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Online Examination & Proctoring System

Palash Poharkar, Sahil Maske, Parth Lavtawar, Pranay Bhure, Palvesh Dandre, Mr. Kunal Kanchankar,
G H Raison University, Amravati, Nagpur, Maharashtra, India

Abstract: *The increasing adoption of online education has created a strong demand for secure and reliable examination systems, while simultaneously raising concerns regarding academic integrity in remote environments. This paper presents an enhanced AI-based Online Examination Proctoring System (OEPS) that incorporates role-based access control, biometric identity verification, and realtime behavioral analysis to ensure fair and transparent online assessments. The system is designed using a full-stack architecture consisting of a React-based frontend, a Node.js and Express backend, Supabase database integration, and a FastAPI-based AI microservice. During student registration, facial data is captured and stored, which is later used for identity verification before the examination begins. Real-time monitoring is performed using computer vision techniques through libraries such as face-api.js and MediaPipe to detect cheating behaviors including head movement, absence of face, and multiple face detection. All suspicious activities are logged as violations and made accessible to teachers via a dedicated dashboard for analysis. Additionally, the system supports exam creation, publishing, OCR-based question extraction using Tesseract.js, and performance analytics. The admin module provides complete system oversight by allowing access to both teacher and student dashboards. Experimental observations indicate that the system effectively minimizes cheating, enhances exam security, and reduces reliance on manual invigilation, making it a scalable and efficient solution for modern digital education platforms.*

Keywords: *Online Proctoring, Artificial Intelligence, Computer Vision, Facial Recognition, Behavior Monitoring, OCR, Cloud Computing, Academic Integrity*

I. INTRODUCTION

The rapid expansion of online education and digital learning platforms has significantly transformed the way examinations are conducted. Remote assessments provide flexibility, accessibility, and scalability, allowing students to participate from any location. However, this shift has introduced serious challenges in maintaining academic integrity, as the absence of physical supervision creates opportunities for cheating, impersonation, and unauthorized assistance. Traditional online examination methods, such as manual invigilation and browser restrictions, are often inefficient, difficult to scale, and unable to detect sophisticated malpractice. Therefore, there is a growing need for intelligent and automated systems that can ensure secure and fair examination processes. Advancements in artificial intelligence (AI), machine learning (ML), and computer vision have enabled the development of smart proctoring systems capable of analyzing real-time user behavior. In this paper, we propose an enhanced AI-based Online Examination Proctoring System (OEPS) that integrates role-based system design, biometric authentication, and real-time monitoring. The system is built using a full-stack architecture consisting of a React-based frontend, a Node.js and Express backend, a Supabase database, and a FastAPI-based AI microservice. It supports three primary roles—Admin, Teacher, and Student—where the admin has full control over the system, teachers can create and manage exams, and students can register, verify their identity, and participate in examinations. During registration, the system captures and stores the student's facial data, which is later used for identity verification before the exam begins.

II. LITERATURE SURVEY

Nigam (2021) presented a comprehensive review of AI-based online proctoring systems, highlighting the use of facial recognition, eye tracking, and behavioral analysis to detect cheating during online examinations. The study emphasized that AI-driven systems significantly improve monitoring efficiency compared to traditional invigilation methods, while also raising concerns regarding privacy and ethical implications. Similarly, Tweissi (2022) examined the effectiveness of automated proctoring systems in online education and demonstrated that AI-based video analysis can help maintain academic integrity by identifying suspicious behaviors. The research concluded that such systems are scalable and reduce reliance on manual invigilation, although their performance largely depends on the accuracy of the underlying algorithms.

Erdem (2025) explored the application of machine learning and deep learning techniques for detecting cheating behavior in online examinations.

