New Detection Cheating Method of Online-Exams during COVID-19 Pandemic

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Abstract
A novel approach for the detection of cheating during e-Exams is presented here using convolutional neural networks (CNN) based systems. This system will help the proctors to identify any kind of uncertain event at the time of online exams, for which most of the government's across the globe are recommending due to the Covid-19 pandemic. Most of the institutions and students across the globe are badly affected by their academic programs and it is a challenging task for universities to conduct examinations using the traditional methods. Therefore, the students are attending most of their classes using different types of third party applications that are available online. However, to conduct online exams the universities cannot rely on these service providers for a long time. Therefore, in this work, a complete setup of the software tools is provided for the students, which can be used by students at their respective laptops/personal computers with strict guidelines from the university. The proposed approach helps most of the universities in Saudi Arabia to maintain their database of different events/activities of students at the time of E-Exams. This method proved to be more accurate and CNN based detection proved to be more sensitive with an accuracy of 97% to detect any kind of uncertain activity of the students at the time of e-Exam.
Keywords *– E-exam, CNN, Proctoring, Cheating, Covid-19*

I. INTRODUCTION

Since the identification of the Coronavirus in Wuhan, China many countries are worried about the life of their citizens and economy. The major impact of the Covid-19 pandemic is due to its nature of spreading the virus exponentially from one person to another. Most of the people get affected due to physical contact, and due to the droplets produced by an infected person at the time of coughing or sneezing. Therefore, direct contact between two individuals is not recommended, and maintaining the social distancing of at least 5 feet is made mandatory. Therefore, most of the business units, manufacturing, and product development activities across the globe are halted to survive from the pandemic. On the other side, the functioning of educational institutions is affected seriously, due to which country-wide closure of schools was the only option left for various governments across the world.

According to the UNESCO Institute for statistical data, there are about 1,190,287,189 affected students, which is equal to 68% of the students enrolled across the world [1]. More than 150 countries declared the lockdown in their respective countries and strictly instructed to close all the educational institutions. School management are encouraging online training programs to coverup the syllabus and encouraging them to perform different activities of school using a variety of online tools. The Kingdom of Saudi Arabia (KSA) is registered with the highest confirmed cases of coronavirus amount the rest of the Gulf states. Therefore, all kinds of entry to Mecca and Madinah for pilgrims are been suspended to limit the coronavirus cases in the kingdom. All types of educational institutions are instructed to follow the lockdown and due to which more than 8 million learners in Saudi Arabia (SA) (as shown in Fig. 1) are affected by traditional classroom teaching and learning process.

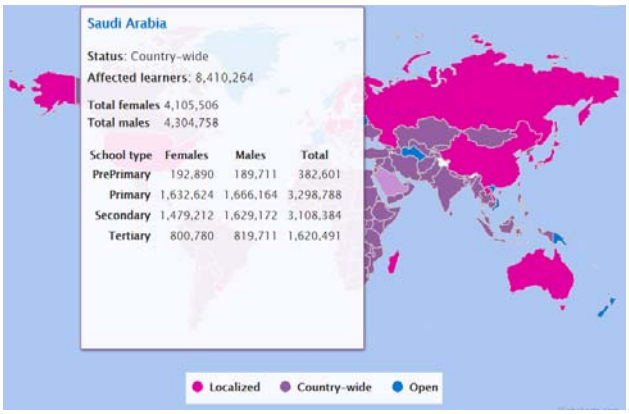

Fig. 1. Impact of Covid-19 on students/learners with statistics of male vs. female in Saudi Arabia

Conducting online courses, training the learners using web-based tools, and covering the curriculum as per the schedule is a challenging job due to the involvement of different computers at different student locations. But conducting exams during pandemic situations is another big challenge for most of the institutions. Some of the challenges may not be rectified if the parents are not aware of computer operations or using different tools over the internet. So training students using online tools needs special attention of parents but at the same time, it has got

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it's own drawbacks while conducting online exams (i.e. eExam). eExam concept is known for its timed, supervised, and summative assessment by using the student's computer with a special and standardized operating system. Of course, this approach is quite common in some universities where the institutions follow the Bring Your Own Device (BYOD) approach. Sindre and Chirumamilla discussed and analyzed the cheating-related security threats while conducting the eExams and proposed some of the countermeasures too [2]. Some of the drawbacks and challenges that frequently observed are listed here: a) Excessive involvement of parents, family members, and friends may spoil the actual purpose of the eExams. b) People will try to use a variety of methods such as pen drives, mobile phones, tabs, etc. to cheat during eExam. c) Sometimes the e-learning provider may use technologies such as digital image processing, keystroke method, etc. to identify the emotions of the students during the online exams. However, the installation of these technologies may not be possible for all the students due to a lack of computer knowledge or due to some of the other issues. d) Parents/guardians may show some kind of negligence towards different activities/guidelines proposed by the institution due to lack of awareness or due to their busy schedule.

