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Secure Online Examination System with Live Proctoring Capabilities and AI-Based Plagiarism Detection using FastAPI, OpenCV, and WebRTC

Mr.M.Venkatadri, R Surendra prasad, R Arthi, S Jeevan, E Salman Khan

Asst. Professor, Department of CSE (AI&ML), Kuppam Engineering College, AP, India

Student, Department of CSE(AI&ML), Kuppam Engineering College, AP, India

Student, Department of CSE(AI&ML), Kuppam Engineering College, AP, India

Student, Department of CSE(AI&ML), Kuppam Engineering College, AP, India

Student, Department of CSE(AI&ML), Kuppam Engineering College, AP, India

ABSTRACT: The rise in online educational platforms has caused a substantial shift in the traditional method of examinations. But the biggest issue with online examinations is maintaining academic integrity and preventing cheating. Traditional online examination platforms are mainly designed for conducting and analyzing tests, but they do not have intelligent monitoring systems to track cheating. This paper presents a Secure Online Examination System that incorporates real-time AI-based proctoring and plagiarism detection services. The system is designed using FastAPI for backend operations, OpenCV for computer vision-based behavioral analysis, and WebRTC for real-time video streaming. The proctoring service analyzes candidate behavior in real-time, including facial presence, gaze, blink rate, head movement, mouth movement, and the presence of unauthorized objects. Moreover, the similarity methods using Natural Language Processing (NLP) are also used for the analysis of descriptive answers for plagiarism. The system also provides automatic notifications and records the suspicious actions along with their timestamp. The experimental setup proves that the proposed framework is capable of efficient remote examination monitoring.

KEYWORDS: Online Examination System, AI-Based Proctoring, OpenCV, FastAPI, WebRTC, NLP, Plagiarism Detection, Computer Vision, Academic Integrity, Remote Monitoring.

I. INTRODUCTION

Online exams have become an integral part of the modern education system because of their flexibility, accessibility, and scalability. Institutions across the globe are increasingly using online exams for academic assessment, recruitment exams, and certification courses. However, the issue of integrity in online exams is a major concern despite the numerous benefits.

The traditional method of invigilation cannot be implemented in an online setting, and manually monitoring video streams is both time-consuming and unreliable. Most current online examination systems support secure login and time-bound exams but neglect to integrate intelligent invigilation systems that can identify real-time suspicious behavior.

The main aims of the proposed system are:

- To achieve continuous facial verification of candidates
- To identify suspicious activities such as looking away, speaking, or unusual movements
- To detect unauthorized objects in the examination environment
- To detect plagiarism in descriptive answers using NLP
- To achieve scalable and automated remote invigilation

The proposed system combines computer vision and NLP to improve the transparency and integrity of online academic assessments.

II. LITERATURE SURVEY

The development of intelligent online proctoring systems has gained attention in recent years. Several researchers have proposed different approaches to address the challenges of remote examination monitoring.

Kumar et al. (2024) proposed an AI-based proctoring system using OpenCV and Convolutional Neural Networks (CNN) for the detection of suspicious activities. Although the proposed system had high detection accuracy, it suffered from scalability issues and limited camera coverage.

Ahmed et al. (2023) designed a remote examination system using FastAPI, which emphasized authentication and safe examination delivery. Nevertheless, the system did not incorporate real-time AI-assisted behavioral analysis.

Wang et al. (2022) designed a video-based face monitoring system, which mainly focused on face presence detection and could not analyze actions like gaze shifting and object manipulation.

Haynes et al. (2021) showed the effectiveness of WebRTC for low-latency streaming in real-time communication but did not incorporate AI analysis for examination purposes.

Morrison et al. (2020) used NLP similarity measures for plagiarism detection, but the method was ineffective against paraphrased responses and context similarity.

Based on the literature review, the following research gaps were identified:

- There is a lack of integrated mechanisms for behavioral analysis.
- There is no automated system for real-time violation notifications.
- The plagiarism detection system is not effective.
- The system lacks scalability for large-scale exams.

The proposed system will fill these gaps by combining computer vision, WebRTC streaming, and plagiarism detection using natural language processing.