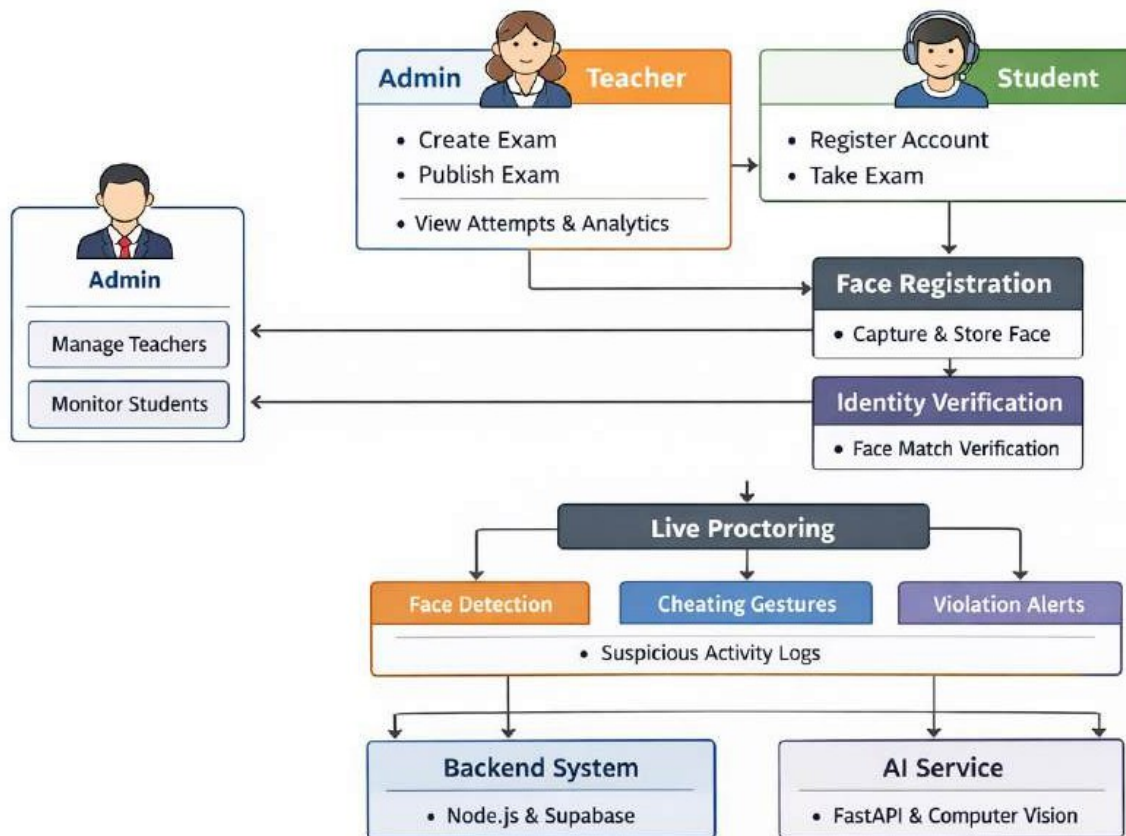
The study compared various models, including Support Vector Machines (SVM), Random Forest, and Deep Neural Networks (DNN), and found that deep learning approaches achieved the highest accuracy in behavior classification and anomaly detection. In addition, Singh (2024) proposed a multi-modal proctoring system that integrates computer vision and audio analysis techniques. Their approach utilizes facial detection, head pose estimation, and sound monitoring to identify malpractice, with results indicating that combining multiple data sources improves detection accuracy and overall system reliability.

Furthermore, Heinrich (2025) conducted a systematic review focusing on both the technical and ethical aspects of online proctoring technologies. The study highlighted that modern systems heavily rely on artificial intelligence and biometric data for monitoring purposes, but also raised significant concerns regarding data security, transparency, and user trust. It emphasized the need for incorporating ethical frameworks and privacy-preserving techniques in the design of such systems to ensure responsible deployment.

III. METHODOLOGY

The proposed Online Examination Proctoring System (OEPS) is designed as an AI-driven, role-based platform that ensures secure and reliable online assessments through continuous monitoring, identity verification, and behavioral analysis. The system integrates three primary user roles—Admin, Teacher, and Student—along with a backend server, database, and AI-based microservice to deliver a complete examination ecosystem. The methodology follows a structured workflow starting from user registration to exam completion and result analysis.

Flow Chart 3.1



A. Role-Based System Design

The system is structured around three key roles. The Admin has complete control over the platform, including managing teachers and students and accessing their dashboards for monitoring purposes. The Teacher is responsible for creating, managing, and publishing examinations, as well as analyzing student attempts and violation reports. The Student registers on the platform, completes identity verification, and participates in examinations. This role-based architecture ensures proper access control and efficient system management.

Name	Email	Role	Created	Actions
P Parth Lavtawar A1001149-8108-414e-8f0d-4c08b092876b	Plavtawar@gmail.Com	Student	3/27/2026, 3:01:50 PM	View Dashboard Student
P Palash Poharkar F982ca7d-F67d-4760-A770-08ec0d910d7f	Random2@gmail.Com	Student	3/26/2026, 5:26:35 PM	View Dashboard Student
P Piyush Shende 74f08672-3d87-48a9-8299-7c8390434c0c	Piyush@gmail.Com	Student	3/18/2026, 10:27:45 AM	View Dashboard Student
R Random F73707ac-6d08-47c0-80a3-8c80aed00763	Random@gmail.Com	Student	2/5/2026, 12:04:28 AM	View Dashboard Student
S Sahil 7aa75d0c-090f-450f-9078-62219e68d018	Sahilmaske964@gmail.Com	Teacher	1/22/2026, 4:44:03 PM	View Dashboard Teacher
P Palash Poharkar C0c7d85b-2045-4c7e-8d1c-53a38a9c6a88	Palashpoharkar57@gmail.Com	Admin	1/14/2026, 3:42:04 PM	Admin

Tip: Admin Can Explore Teacher & Student Dashboards.

Fig 3.1

B. Student Registration and Face Enrollment

During registration, the system captures the student's facial image using the device camera. This image is processed and stored securely in the database as a reference for future identity verification. This step establishes a biometric profile for each student, which is later used to authenticate the user before and during the examination process.

