VIVA-TECH INTERNATIONAL JOURNAL FOR RESEARCH AND INNOVATION
ANNUAL RESEARCH JOURNAL
ISSN(ONLINE): 2581-7280

A Survey on AI Proctoring Systems

Neha Hosbet[1], Aparna Rane[2], Rahul Prajapati[3], Saniket Kudoo[4]
[1](Computer Engineering, VIVA Institute of Technology, Mumbai University, India)
[2](Computer Engineering, VIVA Institute of Technology, Mumbai University, India)
[3](Computer Engineering, VIVA Institute of Technology, Mumbai University, India)
[4](Computer Engineering, VIVA Institute of Technology, Mumbai University, India)

Abstract: *Online examination proctoring has become increasingly crucial with the widespread adoption of remote learning and assessments. This survey paper synthesizes findings from various research efforts focused on enhancing the integrity, scalability, and reliability of online proctoring systems using advanced technologies. The surveyed studies highlight innovative methods such as AI-driven proctoring models, deep learning algorithms, and biometric verification techniques. Key contributions include the integration of YOLO algorithms, Siamese networks, and multimodal biometric systems for real-time cheating detection, alongside client-side processing to reduce server dependency. Furthermore, challenges such as privacy concerns, algorithmic bias, and the need for scalable, cost-effective solutions are critically examined. Approaches like hybrid machine learning classifiers, gaze tracking, and facial activity monitoring demonstrate significant accuracy in detecting dishonest behaviors, while frameworks like Sub-center ArcFace advance facial recognition capabilities. Emphasis is placed on balancing robust security measures with user accessibility and privacy. This survey provides a comprehensive overview of the current advancements in online proctoring technologies, addressing limitations and proposing directions for future research to ensure secure, fair, and efficient online examination environments.*

Keywords *- Academic Integrity, AI, Biometric Authentication, Online examinations, Proctoring Technologies.*

1. INTRODUCTION

The shift to online education, particularly accelerated by the COVID-19 pandemic, has profoundly altered traditional educational landscapes. With the widespread adoption of remote learning, the way students are assessed has evolved, bringing significant advantages in terms of flexibility, accessibility, and scalability. However, this transformation has also introduced new challenges, particularly around maintaining the integrity of online examinations. The lack of in-person supervision has created opportunities for dishonest behaviors, such as cheating, identity fraud, and the use of unauthorized resources during assessments. As a result, ensuring the security and reliability of online exams has become a top priority for educational institutions worldwide. To combat these emerging issues, online proctoring systems (OPS) have been developed as a solution to monitor and regulate students during remote exams. These systems employ a wide range of technologies, including artificial intelligence (AI), machine learning (ML), computer vision, and biometric authentication, to detect suspicious activities and maintain exam integrity. OPS utilize facial recognition, gaze tracking, behavioral analysis, and even device detection to monitor candidates throughout their assessments. These tools have proven effective in detecting a variety of cheating behaviors, such as the use of mobile devices for cheating, the presence of unauthorized individuals in the testing environment, and attempts to impersonate the student taking the exam.

While the technology behind OPS offers considerable potential to enhance the security of online exams, several challenges remain. Traditional human proctoring, though effective, is often too expensive and resource-intensive to scale for large groups of students, especially in remote or resource-constrained environments. As an alternative, automated systems have been developed, leveraging AI-driven algorithms that can analyze real-time video feeds to detect irregularities in student behavior. One such innovation includes the use of YOLO (You Only Look Once) object detection algorithms, which can identify and track suspicious objects or actions during an

exam. Beyond the technical aspects, the implementation of OPS raises significant concerns related to privacy, data security, and the ethical implications of continuous surveillance. Privacy concerns are particularly pressing, as these systems often require the collection and analysis of extensive personal data, including biometric identifiers like facial features, voice, and eye movements. Moreover, the use of AI and ML in monitoring student behavior can inadvertently lead to biased results, particularly if the algorithms are not trained on diverse datasets or if they misinterpret non-threatening actions as suspicious. As such, a balance must be struck between maintaining academic integrity and protecting student privacy and rights. The effectiveness and scalability of OPS are also affected by network limitations and the technical capabilities of institutions. In many cases, schools and universities must contend with issues such as insufficient bandwidth, varying internet speeds, and the need for costly hardware, which can impede the implementation of these systems in less-developed regions or among underprivileged student populations. Additionally, while AI-based systems show promise in detecting cheating in real-time, they are not infallible. The need for continuous updates, training, and monitoring of these systems is paramount to ensure their long-term effectiveness.

