Machine Learning Technique for Facial Datasets to Detect Examination Fraudulent Activities in the Online Examination: A Systematic Review Approach

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Abstract— **Online Examination (OE) is the most challenging part of E-Learning (EL) since there is no proper mechanism provided to reduce the OE's fraudulent activities by the students. All the previous research provided different methods to avoid this issue, but those techniques could not be applied due to a few drawbacks of those methods. Recent studies suggested using facial recognition with Machine learning (ML) applications to reduce OE malpractices. This systematic review confirmed that Convolutional Neural Networks (CNN) can be applied to identify students' facial recognition with the help of the CK+ dataset compared to other ML techniques and datasets. Furthermore, future research can be conducted to develop an automated OE proctoring system in real-time. It is noted that this study could not be included a few more recent study results due to no funding. Also, there are no studies found related to this study for comparison of ML techniques and datasets.**

Keywords— CNN, Machine Learning, Online Examination, E-Learning, Malpractices.

I. INTRODUCTION

E-Learning is the most suitable alternative to continuing education as per the planned academic calendar. And the assessment is the way to ensure the quality of education. In that sense, after the COVID pandemic, conducting the online examination (OE) is the major challenging part due to the sudden movement of E-Learning around the world since the online examination provides many ways for examination malpractices [1]. Not like face to face examinations, online examinations have a lot of challenges such as power interruption, stable internet connectivity, digital device familiarity, examination place, proper invigilation methods, and a few more [2]. But, online examination invigilation is the most challenging issue faced by the educational sectors and supervisors or invigilators, and no proper digitalized examination proctoring system has yet been developed.

Different educational organizations follow different methods to reduce OE fraudulent activities such as the dynamic profile question approach [3] and AI-based OE Protecting [4], [5] but again these methods did not provide a better outcome as expected due to data privacy & security issues, cost, and not suitable for all course works. Furthermore, some educational institutes use ZOOM live in-person invigilation which makes another headache for the staff as the staff needs to concentrate on the live video continuously. In addition to t, few institutes use recorded video invigilation where the staff needs to watch the recorded videos to identify the abnormal behavior of the students after the examination is completed.

None of the above methods and developed systems considered students' abnormal facial features to identify examination fraudulent activities. Researchers have used various machine learning algorithms to recognize facial expressions [6], but all such researchers have used only one particular machine learning technique. Therefore, this review study is conducted to find a machine learning technique that predicts human facial expressions with high accuracy and in less time by reviewing such research. Further, this study examines to find the most suitable image dataset to train the model which will develop by the selected machine learning technique.

This study was developed using a systematic review process to reach the required decision. In the next section, the

methodology was explained, followed by the literature review and discussion together. Finally, a conclusion was drawn by including major findings, limitations, and future research directions.

II. METHODOLOGY

This review study concentrated on identifying the most suitable ML technique for facial expression recognition. It was done by the systematic review process to collect the required data and used qualitative methods to analyze the collected data. A review of literature is the process of creating questions, locating published articles, evaluating the research quality, summarizing required evidence, and debating the conclusions in order to form a new notion [7].

A. Creating Research questions (RQ):

The following table I shows the developed RQs according to the author's motivation for this research.

TABLE I: RQS AND MOTIVATIONS

S.No	RQs	Motivations
1	What is the most suitable ML technique for facial recognition identification?	Researchers have used different ML techniques but they did not show a comparison of the other ML techniques.
2	What is the most suitable freely available face dataset to train and test the developed ML model?	Previous studies have used maximum of three face datasets for training and testing purposes. But, there are many more different face datasets freely available on the internet and it is important to find the face dataset that shows a higher accuracy level.
3	What are the issues that have been faced by the supervisors and invigilators during OE?	Develop new research directions in the EL environment with the use of ML.

