International Journal on Science and Technology (IJSAT)

E-ISSN: 2229-7677 ● Website: www.ijsat.org ● Email: editor@ijsat.org

Hybrid Approach for Attendance ERP Using Biometric and QR Code Verification

Tanuj Tongse[1], Pranay Solanki[2], Ishali Deshmukh[3], Ashvi Deshmukh[4], Dr. Pankaj Singh Sisodiya[5]

[5]Guied

Abstract:
Attendance management is an integral component of academic institutions and organizations, serving as a foundation for discipline, evaluation, and decision-making. Traditional methods, including manual roll calls or paper registers, are not only time-consuming but also prone to inefficiencies such as errors, proxy attendance, and delays in record updating. As institutions grow larger and digitization becomes essential, the need for an automated, secure, and reliable attendance monitoring system has become more critical.

While numerous systems exist that employ biometric authentication or QR code verification individually, they often fail to provide a comprehensive solution. Biometric systems require expensive hardware and may face accuracy issues under varying conditions such as lighting or image clarity, whereas QR-based systems, though cost-effective, are vulnerable to misuse and proxy attempts. There is limited research that combines multiple authentication mechanisms into a single attendance system, ensuring enhanced accuracy and security.

The primary objective of this research is to design and implement a Face Recognition and QR Code Based Attendance System that integrates the strengths of both techniques. The system aims to provide a dual-layer verification mechanism, thereby reducing the probability of proxy attendance, minimizing human error, and increasing operational efficiency. By merging computer vision with quick response (QR) technology, the proposed approach ensures robust verification, user convenience, and scalable integration into institutional frameworks.

The methodology of the system development is based on the Agile software development model, enabling iterative progress and continuous improvement at each stage. The implementation employs Java Swing for building a userfriendly graphical interface, OpenCV for real-time face detection and recognition, the ZXing library for QR code generation and scanning, and a MySQL database for storing and managing attendance records. The workflow involves four major phases: student registration (with photograph and unique QR code), attendance marking (via face recognition and QR scan), verification (dual-authentication process), and notification/record maintenance.

The experimental evaluation of the system reveals that it provides a significant improvement in accuracy, efficiency, and security compared to conventional attendance methods. The dual verification mechanism effectively prevents proxy attendance, while the use of MySQL ensures reliable storage and retrieval of records. The combination of OpenCV and ZXing libraries results in fast and accurate processing, even in real-time classroom or organizational scenarios.

INTRODUCTION:

Attendance management plays a vital role in academic institutions and corporate organizations for monitoring participation and ensuring discipline. Attendance management is an important part of every school, college, or office. It helps to keep records of people who are present or absent and ensures discipline and responsibility. In many places, attendance is still taken by calling names or signing on paper. This manual method takes more time, can have errors, and sometimes students mark attendance for others (proxy attendance).

To solve these problems, many institutions started using digital systems such as biometric or QR code-based attendance. Biometric systems use face or fingerprint recognition, while QR systems scan codes assigned to each person. But both methods have some limits — for example, biometric systems may not work properly if the sensor is not clean, and QR systems can be misused if someone shares their code.
To make the system more reliable, our project uses a **hybrid approach** that combines both **biometric verification** and **QR code scanning**. If one method fails, the other can still be used. The system is connected to an **ERP (Enterprise Resource Planning)** platform that stores all attendance data in one place and can generate reports easily.

OBJECTIVES:

- To design and implement a hybrid attendance management system using biometric and QR verification.
- To connect attendance records with an ERP system for easy data management.
- To reduce proxy attendance and enhance system reliability.
- To store attendance data safely in a **MySQL database** for future use and report generation.
- To provide simple and fast access for teachers and administrators.

Scopes:

The system is suitable for schools, colleges, offices, and organizations where accurate attendance tracking is crucial. It helps teachers mark attendance quickly using biometric or QR verification, while students can record their presence without manual effort. The system stores all attendance data safely in a MySQL database through an ERP platform, making it reliable, timesaving, and suitable for future expansion.

LITERATURE REVIEW:

Many researchers and developers have worked on attendance systems over the years. The goal of all these systems is to make attendance faster, more accurate, and less dependent on manual work. This section explains how different attendance methods have developed and what their advantages and problems are.

[1] proposed a fingerprint-based biometric authentication system that integrates minutiae extraction and template matching techniques to verify user identity over internet-based systems. Their work demonstrated the potential of biometric methods to enhance security in network applications. In the proposed system, we extend this concept by utilizing face recognition (Haar Cascade and LBPH) and QR code verification to achieve contactless, multi-factor authentication for attendance management.

Zhou and Lu [2] presented a study on fingerprint identification algorithms and their applications in information security. Their work explained the fundamental steps of fingerprint processing, including preprocessing, minutiae extraction, and template matching, to achieve secure user authentication. The authors emphasized the advantages of biometric authentication over traditional password systems, highlighting its resistance to duplication and misuse. While their approach relied on fingerprint features

for secure access, the present study extends this concept to facial recognition and QR code verification, offering a contactless and hybrid authentication model suitable for modern ERP-based attendance management systems.

[3]Alam and Akhteruzzaman (2000) introduced an innovative approach for **real-time fingerprint identification** using *optical correlation techniques* rather than conventional digital matching algorithms. Their research focused on enhancing **speed and accuracy** in biometric authentication systems by leveraging **Joint Transform Correlator (JTC)** and **Fringe-Adjusted Joint Transform Correlator (FJTC)** architectures.

