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Development and Performance Evaluation of a Web-Based Facial Recognition Attendance System for Higher Education Institutions

Maribel M. Estioco[1*], Wences Love Ylanan[2], Jezreel Roy Mamhot[3], Jeza Senining[4], Erica Pearl Faith Sarueda[5]
[1]Faculty, J. H. Cerilles State College, Philippines
[2,3,4,5]Student, J. H. Cerilles State College, Philippines

Abstract

The web-based facial recognition attendance system, designed and evaluated in this project, provided an efficient, accurate, and secure means of taking attendance at J.H. Cerilles State College. Face-to-face identification can eliminate errors in manual and pen-and-paper recording, such as late manual logs and logbook signing for absent students. This system utilizes the 4D development model: Discover, Design, Develop, and Deploy for automating this traditional process. The web system is built with HTML, CSS, JavaScript, PHP, MySQL, and face-api.js for browser-based real-time face detection and recognition. Security for user login, face enrollment, automatic attendance recording, role-based management, and record export are among the main features of this system. In terms of system evaluation, the tests undertaken included alpha, beta, load, stress, compatibility, usability, and functionality testing. Analysis of these tests showed high user acceptance. The total weighted mean across these tests was 4.73, corresponding to Strongly Agree. The system demonstrated consistent response time and maintained accurate recognition performance with 30 users concurrently operating. Stress testing successfully identified 249/265 users, achieving 93.96% recognition accuracy during peak usage. Compatibility testing revealed that the system functions correctly in current web browsers like Google Chrome and Brave and includes proper privacy measures. The result shows that the system reduced the workload on admin staff, reduced attendance errors, and increased the transparency of the attendance system. We conclude that the web-based facial recognition attendance system is suitable and flexible to apply in a higher education system.

Keywords: Facial Recognition, Web-Based Attendance System, Higher Education, Attendance Management, Real-Time Monitoring, Biometric Authentication

1. Introduction

The administration and education process remains the most essential task for academic and learning institutions, as attendance management helps monitor students, teachers can be held accountable, and reports can be generated for the institution and used to assess the performance of each element. Researchers have also shown that there is a positive correlation between attending class regularly and academic success, student commitment, and retention (Cred et

*Corresponding Author Email: maribel.estioco@jhcsc.edu.ph
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al., 2010; Kassarnig et al., 2017). Still, most of the universities or colleges use the conventional method in the present times: roll calls, papers for signing and logs books, but all of these methods have proven to be time consuming, prone to clerical errors and also can be subject to false attendance by substituting the actual student or signing more than once (Mohammed et al., 2018; Mondal & Mondal, 2024).

Considering the growing interest in digital transformation in education, many institutions deploy automated attendance systems such as RFID, QR codes, mobile-based systems, and Biometric systems. Among the many biometrics, face recognition has received widespread recognition for its non-contact, non-shareable, and real-time identification capabilities. Cards and QR codes may be misplaced, stolen, and shared, thereby reducing the security of authentication, whereas face recognition enables stronger authentication while reducing institutions' workload (Essien & Ansa, 2023; Kamil et al., 2023).

Moreover, the latest developments in browser-based machine learning libraries, such as face-api.js, have made facial recognition even easier to implement. These libraries enable web applications to implement facial recognition functionality directly within a web browser, thereby eliminating the need to invest in expensive, specialized hardware or install complex software. Thus, web-based attendance systems are scalable, cost-effective, and easier to integrate into campus information systems (Iftekar & Zeeshan, 2024).

Previous studies have examined biometric attendance systems; few studies have investigated browser-based facial recognition systems, especially in terms of design and evaluation in a real-world setting using Philippine higher education institutions. This paper does that.

Attendance at J.H. Cerilles State College has historically relied on a time-consuming, labor-intensive manual attendance system (especially during major convocations and activities), which can result in delayed attendance reports and inconsistent records, and add work to employees. This problem highlights the need for a current attendance system suitable for implementation at J.H. Cerilles State College, a school embracing digital transition.

This research, entitled Development and Performance Evaluation of a Web-Based Facial Recognition Attendance System for Higher Education Institutions, developed and evaluated the functional capability and performance of a web-based, real-time facial recognition automated attendance-capture system, specifically its functionality, usability, compatibility, reliability, and accuracy when integrated into a real environment. The study will provide evidence of the utility of a web-based biometric system for modernizing attendance tracking.

