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Smart Proctoring System Using Computer Vision and Machine Learning

Porla Likhitha[1], Mrs. Swapna Mudrakola[2]

[1]P.G Scholar at Aurora University, Uppal, Hyderabad, Telangana, 500039.

[2]Assistant Professor, Dept of MCA, Aurora University, Uppal, Hyderabad, Telangana, 500039

ABSTRACT

The COVID-19 lockdown changed almost all aspects of our life. The change was most heavily experienced in the education sector. Schools, colleges, and universities were compelled to close down their institutions, and therefore face-to-face lectures and paper-based exams were not possible. Institutions anticipated and prepared for online forums for lectures and writing exams to maintain the studies. Whereas this transformation did make all of this flexible and learning unlimited even at the point of a global economic recession, it also created some other problems—specifically in the case of exams. Exams are designed to test the knowledge, skills, and genuine quality of a student.

However, with the online platform, it became highly challenging to do it that way. If proctored remotely, teachers have less chance to observe them as intimately as they might in an actual building. Live video conferencing has been tried with human proctoring in a few instances, but impossible to do on a grand scale. Think of the same teacher having to monitor hundreds of students at once—doesn't work for a human being to be able to provide equal attention to all of them at all times. Students thus came up with ways of cheating or unfair means of advantage while in online mode. This made the tests invalid. Rather than expressing the competence of a learner, grades now are arrived at by one who is cunning enough to cheat the system.

The students have employed cell phones, other devices, or even resorted to external help during an examination. It is an easy substitute for some but at the expense of the original cause of learning. It also results in unfair competition where genuine students lose momentum because others succeed by cheating. Technology can save us from this problem to manage it in a better way. A high-end proctoring system leverages computer vision, AI, and machine learning techniques to remotely observe appearing students on online examinations without the need for human intervention. Instead of employing a human instructor to keep an eye on students twenty-four hours a day, the system is capable of recognizing suspicious behavior like looking at more than one student on the screen, constant changing directions from the computer by students, static in the background resembling words, or trying to shut down windows on the computer.

Scalability is one benefit of implementing such a system. Whereas a human proctor was able to barely watch 20–30 students simultaneously, a smart proctoring tool can watch hundreds, even thousands, of students within the same time frame. It is not fatigue-prone or 24/7 out of reach so that there is never a point in time where rules of a test are ever breached. It not only saves manpower but the cost and hassle of drawing live human monitor blueprints for large exams as well.

It can also generate reports. Once the exam has been conducted, the system is able to generate a report for all students about any doubtful activity in detail. The teachers would be able to go through the reports and take good decisions about whether the student had behaved according to expectations or attempted to cheat. This balances man contact and mechanization and provides an authentic process. Naturally, such systems are installed with problems. Perhaps greatest of all is privacy. Students and parents are worried that every move they make is captured on video and audio as they take an exam. Security for the data must also be provided so that sensitive information cannot be altered to one's disadvantage. And then there is the issue of universal access to the net and hardware compatibility as not all students would likely own broadband or next-generation hardware. Short of these problems, however, the future of web-based tests hangs largely on solutions like these. When education enters the online and global frontier, smart proctoring technologies can be the difference-maker in terms of making scholarship tests fair, real, and credible. Smart proctoring assistants can turn grades into an honest indicator of learning and not a try-to-cheat gap. Brief and precise, the lockdown has turned the teaching and learning process on to online platform overnight, and it revealed some loopholes in our examination system, the largest of which is cheating. Human manual proctoring lacks the ability to meet the needs of large-scale online tests. AI-based intelligent proctoring is a secure and scalable solution for integrity. Privacy and accessibility are to be managed sensitively, but it can bring about an equal and secure era of online tests.