The proposed system captures a fingerprint image and converts it into an **optical pattern**, which is then compared in real time with stored reference patterns. The **correlation peaks** obtained from the optical processing indicate the degree of similarity between the test and reference fingerprints. The authors also applied **Synthetic Discriminant Function (SDF) filters**, which significantly improved the system's robustness against geometric distortions such as *rotation, translation*, and *scaling*.

Jain, Ross, and Prabhakar [4] provide a foundational overview of biometric recognition systems, detailing the standard architecture (sensor, feature extraction, matcher, and template storage) and contrasting verification versus identification paradigms. They examine various biometric modalities (e.g. fingerprint, face, iris, voice), articulate evaluation metrics (FAR, FRR, EER, ROC), and analyze practical issues such as template security, spoofing, and multimodal fusion. Although their work does not propose new algorithms, its structured framework and clarity in presenting trade-offs have made it a seminal reference in biometric literature. In the present work, we build on this standard architectural model and address additional challenges inherent to face-based attendance systems, such as pose variance, lighting conditions, and hybrid verification with QR codes.

METHODOLOGY:

Algorithms Used in This Project

- **Haar Cascade Classifier:** The Haar Cascade Classifier is a machine learning–based approach proposed by Viola and Jones, primarily used for object detection in digital images and video streams. It utilizes a series of **Haar-like features**, such as edge and line detectors, to identify regions in an image that resemble human facial structures.

During the detection process, the input image is converted into an **integral image**, allowing rapid computation of feature values. Multiple weak classifiers are combined using the **AdaBoost algorithm** to form a strong classifier. These classifiers are then arranged in a **cascade structure**, which enables the system to quickly discard non-face regions and focus computational resources on likely face areas.

In this project, the Haar Cascade Classifier is employed to accurately locate and extract facial regions from live camera input before performing recognition.

HOG (Histogram of Oriented Gradients): The HOG algorithm

Is a powerful feature descriptor used in computer vision and image processing for the purpose of object detection and face recognition. Unlike texture-based methods, HOG focuses on the shape and appearance of an object by extracting the distribution of intensity gradients or edge directions**.**

- **Gradient Calculation:** The first step involves calculating the gradient values for every pixel in the image. It captures how the intensity changes in both the horizontal (x) and vertical (y) directions. This helps the system identify edges and corners, which are the most defining parts of a face.
- **Cell Selection and Orientation Binning:** The image is divided into small connected regions called **cells** (typically 8×8 pixels). For each cell, a histogram of gradient orientations is

compiled. Each pixel within the cell casts a weighted vote for an orientation-based "bin" based on the gradient's direction and magnitude.

- **Block Normalization:** To account for changes in illumination and shadowing, the cells are grouped into larger, spatially connected **blocks** (e.g., 2×2 cells). The gradient results are normalized within these blocks. This ensures that the recognition remains accurate even if the lighting conditions in the classroom or office change.

Feature Vector Generation: The normalized histograms from all blocks are concatenated to form a final, high-dimensional **feature vector**. This vector serves as a unique "mathematical fingerprint" of the face. During the recognition phase, the system compares the HOG feature vector of the person standing in front of the camera with the vectors stored in the database. HOG is particularly robust against variations in lighting and small changes in facial pose, making it ideal for a secure and reliable attendance system.

QR Code Verification – ZXing (Zebra Crossing Library):

- **QR Encoding & Decoding Algorithm:** The system also integrates a **QR-based identity verification mechanism** using the ZXing library to provide an alternative and reliable method for attendance marking.
- **QR Code Encoding**

The **QR Encoding Algorithm** converts user-specific information
(Such as ID, name, and email) into a binary format using Reed– Solomon error correction. The data is then arranged into a two dimensional matrix of black and white modules that form the QR code. Each user is assigned a unique QR code during the registration phase. The generated code can be stored digitally or printed for physical verification.

- **QR Code Decoding**

During attendance, the camera captures the QR image, which is
Processed and decoded by the ZXing library.

The algorithm identifies the QR's **finder patterns** to determine its orientation and grid alignment, converts the image to a binary matrix, and reconstructs the encoded data. Reed–Solomon error correction ensures the accuracy of the decoded information even in cases of partial damage or distortion. The decoded data is then matched against the MySQL database to verify user identity and mark attendance automatically.

ERP / Database Module – MySQL & Validation Logic:

The database management component of the system is developed using **MySQL**, serving as the central repository for all user, attendance, and authentication data.

SQL Query Algorithms

The module executes several database operations:

- **Insertion:** Stores user registration details, including facial data and QR code information.
- **Selection:** Retrieves records for login, recognition, or attendance verification.
- **Updation:** Updates attendance logs with check-in, check-out, and datetime entries.
- **Deletion:** Removes outdated or invalid data entries.

Validation and Data Integrity

To ensure reliability, the system performs strict validation checks to:

- Prevent **duplicate attendance entries** for the same user on a given date.
- Validate that all stored records correspond to authenticated biometric or QR data.

