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Original Article

Automated Remote Proctoring and Malpractice Detection Using Facial Tracking and Object Recognition Models

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Abstract

Examinations are widely used to assess student knowledge, skills, and academic performance. However, main- taining examination integrity in remote and large-scale envi- ronments is a major challenge. Traditional monitoring methods such as manual invigilation and simple camera observation are time-consuming, inconsistent, and prone to human error. This paper presents an automated remote proctoring and mal- practice detection system that integrates facial tracking and object recognition in a unified computer vision framework. The proposed system monitors candidates through live video streams to detect prolonged face absence, multiple faces, suspicious head movements, gaze deviation, and prohibited objects such as mobile phones, books, and paper notes. Instead of directly accusing students, the system generates an exam integrity report with a cumulative suspicion score to support fair decision-making by invigilators. The proposed framework improves monitoring consistency, reduces human workload, and provides scalable support for examination halls and supervised remote assessments.

Introduction

Examinations play a vital role in evaluating students' academic performance, knowledge, and skills. Ensuring fairness and integrity during examinations is essential for maintaining the credibility of educational institutions. In traditional offline examination halls, invigilators are responsible for monitor- ing students and preventing malpractice. However, when the number of students is large, continuous supervision becomes difficult, time-consuming, and prone to human error. Invig- ilators may fail to notice subtle cheating behaviors such as repeated looking away, exchanging signals, using hidden notes, or accessing unauthorized devices.

Most existing automated proctoring systems focus either on facial behavior analysis or on object detection alone. Face-based systems monitor gaze direction, head pose, and face presence to identify suspicious behavior, but they often fail to detect the presence of prohibited objects such as mobile phones or books. In contrast, object detection systems can recognize cheating tools but do not sufficiently analyze student attention or behavior. This separation reduces the reliability of malpractice detection.

To overcome these limitations, this paper proposes an auto- mated remote proctoring and malpractice detection system that combines facial tracking and object recognition into a single framework. The system uses computer vision and deep learn- ing techniques to monitor students through CCTV or webcam video. Facial tracking is used to analyze head movement, gaze direction, face presence, and multiple-face conditions. Object detection is used to identify unauthorized items such as mobile phones, books, and paper notes. The system accumulates suspicious evidence over time and generates an integrity report with a suspicion score for each candidate.

Objectives

The objectives of the proposed work are as follows:

1. To monitor multiple students simultaneously using live video streams.
2. To detect suspicious facial behavior such as head turning, gaze deviation, face absence, and multiple faces.
3. To identify prohibited objects such as mobile phones, books, and papers.
4. To combine behavioral and object-based evidence into a reliable suspicion score.
5. To generate alerts and post-exam reports for invigilators and administrators.

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Problem Statement

In offline examination halls, invigilators are required to monitor many students at the same time, making continuous observation difficult. Manual supervision is affected by fatigue, limited attention span, and inconsistency, allowing certain malpractice activities to go unnoticed. Existing automated systems often handle facial analysis and object detection separately, which lowers accuracy and increases false alerts. Therefore, there is a need for an intelligent system that combines facial tracking and object detection in a unified monitoring framework.

Literature Review

Automated examination monitoring has received significant attention with the growth of online and hybrid assessment systems. Earlier works focused on face detection, head pose estimation, and gaze analysis to monitor candidate attention. Facial landmark-based systems provide lightweight and real-time analysis of face orientation and presence. Such systems are useful for identifying suspicious head movement, repeated looking away, and candidate absence.

In parallel, object detection methods based on deep learning have been used to detect prohibited items such as mobile phones, books, and papers. The YOLO family of detectors has become popular because it offers a good balance between speed and detection accuracy. Object recognition provides an important layer of evidence in proctoring systems, especially when candidate behavior alone is insufficient to establish suspicion.

Recent research shows a trend toward hybrid monitoring systems that combine multiple modalities such as facial tracking, object detection, identity verification, and behavioral analysis. These integrated systems are more reliable than single-modality systems because they accumulate corroborative evidence from different sources. The present work follows this direction by combining facial behavior monitoring, prohibited object detection, per-student tracking, and suspicion score-based decision-making into one pipeline.

Methodology

The methodology of the proposed automated remote proctoring and malpractice detection system follows a structured workflow similar to how a human invigilator observes an examination hall. The system captures live video streams, processes frames, detects and tracks students, analyzes facial behavior, recognizes prohibited objects, and generates alerts and reports.

