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Cheating Detection and Prevention Techniques in Online System for University Examinations: A Comprehensive Review

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Abstract
With the advancement of technology and ICT, the mode of teaching and learning has been transformed from traditional classroom teaching to online education system. Accordingly, the evaluation method or examination system has also shifted towards online examination system and has been accepted almost universally. Due to increased access of online resources and their familiarity to most of the people around the world, the increasing cases of cheating inonline examination environment has given rise to a lot of challenges in ensuring academic integrity. The paper provides a comprehensive review of various types of cheating, common methods of cheating,cheating detection techniques and covers a wide range of technologies used to combat cheating including machine learning approaches, computer vision, network and system monitoring, technological tools and remote proctoring systems. The paper also discussed various cheating prevention techniques developed by different researchers including exam design, biometric authentication and authorization, policy making and their effectiveness in preventing various forms of cheating. The paper also includes a case study and real-world implementation of proctored based online examination system in a state university of Haryana, India. The on-ground implementation and challenges faced by the institution are covered in the case study. Furthermore, the paper provides the comparison of various research studies conducted in the field of online examination system, cheating detection and prevention techniques for online examinations. The paper also discussed the role of machine learning and artificial intelligence in enhancing the process of cheating detection and propose future directions for research in this area.

Keywords: *Cheating; Cheating detection; cheating prevention; online examinations*

1. Introduction
Education is the basis for learning and it can be accessed by examination system in different ways. University examination are the basic practices for the students of the academic programs to examine or evaluate the knowledge acquired by the students during that academic session. The University examination generally conducted after the end of academic sessions that is at the end of every semester or every year. Examination is always a significant tool to evaluate the quality and quantity of knowledge or say learning in a specific field and time (Abbasi et al., 2011). The further subfields introduce the university examination system in detail. [1-5]

1.1. Background and Importance of Examination System in Universities
The University examination system is a very old practice for evaluation of knowledge gained by the students. In the higher education system, there is hardly any month for when exams are not conducted (Aggarwal, 2005). The university examinations are generally conducted in Pan Paper mode in a secured examination centers located either inside the University Campus or in the affiliated colleges of that University. This type of examination system runs smoothly under the supervision of human invigilators as well as supervisors and examinations are conducted in a fair manner. The type of exam i.e. descriptive or OMR based exam, both are conducted under the surveillance of the physical invigilator. In this system, the students are to complete the exam by writing their own hands in the particular exam hall and submit the answer script or written paper to the institution (Rajput et al., 2019).Examinations are very important and have a significant role in

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university as well as in education system. Examinations are significant for both the student and teacher because a student can examine what is learnt and how much has retained in his mind. A teacher verifies about goal orientation towards his/ her work through examination. To sum up, we can say that examinations are very important, without examination the work of students and teachers will neither have precision and any direction. Examination is always an effective tool to evaluate the quality and quantity of knowledge in an effective time and in a particular field of study. [6-10]

1.2.Structure of the Research Paper

The paper has total 8 sections: introduction, overview of online examination system, cheating in online examinations, cheating detection techniques, cheating prevention techniques, case study and real-world implementation, comparative analysis, conclusion and future research directions.

2. Overview of Online Examination System

Any of the existing practice gets older with the passage of time and new methods and techniques gets introduced in any of the field present on the universe. The examination system is not distinct from this change, with the emergence of internet, the online education and ICT come into existence and this causes the online examination system to be introduced. The following subfields gets more insight about this.

2.1.Evolution and Adoption of Online Examination System

The evolution and adoption of online examination systems in universities have been driven by advancements in technology and the need for flexible, scalable, and efficient assessment methods. Initially, online exams were limited to objective-type questions due to the constraints of early digital platforms. However, with the development of more sophisticated software, universities began integrating various question formats, including essays and practical tasks (Hodges et al., 2020). The COVID-19 pandemic accelerated the adoption of online examinations, as institutions worldwide sought to maintain academic continuity amidst lockdowns and social distancing measures. Universities have invested in secure online platforms that offer features such as automated proctoring, plagiarism detection, and real-time analytics to ensure the integrity and reliability of online assessments (Jisc, 2020). These systems have enabled greater accessibility for students, allowing them to take exams from remote locations while providing educators with tools to efficiently manage and evaluate large volumes of exam data(Universities UK, 2020). [11-15]

2.2.Benefits of Online Examinations

There are several benefits of conducting examinations in online mode by the universities, the common benefits are given below: The benefits of online examinations are:

a) **Flexibility:** The online examination system has flexibility for the students as they do not need reach the examination hall and can attempt their exam form their home location easily(Jisc, 2020), (Hodges et al., 2020).
b) **Efficiency and Scalability:** Online exams fasten the administration process, reducing the need for physical infrastructure and help universities to efficiently manage large numbers of students. Automated grading for objective questions accelerates the evaluation process (Educause Review, 2020).

2.3.Challenges of Online Examinations

The challenges of online examinations are:

a) **Technical Issues:** Continuous internet facility and digital devices are fundamentals for online exams. Technical faults, such as system crashes or connectivity problems, can disrupt the examination process and disadvantage students (Jisc, 2020).
b) **Academic Integrity:** Despite enhanced security features, there is a constant challenge tocombat cheating and confirming the authenticity of student work in an online environment.
c) **Digital Divide:** All students does not have equal access to technology that can worsen existing inequalities. Students from remote and facility lacking backgrounds may struggle with inadequate hardware or internet access (Hodges et al., 2020).
d) **Training and Adaptation:** Students and invigilators require proper training to adopt the online examination systems. Resistance to change and the learning curve associated with

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new technologies can hinder effective adoption (Universities UK, 2020).

e) **Privacy Concerns:** The use of proctoring software and data collection in online exams can lead to privacy and data security concerns (Educause Review, 2020).

2.4.Importance of Maintaining Integrity in Online Examination

Role of maintaining integrity in online examinations is vital for some reasons, having covered both the educational body and the wider society. Some of the reasons are:

a) **Trustworthiness of degrees:** The integrity of online examinations makes sure that the degrees awarded by educational body are credible and recognized. If exams are compromised, the value of the degrees or certificates granted can be questioned by employers, other educational institutions, and accrediting bodies ((Bawa, 2020).

b) **Fairness and Equity:** Academic integrity ensures that all students are examined fairly and equitably. Cheating breaks the principle of equal opportunity and allow dishonest students take advantage over the intelligent students (McCabe et al., 2012).

c) **Reputation of Institutions:** The reputation of educational institutions can only be measured by their standard of academic integrity. Institution's image falls down if a number of cheating cases are recognized and also lead to loss the trust of stakeholders, including students, parents, and employers (International Center for Academic Integrity, 2020).

d) Student learning and Development: Proper and fairness in exams promotes genuine learning and intellectual development. If students rely on dishonest means to pass exams, they miss the opportunity to truly understand the material and develop critical thinking skills, which are essential for their future careers and personal growth (Newton, 2016).