In light of these challenges, this paper aims to provide a comprehensive survey of the various technologies and methodologies employed in the design of online proctoring systems. We explore advancements in machine learning, computer vision, and biometrics, highlighting their strengths and limitations. We also address the ethical, privacy, and scalability concerns that accompany the use of these technologies. Finally, by evaluating current solutions and identifying areas for improvement, this paper seeks to offer insights into the future direction of online proctoring, contributing to the development of secure, reliable, and ethically sound assessment systems that uphold academic integrity in the digital era.

2. REVIEW OF LITERATURE SURVEY

Tripty Singh, Rekha R Nair, Tina Babu, Prakash Duraisamy [1], the paper “Enhancing Academic Integrity in Online Assessments: Introducing an Effective Online Exam Proctoring Model using YOLO” presented an Online Exam Proctoring Model that leverages the You Only Look Once (YOLO) algorithm to enhance academic integrity during online assessments. With the rise of online education, cheating has become more prevalent. The proposed model addresses this issue by utilizing advanced computer vision techniques and pre-trained YOLO weights to monitor and detect cheating behaviors. Key features include face orientation, face spoofing detection, mouth tracking, mobile device recognition, and person counting. The system automatically terminates the exam if it detects multiple individuals, mobile devices, or if the student is absent for 10 seconds. This model ensures a secure online exam environment, fostering academic honesty and enhancing the reliability of online assessments.

Devesh Bedmutha, Purva Bapecha, Digambar Chaure, Piyush Boraet [2], the paper “Online Proctoring System: A Client-Side Approach Using Deep Learning” addressed the limitations of existing online proctoring systems (OPS), which rely on server-side processing for suspicious activity detection, often resulting in high costs and server strain. The proposed solution leverages client-side processing to reduce server load and network dependency. Key features include real-time face verification using the Siamese network technique and object detection with MobileNet to identify prohibited items. This approach not only enhances system scalability but also improves proctoring efficiency by reducing bandwidth usage and maintaining consistent video quality. The system also addresses browser extension management and provides support for diverse exam question types.

Sagaya Aurelia, R. Thanuja, Subrata Chowdhury, Yu-Chen Hu [3], the paper “AI-based online proctoring: a review of the state-of-the-art techniques and open challenges” provided a comprehensive overview of various AI-driven online proctoring methods used to enhance the integrity of online examinations. It discusses several technologies, including facial recognition, gaze tracking, and behavior analysis, highlighting their effectiveness in preventing cheating during assessments. The authors explore the current limitations and challenges faced by these systems, such as privacy concerns, the potential for bias in algorithms, and the need for transparent operational guidelines. The paper emphasizes the importance of balancing security measures with user privacy and accessibility to ensure a fair testing environment for all students.

Tejaswi Potluri, Venkatramaphanikumar S, Venkata Krishna Kishore K [4], the paper “An automated online proctoring system using attentive-net to assess student mischievous behavior” addressed the challenges in remote online examinations due to the COVID-19 pandemic. Traditional human proctoring methods are labor-intensive and require substantial infrastructure. This study proposes an AI-based proctoring system called "Attentive-Net" to automate the evaluation process by detecting examinee behavior through video analysis. The system integrates components like face detection, face spoofing detection, and head-pose estimation. Using the CIPL dataset, the authors achieved a high accuracy of 0.87 by combining Attentive-Net, Liveness-Net, and head-pose estimation techniques, demonstrating the system's robustness in real-time environments for identifying cheating and ensuring the integrity of online assessments.

B. J. Ferdosi, M. Rahman, A. M. Sakib, T. Helaly [5], the paper "Modeling and Classification of the Behavioral Patterns of Students Participating in Online Examination" focused on understanding student behavior during online examinations. It presents a comprehensive analysis of various behavioral patterns exhibited by students, aiming to enhance the integrity of online assessments. The authors employ machine learning techniques to model and classify these behaviors, addressing issues such as cheating and disengagement. By collecting data on student interactions during exams, the study identifies significant patterns that can be indicative of academic dishonesty or lack of focus.The findings emphasize the importance of developing effective monitoring systems to ensure fairness in online testing environments. The paper contributes to the field of educational technology by providing insights into behavioral analytics and suggesting improvements for online examination practices. Overall, it highlights the potential for technology to support academic integrity in remote learning settings.

