

A Secure QR Code-Based Attendance Management Framework

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Abstract— Attendance management plays an important role in educational institutions and organizations, where maintaining accurate attendance records is essential. Traditional attendance methods, such as manual registers or paper-based records, are time-consuming and prone to human errors and proxy attendance. This project presents a Smart QR Code-Based Attendance Management System that simplifies and automates the attendance process using QR code technology. Each employee or student is assigned a unique QR code, which is scanned through a webcam or mobile device to record attendance instantly. The system stores attendance records securely and allows administrators to manage user details, monitor attendance, and generate reports efficiently. Users can also log in to view their attendance history within a selected date range. The proposed system improves accuracy, reduces paperwork, minimizes administrative effort, and prevents duplicate attendance entries. Developed using Python and related libraries, the system offers a reliable, secure, and user-friendly solution for modern attendance management in educational institutions and workplaces.

Keywords — QR Code, Attendance Management System, QR Code Scanner, Python, OpenCV, Employee Attendance, Student Attendance, Automated Attendance, Webcam Scanning, Database Management.

I. INTRODUCTION

Attendance management is an essential activity in educational institutions and organizations because it helps monitor participation, maintain discipline, and ensure accountability. Traditionally, attendance has been recorded manually using paper registers or punch card systems. Although these methods have been widely adopted, they require considerable time and effort, especially in classrooms or workplaces with a large number of individuals. Manual attendance records are also prone to errors, misplaced records, and proxy attendance, making

them less reliable. Punch card-based attendance systems improved the recording process to some extent, but they still require dedicated hardware and regular maintenance, increasing operational costs and limiting flexibility in modern environments [1], [2].

With the rapid advancement of digital technologies, institutions are increasingly adopting automated attendance management systems to improve efficiency and accuracy. Several researchers have proposed attendance systems based on RFID, secret codes, and web-based platforms to simplify attendance recording while reducing manual effort. These systems minimize the time required for attendance verification and provide better record management compared to conventional methods. However, some existing approaches require expensive infrastructure, specialized devices, or complex implementation, making them difficult to deploy in educational institutions with limited resources. Therefore, there is a growing need for a cost-effective, secure, and user-friendly attendance management solution that can be implemented with minimal hardware requirements [3], [4], [5].

Quick Response (QR) code technology has emerged as an effective solution for automating attendance management. A QR code is a two-dimensional barcode capable of storing a large amount of information that can be scanned quickly using smartphones or webcams. Each student or employee can be assigned a unique QR code, allowing the system to identify individuals accurately and record their attendance instantly. Compared with traditional attendance methods, QR codes provide faster processing, reduce human intervention, and significantly minimize the possibility of duplicate or proxy attendance. Their ease of generation, low implementation cost, and compatibility with mobile devices make QR codes highly suitable for educational institutions and business organizations [6], [7], [8].

This project presents a Smart QR Code-Based Attendance Management System developed using Python and QR code technology to automate

attendance recording. The system allows administrators to register users, generate unique QR codes, maintain attendance records, and produce attendance reports efficiently. Users can scan their QR codes using a webcam to mark attendance, while administrators can monitor attendance information through an easy-to-use interface. By replacing manual attendance procedures with an automated digital solution, the proposed system improves accuracy, saves valuable time, enhances data security, and provides an efficient attendance management process suitable for modern educational institutions and workplaces [6], [7].

II. RELATED WORK

“Attendance Management System (AMS) with Fast Track Analysis,” M. A. Abas, T. B. Tuck, and M. Dahlui [3]

This study proposed an Attendance Management System (AMS) that combines RFID technology with a web-based platform to simplify attendance recording and analysis. The system was designed to reduce the time required for taking attendance in large classrooms while minimizing manual errors associated with traditional attendance methods. The authors developed a fast-track analysis module that enables lecturers to monitor attendance records efficiently and generate reports automatically. The proposed solution also provides real-time attendance monitoring, making it easier to identify absent or late students. Experimental results showed that the system significantly reduced attendance recording time and improved data accuracy compared to manual methods. The research highlighted the importance of automation in educational environments by demonstrating how technology can streamline administrative tasks and improve record management. However, the reliance on RFID hardware increases implementation cost, motivating the development of more affordable QR code-based attendance systems.