3. Cheating in Online Examinations

With the rapid growth of online education and remote learning, online exams have become increasingly prevalent in the educational landscape, especially in the wake of technological advancements and the COVID-19 pandemic (Jisc, 2020).However, with the growing reliance on online exams, there is a significant concern about cheating behaviors, such as plagiarism, impersonation, collusion, and other unethical activities, that compromise the integrity and fairness of the examination process. Cheating in online exams can take various forms, such as using unauthorized materials or devices, copying answers from others, or collaborating with other students (Noorbehbahani et al., 2022). There are different types through which cheating activities takes place. The types of cheating are explained below. [16-20]

3.1.Types of Cheating

There are various types of cheating practices used by the examinees during the exams. The studies about these practices have been done across the world and various strategies have been developed to combat these types. (Refer Figure 1) The main cheating practices are categorized into three types that are, individual cheating, and group cheating and using unauthorized resources. The individual cheating activity is done by the single person and the group cheating involves cooperation with the other students (Noorbehbahani et al., 2022).

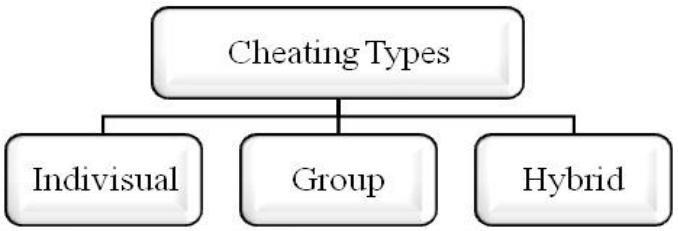

Figure 1 Different Types of Cheating in Online Examinations

3.1.1. Individual Cheating

Performing the cheating alone without the help of other person is known as individual cheating and it uses forbidden materials to attempt cheating in online examination (Korman, 2010). The use of forbidden materials includes textbook copying, surfing the web, use of electronic gadgets in the offline mode to look for images, notes etc. (Holden et al., 2020). [21-25]

3.1.2. Group Cheating

The cheating activity performed with the help of

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other person or persons during the examination is called as group cheating. Group cheating is generally categorized as impersonation and collaboration types (Kasliwal, 2015). Impersonation is the activity of giving the exam by someone other in place of the examinee, either the whole exam or some parts of it (Korman, 2010; Holden et al., 2020).Collaborating is the process of taking help in the exam hall to write the answers by the examinee. This can be in the form of communication through sign language such as dropping any object or foot taping, any abnormal activity to seek help from the side during proctored exam (Noorbehbahani et al., 2022).

3.1.3. Mixed Cheating Approach

Both the individual as well as group cheating methods are used in some scenarios called hybrid approach. Using virtual machines on a computer allows the user to execute a virtual operating system within the primary one. This approach provides a means to conceal activities performed on the secondary operating system from both the software and human proctor supervising the primary operating system (Kasliwal, 2015). Another noteworthy method involves compromising the integrity of the exam system to manipulate exam results post-assessment, which includes altering scores or answers after the examination has taken place (Korman, 2010).

3.2.Common Methods and Tools used for Cheating in Online Examination

There are a number of cheating methods used in online examinations for performing cheating activities. External materials like books and notes, digital files related to examination are arranged in the exam hall. Hacking the communication server that forwards the question paper or the online exam. Special seating arrangements for the examinee to perform the cheating activities. Easily, an unauthorized device like smart phone, bluetooth devices and scientific devices are used to get the outside help by the examinee to perform cheating(Korman, 2010; Noorbehbahani et al., 2022).

3.3.Impact of Cheating on Educational Institutes and Students

Cheating in educational institutions has significant negative impacts on both the institutions and students involved. For institutions, it damages reputations, risks accreditation, strains resource, erodes trust, and degrades academic standards. For students, it results in learning deficits, ethical consequences, academic penalties, psychological issues, and professional setbacks. Addressing cheating requires substantial efforts from educational institutions, but it is essential to maintain academic integrity, ensure fair and effective education, and prepare students for ethical professional conduct. [26-30]

4. Cheating Detection Techniques

Cheating detection is the process of finding out the examinee using unfair means to attempt the exam during the examination process. Cheating detection generally applied while the examination is ongoing and the examinee tries to cheat or use any unfair means at that point of time,so we can say that cheating detection is real time process and detect potential cheaters during the examination (Noorbehbahani et al., 2022).

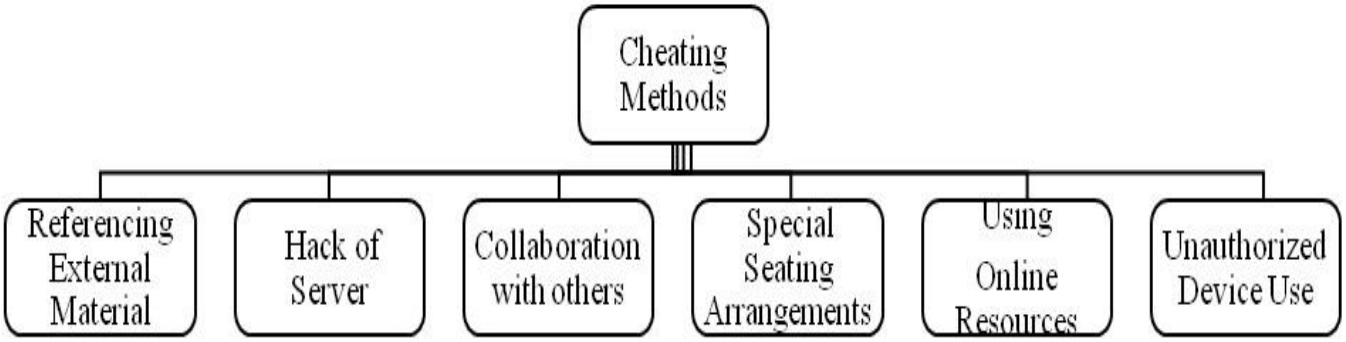

Figure 2 Different Types of Cheating Method used in Online Examinations

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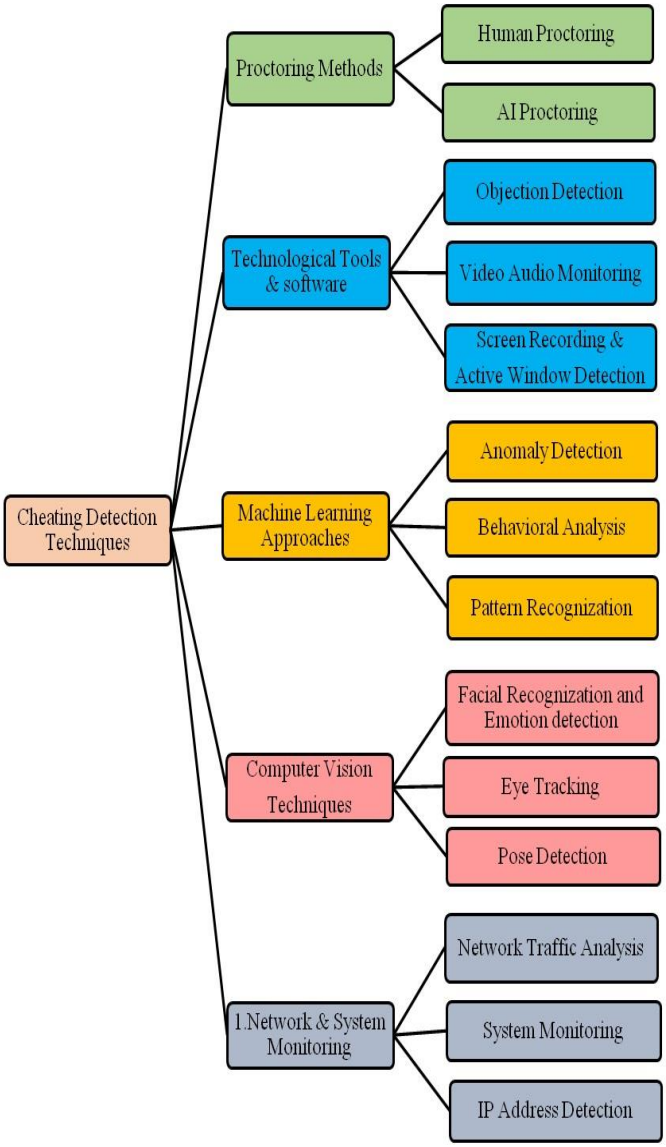