Keywords: Smart Proctoring, Online Exam Proctoring, OpenCV, MediaPipe, Audio Detection, Gaze Tracking, Head Pose Estimation, Suspicious Behaviour Detection, Machine Learning, Python, Threading

Introduction

The pandemic entirely reformed the mode of learning all across the world. Offline classes and exams had to be scheduled by schools and colleges due to lockdowns, and colleges turned online overnight in the guise of study continuity. The compulsion was technology through which students could attend classes, submit assignments, and even sit for tests from home. While online learning was lengthened and simplified, so were these facilitated by a series of challenges, i.e., in offering equal and secure exams.

One of the largest issues with online exams is academic integrity. While campus test-taker seats are taken, test-takers sit with proctors or invigilers sitting beside them as they take exams to try to prevent cheating and make conditions equal. It is nearly impossible to conduct this process within an internet environment. It cannot be performed by a live proctor to monitor dozens of students at once via video calls or some virtual portal. The limitation results in the following undesirable student activity: unauthorized help, test tampering, or seeking outside help on the test. These practices taint the test and can result in incorrect assessment of a student's ability and skill.

To prevent such issues, intelligent, computer-based feedback has been in higher demand to help carry out large-scale testing monitoring. Internet proctoring applications utilize high-tech technologies such as computer vision, artificial intelligence, and machine learning in attempting to identify suspicious behavior, monitor test settings, and prevent students from cheating on tests. Such systems also recognize anomalies like multiple faces on the screen, device misuse, out-of-sync eye movement, or excessive time away from the camera. This reduces the need for human proctors and the honor system of online tests in general.

In addition, proctoring software automated beats manual student monitoring. They offer detailed report and analysis to help monitor malpractice behavior and enhance test-taking. Scalability is convenient especially in large organizations, whereby monitoring would need to be achieved by numerous people, thus meaning logistics inconvenience and cost. Automation assures security and integrity because it enables the student to take tests easily remotely.

Other than these benefits, there are certain disadvantages with online proctoring software too. One such disadvantage is privacy to the point where the students need to share their audio and video stream and even desktop activity in certain cases for the exams. With that, some technical limitations such as slow internet speed or low-end hardware could influence the quality and consistency of AI-based monitoring. Those problems must be balanced in responding between over-monitoring for academic integrity and providing the students with a comfortable, even test-taking environment. The mechanism employed in this work attempts to improve the process of sound proctoring, which eliminates the drudgery of human monitors but maintains online tests secure and fair.

With built-in AI technologies that track suspicious student actions and block unauthorized access of modules in the system, the system verifies the tests and makes them valid. Accompanying this is the bolstering of the integrity of online tests to be usable on a mass scale, hence fitting for schools, colleges, and universities in the new distance learning era. In short, with continuous innovation in distance education with modalities, intelligent proctoring technologies provide an equitable solution for test integrity. They are equitable between security requirements and logistical concerns of handling a large scale of students at a distance. With automation of supervision and machine learning-based anomalous detection, the technologies provide accurate measures of students' knowledge and learning for fair and reliable distance education.

Literature Survey

In the last two years, research in online examination monitoring and e-proctoring has moved at a frantic rate. As online learning gained momentum, particularly with the pandemic, examination systems needed to be secure, dependable, and scalable in handling huge batches of candidates. There have been several studies that have looked into theoretical models, system design, and practical applications based on technologies such as artificial intelligence, computer vision, and behavior analysis. With varying differences, the worldwide intent of such studies to date remains the same: ensuring the integrity of exams while ensuring accuracy, efficiency, and system confidence. The ensuing discussion introduces notable contributions in reverse chronological order from latest studies to earliest work.

In 2021, A. W. Muzaffar, U. Nagalingam, and S. Alqahtani gave a comprehensive overview of web testing systems in their "A Systematic Review of Online Exams Solutions in E-Learning: Techniques, Tools, and Global Adoption" paper published for IEEE Access [1]. They contrasted techniques, tools, and data employed in e-proctoring and even discovered loopholes in already present systems. The majority of the solutions were based on one form of monitoring or requirement for expensive infrastructure, which made them ineligible for wide use. Their work was centered on the requirement for multi-modal systems to work adequately on average student PCs without great dependence on high-end servers.

