



AN INTELLIGENT DEEP LEARNING-BASED FACE RECOGNITION SYSTEM FOR EXAMINATION ATTENDANCE

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Abstract: Ensuring the authenticity of student identity during examinations remains a significant challenge in higher education, where conventional attendance procedures based on manual verification and examination slips are vulnerable to impersonation, administrative inefficiencies, and human error. This study presents an intelligent deep learning-based face recognition system developed to automate examination attendance management within the Faculty of Computing, Northwest University, Kano. The proposed system integrates Multi-task Cascaded Convolutional Networks (MTCNN) for robust face detection and alignment with FaceNet for discriminative facial feature embedding and identity recognition. To demonstrate its practical applicability, a web-based supervisor interface was developed to support real-time student authentication, automated attendance recording, secure storage of attendance records, and flexible attendance retrieval through student-based and course-based CSV reports. The proposed system utilized a facial image dataset collected from 69 registered students across four departments within the Faculty of Computing, Northwest University, Kano. Enrolment images were used to generate facial embeddings for each registered student, while the system was evaluated using 3,450 test images to assess its face recognition performance and practical applicability for examination attendance management. Experimental evaluation showed that the system correctly recognized 3,441 facial images, yielding an overall recognition accuracy of 99.74%, while achieving an average precision, recall, and F1-score of 0.99. Functional evaluation further confirmed the system's capability to perform reliable real-time attendance recording, prevent duplicate attendance entries, and efficiently generate attendance reports required for examination administration. Although recognition performance was influenced by variations in illumination and image quality, the overall findings demonstrate that the developed system provides an accurate, efficient, and practical biometric solution for strengthening examination attendance management and mitigating impersonation within the Faculty of Computing, Northwest University, Kano.

Keywords: Deep Learning; Face Recognition; Examination Attendance; FaceNet; MTCNN.

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1.0 Introduction

Examination attendance serves as an essential component of academic administration, providing evidence of student participation in scheduled assessments and supporting institutional efforts to uphold examination integrity (Haron et al., 2025). Accurate attendance records facilitate candidate verification, regulatory compliance, and post-examination auditing while contributing to the transparency and credibility of assessment processes (Irwan et al., 2025). Despite advances in digital technologies across higher education, attendance verification during examinations in many institutions continues to rely on conventional procedures such as examination slips, identity cards, and manual attendance registers (Haron et al., 2025; Irwan et al., 2025). Although these methods are widely adopted because of their simplicity and low implementation cost, they remain vulnerable to impersonation, inaccurate record keeping, administrative delays, and human error (Ajayi et al., 2025). These challenges become increasingly pronounced as student populations grow, making timely and reliable identity verification more difficult and highlighting the need for more secure, efficient, and automated approaches to examination attendance management (Ajayi et al., 2024; Akanni et al., 2025).

The growing demand for secure, accurate, and efficient attendance management has accelerated the adoption of automated identification technologies designed to enhance identity verification while addressing the limitations associated with conventional manual attendance procedures (Shirkande et al., 2025). In response to these challenges, biometric authentication has emerged as a reliable alternative by verifying individuals using unique physiological or behavioural characteristics rather than identity documents or manually recorded information (Uwaechia & Ramli, 2021; Al Mamun, 2023). Existing biometric attendance systems have employed a range of modalities, including fingerprint, iris, voice, and facial recognition, each characterised by distinct operational capabilities, performance characteristics, and implementation constraints (Uwaechia & Ramli, 2021). Among these modalities, facial recognition has emerged as one of the most widely adopted biometric modalities for attendance management because it enables contactless identity verification, supports automated real-time recognition, and can be deployed using standard digital cameras without requiring specialised biometric acquisition hardware (Saraswat et al., 2023). Recent advances in deep learning have further strengthened the performance of facial recognition systems by enabling more discriminative feature representation and robust identity matching under variations in facial expression, pose, illumination, and other unconstrained imaging conditions (Du et al., 2022). Consequently, facial recognition has become one of the most

practical biometric solutions for attendance management in higher education because it provides accurate, automated, and scalable identity verification while improving the efficiency of attendance recording (Nguyen-Tat et al., 2024).

Among contemporary face recognition approaches, deep learning has emerged as a leading paradigm for learning highly discriminative facial representations from large-scale image datasets. Unlike conventional machine learning approaches that depend on manually engineered features, deep learning models can learn hierarchical representations directly from image data, supporting automated image analysis across diverse application domains (Deng, 2024; Tofa et al., 2025). FaceNet generates compact and highly discriminative facial embeddings that preserve identity information, whereas Multi-task Cascaded Convolutional Networks (MTCNN) provide reliable face detection and facial alignment, thereby improving recognition performance under practical operating conditions (Karamizadeh et al., 2025). The integration of these techniques has substantially improved the reliability of facial recognition systems across a wide range of applications, including access control, surveillance, identity verification, and attendance management (Karamizadeh et al., 2025). Nevertheless, successful deployment in examination environments requires more than accurate facial recognition alone; it also demands seamless integration with attendance recording workflows, reliable data management, and practical reporting mechanisms capable of supporting examination administrators in real-world academic settings (Olojido & Oladimeji, 2025).