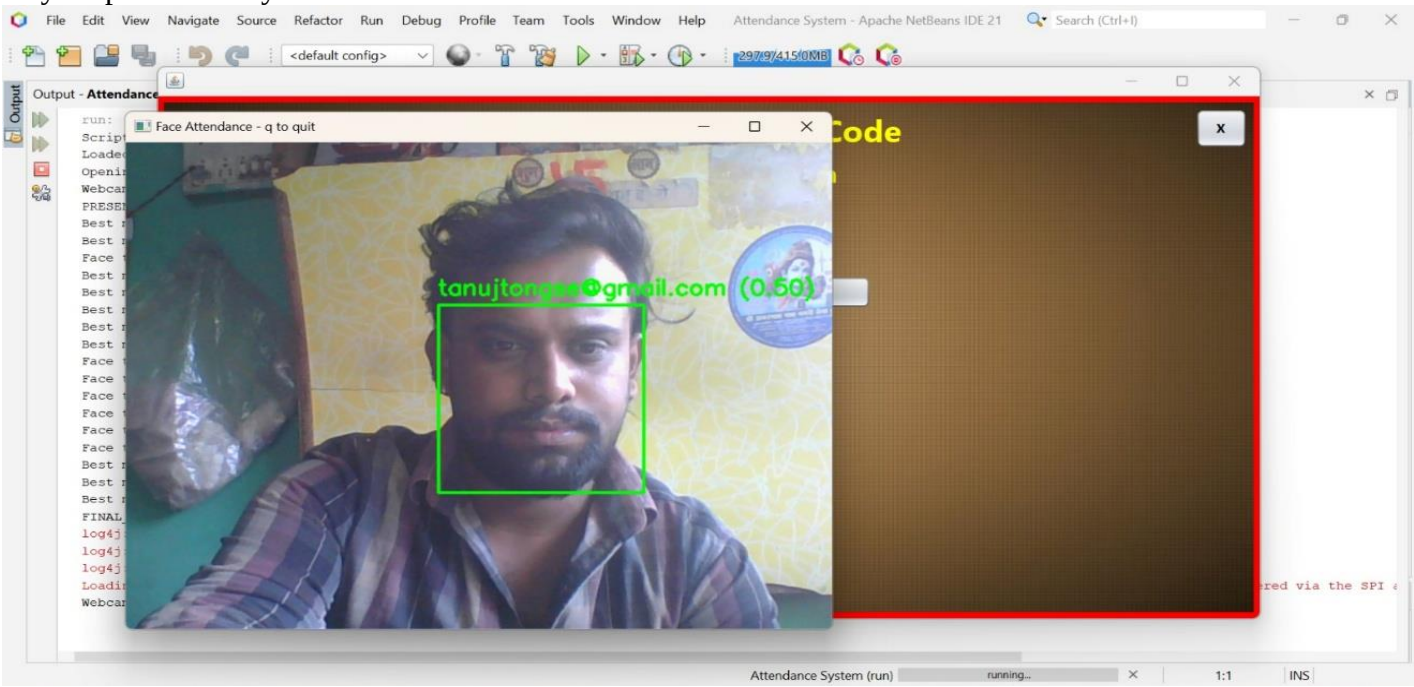
- Maintain **referential integrity** between user profiles and attendance logs. This combination of biometric, QR, and database algorithms ensures **multilayered authentication**, **real-time verification**, and **accurate attendance management** within the system.

Implementation Results:

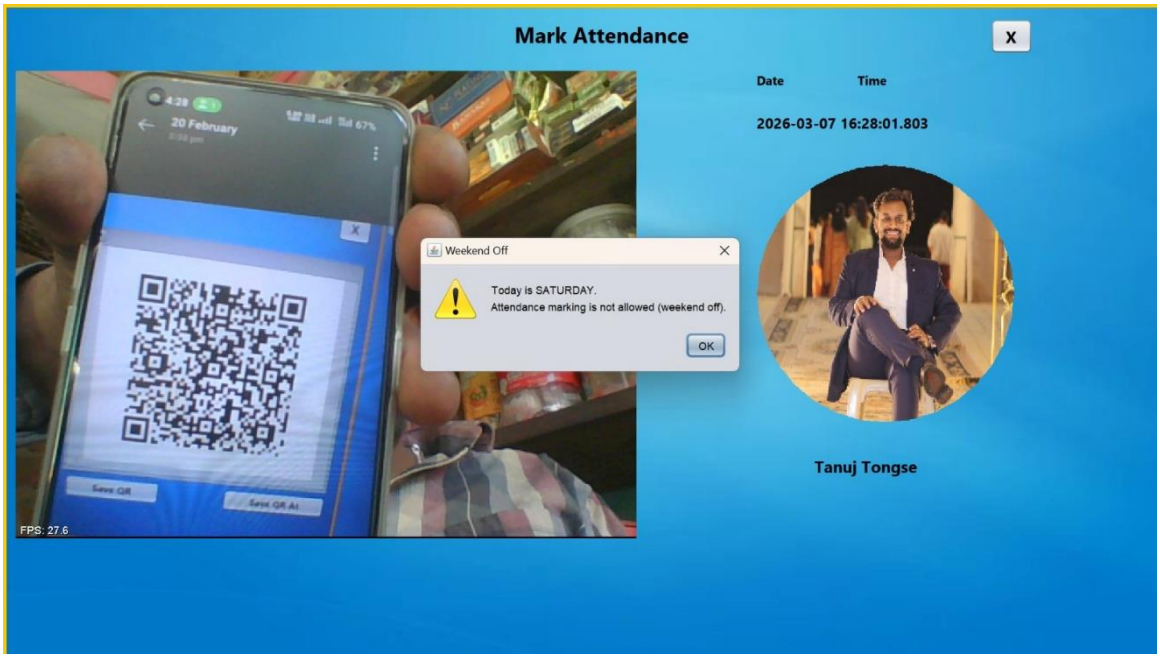
The hybrid attendance ERP system was successfully implemented using Java Swing, OpenCV, ZXing, and MySQL database.