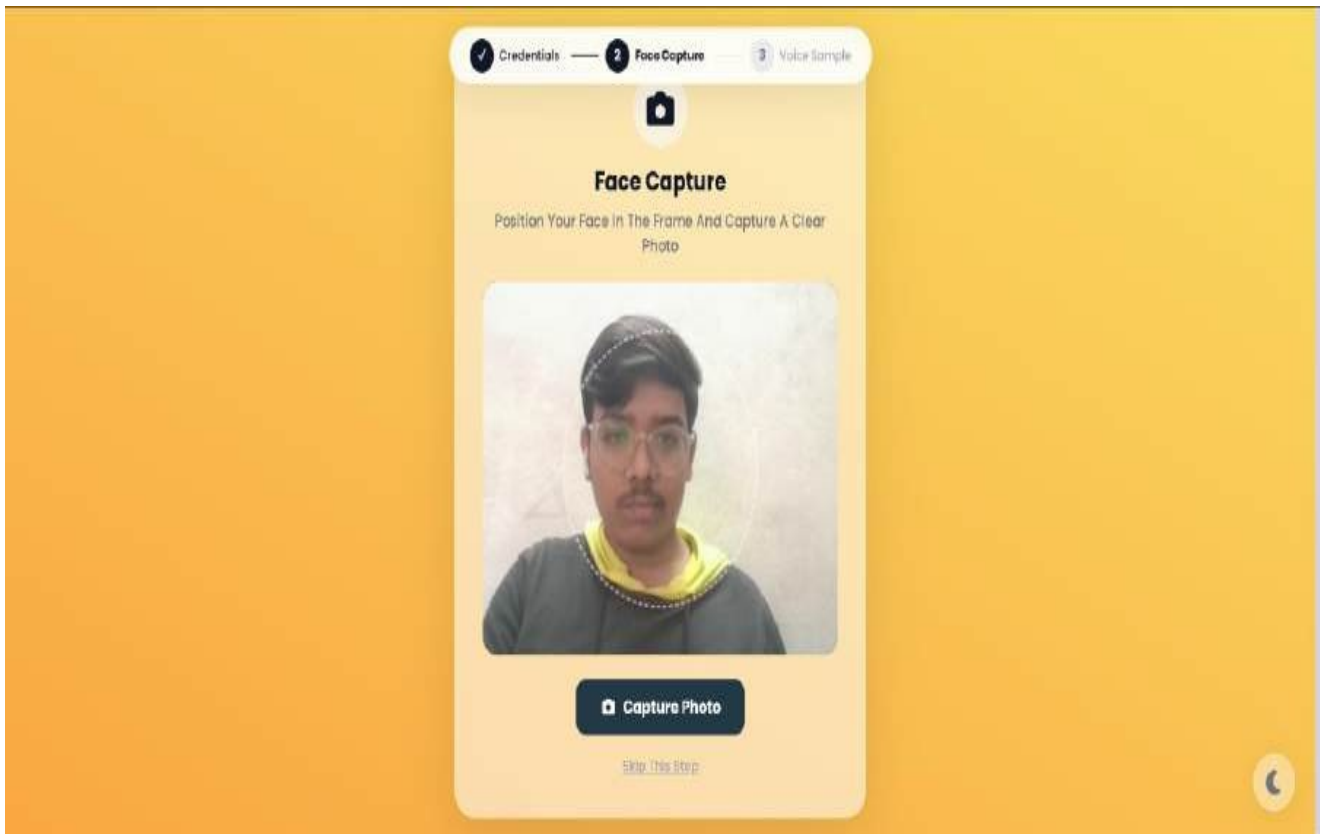


Fig 3.2

C. Identity Verification Before Examination

Before starting an exam, the system performs real-time identity verification by capturing live video frames from the student's webcam. The captured image is compared with the stored facial data using computer vision techniques to ensure that the registered user is the same person attempting the exam. If the verification fails, the system restricts access to the examination, thereby preventing impersonation.



Fig 3.3

D. Exam Creation and Publishing

Teachers can create and manage multiple-choice question (MCQ) based examinations through the system interface. Questions can be added manually or extracted using Optical Character Recognition (OCR) from images and documents. Once finalized, the teacher publishes the exam, making it available to students. The system also allows teachers to track attempts, view performance metrics, and analyze examination data.