Figure 3 Different Types of Cheating Detection and Prevention Techniques

There are large numbers of cheating detection techniques available in the literature, sum of these techniques which are more frequent in use as well as have good response in cheating detection process are considered in this paper. The classification and elaboration of these techniques is below. Figure 2 shows Different Types of Cheating Method used in Online Examinations

4.1.Proctoring Methods

Proctoring methods are the process of supervising the examinee during an online exam. Where the remotely located centers are monitored with the help of technology by the supervisors being at another remote location. The proctoring methods can take various forms as:

4.1.1. Human Proctoring

In human proctoring, a human invigilator keeps an eye on the examinee from a distance in order to spot questionable conduct (Noorbehbahani et al., 2022). Human proctoring also categorized into 'Real time proctoring' and 'Recorded Proctoring'. In real time human proctoring, and invigilator monitors the examinee from remote location through audio visual communication during examination, and if any fraud or cheating activity is encountered from the examinee side, that is handled on the spot by the remotely located invigilator (Yelkar et al., 2022).

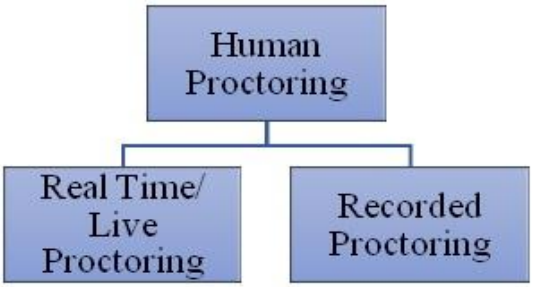

Figure 4 Types of Human Proctoring in Online Examinations

In recorded proctoring, examination is conducted on a remote location with video and audio recording of the complete exam time. These video & audio recording are saved and monitored by the invigilator on a later stage. If any unfair means are found in the recorded video, then required action are taken by the human proctor (Yelkar et al., 2022). [31-35]

4.1.2. AI Proctoring

Automated systems use AI to monitor and analyze student behavior.AI proctoring is the process of monitoring the examinees through webcam and audio recognizer in real time and detecting the cheating activities automatically with the help of intelligence algorithms by extracting the features in the received video and audio. Numerous detection mechanisms, such as face detection, noise detection, gaze tracking, mouth movement detection, mobile or other device detection, head pose detection to determine the examinee's location, and change of tabs detection, are part of the AI-based Proctoring System(Saurav et al., 2021).Software like ProctorU and Examity are the

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Page No: 2412 - 2428
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examples of AI based proctoring. Various research studies have been done in the field of AI proctoring. Some of the studies are under as: Rajput et al. (2019) proposed an automated cheating detection system for exams using posture and emotion analysis via CCTV footage and identifies abnormal actions and utilizes facial recognition for culprit identification, enhancing invigilation efficiency. The research employs OpenPose for posture detection, ALEXNET for cheating type detection, and convolutional neural networks for emotion analysis. Posture detection involves key point estimation and angle calculation. Monteiro et al. (2022) proposed a system utilizes advanced AI algorithms such as Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN) for real-time monitoring of students during exams. Vision-based tracking techniques, including eye movement and lip movement tracking, are employed to detect suspicious behavior, while facial landmark detection facilitates accurate monitoring of specific facial features. The system also incorporates thresholding mechanisms to flag potential cheating instances and alert supervisors. The integration of WebRTC technology enables seamless video conferencing among students and supervisors, while Flask and Twilio API facilitate features such as screen sharing and communication during exams. OpenCV and Dlib are utilized for various computer vision tasks, including eye tracking, mouth tracking, and head pose estimation. Figure 4 Types of Human Proctoring in Online Examinations and Figure 3 showsDifferent Types of Cheating Detection and Prevention Techniques.

4.2.Technological Tools and Software

There are different type of tools and software are in use for detection of cheating in a live examination hall as well as in recorded session of an examination. These technological tools are the heart of the remote proctoring system as all the other parameters depends on these tools. For example, a webcam for the live video monitoring or recording the exam session is the key to further processing of data. Other research approaches like machine learning, computer vision techniques, feature extraction and pattern recognition etc. will depend on the good picture or video quality of the tool. Depending on the research study, the technological tools are categorized as:

4.2.1. Objection Detection

Object detection method is necessary for maintaining the integrity of the examination. These methods check for presence of any unauthorized object in the examination hall in the form of technological tools like smart phone, Bluetooth devices, and any kind of wearables as well as presence of person other than the examinee himself. Various research studies have been done by the researchers around the world in this field, some of the important studies are as under: Korman (2010) proposed a technique that employs two cameras, including a webcam and a follower-cam controlled by an Arduino board. A custom-trained object detection model using Tensor Flow 2 Object Detection API is implemented to identify common cheating targets like open books, written notes, smartphones, and calculators. Transfer learning is applied to enhance the performance of the custom model, which is trained on a dataset of annotated images containing cheating target objects. Maniar(2021)has done object detection using YOLOv3 on the COCO dataset, Object detection identifies people and objects in the webcam feed. In (Gupta & Bhat, 2022),deep learning techniques, particularly transfer learning using InceptionV3model, are applied to analyze the images and detect cheating behavior and Object detection algorithm YOLO (You Only Look Once), has been utilized within the deep learning pipeline to identify specific objects or actions indicative of cheating.

4.2.2. Video and Audio Monitoring

The video and audio monitoring techniques for detection of cheating in online examination comes under the umbrella of both the technological tools as well as software, as the video and audio analysis are done on the base of the tools used for video and audio capturing(Gupta & Bhat, 2022). The data collected from audio and video monitoring technical tools like webcam and microphone is analyzed on various AI techniques like computer vision, pattern recognition, feature extraction, voice detection. The video and audio monitoring tools are also essential for both real time as well as remote monitoring purposes. The research studies based on computer vision, machine learning or deep learning have the prerequisite of video and audio monitoring, without capturing the audio visuals of the candidates during the

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Page No: 2412 - 2428
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https://doi.org/10.47392/IRJAEH.2024.0331

examination, no feature extraction and learning algorithm application is possible (Yelkar et al., 2022; Monteiro et al., 2022; Maniar et al., 2021).