“Effective and Efficient Attendance Tracking System Using Secret Code,” T. J. Zhi, Z. Ibrahim, and H. Aris [4]

This research introduced a secure attendance tracking system that uses dynamically generated secret codes to prevent proxy attendance and improve attendance verification. Instead of relying on traditional signatures or manual registers, each student receives a unique secret code for every attendance session. The generated codes are protected using the MD5 hashing algorithm, ensuring that attendance records remain secure and

cannot be easily manipulated. The proposed system automatically stores attendance information in a centralized database, allowing instructors to monitor student participation more efficiently. Experimental evaluation demonstrated that the system significantly reduced attendance processing time while improving security and reliability. The authors concluded that automated attendance tracking using secure authentication techniques can effectively eliminate fraudulent attendance practices. Although the system provides enhanced security, students are still required to manually enter codes, which can reduce convenience compared to automated QR code scanning systems.

“Attendance Management System,” S. K. Jain, U. Joshi, and B. K. Sharma [5]

The authors presented an attendance management framework aimed at replacing conventional paper-based attendance systems with an automated digital solution. Their proposed system integrates software and hardware components to simplify attendance recording while ensuring better data accuracy and storage. The system was designed to be portable, energy-efficient, and cost-effective, making it suitable for educational institutions and other organizations. The research emphasized the importance of reducing paperwork, eliminating duplicate attendance entries, and generating attendance reports automatically. By maintaining attendance records electronically, the system also minimizes the risk of data loss and improves accessibility for administrators. The authors highlighted that an automated attendance management system enhances operational efficiency and reduces administrative workload. Their work laid the foundation for future attendance solutions that utilize modern identification technologies such as QR codes, RFID, and biometric authentication to provide more secure and user-friendly attendance management.

“QR Code Based Smart Attendance System,” A. Manori, N. Devnath, N. Pasi, and V. Kumar [6]

This paper proposed a QR Code-Based Smart Attendance System that leverages smartphone technology for fast and efficient attendance recording. The system consists of two applications: one for generating unique QR codes for students and another for scanning these QR codes during attendance sessions. Each student receives a personalized QR code, which is scanned by the instructor to verify attendance and update records in the database automatically. The generated attendance reports can be exported in CSV or Excel

formats for further analysis and documentation. The proposed system eliminates manual attendance registers, reduces attendance recording time, and minimizes human errors. The authors also discussed methods for verifying student identity to prevent false attendance entries. The study concluded that QR code technology provides a low-cost, accurate, and reliable solution for educational institutions seeking to modernize attendance management while improving administrative efficiency.

“A Students Attendance System Using QR Code,” Fadi Masalha and Nael Hirzallah [7]

This study introduced an innovative attendance management system that utilizes QR code technology and smartphones to automate student attendance in classrooms. The proposed system generates a unique QR code for each lecture, which is displayed by the instructor at the beginning of the class. Students scan the displayed QR code using a mobile application, and their attendance is automatically recorded in a centralized database after successful identity verification. The system reduces the time spent on manual attendance, improves data accuracy, and prevents proxy attendance by validating student identities before recording attendance. The authors emphasized that the widespread availability of smartphones makes QR code-based attendance systems practical, scalable, and easy to implement without requiring expensive hardware. Their research demonstrated that QR code technology provides an efficient, secure, and cost-effective alternative to traditional attendance methods, making it highly suitable for modern educational institutions.

III. DATASET DETAILS

The dataset used in this study consists of employee information and attendance records collected for developing a Smart QR Code-Based Attendance Management System. The dataset includes details such as Employee ID, Employee Name, Contact Number, Email ID, Gender, Address, Designation, Salary, and attendance status. Each employee is assigned a unique QR code generated by the system during the registration process. This QR code serves as a unique identifier and is scanned using a webcam to record daily attendance automatically. Every attendance entry stores the employee ID along with the corresponding date and time, ensuring that only one attendance record is maintained for each employee per day. The dataset is organized into two main tables: one containing employee registration details and another maintaining attendance logs. Since the attendance information is collected digitally, the chances of duplicate entries and

manual recording errors are significantly reduced. The structured dataset provides reliable information for generating attendance reports, monitoring employee presence, and managing payroll calculations efficiently. It serves as the primary source for training and evaluating the attendance management workflow while ensuring secure and accurate record maintenance.