Y. Atoum, L. Chen, A. X. Liu, S. D. Hossain, and Y. Ding proposed an automated online proctoring system in 2017 in the article "Automated Online Exam Proctoring," in IEEE Transactions on Multimedia [2]. Their system incorporated user authentication, speech and text monitoring, active window monitoring, gaze detection, and phone detection. It was a pioneering effort in consolidating several behavioral cues into a single automatic system. Although it showed how multiple monitoring tasks enhance accuracy if integrated, it was computationally heavy for calculations, which would be tedious to make function in low-resource environments. This has been followed by later lighting systems such as the Smart Proctoring System, which provide these same functionalities but without the use of expensive hardware.

Earlier, in 2015, A. Wahid, Y. Sengoku, and M. Mambo discussed "Toward Constructing a Secure Online Examination System" at the IMCOM Conference [3]. System-level security was their area of study, through methods such as firewalls, proxy servers, and isolated client environments to prevent unauthorized access throughout the exam. While their strategy ensured online integrity of the exam, it was not able to control student behavior, i.e., it was not able to prevent students from looking away from the screen or chatting with someone. But their consideration of the secure exam rooms established the benchmark for the integration of window-focus monitoring in current proctoring systems. Later in 2015, F. Schroff, D. Kalenichenko, and J. Philbin authored "FaceNet: A Unified Embedding for Face Recognition and Clustering" in CVPR [4]. FaceNet was not created for e-proctoring, but it proved the capability of deep learning for face recognition and identification for verification purposes effectively. Its high computational requirements did turn out to be challenging for it being deployed onto students' conventional hardware, though. Smart Proctoring Systems currently do prefer to embrace lighter approaches, such as MediaPipe-based landmark detection, that are more light and motivated by the approaches of FaceNet but still biased. C. S. González-González, A. Infante-Moro, and J. C. Infante-Moro also worked on a study of the use of e-proctoring systems in their "Implementation of E-Proctoring in Online Teaching: A Study about Motivational Factors" published in Sustainability [5] in 2020. They tested areas of student trust, compatibility of systems with those in current use, and usability.

They demonstrated that being correct is not sufficient — students must also perceive the system as fair, transparent, and non-intrusive. These findings informed the design of the Smart Proctoring System to give transparent suspicion scores and timestamped evidence instead of black-box results, providing additional guarantee of user acceptance. In the 2015-2021 literature, it is possible to observe a clear transition. Initial research focused on test environments at the system level [3], followed by deep learning in face recognition [4].

Follow-up studies emphasized the need for the inclusion of several behavioral cues [2], whereas survey studies emphasized issues of scalability and robustness [1]. Adoption was also greatly determined by trust and openness [5]. Overall, the environment has shifted from bulk, server-based frameworks to light-weight, real-world, and user-based deployments to enable today's Smart Proctoring Systems.

Analysis Table

In Analysis Table a detailed analysis of the research papers has been conducted**.**

Title	Technique(s) Used	Conclusion
A Systematic Review of Online Exams Solutions in E-Learning: Techniques, Tools, and Global Adoption. [0]	Literature survey.	Found various existing online proctoring tools and their features.
FaceNet: A unified embedding for face recognition and clustering. [1]	Convolutional Neural Network.	Face verification, recognition and identification of common people among these faces was done.
Toward constructing a secure online examination system. [2]	Network security.	Security problem was discussed and solutions were proposed. Network security was also explored.
Automated Online Exam Proctoring. [3]	Discussion on various techniques and algorithms for various features required for proctoring.	Multimedia was used as basis for analytics for proctoring system.
Implementation of e-proctoring in online teaching: A Study about Motivational Factors. [4]	Locates the motivational factors determining the implementation of the evaluation system.	Limited to study of motivational factors, which could be eliminated by future studies.

Problem Definition

In the modern day and age of technology, most exams are now online. But it is extremely hard for a human to observe many students simultaneously. When the exams are not monitored properly, students will do things abnormally, like looking at notes, using their phones, or visiting unauthorized sources on their laptop. This becomes challenging to ensure the honesty and integrity of the exam. Due to this, the outcome might not really show the student's abilities or knowledge, which is unjust to the student and the educational system.