4.2.3. Screen Recording and Active Window Detection

Captures the screen activity and keystrokes to identify cheating attempts. Screen recording during the examination is done to monitor the various movements like screen switching, mouse movements, and active window on the computer screen. Some of the important research studies about these fields are discussed below as: A research frame work incorporates a multi-modal approach to analyze real-time exam sessions, capturing both visual and auditory cues to identify suspicious behaviors indicative of cheating. Computer vision algorithms are employed to track eye movements, facial expressions, and screen content, while audio processing techniques monitor for irregularities in speech patterns and background noise. Machine learning models are trained on annotated datasets to recognize patterns associated with cheating behaviors, enabling the system to classify exam sessions based on the likelihood of academic dishonesty. Statistical analyses are conducted to evaluate the framework's performance, including precision, recall, and F1-score metrics, which demonstrate its effectiveness in accurately detecting instances of cheating with high confidence levels (Atoum et al., 2017).

4.3.Machine Learning Approaches

Machine Learning is the field of study that gives computers the capability to learn without being explicitly programmed. Machine Learning is the subfield of artificial intelligence where the developed system firstly learns orimproves the performance based on the data ingest. The machine learning approaches used in cheating detection are discussed below as:

4.3.1. Anomaly Detection

Anomaly detection identifies unusual patterns in student behavior during exams. Akif et al. (2022) collected a dataset of short videos from volunteer participants simulating both cheating and non-cheating behavior during online exams and extracted features as head pose angles and iris positions from the video frames using pre-processing techniques and evaluated the performance of various machine learning models for detecting cheating behavior. The models were Logistic Regression, Bernoulli Naive Bayes, Decision Tree Classifier, XGB Classifier, Gaussian Naive Bayes, KNN (K Nearest Neighbors), Random Forest, DenseNet, and VGG19. These models were trained and tested on features extracted from video frames, including mean value, standard deviation value, differentiated mean value, and differentiated standard deviation value. The evaluation metrics used were accuracy and prediction time. The results showed that KNN-1 achieved the highest accuracy of 93.13% with mean value features, while XGB Classifier performed the best in terms of prediction time.

4.3.2. Behavioral Analysis

Analyzes students' typing patterns, mouse movements, and other behaviors. Sokout et al. (2020) proposed a mouse tracking software has been used to capture real-time behavioral data including cursor movements and keyboard inputs from students undertaking online assessments. This gathered data is preprocessed for extraction of features like velocity and acceleration profiles of cursor movements, and then fed into a Support Vector Machine (SVM) classifier for training. Various techniques including grid-search for hyper parameter tuning and k-fold cross-validation for performance evaluation were applied to optimize the SVM model.

4.3.3. Pattern Recognition

Detects patterns in answer selections or submission times that indicate cheating. The automated cheating detection system for exams using posture and emotion analysis by capturing CCTV footage and identifies abnormal actions and utilizes facial recognition for culprit identification, enhancing invigilation efficiency. The research employs OpenPose for posture detection, ALEXNET for cheating type detection, and convolutional neural networks for emotion analysis. Posture detection involves key point estimation and angle calculation. ALEXNET is trained using transfer learning, achieving 96% accuracy. Emotion analysis utilizes CNNs with a 63% accuracy rate (Nishchal et al., 2020).

4.4.Computer Vision Techniques

Computer vision is a domain of AI that allows

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Page No: 2412 - 2428
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https://doi.org/10.47392/IRJAEH.2024.0331

computers to understand and make conclusions based on visual data from the real world. In the context of cheating detection for online examinations, computer vision is used to monitor and analyze video feeds of examinees to identify suspicious behavior and potential cheating activities.

4.4.1. Facial Detection and Emotion Analysis

Facial detection verifies the identity of the examinee by ensuring that the person taking the exam is the same as the one registered for the exam. Facial recognition algorithms compare the live video feed with stored images of the student. Various tools and platforms that are OpenCV, Amazon Recognition, Microsoft Azure Face API, Affectiva, Emotion AI. Saurav et al. (2021) employed facial recognition using ResNet-10 architecture and eye tracking with a 68-key point detector. It utilizes TensorFlow for facial landmark detection. Hossain et al. (2021) proposed an automated online exam proctoring system using computer vision and machine learning techniques to detect cheating activities during online examinations. The system estimates the orientation of the examinee's head using a pre-trained model called Real HePoNet, which detects head pose angles such as yaw and pitch. Hyper parameters of the classifiers are tuned to optimize performance, resulting in a high accuracy rate of 96.5% for detecting cheating. Convolutional Neural Networks (CNNs), for face recognition introduces an incremental training process for face recognition, wherein training data is gradually acquired from online lecture sessions, reducing training time and dataset size. Four face detection methods are used Viola-Jones/Haar-cascade, Local Binary Pattern (LBP), Multi-Task Cascaded CNN (MTCNN), and YOLO-face, with the latter two showing superior performance. The Face-net model is employed for face recognition, generating compact face embeddings using a triplet loss function. Evaluation metrics include training time, accuracy rate, average face detection time, and dataset size, with experiments conducted using Python, Tensor Flow, and OpenCV (Ganidisastra & Bandung, 2021).

4.4.2. Eye/ Gaze Tracking

To track the student about where he is looking during the examination. The eye or gaze tracking technique monitors the eye movements of the examinee for unnecessary away screen moves that may indicate about looking at unauthorized resources. Tobii Eye Tracker, Gaze Tracker. Two cameras are used, a webcam and a follower-cam controlled by an Arduino board, to track the test-taker's gaze in real-time without intrusion. A mathematical 3D gaze motion formula is derived to accurately capture the test-taker's gaze movements (Li & Li, 2022). Maniar et al. (2021) proposed Facial landmark detection, eye gaze tracking and mouth detection, is performed using a convolutional neural network developed with Tensor Flow. Eye gaze tracking involves detecting key facial points using Dlib's pre-trained network and analyzing their positions to determine the direction of gaze. A proposed cheating detection approach involves developing a browser plugin for online proctoring equipped with eye gaze tracking functionality. This plugin controls browser and application usage during exams, locks the browser to the exam tab, and continuously monitors the user's gaze through the webcam. The collected eye gaze data is preprocessed to classify gaze points and calculate elapsed time for state changes, creating a dataset for anomaly detection using a One-Class Support Vector Machine (OCSVM). Participants are guided to calibrate the eye tracker before exams, and visualization techniques used for data analysis are scatter plots and fixation-based heat maps (Dilini et al., 2021). Another system integrates various AI-based techniques to create a comprehensive online exam invigilation solution. The students enroll through facial recognition for attendance marking that is stored in a CSV file for authorities' access. Gaze and mouth monitoring features ensure students' focus and detect any attempts to refer to external materials or communicate during exams. Background analysis using YOLOv3 detects and alerts authorities about unauthorized objects in the exam environment. The implementation utilizes LBPH algorithm for attendance marking, Dlib for facial key point detection, and OpenCV for gaze and mouth monitoring (Thampan et al., 2022).