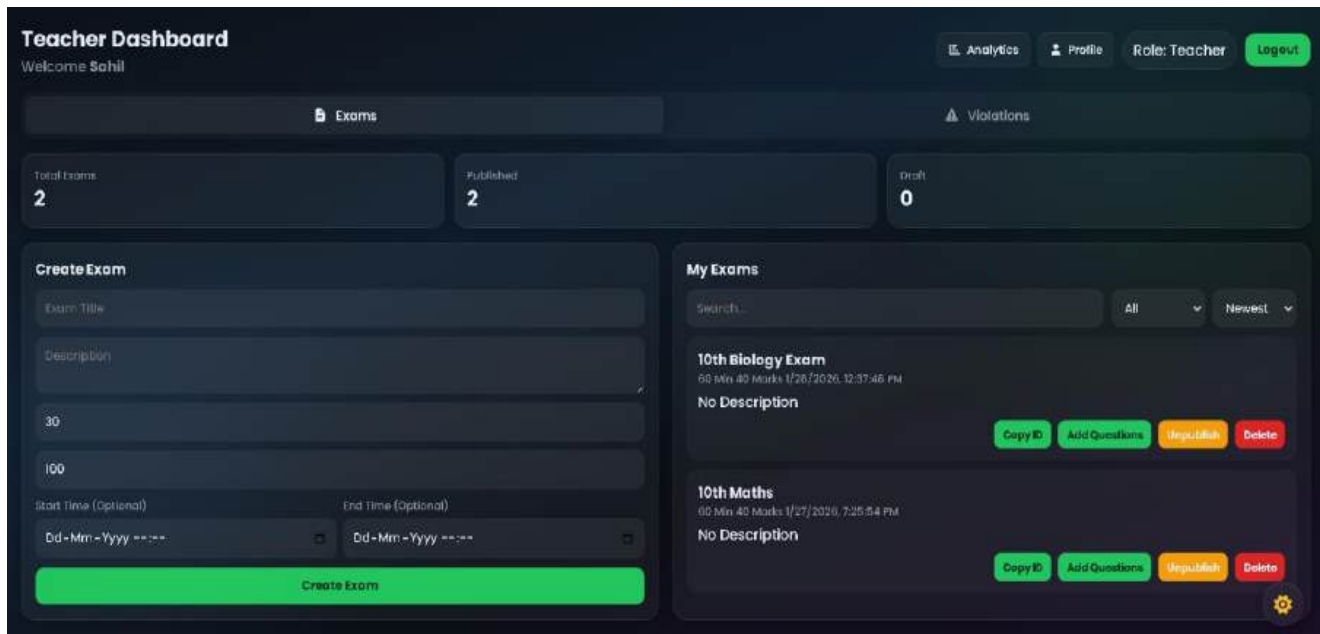


Fig 3.4

E. Real-Time Proctoring and Monitoring

During the examination, the system activates continuous monitoring using the student's webcam. Real-time video frames are processed using computer vision libraries such as face-api.js and MediaPipe. The system detects facial presence, head orientation, and eye movement to ensure that the student remains attentive and follows examination rules. These frames are sent to the AI microservice, implemented using FastAPI, for further analysis.

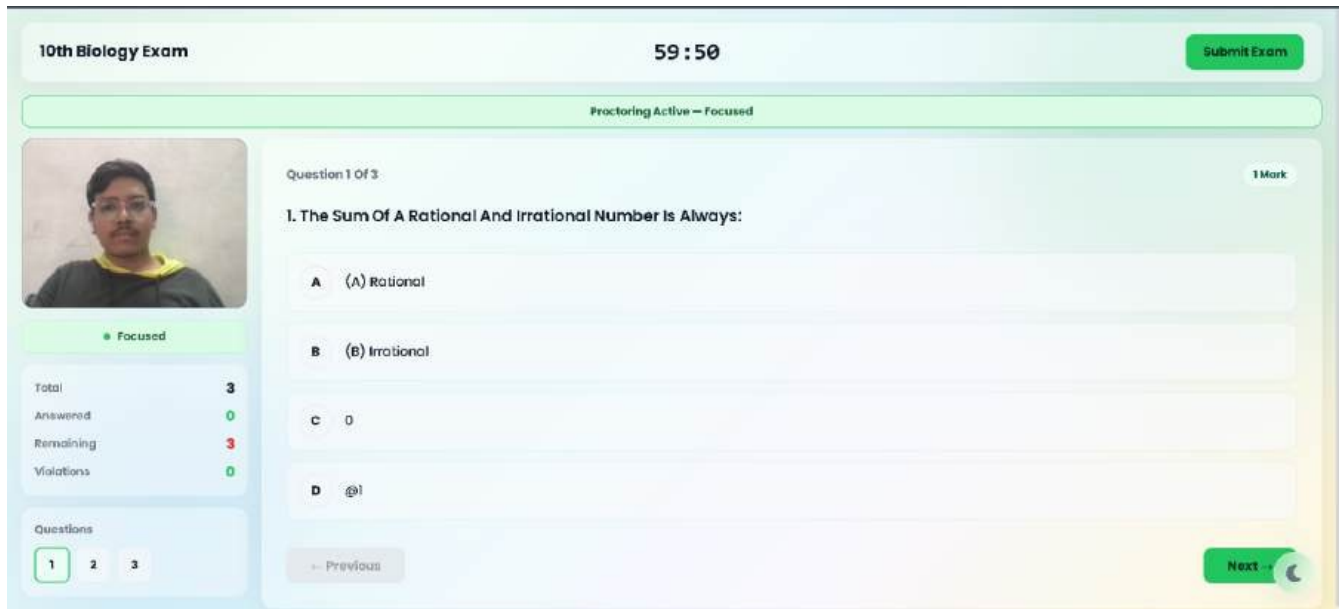


Fig 3.5

F. Cheating Detection and Violation Logging

The AI module identifies multiple cheating gestures and suspicious behaviors, such as looking away from the screen, absence of face, presence of multiple faces, or unusual movements. Each detected anomaly is recorded as a **violation** and stored in the database. These violation logs are made accessible to teachers through their dashboard, allowing them to review student behavior during the exam.