2. Literature Review

Attendance management systems have evolved from manual to automated, intelligent systems. In higher education institutions, attendance records are important for tracking student engagement, compliance with institutional regulations, and student performance. Ineffective manual attendance recording often eats up class time, leads to administrative errors, and allows attendance to be taken by a surrogate (Mondal & Mondal, 2024). Therefore, digital technologies such as RFID, QR codes, fingerprint biometrics, and face recognition have been investigated by researchers and institutions.

Traditional and Smart Attendance Systems: Numerous studies have analyzed automated attendance systems, and Aldabagh (2024) conducted a systematic review of students' attendance technologies, classifying them into biometric and non-biometric systems. The study explains that automated systems help ensure high accuracy, reduce manual work, and facilitate the use of a central database. RFID-based systems, for example, provide fast attendance tracking, but they can be compromised by card sharing and theft. The QR code system offers low cost and high installation efficiency, though its authenticity can be verified by capturing screenshots of the code or by sending it to other students via various sources. The identified drawbacks have led to an increasing inclination towards facial recognition as a biometric system.

Facial Recognition Attendance Systems: Systems also use biometrics, a concept that involves identifying a person by a unique characteristic, such as the face (which is inherently more secure than card- or code-based identification systems). Recent experiments have shown that face recognition can be effectively used for attendance monitoring. Boe et al. (2024) developed an automated classroom attendance-tracking system and observed that the computer vision component achieved higher accuracy and reduced the time required to take attendance. Similarly, Bugingo et al. (2025) designed a real-time face-tracking attendance system that improved accuracy and reliability during lively class activities.

With increased accuracy, attendance systems are increasingly using deep learning. Essien and Ansa (2023) concluded that systems that implement deep learning achieve better performance in changing environments and expressions. The recognition accuracy of some systems exceeded 90% in controlled environments, suggesting that biometrics are highly feasible in real-world settings. These experiments suggest that face recognition systems can work for biometric attendance.

Web-Based Attendance Monitoring Systems: Many face recognition systems have been developed for desktops, yet web-based systems offer the advantages of wider access, scalability, and greater maintenance flexibility. With browser-based systems, users no longer need to download or install any special program to use attendance services. Domingo et al. (2024) have designed QSUM-eASys, a face recognition and web-based attendance checking and monitoring system for the staff in a university, and found that the system provided effective assistance for checking attendance and monitoring records. Thus, a marriage between face recognition and the web is highly beneficial to institutions. Recently, modern JavaScript libraries such as face-api.js offer greater deployment options on the web. Iftekar and Zeeshan (2024) indicated that face-api.js supported facial detection and recognition in the browser, eliminating the need for specialized hardware, reducing the burden of use, and enhancing portability. Browser-native systems such as this would serve universities well as they seek to upgrade to digital technology at minimal cost.

Performance Evaluation in Attendance Systems: Another important system assessment involves system performance testing, system usability, system compatibility testing, system response testing, system scalability testing, and system recognition testing. Tests typically include load, stress, and user acceptance tests to determine whether the system is ready for installation in institutions. According to Bugingo et al. (2025), real-time attendance systems

require performance testing to support a multi-user environment effectively, especially during lectures for large crowds of students or in mass attendance situations.

Research Gap and Relevance to the Present Study: Although numerous related works have shown that biometric attendance systems are effective, most focus on general classroom environments or employee monitoring. Web-based facial recognition systems tailored to the needs of Philippine higher education, using practical browser-based tools with robust performance evaluation, were insufficient. As a matter of fact, localized case studies should be developed, as there is variance in environmental conditions, network capabilities, and workflows across institutions.

Hence, the study that was conducted was entitled the "Development and Performance Evaluation of a Web-Based Facial Recognition Attendance System for Higher Education Institutions: A Case Study of J.H. Cerilles State College," and its aim was to develop and evaluate a browser-based system that has facial recognition capabilities coupled with a centralized database and role-based reporting functionality. It also presents a number of empirical findings relative to its usability, reliability, and recognition capability in the actual higher education environment.