The system was tested with multiple students under different conditions such as lighting variations and QR code scanning distances. The results showed that the system accurately recognized registered users and successfully recorded attendance in real time.

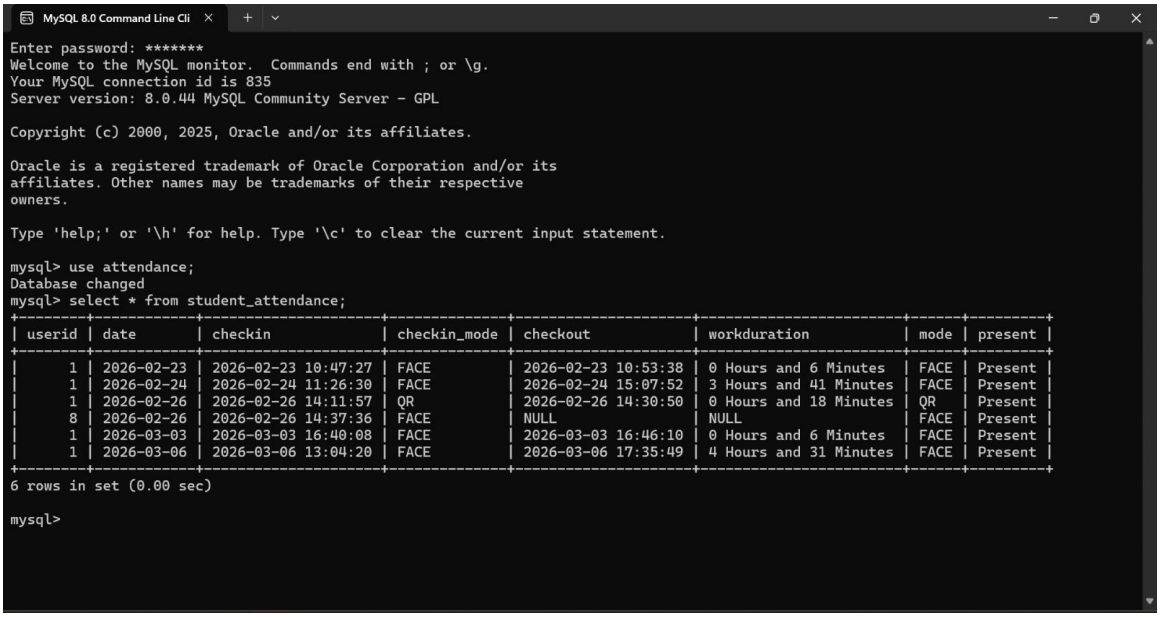
Key outputs of the system include:



- Face recognition verification through webcam.