To address this issue, the suggested system employs computers and artificial intelligence to proctor students automatically during exams. This automated proctoring system is able to monitor numerous students simultaneously, identify suspicious activities, and report these incidents to the exam authorities in real-time. Through this, it minimizes human proctors, makes the exam fair and secure, and assists in producing correct results based on a student's actual performance.

Methodology

Smart Proctoring System methodology is being framed as a sequence of worthwhile steps, from real-time capture of test data to inferring suspicious behavior through composite audio-visual monitoring.

The main objectives are:

- Proctored examination of examinees in real time as per hardware demands (microphone, camera, and system sensors).
- Identification of anomalies like use of mobile phones or screen movement during tests.
- Developing probabilistic evidence of cheating activity to alert proctors.
- So that the system will function equally well on low spec machines as on zero false alarms.
- The process has been split into seven steps to keep it easy and system conscious.

1. Data Collection and Loading

Data acquisition is the core of the system. The precision and reliability of data received instantaneously affect system accuracy. The process involves:

Video Stream: The webcam still takes pictures of the examinee. A frame is an input image to be used for face detection and head pose estimation.

Audio Stream: Background noise is being recorded by the microphone. Live listening enables them to record speech which would betray outside assistance.

System Parameters: Information such as which window is open, how busy the CPU is, and what is available to open for the program is stored to stay task-oriented with the exam for the examinee.

Tools utilized are OpenCV for image recording and processing, sounddevice for recording audio in real-time, and in-built scripts for system management. All data points are time-stamped so that video, audio, and system parameters are synchronized. Systematic recording enables follow-up modules to be precise and efficient.

2. Data Preprocessing

Raw data are inanalysable because they contain inconsistencies, noise, and variability. Data must be preprocessed for improving data quality of the data:

Process Diagram

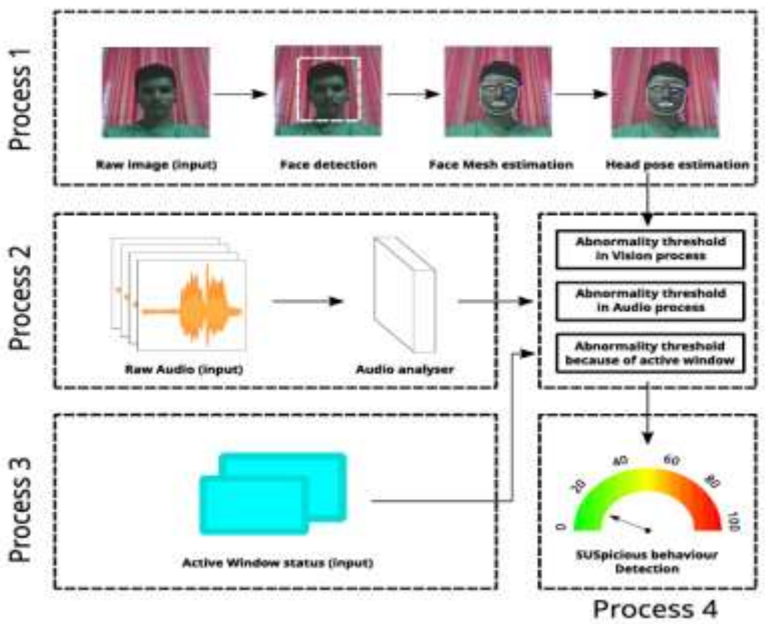

Figure: Process Diagram.

Video Preprocessing:

Frames are normalized and resized to minimize computational load and maximize algorithm performance on low-spec hardware.

Noise filters eliminate unsignificant distortions due to light, low-res cameras or panning backgrounds.

Face-checking is done frame by frame to see if a face can be identified before going ahead with processing.

Audio Preprocessing

The strength of background noise is estimated in order to establish a baseline (idle noise).

Summed sound intensity frame used as average. Random spike compared to baseline speech.