In Section II, a detailed literature survey of eExams is provided based on different technologies implemented at various universities across the globe. In Section III, some of the existing proctoring technologies are discussed to propose a CNN based approach for proctoring in Section IV. The obtained results and discussions are made in Section V and finally ended this article with a brief conclusion in Section VI.

II. BACKGROUND LITERATURE

In this context, the prevention of cheating at the time of eExams (sometimes it may be pronounced as online exams in this paper) become a greater challenge for the administrators conducting the exams. Cuskey *et al.* suggested a method by not involving proctor supervision using eight control procedures. This method asserts a reduction in total cost by minimizing the total time and money invested by the institute and students [3]. The authors claimed that this method will help to reduce the likeliness of cheating at the time of eExams. The eight online exam control procedures (OECP) included with the following steps: 1) only one set of time for conducting the exams for all students; 2) accessibility of the computer to be used for online exam will be available for a brief period (assume 15 minutes window); 3) randomized sequence of questions; 4) one question at a time will be presented; 5) design of online exam for a limited time that will occupy the maximum time of the participant; 6) only one-time access to the exam; 7) making the students use only blackboard response lockdown browser (RLB) at the time of exam (which restricts exit/return, cut/paste, usage of electronic calculators from the system, etc.); and 8) changing one-third of multiple-choice questions each time they conduct an exam. In another work to identify the willingness of the students to cheat was based on the relationships maintained between the students and teachers [4]. Kalhori suggested that the emotional factors, environmental factors at the schools, and teaching methodologies practiced by teachers influence student behavior towards cheating in the online exams. Sometimes the poor financial conditions also force them to cheating in online exams.

To avoid any kind of nuisanse at the online examination centers Keresztury & Cser suggested restricting/prohibit the students from bringing any type of flash memories, pen drives, mobile phones, calculators, and electronic gadgets to the examination centers [5]. Apart from the technological and non-technological factors, some of the trusting factors are highlighted by Miguel *et al.* to make the student understand responsibility and teamwork activities for self-development during the academic training sessions [6]. Under some specific conditions, even the best behaved and background students also involve in the act of cheating during the online examinations. To avoid such situations Hylton *et al.* suggested using webcam-based proctoring for identifying the possible students that are involved in cheating [7]. However, using this method creates a need for regular inspection and monitoring of the recorded images from the webcam, which is similar to the traditional way of proctoring in paper-based examinations.

Later, Korman emphasized the technique to use the type of interaction between the computer and human as a tool to detect the people who are involved in cheating at the time of eExams [8]. Speed of typing, distractions, irregular typing, etc. could be the possible identifying parameters for the cheating students. An attempt to design a paperless examination system was made by Zhang & Ke for SQL language in terms of practical and theoretical levels [9]. This kind of examinations is helpful for a scenario where the accessibility of computer systems is not available. Similarly, biometric authentication was used by Alotaibi via fingerprint recognition [10]. The author discussed various solutions related to low quality of inputs, fake inputs, and tampering of databases. Hiller & Fluck strongly recommended conducting the e-exams for the usage at high stakes examinations for the tertiary sectors [11]. In this work, the authors suggested a program to implement which suits the requirements of a larger university. A tool to monitor the student browsing activity was introduced by Kasliwal to detect cheating in a real-time environment where usage of the internet is allowed [12]. In a detailed

study, Hiller and Lyon conducted two trials with the students for tex-based assessment and computerized examination to understand the writing styles, habits, and strategies students apply during the examinations [13]. The impact these elements on the grades, word count, and handwriting are correlated and compared. A similar attempt was made by Umar & Wilson to understand the perception of students towards the e-exams for assessing their undergraduate students [14]. Some of the challenges were highlighted include the dissatisfaction levels of students towards the questions being asked, the format of questions, timings, etc. Later, Khlifi suggested an advanced scheme to resolve the security issues for e-exams and e-evaluations [15]. The author claimed that the proposed system does not require any kind of additional components and continuous authentication is established by using randomly generated questions from the existing information.

III. EXISTING PROCTORING TECHNOLOGIES

Several methods are adopted in recent times to proctor the e-exams with highly guaranteed test integrity. From various reports, it is observed that academic misconduct is increasing with the rise in technology and different types of online tools to avoid plagiarism, etc. Many British universities reported students getting caught with cheating and some of the websites are providing tools to hideout from getting caught in most of the online exams [16]. Some students are even using wireless micro earpieces for cheating at the time on e-exams and these are available on different types of online stores such as eBay. Generally, such types of devices is used by private investigators, police, etc. for interrogating the criminal offenders. With a wide range of companies providing advanced and undetectable gadgets, conducting the e-examination has become a greater challenge to most of the universities and training institutions. Some of the anti-cheating methods are discussed in the following sections towards thawing the sneaky cheating attempts.