B. Article selection:

There were 33 research articles were selected from 107 articles published after 2018 and these articles were downloaded only from world-renewed reputed publishers such as IEEE, Springer, Emerald, ACM Library, Science direct, Elsevier, and Taylor & Francis. And the keywords machine learning, facial expression, online examination, e-learning, examination malpractices, examination fraudulent activities, and online examination invigilation were used to search the articles with the Boolean operations such as AND, and OR. Furthermore, the following Fig. 1 shows the conditions st the required articles. Selected research journal articles have been divided into four categories to reach the answers to the RQs and find new research directions. Those are, issues in OE, OE systems & applications and their limitations, proposed solutions for facial expressions identification, and ML for OE supervision purposes.
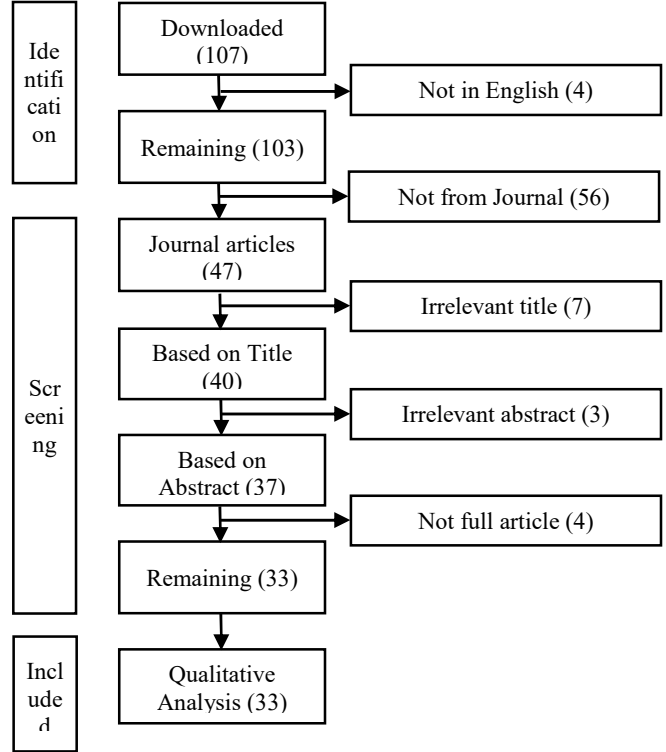

Fig. 1. Classification Diagram For Article Selection

III. REQUIRED RESULTS FROM PREVIOUS WORKS

This section summarizes previous studies by categorizing them into four sub-sections from 1 - 4 to select the most suitable ML technique to develop a model and a dataset for training & testing to check the validity of the developed model since the machine learning approach with facial recognition technology can be used to verify human faces [8].

A. Issues in Online examination

A review study by [9] mentioned that despite many advantages of e-learning, improper training of e-learning tools, internet connectivity, the financial burden to buy new equipment, no proper place for study at home, improper supervision method, and copyright issues are the major issues that arise while conducting online examinations. Similarly, researchers [2] pointed out that, impersonation and abet are affecting the security of online examinations. Apart from the previous studies here, a study based on internet data in Spain by [1] showed that students tried to cheat in online examinations during the pandemic period lockdown compared to traditional examination methods before the pandemic.

A review article by [10] stated that student stress and anxiety level decreases in the online examination despite both online examination and traditional examination methods representing the same student performance. Furthermore, the need for the online examination is reduced due to the expected system features such as keystroke, user

authentication, movement, sound, ease of use, and technological skills. On the contrary, a systematic review study by [11] strongly proposed reducing the use of online examination proctoring software to find examination malpractices since it is creating a distrusting relationship between students and staff because students do not feel comfortable with being supervised by third parties instead of their teachers. Also, the authors advise conducting different examination methods such as home-taking assignments or open book methods rather than online examinations. Apart from the above, a review work by [12] based on the categories of cheating reasons, cheating types, cheating detection, and cheating prevention concluded that examination cheating cannot be prevented only by technologies but the cheating motivations need to be addressed to prevent any examination malpractices.

B. Online examination proctoring systems & apps and their limitations.

A statistical study by [3] supported that impersonation through Instant Messaging apps, Emails, Phone calls, and Remote Desktop Sharing in online examinations can be significantly reduced by the dynamic profile question approach, but, this study did not study any other major malpractices in the online examination. Researchers [12] mentioned that the Recurrent Neural Network was used to develop an algorithm to check the pre-exams results and the final examination results to find the abnormal examination scores of the student in the online examination; which shows higher accuracy as expected but this system cannot be used in real-time.