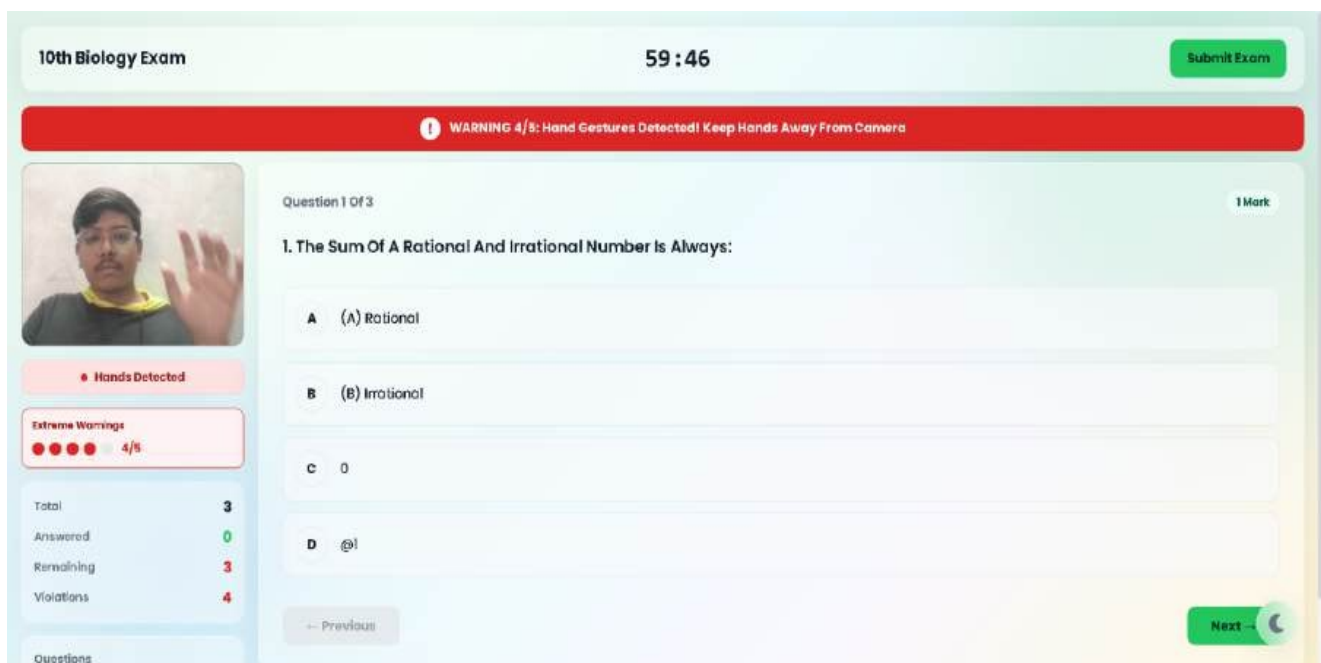
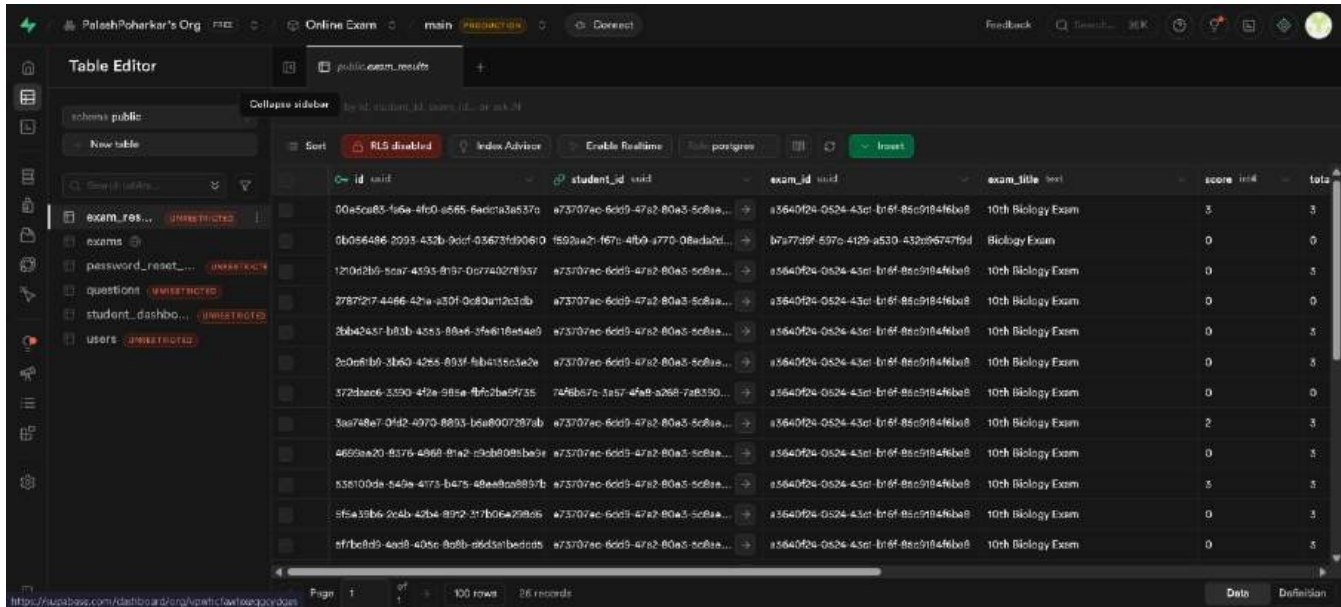