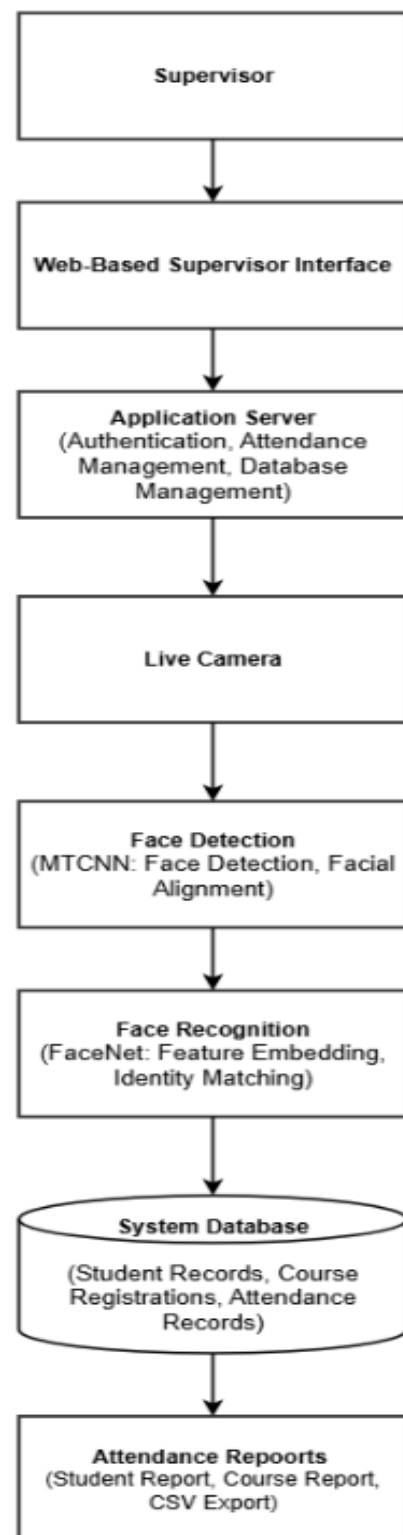
Although deep learning-based facial recognition has achieved remarkable performance in identity verification and automated attendance applications, much of the existing research has focused on improving recognition accuracy or classroom attendance monitoring (Ismail et al., 2022). Comparatively less attention has been devoted to examination attendance, where identity verification must be integrated with operational tasks such as real-time attendance recording, secure storage of attendance records, and efficient retrieval of examination reports for administrative purposes. In addition, many reported systems have been evaluated under controlled experimental conditions with limited discussion of their deployment within real institutional environments. These limitations underscore the need for practical solutions that not only deliver reliable facial recognition performance but also support the operational requirements of examination attendance management in higher education institutions. This study addresses this need through the design, implementation, and evaluation of an intelligent deep learning-based face recognition system developed and evaluated within the Faculty of Computing, Northwest University, Kano.

Motivated by these challenges, this study presents the design, implementation, and evaluation of an intelligent deep learning-based face recognition system for examination attendance within the Faculty of Computing, Northwest University, Kano. The system integrates MTCNN for robust face detection and facial alignment with FaceNet for discriminative facial feature representation and identity recognition, and embeds these capabilities within a supervisor-oriented attendance management platform that supports real-time student authentication, automated attendance recording, secure data management, and retrieval of attendance reports based on either individual students or examination courses. The proposed system was evaluated using facial image data collected from 69 registered students across four departments within the Faculty of Computing under actual institutional conditions to assess both its recognition performance and its practical applicability to examination attendance management. The study demonstrates that integrating deep learning-based face recognition with an operational examination attendance workflow provides an effective and practically deployable approach to strengthening examination integrity while improving the accuracy, efficiency, and reliability of attendance administration. The remainder of this paper is organized as follows. Section 2 describes the research methodology, Section 3 presents the experimental results and discussion, and Section 4 concludes the paper with recommendations for future research.

2.0 Materials and Methods

The development of the proposed examination attendance system involved a systematic methodology comprising dataset acquisition, facial image preprocessing, deep learning-based face recognition, attendance management, and performance evaluation. The methodology was designed to ensure reliable student identification under practical examination conditions while supporting automated attendance recording and efficient attendance management. Figure 1 illustrates the overall architecture of the proposed system, while the individual methodological components are described in the following subsections.