A study by [4] revealed that AI-based online examination Protecting (AIPS) tools serve as in-person invigilation; meanwhile, it is said that the same AIPS can raised a lot of security, privacy, and higher cost. In addition to that, [13] concluded that the OE protection systems based on webcams significantly decreased the examination fraudulent activities among the students, but the same system reduces student performance because the students feel stress and anxiety due to the webcam recording students' activities during the examination. Instead, a study in the US by [14] confirmed that there is no difference in students' examination performance in both Online live KIOSK examination protection methods via webcam video surveillance and the traditional on-site examination invigilation method.

Apart from these above all, a study by [15] mentioned that the Erasmus+ KA strategic partnership project OP4RE discussed existing issues in the online examination such as data privacy & data protection, extra cost for additional/ re-sit test-taker of online examination software, malfunctioning of the software that can arise in the future, limitations, unresolved cheating methods in the OE proctoring software, and language barriers for the test-takers; furthermore, it was confirmed that anxiety of test-taker due to the online

protecting software can be significantly reduced after the first attempt of using online examination software.

A study by [5] discussed major OE systems such as ProtectU, Respondus, Proctorio, and AIProctor's features, and limitations, and proposed a few guidelines for the future development of online examination systems; furthermore, all of these protection software were analyzed user perception with a few selected university staff. All the software included a few similar functionalities except for the facial expression identification of students while cheating on exams. In the same study, the authors mentioned that OE protection can be done in different ways such as live protecting, recorded protection, and automated protection, but automated proctoring can be the most efficient way compared to the other two methods.

C. Proposed or implanted solution for facial emotion recognition and identification.

A review study by [16] confirmed that facial recognition technology is highly acceptable to identify individuals in terms of cost-effectiveness and accuracy rate compared to other biometric methods, furthermore, this study has compared different facial recognition methods and facial recognition applications from 1972 to 2019 their pros and cons. Also, [17] discusses the importance of facial recognition for a person's identification through Artificial Intelligence (AI). Table II is showing the facial recognition techniques used or proposed in the previous studies, the data set used to train the computer if any, results, and limitations & future directions if any. Furthermore, a research study by [13] confirmed that the CNN-based model called VGGF can be used to identify human faces facially by testing the Brazilian FEI and uncontrolled LFW datasets.

TABLE II. SUMMARY OF MACHINE LEARNING TECHNIQUES AND DATASETS FOR FACIAL EXPRESSION RECOGNITION

Techniques used or Proposed	Data set	Result	By
Convolutional Neural Network. (CNN)	Olivetti Research Laboratory (ORL)	CNN shows higher accuracy with a higher number of training datasets compared to other Machine Learning (ML) techniques.	[14]

Technique	Dataset	Accuracy	Ref.
CNN Support Vector Machine (SVM) Deep Neural Network (DNN) Random Forest (RF)	Real data from K-12 virtual school students.	93.3% 84.68% 86.09% 84.96%	[15]
DCNN	ORL CMU-PIE	91.28%	[16]
Pure CNN	AFW PASCAL face FDDB WIDER face	99.87% 99.23%	[17]
CNN	BAUM-1s CK+	This article measure the time consuming for facial recognition and CK+ showed quickest response compared to BAUM-1s	[18]
CNN Sparse Representation Classifier (SRC) Dropout	Extended YALE B AR MIT faces ORL faces	99.17% 95.85%	[19]
CNN local binary patterns (LBP)	ORL YALE B CBSL INRIA	100% 97.5% 96.3% 89.2%	[20]
Covariance Matrix of Gabor Wavelet (LCMoG)-CNN Log-Euclidean WPCA Z-score standardization (LCMoG-LWPZ)	FERET (200) Ext Yale-B standard FERET MoBo & YouTube LFW	88.83% 98.29% 98.41% 96.62% 95.32% 83.88%	[21]
Attention mechanism (ACNN).	Facial expression dataset in the presence of real occlusions (FED-RO) AFFECTNET CK+	85.07% 58.78% 97.03%	[22]
CNN L2-GraftNet ASO algorithm	CUI-EXAM	93.88%	[23]

D. ML for online examination supervision purpose

A review study by [29] revealed that ML such as CNN [32] can be used for EL activities such as attendance, online classes, predicting student performance, and examinations (scheduling, finding examination malpractices, authentication, and protecting), even though there are a few drawbacks such as privacy, security, and fairness.