III. PROBLEM STATEMENT

The task of ensuring integrity in online exams is a challenging one because of the lack of physical presence during the exam. The current system is highly dependent on the following:

- Manual supervision
- Video analysis after the exam
- Simple authentication processes

These are:

- Reactive rather than proactive
- Not scalable for large volumes of candidates
- Incapable of detecting sophisticated cheating patterns
- Inefficient in real-time violation management

Moreover, the evaluation of descriptive answers is often not equipped with effective plagiarism detection systems that can detect paraphrased or altered text.

Thus, there exists a great need for the development of an intelligent, automated, and scalable examination monitoring system that has the ability to:

- Analyze behaviors in real-time
- Log violations automatically

- Authenticate securely
- Detect plagiarism using AI
- Deploy on the web in a scalable manner

The proposed system will be able to address these issues effectively.

IV. PROPOSED SYSTEM

A. System Overview

The proposed system is an AI-based secure online examination system that aims to ensure the integrity of the examination process through continuous monitoring and analysis.

The system architecture includes:

1. Authentication Module

- Secure login with credentials
- Session management and examination validation

2. Live Proctoring Module

- Real-time video recording using WebRTC
- Continuous monitoring of behavior using OpenCV

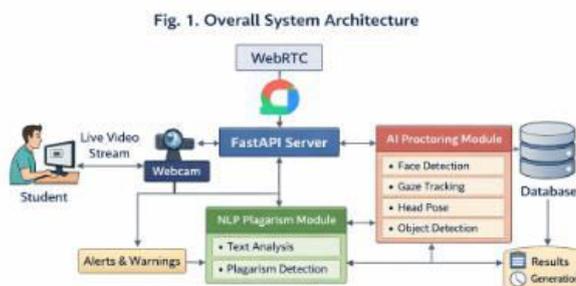
3. Plagiarism Detection Module

- Similarity analysis using NLP
- Automated comparison of answers

4. Violation Logging Module

- Event logging based on timestamps
- Warning counter system

The proposed system differs from the existing system in that it makes use of automated real-time monitoring and decision-making.



B. Functional Components

1. Face Detection (detectFace())

The system ensures that only one candidate is present throughout the examination. No face or multiple faces detected trigger immediate warnings.

2. Blink Detection (isBlinking())

Eye Aspect Ratio (EAR) is used to monitor blinking frequency. Unusual blinking patterns may indicate stress or suspicious activity.

3. Gaze Detection (gazeDetection())

The system uses eye direction to detect whether the candidate frequently looks away from the screen.

4. Mouth Tracking (mouthTrack())

Mouth movement detection enables the system to detect talking during the examination.

5. Object Detection (detectObject())

Pre-trained object detection models are used to detect unauthorized objects such as mobile phones or books.

6. Head Pose Estimation (head_pose_estimation())

Head orientation angles are calculated to detect unusual head movements.

When the number of violations crosses a certain threshold, the system automatically ends the examination session.

Fig. 2. Data Flow Diagram



V.METHODOLOGY

1. Real-Time Video Acquisition

Real-time video streaming is done using WebRTC from the candidate's webcam to the server.

2. Feature Extraction

Facial landmarks are extracted using OpenCV and Dlib-based models. The key features extracted are:

- Eye coordinates
- Mouth coordinates
- Head pose angles
- Object bounding boxes

3. Behavioral Analysis

The features are analyzed using predefined thresholds and rule-based logic to classify activities as normal or suspicious.

4. NLP-Based Plagiarism Detection

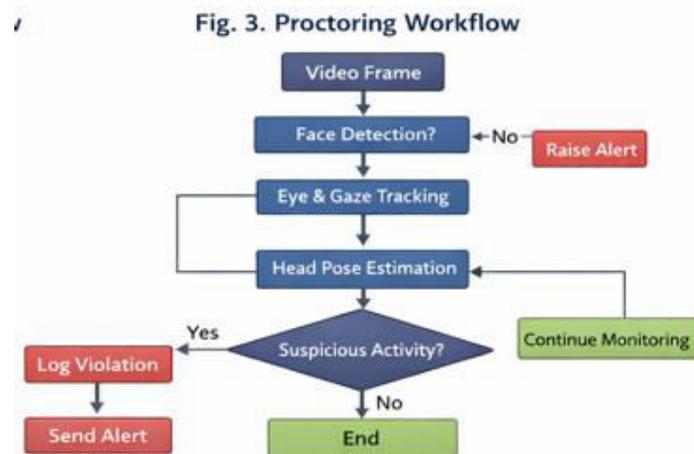
Descriptive answers are preprocessed:

- Tokenization
- Stop-word removal
- Vectorization using TF-IDF

Cosine similarity is calculated to determine similarity.