Sanaa Kaddoura, Shweta Vincent, D. Jude Hemanth [6], the paper "Computational Intelligence and Soft Computing Paradigm for Cheating Detection in Online Examinations" investigated innovative methods for detecting cheating in online assessments using computational intelligence and soft computing techniques. The authors propose a framework that integrates artificial intelligence, machine learning, and data analysis to enhance the accuracy and reliability of cheating detection. By analyzing student behavior and response patterns during exams, the study aims to differentiate between legitimate and dishonest actions. The findings underscore the potential of these advanced technologies to strengthen academic integrity in online testing environments, advocating for their broader adoption to ensure fair evaluation standards for all students.

Mohammad M. Masud, Kadhim Hayawi, Sujith Samuel Mathew, Temesgen Michael & Mai El Barachi [7], the paper "Smart Online Exam Proctoring Assist for Cheating Detection" addressed the challenge of preserving academic integrity during online exams, especially in the absence of human proctors. The authors propose an AI-based solution that analyzes video footage from exams to detect cheating through eye movement, head movement, mouth opening, and identity recognition. By transforming video data into multivariate time-series and using deep learning models, the system can classify cheating behaviors with an accuracy of up to 97.7%. The study builds on existing research in proctoring systems and suggests that their approach is cost-effective, scalable, and capable of real-time cheating detection.

Geoffrey T. LaFlair, Thomas Langenfeld, Basim Baig, André Kenji Horie, Yigal Attali, Alina A. von Davier [8], the paper "Digital-first assessments: A security framework" addressed the growing need for secure online assessment practices in educational settings. It presents a comprehensive security framework designed to safeguard digital assessments from various threats, including cheating and data breaches. It propose a multi-layered approach that incorporates technology, policy, and best practices to enhance security. Key components of the framework include user authentication, monitoring mechanisms, and data integrity protocols. The findings emphasize the importance of a proactive security strategy to ensure the reliability and credibility of online assessments, ultimately contributing to a more trustworthy educational landscape.

Santosh Gopane, Radhika Kotecha [9], the paper "Enhancing Monitoring in Online Exams Using Artificial Intelligence" proposed an approach of monitoring during the test that includes subtle micro-expansion detection such as laughter detection, eye gaze tracking to predict applicant's viewing direction, eyes blinking/close duration, and head activity/head movement detection. In proposed paper, the monitoring system includes two main phases i.e., Face identification and verification and Face activity monitoring. FaceNet is used to identify the examinee's face and various algorithms and techniques are used for face activity monitoring.

Sanaa Kaddoura, Abdu Gumaei [10], the paper "Towards effective and efficient online exam systems using deep learning-based cheating detection approach" focused on enhancing online examination systems through a deep learning-based approach for cheating detection. It addressed challenges associated with academic dishonesty in online assessments and presents a framework that leverages deep learning techniques to identify cheating behaviors. The authors evaluate various models and algorithms to determine their effectiveness in real-time monitoring and analysis of student actions during exams. The findings highlight the potential of deep learning and DFT to improve the integrity and reliability of online testing environments, ultimately contributing to more secure and efficient assessment systems.

Delong Qi, Weijun Tan, Qi Yao, Jingfeng Liu [11], the paper "YOLO5Face: Why Reinventing a Face Detector" proposed a face detection system based on the YOLOv5 object detector, named YOLO5Face. It adapts YOLOv5 for face detection by incorporating a five-point landmark regression and using the Wing loss function. The paper presents various model sizes designed for different applications, from large models for high-performance tasks to smaller models optimized for real-time detection on embedded or mobile devices. Through evaluations on the WiderFace dataset, YOLO5Face achieves state-of-the-art performance across all difficulty subsets (Easy, Medium, Hard), outperforming many dedicated face detection models. The system is also open-source, available on GitHub, making it highly accessible for real-world applications.

Zarin Tahia Hossain, Protyasha Roy, Rina Nasir, Sumaiya Nawsheen, Muhammad Iqbal Hossain [12], the paper "Automated Online Exam Proctoring System Using Computer Vision and Hybrid ML Classifier" proposed a low-cost solution for online exam proctoring, addressing the challenges of cheating during online

assessments. The system integrates computer vision and machine learning to monitor students' behaviors using features such as eye gaze, head pose estimation, and audio detection. By leveraging a hybrid machine learning classifier (XGBoost and MLP), the system aims to detect suspicious activities, flagging potential cheating attempts for further review. The approach eliminates the need for expensive hardware and can be scaled efficiently for institutions facing challenges with traditional proctoring systems. The study shows a promising 97% accuracy, offering a cost-effective alternative to existing proctoring solutions.