A. Secured Online Authentication ID

This can be used from remote locations like home, workplace, holiday spots, etc. This online authentication ID helps the examiner to switch candidate authentication during the configuration of e-exam proctoring settings. In this method, the student needs to click a test link, their photo, ID proof, and authentication information (if any available) across the registration process. The proctor will be able to verify the details using their online portal and verify the legitimate candidates [16, 17]. It will help to avoid fake exam takers or impersonators by using the different types of facial recognition tools. However, it is not a foolproof method and therefore multiple checks are essential using this method. Biometrics, keystroke authentication, and cross-questioning are needed to prove the identity.

B. Secured Examination Browser Setup

In this method, a secured environment is hosted with predefined applications and useful websites. Once the student clicks the application, it makes the system to shut down automatically and the only app-related tools or websites will run on the system [18]. These type of methods helps to disable the screen recording, projections, desktop-based applications, and other web applications. This method can be more applicable for open book exams with limited/selected resources available for the students using the whitelisting approach. However, anti-cheating methods using this approach is not as effective as the examiner can still access external resources to find the answers.

C. Preventing Mobile Phones

In this method, the preventive measures are taken to access the test answers using mobile phones and blocking some of the sites that are taking place which generally contains the answers for certain questions. Almost 35% of students use mobile phones for cheating in online exams [16]. The technology detects devices that are under usage, searching for similar content related to the examination and will be flagged if detected with some activity [19]. It also scans internet browsers and blocks the sites that are browsed for answers and reports the same which contains the related test questions and answers. This technique helps to avoid any kind of leakage of online question papers. The biggest disadvantage of this method is that it is not a stand-alone anti-cheating solution. Apart from that it is not having any kind of auto-proctoring process.

D. Auto-Proctoring

Having an automated proctoring method with in-built software helps to monitor the student's behavior and activities using the recordings to detect suspicious activity [20]. The developers are using artificial intelligence (AI) based algorithms to monitor student behavior, gestures, gadgets used, etc. Any kind of suspicious behavior will be notified/flagged. This method proved to be one of the cost-effective solutions and it is still under progress with various add-ons.

E. Proctoring using Record and Reviews

In this method, an expert team will review the sessions to identify the instances where integrity was compromised. Using this method auto-proctoring process is made to run by default and then reviewed for anomalies by the expert proctors. The flags raised by AI algorithms will assist proctors for conducting detailed checkings [16, 20]. This method is cheaper as compared to live proctoring but consumes a lot of time.

F. Live Proctoring

This is a combination of auto and human proctoring (which is generally used in schools, colleges, etc.). The proctoring software helps to generate red flags on the detection of suspicious behavior and will be assessed for the integrity of the exam conducted [16]. Using this method chances of cheating are low and it is very difficult to scale the integrity at times. Also, this method has the flexibility of adjusting the cost and generally, it is more expensive as compared with auto-proctoring technique.

G. Using 360^0 Cameras for Proctoring

Some of the companies are providing the cameras with flexibility of image capturing for 360^0 views in a room or examination center. These cameras can be operated with the help of a computer screen or headgear to capture candidate's gaze and actions in the examination hall [21]. It will allow us to have great audio and video coverage but is an expensive choice to adopt by all students at their own cost.

IV. Proposed CNN Based Method for E-Exams

A small list of safety guidelines and precautionary measures for the students is provided on the proposed web portal related to Covid-19 before starting the E-Exam. This is to ensure that students are understanding the importance of social distancing, cleanliness, and sanitization at their respective places. The main purpose of this work is to avoid cheating using image processing techniques along with machine learning techniques.

A. Flow Process of Proposed eExam Method

In this experiment, the eExam was conducted for 10 students by providing dedicated software, which was developed in this research itself. This software does not allow any other application to function when the exam is under progress; however, for certain specialized (engineering/ medical) subjects certain materials such as scientific calculators, catalogs, datasheets, online documents, etc. are needed by the students at the time of examination. Such facilities are exempted and allowed to use at the time of eExam with the help of some special in-built authentication process of the software tool. These materials are provided as a special folder on the screen. For the entire examination period, the computer screen of each student will be recorded and stored in the database for remote proctoring. The images obtained from the webcam are being processed using a geometric approach, an image processing technique to identify different facial expressions based on the distinguished key points on a face. More details on the geometric approach used in this method are discussed in the following Section-D.

