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AI Powered Attendance Management System

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ABSTRACT: Attendance monitoring is a basic academic requirement in engineering colleges, but physical roll-calls consume lecture time and static QR codes can be photographed and forwarded to absent students. This paper presents an AI powered attendance management system that marks attendance only when four independent checks pass. A faculty member starts a session that issues a dynamic QR token valid for ten minutes. The student's device reads the QR code in the browser, and the Haversine formula confirms that the student is within 20 m of the teacher's classroom anchor. A TensorFlow.js COCO-SSD (MobileNet) model then checks that the surroundings look like a classroom with a confidence of at least 60%, and the Express server rejects repeated roll numbers and repeated face signatures in the same session. Verified records are presented as subject-wise donut charts, bar diagrams against the 75% eligibility cutoff and a multi-sheet Excel report. The system is built with React, Vite, Node.js and Express, needs no extra hardware, and in functional tests rejected expired tokens, distant locations, non-classroom scenes and duplicate entries with specific error codes.

KEYWORDS: Attendance Management, Dynamic QR Code, Geofencing, Haversine Formula, Computer Vision, COCO-SSD, TensorFlow.js, Anti-Proxy Verification, React, Express.

I. INTRODUCTION

Attendance is one of the main indicators of student engagement in higher education, and most universities require a minimum of 75% attendance before a student may write the semester examination. In many colleges attendance is still taken by calling out roll numbers, which consumes ten to fifteen minutes of every lecture, and paper registers are difficult to analyse at the end of the semester.

Automated alternatives exist but each has a weakness. RFID cards, fingerprint scanners and face-recognition terminals need dedicated hardware. QR-code attendance is cheap, but a static or long-lived QR code can be photographed and forwarded to absent students, who then mark attendance remotely from a hostel, a cafeteria or outside the campus. Students can also mark attendance on behalf of friends who are not present.

This paper presents an AI powered attendance management system that accepts attendance only when four independent checks pass: (i) a dynamic QR token that expires after ten minutes, (ii) a GPS geofence of 20 m based on the Haversine formula, (iii) a browser-based computer-vision check that the surroundings look like a classroom, and (iv) a server-side ledger that rejects repeated roll numbers and repeated faces. Verified records feed subject-wise analytics and an Excel audit report.

The system is a screening aid. It needs no extra hardware and runs in a modern web browser, and the AI model runs on the student's device so camera frames are not uploaded to the server. The faculty member remains responsible for the final attendance record.

The rest of this paper is organized as follows. Section II reviews related work. Section III describes the methodology. Section IV presents the experimental results and Section V gives the conclusion and future enhancement.

II. LITERATURE SURVEY

Several studies combine QR codes with location checks. Gaftandzhieva and Lyavova [1] use time-limited dynamic tokens, duplicate-registration checks, device binding and Haversine geofencing in a four-layer validation, and Nwabuwe et al. [2] prevent QR sharing by combining dynamic QR codes, geofencing and device identity. Masalha and Hirzallah [3] use a unique QR code for each class to cut check-in time, while Taju et al. [4], Gangurde et al. [5] and Muthulakshmi et al. [6] add geolocation or a geofence so that attendance registered outside the classroom can be rejected. Chinedu et al. [7] describe a QR-based system for a university.

Hardware-based systems automate attendance but need extra equipment. Kassem et al. [8] use RFID cards read by classroom readers, Akinduyite et al. [9] use fingerprints, and Shah et al. [10] use face recognition. These approaches save lecture time, but they add equipment cost, enrolment effort or dependence on good lighting, and they do not by themselves show that the person is inside the classroom.

Lightweight object detection now makes it possible to inspect the surroundings on the user's own device. The Single Shot MultiBox Detector [11] detects objects in one network pass, MobileNets [12] provide efficient networks for mobile vision, the COCO dataset [13] defines the common object classes, and TensorFlow.js [14] runs such models inside a web browser. Distance between two GPS positions is computed with the Haversine formula [15], which is accurate at classroom scale.

Taken together, the literature shows that dynamic QR codes and geofencing reduce proxy attendance, and that browser-based object detection is practical. The gap is a system that adds a visual check of the surroundings and a duplicate-prevention ledger to those layers and also reports attendance by subject.

TABLE I. SUMMARY OF RELATED WORK AND ITS RELEVANCE TO THE PROPOSED SYSTEM

Ref.	Focus of the work	Relevance to the proposed system
[1] Gaftandzhieva and Lyavova, 2026	Dynamic tokens, duplicate checks, geofencing	Same layered idea; no visual check of surroundings
[2] Nwabuwe et al., 2023	Dynamic QR code, geofencing, device identity	Prevents QR sharing; no AI vision tier
[4] Taju et al., 2024	QR scanning with geolocation	Location-aware attendance; fixed radius only
[8] Kassem et al., 2010	RFID card attendance	Automated but needs readers and cards
[11], [12] Liu et al., 2016; Howard et al., 2017	SSD and MobileNets detectors	Basis of the in-browser classroom check
[15] Sinnott, 1984	Haversine great-circle distance	Basis of the 20 m geofence

The surveyed work treats QR codes, geofencing and visual checks separately and rarely reports attendance analytics. The proposed system joins the four layers in one browser-based pipeline and adds subject-wise charts and an audit report.