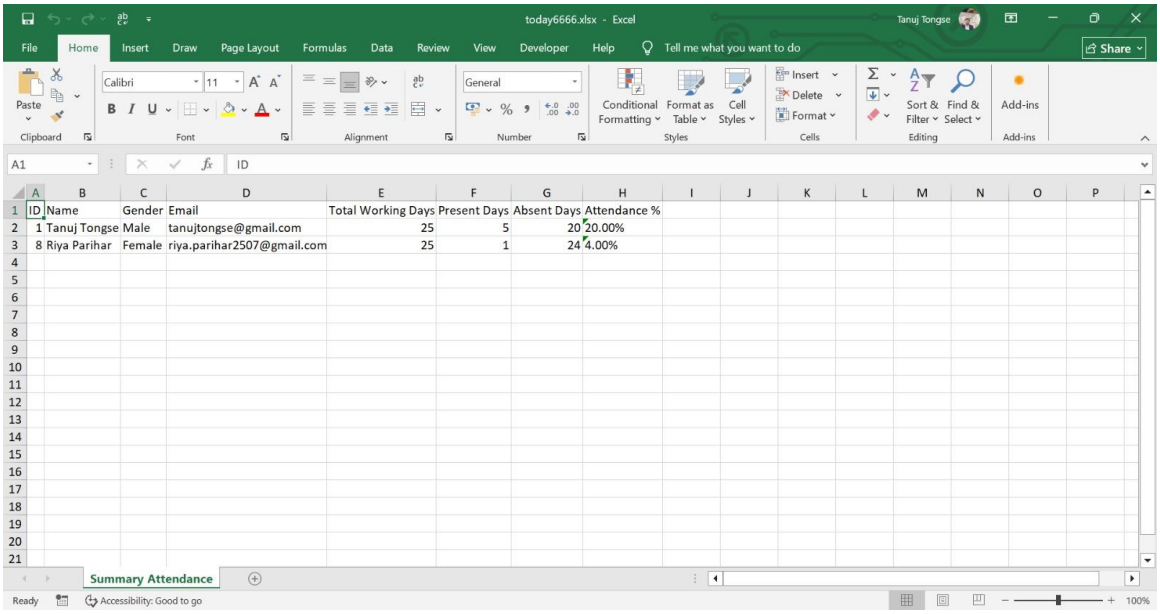


- QR code scanning for alternative attendance marking.
-



```
MySQL 8.0 Command Line Cli
Enter password: *******
Welcome to the MySQL monitor.  Commands end with ; or \g.
Your MySQL connection id is 835
Server version: 8.0.44 MySQL Community Server - GPL

Copyright (c) 2000, 2025, Oracle and/or its affiliates.

Oracle is a registered trademark of Oracle Corporation and/or its
affiliates. Other names may be trademarks of their respective
owners.

Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.

mysql> use attendance;
Database changed
mysql> select * from student_attendance;
+--------+------------+---------------------+--------------+---------------------+-----------------------+------+---------+
| userid | date       | checkin             | checkin_mode | checkout            | workduration          | mode | present |
+--------+------------+---------------------+--------------+---------------------+-----------------------+------+---------+
|      1 | 2026-02-23 | 2026-02-23 10:47:27 | FACE         | 2026-02-23 10:53:38 | 0 Hours and 6 Minutes | FACE | Present |
|      1 | 2026-02-24 | 2026-02-24 11:26:30 | FACE         | 2026-02-24 15:07:52 | 3 Hours and 41 Minutes | FACE | Present |
|      1 | 2026-02-26 | 2026-02-26 14:11:57 | QR           | 2026-02-26 14:30:50 | 0 Hours and 18 Minutes | QR   | Present |
|      8 | 2026-02-26 | 2026-02-26 14:37:36 | FACE         | NULL                | NULL                  | FACE | Present |
|      1 | 2026-03-03 | 2026-03-03 16:40:08 | FACE         | 2026-03-03 16:46:10 | 0 Hours and 6 Minutes | FACE | Present |
|      1 | 2026-03-06 | 2026-03-06 13:04:20 | FACE         | 2026-03-06 17:35:49 | 4 Hours and 31 Minutes | FACE | Present |
+--------+------------+---------------------+--------------+---------------------+-----------------------+------+---------+
6 rows in set (0.00 sec)

mysql>
```

- Real-time attendance marking in the database.



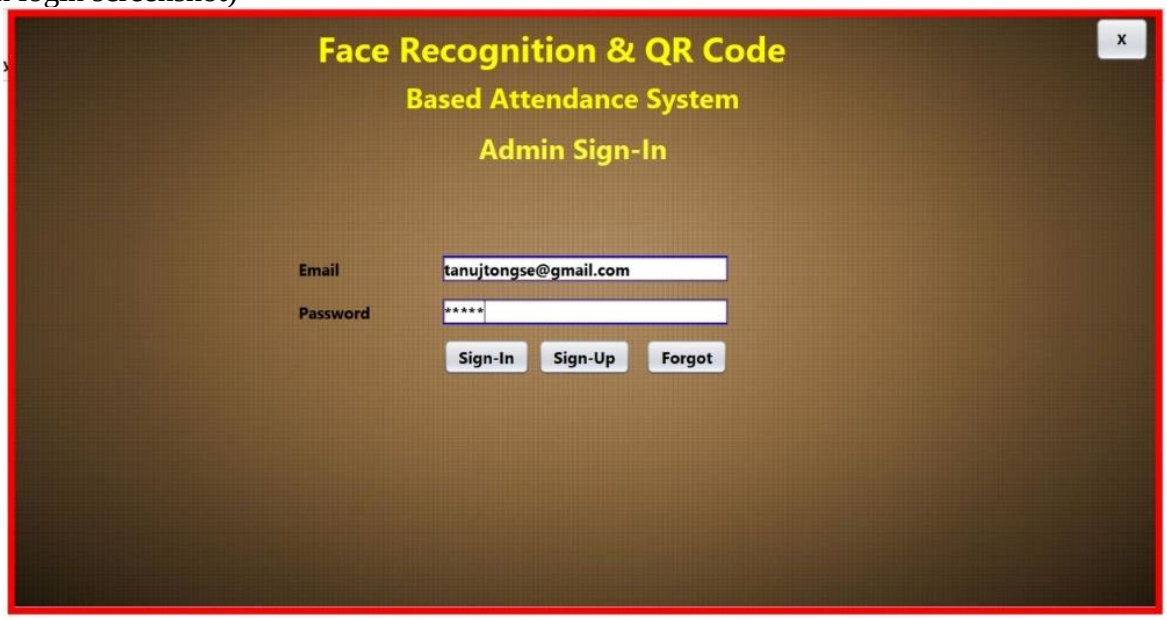
ID	Name	Gender	Email	Total Working Days	Present Days	Absent Days	Attendance %
1	Tanuj Tongse	Male	tanujtongse@gmail.com	25	5	20	20.00%
8	Riya Parihar	Female	riya.parihar2507@gmail.com	25	1	24	4.00%