4.4.3. Pose Detection

Pose detection techniques are used to detect body movements and positions. These techniques examine the posture and movements of body parts to identify

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Page No: 2412 - 2428
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behaviors that may indicate cheating, such as unusual head or hand movements. Various developed techniques for pose detection are OpenPose, Media Pipe. OpenCV's DNN module for head pose detection (Saurav et al., 2021). Samir et al. (2021) proposed a system that employs a combination of advanced computer vision techniques and machine learning algorithms to monitor and analyze students' behavior during exams. Using Human Pose Estimation, specifically the Tensor flow-PoseNet model, the system tracks key body points such as the head and wrists to detect abnormal head angles and hand movements that may indicate cheating behaviors such as paper trading or looking at neighboring papers. It continuously analyzes real-time video footage captured by cameras positioned in front of students.

4.5.Network and System Monitoring

Network and system monitoring in online examination include tracking and analyzing network traffic, device usage, and other system activities to detect unauthorized access or suspicious behavior. Network and system monitoring techniques are basically categorized as:

4.5.1. Network Traffic Analysis

The network traffic analysis during online examination is performed to detect unauthorized access to online resources or communication between students and monitors data chunks communicated over the network during the exam. From the monitored data chunks, patterns are analyzed to identify connections to cheating websites, collaboration tools, or external parties. The techniques used for traffic analysis are Wireshark, NetFlow, PRTG Network Monitor. Siyao & Qianrang (2011) introduced an ActiveX control designed to prevent cheating through network access or illegal local operations during the exam. This control monitors and disables forbidden processes, restricts program switching, and restores disabled functions after the examination ends. Moten Jr. et al. (2013) designed an online examination system that monitors the network traffic using a kismet server during the exam. The monitored data can then be analyzed to determine the frequency of URLs accessed by students. If any URLs is frequently accessed or very rarely accessed, it could be considered an attempt to cheating.

4.5.2. System Monitoring

System monitoring is the technique to uniquely recognize devices accessing the examination process. Browser information and device configuration (such as screen resolution, installed plugins, time zone, etc.) are used for monitoring of the system during examination.

4.5.3. IP Address Detection

IP address detection is the method to verify the physical address of the response submitting computer/ device of the examinee. Uses IP addresses and GPS data to ensure students are taking the exam from an expected and individual computer. Most learning management systems allow the instructor to view IP addresses. Therefore, if different students submit their assessments by the same IP address in a short time frame, it could be detected and considered as a sign of collusion (Moten et al., 2013).

5. Cheating Prevention Techniques

Cheating prevention refers to avoidance of the cheating activities before the start of examination. The prevention of cheating requires the majors of cheating to be known prior to the start of examination. These methods actually help in designing and conducting the examination with constraints such that the potential cheaters are not able to break the security and various verification processes. The policies made by the exam conducting bodies or govt. for involvement in the cheating activities also helps in reducing and preventing the exams from these activities.

5.1.Exam Design Techniques

Exam design techniques refers to the methods to structure the question paper in a way such that no two neighboring candidates gets a similar question paper. Different techniques have been proposed through the research studies. Randomization of questions works in the exam where the candidate’s areseating in a common place, one after another. Time limit on each question works only in case the candidate is attempting the paper on screen, this technique cannot work on a pen paper based proctored exam. Some of the important studies are explained below: Chua et al. (2019) describedDistribution Algorithm, which ensures that each exam taker receives a unique set of questions by generating keys for one-time use, thus

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 02 Issue: 09 September 2024
Page No: 2412 - 2428
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2024.0331

preventing identical question sets within an examination.Following the Royce Model, the system undergoes preparation, development, validation, modification, and evaluation stages.Mistry et al. (2022)proposed a system that employs Flask Blueprint to structure the application into separate modules for admin,faculty, and student functionalities. HTML forms are utilized for user interfaces, while jQuery enhances security by preventing users from exiting full-screen mode during exams. Data management is streamlined using Excel for importing and exporting data, simplifying administrative tasks.

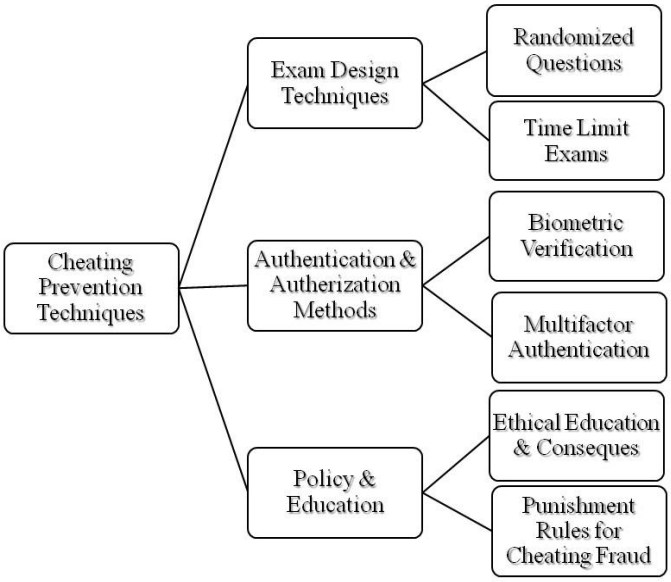

Figure 5 Different Types of Cheating Prevention Techniques in Online Examination

5.2.Authentication and Authorization Methods

The candidates appearing for the examination must go through their identity verification process and these candidates then authenticated as well as authorized to appear in the examination hall. No candidate will be permitted to enter the exam hall without authentication. The user verification process can be of biometric or multifactor. The studies related to these are: Number of studies have been considered biometric authentication for user verification. In the biometric authentication process, the fingerprints of the candidate are taken while registering for the examination. The same process is followed on the exam day prior to the start of examination. if the fingerprints match with the actual fingerprints recorded at the time of registration, the candidate is authorized to attempt the examination otherwise the candidate is denied to enter the exam hall. Hence, impersonation type of cheating is prevented using the method (Abbasi et al., 2011). In multifactor authentication, the authentication process requires more than one factor of verification, like fingerprints and iris scan both are recorded first and then the recorded factorsare verified at the exam day as done by the Board of School Education Haryana for conducting Haryana Teacher Eligibility Test (HTET).

5.3.Policy Formation and Education

The education about ethics in academic integrity and policies formed for cases of cheating and fraud in examination helps in reducing the cheating activities (Korman, 2010). Thecentral and state govt. can make strict rules and laws for acting against cheating activities. The education on the moral and ethical values course during the academic programs also helps in prevention of cheating by making the students aware about consequences of cheating in examinations (Korman, 2010). Another way to reduce and prevent cheating by declaring the cheating policy for examinees prior to stat of examination. Giving instructions and warnings to the examinees about the consequences of being caught cheating helps reduce the cheating motivation. The results of such two experiments showed significant improvement in lowering the cheating cases as this method decreased the number of cheatings by 50% (Corrigan-Gibbs et al., 2015).

