV. RESULTS AND DISCUSSION

The proposed system supports student authentication, continuous monitoring, suspicious-activity detection, real-time alerts, and violation logging. Since verified experimental data are not available, numerical performance values are not included. The final results should be based on actual testing, considering detection accuracy, false alerts, processing time, and system response time.

1. Admin Page

a) Admin dashboard

The Admin Dashboard of the Athena Smart Proctoring System provides a centralized interface for monitoring online examinations. It allows administrators to view student details, identity verification status, suspicious activity alerts, and violation logs. The dashboard helps review examination incidents and maintain records, supporting secure and efficient examination management. All automated alerts should be reviewed by authorized administrators before taking disciplinary action.

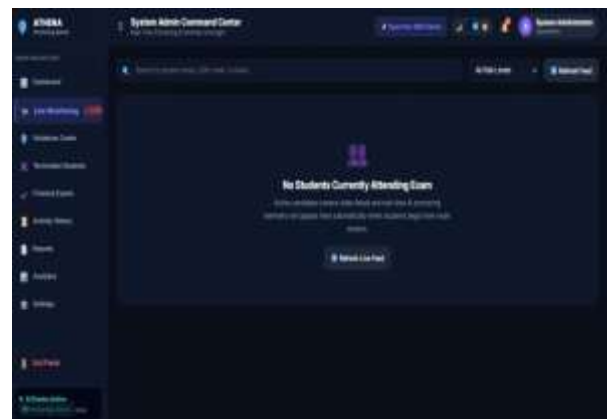


Fig 1.a Admin Dashboard.

2 Face Enroll & Face Verification

The Face Enrollment and Face Verification module is an important component of the Athena Smart Proctoring System. During enrollment, the student's facial images are captured through a webcam and processed to create facial feature representations, which are stored securely for future identification. During an examination, the



system captures the student's live face and compares it with the previously enrolled facial data to verify identity. This process helps prevent impersonation and ensures that the registered student is attending the examination. The module supports secure authentication and continuous identity monitoring throughout the examination.

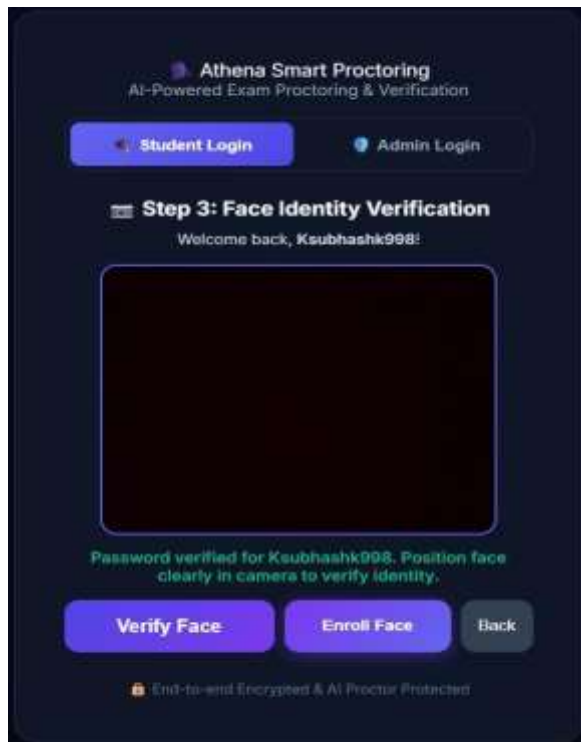


Fig.2 Face Enrollment& Face Verification

3 Before Exam Start

Before Starting the Exam – Device Verification. The Device Verification interface checks the availability and permission status of the webcam and microphone before the examination begins. It ensures that both devices are functioning properly and accessible to the examination platform. The webcam is checked for capturing the student's face, while the microphone is verified for audio monitoring. The interface displays the device status so students can confirm that all required components are ready.

If the webcam or microphone is unavailable or permission is denied, the system prompts the candidate to enable access or resolve the issue before proceeding. This step helps identify technical problems in advance and ensures that

the required monitoring features can operate during the examination.



Fig.3 Before Exam Start

4. Examination Dashboard

The examination dashboard provides the main interface through which candidates attend online examinations. It displays essential examination information such as the examination title, candidate details, question number, available questions, answer options, and remaining examination time. The interface allows candidates to navigate between questions, select or modify answers, review their responses, and submit the examination after completing the required questions. During the examination, the dashboard remains connected to monitoring components, including the webcam and microphone, to support continuous proctoring. The system displays monitoring status and generates alerts when predefined suspicious activities are detected, such as face absence, multiple faces, prohibited objects, or unusual browser activity, where these features are implemented. Examination responses, monitoring events, and detected violations can be recorded in the system database for further analysis and reporting. The dashboard is designed with a simple and user-friendly interface to help candidates attend examinations without



unnecessary confusion. It integrates examination activities with AI-based proctoring mechanisms and supports administrators in reviewing recorded incidents. Overall, the examination dashboard helps organize the examination process, improve monitoring, and maintain a structured online examination environment.

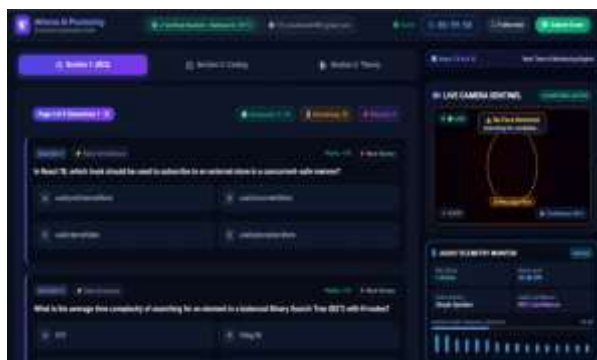


Fig 4 Exam Dashboard.

V. CONCLUSION

The system also provides an administrator dashboard for monitoring examination sessions, viewing alerts, reviewing screenshots, and generating examination reports. By automatically identifying predefined suspicious events and recording relevant examination activities, the system reduces the dependence on continuous manual supervision and provides administrators with structured information for post-examination review. The integration of multiple monitoring techniques provides broader coverage than systems that depend on a single detection mechanism. At the same time, the system is designed to distinguish normal candidate activities from potentially suspicious events through appropriate detection conditions and thresholds. This can help reduce unnecessary alerts caused by normal actions such as reading questions, changing posture, or briefly moving the head.

Furthermore, the system maintains examination records that support transparency and make it easier to investigate reported incidents. The recorded information helps administrators review events and make informed decisions based on available evidence. The proposed approach aims to improve examination security, monitoring efficiency, and the reliability of online

assessment. However, automated alerts should be treated as indicators of possible violations and reviewed by authorized administrators before any final decision is made.

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