Mikel Labayen, Ricardo Vea, Julián Flórez, Naiara Aginako, Basilio Sierra [13], the paper "Online Student Authentication and Proctoring System Based on Multimodal Biometrics Technology" presented a novel approach to enhancing online examination security through a multimodal biometrics system. It explored the integration of various biometric modalities, such as facial recognition and voice recognition, to authenticate students and monitor their activities during online assessments. The authors discuss the system's architecture and its effectiveness in reducing the likelihood of cheating by ensuring reliable identification and tracking of students throughout the examination process. The findings highlight the advantages of using multimodal biometrics to bolster the integrity of online exams, providing a comprehensive solution to the challenges posed by remote testing environments.

Faten F Kharbat, Ajayeb S Abu Daabes [14], the paper "E-proctored exams during the COVID-19 pandemic: A close understanding" explored the implementation and effectiveness of e-proctored examinations during the COVID-19 pandemic. It examined the challenges and opportunities of online proctoring solutions in response to the rapid shift to remote learning. The authors analyze various e-proctoring methods and their impact on academic integrity, student performance, and assessment quality. Through qualitative and quantitative research, the findings offer insights into the experiences of students and educators, highlighting the effectiveness of e-proctoring in maintaining exam security while addressing concerns related to privacy and technology accessibility. The study emphasizes the need for refined proctoring strategies to enhance the reliability of online assessments in the future.

Jiankang Deng, Jia Guo, Tongliang Liu, Mingming Gong, Stefanos Zafeiriou [15], the paper "Sub-center ArcFace: Boosting Face Recognition by Large-scale Noisy Web Faces" introduced a novel approach to improving face recognition accuracy through a technique called Sub-center ArcFace. The study focuses on leveraging large-scale, noisy web-sourced facial data to enhance the training process of face recognition models. The authors propose the use of sub-centers within the ArcFace framework to effectively manage and utilize the inherent noise and variability in web images, ultimately leading to better representation and classification of facial features. Through extensive experiments, the findings demonstrate that Sub-center ArcFace significantly outperforms existing face recognition methods, providing insights into the potential of incorporating diverse and extensive datasets to enhance model robustness and accuracy in real-world applications.

2.1 Analysis Table

The following table presents the objective analysis of the research conducted.

2.1 Analysis Table

Title	Technology Used	Advantages	Disadvantages
Enhancing Academic Integrity in Online Assessments: Introducing an Effective Online Exam Proctoring Model using YOLO. [1]	Yolo (You Only Look Once), OpenCV, TensorFlow, MediaPipe and PyAudio, convolutional neural networks (CNN's).	Improved academic integrity, real-time monitoring, scalability and efficient proctoring.	Complex, data privacy issues, and hardware limitations.
Online Proctoring System: A Client-Side Approach Using Deep Learning. [2]	Convolutional neural networks (CNN), cloud storage, react, TensorFlow Object Detection (TFOD),	Reduced server load and efficient bandwidth usage	Dependency on client-side resources and limited real-time capabilities.

	MobileNet and Siamese Networks.		
AI-based online proctoring: a review of the state-of-the-art techniques and open challenges. [3]	Support Vector Machines (SVM), Random Forests, Neural Networks, Convolutional Neural Networks (CNN), OpenCV, speech recognition algorithms, Voice Activity Detection (VAD), keystroke dynamics analysis, behavioral biometrics, image segmentation, feature extraction techniques, k-means clustering, TensorFlow and PyTorch.	Increased accessibility, cost effectiveness, efficiency and enhanced security.	Technical challenges and privacy concerns.
An automated online proctoring system using attentive-net to assess student mischievous behavior. [4]	Attentive-net, FaceNet, liveness-net, Affine transformation and YOLOV3.	Automation and efficiency, reduced false positives, cost-effectiveness, comprehensive malpractice detection, accuracy and reliability.	Less reliable face spoofing accuracy, and cheating can be done via voice.
Modeling and Classification of the Behavioral Patterns of Students Participating in Online Examination. [5]	Logistic regression, MediaPipe library, K-Nearest Neighbor (K-NN), random forest and Support Vector Machine (SVM).	Enhanced behavioral analysis, improved classification, accuracy, effective monitoring and integration potential.	Limited generalizability and dependence on feature selection.
Computational Intelligence and Soft Computing Paradigm for Cheating Detection in Online Examinations. [6]	ResNet CNN, Source-Aware Self-Attention (SASA) algorithm and RNN-GRU model.	Improved accuracy, enhanced ability to handle diverse cheating strategies and increased adaptability to different examination environment.	High computational requirements and limited real-time application.

