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FRAMEWORK FOR DESIGN OF SECURITY SYSTEMS FOR MONITORING EXAMINEES AND PROCTORS DURING EXTERNAL OFFLINE EXAMINATIONS IN NIGERIA

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ABSTRACT

This paper seeks to design a system for monitoring the compliance of external examination centers to set rules and regulations governing the conduct of an external offline examination. The system is designed to check impersonation of examinees, aiding and abetting by teachers and other proctors, importing and submitting answer scripts written outside the approved examination halls and finally monitoring the script submission process to prevent swapping of answer booklets after completion of the examination. The proposed system consist of biometric authentication system, automated attendance system, Closed-Circuit Television (CCTV) cameras for video recording, a script submission system (SSS), a drop box for temporal storage of scripts and human monitors to analyse the recorded videos at monitoring center of the examination board. The system is designed to work even in remote areas with unstable internet as is the case with most examination centers in rural areas in Nigeria. When implemented the system will help check illegal activities in miracle examination centers and reduce examination malpractices by both examinees and proctors drastically.

Keywords: Biometric, CCTV, Drop Box, Examination Malpractice, Offline Examinations

INTRODUCTION

Examination is an organized assessment technique which presents individuals with a series of questions or tasks geared towards ascertaining the individual's acquired knowledge and skills (Oduwaiye, 2014 cited in Oko & Adie, 2016). Examination can be internal or external. It is internal when it is held under the direct supervision of the educational institution concerned and external when it is conducted by external bodies or agencies for the purposes of certification, entrance to further studies or job selection (Osuji, 2020). In Nigeria, examination malpractices occur in both internal and external examinations. It is a problem which has affected the educational system for many years and has defied solutions, as all antidotes applied so far have been faulted by fraudsters (Dajwan *et al*., 2021). According to Omeri (2012) cited in (Osuji, 2020), examination malpractice in Nigeria has attained a frightening and sophisticated proportion that Nigeria was ranked number one position in the world examination malpractice index.

Examination malpractice is an act of omission or commission by a person who in anticipation of before, during or after any examination fraudulently secures any unfair advantage for himself or any other person in such a manner that contravenes the rules and regulations to the extent of undermining the validity, reliability, authenticity of the examination and ultimately the integrity of the certificates issued (FRN, 1999). There are different forms of malpractices in external examinations and according to Ijaiya (2011), examination malpractice in Nigeria involves students, parents, teachers, school heads, examination officials and even supervisors. Exam malpractice may occur in the form of impersonation in which case an individual who is not registered as a candidate for a particular examination takes the place of one that is registered usually with the cooperation of the examination supervisor (Oko & Adie, 2016). According to Anakwe (2008) cited in Anakwe (2010), there are cases where teachers who were selected for invigilation acted as accomplices to candidates by dictating answers to them, organizing contribution from students to settle supervisor, allowing examinees to use mobile phones with answers stored in them, allowing examinees to communicate with outsiders who dictate answers to them and allowing examinees to use ear-phones to listen to dictated answers and other sharp practices carried out during examinations. These terrible acts of collusion between proctors and examinees are more prevalent in remote areas with no internet access and other technological facilities that could facilitate real-time online proctoring. These difficult terrains have motivated many cheaters to establish schools popularly known as Miracle Examination Centres or Special Centres, which offer candidates the promise of excellent grades through illegal means (Agwu *et al*., 2022). According to Ojerinde (2004) cited in Anzene (2014) this explains why secondary schools located in rural areas with no access road or difficult terrains that hinder external monitoring or supervision witness influx of candidates during SSCE examinations.