Before utilizing the dataset, several preprocessing operations are performed to ensure consistency and improve system reliability. Missing or incomplete employee records are verified and corrected during the registration process, while duplicate attendance entries are prevented through unique QR code validation. The QR code generated for each employee is linked directly to the employee database, enabling quick identification during attendance scanning. The attendance records are then organized according to employee ID and attendance date, making retrieval and report generation more efficient. For system evaluation, the processed dataset is divided into training and testing sets using an 80:20 ratio, where 80% of the data is used to validate the attendance recording workflow and 20% is used to evaluate system performance. The dataset supports testing of QR code generation, webcam-based scanning, attendance verification, report generation, and employee login functionalities. Through systematic preprocessing and validation, the dataset enables the proposed attendance management system to provide accurate, secure, and efficient attendance recording while reducing manual effort and improving administrative productivity.

IV. PROPOSED METHODOLOGY

The proposed methodology presents a Smart QR Code-Based Attendance Management System that automates employee attendance recording using QR code technology, Python, OpenCV, and a MySQL database. Initially, all employee information, including Employee ID, Name, Contact Number, Email, Gender, Address, Designation, and Salary, is stored in the MySQL database through the administrator module. During employee registration, the system automatically generates a unique QR code for every employee using the registered Employee ID. The generated QR code is downloaded by the administrator and shared with the respective employee. The employee can save the QR code on a mobile device or print it for future attendance marking. This digital registration process eliminates manual record maintenance and ensures

that every employee has a unique identification code linked directly to the attendance database.

After employee registration, the attendance recording process is performed using a webcam-based QR code scanner. When the administrator starts the webcam module, employees simply display their assigned QR code in front of the webcam. The OpenCV-based scanner detects and decodes the QR code instantly, identifies the corresponding employee from the database, and records the attendance along with the current date and time. The system validates the attendance record before storing it to ensure that an employee cannot mark attendance more than once on the same day. This validation mechanism prevents duplicate attendance entries and proxy attendance while improving the reliability and accuracy of attendance records. Since the attendance process is completely automated, the time required for recording attendance is significantly reduced compared to conventional manual methods.

Once attendance has been recorded successfully, the administrator can monitor employee attendance through the web application. The system provides options to view employee details, select an employee ID, specify a start date and end date, and generate attendance reports for the selected period. The attendance report displays all attendance dates along with the total number of working days recorded. Based on the stored salary information and the total attendance days, the system automatically calculates the payable salary for each employee. This automation eliminates manual attendance calculations and simplifies payroll processing. The administrator can efficiently monitor attendance records, employee information, and salary details from a centralized dashboard without maintaining paper registers or separate attendance sheets.

In addition to the administrator module, the proposed system also provides an employee login module. Employees can securely log in using their Employee ID and access their individual attendance records. After selecting a desired date range, employees can view their attendance history along with the total number of present days and the calculated payable salary. This self-service feature improves transparency by allowing employees to verify their attendance records independently. Since all attendance information is stored digitally in the database, records can be retrieved quickly without manual searching. The system therefore provides an efficient, secure, and user-friendly attendance management solution suitable for educational institutions, offices, industries, and other

organizations requiring accurate attendance monitoring.

The complete system architecture is illustrated in Figure 1, which presents the workflow of the proposed QR Code-Based Attendance Management System. The architecture includes employee registration, QR code generation, MySQL database storage, webcam-based QR code scanning, attendance verification, attendance recording, employee login, attendance report generation, salary calculation, and attendance history management. The integration of Python, OpenCV, QR code technology, and MySQL ensures secure data storage, fast attendance recording, prevention of duplicate entries, and simplified attendance management through an easy-to-use web interface.

