Chapter 11
AI-Assisted Remote Proctored Examinations

11.1 What Is Remote Proctoring?

"Remote proctoring" refers to scalably authenticating, approving, and controlling online examinations. It is a method that guarantees the highest level of security while allowing organizations to conduct assessments at any time, from any location.

Exams can be taken from the comfort of one's home, eliminating applicants' need to travel to a central location.

For a standard exam, an invigilator must be present at the testing facility to verify the identities of those taking the test. One invigilator is needed for every 30–40 exam takers. However, you would require more than 25 invigilators to manage the testing procedure for 1000 or more students.

Online proctoring can be done using the candidate's webcam and an Internet connection. Not only can it record video of an entire exam, but it can also record screenshots of the computer's desktop, logs of online chats, and even still photographs from the camera's frame.

Different kinds of proctoring (see Fig. 11.1) include the following (Takyar 2022):

- *Video Proctoring:* Video proctoring is a service that helps students take tests with high stakes while keeping a close eye on them via live video. A candidate's video activity during the exam is recorded, and the assessment controller analyzes their conduct to determine whether or not the candidate engaged in any form of cheating or unfair tactics.
- *Image Proctoring:* Using image proctoring in areas with poor Internet connection is appropriate. For instance, every 30 or 45 s, the system would take a photo of the candidate while they answer questions on the exam. Educational institutes can use the photographs to verify that a legitimate student took the online exam and rule out any possibility of cheating. The goal of this variety of proctoring is to randomly re-verify distant candidates many times. The cost of image proctoring is significantly lower than the quality of video streaming.

M. Kurni et al., *A Beginner's Guide to Introduce Artificial Intelligence in Teaching and Learning*, https://doi.org/10.1007/978-3-031-32653-0_11

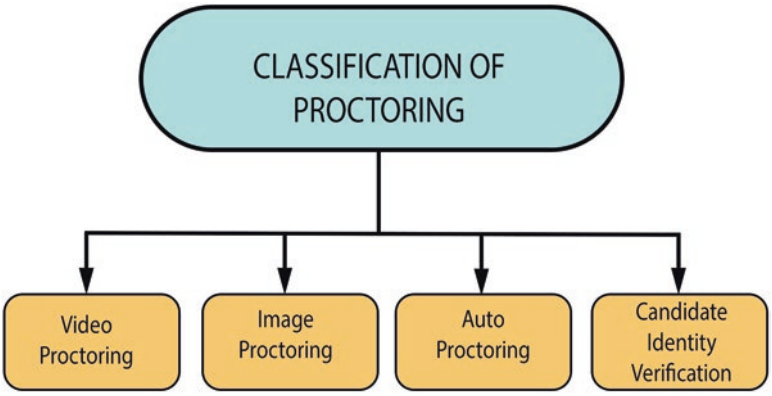

Fig. 11.1 Different kinds of proctoring

- *Auto Proctoring:* To automate the process of monitoring and analyzing distant applicants, "auto proctoring" might be used. It monitors live-streaming activities from candidates in different regions for online testing. Images and videos are analyzed to determine if a candidate has cheated on an exam by, for example, utilizing a mobile phone, having someone else take the test for them, or consulting a reference book.
- *Candidate Identity Verification:* This proctoring form checks students' identification before they begin their online exam. The camera will record the candidate as they provide their identification document and exam ticket. The proctor checks the candidate's identification card and grants or denies access based on the information provided.

One of the most effective uses of a webcam and screen-sharing software for proctoring is automated proctoring. In place of a human proctor, this system uses algorithms to detect potentially fraudulent actions.

ML allows remote proctoring systems to learn, adapt, and become increasingly intelligent. However, the goal of incorporating AI into proctoring is not to do away with human monitors altogether but to improve proctoring accuracy by assisting human monitors in picking up on subtle cues like low sound levels, whispers, reflections, shadows, etc.