6. Case Study

Due to the covid-19 pandemic and various online courses run by the universities as well as digital learning shifted the traditional offline/ physical mode examination system to the online system. The online examination system has benefited both the examination governing body as well as the examinee in some aspects but it has various consequences as well. In the wake of covid-19, most of the educational bodies including universities and colleges has conducted their annual or semester exams in online mode because the physical presence was not possible in that scenario. This paper has found some of the

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 02 Issue: 09 September 2024
Page No: 2412 - 2428
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2024.0331

cases where the online examination has been conducted.

6.1.Case Study of CRSU,Jind

A state university named Chaudhary Ranbir Singh University, situated in Jind district of Haryana state in India has conducted their semester examination in online mode from 2020 to 2021 academic sessions. The university used the Proctored Online Examination System for monitoring the students during the exam. The Proctored Online Examination system used by the university has web camera and audio mic-based monitoring system. The exam taker has to sit in front of the computer system equipped with a microphone and a web cam, after that the examinee login to the examination system portal using their credentials provided by the university. The university has also instructed to hang a mirror at the wall behind the seating of the examinee in order to capture the background and to find any movement of either a person or object in the room of the examinee (Kumar, 2024).

6.2.Implementation of Proctored Based Online Examination System

The 'Proctored Online Examination System' has been actually adopted by the university to facilitate the students to write their academic exams from their homes when the physical presence in the college or university has been denied due to lockdown. The question paper of the concerned subject then uploaded by the master exam controller system admin on the online exam portal for the examinee. The 'Proctored Online Examination System' continuously monitored the examinee and captured both the audio as well as video of the examinee during the whole period of the exam. The Proctored Examination System has facilitated with the automatic cheating detection mechanism where if any unethical activity of unwanted movement by the examinee or presence of another person in the room is detected, a warning message is generated for the first time and for the subsequent activity, an unfair means case has been filed against the examinee (Kumar, 2024). The university examinations were conducted using the 'Proctored Online Examination System' for all the affiliated colleges and university teaching departments. Although the system used by the university for conducting the examinations in online mode was a success as compared to previous methods, however the system encountered some challenges and issues in conducting the cheating free examination.

6.3.Challenges and Limitations Encountered

'Proctored Online Examination System' used by CRSU, Jind has many limitations encountered during the online examinations conducted by the university. A large number of UMC cases were filed against the candidates due to unethical use of the examination system (Kumar, 2024). The main problems faced by the conducting body in the online examinations were:

a) The 'Proctored Online Examination System' has been developed/ adopted by the university for the students to write their exams from an isolated room in their respective homes but the candidates were found writing their papers from private common study centers/ libraries/ computer labs and hence degrading the integrity of the examination.
b) 'Proctored Online Examination System' lacked the biometric authentication of the candidates and hence the authenticity of the candidates were not verified if the candidate writing the paper is the same who enrolled in the academic program.
c) Another major problem faced by the 'Proctored Online Examination System' is the lack of IP address detection that allowed the cheaters to open the uploaded question paper at another computer/ device and write the sheet for the candidate who appeared present in front of 'Proctored Online Examination System' during the exam time.
d) 'Proctored Online Examination System' lacked the facility of keyboard locking and browser locking/ window/ tab lacking after uploading the question paper that allowed the potential cheaters to surf the internet or web to find the answers or share the paper to others to seek help.

7. Comparative Analysis

The various research studies have been done across the world for detection and prevention of cheating in online examination have similarities as well as uniqueness in type or procedure for detection of cheating. The comparative analysis of these studies is

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 02 Issue: 09 September 2024
Page No: 2412 - 2428
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2024.0331

given below in the table. [36-39]

7.1.Comparison of Different Techniques

A number of techniques for detection and prevention of cheating in online examinations has been developed in last decade to combat the cheating fraud in the online examinations conducted by the various bodies around the world. The table shows the types and features used by various researchers in their study to detect and prevent cheating and maintaining the academic integrity of the online examinations.

Table 1 Various Research Studies for Cheating Detection and Prevention Techniques

Title of Study	Author & Year	Detection/ Prevention	Biometric/ User verification	Continuous monitoring	Eye/ Gaze monitoring	Pose Detection	Object Detection	Active Window	Browser /Tab locking
A Novel Framework for Online Exams during the Pandemic of COVID-19: Evaluation Methods, Students' Priorities and Academic Dishonesty in Online Exams	(Dayananda et al., 2021)	Detection And Prevention	Yes	Yes	No	No	No	No	No
AI-Based Proctoring	(Saurav et al., 2021)	Detection and Prevention	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Automated CheatingDetection in Exams using Posture and Emotion Analysis	(Nishchal et al., 2020)	Detection	No	Yes	No	Yes	No	No	No
Automated Online Exam Proctoring System Using Computer Vision and Hybrid ML Classifier	(Hossain et al., 2021)	Detection	No	Yes	Yes	Yes	No	No	No
Automated Online Proctoring System Using Gaze View Tracking and Custom Object Detection	(Li & Li, 2022)	Detection	No	Yes	Yes	Yes	Yes	No	No
Automated Proctoring System using Computer Vision Techniques	(Maniar et al., 2021)	Detection	No	Yes	Yes	Yes	Yes	No	No
Bluetooth Camera based Online Examination System with Deep Learning	(Gupta & Bhat, 2022)	Detection	No	Yes	No	Yes	Yes	No	No
Cheating Detection in Browser-based Online Exams through Eye Gaze Tracking	(Dilini et al., 2021)	Detection	No	Yes	Yes	No	No	Yes	Yes
Exam Cheating Detection System with Multiple-Human Pose Estimation	(Samir et al., 2021)	Detection	No	Yes	No	Yes	No	No	No
Identifying potential cheaters by tracking them behaviors through mouse activities	(Sokout et al., 2020)	Detection	No	Yes	No	No	No	Yes	No
Online Exam Monitoring System based on Factor analysis (FA) Method	(Alkilani &Nusir, 2022)	Detection	No	Yes	No	Yes	No	No	No

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 02 Issue: 09 September 2024
Page No: 2412 - 2428
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2024.0331

Online Examination System with Cheating Prevention Using Question Bank Randomization and Tab Locking	(Chua et al., 2019)	Detection and Prevention	No	Yes	Yes	No	No	No	Yes
Performance Analysis of Machine Learning Models for Cheating Detection in Online Examinations	(Atoum et al., 2017)	Detection	No	Yes	Yes	Yes	No	No	No
Proct-Xam – AI Based Proctoring	(Monteiro et al., 2022)	Detection	No	Yes	Yes	Yes	No	Yes	No
An Incremental Training on Deep Learning Face Recognition for M-Learning Online Exam Proctoring	(Ganidisastra& Bandung, 2021)	Detection	No	Yes	No	Yes	No	No	No
Automated Online Exam Proctoring	(Hossain et al., 2021)	Detection and Prevention	Yes	Yes	Yes	Yes	Yes	Yes	No
Smart Online Exam Invigilation using AI based Facial Detection and Recognition Algorithms	(Thampan et al., 2022)	Detection	Yes	Yes	Yes	Yes	Yes	No	No
The Research on Anti-Cheating Strategy of Online Examination System	(Siyao&Qianrang, 2011)	Detection and Prevention	No	No	No	No	No	Yes	Yes
Tracking Input Devices to Detect Cheating Using Machine Learning Techniques	(Sarmiento et al., 2023)	Detection	No	Yes	No	Yes	Yes	Yes	Yes

