Leveraging Qr Code Technology for Efficient and Secure Attendance Management in Educational Institutes

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***Abstract*—This research looks at using QR codes for taking attendance, but with an extra layer of security: face recognition. We know traditional attendance methods can be a real hassle and waste time, which is why QR codes have become a popular shortcut. But, there's a catch – QR codes can sometimes be cheated. So, our system is designed to create two brand-new QR codes every single second, meaning only the one that's live at that exact moment will work.**

We wanted to see how this new tech impacts a few things: how often students show up, how accurate the attendance records are, and whether it's easy and pleasant for both students and teachers to use. We looked at the data and also asked people what they thought through surveys. What we found is pretty encouraging: using QR codes with face recognition actually boosted attendance, made the records much more reliable, and everyone seemed to like using it.

***Index Terms*—Mobile Computing, Attendance System, Educational System, QR code, Face recognition.**

I. INTRODUCTION

Technology has transformed every sector of society including education. Yet, a lot of educational institutions are stuck with old-fashioned attendance tracking methods that are inefficient and riddled with errors.

Attendance taking for long has been seen as a tedious, yet unavoidable job. The conventional means like pen-paper sign-in sheets and card swipe systems have always proved to be unsatisfactory and inaccurate too in most cases. Availability of technology has helped schools adopt various forms of digital attendance tracking mechanisms such as biometric identification (e.g. fingerprint scanners) or QR code-based solutions, using automated systems to assist in the process.

These automated systems use technologies such as facial recognition and QR codes with

the latter being more popular due to its user-friendly nature, cost effectiveness and simplicity. In a QR code-based system, everyone is assigned a unique QR code which they can scan using their smartphone to record their attendance automatically into a central system security by confirming either users, services or systems are whom they claim to be or whether an accessing the entity has identities and control their accesses. In addition, privacy issues are more concerning due to the use of learning management systems which may gather large amounts of personally identifiable information about students during online identity and award credits or qualifications in respect of that coursework. Biometrics are a widely used method for verifying a technique to identify an individual's identity.

II. SPECIFIC RESEARCH

Recently educators and researchers have taken keen interest in the use of QR codes for student attendance monitoring. It allows efficient attendance recording; enables students to check in and out of class without multiple keys or clicks; provides real-time attendance information to teachers and administrators; and helps to reduce time or effort in taking attendance manually which allows teachers to focus on instruction and student engagement.

The system would enhance the present attendance management with the application of data-hiding algorithms to embed QR codes serving with student information. Scanning the QR code by students using their smartphone camera when displayed by the teacher triggers automatic attendance marking based on the user identifier (ID) for consistently monitoring attendance.

At the specified attendance point, a student or employee scans a QR code with a smartphone or mobile device with the QR code scanner app on it. The application extracts data from the QR code and

forwards it to the attendance system for record keeping. The attendance system generates attendance records for individual personnel and makes such records accessible and viewable by authorized personnel. The attendant data is thus safely stored in a remotely accessible cloud database. The system will have reporting function where authorized personnel will be able to generate attendance records for individuals, groups, or departments.

Many educational institutions have implemented automated systems to take students' attendance through facial recognition.

The systems depend on either a camera that captures all students in one go or a camera that captures them one by one.

Most of the existing studies in literature have addressed algorithm accuracy and other technical aspects of an automated attendance recording system. There's little interest in post-processing of attendance data, which is critical to monitoring and audit, management of absenteeism, and reporting. User preference, acceptance, and satisfaction with these technologies have also not been adequately studied. Our work attempts to fill the gap by developing a web-based attendance management system using both facial recognition and QR code technology. Reduce hardware installation and long-term maintenance, thus helpful in offering an economically viable solution with flexibility. A deep need is given that the technological infrastructure establishment is entirely needed within the educational institutions as far as the connection to the internet, hardware, platforms, as well as a level of competence of the staff are concerned to bring within the walls of the institution's dimensions or capacity.

Our literature survey, thus, by a summarization of indicated emerging patterns, trends, and insights from this vast review. These observations are the underpinnings of our project, bridging the chasm between the review of the existing literature and development of our face recognition-based attendance system.