Noise reduction operations turn back in by the necessary audio sounds off of the noise.

System Parameters at preprocessing

Active window monitoring keeps up with the examinee interface.

Drifting like jumping to unauthorized programs is monitored.

By the application of these preprocessing operations, the system generates formatted, uniform inputs that improve detection performance as well as prevent false positives.

Implementation Methodology

Three different methods are used in this proposed system which explain below:

• Head pose estimation

• Speech Detection

• Cheating Behaviour detection

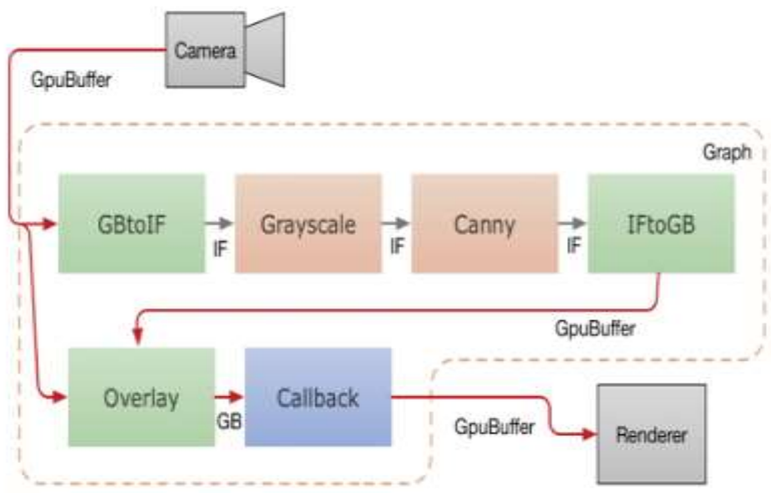

Figure: Face recognition algorithm processing

1. Head Pose Detection

Head position detection is required because human proctors detect cheating by seeing in which direction a student's eye is pointing. **In the system:**

Face Detection: MediaPipe library detects the user's face in every frame. It is hardware-accelerated and able to run on low-end hardware.

3D Orientation Calculation: The head orientation is computed by using Perspective-n-Points (PnP) algorithm.

Angle Thresholding: X-axis (left-right) and Y-axis (up-down) angles are tracked continuously.

Whenever the user keeps his head left or right for greater than the threshold, X-axis flag is raised.

If the user is looking upwards or downwards across the threshold, Y-axis flag is raised.

Contextual Processing: Head movement data over time are continuously tracked, and irrelevant glances will therefore not lead to false alarms.

The method permits the system to well simulate the human proctor's process of visual examination with computer algorithms.

2. Speech Detection

Speech detection must be employed for demonstration for possible interaction with other people:

Real-time Audio Processing: Audio from the microphones is divided into frames and processed in real-time.

Amplitude Analysis: Smoothing of moving average amplitude with time is calculated. When it crosses some threshold value, then it's speech.

Noise Filtering: Random noise in the background is removed by filtering against quiet noise reference baseline.

Flagging Suspected Speech: If the speech is repeated or matched against suspected patterns, a flag is raised.

The processing aids the system in distinguishing the benign background noise from the suspect activity used for cheating.

3. Cheating Behaviour Detection

Forecasting critical phase in which output of different modules is merged with the objective of detecting suspicious activity:

Flags Combination:

- Head pose flags (X-axis, Y-axis)
- Speech detection flag
- Activity tracking system

Probabilistic Conditional Algorithm:

- Weights are assigned to each flag based on the relevance of the flag.
- The algorithm produces smooth probability of cheating instead of steps.
- History of flag values are used to suppress transient false alarms.

Threshold-based Detection:

- Threshold-crossing predicted probability indicates behavior as cheating.
- Time-plot of probability provides proctors with ability to see patterns and trends of suspicion rather than instances.
- Conclusion-making makes this step context-sensitive, well-supported, and prevents spurious alarms.