The images are in this work are considered in pixel format and are processed using the convolutional neural networks (CNN) based approach for any kind of feature extraction, i.e. to understand different emotions expressed by students at the time one eExam. The outputs of CNN will be compared with the corresponding ideal values that are stored in a database using a checker component as shown in Fig. 2. The assessment outputs will generate alerts for the exam coordinators/online proctors when an uncertain event takes place.

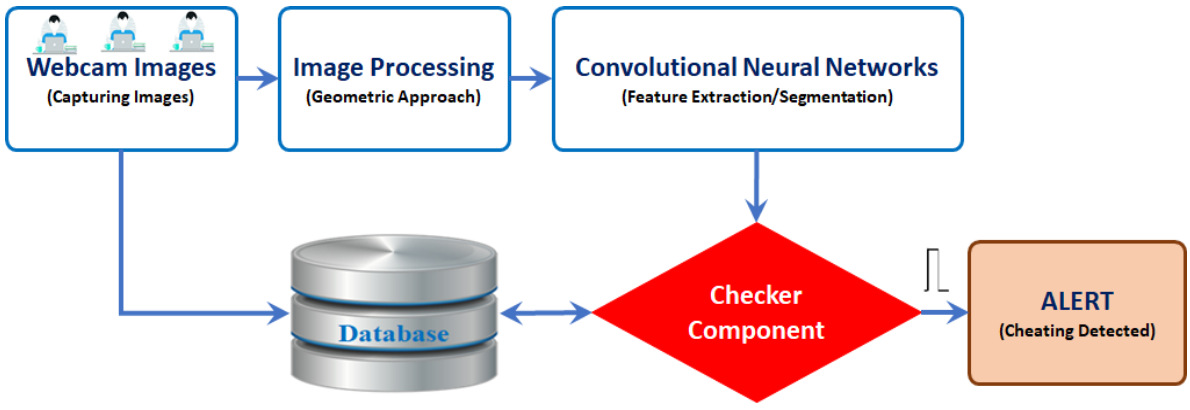

Fig. 2. Arrangement of webcams in the experimental setup to capture the student images

B. Problem Assumptions

In this research, certain assumptions are made for the students attending eExam

- Students must be alone in the room where the test is given and away from any kind of communication with parents, family members, and friends. (security measure)

- Student needs to sit in front of the computer with no electronic gadgets such as mobile phones, pen drives, flash memory cards, etc. during the exam (to avoid cheating)
- Students can use writer material such as a book, paper, pen, and pencil.
- Throughout the examination process the environment must be same, i.e. the desk, chair, clothes and system-related peripherals such as the keyboard, mouse, etc. must be same (to check the consistency of environment)
- Student needs to arrange the webcam in such a way that it is showing the same images repeatedly. The cameras with flexibility of image capturing for 360^0 views is highly preferable (for a complete online proctoring and reviews)
- The lighting of the room must be same throughout the examination duration (for better detection of cheating from images)

C. Data Collection

The duration of eExam conducted for 30 minutes and the webcams are assumed to capture an image every 10 seconds. Therefore, ten students appeared for the eExam generated 3,600 images with high resolution RGB colored images. The captured images were processed using a digital image processing technique called geometric approach at the initial stages and later they are processed through a CNN based approach for extracting different facial expressions, textures, and also for segmentation purposes.

The recommended set up for the students is shown in Fig. 3, where the videos obtained from the webcam 1 and 2 will generate an image for every 10 seconds, i.e. each student produces 12 images from webcams and 6 screenshots of the computer screens are considered for the analysis to improve the accuracy of eExam and online proctoring.

The data collection is a continuous process that starts from online classes to online exams. At the time of online classes, the CNN based system will be considered for user registration, dataset collection, and dataset training. However, at the time of eExam it will be oriented to deal with face detection and face verification. That means incremental training of student face images is trained to the networks continuously. With the constant and consistent training process, the accuracy of detection increases and the verification process with different posses and lighting conditions also increases [22]. In this way, by enhancing the efficiency and accuracy of cheating detection the CNN based models are considered to be more useful as runtime monitoring systems for educational institutions [23].