Smart Online Exam Proctoring Assist for Cheating Detection. [7]	Long Short-Term Memory (LSTM), Convolutional Neural Networks (CNN), and CNN-BiGRU for time-series classification, OpenCV, random forest and logistic regression.	High accuracy (97.7%), real-time cheating detection and scalability.	Potential for false positives and not 100% foolproof.
Digital-first assessments: A security framework. [8]	Computer Vision and psychometric analyses.	Improved security, enhanced integrity and scalable solutions.	High implementation costs and risk of false security assumptions.
Enhancing Monitoring in Online Exams Using Artificial Intelligence. [9]	FaceNet using Multi-Task Cascaded Convolutional Neural Network (MTCNN), Lucas-Kanade algorithm and Support Vector Machine (SVM).	Convenient and affordable and facial expression.	Cheating possible by speaking and unstable result.
Towards effective and efficient online exam systems using deep learning-based cheating detection approach. [10]	Deep CNN and Gaussian-based DFT statistical methods with decision fusion.	Real-time cheating detection, high accuracy, scalability, automation and behavioral analysis.	False positives, and limited contextual understanding.
YOLO5Face: Why Reinventing a Face Detector. [11]	YOLOV5 backbone, convolutional neural networks (CNN), shufflenetv2 backbone, Spatial Pyramid Pooling (SPP) and Path Aggregation Network (PAN).	State-of-the-art performance, versatility, open-source and landmark detection	Limited focus on small faces, lack of paper for YOLOV5 and complex for small-scale projects.
Automated Online Exam Proctoring System Using Computer	Computer vision, XGBoost (Extreme Gradient Boosting) and MLP (Multilayer Perceptron), Librosa,	Cost-effective, high accuracy (97%) and efficiency.	No real-time processing and limitations in dark environments.

Vision and Hybrid ML Classifier. [12]	RealHePoNet model and Canny Edge Detection algorithm.		
Online Student Authentication and Proctoring System Based on Multimodal Biometrics Technology. [13]	Convolutional Neural Networks (CNNS), eigenfaces, FisherFaces, FaceNet, VGGFace, Hidden Markov Models (HMMs), Deep Neural Networks (DNNs), Recurrent Neural Networks (RNNs), Long Short-Term Memory (LSTM), Support Vector Machines (SVM), Random Forests, Haar Cascades, YOLO (You Only Look Once) and Digital Signal Processing (DSP).	Enhanced security, non-intrusive monitoring, automatic proctoring, cloud based solution and user experience focus.	Privacy concerns, technical limitations and cost of implementation.
E-proctored exams during the COVID-19 pandemic: A close understanding. [14]	Online proctoring tools, biometric authentication, video monitoring, AI-based analysis and detection.	Enhanced accessibility for students, reduced risk of cheating compared to traditional online assessments and flexibility in exam scheduling.	Privacy concerns with biometric data, limited contextual understanding of behavior and resource inequality among students.
Sub-center ArcFace: Boosting Face Recognition by Large-scale Noisy Web Faces. [15]	Arcface, sub-center Arcface, SoftTriple, face detection with RetinaFace, OpenVINO toolkit and ResNet (ResNet-50 and ResNet-100).	Improved accuracy, robustness to noisy data, scalability, and enhanced generalization.	High computational cost and privacy concerns with web-sourced data.

3. CONCLUSION

Online proctoring systems have become indispensable in ensuring academic integrity during remote assessments. This survey highlights advancements such as AI-driven models, deep learning techniques, and biometric systems that detect cheating behaviors with high accuracy and efficiency. While these innovations have significantly enhanced the reliability of online exams, challenges like privacy concerns, algorithmic bias, and scalability remain critical. Addressing these issues requires a focus on ethical implementation, transparent frameworks, and improved user accessibility. By leveraging emerging technologies and refining existing methodologies, future research can pave the way for proctoring solutions that are secure, cost-effective, and equitable for diverse educational settings.

