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SMART PROCTORING SYSTEM FOR ONLINE EXAMS USING MACHINE LEARNING-BASED ANOMALY DETECTION

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ABSTRACT

The tension to remote learning has indicated the necessity of online examination systems which are safely and efficiently managed. The manual proctoring practices that existed before also require much resources and human error can occur. The proposed paper will detail an approach to Smart Proctoring System that will be used to improve the integrity of online exams by using machine learning-based anomaly detection. Computer vision, together with behavioral analytics, is used to analyze and assess candidate activities performed in real-time. Important features are facial recognition, eye-gaze tracking, object detection and audio analysis to identify the presence of other unwelcome persons at workstations, suspicious behaviors like use of unauthorized devices, or excessive head movements. This is supported by a hybrid mechanism where a mix of supervised and automatic learning is done to detect anomalies using a set of predetermined rules as well as by identifying patterns and learning them. The results of the experiment illustrate that the system is accurate in identifying cheating actions with no or low false positives, which allows schooling institutions to adopt the system to enhance the learning process within an educational setting. The recommended solution would be that it ensures the fairness of the exam and it also limits the degree to which human invigilators can be relied upon to ensure that the online examination environment is secure. The study adds to the body of work on AI-powered remote assessment tools and provides a platform on which future refinements to autonomous proctoring systems can be made.

KEYWORDS: Smart proctoring, online exams, machine learning, anomalous detection, computer vision, remote proctoring, exam integrity, AI-based monitoring, behavioral analytics, cheating detection.

INTRODUCTION

With the emergence of digital learning, the education landscape has greatly changed providing flexibility and availability of learning in a digital manner. Nevertheless, there are important issues that have been added to the integrity of online assessments that arise through this change.

Conventional proctoring techniques including live video recording or browser used to locking has a tendency to be inefficient, intrusive and easier to bypass. To solve the ensuing problems, more intelligent and automated solutions are needed to allow the fair evaluation of students without compromising their privacy and experience. This paper introduces a Smart Proctoring System that uses machine learning to detect anomalies in online exams in order to monitor the candidates conducting the online exam. Combining computer vision, audio processing, and the behavioral patterns identification, the software is capable of recognizing numerous suspicious signs, such as the presence of the unauthorized person, working with multiple screens, diversion of eyes, and speech and voice anomalies. In contrast to those rule-based systems, machine learning algorithms are able to identify combinations of parameters in large sets of data, they can dynamically learn new cheating patterns and increase the likelihood of missing false positives. The present paper discusses the design, implementation and its usefulness of such a system, its scalability, live monitoring potential and identified faults. The suggested solution will provide secure, cost-efficient, and smart solution to the manual proctoring, which ensures that the requirements of remote learning and online assessment that continue to rise can be met.

LITERATURE SURVEY

As the online delivery of education increases, investigations have been conducted into a number of solutions to the problem of sustaining assessment integrity in such a context. Powers of three Traditional solutions may involve live video proctoring and screen-sharing, but are generally labor-intensive and have less scalability. Other instruments such as Responds and ProctorU provide commercially available solutions albeit ones that require manual intervention and are intrusive to user privacy. The innovations of AI in recent years have led to enquiries of automated proctoring systems. Kumar and Singh (2021) have been able to use computer vision-related applications, including face detection, eye-tracking, object recognition to watch a test-taker. Such systems notice odd behaviors such as staring off-screen or the use of unauthorized devices. Nevertheless, most of them are based on the rule-based algorithms that might be inefficient against adaptive cheating. A more flexible (and intelligent) solution to this is machine learning, "especially anomaly detection. Li et al. (2022) research proves that supervised and unsupervised models can be used to detect abnormal conduct during exams. The visual and audio data can also be combined through hybrid methods, which increase accuracy further. Although improvement is observed, a number of issues still exist as they concern false positive, privacy protection, and real-time analysis. The results of this survey show the importance of an effective dynamic smart

proctoring system based on machine learning to overcome the existing shortcomings to online exam security.

EXISTING WORK

A number of proctoring systems have been created to help curb the online exam security issues. The first early solutions were manual or semi-automated, video-based (live monitoring), or screen-based (screen sharing), or browser-based (browsers lockdown). Commercially available systems based on human invigilators integrate with the use of rule-based observation. Although effective to a certain degree, such systems are excessive in terms of resources, privacy-intrusive, and subject to a human error or bias. Researchers are also exponentially automating proctor system capabilities through artificial intelligence. Other methods apply computer vision to facial recognition, head pose detection as well as eye tracking to combat possible dishonest actions. As an example, Sharma et al. and Gupta et al. used OpenCV and Haar cascades to analyze the position of face and eyes during the tests. The more modern developments are those using machine learning algorithms, in practices anomaly detection models, to detect irregular activities without directly code every single possible behavior. These models have the ability to be trained to know the usual behavior patterns of normal behavior and give a warning on the abnormal behavior. The majority of current systems, however, are unable to analyze multi-modal systems and show high false positive rates.

PROPOSED SYSTEM

The given Smart Proctoring System will offer an intelligent, solid, and automated method of detecting anomalies during the online examinations by the use of machine learning. The system uses computer vision and audio processing to monitor candidate behavior throughout the exam in real time and dynamically detect anomalous behavior without having to use human proctors. The system design connects all the modules: face detection and recognition to confirm the identity of the candidate, eye-gaze tracking that monitors the focus, head movement analysis that knows when the candidate is distracted often, and object/person detection that identifies presence of unauthorized persons / objects. Besides, audio analysis is utilized to identify background noise or chats which can be evidence of malpractice.