The table below summarizes the various projects, detailing their strengths and weaknesses

No.	AUTHORS	YEAR	KEY FINDINGS/ NOTES STUDY FOCUS	ACCURACY
1.	Simran B. Wanjare et al.	2024	Introduced a contactless smart attendance system utilizing facial recognition and QR codes to improve efficiency and prevent proxy attendance. Contactless attendance system using facial recognition and QR codes.	Unique QR codes
2.	Bao-Thien Nguyen-Tat et al.	2024	Designed an attendance management system using computer vision and facial recognition to automate attendance tracking. Automating attendance management using facial recognition.	Real-time data capture

3.	Gopi H. et al.	2023	Proposed a student information system that uses QR codes and face biometrics, authentication, enhancing security and efficiency in attendance tracking. Combining QR codes with face biometrics for student authentication.	Automated data processing
4.	Nesma Abd El-Mawla et al.	2022	Developed an attendance system utilizing face recognition, fingerprint, and QR code technologies to manage attendance in educational institutions. Integration of biometric and QR code technologies for attendance management.	Real time monitoring and alerts
5.	Ashwin Rao	2022	Developed a real-time attendance system using face recognition to automate attendance marking in educational settings. Real-time attendance system employing face recognition.	Improved employee satisfaction
6.	Sarker D.K at lee	2021	Created a smart attendance system using QR codes to verify student identity and prevent cheating, with records instantly available to students and lecturers. QR code-based attendance system to enhance security and efficiency.	Reduced Time theft
7.	Gurvinder Singh	2018	Reviewed various approaches for digitizing attendance management in educational institutions, the use of QR codes and facial recognition. Digitizing attendance using QR codes and facial recognition.	Increased Accountability
8.	Chen R. et al.	2015	Introduced an approach for QR codes in warehouse systems to handle effectively. improving QR code scanning under	Integration with HR systems

			varying conditions.	
9.	Hung S.H. & Yao C.	2014	Proposed a method to create high-quality micrography QR codes by warping letters and adjusting font weights for improved scanning accuracy. Enhancing QR code quality for better scanning accuracy.	Time-Stampe d records
10.	Saraswat C. & Kumar A.	2010	Presented an automated attendance system to improve accuracy and reduce manual effort. Fingerprint-based attendance system for automation.	Real Time monitoring and alerts

III. SYSTEM ANALYSIS

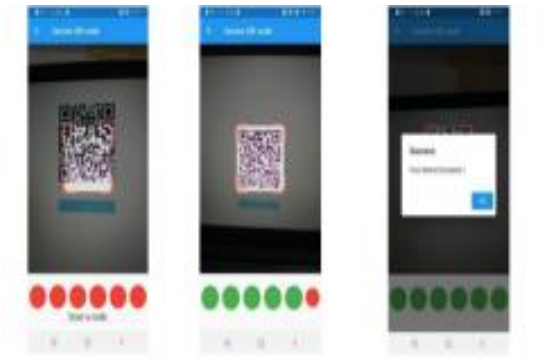
3.1 Face Recognition

It comprised four components, such as: image acquisition, face detection, feature extraction and classification with database matching. The face detection module identifies and locates the face area in the image features which will be extracted from the regions of interest within the image. The module matches the extracted faces with known or unknown faces using a classifier trained on these faces. Feature Extraction module analyzes personal identity information and derives characteristics detected from the area in the face of the human. The Face Recognition Module uses the open-source computer vision library popularly known as OpenCV and integrates the face recognition algorithms easily. The available algorithms were Haar cascade classifier and LBPH Face Recognizer for face detection and recognition.

The haar classifier is chosen for its ability to run against grayscale images, making detection efficient rather than dependent upon colors. It has proven to be naturally resistant to grayscale transformations and has an extremely precise value and speed. It managed to get up to 90 percent of recognition rates in cases of front facing and side facing faces. LBPH surpassed Eigenfaces and Fisherfaces methods when it comes to the effects of lighting and pose variations and proved its strength with different multi-condition factors like light conditions, distance between object and camera, and object age.

3.2 Qr Code

a camera interface for capturing the animated QR codes displayed on the classroom's data show as Figure 2. When the camera starts to capture the QR code the red circles will be green circles to indicate the student transaction process as Figure 10. The app then compares the hash value of the QR code with the hashes retrieved from the server and geolocation of student mobile with the geolocation of classroom, marks the student as present if a match is found as Figure 1 or show error if the information fake, and sends the attendance data to the server through the API.