Overall Workflow

The input to the system is a continuous video stream from CCTV cameras or webcams. Each frame is pre-processed and passed into two complementary analysis branches: facial behavior analysis and object detection. Outputs from both branches are then fused in a decision module that maintains a suspicion score for each tracked student.

Facial Behavior Analysis

The facial behavior analysis module focuses on monitoring student presence and facial movement during the examination. Face detection and facial landmarks are used to continuously identify each student. Head pose and visual attention direction are analyzed to detect abnormal behaviors such as frequent head turning, looking away, prolonged face absence, and multiple-face presence.

This module reflects the way human invigilators observe student posture and facial orientation before suspecting malpractice. By continuously monitoring facial cues, the system can identify suspicious actions that are not captured by object detection alone.

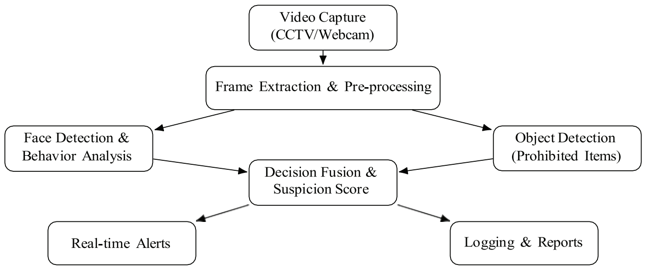

Fig. 1. *High-level workflow of the proposed automated proctoring system.*

Object Detection

The object detection module identifies prohibited items using a deep learning-based detector. Objects such as mobile phones, books, papers, or other unauthorized materials are detected from video frames. Bounding boxes are generated for each detected item, and the detection is associated with the corresponding student region.

This module strengthens the system because certain forms of malpractice involve physical materials that may not be inferred from face analysis. By including object recognition, the system captures both behavioral and material evidence.

Multi-Student Tracking

The proposed system is designed for examination halls containing many students. Each detected face is assigned an identifier and tracked across consecutive frames. This enables the system to maintain a consistent student record over time and prevents confusion between neighboring candidates.

The tracking module is important for scalability. Without reliable student association, repeated suspicious events cannot be accumulated meaningfully. With tracking, the system can generate per-student reports and reduce ambiguity.

Suspicion Score-Based Decision Mechanism

Rather than reacting to a single suspicious event, the system accumulates evidence over time. Each detected event contributes a weighted increment to a student's suspicion score:

$$S_i(t) = \alpha S_i(t-1) + \sum_{k=1}^{m} w_k e_i k(t), \tag{1}$$

where $S_i(t)$ is the suspicion score of student i at time t, α is a temporal retention factor, wk is the weight of suspicious event type k, and $e_i,k(t)$ indicates whether that event was observed. This score-based decision logic helps reduce false positives caused by temporary occlusion, brief pose changes, or innocent movements. Only repeated or combined suspicious events result in stronger alerts.

Framework And System Architecture

The implementation is supported by a set of commonly used software frameworks and libraries. Python is used as the main programming language because of its strong ecosystem for computer vision and machine learning. OpenCV is used for video capture and frame processing. Face detection and tracking are handled by dlib or MediaPipe. Object detection is performed using a YOLO-based model. NumPy is used for numerical operations and array processing. Flask is used to create a simple

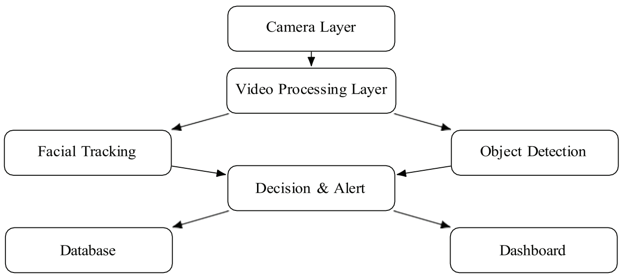

Fig. 2. High-level workflow of the proposed automated proctoring system.

dashboard, and MySQL is used to store data related to students, exams, and suspicious events.

Video Capture Module

The camera serves as the input source of the system. It captures live video streams of the examination hall and should be positioned to cover all students with minimal blind spots.

Video Processing Module

This module handles frame extraction and pre-processing. It resizes frames, reduces noise where necessary, and prepares them for the facial tracking and object detection modules.

Facial Tracking Module

The facial tracking module detects and tracks student faces. It extracts landmarks and uses them to monitor face presence, orientation, and head movements over time.

Object Detection Module

The object detection module identifies prohibited items such as mobile phones, books, and papers. It generates object labels and bounding boxes for each detection.