11.2 Online Proctoring System (OPS): An Overview

The use of remote proctors is not a novel concept in education. Most, if not all, adaptive and competitive tests like the GRE, GMAT, and CAT require a proctor. Despite the pandemic, several schools continued to use proctoring systems for online classes. Virtual tools (tab switching, time stamps, audio levels, etc.) are used to evaluate students taking tests in online proctoring. To maintain honesty, many

Table 11.1 Characteristics of online proctoring system

S.no.	Features	Description	Newer technologies
1.	Authentication	Candidates' and proctors' identities are checked as part of the authentication process in proctoring software	A proctoring system uses one-time passwords (OTPs) and/or facial recognition technology for user authentication
2.	Browsing tolerance	Software that acts as a proctor limits how much time can be spent using various systems and services (such as other tabs of browsers, other face detection during live proctoring, etc.)	Methods such as log tracking and analysis, face detection, object detection, etc., are used to accomplish this
3.	Remote authorizing and control	It allows the proctor to manage the proctoring system (e.g., by remotely beginning or ending an exam for a specific student)	Most of this is accomplished by employing tiered security models and granting users administrative privileges
4.	Report generation	The focus here is on the student's report and exam activity log	Technologies like Python, ASP.net, and other open-source programming languages are typically used for this

examinations are administered online or at designated off-site locations (Foster and Layman 2013).

Two primary components are essential to the online proctoring system: a webcam recording of the student's exam performance and a means by which the examiner or proctor can watch that recording. The examiner/proctor has the right to investigate any suspicious activity during the exam, including cheating. The second component, locking, makes it such that students cannot access any other pages in their current browser window. This is sometimes referred to as a browser or computer lockdown (Alessio et al. 2017). Here are some of the characteristics of proctored exams that have been tabulated in Table 11.1 based on research by Hussein et al. (Hussein et al. 2020):

It was determined that there are three distinct types of proctoring systems (Hussein et al. 2020). Proctoring systems are depicted in Fig. 11.2:

- *Live Proctoring*
  - Real-time proctoring system.
  - Human proctor is involved.
  - Suitable for theoretical exams and long exams which last for 2–3 h.
  - A human proctor can track eye movements, recognize the faces of students, and flag them if they are caught cheating or engaging in malpractice.
  - Requires proficiency in the use of technological enhancements.
- *Recorded Proctoring*
  - Videotaping the candidate during the examination and keeping a detailed journal is required.

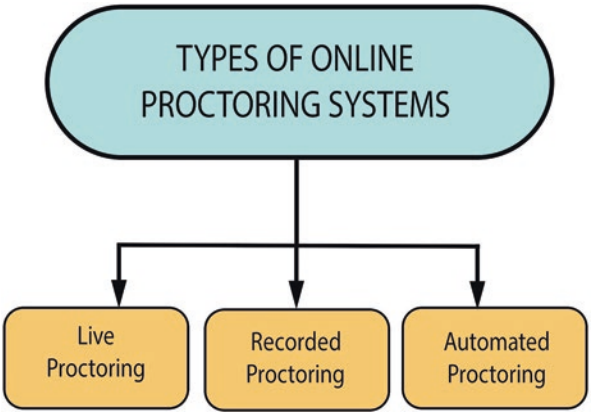

Fig. 11.2 Types of online proctoring systems

  - The post-proctoring process includes recording and analyzing logs, data from the object and face detectors, and tracing students' eye movements.
  - The involvement of humans is essential, but it takes a long time and costs much money.

- *Automated Proctoring*
  - Cost savings due to the absence of human proctors.
  - Greater complexity in design.
  - More advanced version in which humans do not proctor the entire time but instead evaluate.
  - System detects fraud and cheating via a variety of algorithms and technologies.

11.3 What Is AI Proctoring?

Artificial intelligence (AI) proctoring prevents students from cheating on online exams (Kathpalia 2021). AI proctoring closes security loopholes by using an adaptive set of anti-cheating measures. The cutting-edge AI algorithm at Mercer | Mettl has been trained on data from over 2.8 million proctored exams. Over 95% accuracy is achieved in identifying up to 18 dynamic deviations (Kathpalia 2021). The smart algorithm can alert the user in unusual situations, such as when a face or presence is not visible, a mobile phone is detected, an extra person is present, the user's gaze wanders, etc.

11.4 How Can AI Improve Remote Proctoring Services?

The following are the various remote proctoring services where AI can create an impact (Takyar 2022).