Conclusion and Future Research Directions

The paper concludes that cheating is an unethical activity and widely spread throughout the academic institutions across the universe as far as the online examinations are considered. After reviewing different research articles in the literature, we concluded that there are various forms or types of cheating availed by the examinee during the online examinations. Some of the main cheating categories are impersonation, use of unauthorized devices, sources from the internet, capturing or hacking of the device to attempt paper by someone other than the actual examinee. Furthermore, the paper concludes that from a large number of researches conducted to combat cheating activities in the online examinations, some of the most useful techniques are, the proctor based automatic cheating detection and prevention techniques, web cam-based video capturing in real time/ recorded proctoring, computer vision techniques, eye/ gaze tracking, have shown good results in detection of cheating activities in the online examinations. The paper also concluded that the cheating prevention techniques like question order randomization and biometric verification before the start of examination. The education and policy formed for cheating fraud has shown great response in prevention of the fraud. Lowering the cheating motivation has more relevance in prevention of cheating and this can be enhanced by the exam conducting bodies and their policies for cheating cases. The examination bodies need to be more responsible in reporting the suspected cases of cheating to help prevent the cheating in future examinations. The research studies conducted for detection and prevention of cheating fraud have shown some limitations. The cheating detection process need to address all of the detection methods (impersonation, object detection, face/ pose detection, live remote proctoring, IP address

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 02 Issue: 09 September 2024
Page No: 2412 - 2428
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2024.0331

detection, eye/ gaze detection, signal jamming, audio detection, screen monitoring, active window/ tab detection, browser fingerprinting etc.) of cheating in a single framework for future research and also the privacy concerns of the examinee, who's personal details are shared in the online examination system. Machine learning and artificial intelligence techniques need to be applied on large datasets of examination environment to enhance the accuracy of detecting the suspected cheating cases. The prevention of cheating need to be enhanced more for the university examination system as these offer different exam environment as well as descriptive nature of examination. The biometric authentication techniques can be made multilevel or multiple, depending not only on fingerprints but also on iris scanning or face scanning also.The policies made for online examinations in university need to be framed on strict rules against the cheating fraud.

References

[1]. Abbasi, M. N., Malik, A., Chaudhry, I. S., &Imdadullah, M. A. (2011). Study on student satisfaction in Pakistani universities: The case of Bahauddin Zakariya University, Pakistan. Asian Social Science, 7(7), 209.

[2]. Aggarwal, J. (2005). Essentials of examination system: Evaluation, tests and measurement. Vikas Publication.

[3]. Rajput, H., Rani, R., Singh, N., & Srivastava, P. (2019). Examination system in India and e-governance pattern for university examination system. Agriculture & Food: e-Newsletter, 58–64.

[4]. Dayananda, D., Chathumini, K., &Vasanthapriyan, S. (2021). A novel framework for online exams during the pandemic of COVID-19: Evaluation methods, students' priorities, and academic dishonesty in online exams. In 2021 IEEE 1st International Conference on Advanced Learning Technologies on Education & Research (ICALTER) (pp. 1–4). Lima, Peru: IEEE. https://doi.org/10.1109/ICALTER54105.2021.9675092

[5]. Noorbehbahani, F., Mohammadi, A., &Aminazadeh, M. (2022). A systematic review of research on cheating in online exams from 2010 to 2021. Education and Information Technologies. https://doi.org/10.1007/s10639-022-10927-7

[6]. Korman, M. (2010). Behavioral detection of cheating in online examination. https://pure.ltu.se/ws/files/31188849/LTU-DUPP-10112-SE.pdf

[7]. Holden, O., Kuhlmeier, V., & Norris, M. (2020). Academic integrity in online testing: A research review. https://doi.org/10.31234/osf.io/rjk7g

[8]. Kasliwal, G. (2015). Cheating detection in online examinations (Master's thesis, San Jose State University). https://doi.org/10.31979/etd.y292-cddh

[9]. Yelkar, A. R., Pawar, R. V., Khopkar, D. A., &Ratwadkar, P. P. (2022). Online exam proctoring system. International Journal of Creative Research Thoughts (IJCRT).

[10]. Saurav, S. P., Pandey, P., Sharma, S. K., Pandey, B., & Kumar, R. (2021). AI based proctoring. In V. Srivastava & S. M. Sharma (Eds.), Proceedings of the 2021 3rd International Conference on Advances in Computing, Communication Control and Networking (ICAC3N 2021) (pp. 610–613). Institute of Electrical and Electronics Engineers Inc. https://doi.org/10.1109/ICAC3N53548.2021.9725547

[11]. Hossain, Z. T., Roy, P., Nasir, R., Nawsheen, S., & Hossain, M. I. (2021). Automated online exam proctoring system using computer vision and hybrid ML classifier. In Proceedings of the 2021 IEEE International Conference on Robotics, Automation, Artificial-Intelligence and Internet-of-Things (RAAICON 2021) (pp. 14–17). Institute of Electrical and Electronics Engineers Inc. https://doi.org/10.1109/RAAICON54709.2021.9929456

[12]. Li, B., & Li, E. (2022). Automated online proctoring system using gaze view tracking and custom object detection. In Proceedings of the 2022 IEEE MIT Undergraduate Research Technology Conference (URTC 2022). Institute of Electrical and Electronics Engineers

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 02 Issue: 09 September 2024
Page No: 2412 - 2428
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2024.0331

Inc. https://doi.org/10.1109/URTC56832.2022.10002245

[13]. Monteiro, S., Bhate, R., Sharma, L., & Shaikh, P. (2022). Proct-Xam – AI based proctoring. In Proceedings of the 2022 2nd Asian Conference on Innovation in Technology (ASIANCON) (pp. 1–6). Institute of Electrical and Electronics Engineers Inc. https://doi.org/10.1109/ASIANCON55314.2022.9908817

[14]. Maniar, S., Sukhani, K., Shah, K., &Dhage, S. (2021). Automated proctoring system using computer vision techniques. In Proceedings of the 2021 International Conference on System, Computation, Automation and Networking (ICSCAN 2021). Institute of Electrical and Electronics Engineers Inc. https://doi.org/10.1109/ICSCAN53069.2021.9526411

[15]. Gupta, A., & Bhat, A. (2022). Bluetooth camera based online examination system with deep learning. In Proceedings of the 2022 6th International Conference on Intelligent Computing and Control Systems (ICICCS 2022) (pp. 1477–1480). Institute of Electrical and Electronics Engineers Inc. https://doi.org/10.1109/ICICCS53718.2022.9788147