- Attendance report generation in Excel format.
-

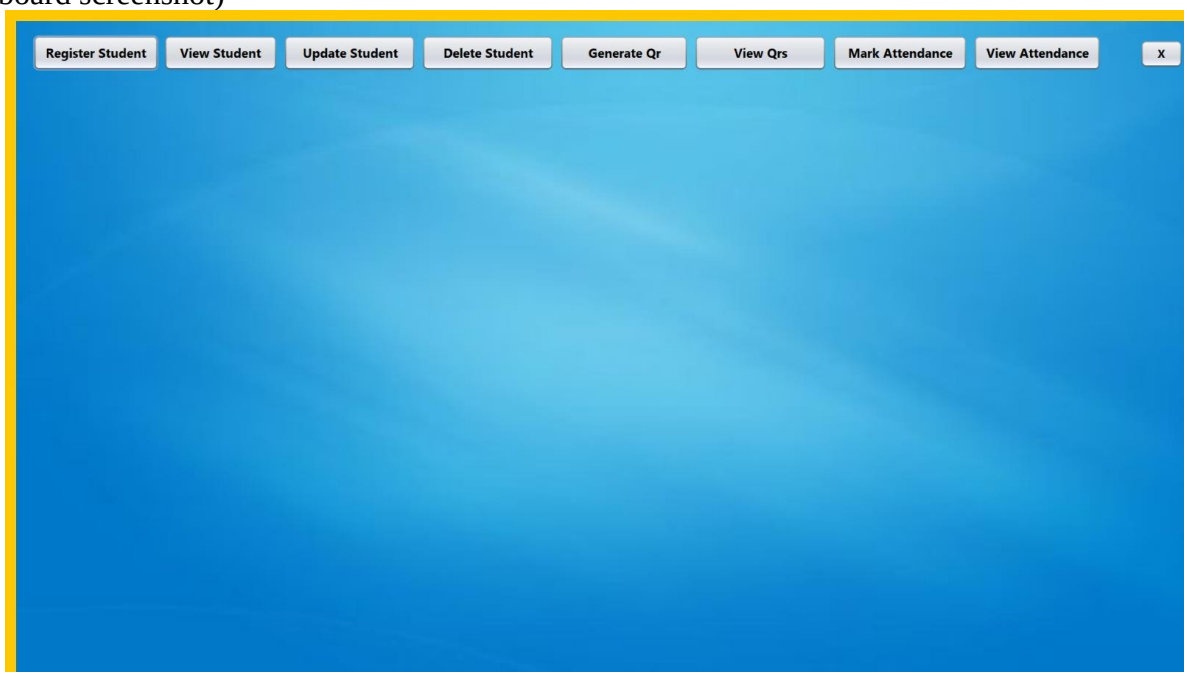
The system demonstrated reliable performance and significantly reduced manual effort and proxy attendance.

1. Admin Login Interface

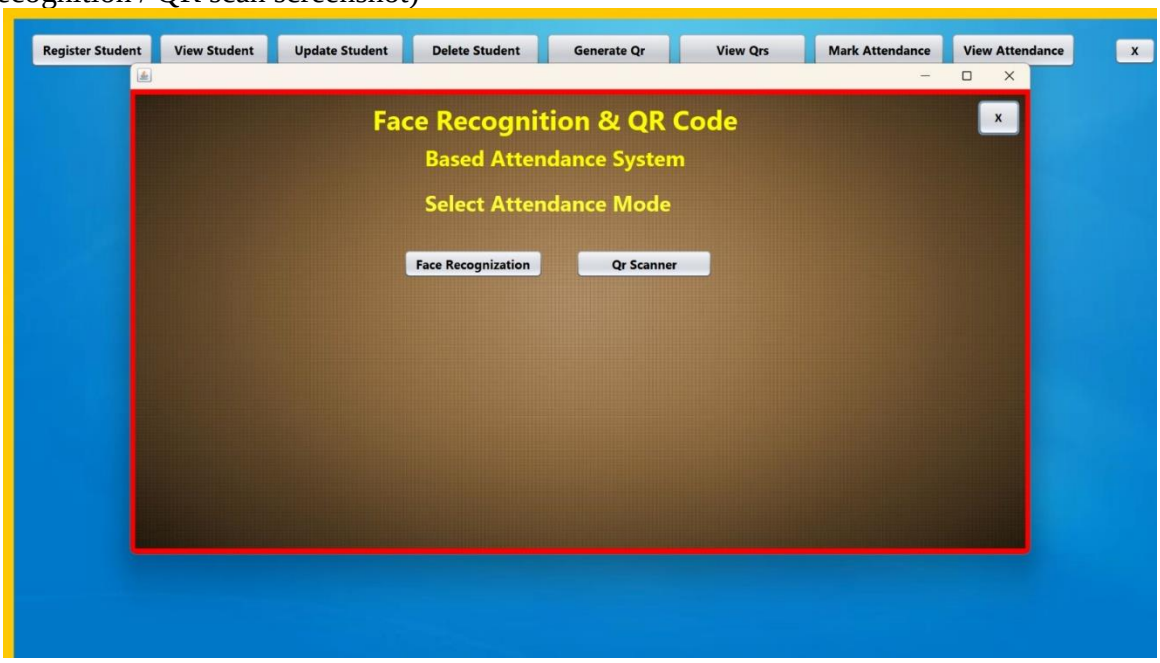
(Admin login screenshot)