3. Research Methodology

The Research and Development (R&D) method has been used in this research with the help of the 4D development model, which comprises four steps, i.e., Discover, Design, Develop, and Deploy, in a systematic development and evaluation of the proposed web-based facial recognition attendance system. R&D methods have been widely used in studies of information systems and educational technology to develop products through systematic evaluation (Peffers et al., 2007). Similarly, the 4D model can support a framework in a structured way by determining user needs, designing solutions, developing a product, and deploying the solution (Indaryanti et al., 2025).

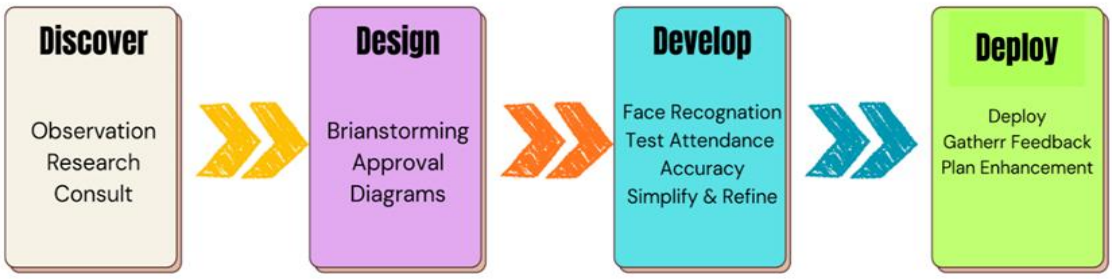

Figure 1. 4D Development Model Used in the Study

In the Discover phase, the process of manually recording student attendance was observed. Meetings were held with students, teaching, and non-teaching staff. Furthermore, a review of other research was undertaken to identify recurring problems, such as tardy attendance registration and student proxy attendance-taking, and to gather more information about them. Needs analysis has great importance for the development of systems. It gives them the right to

serve their users by helping them find and solve the organization's problems (Hariyanto et al., 2022).

During the Design phase, we developed possible solutions, listed the system requirements, and defined the interface layout, database structure, and flowcharts. Good system design makes the system user-friendly and efficient and ensures that users' requirements align with the system's functionality (Adlini et al., 2024).

The development phase involves building the web-based attendance system using HTML, CSS, JavaScript, PHP, MySQL, and face recognition tools, followed by testing, enhancements, analysis, and verification of system performance and attendance accuracy. Technical performance can be analyzed through testing during the development phase (Pressman & Maxim, 2020).

Pilot implementation of the system within the institute, where user feedback, along with their recommendations for improvement, was gathered in the Deploy stage. Pilot implementation enables researchers to test the system's readiness for actual deployment and to identify technical problems and user feedback under operational conditions (Sommerville, 2016). As a result, the systems designed in the study were refined and customized to fit the institute, technologically prepared, and ready for use in higher learning institutions.