According to Agwi *et al*. (2020) the use of CCTV surveillance systems for monitoring activities in the examination hall is gaining prominence because of its benefits which include providing evidence for investigative reasons and also serving as deterrence to intending offenders. However, his findings show that the conventional use of CCTV systems in monitoring examinations in Nigerian tertiary institutions is not effective at a 5% level of significance, there is therefore need for improvement. Many attempts have been made to develop systems that will curb examination malpractices in public online and offline examinations. Nurpeisova et al. (2023) designed a proctoring software to be used for online monitoring, logging, and evaluation of user behavior during online exams and tests. Khanna *et al.* (2021), Reddy *et al.* (2023) and Potluri *et a*l. (2023) developed systems that use facial recognition technology to identify suspicious behaviours in examination halls. These technologies can help to monitor examinees and detect any malpractice more efficiently and accurately. The systems utilize a webcam to collect the student's image, identify landmarks. The data is then analyzed to spot any suspicious activity during examination. Nigam *et al.* (2021) reviewed 43 papers published from the year 2015 to 2021 on existing AI and non-AI-based proctoring systems. Findings show that the digital proctoring systems in the market uses hardware such as webcams and microphones already present in the student's

computers to monitor them and ensure academic integrity. These existing studies on proctoring systems have three detection modes: live proctoring, recorded proctoring, and automated proctoring, but most of them are for online exams (Hussein *et al.*, 2020). This model of proctoring online examinations is not effective in offline examination proctoring since computers with webcams and microphones are not prerequisites for establishing offline examination centers.

There is therefore need to design cost effective models that can work even in remote areas with unstable or even no internet connections. Liu (2023) proposed a proctoring technique with AI-based assessments through surveillance cameras for examination invigilation in real offline examination classrooms. The study proposes the Mini-Batch Cutting approach for converting video information into image information and working for the 2- Longitudinal-Stream Convolutional Neural Network model. Eziechina *et al.* (2017) proposed the introduction and deployment of Closed-Circuit Television (CCTV) surveillance in examination invigilation as an antidote to examination malpractices in Nigeria. Al_airaji *et al.* (2022) proposed a system that uses video surveillance to monitor the activities of the student during exams and can detect cheating in real time. The system can determine the direction of the students' heads when they move from their exam script to peep at the exam scripts of other examinees. The system can also detect when a student's iris moves in a different direction to copy answers from written documents like mobile phones, books, hands, summary papers. Lastly, the system can identify a contact between a student's hands and face, as well as that between different students for shared abnormal behavior detection between students, such as sharing of incriminating materials. When any of these is detected, an automatic alarm alerts the authority about the abnormal behavior that has been detected. Hoque et al. (2020) also automated the traditional exam invigilation model using fingerprint sensor module, 360 degree camera, ultra-sensitive microphone and speaker. The model employs a fingerprint sensor module which permits only registered students of a particular course into the examination hall to take the course. The system allows Invigilators to monitors the exam halls through CCTV live streaming and controls by using ultra-sensitive microphones and speakers. Mahmood *et al.* (2022) implemented an automatic invigilation system to detect unethical activities of students during an examination using deep learning model. The proposed model uses Faster Regional Convolution Neural Network to classify student activities into two categories: cheating; and no cheating. Student identification and recognition were done through Multi-task Cascaded Convolutional Neural Networks and faces Recognition module with an accuracy of 95%.

Apart from the fact that the traditional method of attendance taking is prone to cheating and impersonation, Daramola et al. (2019) opined that it is tedious, error prone, time consuming and inefficient as some students may double-dip or attendance paper misplaced. These challenges in recent time have imposed a need for an improved and more efficient process of attendance registration. As a result of the many flaws noticed in the traditional attendance system, there have been many studies aimed at building automated attendance tracking systems, and many of them have been implemented successfully. Johari (2015) used barcode scanner and student card to get the attendance of students during final exams. Students scan the barcode on their matric card using barcode scanner. The student attendance is updated in real-time, as each attendance registration take place. Eneh (2013) proposed a fingerprint biometrics system that assists in the elimination of examination impersonation in West African Examinations Council (WAEC) examinations. The system recognizes an individual by comparing his/her biometrics with every record in the database. Onaolamipo (2014) proposed a Computerized Biometric Control Examination Screening and Attendance Monitoring System with ability to take student class attendance and screening before and after examination. Ingashitula (2017) also developed a fingerprint Based Exam Hall Authentication systems that assist in the elimination of examination impersonation in Namibian Universities (particularly IUM) Examination control board. The system is targeted mainly towards image preprocessing, feature extraction and feature match and is coded using C programming language. Awojide *et al.* (2018) proposed a secure fingerprint Biometrics authentication system for Joint University Preliminary Examination Board (JUPEB). The system design covers authentication, registration, verification, and Exams and was coded using visual studio. Ullah *et al.* (2018) introduced an automatic examination attendance system on smartphones which uses barcode to automatically capture student examination attendance. The Smartphones communicates with the server via either the local Wi-Fi or through the internet.