Figure 1: Overall Architecture of the Proposed Intelligent Deep Learning-Based Face Recognition System



2.1 Proposed System Architecture

The architecture of the proposed examination attendance system comprises two interconnected operational phases: student enrolment and examination attendance verification, as illustrated in Figure 1. These phases are integrated through a centralized facial representation database and an attendance management module to enable automated student authentication and attendance recording during examinations.

During the student enrolment phase, facial images are acquired from registered students and preprocessed before being passed to the face recognition pipeline. The pipeline employs Multi-task Cascaded Convolutional Networks (MTCNN) to detect and align facial regions, after which the aligned facial images are processed using the pretrained FaceNet model to extract discriminative facial embeddings. To improve the stability of facial representation, embeddings generated from the five enrolment images of each student are averaged to produce a single representative embedding, which is stored as the student's reference template within the serialized recognition model.

During the examination attendance phase, the supervisor authenticates into the system and first selects the applicable academic session and semester. The integrated camera is then used to capture the facial image of the student, which undergoes face detection, alignment, and feature extraction through the recognition pipeline. Upon successful identification, the system retrieves and displays the student's profile information, including the full name, registration number, academic level, and the list of courses registered for the selected academic session and semester. The supervisor subsequently selects the appropriate examination course from the displayed course list, after which the system records the student's attendance automatically. To preserve data integrity, duplicate attendance entries for the same student and examination course are prevented. All attendance records are securely stored in the attendance database and may subsequently be retrieved and exported as either student-based or course-based CSV reports to facilitate examination administration and record management.

2.2 Dataset Acquisition and Preparation

To ensure that the proposed examination attendance system was developed and evaluated using data representative of its intended deployment environment, a facial image dataset was collected from registered undergraduate students within the Faculty of Computing, Northwest University, Kano. The dataset was acquired under institutional conditions and organized into separate enrolment and evaluation subsets. During the enrolment phase, facial images were collected to establish the reference facial representation for each registered student, whereas a separate set of facial images

was acquired during the evaluation phase to assess the recognition performance of the proposed system under practical operating conditions.

Table 1. Summary of the facial image dataset used in this study.

Dataset Characteristic	Value
Number of participating students	69
Academic departments	4
Enrolment images per student	5
Total enrolment images	345
Representative facial embeddings	69
Test images per student	50
Total test images	3,450

The facial image dataset comprised 69 registered undergraduate students drawn from the four academic departments within the Faculty of Computing, namely the Department of Computer Science, Department of Cyber Security, Department of Information Technology, and Department of Software Engineering. During the enrolment phase, five facial images were captured for each student, resulting in a total of 345 enrolment images. Each enrolment image was processed through the face recognition pipeline to extract a facial embedding, after which the five embeddings corresponding to each student were averaged to generate a single representative embedding. Consequently, 69 representative facial embeddings were generated and serialized into a trained model file (.pkl), with one representative embedding serving as the reference template for each registered student during identity recognition.

To evaluate the performance of the proposed system, 50 facial images were captured for each enrolled student, resulting in an evaluation dataset containing 3,450 test images. Unlike the enrolment images, which were used to construct the reference facial representations, the evaluation images were used solely to assess the recognition performance of the proposed system and were not involved in generating the representative facial embeddings. The evaluation dataset enabled the assessment of the system's recognition performance under practical operating conditions representative of examination attendance scenarios within the Faculty of Computing.

2.3 Face Detection and Recognition

Reliable face recognition requires accurate face localization, robust feature extraction, and effective similarity matching. To achieve these objectives, the proposed system employs a two-stage deep learning pipeline comprising Multi-task Cascaded Convolutional Networks (MTCNN) for face detection and alignment, followed by FaceNet for facial feature extraction and identity recognition.

During both the enrolment and examination attendance phases, each captured facial image is first processed using the MTCNN detector to identify the facial region and localize key facial landmarks. To improve the quality of the extracted facial features, only detections with a confidence score of at least 0.95 and a minimum face size of 40×40 pixels are accepted for further processing. The detected facial region is subsequently aligned and resized to 160×160 pixels, producing a standardized facial image suitable for feature extraction. These preprocessing operations reduce the influence of variations in facial position and scale, thereby improving the consistency of the extracted facial representations.

The aligned facial images are subsequently processed using the pretrained FaceNet model to generate compact numerical representations, commonly referred to as facial embeddings. Each embedding is normalized using L2 normalization to ensure a unit-length feature vector, thereby improving the stability of similarity computation during identity matching. Given a facial embedding e , the normalized embedding $\hat{e}$ is computed as

$$\hat{e} = \frac{e}{\|e\|_2}$$

where $\|e\|_2$ denotes the Euclidean norm of the embedding vector.