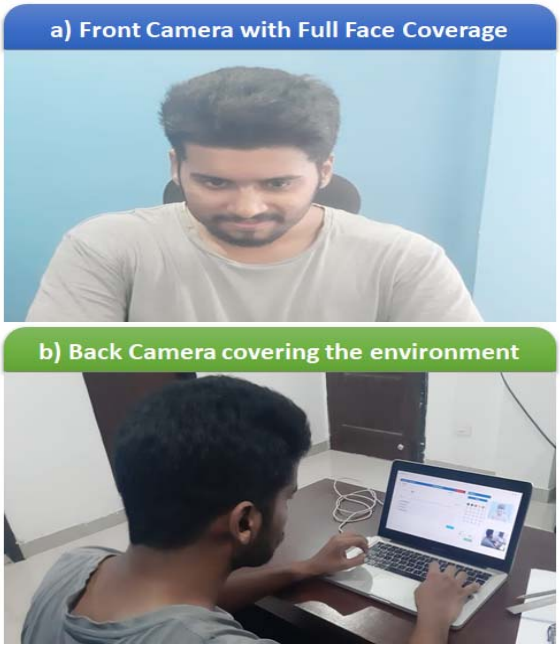

Fig. 3. Arrangement of webcams in the experimental setup to capture the student images from two different directions covering complete environment

D. Image Analysis using Image Processing and CNN

Two approaches existing in the market which help to identify the face and facial features for performing the student behavioral analysis in the eExam based on facial expressions: geometric features approach and appearance-based approach. In the first case, data interpretation takes place based on the facial expressions, and in the later case, the distinguished key points are identified from the images obtained from the webcam. Using the geometric facial feature-based methods the obtained face images are analyzed to understand the changes in shapes, textures, and location information with different facial expressions of the students appearing for the eExam. The prominent components that are involved to help in this analysis are eyes, nose, chin, mouth, and eyebrows as shown in Fig. 4. Each expression or emotion made by the humans has a slight difference between the distinguished key point on a face (such as I-J; K-L, C-D, and C1-D1). For example, when a person is happy or angry means the size between these key points varies as listed in Table I.

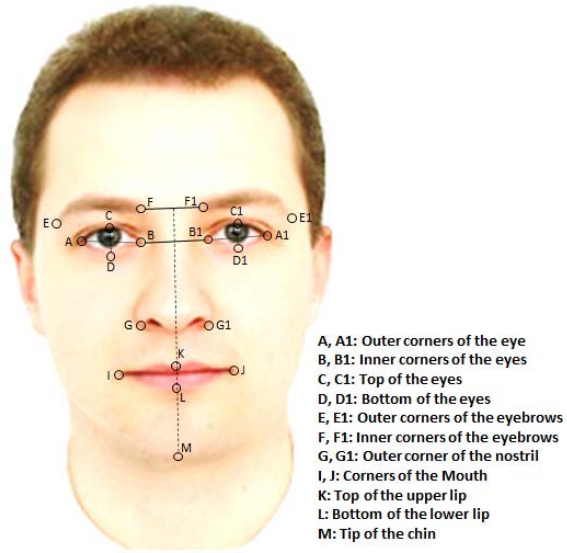

Fig. 4. Labeling of different key points used to identify the emotions of the students appearing for eExams

Normally distance between eyes and eyebrows in case of a student was 5.5 pixels in normal condition, changed to different levels when the emotions changed to a happy mood and angry mood with 5.71 and 5.21 pixels respectively. Similarly, changes in width and height of the mouth are also noted using the geometric facial features approach.

TABLE I. THE CALCULATED DISTANCE (IN PIXELS) BETWEEN KEY POINTS OF A HUMAN FACE FOR DIFFERENT EMOTIONS SUCH AS HAPPY AND ANGER

Emotion	Neutral	Happy	Anger
Eye Brow-Eye	5.5	5.71	5.21
Width of Mouth	13.1	13.4	13.9
Height of Mouth	1.4	1.53	1.46

In the case of an appearance-based approach, some of the image filters (such as Gabor wavelets) are applied over the captured face image to obtain the facial features for a whole-face or a defined specific region. The role of the webcam is key in this method by distinguishing the key points and classify the images accordingly. In this work, some of the observations towards emotions (Neutral-1, Smile-2, Laugh-3, Anger-4, Sad-5, and Surprise-6) expressed by the ten students during eExam are tabulated in Table II.

TABLE II. THE FACE COLLECTION OF TEN STUDENTS PARTICIPATED IN E-EXAM AND THE RELATIVE DATA (UNITS: PIXELS)