The National Open University of Nigeria (NOUN) uses an online script submission system for verification and capturing of students' scripts after each examination. The platform is also used for script collation, marking and uploading of scores. The use of a script submission system allows for efficient and secure handling of exam scripts, as well as timely feedback to students. (NOUN, 2023).

This research proposes a systemic combination of these existing technologies to curb examination malpractices from pre-examination to post-examination stages of external offline examinations in Nigeria.

MATERIALS AND METHODS

The proposed security framework covers pre-examination, examination and post-examination activities. Pre-examination activities are further broken down into registration, verification and check-in processes while the post-examination activities are subdivided into Script capturing and packaging, script deposit, Sending of the recorded CCTV footage and the e-attendance register, Monitoring and review of the examination process using recorded session of the CCTV, collation, marking and release of results.

Pre-examination Activities

The activities in this category include registration, verification and checking of examinees into the examination hall.

Registration

During registration the bio data, biometrics (Fingerprints and facial images) and subjects registered by the examinees are obtained and saved in a database. A unique examination number is then assigned to each examinee. This process of registration is usually done by the examination board and concluded before the commencement of examination.

Verification

On the day of examination, examinees are verified using fingerprint scanners to identify the examinees and to take attendance for the particular course to be examined. The automated attendance system has a timestamp which should amongst others, show when an examinee is verified and when the examinee submits his/her script. If an examinee is

successfully verified for a particular subject, he/she is automatically assigned a seat number and allowed to enter the examination hall where his/her seat is located. On the other hand examinees/ imposters who fail biometric verification are denied access to the examination hall. Table 1 illustrates the attendance register after the verification process is completed.

Table 1: Examinees attendance register after biometric verification

SN	Exam No.	Exam Center ID	Subject	Date	Check-in time	Seat No.
1	NOU1234	BNJX002	CMP001	03-11-23	08:01:05	3
2	NOU1345	BNJX002	PHY101	03-11-23	08:10:01	15

The exam number and exam center ID of a successfully authenticated examinee is automatically inserted into the e-attendance register of the examination session for which the authentication was done as shown in Table 1. The subject is selected from the list of subjects registered by the examinee, while the date and check-in time are system generated. The seat numbers are auto-generated using a suitable random number algorithm.

Check-in Process

Upon verification an examinee is allowed into the examination hall and ushered to the seat that is allocated to him/her by the system. The seats should be clearly numbered for easy identification. The verification and check-in processes are done in an orderly manner at the entrance of the examination hall with clear CCTV footage. The entrance and exit of the examination hall should be clearly covered by CCTV cameras. It is the responsibility of the local proctors at the examination centers to ensure orderliness and adherence to rules and regulation within the halls and entrances.

Examination

The examination is monitored using CCTV cameras. The CCTV must be on and confirmed to be working and recording before the commencement of the examinees' verification process and must remain on until the scripts are deposited into the temporal safe (drop box). Figure1 shows a portable drop box whose design is adopted and can be resized for the purpose of temporal storage of scripts. Each examinee should be given an answer booklet with a unique script number on all the pages of the booklet amidst other security features adopted by the examination board.

Figure1: A portable drop box

Post-examination Activities

The activities in this section are categorized into Script capturing and packaging, script deposit, sending of the recorded CCTV footage and the e-attendance register to the monitoring center of the examination board.