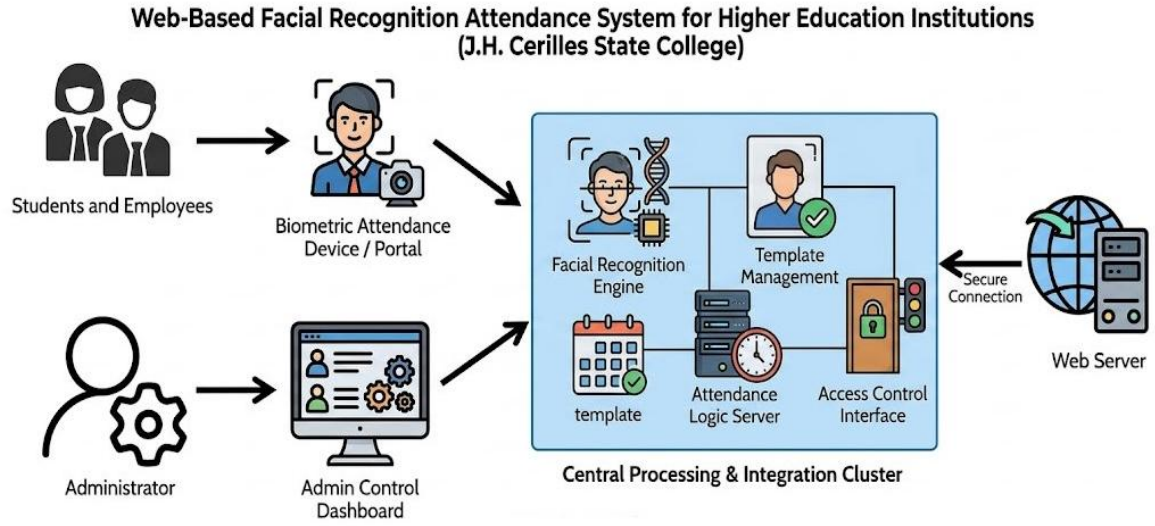

Figure 2. System Architecture

The framework displayed in Figure 2 is an online-specific web-based framework with a user interface layer that enables administrators and students to access the system via biometric ports and a management interface. It has a Facial Recognition Engine to extract features, which in turn replaced traditional internet routing as the Central Processing Cluster. The Attendance Logic Server is at the heart of the system, which then uses those features to check records against the institutional schedule. All data integrity and efficiency, crucial for your performance evaluation, are provided through a Secure connection to the Web Server, enabling faster, more accurate biometric template handling that meets your requirements at J.H. Cerilles State College.

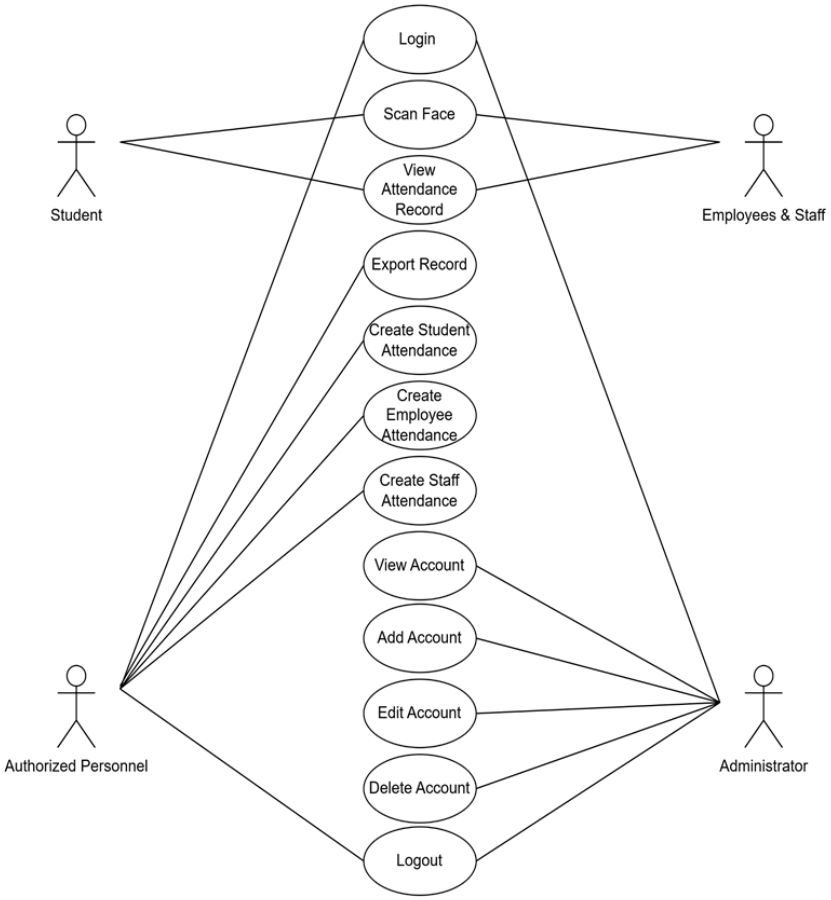

Figure 3. Use Case Diagram of the Web-based Facial Recognition Attendance System

The relationship between users and the system we built is shown in Figure 3. The user can scan their face and log in and access attendance-related functions, and the administrator can manage accounts, generate attendance records, export reports, and view records.