III. METHODOLOGY

A. System Architecture

The system follows a three-tier architecture, shown in Fig. 1. The presentation tier is a single-page application built with React 18 and Vite, used by faculty and students. It opens the device camera through WebRTC (`getUserMedia`), decodes QR codes with `jsQR` and runs the COCO-SSD model with `TensorFlow.js`. The application tier is a Node.js and Express REST API with the endpoints `/api/sessions/create`, `/api/sessions/active`, `/api/attendance/verify` and `/api/attendance/records`. The data tier is a JSON persistence store for sessions and verified records, and ExcelJS builds the reports.

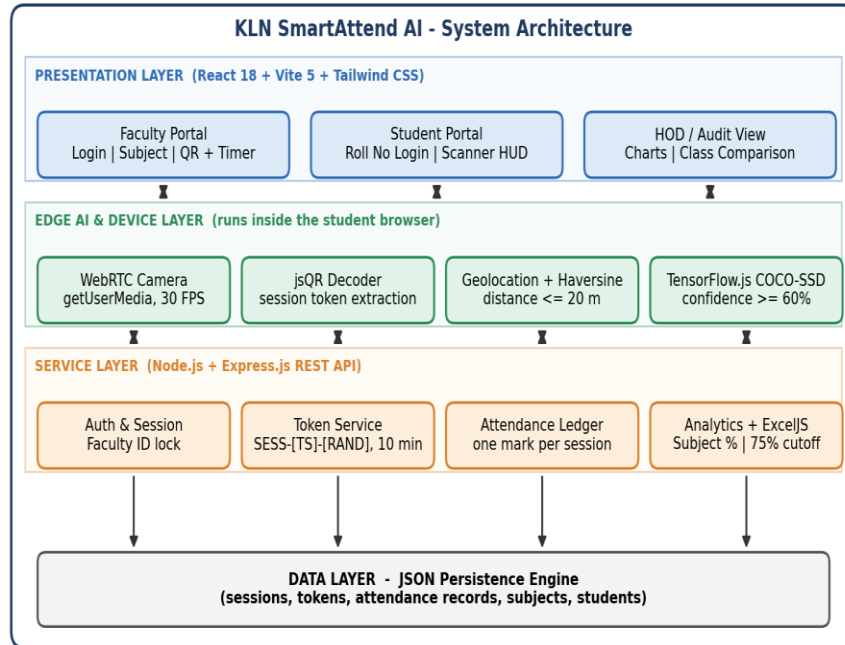


Fig.1.System architecture of the proposed system

B. Data Flow

Fig. 2 shows the data flow of the system. The faculty member logs in, selects a subject and starts a session (process 1.0); the server stores the session with its ten-minute expiry and the classroom GPS anchor, and the QR code is displayed. The student enters a roll number and scans the code; the browser sends the session token, the device GPS position and the AI confidence to the server (process 2.0). The server applies the four checks, writes the verified record to the ledger (process 3.0), and the analytics module reads the ledger to build charts and the Excel report (process 4.0).

Data Flow Diagram - KLN SmartAttend AI (Level 1)

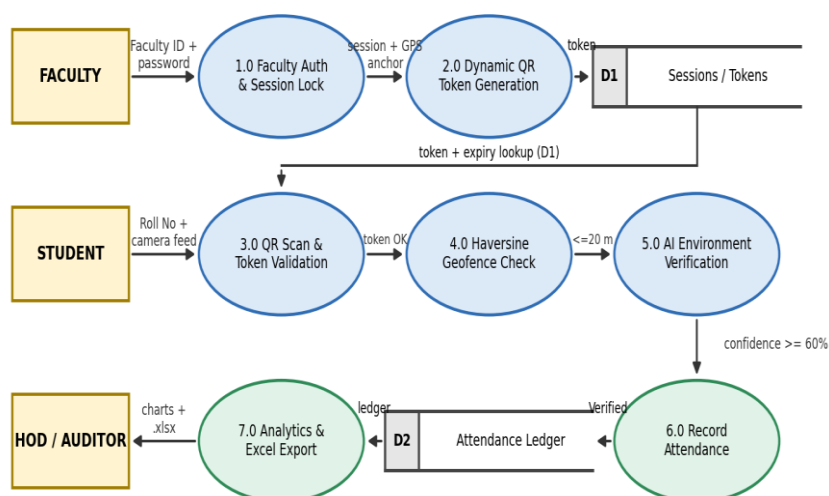


Fig.2. Data flow diagram of the proposed system.