Decision and Alert Module

This module combines the outputs of the facial behavior and object detection modules. It updates suspicion scores, triggers alerts, and stores timestamps of suspicious events.

Report Generation Module

The report generation module organizes the recorded events into a structured integrity report. The report helps invigilators and administrators review suspicious cases after the examina tion.

Implementation Summary

The overall function of the system modules is summarized in Table I. This tabular representation makes the workflow easier to understand and supports implementation planning.

Results And Performance Analysis

The original paper describes the system qualitatively rather than through a detailed experimental benchmark. Based on the provided manuscript, the implementation successfully demonstrates effective monitoring of multiple students in real time. The facial tracking component identifies face presence, multiple faces, and abnormal head movement. The object detection component identifies prohibited items such as mobile phones and books, even in examination-hall conditions.

By combining facial behavior analysis and object detec- tion, the system improves the completeness of malpractice detection. The suspicion score mechanism prevents the system from overreacting to a single event and instead focuses on repeated or combined suspicious patterns. Real-time alerts support invigilators during the exam, while event logs and reports support post-exam review.

The uploaded paper does not include numerical values such as accuracy, precision, recall, latency, or benchmark comparisons. To avoid unsupported claims, this reformatted version preserves the qualitative interpretation without introducing fabricated results.

Table 1. *Major modules and responsibilities*

Module	Responsibility
Video Capture	Acquire live examination video from CCTV or webcam sources
Pre-processing	Extract frames, resize them, and prepare input for analysis
Face Tracking	Detect faces, assign identities, and monitor presence
Behavior Analysis	Detect head turning, gaze deviation, multiple faces, and absence
Object Detection	Identify prohibited items such as phones, books, and papers
Decision Layer	Fuse evidence and update suspicion scores
Alert Engine	Generate real-time warnings for invigila- tor review
Database & Logs	Store events, timestamps, and exam- related information
Report Generator	Produce candidate-wise integrity reports after the exam

Table 2. *Illustrative Suspicious Events Detected By The System*

Event Type	Source	System Action
Face absence	Face tracking	Increase suspicion score after prolonged absence
Multiple faces	Face tracking	Log event and trigger re- view alert
Frequent head turns	Behavior analysis	Accumulate repeated suspicious behavior
Looking away	Behavior analysis	Record attention devia- tion
Phone detected	Object detection	Mark high-priority suspicious event
Book/paper detected	Object detection	Log object evidence for review
Combined re- peated events	Fusion module	Escalate candidate to higher review level

Discussion

The proposed automated remote proctoring and malpractice detection system demonstrates how computer vision and deep learning can strengthen examination monitoring. By integrating facial tracking and object recognition, the system addresses both behavioral and object-based malpractice. This is a clear improvement over manual invigilation, which is limited by fatigue, distraction, and inconsistency.

A major strength of the system is its hybrid detection design.

Facial behavior analysis provides evidence about student attention and movement, while object detection provides evidence about unauthorized materials. When these cues are fused through a cumulative suspicion score, the system becomes more robust and practical for real-world deployment.

The modular design also improves flexibility. Each component can be enhanced independently. For example, a stronger face tracker, a better object detector, or a more advanced dashboard can be integrated without redesigning the complete architecture.

However, deployment conditions can affect performance. Factors such as lighting variation, camera angle, low- resolution input, desk arrangement, and occlusion may reduce detection reliability. Therefore, correct camera placement and calibration remain important for practical use.

Conclusion

This paper presents an IEEE two-column reformatted version of the work on automated remote proctoring and malpractice detection using facial tracking and object recognition models. The proposed framework addresses the limitations of traditional manual monitoring and single-modality automated systems by combining behavioral analysis and object detection in one integrated workflow.

The system supports multi-student monitoring, suspicious event logging, cumulative evidence scoring, and report generation. It improves the consistency of examination monitoring while reducing invigilator workload. Instead of making direct accusations, it provides review-based evidence that supports fair decision-making.

Overall, the proposed work offers a practical foundation for intelligent examination monitoring in offline halls and similar supervised environments. It can be further extended with stronger tracking methods, quantitative evaluation, biometric verification, and privacy-aware reporting mechanisms.

Future Work

Future improvements can include:

1. creation of a labeled dataset for examination-hall malpractice scenarios,
2. quantitative evaluation using detection and tracking metrics,
3. stronger student re-identification and robust multi-object tracking,
4. privacy-preserving report generation and secure data retention,
5. support for larger classrooms and additional camera views.

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