- *Improved accuracy:* AI acts as an additional set of eyes for human proctors, raising the alarm for any suspicious behavior it detects that humans would miss.
- *Additional scalability:* Increased efficiency in spotting suspicious conduct makes it possible for remote proctoring software to proctor online exams without compromising the extra security a human proctor provides.
- *Unmatched security:* The remote proctoring system can take prompt action against the applicant if it detects any inappropriate activity or use of unauthorized resources that a human proctor might overlook. This feature can instill even more trust when avoiding or correcting cheating would be ideal in high-stakes exams.
- *Mimic human behavior:* Artificial intelligence can assist humans in detecting abnormal behavior in real time. If the machine can eventually match human accuracy, human care for each applicant will no longer be necessary.
- *Creating a smarter AI system:* The success of an AI model depends on its precision. To achieve accuracy, the system needs hundreds of data points. This means that the more data your AI has to analyze, the smarter it will get.

11.5 How AI-Based Remote Proctoring Work?

The three main themes of AI-enabled remote proctoring are (Takyar 2022):

- Detect identity fraud
- Analyze cheating behavior
- Discover content theft

Throughout thousands of iterations, the AI-powered remote proctoring process builds, trains, and refines each and every event defined in the system. Identify fraud, content theft, and cheating can all be exhibited in a single incident.

If someone is observed glancing off-screen to the left, for instance, the observation can be treated as a discrete data point, and the relevant segment of the video can be identified as evidence of dishonest investigation tactics. Initiating the ongoing construction, training, and improvement process happens when the number of data points exhibiting the same behavior reaches the threshold.

Each of the millions of actions taken throughout the process is flagged for possible dishonesty. A session's integrity would be suspected if all the occurrences met the criteria.

Numerous forms of AI technology are already being employed to improve remote proctoring services and provide a more streamlined method of exam

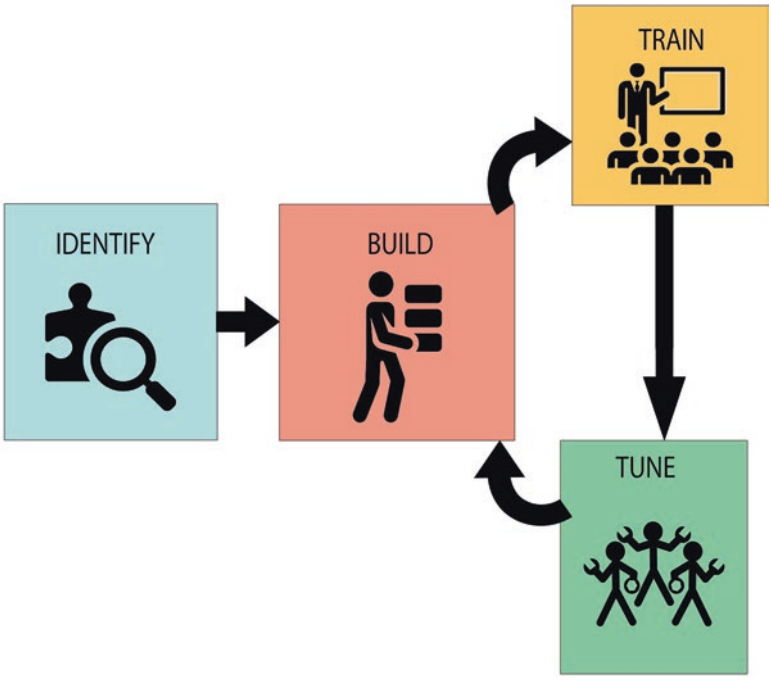

Fig. 11.3 Working of AI-based remote proctoring

administration for educational institutions. Figure 11.3 provides an overview of the working of AI-based remote proctoring.

11.6 How AI Prevents Cheating in Remote Proctoring Exams?

Every organization hopes for a cheating-free environment regarding online proctored exams, and AI can interpret human behavior precisely to give just that. Let us look at how AI makes online tests completely honest (MapleLMS 2021).

- *Live proctoring for maximum accuracy:* AI utilizes online camera proctoring to observe candidate behavior. It records every candidate's action, including eye tracking, voice and face recognition, multiple face logging, and more.
- *Optimum security:* If the AI-enabled system detects suspicious activity, the candidates will see a warning message on their screens. In addition, the human proctor is looking for suspicious behavior from the candidates.
- *Recording:* The sessions are recorded for future audits and reviewed afterward to ensure no violations were committed.