5. Evaluation and Logging

All violations are logged with timestamps in the database. Performance metrics such as accuracy and response time are evaluated.



V. EXPECTED OUTCOMES

The proposed system is expected to achieve the following results:

- High accuracy of suspicious behavior identification
- Less reliance on manual invigilation
- Automatic real-time warning generation
- Improved scalability for handling large numbers of candidates
- Effective plagiarism detection in descriptive answers
- Systematic activity recording for auditing

The proposed system will enable the proactive transformation of online examination invigilation from a manual to an AI-based process.

VII. CONCLUSION

The paper introduced the Secure Online Examination System that combines AI-powered live proctoring and NLP-driven plagiarism detection. The system uses the strengths of FastAPI, OpenCV, WebRTC, and Natural Language Processing to provide secure login functionality, constant student activity monitoring, and intelligent answer assessment.

The automated detection mechanisms greatly improve the integrity of the examination process and minimize human effort. The proposed framework is scalable, efficient, and can be applied in universities, certification platforms, and large-scale remote examination systems.

VIII. FUTURE ENHANCEMENTS

Although the proposed Secure Online Examination System shows strong real-time proctoring and plagiarism detection capabilities, there are a few areas that can be improved to make it more intelligent and robust in the future versions.

1. Deep Learning-Based Behavioral Analysis

Although the proposed system relies on rule-based thresholding for detecting anomalies such as gaze deviation and head movement, future versions can consider the use of more advanced deep learning models such as Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN) for:

- Behavioral anomaly detection
 - Analyzing the temporal patterns of student movements
- Improving the accuracy of behavioral classification under varying lighting conditions

2. Transformer-Based Plagiarism Detection

The current plagiarism detection system relies on TF-IDF and Cosine Similarity for text comparison. Although efficient for direct similarity checks, it might not be so effective for sophisticated levels of paraphrasing.

- Possible future improvements may involve:
- Semantic similarity models based on BERT
- Contextual embeddings using Transformers
- Cross-language plagiarism detection

These semantic-level capabilities would improve the detection of intelligently altered copied content.

3. Voice Recognition and Audio Monitoring

The existing system is mainly video-based. Future systems can be developed to include:

- Real-time speech recognition
- Speaker recognition
- Keyword spotting

This will enable the recognition of verbal interactions or assistance during exams.

4. Emotion and Stress Analysis

Facial expression recognition algorithms can be incorporated to:

- Detect unusual stress patterns
- Recognize dubious nervous behavior
- Analyze emotional patterns during exams

Deep learning algorithms for emotion recognition can further improve proctoring intelligence.

5. Cloud-Based Scalable Deployment

For large-scale exams in multiple institutions, the system can be developed for scalable deployment on cloud platforms such as:

- AWS or Azure cloud platforms
- Docker-based containerization
- Load-balanced microservices architecture

This will enhance scalability, robustness, and efficiency during peak usage.

6. Blockchain-Based Result Storage

For secure and tamper-proof storage of exam results, blockchain technology can be incorporated. This will enable:

- Immutable storage of records

- Secure result validation
- Transparent audit trails

This will further increase the credibility of digital exam systems.

7. Mobile-Based Proctoring Support

Future systems can be developed for mobile platforms to enable:

- Secure smartphone-based exams
- Cross-platform compatibility
- AI-powered camera monitoring on mobile platforms

This will further increase flexibility and accessibility for online students.

8. Multi-Camera Support

Incorporating multiple cameras can enhance monitoring capabilities by:

- Removing blind spots
- Identifying environmental malpractice
- Enhancing object detection accuracy

With the integration of these improvements, the proposed system can develop into a highly intelligent, scalable, and enterprise-class remote examination system that can address future educational needs.

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