Authors [24] proposed a CNN-based system to detect examination fraudulent activities during online examinations by checking their facial expressions such as smiles, angry and natural poses. Similarly, a review study by [25] concluded that ML techniques, AI, and Image processing techniques are the most emerging technologies that can be used to significantly reduce examination malpractices, where this study considered eight research questions according to the selected articles in various regions, developed applications, datasets, and techniques. Furthermore, another research conducted to develop a system using some ML techniques to identify examination malpractices by analyzing students' head pose and gaze estimation during online examinations, where the proposed system showed an accuracy of 96.04%.

IV. DISCUSSION

Based on the above study, there are many new research directions found in terms of facial recognition and face identification but this study focuses on identifying the most suitable ML technique for facial expression recognition such as nervousness or fear using the utmost selected machine learning algorithm with freely available datasets on the internet to identify examinational fraudulent activities. Researchers [33] confirmed that the ML can be used to identify human emotions. Further, research work by [7] said that, whenever an e-learning system is developed, it is to be planned by considering both student and staff perceptions for easy use and a secure way to conduct learning and assessments.

There are various issues such as technical issues, data privacy & protection, students' perception of depending on third-party software, and user-friendliness in using online examination proctoring tools [34]. But it is of the utmost requirement to develop any automated tool to maintain the quality of examination, reduce supervisor stress, and remove the unbiasedness in online examination since the emerging technologies allows to remove all the above issues. Also, the institutes need to find the cheating motivations too rather than always depending on the technologies.

There are various methods proposed and tested for OE proctoring which is including a few automated and AI-based

software. But none of these solutions were not successful as expected since few of them are based on regional-based and all the developed or proposed methods showed security issues and over cost. But, none of the above methods and software used facial recognition methods to identify online examination malpractices. Furthermore, students feel uncomfortable while sitting in front of a third party software while writing exam.

According to table II, it can be summarized that different ML techniques can be used to recognize the facial expression of a human with the help of different data set but, different techniques showed different accuracy level for different data sets. Although, CNN showed not only higher accuracy but also quick processing time for training & testing with the different data sets. In addition, the majority of the research works used CK+ data set due to the higher number of images from different national's facial expressions and showing higher accuracy rate with ML techniques compared to other facial datasets.

Based on this study, there are a few new research that could be conducted in the future for EL such as developing a CNN-based OE proctoring system for real-time facial datasets and analyzing students' emotions by detecting their facial expressions during EL.

Apart from the above, there were a few limitations arises while conducting this study such as a few open access journal articles were only available, less research conducted on OE and its related contents, could not find any implementation research papers for detecting OE malpractices that based on ML techniques for facial expressions, and no funding available for purchase some journal articles.

V. CONCLUSION

EL is the most possible solution to continue education in any pandemic situation, but there is an issue with handling OE examinations due to improper invigilation mechanisms. This leads to unfair results for the students and increases the stress level & health issues of staff while supervising students continuously during the OE period. There are many solutions provided to reduce OE fraudulent activities but those mechanisms are having some drawbacks such as data privacy & security, higher cost, a limited number of students only can join at the same time, no user-friendliness, not suitable for all types of courses, and a few more. Some of the research concluded that facial expressions can be used to identify examination malpractices but there is no unique ML technique provided to accurately recognize students' facial expressions. Therefore, this study confirmed that CNN provided a quick and higher accuracy rate for facial recognition compared to other ML techniques while the CK+ dataset is most used by the researcher for facial recognition compared to other free facial dataset to train the models developed by CNN or ML. Further, the future research study

can be developed an automated OE proctoring application for real-time facial data based on CNN as well students' emotions detection during OE. In addition to that, this study could not find implementation related journal articles due to no funding. Also, no article found related to ML techniques and real-time data.

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