During the enrolment phase, five normalized facial embeddings are generated for each registered student. Rather than using individual embeddings independently, the proposed system constructs a single representative facial template by computing the centroid of the five normalized embeddings. Let $\hat{e}_1, \hat{e}_2, \dots, \hat{e}_5$ denote the normalized embeddings obtained from the enrolment images of a student. The representative embedding C is computed as

$$C = \frac{1}{5} \sum_{i=1}^5 \hat{e}_i$$

The resulting representative embeddings are serialized and stored within the trained model (saved_model.pkl), where each centroid serves as the reference facial template for a single enrolled student during identity recognition.

During examination attendance, the facial image captured through the supervisor interface undergoes the same detection, alignment, normalization, and feature extraction process. The generated normalized embedding is compared with the representative embeddings stored in the trained model using cosine similarity, defined as

$$S(x, c) = \frac{x \cdot c}{\|x\| \|c\|}$$

where x denotes the normalized embedding extracted from the captured facial image, c represents the stored representative embedding of an enrolled student, and $S(x, c)$ is the confidence score between the two embeddings. The identity corresponding to the highest similarity score is

selected as the recognition result and subsequently passed to the attendance management module for further processing.

2.4 Examination Attendance Procedure

The proposed examination attendance procedure integrates the deep learning-based face recognition module with an automated attendance management workflow to provide secure student authentication and real-time attendance recording during examinations. The workflow establishes a direct interaction between the recognition model, student registration records, and the attendance database, thereby ensuring that attendance is recorded only for authenticated students within the selected academic session and semester.

Once the academic session and semester have been specified, the integrated camera is activated to capture the facial image of each student presenting for examination. The captured image is processed using the face recognition pipeline described in Section 2.3, after which the identified student's academic information is retrieved automatically from the student database. The system displays the student's full name, registration number, academic level, and the list of courses registered for the selected academic session and semester. The automatic retrieval of student information enables immediate identity verification while restricting course selection to those officially registered by the authenticated student for the selected academic session and semester.

Following successful identity verification, the supervisor selects the appropriate examination course from the displayed list of registered courses. Upon course selection, the system creates an attendance record comprising the student identity, selected examination course, recognition confidence score, and automatically generated timestamp. To maintain the integrity of examination records, the system enforces a uniqueness constraint that prevents multiple attendance entries for the same student-course combination. All attendance records are maintained within the attendance database and can subsequently be retrieved through dedicated reporting functions, allowing supervisors to generate student-based or course-based attendance reports in CSV format for examination monitoring, administrative review, and institutional record keeping.

Algorithm 1: Examination Attendance Recording Procedure

Input:

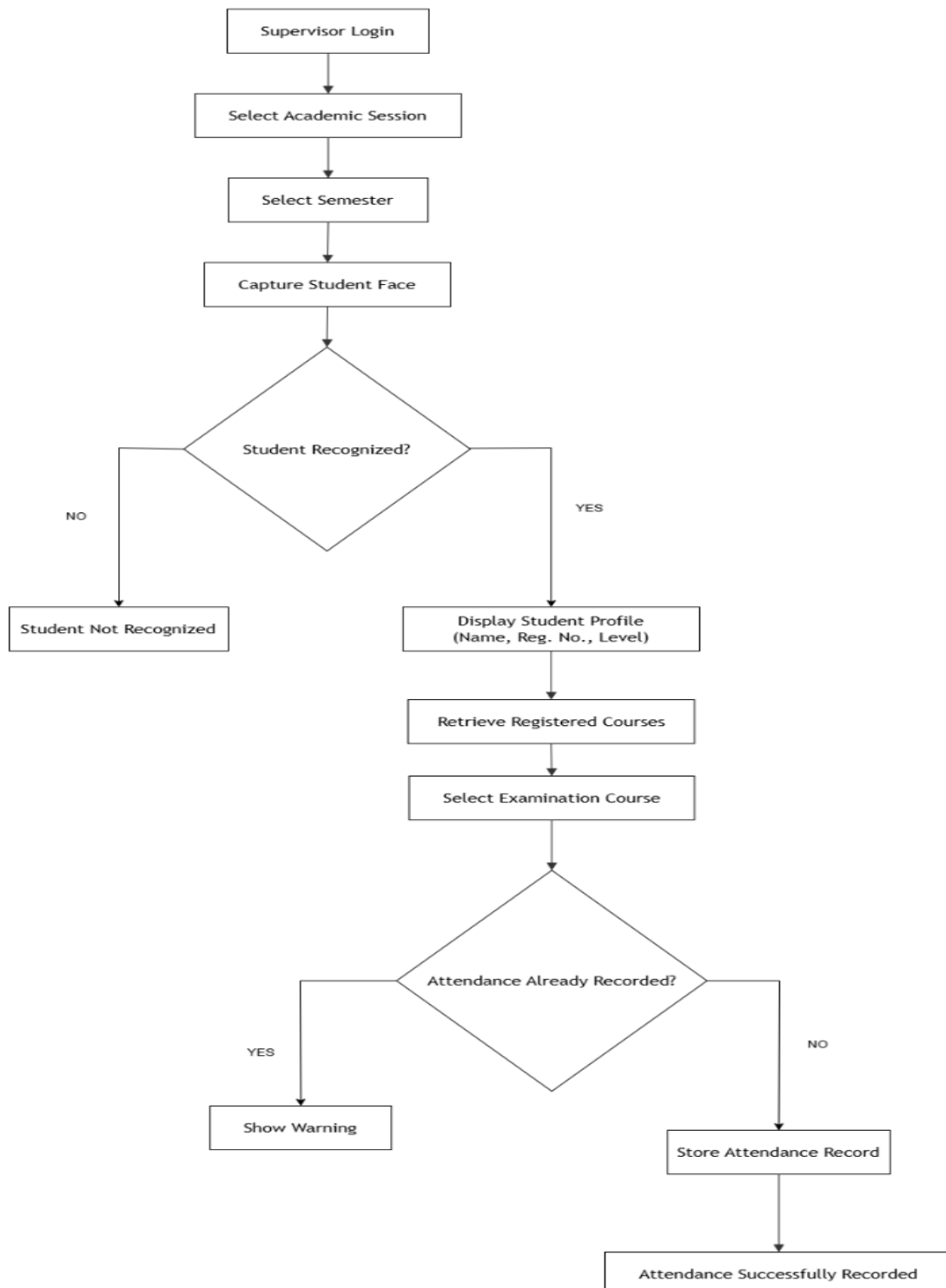
- Live facial image I
- Selected academic session S
- Selected semester T