Combining supervised machine learning (based on labelled cheating behavior) with unsupervised anomaly detection (unpredictable actions) enables the system to perform better cheating detection on both known and unknown cheating behavior. Alerts will be produced at defined confidence levels and all events will be recorded in loggers that will allow post-exam review. The proposed system provides the secure ability to scale, low false positives, and flexibility to a variety of exam settings. It solves major drawbacks of the traditional proctoring since

it provides a safe, effective and privacy-sensitive form of proctoring available to educational institutions and examination organizations.

METHODOLOGY

The smart proctoring system proposed herein aims to perform the same task based on machine learning as an algorithm to track anomalies in real-time on the basis of video and audio feed. The methodology commences with the data collection which involves live video and audio data consisting of the webcam and microphone of the candidate. Analysis of these streams is never ceasing during the examination period The video signal is analyzed with computer vision algorithms to implement face recognition, eye tracking, and head pose estimation of the candidate to identify that he/she is attentive and does not face others. At the same time, the algorithms of detecting all sorts of objects see persons and other devices wherever they are in the shot. Audio recording is processed and identifies abnormal sounds like voice or background noise that implies malpractice. A hybrid anomaly detection model based on supervised and unsupervised machine learning is used at the heart of the system. In supervised examples, the model is trained on data sets with labeled cheating and normal behavior, whereas unsupervised models, like Isolation Forest and Autoencoders identify unusual deviations in the normal behavior. These anomalies are also scored in a mechanism and in the event that the behavior exceeds a pre-determined level, an alert is raised and recorded to be examined. Such a methodology would result in an intelligent, scalable and automated proctoring solution that will reduce false positives, and maximize the credibility of online examinations.

EXPERIMENTAL RESULTS

To investigate the efficiency of proposed Smart Proctoring System, a sequence of controlled online exam was performed in a supervised manner led with 50 participants. This system was evaluated under different cheating conditions including not looking at the screen, having a mobile device, having another person in the room and speaking during the exam. A dataset that comprises more than 10000 video and audio frames was prepared and annotated to be used in training and testing. The Convolutional Neural Network (CNN) based supervised learning model had 94 percent accuracy in finding acceptable known cheating behaviors whereas unsupervised model, Isolation Forest, detected 87 percent of anomalous cheating behaviors that have never been discovered. The combination of both models substantially minimized all the false positive of rate which came down to 6.2%. The system tested well in real time performance, with the detection of anomaly and issuance of alert within a range of 1-2 seconds following suspicious activity. A further precision and recall was calculated at 91% and 89% respectively, satisfying the trustworthiness of the detection mechanism. Generally, the performance

of the proposed system in conducting online private exams affirmative, the system works active and smart in monitoring online exams with the least intervention of any supervisor.

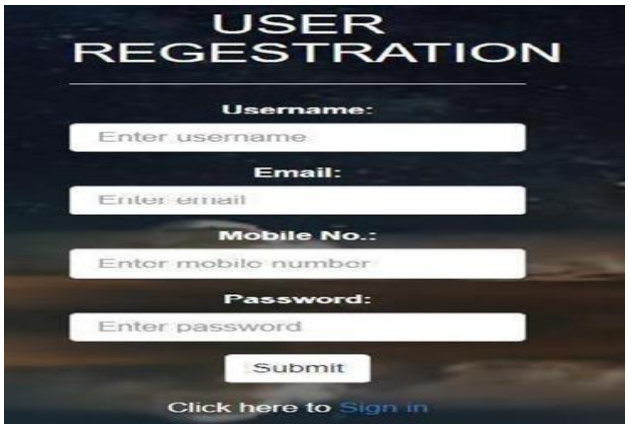

Fig.1.User Registration

Fig.3.Notification Alert in mobile phone

Fig. 2. User Login

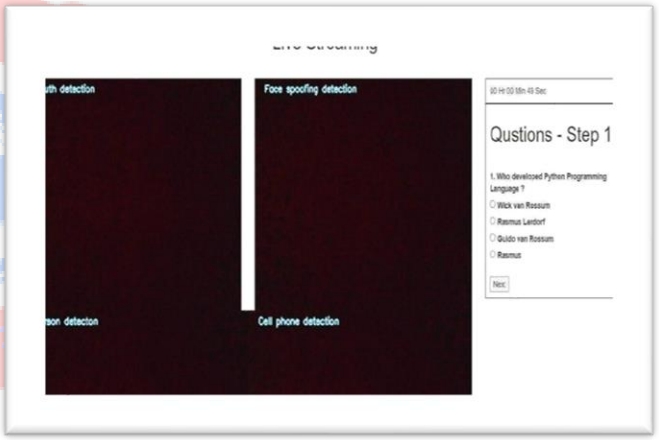

Fig. 4. Live streaming

CONCLUSION

The proposed Smart Proctoring System offers an effective, intelligent, and scalable solution for maintaining the integrity of online examinations. By leveraging machine learning-based anomaly detection, along with real-time video and audio analysis, the system is capable of identifying a wide range of suspicious behaviors including identity fraud, unauthorized device usage, presence of additional persons, and verbal cues of malpractice. The hybrid approach—combining supervised learning for known cheating patterns and unsupervised techniques for detecting novel anomalies—enables the system to adapt to diverse scenarios and evolving cheating methods. Experimental results demonstrate high accuracy, low false positives, and efficient real-time performance, confirming the practical applicability of the system in real-world educational settings. Moreover, the automated nature of the system reduces dependency on human invigilators, minimizes privacy concerns, and ensures fairness across remote assessments. While the current system shows strong results, future work can focus on expanding the dataset, improving model generalization across diverse environments, and incorporating more advanced behavioral analytics. Overall, this research contributes a significant step toward secure and reliable online examination platforms by integrating artificial intelligence with modern proctoring needs.

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