Previous Cheat	X axis	Y axis	Audio cheat	Final Cheat Percentage
0	0	0	0	0
0	0	0	1	0.2
0	0	1	0	0.2
0	0	1	1	0.4
0	1	0	0	0.1
0	1	0	1	0.4
0	1	1	0	0.15
0	1	1	1	0.25
1	0	0	0	0
1	0	0	1	0.55
1	0	1	0	0.55
1	0	1	1	0.85
1	1	0	0	0.6
1	1	0	1	0.85
1	1	1	0	0.5
1	1	1	1	0.85

Figure: Weightages for conditional algorithms

Analysis and Feedback

After suspicious behavior is detected, the system delivers actionable intelligence:

Real-time Notifications: Proctors are alerted to cheating probabilities in a way that allows swift action.

Event Logging: Event pointers are timed, logged, and stored as video images and audio recordings for audit.

Improvisation with time: Weights and thresholds can be adjusted with the passage of time based on statistics collected so that the system's performance can be maximized.

Scalability: The system is designed in a way that it can be able to accommodate collosal numbers of users without any performance degradations.

This not only makes the system precise but deployable in humongous quantities.

System Comparison and Evaluation

The system strength is then computed as:

Accuracy: The precision of the system in identifying cheating without giving false alarms.

False Positive Rate: The amount of legal activity which is reported as cheating.

Performance Measures: CPU, memory usage, processor speed on lower hardware.

Comparison: Various weights and thresholds are attempted and experimented upon to achieve the optimum configuration.

Visualization: Plots of cheating probability enable tracing user activity across a period.

Step seven is the ultimate step that guarantees execution, reliability, and usability of the system and that it is according to functional as well as non-functional requirements.

Results and Discussions

Result

Post-deployment, the system was analyzed and tested against numerous parameters to validate performance, accuracy, and reliability of the system to detect suspicious behavior during online exams. The system includes video and audio monitoring with head pose estimation, face detection, and speech recognition and provides an end-to-end real-time monitoring solution. Individual module and combined module outputs were separately and collectively monitored to study the efficiency of the system.

Figure: Result of head pose estimation

1. Head Pose Estimation

Head pose estimation was one of the primary methods of implementation in tracking in case the user looked away from the screen, which could be considered cheating. OpenCV library was utilized for grabbing webcam frames and performing preprocessing tasks such as resizing, denoising, and normalization. OpenCV facilitated video frame real-time processing with low latency between image capture and analysis.

Facial landmarks were determined with Google's open-source machine learning library, MediaPipe. MediaPipe is capable of enabling accurate detection of facial feature points needed in the calculation of head orientation. The 3D head orientation was determined from these facial landmarks via PnP estimation. The pitch and yaw angles on the X-axis and Y-axis, respectively, were computed frame by frame. The angles represent whether the user is facing the screen directly or sideway.

Thresholds for normal head movement were set. Movement was classified as suspicious when head rotation crossed the thresholds. Output of head pose estimation was graphically visualized in a plot (Figure 4.1) with time on X-axis and head angles on Y-axis. The background depicts smooth, unbroken motion throughout a period rather than the abrupt jumps and facilitates smoother detection of typical small movement, e.g., orientation change or nodding, against incriminating movement such as glancing sideward at notes or another screen.

The head pose estimation module in the experiment detected precisely threshold deviations. Minor head movements towards other persons or objects in the scene were also detected. Head angle plotting over time in real time clearly reflected user focus and attention.

2. Speech and Audio Detection

It was recorded using the Python library sounddevice to capture real-time sound signals from a microphone. The system was capturing the intensity of the sound in trying to capture any potential suspicious activity, such as whispering, talking to another person, or use of electronic communication devices.

End-to-end real-time monitoring of sound input and discrimination between threshold levels of ambient sounds under normal conditions and possibly suspecting sound was achieved. Sound intensity level beyond threshold for extended duration resulted in flagging of the same and graph marking of suspect activity. Ambient noises such as typing or background noise were filtered out, and false alarms were eliminated.