3.1 Participants and Sampling

Actual intended users were hand-picked from various departments to test performance and usability. Faculty members, administrative staff, and students were selected purposively because they will be responsible in some way for managing attendance. Purposive sampling is applicable to system acceptance research because domain users possess valuable information (Etikan et al., 2016).

Participants	Population Size	Sampling Technique	No. of Respondents
Staff	70	Purposive Sampling	35
Faculty	90	Purposive Sampling	45
Students	3830	Purposive Sampling	180
IT Personnel	10	Expert Sampling	5

Total	**4000**		**265**

Table 1. Respondents of the study

A total of 265 respondents were selected from the pool of administrative personnel, teaching personnel, students, and IT personnel. The estimate of the institution population was 70 administrative personnel, 90 teaching personnel, and 3830 students (Total: 4000). Respondents were selected by means of Purposive Sampling, in which selection was done based on the extent of involvement of respondents in the processes that involved attendance taking, as well as their ability to assess the web-based facial recognition attendance system being developed. IT personnel were involved as evaluators to assess technical functionality.

3.2 System Evaluation Procedures

The developed system has been subjected to the following tests:

1. Alpha Testing-An internal test by the developers and evaluators of the functionality of the system before release.
2. Beta Testing-A test by real-life users in the field to determine usability and efficiency.
3. Load Testing-A test to evaluate how the system performs when it is used concurrently by many users.
4. Stress Testing-A test to evaluate the system's performance under peak conditions of many concurrent users.
5. Compatibility Testing-A test across new modern devices and browsers.
6. Usability Testing-A test to determine user satisfaction, learnability, and operability.
7. Functionality Testing-A test to determine if the features are working as required.

Dimensions for evaluating software quality are identified in ISO/IEC 25010: functionality, reliability, usability, efficiency, maintainability, and portability (ISO, 2011).

3.3 Data Gathering Instruments

To assess user acceptability, a closed Likert-scale questionnaire was used. This questionnaire ranged from 1 (Strongly Disagree) to 5 (Strongly Agree) and is typical of questionnaires in information system evaluation, as it allows measurement of user perceptions of issues related to usability and satisfaction (Joshi et al., 2015).

Measures of system performance were:

- Rate of success in correctly identifying the user
- Rate of success in logging user attendance
- Response time
- Results of browser compatibility test

- Weighted mean of user ratings

3.4 Data Analysis

To describe the data gathered, descriptive statistics were used. The frequencies, percentages, weighted means, and accuracy were determined to provide a general view of user responses and system performance. The accuracy of recognition was found to be:

$$\text{Accuracy Rate} = \frac{\text{Correct Recognitions}}{\text{Total Attempts}} \times 100$$

This technique has also been widely adopted for evaluating biometric systems (Jain et al., 2016).

3.5 Data Privacy and Ethical Considerations

The system handles face biometric information; therefore, ethical issues and data privacy considerations were strictly observed throughout the study. The respondents' participation was voluntary, and consent was gathered from them before proceeding to face registration and system testing. The face images collected were used solely for attendance recognition and were not shared with third parties. Biometric templates and attendance records stored in the database were not exposed to anyone outside authorized personnel due to restricted access and the use of a password. All steps in this project followed the provisions of the Philippine Data Privacy Act of 2012 (Republic Act No. 10173).

4. Results and Discussion

The resulting system was tested for performance, ease of use, and the efficiency of the modern-day attendance system implemented in higher education institutions. The web-based facial recognition attendance system automatically records and maintains attendance, with improved speed, accuracy, and clarity.