- *Reporting and analytics:* These AI-powered proctored testing environments collect exam data for more accurate reporting and analysis. This is useful for determining how well and how intuitively the application functions. Insights that can be put to use in the future to improve the user experience are gleaned through analytics.

11.7 AI-Assisted Proctoring Software for Monitoring Online Exams

This section details an AI-assisted proctoring software designed (Bartamani et al. 2021) to keep tabs on students taking tests online. Python software that can count the times a student speaks and identify when they are out of frame has been built. Furthermore, the time and date that these occurrences occurred can be noted. The analysis engine will use these factors to identify suspicious behavior or attempts at cheating. Figure 11.4 gives the block diagram of AI-assisted proctoring software.

- *Methodology:* The student's performance on the online exam is recorded in real time via video and audio using a camera and microphone. An AI-enhanced analytical engine is fed the live video and audio a microphone acquires. The analyti-

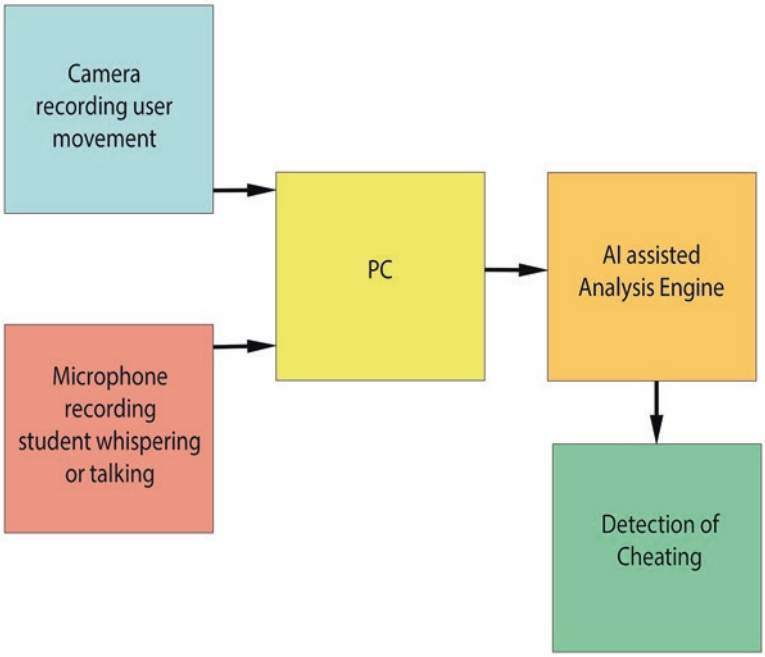

Fig. 11.4 Block diagram of AI-assisted proctoring software

cal engine is written in Python and uses machine learning to spot out-of-the-ordinary activity patterns. The python code is compiled using the Thonny IDE.

- *Data analysis:* Using the recorded audio and video feed, python software detects the following:
  - The timestamps and the number of times the student leaves the camera's view. When a human face is present, the occurrence is accepted as typical, but it is viewed as suspicious when one is absent. We employ the face recognition method known as the Haar Cascade classifier to achieve this goal.
  - The Google API for speech recognition is used to decipher spoken words.
  - With the help of the time stamp, we can also calculate how long the student spent outside of the camera's field of view.
  - The analysis engine is "trained" with data from students who take the exam honestly and those who cheat.
- *Results:* The Python, facial, and speech recognition programs accurately detect the number of times a student exits the camera's field of view and the words spoken by the student during the online exams. The system can also track when the student is no longer in view. Anomaly events must be detected using the data collected.

11.8 AI Technologies Used for Remote Proctoring

The following is a list of the various forms of artificial intelligence utilized in Remote Proctoring.

- *Pattern recognition:* There (Takyar 2022) is no universal pattern of behaviors that constitutes cheating. It examines the data at hand to detect any recurring patterns. Data patterns are easily identifiable by AI. Classifying data using prior knowledge or statistical information gleaned from patterns and/or their representations is the essence of pattern recognition.
- *Voice recognition:* Voice recognition technology can assist in eliminating dishonesty by identifying speech patterns in a noisy environment. It can help identify expected and unexpected noises during testing.
- *Facial recognition:* Facial recognition has several applications, such as identity verification and detecting new faces in a testing setting. It can detect if the candidate is being helped in any way during the online exam by recognizing multiple faces at once.
- *Eye movement detection:* Using artificial intelligence, eye movement detection can tell whether a candidate is staring at the screen or distracted by anything else, such as a book or a cell phone. Unfair practices can be uncovered by tracking the candidate's eye movements for telltale signs of misconduct.