		(1)	(2)	(3)	(4)	(5)	(6)
S1	**Eye Brow**	6.9	8.26	8.29	6.2	6.64	6.82
	Eye	2.45	2.33	2.22	4.3	3.1	2.8
	Width of Mouth	13.58	13.36	14.65	17.46	13.48	17.4
	Height of Mouth	1.1	1.5	3.1	1.19	0.59	2.56
S2	**Eye Brow**	7.56	7.49	7.1	6.52	6.46	7.45
	Eye	2.35	2.55	2.3	2.6	2.88	2.86
	Width of Mouth	17.1	15.6	16.92	14.45	20.27	13.4
	Height of Mouth	2.4	1.15	4.46	1.19	2.78	1.35
S3	**Eye Brow**	6.66	7.2	7.06	6.9	7.59	8.1
	Eye	3.29	2.82	2.34	3.18	2.84	2.5
	Width of Mouth	21.19	13.7	13.23	13.7	12.42	13.7
	Height of Mouth	1.73	1.05	3.5	1.36	1.35	1.83
S4	**Eye Brow**	7.52	7.19	6.84	6.96	7.96	7.35
	Eye	2.61	2.75	2.69	3.27	2.46	3.4
	Width of Mouth	15.89	14.89	16.75	12.84	12.6	11.7
	Height of Mouth	2.9	1.1	3.61	1.3	1.23	1.98
S5	**Eye Brow**	7.3	7.48	6.79	7	6.89	7.19
	Eye	2.81	2.65	2.74	2.76	3.31	18.2
	Width of Mouth	13.99	15.55	13.7	13.66	13.2	18.1
	Height of Mouth	1.15	1.33	2.22	1.26	1.24	2
S6	**Eye Brow**	7.51	7.51	7.11	6.53	6.48	7.4
	Eye	2.39	2.54	2.32	2.63	2.86	2.89
	Width of Mouth	17.12	15.63	16.9	14.48	20.23	13.42
	Height of Mouth	2.45	1.13	4.44	1.2	2.8	1.39
S7	**Eye Brow**	7	8.29	8.31	6.23	6.6	6.8
	Eye	2.49	2.36	2.2	4.31	3.15	2.83
	Width of Mouth	13.6	13.39	14.6	17.44	13.5	17.44
	Height of Mouth	1.11	1.53	3.11	1.2	1	2.6
S8	**Eye Brow**	7.54	7.15	6.89	6.9	7.94	7.37
	Eye	2.64	2.71	2.73	3.28	2.49	3.45
	Width of Mouth	15.7	14.85	16.74	12.8	12.64	11.73
	Height of Mouth	2.92	1.14	3.65	1.33	1.28	1.92
S9	**Eye Brow**	6.69	7.22	7.01	6.87	7.56	8.15
	Eye	3.27	2.85	2.32	3.17	2.83	2.54
	Width of Mouth	21.15	13.72	13.24	13.72	12.48	13.9
	Height of Mouth	1.79	1.06	3.54	1.33	1.37	1.86
S10	**Eye Brow**	7	8.21	8.26	6.24	6.65	6.81
	Eye	2.47	2.36	2.21	4.33	3.17	2.84
	Width of Mouth	13.55	13.32	14.68	17.42	13.44	17.42
	Height of Mouth	1.13	1.51	3.11	1.16	0.55	2.58

It is very important to train the CNN with the latest updated information and student information on a regular and consistent basis for appropriate face verification. Dataset created during the online training is stored in the database as a standard numbered value for each student as summarized in Table II. The architecture of a CNN consists of multiple neurons with weights, bias, and different types of displacement functions. These neurons form different architectures such as local receptive fields, sharing weights (generally have filters/kernels), and spatial subsampling (consists of unification). To evaluate the performance of the proposed CNN based detection system, three parameters are considered includes accuracy, false acceptance rate (FAR), and false rejection rate (FRR). The equations for the above parameters are given by the following equations:

$$Accuracy = \frac{Number\ of\ Valid\ Results}{Number\ of\ Tests} \times 100 \quad (1)$$

$$FAR = \frac{Number\ of\ False\ Acceptance}{Number\ of\ Tests} \times 100 \quad (2)$$

$$FRR = \frac{Number\ of\ False\ Rejection}{Number\ of\ Tests} \times 100 \quad (3)$$

V. RESULTS AND DISCUSSION

The proposed approach using CNN has delivered interesting results by creating a substantial link between the neural networks and the image processing based adaptive filters. The introduction of CNN based approach helped to improve the detection and analysis speed of the images captured by the webcams at student locations. Any kind of uncertain event is detected at a faster rate and compared with

the database standards using a checker component in the real-time environment. The facial expressions, movement of eyes, eyebrows, and sitting postures are considered in this analysis to make a final decision. Similarly, the objects on a computer table, movement of hands, head, and body postures are also considered at the time of analysis.

From the performance parameters of CNN based eExam Database the threshold values are calculated and plotted for FAR and FRR values as shown in Fig. 5. The accuracy was calculated for the present system comes out to be 97%, which is far better than the existing proctoring systems.

Some of the observations calculated the emotions by using the distance between different key points as listed in Table I. these key points (such as Eye Brow to Eye, width, and height of the mouth) were key to understand the emotions of a student appearing for an eExam. Most of the time, the distance (measured in pixels) between these key points appears to be changing when the student's emotions are shifting from one mood to another mood. The possibility of student's being ignorant at the time of exams is avoided to some extent by introducing the front camera view and rare camera view on the screen at the time of exam on the computer screen as shown in Fig. 6. This is a kind of alarm for the student to be stable and consistent during the exam period.