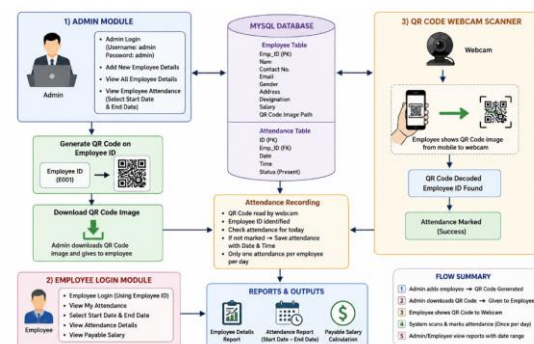


Figure 1. System Architecture for Smart QR Code-Based Attendance Management System

The proposed attendance management methodology is designed to replace conventional attendance registers with a fully automated digital solution. Initially, employee details are registered in the system, and a unique QR code is generated for each employee. The generated QR code acts as a secure digital identity for attendance verification. During attendance marking, employees display their QR code to the webcam, where the OpenCV scanner extracts the encoded information and validates it against the database before recording attendance. If attendance has already been marked for the current day, the system prevents duplicate entries automatically.

After successful attendance recording, administrators can generate attendance reports by selecting employee IDs and date ranges. The system calculates attendance statistics and payable salary automatically based on the recorded attendance days. Employees can also access their personal attendance records through the employee portal to

verify attendance and salary information. Compared with traditional attendance methods, the proposed QR code-based system offers higher accuracy, improved security, faster attendance recording, reduced paperwork, and efficient attendance management through automated report generation and centralized database storage.

V. RESULT AND DISCUSSION

The experimental results demonstrate the effectiveness of the proposed QR Code-Based Attendance Management System for automating employee attendance recording and management. Initially, employee information, including Employee ID, Name, Contact Number, Email, Designation, Salary, and other personal details, was registered through the administrator module and stored securely in the MySQL database. During registration, the system automatically generated a unique QR code for every employee based on the assigned Employee ID. The generated QR code was downloaded by the administrator and shared with the respective employee for attendance marking. After successful registration, the webcam-based QR code scanner was used to verify employee identity and automatically record attendance. The system ensured that each employee could mark attendance only once per day, preventing duplicate entries and improving attendance accuracy. Attendance records were stored along with the corresponding date and time, enabling efficient attendance management. Experimental observations showed that the proposed system significantly reduced manual effort, minimized attendance recording time, eliminated paperwork, and improved data reliability compared to traditional attendance methods.

The administrator module successfully managed employee registration, QR code generation, employee details, and attendance reports through a centralized interface. Employees could securely log in using their Employee ID to view attendance records for any selected date range along with the automatically calculated payable salary. The QR code scanning module accurately detected QR codes displayed on employee mobile devices using a webcam and recorded attendance instantly without requiring manual verification. Attendance reports generated by the system provided complete information regarding attendance dates and total working days for each employee. Overall, the experimental results demonstrate that the proposed QR Code-Based Attendance Management System provides a secure, efficient, and reliable solution for attendance automation. The integration of Python, OpenCV, QR code technology, and MySQL enables faster attendance processing while reducing

administrative workload and improving record management.

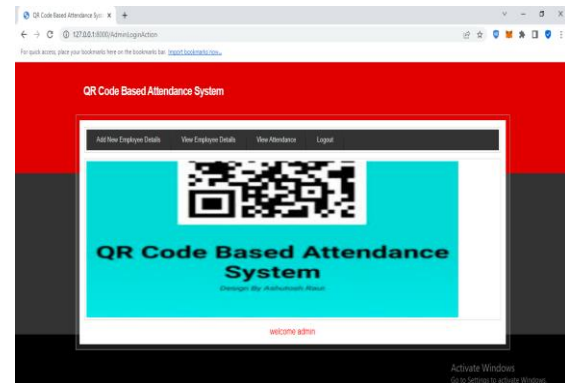


Figure [2] Admin Module Dashboard

The Admin Module serves as the central management interface of the proposed attendance system. It allows the administrator to securely log in using authorized credentials, register new employees, generate unique QR codes, download QR code images, view employee details, and monitor attendance records. The administrator can also generate attendance reports by selecting employee IDs and specifying the desired start and end dates. This module simplifies employee management while maintaining all attendance information in the MySQL database.