Fig 3.6

G. BackendProcessingandDataManagement

The backend system, developed using Node.js and Express, handles all core functionalities including authentication, exam management, data storage, and communication with the AI service. Supabase is used as the database for storing user profiles, facial data, exam details, responses, and violation logs. Secure authentication is implemented using JSON Web Tokens (JWT), ensuring safe access to system resources.



id	student_id	exam_id	exam_title	score	total
00a5ca85-166e-4fc0-a565-6edc1a3a537a	a73707ac-6dd9-47a2-80a3-5c8ba...	a3640924-0524-43ad-b16f-8ec9184f6ba8	10th Biology Exam	3	3
0b056486-2093-432b-9dcf-03673fd906d0	1592ba2c-167e-48b9-4770-08ada2d...	b7a77d9f-597c-4129-a530-432b967479d9	Biology Exam	0	0
12f062b0-5ca7-4593-b19f-0a7402789377	a73707ac-6dd9-47a2-80a3-5c8ba...	a3640924-0524-43ad-b16f-8ec9184f6ba8	10th Biology Exam	0	3
2787217-4486-42ba-a30f-0c80a12c3ab3	a73707ac-6dd9-47a2-80a3-5c8ba...	a3640924-0524-43ad-b16f-8ec9184f6ba8	10th Biology Exam	0	0
2bb42a51-b83b-4353-88a6-3fa6118a54e9	a73707ac-6dd9-47a2-80a3-5c8ba...	a3640924-0524-43ad-b16f-8ec9184f6ba8	10th Biology Exam	0	3
2c0a61b0-3160-4255-893f-f8b4135c5e2e	a73707ac-6dd9-47a2-80a3-5c8ba...	a3640924-0524-43ad-b16f-8ec9184f6ba8	10th Biology Exam	0	3
372bae6-3390-442e-985e-f8fc2ba9f335	74f8b67c-3a57-4fa9-a268-7a8330...	a3640924-0524-43ad-b16f-8ec9184f6ba8	10th Biology Exam	0	0
3a9748e7-0fd2-4970-8893-bda8007287ab	a73707ac-6dd9-47a2-80a3-5c8ba...	a3640924-0524-43ad-b16f-8ec9184f6ba8	10th Biology Exam	2	3
4669aa20-8376-4968-81a2-d3ab0981ba2e	a73707ac-6dd9-47a2-80a3-5c8ba...	a3640924-0524-43ad-b16f-8ec9184f6ba8	10th Biology Exam	0	3
535100da-540e-4173-8475-48ead8a9897b	a73707ac-6dd9-47a2-80a3-5c8ba...	a3640924-0524-43ad-b16f-8ec9184f6ba8	10th Biology Exam	3	3
5f5a39b6-2c4b-42b4-8992-317b06a29805	a73707ac-6dd9-47a2-80a3-5c8ba...	a3640924-0524-43ad-b16f-8ec9184f6ba8	10th Biology Exam	0	3
5ff1bc8d3-4ed9-4d5c-8a8b-a6d5a1bedd85	a73707ac-6dd9-47a2-80a3-5c8ba...	a3640924-0524-43ad-b16f-8ec9184f6ba8	10th Biology Exam	0	3

Fig 3.7

H. ResultEvaluationandAnalytics

After the completion of the examination, the system automatically evaluates student responses and generates results. Teachers can access detailed analytics, including scores, attempt data, and violation reports. These insights help in assessing both student performance and exam integrity.