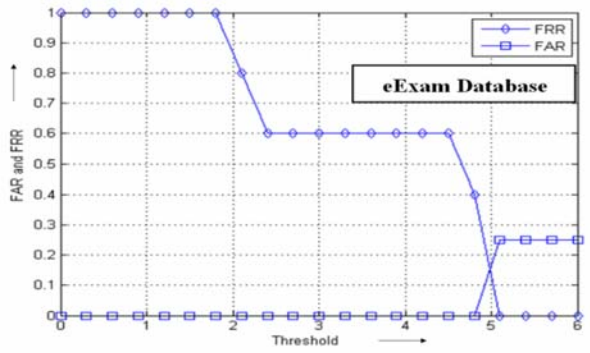

Fig. 5. A plot between the calculated FAR and FRR Vs. threshold values

Tampering with the environment is avoided by using the proposed software by the temporary halting of the examination process when multiple faces are detected once the exam is in progress. Similarly, any kind of new material on the computer table or any kind of new object identified in the hands of students is considered to be the violation of rules and the system considers this as a negative object to be present at the time of the exam. Therefore, the guidelines are subjected to be followed strictly by the students appearing for eExam at home.

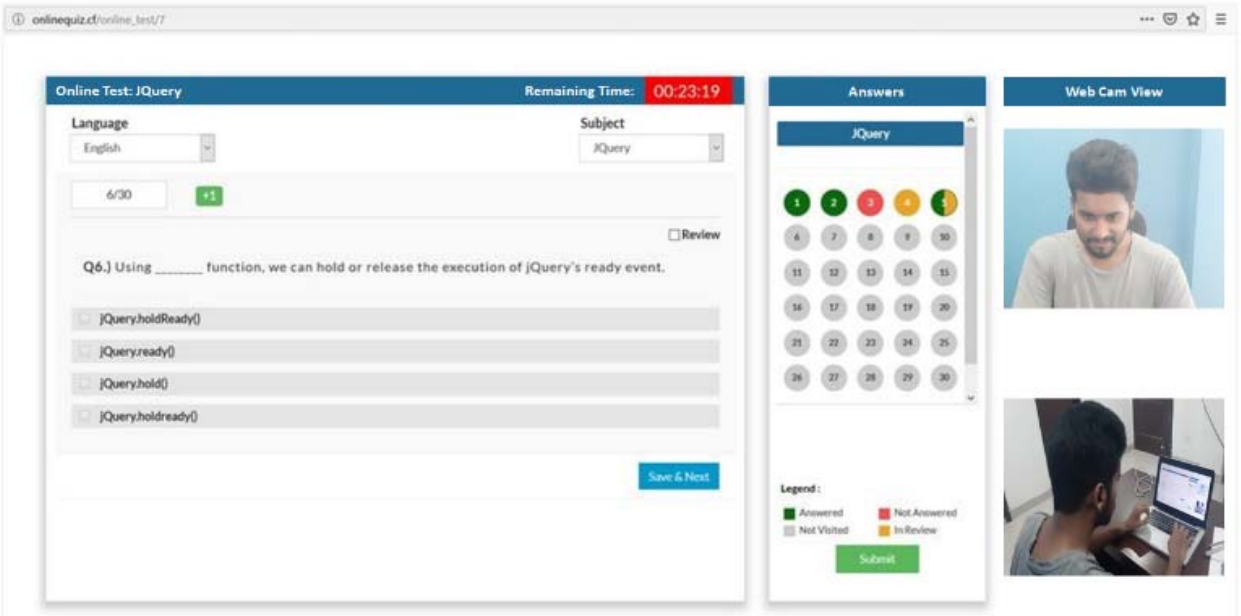

Fig. 6. Web portal view of eExam presenting the screen proctoring along with front and rare camera views on the computer screen.

VI. CONCLUSIONS

The CNN based detection proposed in this work is very useful for the Saudi Arabian universities. The software tool presented in this work provides additional security for the data while conducting e-Exams. Complete lockdown conditions due to Covid-19 needs careful attention to maintain certain guidelines for the safety of the students. However, the academic progress with the training and learning process should end without examinations. Therefore, the proposed CNN based approach not only helps to detect the cheating but also helps to carry out the online proctoring in an automatic manner. This needs consistent training to improve the accuracy to classify the right student attending for the online exams. Also, it helps to improve the face verification by comparing the standard

values stored in the database. Calculations for accuracy, FAR and FRR with different facial expressions and lighting conditions have been calculated and are proved to give better results as compared with the earlier proctoring systems.