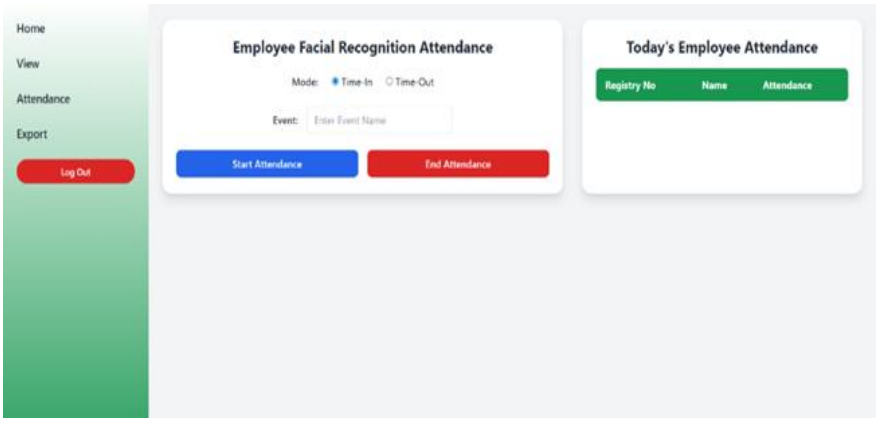

Figure 4. Main Dashboard Interface

Figure 4 displays the main dashboard of the built web-based facial recognition attendance system. The admin interface is where administrators initiate and end the attendance session, select the attendance mode (Time-In/Time-Out), and enter the event names. Admin can also

view the present employees in real time. Navigation links to view attendance, export records, and log out from the system are displayed.

The live camera-capture module shown in Figure 5 is used by the system to capture users' live faces for face recognition and attendance checking. After capturing the live image from the camera, the system automatically processes it for database search.

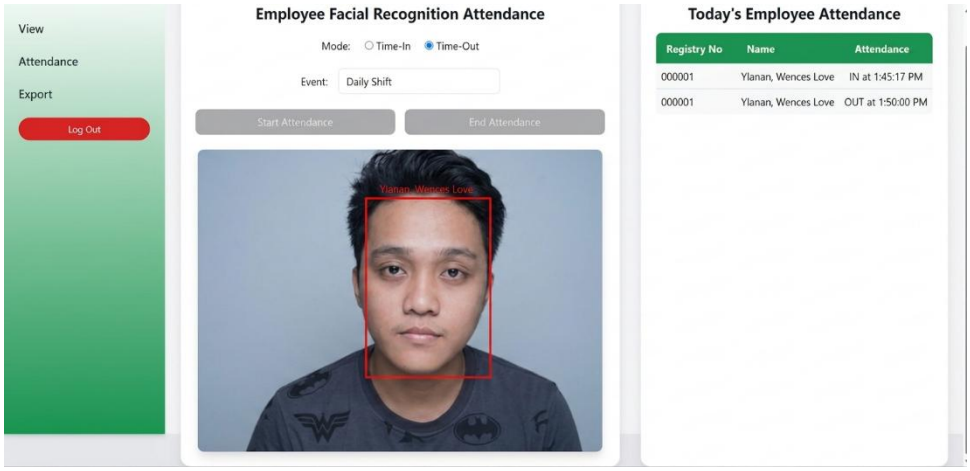

Figure 5. Live Camera Capture Interface

In the user acceptability testing, the responding departments indicated they are highly pleased with the system, with a weighted mean of 4.71 on a 5-point Likert scale, indicating strong approval of its usability, convenience, and overall acceptance. Users found the interface navigation straightforward, and that contactless attendance had reduced typical delays associated with manual attendance tracking. Similar sentiments were shared in Essien and Ansa (2023), where biometric attendance has added significant value to user convenience and institutional functioning.

Department	**Weighted Mean**	**Interpretation**
School of Computing Studies (SCS)	4.62	Strongly Agree
School of Arts and Sciences (SAS)	4.67	Strongly Agree
School of Teacher Education (STE)	4.74	Strongly Agree
School of Engineering and Technology SET)	4.69	Strongly Agree
School of Agriculture, Forestry and Environmental Studies (SAFES)	4.71	Strongly Agree
School of Criminal Justice Education (SOCJE)	4.82	Strongly Agree
Department of Student Affairs (DSA) Staff	4.85	Strongly Agree
Overall Mean	**4.73**	Strongly Agree

Table 2. User Acceptability Results

Legend: 4.21–5.00 = Strongly Agree; 3.41–4.20 = Agree; 2.61–3.40 = Neutral; 1.81–2.60 = Disagree; 1.00–1.80 = Strongly Disagree.

Table 2 summarizes the results on user acceptability of the developed web-based facial recognition attendance system among respondents from different academic departments and administrative offices of J.H. Cerilles State College. The overall weighted mean was 4.73, and it was interpreted as Strongly Agree.