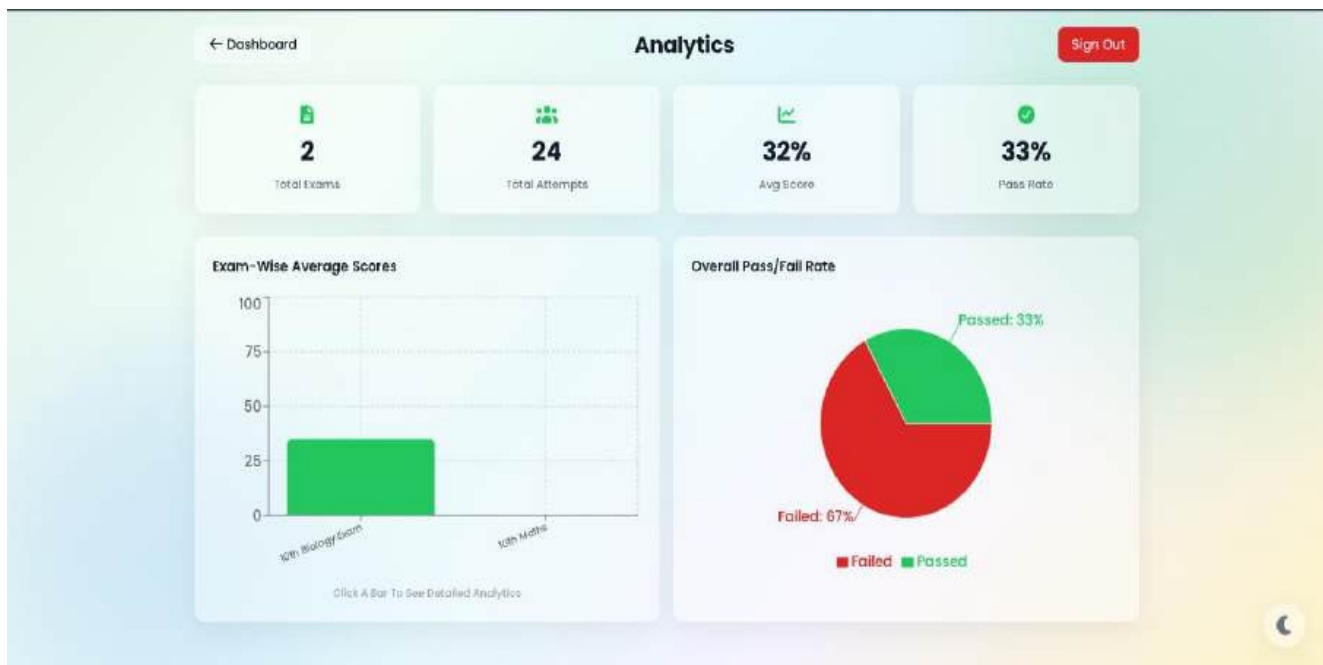


Fig 3.8

I. System Security and Integrity

To ensure reliability, the system incorporates multiple security mechanisms such as encrypted password storage, secure API communication, and rate limiting. Continuous monitoring and AI-based validation enhance the integrity of the examination process by minimizing the chances of malpractice.

Overall, the proposed methodology integrates biometric authentication, real-time AI monitoring, and role-based system design to create a secure, scalable, and intelligent online examination platform. The combination of automation and advanced analytics ensures both efficiency and credibility in digital assessments.

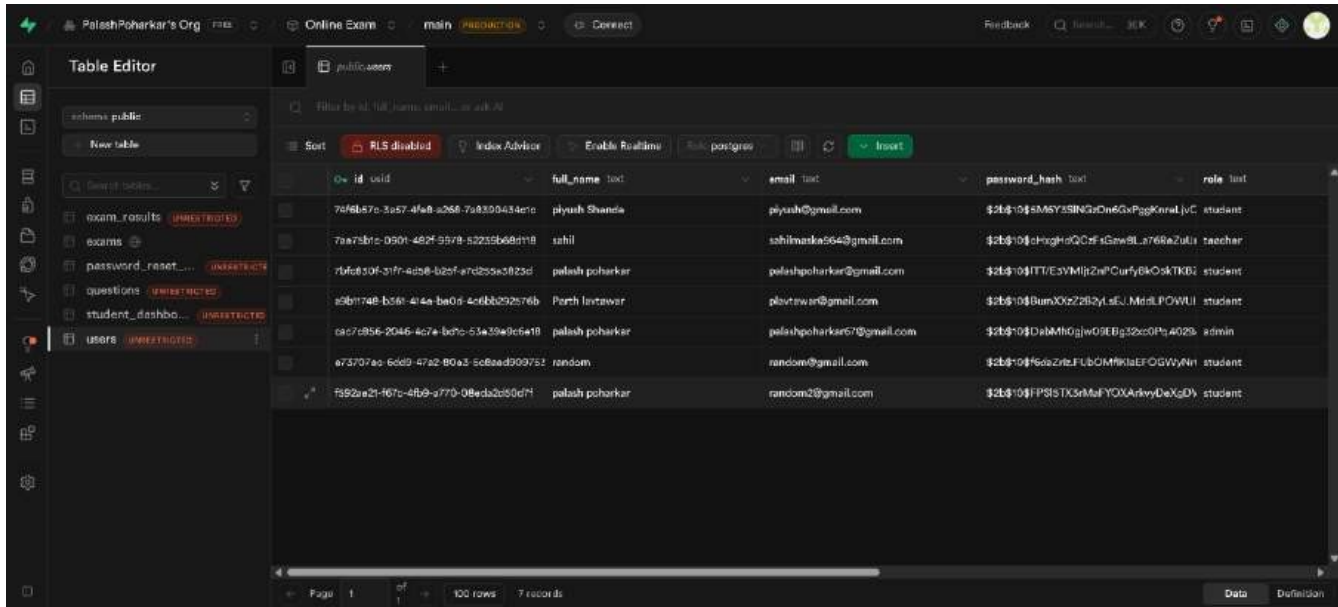


Fig 3.9

IV. RESULTS AND ANALYSIS

In this study, the proposed Online Examination Proctoring System (OEPS) was evaluated based on its ability to ensure secure online examinations, accurately detect suspicious activities, and efficiently manage examination workflows. The system integrates AI-based monitoring, identity verification, and role-based access control, and its performance was analyzed through functional testing and simulated examination scenarios.