Output:

- Verified attendance record R

- 1: Authenticate supervisor
- 2: Select academic session S and semester T
- 3: Capture live facial image I
- 4: Detect and recognize the student's face
- 5: Retrieve the student's academic profile
- 6: Display registered courses for S and T
- 7: Supervisor selects the examination course
- 8: Verify that no previous attendance record exists
- 9: Generate attendance record with timestamp and recognition confidence
- 10: Store attendance record in the attendance database
- 11: Enable attendance retrieval and CSV export
- 12: Return attendance record R

Figure 2. Workflow of the proposed examination attendance recording procedure.



2.5 System Implementation

The proposed examination attendance system was implemented as a web-based application that integrates deep learning-based face recognition with an attendance management platform to facilitate real-time examination attendance recording. The system adopts a modular architecture consisting of a face recognition module, an application server, a relational database, and a web-based user interface. The face recognition module is responsible for facial image preprocessing, feature extraction, and identity recognition, while the application server manages user authentication, attendance processing, student information retrieval, course management, and report generation. This modular organization improves system maintainability by separating the artificial intelligence components from the attendance management functionalities.

The face recognition component was implemented using OpenCV for image acquisition and preprocessing, MTCNN for face detection and facial alignment, and the pretrained FaceNet model for facial feature extraction. During the enrolment stage, representative facial embeddings generated for registered students were serialized and stored in a trained model file (saved_model.pkl), which is subsequently loaded during examination attendance to perform identity recognition through cosine similarity matching. Unlike attendance and academic records, which are maintained within the relational database, the serialized model file serves exclusively as the repository of representative facial embeddings used during the recognition process.

The application layer was developed using the Flask web framework with SQLAlchemy serving as the Object Relational Mapping (ORM) layer for database interaction. Student information, academic sessions, semesters, registered courses, supervisor accounts, and attendance records are managed within a MySQL database, while the web interface provides supervisors with facilities for student authentication, attendance recording, attendance retrieval, and CSV report generation. The integrated architecture enables seamless interaction between the face recognition module and the attendance management system, thereby supporting efficient examination attendance administration within the Faculty of Computing, Northwest University, Kano.

2.6 Performance Evaluation

The performance of the proposed face recognition system was evaluated using the independent test dataset described in Section 2.2, comprising 3,450 facial images collected from 69 registered students under practical operating conditions representative of examination attendance. The evaluation images were excluded from the enrolment

process and were used solely to assess the recognition capability of the proposed system. For each test image, the predicted identity produced by the face recognition model was compared with the corresponding ground-truth identity to determine whether the recognition outcome was correct. The resulting predictions were subsequently used to compute standard classification performance metrics commonly employed in face recognition studies.