Script Capturing and Packaging

Students are expected to submit their answer booklets after each examination. The booklets are first captured using the Personal Digital Assistant (PDA) provided by the examination board. The script submission system model of the National Open University of Nigeria is adopted with modifications to include automated face recognition and script number capturing. Table 2 illustrates the attendance register after script capturing process is completed. The following procedure is followed in script capturing:

i. An examinee who wishes to submit script walks up to the staff assigned the role
ii. The staff searches for the examinee's record on the list of verified examinees for that course or simply searches using the examinee's examination number.

iii. The system finds the examinee's record and displays his/her picture stored in the database.
iv. The PDA provides an interface for the staff to take a new picture of the examinee and compare it with the stored picture. The facial recognition system matches the two pictures and returns a positive feedback if there is a match. This additional check during script submission is to detect any examinee that may have been fraudulently allowed into the hall during verification and check-in process. At this point the entrance to the examination hall is close and the exit is opened as no examinee is expected to come in.
v. If there is a match, the system allows the staff to proceed and capture the script number of the examinee and then completes the attendance taking for that examinee.
vi. The script submission software (SSS) generates an envelope number where the booklet will be placed. When an envelope is full (depending on the size of the envelopes provided by the examination board), the SSS opens a new envelope for the same subject and continues to populate it until all the scripts for that subject are captured.
vii. The envelope label contains the envelope number, the number of scripts in it, the name of the exams center and date, time and session the exams was taken.

Table 2: Complete examinees attendance register after script capturing process

SN	Exam No.	Exam Center ID	Subject	Date	Check-in time	Seat No.	Envelope No.	Script Number	Script submission Time
1	NOU1234	BNJX002	CMP001	03-11-23	08:01:05	3	CMP001BNJX002K1	124356	10:05:05
2	NOU1345	BNJX002	PHY101	03-11-23	08:10:01	15	PHY001BNJX002K1	123459	09:54:01

The system will generate envelope labels for each subject with examinees in attendance as shown in Table 2. The script numbers of the examinees are then captured after facial recognition is carried out by the system. The submission time is then finally generated by the system.

Script Deposit

The use of drop boxes for temporal storage of scripts in the presence of CCTV cameras is proposed. A drop box is a secured container or receptacle into which items such as returned books, keys, payments, or charity donations can be deposited. A sizable drop box is mounted on the wall in the examination hall to deposit script at the end of each examination session. The keys to the drop boxes are kept with high ranking officers of the examination board who move around to collect the scripts to the marking/collation centers as the case may be. The exams supervisor at the examination center is only able to deposit the scripts in the presence of CCTV cameras but cannot retrieve them because they do not have the keys. It is the responsibility of the examination center owners to provide security for the boxes to avoid vandalization as such activities could lead to cancellation of an entire examination or other penalties imposed by the examination board.

Sending of the Recorded CCTV Footage and the e-attendance Register

After each session when the scripts are successfully deposited in the drop boxes, backup of the video recording of the examination session is done and sent to the monitoring center for review. The e-attendance register is also sent along.

Monitoring and Review of the Examination Process Using Recorded Session of the CCTV

At the monitoring center the examination board hires monitors who are responsible for reviewing video footages received from the examination centers. A blind review of each examination session is carried out by monitors at the monitoring center.

Collation, Marking and Release of Results

The scripts are moved from the drop boxes to the collation centers by senior officers of the examination board. At the collation centers, scripts of examinees involved in malpractices are quickly identified and isolated using the envelope number. Likewise scripts of an entire examination session involved in malpractices are isolated. Only scripts cleared by monitors are taken for marking. If there are cases of malpractices and the scripts are removed, the new number of scripts in an envelope is indicated on the envelope by the collator. The marker first verifies that the script number on the attendance register is the same with the one on the script before marking. When marking is completed, the scores are uploaded through the scripts submission software and also recorded on customized manual score sheets as may be decided by the examination board. Results are released with pictures of the examinees.