A. System Performance

The system successfully handled core functionalities including user authentication, exam creation, exam participation, and result generation. The integration of frontend, backend, and AI microservice demonstrated smooth communication and real-time processing. The platform was able to support multiple users simultaneously, indicating good scalability and stability for practical deployment.

B. Identity Verification Accuracy

The facial recognition mechanism used during student registration and pre-exam verification showed reliable performance in validating user identity. In most test cases, the system correctly matched the live webcam image with the stored facial data, effectively preventing unauthorized access and impersonation attempts. Minor variations in lighting and camera quality affected performance slightly but did not significantly impact overall verification accuracy.

C. Real-Time Proctoring and Behavior Detection

The AI-based monitoring system demonstrated effective detection of various cheating behaviors. Activities such as looking away from the screen, absence of face, and presence of multiple faces were successfully identified during the examination. The use of computer vision libraries enabled continuous tracking of facial movements and user attention. The system maintained consistent monitoring throughout the exam without significant latency.

D. Violation Logging and Reporting

All detected suspicious activities were recorded as violations and stored in the database. These logs were accurately reflected in the teacher dashboard, allowing instructors to review student behavior in detail. The violation reporting mechanism provided clear insights into the frequency and type of anomalies, helping teachers make informed decisions regarding exam integrity.

E. Exam Management and Analytics

The exam management module allowed teachers to create, publish, and monitor examinations efficiently. The system generated detailed analytics, including student scores, attempt history, and violation data. Visual representations such as charts and reports improved the readability of performance data. The integration of OCR also reduced the time required for question input and exam preparation.

F. Overall System Effectiveness

The combined use of AI-based monitoring and secure backend processing resulted in a robust and reliable examination system. The platform significantly reduced the need for manual invigilation while maintaining high levels of security. The role-based access ensured proper system control, with administrators having complete oversight of both teacher and student activities.

G. Limitations and Observations

Although the system performed effectively, certain limitations were observed. The accuracy of face detection and behavior analysis depends on camera quality, lighting conditions, and internet stability. Additionally, some subtle cheating behaviors may not always be detected with high precision. These challenges highlight the need for further improvements using advanced deep learning models and multi-modal analysis techniques.

In summary, the experimental evaluation demonstrates that the proposed OEPS system provides a secure, scalable, and efficient solution for online examinations. The integration of artificial intelligence enhances monitoring capabilities, ensures academic integrity, and offers a practical alternative to traditional invigilation methods.

V. CONCLUSION

In this paper, an AI-based Online Examination Proctoring System (OEPS) has been proposed and developed to address the challenges of maintaining academic integrity in remote assessment environments. The system integrates modern web technologies with artificial intelligence to provide a secure, scalable, and automated platform for conducting online examinations. By incorporating role-based access control, the system effectively manages interactions between administrators, teachers, and students, ensuring smooth operation and centralized monitoring.

The implementation of facial recognition for identity verification, along with real-time proctoring using computer vision techniques, significantly enhances the reliability of the examination process. The system successfully detects various cheating behaviors and log violations, which are made available to teachers for further analysis. Additionally, features such as automated exam management, OCR-based question extraction, and performance analytics contribute to improved efficiency and usability.

The results demonstrate that the proposed system reduces the dependency on manual invigilation while maintaining high levels of security and accuracy. Although certain limitations exist, such as sensitivity to environmental conditions and the need for more advanced detection models, the system provides a strong foundation for intelligent online examination platforms. Future work can focus on improving detection accuracy using deep learning techniques, integrating multi-modal analysis (audio and video), and implementing real-time alert systems for enhanced responsiveness.

Overall, the OEPS system highlights the potential of combining artificial intelligence with full-stack development to create a robust and effective solution for modern digital education, ensuring fairness, transparency, and scalability in online assessments.

VI. FUTURE SCOPE

The proposed AI-based Online Examination Proctoring System (OEPS) establishes a strong foundation for secure and intelligent online assessments; however, there is significant scope for further enhancement. Future work can focus on integrating advanced deep learning techniques such as Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs) to improve the accuracy of behavioral analysis and anomaly detection. These models can help identify subtle cheating patterns more effectively while reducing false positives and enhancing the overall reliability of the system.

The system can also be expanded by incorporating multi-modal monitoring techniques, including audio analysis, keystroke dynamics, and screen activity tracking, to provide a more comprehensive evaluation of student behavior during examinations. Additionally, real-time alert mechanisms can be implemented to notify teachers or administrators instantly when suspicious activities are detected, allowing immediate intervention. Improvements in facial recognition, such as liveness detection and robust verification under varying environmental conditions, can further strengthen the system's security and prevent impersonation attempts.

Furthermore, the scalability and usability of the system can be enhanced by deploying it on cloud-based infrastructure to support a larger number of concurrent users. Integration with Learning Management Systems (LMS) and the development of mobile-based applications can increase accessibility and adoption. Future developments should also focus on ensuring data privacy and ethical compliance through secure encryption, user consent mechanisms, and transparent data handling policies, thereby making the system more trustworthy, efficient, and adaptable to modern digital education requirements.

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