To provide a comprehensive assessment of the recognition performance, four evaluation metrics were considered, namely accuracy, precision, recall, and F1-score. Accuracy measures the overall proportion of correctly recognized facial images, precision evaluates the reliability of the predicted identities, recall measures the ability of the system to correctly recognize enrolled students, while the F1-score provides a balanced evaluation by combining precision and recall into a single performance indicator. These metrics were computed from the confusion matrix comprising true positives (TP), true negatives (TN), false positives (FP), and false negatives (FN) using the following equations..

$$\text{Accuracy} = \frac{TP + TN}{TP + TN + FP + FN}$$

$$\text{Precision} = \frac{TP}{TP + FP}$$

$$\text{Recall} = \frac{TP}{TP + FN}$$

$$F1 = 2 \times \frac{\text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}}$$

The selected evaluation metrics collectively provide a comprehensive assessment of the proposed system by measuring not only its overall recognition accuracy but also the reliability and consistency of its identity predictions. This evaluation methodology enables an objective assessment of the suitability of the proposed system for real-time examination attendance management under practical institutional conditions.

3.0 Results and Discussion

This section presents the implementation results and experimental evaluation of the proposed intelligent deep learning-based face recognition system for examination attendance. The discussion is organized into three parts. First, the functional implementation of the developed system is presented to demonstrate the operational workflow of the web-based attendance platform. Next, the quantitative performance of the face recognition model is evaluated using standard classification metrics and a confusion matrix. Finally, the results are interpreted with respect to the practical requirements of examination attendance management, highlighting the strengths, limitations, and applicability of the proposed system within the Faculty of Computing, Northwest University, Kano.

3.1 Functional Implementation of the Proposed System

The proposed examination attendance system was successfully implemented as a web-based application that integrates deep learning-based face recognition with an automated attendance management platform. The implementation provides a unified environment through which supervisors can authenticate into the system, verify student identities in real time, record examination attendance, and retrieve attendance reports. The developed interface was designed to support the operational workflow of examination attendance while minimizing manual intervention and reducing opportunities for impersonation. The major functional components of the implemented system are presented and discussed in the following subsections.

Supervisor Authentication

The operational workflow of the proposed examination attendance system begins with supervisor authentication. Access to the attendance management platform is restricted to authorized supervisors through a secure login interface that requires valid authentication credentials before any examination activities can be performed. This authentication mechanism establishes the first layer of system security by preventing unauthorized access to student records and attendance data. Following successful authentication, the supervisor is granted access to the examination attendance environment, thereby ensuring that all subsequent attendance operations are performed only by authorized personnel.

Academic Session and Semester Selection

Following successful authentication, the supervisor selects the applicable academic session and semester. These selections establish the academic context for the examination attendance exercise and ensure that all subsequent operations are associated with the correct examination period. Once the academic session and semester have been specified, the system retrieves the corresponding student registration information, allowing attendance to be recorded only for students and courses registered within the selected academic period. This preliminary step minimizes administrative errors arising from incorrect session or semester selection and provides a structured framework for managing attendance records across multiple academic sessions.

Real-Time Face Recognition and Attendance Recording

After the academic context has been established, the supervisor initiates the attendance process through the integrated live camera interface. The system captures the student's facial image and immediately performs face detection, facial alignment, feature extraction, and identity recognition using the proposed deep learning pipeline. Upon successful recognition, the system automatically retrieves

and displays the student's academic information, including the full name, registration number, academic level, and registered examination courses for the selected academic session and semester. The supervisor then selects the appropriate examination course from the list of registered courses, after which the system records the attendance together with the recognition confidence score and timestamp. To preserve the integrity of attendance records, duplicate attendance entries for the same student and examination course are automatically prevented. This integrated workflow enables rapid identity verification while substantially reducing the manual effort associated with conventional examination attendance procedures.

Attendance Reporting and CSV Export

Beyond real-time attendance recording, the developed system provides comprehensive reporting facilities to support examination administration. The reporting module enables supervisors to retrieve attendance records either on a student basis or on a course basis. Student-based reporting allows attendance records to be generated by specifying a student's registration number together with the relevant academic session and semester, whereas course-based reporting produces attendance records for all students registered in a specified examination course. Both reporting options support export in CSV format, thereby facilitating record keeping, administrative review, and subsequent analysis using spreadsheet applications. These reporting capabilities extend the functionality of the proposed system beyond identity recognition by providing an efficient mechanism for managing and documenting examination attendance within the Faculty of Computing, Northwest University, Kano.

3.2 Face Recognition Performance Evaluation

The recognition performance of the proposed system was evaluated using the independent test dataset comprising 3,450 facial images obtained from 69 registered students, with 50 test images used for each student. Each test image was processed independently through the complete face recognition pipeline, and the predicted identity was compared with the corresponding ground-truth identity. The evaluation was performed using standard multi-class classification metrics, including accuracy, precision, recall, and F1-score, to provide a comprehensive assessment of the system's recognition capability under conditions representative of examination attendance within the Faculty of Computing, Northwest University, Kano.