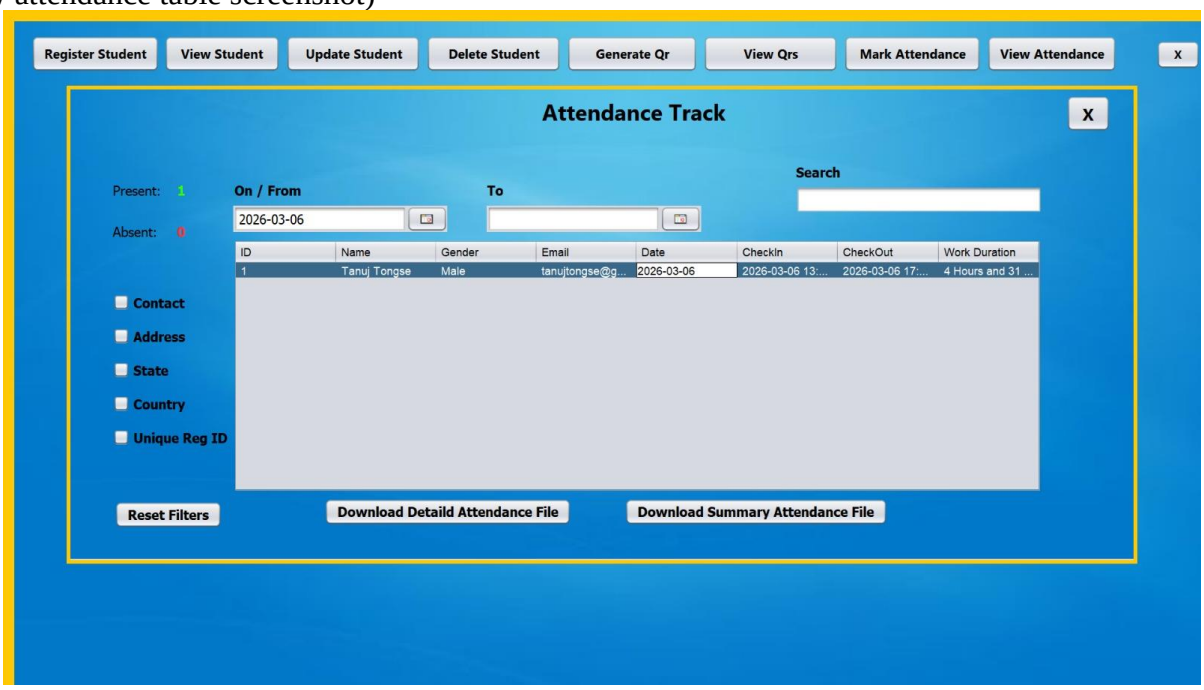
2. Admin Dashboard
(Dashboard screenshot)



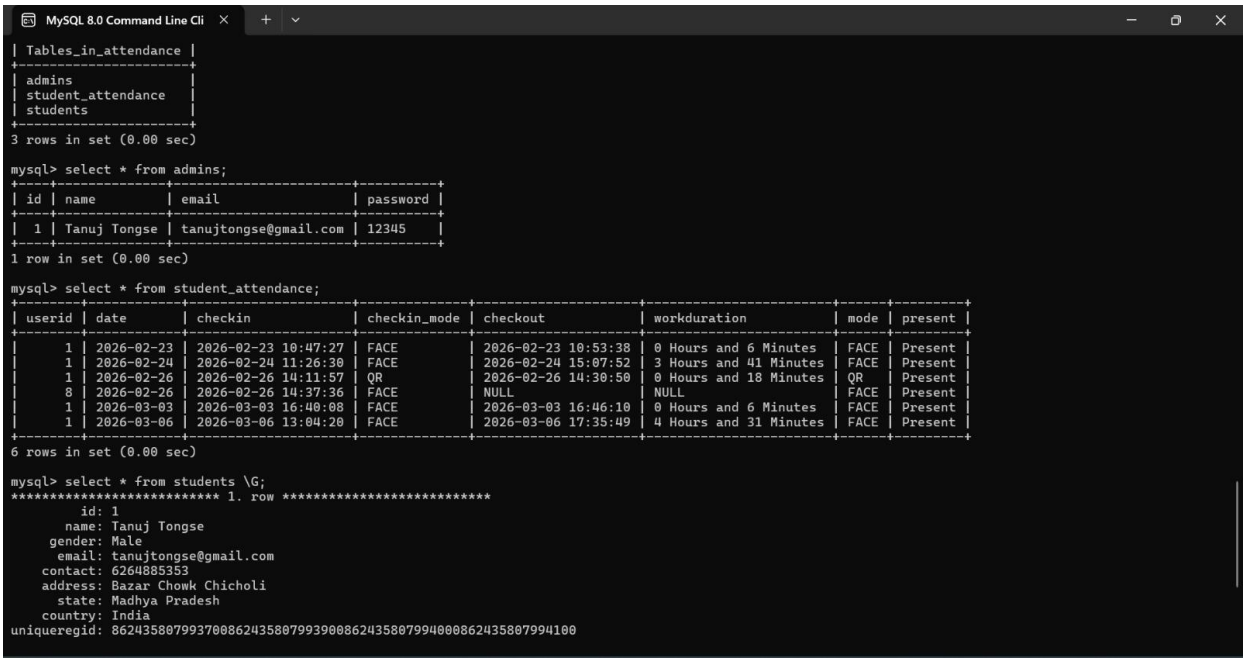
3. Attendance Mode Interface
(Face recognition / QR scan screenshot)