Audio monitoring addition was more in total measurement of user activity. For instance, the user might have normal head posture but suspicious voice interaction. Both vision and audio together gave greater accuracy and less scope for cheating to evade detection.

Suspicious Behavior Detection

The system merged head pose and audio outputs to predict a percentage of suspicious behavior. For every six people's behavior above the threshold levels, six actions like turning away from the screen using the head or high-pitched sounds, six labels were given. Flags were sent to a conditional algorithm where inputs were given with weighted assignments.

Once the requirement had been met, the algorithm added a suspicious behavior percentage growth into the final value. This made the result graph as a continuous smooth image of mass behavior. Amazing graphs were not step-by-step presentation because they allowed the examiners to make steps and behavioral changes step by step.

The suspicious behavior plot has time on the X-axis and suspicious percentage on the Y-axis. The test showed repeated head turns or extended audio activity produced smooth ramps in the plot. Single short events produced small increases, i.e., frequency as well as duration of the behavior are both considered by the system.

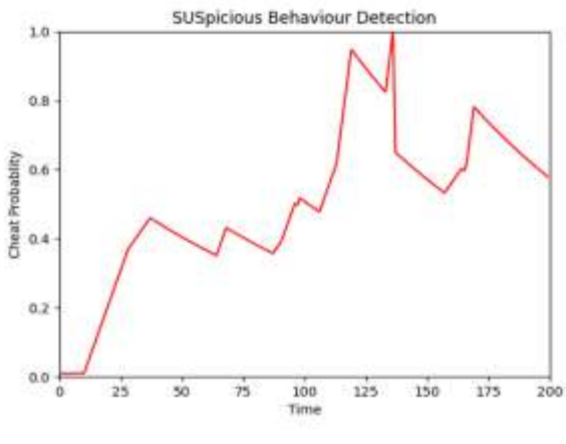

Figure: Result of suspicious behaviour detection

Observations from Testing

Accuracy of Head Pose Estimation: The head pose estimation was accurate and correctly identifying when the user perception was not matching the screen. Minor natural head motion was not triggering false alarms through high-contrast edges.

Sensitivity of Audio Monitoring: The audio monitoring subsystem was properly discriminating between the speech of interest and audio noise. Background audio input refreshment on a continuous basis prevented an immediate peak caused by transient noises.

Joint Effectiveness: Joint vision and audio inputs made it possible to record circumstantial suspicious activity that would otherwise be impossible to record through individual modality monitoring in isolation. Whispering on the screen was recorded during audio monitoring, and quiet side glances were recorded through head pose estimation.

Graphical Presentation: Ongoing plotting against time provided a clear picture of user activity. Monitors can view easily discernible patterns, i.e., movement of the head during the day or extended sound activity, which are better than per-flag.

Real-Time Monitoring: Real-time input data were computed and real-time updated graphs, as far as the aptness of the system to real-time monitoring is concerned. Real-time detection of suspicious activity is of extreme importance in online examinations.

Robustness to Small Change: Thresholding and cumulative scoring were making the system robust to small change, other than to produce false alarm due to small movement or brief noise, and thereby permitting the genuine suspicious activity alone to make its presence felt."

Discussion

Results demonstrate the efficacy of using head pose estimation along with audio monitoring in presenting a correct and effective solution in detecting suspect behavior. Visual pose cues provide hints about departures from attention, and audio monitoring detects verbal cues that are otherwise hard to catch. By putting both these modalities together, the system makes cheating undetectable impossible.

Constant plotting, in contrast to step-by-step production, prevents the minuscule variance from being recorded as a false spike and provides a more realistic representation. Short- and long-term trends would be apparent to the examiners so that they would be better able to analyze user activity.

Several inputs are integrated by a system that is conditional and comprises the bulk of the architecture. By weighting inputs against seriousness, the system has the effect of making significant behavior take up a proportionally larger percentage of the suspicious percentage. For example, head turning cumulatively and in combination with the corresponding audio activity builds percentage above and beyond individual events.