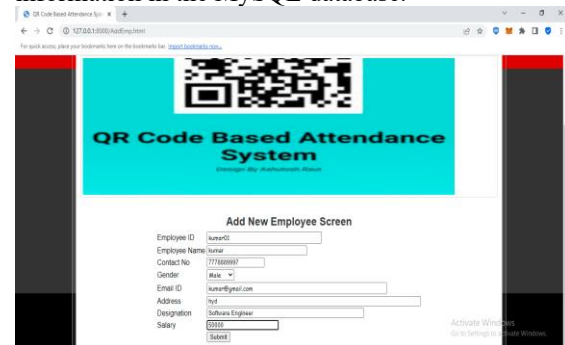


Figure 3: Employee Login Module

The Employee Login Module enables employees to access their attendance information securely using their Employee ID. After successful authentication, employees can select a specific date range to view their attendance history, including attendance dates, total present days, and payable salary. This self-service module improves transparency by allowing employees to verify their attendance records without requiring administrator assistance.

Figure 5 illustrates the attendance report generated by the administrator after selecting an employee and specifying the start and end dates. The report displays the Employee ID, attendance dates, total number of present days, and automatically calculated payable salary. This report enables efficient attendance monitoring and payroll management while eliminating manual attendance calculations.

DISCUSSION

The experimental findings demonstrate that the proposed QR Code-Based Attendance Management System provides an effective solution for replacing conventional attendance registers with a fully automated digital attendance process. The administrator module efficiently manages employee registration, QR code generation, attendance monitoring, and report generation through an easy-to-use interface. The QR code generated for each employee acts as a unique digital identity, ensuring secure attendance verification.

The webcam-based QR code scanner accurately identifies employee QR codes and records attendance automatically without requiring manual intervention. The built-in validation mechanism prevents multiple attendance entries on the same day, thereby improving attendance accuracy and eliminating duplicate records. Compared to traditional attendance methods, the proposed system significantly reduces attendance recording time, minimizes human errors, and removes paperwork.

The employee login module further enhances transparency by allowing employees to access their attendance history and payable salary information independently. Attendance reports generated by the system provide complete attendance statistics for any selected period, simplifying administrative work and payroll processing. Overall, the proposed QR Code-Based Attendance Management System offers a secure, reliable, and user-friendly attendance management solution suitable for educational institutions, offices, industries, and other organizations requiring efficient employee attendance monitoring.

VI. CONCLUSION

The proposed QR Code-Based Attendance Management System provides an efficient, secure, and user-friendly solution for automating the attendance process in educational institutions and organizations. Unlike traditional paper-based attendance methods, the proposed system uses unique QR codes and webcam-based scanning to record attendance accurately and quickly. By assigning a unique QR code to every employee or student, the system eliminates manual errors, reduces the possibility of proxy attendance, and ensures that only one attendance entry is recorded for each individual per day. The integration of Python, OpenCV, and MySQL enables secure data storage, fast attendance verification, and automatic report generation, thereby reducing administrative workload and saving valuable time.

The developed system also offers additional features such as employee registration, QR code generation, attendance history, report generation, and automatic salary calculation based on attendance records. These features improve transparency and simplify attendance management for both administrators and employees. Furthermore, the digital approach minimizes paperwork, enhances data security, and allows attendance records to be accessed easily whenever required.

Overall, the proposed system demonstrates that QR code technology is a practical and cost-effective alternative to conventional attendance systems. Its simple implementation, low operational cost, and high accuracy make it suitable for educational institutions, offices, industries, and other organizations. In the future, the system can be further enhanced by integrating facial recognition, mobile applications, cloud storage, GPS-based verification, and real-time notification services to provide an even more secure, scalable, and intelligent attendance management solution.

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