The quantitative evaluation demonstrated that the proposed system achieved an overall recognition accuracy of 99.74%, correctly identifying 3,441 out of 3,450 test images, with only 9 images incorrectly classified. A summary of the performance metrics is presented in Table 2. The high recognition accuracy indicates that the integration of

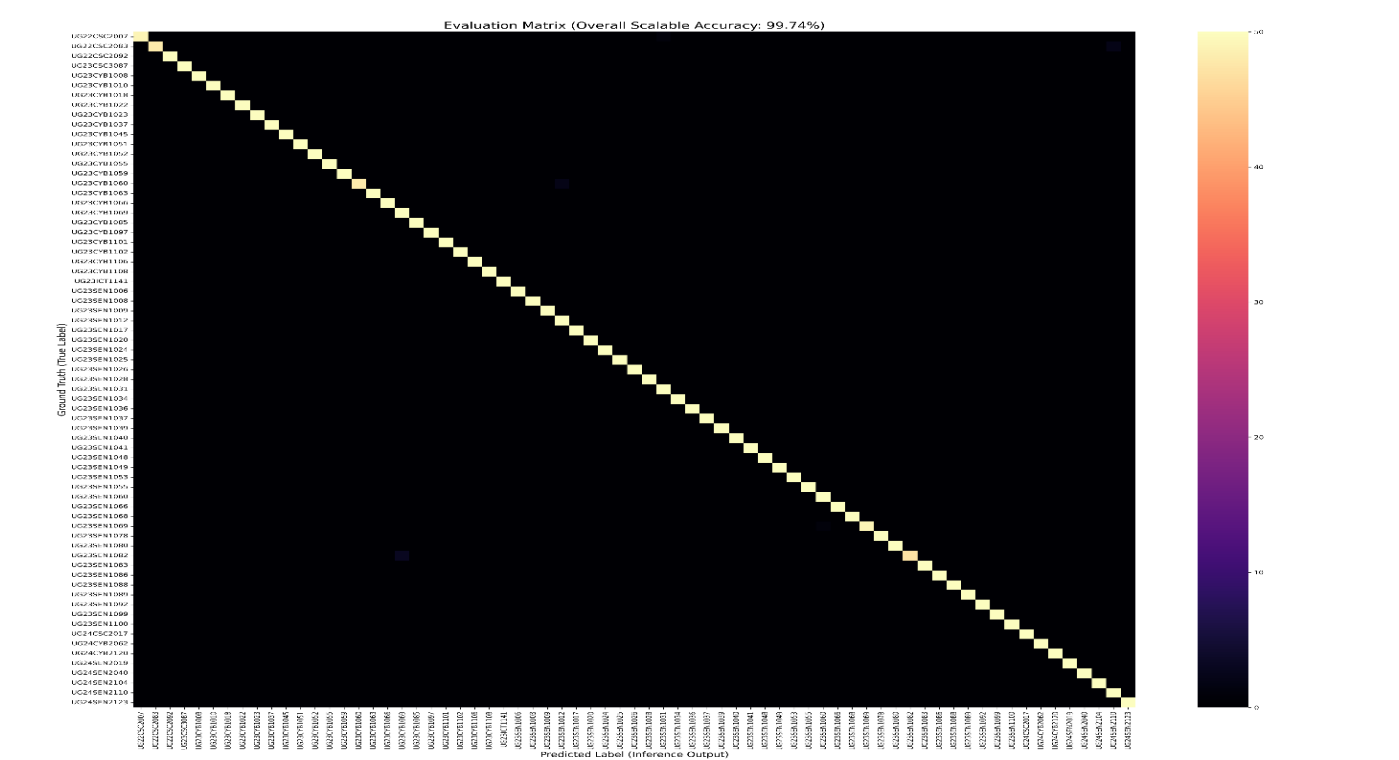
MTCNN for face detection and alignment with FaceNet for facial feature representation provides a reliable framework for distinguishing enrolled students during examination attendance. The small number of misclassified samples further suggests that the representative facial embeddings generated during the enrolment phase were sufficiently discriminative to support consistent identity recognition across the evaluation dataset.

Table 2. Performance evaluation of the proposed face recognition system.

Metric	Value
Accuracy	99.74%
Average Precision	0.99
Average Recall	0.99
Average F1-Score	0.99
Total Test Samples	3450
Correct Predictions	3441
Misclassifications	9

Further analysis of the classification report showed an average precision of 0.99, recall of 0.99, and F1-score of 0.99 across all student identities. These results indicate that the proposed system produced very few false positive and false negative recognitions while maintaining a balanced recognition performance across the enrolled students. From the perspective of examination attendance management, this balanced performance is particularly important because it reduces both the likelihood of incorrectly authenticating an individual and the possibility of failing to recognize a legitimately enrolled student. Consequently, the obtained performance metrics demonstrate that the proposed system provides a dependable biometric authentication mechanism suitable for practical examination attendance applications.