IV. PROPOSED SYSTEM

4.1 Overview of Proposed System In today's world of progressive technology, the multi-view face recognition student attendance system generates attendance records based on a QR code and facial recognition with the advantages of the HAAR cascade algorithm and neural network algorithms due to its high accuracy. Attendance is recorded through QR code detection without including faces, and students are enrolled into a database. Also built-in is that alert through SMS and emails with real time implementation. It provides additional student features, keeping them updated about their fee details and overall report. It is a unique way in face recognition of video scenes that will help solve the problem with unlimited orientations and positions of human faces. This concept will project the face texture on a sphere surface able to construct texture maps for the whole face collecting image intensity values back from each view on the sphere model surface. The applicability of such a method can ensure a high accurate matching and hence robustness of the face recognition systems, making it a promising solution for student attendance systems in educational organizations.

The server-side application will create unique QR codes, store attendance records within a secure database, and process data received from the mobile application. The application works by checking in quickly through QR scans and confirms students' physical presence with geolocation tracking within the radius of the classroom. The required solution is to simplify the attendance system, definitely inject a few to improve accuracy, and reduce administrative burdens.

4.2 Workflow of Proposed System The new system aims to automate the attendance-taking procedure in educational institutions. To depict the method of marking attendance, a flowchart was created as illustrated in Figure 2, indicating how to create the attendance session and generate its unique hash, and display it as an animated QR code. This flowchart is a visual representation of the approach for capturing student attendance. The focus of system design and development was to meet end-user requirements by customizing the architecture to their specific needs. An Agile approach was adopted, utilizing iterative cycles of design, development, and testing.

To clearly show the proposed system's architecture, Figure 2 displays critical components, such as facial recognition technology, QR code scanning, and a centralized database. In Phase 3, comprehensive testing stages have been carried out on the developed system- unit testing, integration testing, and acceptance testing. Evaluation efforts include module functionality assessment, user perceived usefulness, and intention to adopt this innovative solution.

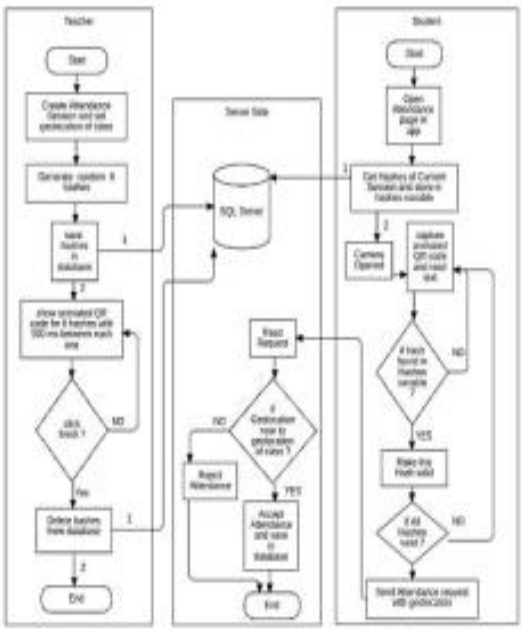
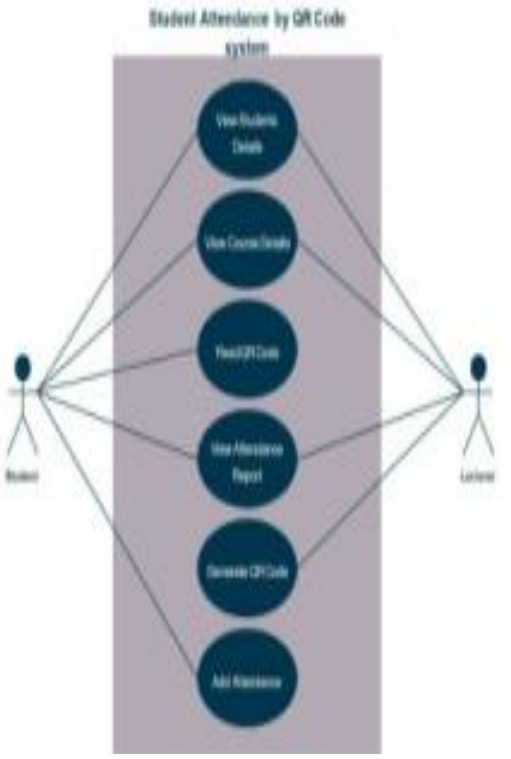


Figure 2. Flowchart of the secure attendance system using animated QR code

4.3 Use Case Diagram

The Use Case diagram outlines a broad depiction of users and lecturers' interactions with the QR system featuring essential functionalities such as student course detail viewing, QR code reading, and QR code generation.