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References

[1] UNESCO Education Response. "Covid-19 Impact on Education" [Online] available at URL: <https://en.unesco.org/covid19/educationresponse>, (Accessed on May 12, 2020).

[2] G. Sindre, and A. Vegendla. "E-exams versus paper exams: A comparative analysis of cheating-related security threats and countermeasures." In *Norwegian Information Security Conference (NISK)*, vol. 8, no. 1, pp. 34-45. 2015.

[3] G. R. Cluskey Jr, c. R. Ehlen, and M. H. Raiborn. "Thwarting online exam cheating without proctor supervision." *Journal of Academic and Business Ethics* 4, no. 1 (2011).

[4] Z. Kalhori. "The Relationship between Teacher–Student Rapport and students Willingness to Cheat." *Procedia-Social and Behavioral Sciences* 136 (2014): 153-158.

[5] B. Keresztury, and L. Cser. "New cheating methods in the electronic teaching era." *Procedia-Social and Behavioral Sciences* 93 (2013): 1516-1520.

[6] J. Miguel, S. Caballé, F. Xhafa, and J. Prieto. "Security in online web learning assessment." *World Wide Web* 18, no. 6 (2015): 1655-1676.

[7] K. Hylton, Y. Levy, and L. P. Dringus. "Utilizing webcam-based proctoring to deter misconduct in online exams." *Computers & Education* 92 (2016): 53-63.

[8] M. Korman. "Behavioral detection of cheating in online examination." *Ph.D Thesis* (2010).

[9] G. Zhang, and H. Ke. "SQL paperless examination system design." In *2010 Second International Conference on Computer Modeling and Simulation*, vol. 3, pp. 475-478. IEEE, 2010.

[10] S. J. Alotaibi. "Using biometrics authentication via fingerprint recognition in e-exams in e-learning environment." *University of Southampton* (2010).

[11] M. Hillier, and A. Fluck. "Arguing again for e-exams in high stakes examinations." In *ASCILITE-Australian Society for Computers in Learning in Tertiary Education Annual Conference*, pp. 385-396. Australasian Society for Computers in Learning in Tertiary Education, 2013.

[12] G. Kasliwal. "Cheating Detection in Online Examinations." *Ph.D Thesis* (2015).

[13] M. Hillier, and N. Lyon. "Writing e-Exams in pre-university college." In *Open Conference on Computers in Education*, pp. 264-274. Springer, Cham, 2018.

[14] M. A. Umar, and F. Wilson. "Perception of Electronic Examination among Undergraduate Students of University of Maiduguri." *Journal of Humanities and Education Development (JHED)* 1, no. 5 (2019): 211-221.

[15] Y. Khlifi. "An Advanced Authentication Scheme for E-evaluation Using Students Behaviors Over E-learning Platform." *International Journal of Emerging Technologies in Learning (iJET)* 15, no. 04 (2020): 90-111.

[16] R. Kanchan. "7 Online Proctoring Technologies That Guarantee High Test Integrity". [Online] available at URL: <https://blog.mettl.com/assessment-technology/7-technologies-that-can-prevent-cheating-in-online-examinations>, (Accessed on May 28, 2020).

[17] A. Mhenni, E. Cherrier, C. Rosenberger, and N. E. B. Amara. "Towards a secured authentication based on an online double serial adaptive mechanism of users' keystroke dynamics." 2018.

[18] T. M. Søgaard. "Mitigation of cheating threats in digital BYOD exams." Master's thesis, NTNU, 2016.

[19] D. W. Bedford, J. R. Gregg, and M. S. Clinton. "Preventing online cheating with technology: A pilot study of remote proctor and an update of its use." *Journal of Higher Education Theory and Practice* 11, no. 2 (2011): 41-59.

[20] Y. Atoum, L. Chen, A. X. Liu, S. D. Hsu, and X. Liu. "Automated online exam proctoring." *IEEE Transactions on Multimedia* 19, no. 7 (2017): 1609-1624.

[21] J. J. Mazzilli. "360° automobile video camera system." U.S. Patent 6,333,759, issued December 25, 2001.

[22] H. S. Asep, and Y. Bandung. "A Design of Continuous User Verification for Online Exam Proctoring on M-Learning." In *2019 International Conference on Electrical Engineering and Informatics (ICEEI)*, pp. 284-289. IEEE, 2019.

[23] K. Garg, K. Verma, K. Patidar, and N. Tejra. "Convolutional Neural Network based Virtual Exam Controller." In *2020 4th International Conference on Intelligent Computing and Control Systems (ICICCS)*, pp. 895-899. IEEE, 2020.

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