[16]. Atoum, Y., Chen, L., Liu, A. X., Hsu, S. D. H., & Liu, X. (2017). Automated online exam proctoring. IEEE Transactions on Multimedia, 19(7), 1609–1624. https://doi.org/10.1109/TMM.2017.2656064

[17]. Akif, M. A. H., Roy, K., Abdullah, N., Priota, N. Z., &Onim, M. S. H. (2022). Performance analysis of machine learning models for cheating detection in online examinations. In Proceedings of the 2022 25th International Conference on Computer and Information Technology (ICCIT 2022) (pp. 342–347). Institute of Electrical and Electronics Engineers Inc. https://doi.org/10.1109/ICCIT57492.2022.10055801

[18]. Sokout, H., Purnama, F., Mustafazada, A. N., &Usagawa, T. (2020). Identifying potential cheaters by tracking their behaviors through mouse activities. In Proceedings of the 2020 IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE) (pp. 143–149). Institute of Electrical and Electronics Engineers Inc. https://doi.org/10.1109/TALE48869.2020.9368400

[19]. Nishchal, J., Reddy, S., &Navya, P. N. (2020). Automated cheating detection in exams using posture and emotion analysis. In Proceedings of the 2020 IEEE International Conference on Electronics, Computing and Communication Technologies (CONECCT) (pp. 1–6). Institute of Electrical and Electronics Engineers Inc. https://doi.org/10.1109/CONECCT50063.2020.9198691

[20]. Ganidisastra, A. H. S., & Bandung, Y. (2021). An incremental training on deep learning face recognition for M-learning online exam proctoring. In Proceedings of the 2021 IEEE Asia Pacific Conference on Wireless and Mobile (APWiMob) (pp. 213–219). Institute of Electrical and Electronics Engineers Inc. https://doi.org/10.1109/APWiMob51111.2021.9435232

[21]. Dilini, N., Senaratne, A., Yasarathna, T., Warnajith, N., & Seneviratne, L. (2021). Cheating detection in browser-based online exams through eye gaze tracking. In Proceedings of the 2021 6th International Conference on Information Technology Research (ICITR) (pp. 1–8). Institute of Electrical and Electronics Engineers Inc. https://doi.org/10.1109/ICITR54349.2021.9657277

[22]. Thampan, N., Arumugam, S., &Sasikala, A. (2022). Smart online exam invigilation using AI based facial detection and recognition algorithms. In Proceedings of the 2022 2nd Asian Conference on Innovation in Technology (ASIANCON). Institute of Electrical and Electronics Engineers Inc. https://doi.org/10.1109/ASIANCON55314.2022.9908748

[23]. Samir, M. A., Maged, Y., &Atia, A. (2021). Exam cheating detection system with multiple-

human pose estimation. In Proceedings of the 2021 IEEE International Conference on Computing (ICOCO 2021) (pp. 236–240). Institute of Electrical and Electronics Engineers Inc. https://doi.org/10.1109/ICOCO53166.2021.9673534

[24]. Siyao, L., &Qianrang, G. (2011). The research on anti-cheating strategy of online examination system. In Proceedings of the 2011 2nd International Conference on Artificial Intelligence, Management Science and Electronic Commerce (AIMSEC) (pp. 1738–1741). Institute of Electrical and Electronics Engineers Inc. https://doi.org/10.1109/AIMSEC.2011.6010689

[25]. Chua, S. S., Bondad, J. B., Lumapas, Z. R., & Garcia, J. D. (2019). Online examination system with cheating prevention using question bank randomization and tab locking. In Proceedings of the 2019 4th International Conference on Information Technology: Encompassing Intelligent Technology and Innovation Towards the New Era (InCITE) (pp. 1–5). Institute of Electrical and Electronics Engineers Inc. https://doi.org/10.1109/InCITE46411.2019.9076383

[26]. Mistry, K., Patel, M., & Prasad, B. (2022). Anti-cheating online examination system using image and audio analysis for remote test invigilation. In Proceedings of the 2022 6th International Conference on Computing Methodologies and Communication (ICCMC 2022) (pp. 1443–1446). Institute of Electrical and Electronics Engineers Inc. https://doi.org/10.1109/ICCMC53470.2022.9753854

[27]. Corrigan-Gibbs, H., Ford, B., & Chuang, J. (2015). Examining online cheating in online courses. In Proceedings of the 2015 ACM Conference on Learning at Scale (pp. 233–236). https://doi.org/10.1145/2724660.2724661

[28]. Moten Jr., J., Fitterer, R., Brazier, E., Leonard, J., & Brown, A. (2013). Examining online cheating in online courses. E-Learn: World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education.

[29]. Jisc. (2020). COVID-19 has accelerated digital transformation in HE. https://www.jisc.ac.uk/news/covid-19-has-accelerated-digital-transformation-in-he-22-jun-2020

[30]. Hodges, C., Moore, S., Lockee, B., Trust, T., & Bond, A. (2020). The difference between emergency remote teaching and online learning. Educause Review. https://er.educause.edu/articles/2020/3/the-difference-between-emergency-remote-teaching-and-online-learning

[31]. Universities UK. (2020). What will higher education look like in September? https://www.universitiesuk.ac.uk/what-will-higher-education-look-september

[32]. Educause Review. (2020). 7 things you should know about the difference between emergency remote teaching and online learning. https://er.educause.edu/articles/2020/3/7-things-you-should-know-about-the-difference-between-emergency-remote-teaching-and-online-learning

[33]. Bawa, P. (2020). Retention in online courses: Exploring issues and solutions—A literature review. SAGE Open, 10(1), 215824401989879. https://doi.org/10.1177/2158244019898797

[34]. McCabe, D. L., Butterfield, K. D., &Treviño, L. K. (2012). Cheating in college: Why students do it and what educators can do about it. Johns Hopkins University Press.

[35]. International Center for Academic Integrity. (2020). The fundamental values of academic integrity (3rd ed.). https://academicintegrity.org/resources/fundamental-values

[36]. Newton, P. M. (2016). Academic integrity: A quantitative study of confidence and understanding in students at the start of their higher education. Assessment & Evaluation in Higher Education, 41(3), 482–497. https://doi.org/10.1080/02602938.2015.1024199

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 02 Issue: 09 September 2024
Page No: 2412 - 2428
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2024.0331

[37]. Alkilani, A. H., &Nusir, M. I. (2022, May). Online exam monitoring system based on factor analysis (FA) method. In 2022 19th International Multi-Conference on Systems, Signals & Devices (SSD) (pp. 1568–1574). Sétif, Algeria: IEEE. https://doi.org/10.1109/SSD54932.2022.9955912

[38]. Sarmiento, M. J. F., Lopez, V. A., Altoveros, L. A. D. R., Tiosan, J. C. B., Tabo, R. M. R., &Manangat, R. D. M. (2023, May). Tracking input devices to detect cheating using machine learning techniques. In 2023 8th International Conference on Business and Industrial Research (ICBIR) (pp. 519–524). Bangkok, Thailand: IEEE. https://doi.org/10.1109/ICBIR57571.2023.10147616

[39]. Kumar, N. (2024). Case study of the proctored-based online examination system at CRSU, Jind, Haryana (2020–2022).