ACKNOWLEDGEMENTS

We shall be failing in our duty, if we will not express our sincere gratitude to all those distinguished personalities with the help of whom we have successfully completed our project. My deep gratitude to Dr. Arun Kumar, Principal, VIVA Institute of Technology, who always been playing a great role in all round development of the student. My deep gratitude to Prof. Sunita Naik, The Head of Computer Department and also our project guide Prof. Saniket Kudoo and our project coordinator Prof. Kirtida Naik for her valuable guidance, advice and constant aspiration to our work, teaching and non-teaching staff for their kind support, help and assistance, which they extended as and when required. Last but not the least we wish to thank my team members for providing technical and moral support. We hope that this project report would meet the high standards of all concerned people and we thank them for their continuous co-operation during the whole period of the project enabling enhancement of this project.

REFERENCES

[1] Tripty Singh, Rekha R Nair, Tina Babu, Prakash Duraisamy, Enhancing Academic Integrity in Online Assessments: Introducing an Effective Online Exam Proctoring Model using YOLO, *Procedia Computer Science*, Volume *235*, 2024.

[2] Purva Bapecha, Devesh Bedmutha, Digambar Chaure, et al. Online Proctoring System: A Client-Side Approach Using Deep Learning, *Authorea*. January 15, 2024.

[3] Aurelia, S., Thanuja, R., Chowdhury, S. et al. Retraction Note: AI-based online proctoring: a review of the state-of-the-art techniques and open challenges, *Multimed Tools Appl* (2024).

[4] Potluri, T., S, V. & K, V.K.K. An automated online proctoring system using attentive-net to assess student mischievous behavior. *Multimed Tools Appl 82*, 30375–30404 (2023).

[5] Ferdosi, B. J., Rahman, M., Sakib, A. M., Helaly, T., Modeling and Classification of the Behavioral Patterns of Students Participating in Online Examination, *Human Behavior and Emerging Technologies*, 2023, 2613802, 19 pages, 2023.

[6] Kaddoura, Sanaa, Vincent, Shweta, Hemanth, D. Jude, Computational Intelligence and Soft Computing Paradigm for Cheating Detection in Online Examinations, *Applied Computational Intelligence and Soft Computing*, 2023, 3739975, 23 pages, 2023.

[7] Masud, M.M., Hayawi, K., Mathew, S.S., Michael, T., El Barachi, M. (2022). Smart Online Exam Proctoring Assist for Cheating Detection. In: Li, B., et al. Advanced Data Mining and Applications. ADMA 2022. Lecture Notes in Computer Science(), vol 13087. Springer, Cham.

[8] LaFlair, G. T., Langenfeld, T., Baig, B., Horie, A. K., Attali, Y., & von Davier, A. A. (2022). Digital-first assessments: A security framework. Journal of Computer Assisted Learning, 38(4), 1077–1086.

[9] Gopane, S., Kotecha, R. (2022). Enhancing Monitoring in Online Exams Using Artificial Intelligence. In: Saraswat, M., Roy, S., Chowdhury, C., Gandomi, A.H. (eds) Proceedings of International Conference on Data Science and Applications. Lecture Notes in Networks and Systems, vol 287. Springer, Singapore.

[10] Sanaa Kaddoura, Abdu Gumaei, Towards effective and efficient online exam systems using deep learning-based cheating detection approach, Intelligent Systems with Applications, Volume 16, 2022.

[11] Qi, D., Tan, W., Yao, Q., Liu, J. (2023). YOLO5Face: Why Reinventing a Face Detector. In: Karlinsky, L., Michaeli, T., Nishino, K. (eds) Computer Vision – ECCV 2022.

[12] Z. T. Hossain, P. Roy, R. Nasir, S. Nawsheen and M. I. Hossain, "Automated Online Exam Proctoring System Using Computer Vision and Hybrid ML Classifier," 2021 IEEE International Conference on Robotics, Automation, Artificial-Intelligence and Internet-of-Things (RAAICON), Dhaka, Bangladesh, 2021, pp. 14-17

[13] M. Labayen, R. Vea, J. Flórez, N. Aginako and B. Sierra, "Online Student Authentication and Proctoring System Based on Multimodal Biometrics Technology," in IEEE Access, vol. 9, pp. 72398-72411, 2021.

[14] Kharbat, F.F., Abu Daabes, A.S. E-proctored exams during the COVID-19 pandemic: A close understanding. Educ Inf Technol 26, 6589–6605 (2021).

[15] Deng, Jiankang & Guo, Jia & Liu, Tongliang & Gong, Mingming & Zafeiriou, Stefanos. (2020). Sub-center ArcFace: Boosting Face Recognition by Large-Scale Noisy Web Faces.