- *Plane detection:* Through plane detection, remote proctoring software can learn the spatial definition of the candidate's actual testing environment. By incorporating object recognition, the system can learn more about the world around it.
- *Mouth detection:* Like eye detection, important facial points are utilized, and test-takers must maintain an upright posture. You can track the gap between the lips' pivot points in many frames. An infringement is recorded if the average distance between users' lip points is more significant than a threshold.

11.9 Challenges and Opportunities

While there may be several advantages to taking an online exam powered by artificial intelligence, doing so requires several factors to be in place first. Scaling this technology requires more individuals, even if many already have such a system at home.

Mohan of the Upgrade explains that "in a country like India, the looming challenges for students in remote areas with poor or no internet connectivity and limited infrastructure can restrict their access to this model" since a hiccup in the network could prevent multiple students from logging in at once and finishing the exam. As an additional technological hurdle, he says, "there could be insufficient bandwidth for the webcam application to perform efficiently" (Anu Thomas 2020).

"Even though innovations enable students to take virtual exams, significant difficulties remain before they can become popular in India," says Kumar, CEO of BasicFirst Learning. Many students cannot take online tests because they do not have access to reliable Internet at home or do not have the necessary equipment.

Further, Testbook co-founder Ashutosh Kumar notes, "while the rising trend of online proctoring has been seen in other nations, India still has a few difficulties to overcome before it can be made ubiquitous" (Anu Thomas 2020). Therefore, making the AI proctoring model more accessible can boost its overall efficacy and guarantee its full utilization at all academic levels.

Despite the obstacles, Doshi of GreyAtom sees a potential to leverage proctoring systems as a tool for more reliable test administration and personalizing the learning process.

Doshi believes this is an opportunity to build further examinations in which artificial intelligence (AI) evaluates students repeatedly, providing immediate feedback and a suggested improvement strategy. All sorts of personalization and prediction tests can be carried out if "the systems are intended to capture data from the beginning," she says.

She argues that proctoring exams can be utilized to identify a student's knowledge gaps and lead to more effective learning. This is just one aspect of the broader problem statement of continuously evaluating students.

She explains: "As a student takes additional tests, the system updates its model of the student's understanding and modifies the curriculum depending on the behavioral and cognitive signals. The more students use the system, the more hidden

relationships between ideas are revealed. After these new associations are made, the ML algorithms revise the knowledge graph to reflect them, allowing for more accurate gap analysis, course recommendation, and improved student test scores" (Anu Thomas 2020).

11.10 Future of AI-Based Proctoring Systems

Over the past decade, educational institutions and corporate organizations have gradually embraced online proctoring software worldwide to conduct distance tests properly and ensure that the applicants gave the exam in a known setting. Remote proctoring solutions are in high demand because of the current COVID-19 pandemic. These platforms allow for the smooth administration of examinations while preventing exam cheating by candidates. The year 2020 will mark the introduction of remote proctoring (Nigam et al. 2021).

There are several advantages for an organization to use remote proctoring for an assessment rather than the old-fashioned paper and pen method. Arranging exam dates is far less of a hassle when you do not have to worry about reserving space at approved testing facilities. The examiner and examinee's communication ability is facilitated by fewer barriers and in less time. The examination results can be generated more quickly, sometimes even instantly. Because of the scalability of online testing, organizations can administer exams to many candidates without worrying about testing centers reaching capacity (Arora 2021).

A serious effort is needed to create proctoring technology to ensure that online examinations are on par with offline examinations in terms of quality (including the integrity of marks scored and the prevention of misconduct by applicants). Furthermore, the general public's attitude regarding online examinations must be altered, and the advantages of these examinations must be known. As mentioned above, current technologies must be used to solve problems when creating an AI-based proctoring system. While it is true that technological progress will help engineers build more reliable and secure systems in the future, there is still work to be done to ensure that today's tools can cope with future demands (Pimple 2021).