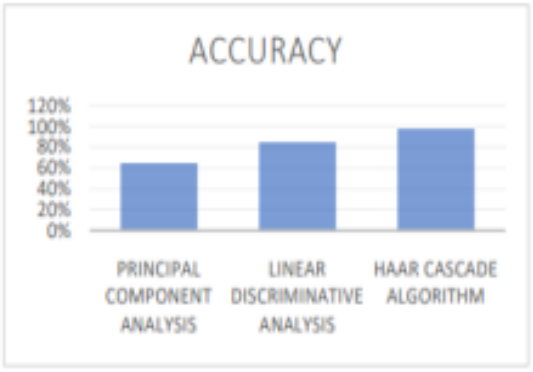
V. RESULT

Set of faces are needed to evaluate the system. Testing and evaluating face detection algorithms is provided with different face database standards. Standardized facial databases become necessary for the uniformity of images for algorithm developers as well as meeting a minimum level of images for conducting tests. Accurate evaluation or comparison of facial recognition algorithms cannot be carried out without the database and standards. Most of the experiments conducted in this module are based on a real-time face database.

Accuracy (ACC) is a common performance measure in machine learning and artificial intelligence for judging the performance of a model. The ratio of correctly predicted outcomes (true positive and true negative predictions) to the number of predictions made by the model states the accuracy. This is normally represented in percentage with 100% accuracy being a perfect model with no errors in the predictions. Lesser accuracy means more errors are being committed by the model in its predictions making it a candidate for improvement or re-evaluation.

ACC=(TP+TN)/(TP+TN+FP+FN)*100

ALGORITHM	ACCURACY
PRINCIPAL COMPONENT ANALYSIS	65%
LINEAR DISCRIMINATIVE ANALYSIS	85%
HAAR CASCADE ALGORITHM	98%



VI. CONCLUSION

This paper does a detailed review of all face recognition methods as applied to still images and video sequences. The traditional method demands a perfectly aligned face image and works with still image recognition or video-to-video matching; thus, it is not applicable for surveillance face recognition. Existing techniques have several limitations including pose, illumination variations, and poor video quality of the very few images extracted from each video as well as insufficient computational resources for real-time processing. Accordingly, we will present a local facial feature-based framework for still image and video face recognition under surveillance conditions. This framework will make real-time video-to-face matching possible, trained on static images while applied to video sequences, resulting in much higher recognition rates. The present effort combines QR-based authentication with fee information and SMS alert systems to evaluate the approach against real-time image datasets.

The overall conclusion from the study states that indeed a secure attendance system based on animated QR code has been effective in ensuring the maximum possible security and accuracy that could be possible in tracking attendance in our institution. The study indicates reliability and ease of convenience in usage for both students and instructors.

VII. FUTURE ENHANCEMENT

While the QR code technology along with facial recognition significantly improved attendance management in educational institutions, there are enhancing dimensions that could optimize the already existing system as follows:

1. Real-Time Analytics and Insights

● Data Visualization: Visualize attendance trends, patterns, and anomalies using interactive dashboards.

● Predictive Analytics: Predict potential attendance issues using machine learning and send alerts.

● Personalized Insights: Personalized feedback for students and teachers based on attendance data

2. Geo-fencing and Location-Based attendance

● Geo-fencing: This ensures that the student is actually present in the school or designated area by GPS technology.

● Location-Based Attendance: Attendance list is automatically marked based on geographical zoning of students.

3. AI-Powered Automation

● Automated Attendance Marking: AI attendance by observing behavioral patterns and usage of the device.

● Intelligent Alerts: Alerting parents and guardians efficiently regarding a student absence or tardiness.

4. Integration with LMS

● Seamless Data Synchronization: Automatic syncing of attendance of any student with the LMS to give a detailed overview of student performance.

● Conditional Access: Give access to some course materials or resources against the attendance rule.

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