4.Attendance Record View
(View attendance table screenshot)



5.Database Records
(MySQL database screenshot)



```
MySQL 8.0 Command Line Cli

| Tables_in_attendance |
+----------------------+
| admins               |
| student_attendance   |
| students             |
+----------------------+
3 rows in set (0.00 sec)

mysql> select * from admins;
+----+--------------+-----------------------+----------+
| id | name         | email                 | password |
+----+--------------+-----------------------+----------+
|  1 | Tanuj Tongse | tanujtongse@gmail.com | 12345    |
+----+--------------+-----------------------+----------+
1 row in set (0.00 sec)

mysql> select * from student_attendance;
+--------+------------+---------------------+--------------+---------------------+-----------------------+------+---------+
| userid | date       | checkin             | checkin_mode | checkout            | workduration          | mode | present |
+--------+------------+---------------------+--------------+---------------------+-----------------------+------+---------+
|      1 | 2026-02-23 | 2026-02-23 10:47:27 | FACE         | 2026-02-23 10:53:38 | 0 Hours and 6 Minutes | FACE | Present |
|      1 | 2026-02-24 | 2026-02-24 11:26:30 | FACE         | 2026-02-24 15:07:52 | 3 Hours and 41 Minutes | FACE | Present |
|      1 | 2026-02-26 | 2026-02-26 14:11:57 | QR           | 2026-02-26 14:30:50 | 0 Hours and 18 Minutes | QR   | Present |
|      8 | 2026-02-26 | 2026-02-26 14:37:36 | FACE         | NULL                | NULL                  | FACE | Present |
|      1 | 2026-03-03 | 2026-03-03 16:40:08 | FACE         | 2026-03-03 16:46:10 | 0 Hours and 6 Minutes | FACE | Present |
|      1 | 2026-03-06 | 2026-03-06 13:04:20 | FACE         | 2026-03-06 17:35:49 | 4 Hours and 31 Minutes | FACE | Present |
+--------+------------+---------------------+--------------+---------------------+-----------------------+------+---------+
6 rows in set (0.00 sec)

mysql> select * from students \G;
*************************** 1. row ***************************
        id: 1
      name: Tanuj Tongse
    gender: Male
     email: tanujtongse@gmail.com
   contact: 6264885353
   address: Bazar Chowk Chicholi
     state: Madhya Pradesh
   country: India
uniqueregid: 8624358079937008624358079939008624358079940008624358079941 00
```

FUTURE SCOPE

The hybrid attendance ERP system can be improved and expanded in many ways in the future:

- **Cloud Integration:**
  The database can be moved to a cloud server so attendance data can be updated and viewed in real time from anywhere.
- **Mobile Application:**

A mobile app can be created for students and teachers to mark or check attendance easily using their phones.

- **AI and Analytics:**
  Artificial Intelligence can be used to analyze attendance patterns and detect irregularities automatically.
- **IoT Integration:**
  Smart devices and sensors can be connected to the system for touchless attendance marking.
- **Multi-Campus System:**
  The ERP can be expanded to handle attendance from different branches or campuses under one management system.

CONCLUSION:

The Hybrid Approach for Attendance ERP Using Biometric and QR Code Verification offers a comprehensive solution to the limitations of conventional attendance systems. By merging biometric and QR verification, it enhances accuracy, security, and reliability while ensuring system flexibility. By combining two verification methods, the system reduces proxy attendance and increases reliability. All records are safely stored in the MySQL database and can be accessed anytime through the ERP platform. The use of Java-based technologies, including Swing GUI, MySQL, OpenCV, and ZXing, makes it cost-effective and scalable. Overall, this project saves time, improves efficiency, and supports digital transformation in schools, colleges, and offices. This research demonstrates that the hybrid model significantly reduces proxy attendance and data manipulation while simplifying administrative work.

References:

[1] G. Aguilar, G. Sanchez, K. Toscano, M. Salinas, M. Nakano, and H. Perez, "Fingerprint Recognition," in Internet Monitoring and Protection, 2007. ICIMP 2007. Second International Conference on, 2007, pp. 32-32. https://www.researchgate.net/

[2] S. Zhou and X. Lu, "Fingerprint Identification and its Applications in Information Security Fields," pp. 97-99, 2010. **Kavitha, D.** *"A Review Paper on Face Recognition Using LBPH." International Research Journal of Modernization in Engineering Technology and Science*, vol. 5, no. 5, May 2023, pp. 392–397**.** IRJMETS.

[3] M. S. Alam and M. Akhteruzzaman, "Real time fingerprint identification," in National Aerospace and Electronics Conference, 2000. NAECON 2000. Proceedings of the IEEE 2000, 2000, pp. 434-440. https://www.researchgate.net/

[4] A. K. Jain, A. Ross, and S. Prabhakar, "An introduction to biometric recognition," Circuits and Systems for Video Technology, IEEE Transactions on, vol. 14, pp. 4-20, 2004. https://www.researchgate.net/

[5] R. Chunxiao, Y. Yilong, M. Jun, and Y. Goping, "Feature selection for sensor interoperability: A case study in fingerprint segmentation," in Systems, Man and Cybernetics, 2009. SMC 2009. IEEE International Conference on, 2009, pp. 5057-5062 .https://www.researchgate.net/