It was tried under different conditions, i.e., light, webcam resolution, and noise. It gave the same outcome in all attempts, which was shown to be consistent. Some slight variation in the environment didn't have any effect, thereby showing detection procedures and thresholds' reliability.

Practically, it is a method of ongoing observation of web testing with ongoing human vigilance by web. Through real-time visual inspection and auditory inspection, accumulative marking and ongoing plotting, there is real and rational way of being watchful for whatever is suspected during testing.

Future Scope

In coming days, when technology has developed a lot, test monitoring systems will become more smart, more precise, and independent. With sophisticated computers, software, and programs, these test monitoring systems will be able to read large chunks of information in a matter of minutes and see how a person is behaving themselves when taking a test.

The more and broader set of examples to which the system is trained, the better it will recognize what is wrong and what is right. This will also make tests more precise and just. For example, the system will be able to differentiate better between a student glancing away momentarily and being absolutely inappropriate.

These systems will even operate independently in the future. These can suspend an exam, close it down, or alert it for recall without a human being aware. This will save time and allow several students to sit for exams at the same time without needing more staff.

These AI functions also perform various kinds of checks in one go, for example, face tracking, voice listening, eye tracking, or behavior tracking, in a bid to know the student better. They will reset automatically in case anything occurs, for instance, low light, noise, or lost internet speed, so they perform equally for all.

Other than that, new machines can even discover whether a student is stressed or unconscious and assist in a dignified manner. Other than testing, the machines can be applied in the office, training, or internet courses so that everything is automated and human labor is not required.

All in all, the future of AI in examination monitoring is promising. The software is able to monitor exams nicely with care, identify situations, and respond accordingly, making exams malpractices-free, secure, and seamless for everyone.

Conclusion

The system itself is recent years, since all of a sudden the trend of online examination is gaining momentum due to the coronavirus pandemic. Physical presence used to be a strong requirement in early examination procedures, for honesty and scrutiny. With the introduction of online testing, staying honest and truthful while taking examinations is now a source of serious concern. To counter this, there was a system that was implemented to be able to detect and monitor off-trend behavior in real-time using video and audio inputs. It essentially detects actions such as unauthorized consumption of content, excessive looking away, or other activity that could be a sign of cheating.

Several sophisticated machine learning techniques were employed to enable this. Head pose recognition was crucial in calculating movement and direction of user attention. From orientation of the head, the system is able to infer that an individual is perpetually gazing at sources within excess of the permissible number along the course of an inspection. This feature enables pre-emptive detection of shift in attention to possess an extra layer of vigilance above normal video monitoring. Computer vision technology with high-level real-time detection was utilized for head pose estimation. Computer vision technology has the capability to sense very slight movement, and with such precision, can observe without affecting the user interface.

Apart from visual monitoring, audio analysis was also included in order to improve the performance of the system in recognizing suspicious behavior. Background noise is detected through a microphone, and audio levels and trends are analyzed for the detection of conversation with a person who is in the immediate vicinity or illegal device communication. By the inclusion of audio and video analysis, the system is more robust and reliable, is less prone to false alarms, and easier suspicious activity detection.

Lightweight and resource-frugal architecture is one of the most persuasive arguments. Unlike most solutions available, which need to consume a lot of processing power and require special hardware, this solution is designed for seamless use on mid-range devices without any detrimental impact on their functionality. Hence, it becomes affordable for numerous users and educational institutes that might be able to facilitate heavy usage without the need to purchase large infrastructures. Its own performance is not influenced in any way, and it is always able to process input in real-time and trigger timely alarms for identified suspicious behavior.

This kind of system is often an innovative and effective means to secure online exams. With the integration of head pose detection and audio analysis, it avoids the shortcoming of the traditional monitoring system and provides an extensible solution that can be compatible with the already implemented digital learning system. It shows how technology can be leveraged for the distribution of equity, transparency, and accountability in an electronic setting. The marking screen system design is implemented to guarantee accuracy, efficiency, and usability to enable efficient conduct of an examination without jeopardizing high levels of surveillance. Its development showcases computer vision techniques and AI to solve actual problems in teaching and testing.

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