Figure 3: Confusion matrix of the proposed face recognition system.



The confusion matrix presented in Figure 3 provides a detailed visualization of the classification performance by comparing the actual student identities with the corresponding predicted identities. The dominant diagonal pattern observed in the matrix indicates that the overwhelming majority of facial images were correctly classified, while only a few isolated off-diagonal entries correspond to the nine misclassified test images. The limited

occurrence of off-diagonal values demonstrates that confusion between different student identities was minimal, further supporting the high recognition accuracy achieved by the proposed system. Collectively, the quantitative evaluation confirms that the developed face recognition system provides accurate and reliable identity verification for examination attendance within the scope of this study.

3.3 Discussion

The experimental results demonstrate that the proposed system is capable of providing accurate and reliable face recognition for examination attendance under practical institutional conditions. The high recognition performance achieved by the proposed system can be attributed to the complementary strengths of the adopted deep learning techniques. MTCNN provided robust face detection and facial alignment by accurately localizing facial regions prior to feature extraction, while FaceNet generated highly discriminative facial embeddings that effectively captured identity-specific characteristics. The combination of these two components enabled the proposed system to distinguish between enrolled students with a high degree of consistency, thereby supporting reliable identity verification during examination attendance.

Beyond its recognition performance, the proposed system demonstrates the practical advantages of integrating deep learning-based face recognition with a complete examination attendance management workflow. Rather than functioning solely as a face recognition model, the developed system incorporates real-time student authentication, automated attendance recording, duplicate attendance prevention, and flexible retrieval of attendance records through student-based and course-based CSV reports. This integration significantly reduces the administrative burden associated with conventional attendance procedures while improving the accuracy, consistency, and traceability of examination records. The ability to automatically retrieve registered courses after successful student recognition further minimizes manual intervention during attendance recording and contributes to a more efficient examination management process.

Although the proposed system demonstrated excellent recognition performance, a small number of recognition errors were observed during the experimental evaluation. The observed misclassifications are consistent with practical imaging challenges such as variations in illumination, facial pose, and image quality, which commonly affect face recognition performance. Nevertheless, the limited number of incorrectly recognized images indicates that the proposed recognition pipeline remained robust under the operational conditions considered in this study. The obtained results therefore demonstrate that the proposed system is sufficiently reliable for practical deployment in examination attendance management within the Faculty of Computing, Northwest University, Kano.

While the present study focused on validating the proposed system using facial image data collected from students within a single faculty, the developed architecture is sufficiently modular to support future extension to broader institutional environments. The integration of deep learning-

based face recognition with automated attendance management provides a foundation that can be adapted for larger student populations and additional academic units with appropriate enrolment data. Future enhancements may further improve the scalability and operational flexibility of the system through integration with institutional information systems, expanded administrative functionalities, and evaluation using more diverse datasets collected across multiple faculties or institutions.

4.0 Conclusion

This study presented the design, implementation, and evaluation of an intelligent deep learning-based face recognition system for automated examination attendance management within the Faculty of Computing, Northwest University, Kano. The proposed system integrated MTCNN for robust face detection and facial alignment with FaceNet for discriminative facial feature representation and identity recognition, and incorporated these capabilities into a web-based supervisor platform that supports real-time student authentication, automated attendance recording, secure attendance management, and CSV-based report generation. A facial image dataset collected from 69 registered students across four academic departments was used for enrolment and system evaluation, demonstrating the practical applicability of the proposed approach in an institutional examination environment.

Experimental evaluation demonstrated that the proposed system achieved a recognition accuracy of 99.74%, with corresponding average precision, recall, and F1-score of 0.99, confirming its capability to provide accurate and reliable identity verification for examination attendance. Beyond its recognition performance, the developed system streamlined the attendance management process by reducing manual intervention, preventing duplicate attendance entries, and providing efficient mechanisms for attendance retrieval and reporting. These findings demonstrate that the integration of deep learning-based face recognition with an operational attendance management workflow offers an effective solution for improving the efficiency, reliability, and integrity of examination attendance administration.

Future research will focus on extending the current system through the development of comprehensive administrative and student management modules, integration with institutional academic information systems to support automated course registration synchronization, deployment through scalable cloud-based architectures and RESTful services, and validation using larger and more diverse datasets collected from multiple faculties and higher education institutions. These enhancements are expected to improve the scalability, interoperability, and broader applicability of the proposed system beyond the institutional scope considered in this study.

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