Among the response groups, Department of Student Affairs (DSA) Staff had the highest score, with a weighted mean of 4.85, followed by School of Criminal Justice Education with 4.82 and School of Teacher Education with 4.74. All the above shows that the system was perceived by the user as efficient, practical, and reliable.

The performance tests also showed that the system can reliably operate under practical conditions. By testing under load, with many concurrent users, steady response times and correct recognition results were still maintained. In stress tests with 265 attendance attempts, the system was 93.96% accurate and demonstrated decent real-time performance while accounting for changes in lighting conditions, facial movements, and user position. High recognition performance should come as no surprise, as previous studies have shown that browser-based and deep learning systems for facial recognition can achieve accuracy higher than 90% when appropriately calibrated (Iftekar & Zeeshan, 2024; Kamil et al., 2023).

Testing Category	**Purpose**	**Key Result Summary**	**Interpretation**
Alpha Testing	Evaluate internal system functions before deployment	Core modules such as login, facial registration, recognition, logging, and report generation operated successfully after minor refinements	Passed
Beta Testing	Assess system performance with actual end-users	A total of 265 respondents, comprising employees, faculty, and students, evaluated the system and reported high satisfaction, usability, and effectiveness during the pilot implementation.	Passed
Load Testing	Measure system performance under normal simultaneous usage	The system maintained a stable response time and accurate recognition with 30 simultaneous users	Passed

Stress Testing	Test system under peak usage conditions	During 265 attendance attempts involving actual respondents, 249 users were successfully recognized, yielding 93.96% recognition accuracy under peak conditions.	Passed
Compatibility Testing	Verify operation across browsers and devices	The system functioned properly on modern browsers such as Google Chrome and Brave	Passed
Usability Testing	Evaluate ease of use and interface acceptability	Users rated the system highly for convenience, clarity, and ease of navigation	Passed
Functionality Testing	Confirm that all required features work correctly	Authentication, face scanning, attendance recording, data storage, and export features performed as intended	Passed

Table 3. Performance Testing Results

Table 3 presents the performance evaluation of the developed web-based facial recognition attendance system. From Alpha Testing, the basic module login, face registration, face recognition, attendance log, and report generation passed the tests after modifications were made. From Beta Testing, the satisfaction levels of the employees, faculty, and students are high. In Load Testing, the web-based facial recognition attendance system maintained a stable response time and a correct recognition rate when 30 users simultaneously accessed it. From the Stress Test, a recognition accuracy of 93.96% was achieved, with 249 out of 265 users identified in the busiest case. The web-based facial recognition attendance system worked efficiently in Google Chrome and Brave browsers, and the desktop and mobile interfaces performed well during Compatibility Testing. In the Usability and Functionality testing, the system was found to be easy to use, and every feature works. Overall, the developed web-based facial recognition attendance system is reliable, efficient, and can be successfully implemented.

5. Conclusion

A web-based face recognition attendance system for higher education was developed and tested in this research, with implementation at J.H. Cerilles State College. The research also shows that the system offers advantages over the manual attendance-taking method, including speed, precision, and contactless attendance recording.

During performance evaluation, we demonstrated that the system achieved acceptable face recognition accuracy, stable response time, and acceptable performance under operational

conditions. It also works with common web browsers, making it very portable. User evaluation results showed high satisfaction with ease of use, convenience, and acceptability.

Using browser-based systems, centralized data management, and online facial recognition has reduced the administrator's workload, making attendance tracking more accurate and records more transparent. These results show that the system developed is workable and suitable for installation in an institution.

In conclusion, the proposed web-based facial recognition attendance system appears to be a practical, scalable, and affordable solution to upgrade attendance systems in higher education. Future work may address recognition under harsh conditions, enhance data privacy, and improve compatibility with other campus information systems.

Declarations

Source of Funding

No particular grant from governmental, private, or nonprofit funding organizations was obtained for this study.

Competing Interests

Regarding this work, the authors declare that they have no conflicts of interest.

Consent for Publication

The authors affirm that they have given their permission for this study to be published.

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The authors admit to using Grammarly and other AI-based tools to paraphrase and improve grammar and style. There are no conflicts of interest resulting from the use of these tools, and all concepts, analyses, and findings given in this study remain the exclusive responsibility of the authors.

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