There must be a foolproof method for verifying the user's identification in any proctoring software. The proctoring software requires candidates to provide identification information or other forms of personal data, which are then checked. The security of online examinations is particularly vulnerable to impersonation, so several measures are taken to verify that the designated examiner is administering the test. Some systems have started using fingerprint scanners as biometric authentication (Nigam et al. 2021), commonplace on modern mobile devices and computers.

Regarding biometric authentication, iris scanning is one of the safest methods (Nigam et al. 2021). Even though this verification method is more widely available nowadays, it is still not a failsafe way to confirm a person's identification. However, machines with the hardware capabilities for the abovementioned procedure do not yet exist on the market; thus, candidates will have to shell out additional cash to

acquire these components. Preventing people from using remote proctoring software because they do not have the proper hardware or software would be counterproductive to expanding its use worldwide. Consequently, when developing proctoring software, it is essential to incorporate the "necessary evil" of continuous human proctoring throughout the exam.

Biometrics are becoming increasingly popular; thus, mobile devices (phones, tablets, laptops) are outfitted with fingerprint and facial recognition scanners. If these gadgets were mass-produced, then everyone would use some form of biometric authentication. Multi-factor authentication is an excellent option if you are concerned about a test taker's identity being compromised. In any OPS, a password can serve as the initial module, while OTP-based verification, facial recognition, and fingerprint authentication can be utilized in the second stage. While several AIPS has employed iris tracking in addition to other methods, it should be kept in mind that doing so necessitates sophisticated technology that is not within the financial reach of the average person (Nigam et al. 2021).

Light Detection and Ranging (or LIDAR for short) is another technology making headlines. LIDAR is a type of remote sensing technology. LIDAR uses a pulsed laser to determine the varying distances of objects from a light source. These light bursts produce precise three-dimensional data of the object of interest and its immediate surroundings.

In addition to its long history of use in astronomy (e.g., the Phoenix Mars Lander used LIDAR technology to detect snowfall), LIDAR is finding promising new uses in fields as diverse as biology, meteorology, and autonomous cars. LIDAR was first launched in mobile phones and is now being implemented into self-driving cars to model the road better and detect adjacent obstructions.

LIDAR enhances the precision of distance measurements and facilitates augmented reality (AR) use. More precise location data is sent to apps for a more dependable augmented reality experience. LIDAR is a valuable technology that has yet to see mass manufacturing in mobile phones to make it more affordable, so while this is excellent news for AIPS, it comes at a hefty price.

We must find a way to unite the two worlds of online learning and testing. Several programs seek to study student behavior in online classes, collect students' unique behavioral features, and share this data with proctoring services for improved invigilation of online tests. In the future, much more similar software will be launched to help improve the many foundations of online education. The future is sludgy (Slusky 2020).

The revolutionary shift the pandemic has wrought will not ease in the following years. All this has done is further solidify the concept that online education is viable, highly efficient, and successful. There are many opportunities to acquire a degree from the convenience of home through distance learning. As a result, AIPS is not going away and will continue to advance.

The usage of OTP-based verification (Joshy et al. 2018), user interface configuration (Karim and Shukur 2016), and anti-plagiarism measures are also taken into account alongside the use of EEG devices (Norris 2019) (Dendir and Maxwell

2020). Prospective findings in identifying incidences of misconduct have been found in studies using these variables.

The cost of incorporating these strategies into a Proctoring System powered by AI may be prohibitive, but this may change as more and more technologies are combined.

11.11 Conclusion

AI-powered remote proctoring has the potential to revolutionize the education system and make the impossible feasible. Integrating AI into computer systems safeguards the integrity of the examination by discouraging the candidate from using unjustified practices during the assessment. Examinations at schools and universities are not postponed or canceled because of the COVID-19 pandemic because of AI-assisted Remote Proctoring. By incorporating AI technologies, schools, and teachers can speed up and improve the reliability of their online testing. Scalability, quick processes, high accuracy, and assessment integrity are only a few advantages AI and ML algorithms provide—a safe and inexpensive method of detecting and punishing exam takers who cheat on online tests. AI in remote proctoring allows for the safe administration of online tests to distant users. Online exam fraud can be detected and prevented with system algorithms. With artificial intelligence, remote proctoring makes it simple to administer examinations online while keeping them safe.

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