System Requirements

As a perquisite for establishment of examination centers for external examinations in the proposed system, each center must have the following:

i. 360 degrees CCTV system installed with clear coverage of all the seats in the examination hall(s).
ii. A speaker and microphone for recording and transmission of sound in the examination hall.
iii. Solar system where applicable or any other cheap and stable source of electricity to power the hardware.
iv. Computer system for printing of attendance registers.
v. Printers

Other items to be provided by the examination board include:

i. A finger print scanner
ii. A PDA with facial recognition application software installed and a database containing the biodata, biometrics and course registration details of all duly registered examinees in the examination center.
iii. Script submission software installed on the PDA and on the computer provided by the examination center.
iv. A wall-mounted drop box installed at a secured location in the examination hall.

RESULT AND DISCUSSION

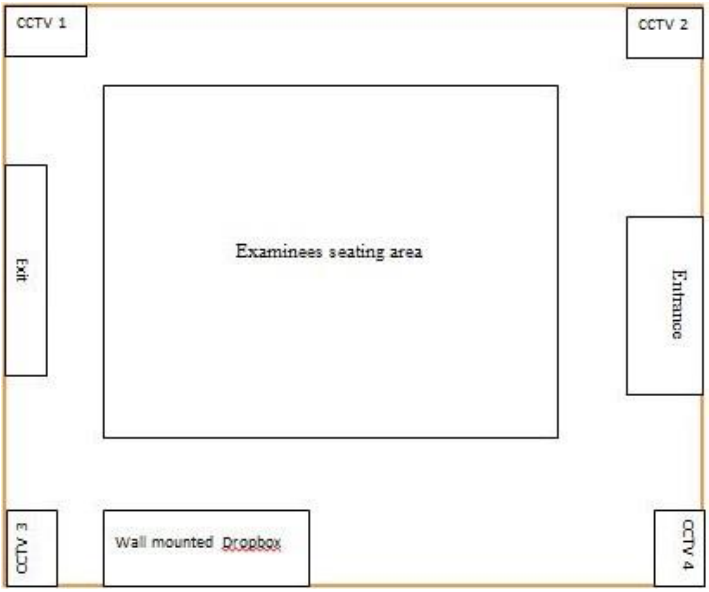

Figure 2: Arrangement of the Hardware and Examinees in the examination hall

Figure 2 shows the proposed seating arrangement of the examinees in the examination hall where CCTV cameras and a drop box are installed. During the examination, all the answer scripts are captured using the proposed script submission system and then deposited in the drop box. The recorded CCTV footage is reviewed by monitors when it arrives at the monitoring center. Cases of malpractice involving examinee(s) are reported by the monitors using the e-attendance script. If there are malpractices involving the staff or the entire center, the observations are also made and the examination board acts appropriately. The scripts of diligent examinees who are not involved in malpractices are cleared by the monitors and sent for marking while scripts not cleared by the monitors are recalled for further review or disciplinary actions.

The biometric authentication at the beginning of the examination and at the point of script submission is to ensure that the examinees are physically present in the examination hall thereby eliminating impersonation as observed by Oko & Adie (2016). The CCTV recordings are used to review the behaviours of examinees during the examination. The CCTV also monitors the activities of proctors and detects the presence of mercenaries and others who collude with examinees to cheat as pointed out by Ijaiya (2011). The use of script submission software and drop boxes to capture script numbers and to store scripts respectively prevents dubious center owners from swapping scripts after they have been submitted as observed in Anakwe (2008) cited in Anakwe (2010).

CONCLUSION

A security system for monitoring students and proctors during external offline examinations was discussed. The system is designed to work even in remote areas with unstable internet signals that cannot support live streaming of CCTV videos and permit online examinees verification. The system covers important aspects of external offline examination where malpractices were noticed in the past. The use of biometric authentication system for verification of examinees at the beginning of the examination and at the time of script submission was recommended. CCTV cameras were recommended for recording of the entire examination session and a blind review of the footage was proposed before clearing scripts for marking. The Script Submission System was recommended for script capturing while drop boxes were proposed for temporal storage of scripts. When implemented, the proposed system will reduce cases of malpractices in external offline examinations to the barest minimum. It will also reduce the migration of examinees from urban areas to write examinations in miracle centers usually established in remote areas.

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