C. Dynamic QR Session and Scanning

When a session starts, the server creates a token of the form SESS-XXXXXXX from a random string and sets the end time to ten minutes after the start time. The QR code carries this token, and a countdown on the faculty screen shows the remaining time. On the student device, jsQR analyses the video frames and decodes the token. The server rejects a scan with the codes MISSING_QR_SESSION, NO_ACTIVE_SESSION, EXPIRED_QR_SESSION or INVALID_QR_SESSION when the token is absent, no session is active, the ten minutes have passed or the token does not match.

D. Geofence Verification

The distance d between the teacher's anchor (ϕ_1, λ_1) and the student (ϕ_2, λ_2) is calculated with the Haversine formula: $a = \sin^2(\Delta\phi/2) + \cos \phi_1 \cdot \cos \phi_2 \cdot \sin^2(\Delta\lambda/2)$ and $d = 2R \cdot \text{atan2}(\sqrt{a}, \sqrt{1-a})$, where $R = 6,371,000$ m. Attendance continues only if $d \leq 20.0$ m. The distance is checked on the device to give quick feedback and calculated again by the server, so editing the page cannot bypass the limit. A failed check returns PROXIMITY_FAILED together with the measured distance.

E. AI Classroom Verification and Anti-Proxy Ledger

The COCO-SSD model with the lite MobileNet v2 base detects desks, chairs or benches, a blackboard and persons in the camera frame. The classroom confidence is 96% when a student and classroom furniture are both detected, 58% when furniture is seen without a student, and 28% or lower otherwise, and the scene is accepted only at 60% or above (Fig. 3). Finally, the ledger allows one record per roll number in a session and compares a 48-value face signature, built from luminance blocks and colour histograms, with earlier records using cosine similarity; a similarity of 82% or more returns DUPLICATE_FACE_DETECTED.

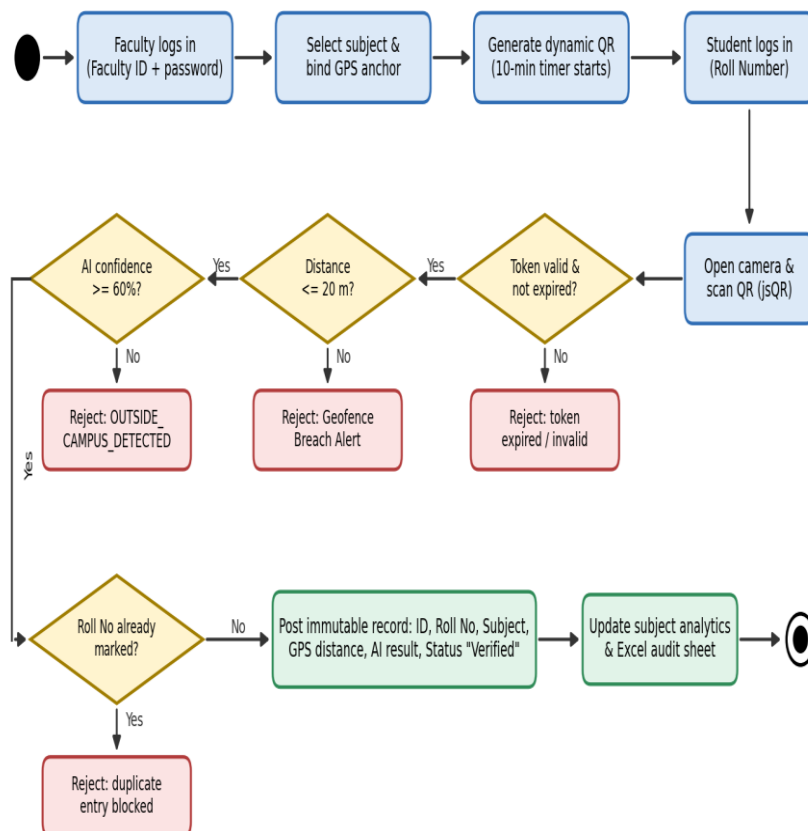


Fig.3.Activity diagram of the attendance verification workflow

F. Analytics and Excel Reporting

Verified records are grouped by subject for five courses (CS301 to CS305). Each subject has a donut chart of attended and absent classes, and a bar diagram compares the attendance percentage with the 75% eligibility line, coloured differently above and below the cutoff. A class-wide chart compares all students. ExcelJS exports a workbook with three sheets: the master summary, the subject-wise breakdown and the chart data table.

G. Implementation and Privacy

The frontend uses React 18, Vite and Tailwind CSS, and the backend uses Node.js and Express with CORS enabled. Because the object-detection model and the QR decoder run inside the browser, camera frames are not sent to the server; only the token, roll number, location, confidence and face signature are submitted. No RFID cards, fingerprint readers or special scanners are required.

IV. EXPERIMENTAL RESULTS

A. User Interfaces

The faculty portal (Fig. 4) displays the dynamic QR code with its ten-minute countdown for the selected subject. The student portal checks the classroom surroundings with a live bounding-box overlay (Fig. 5), and the analytics page presents the subject-wise donut charts (Fig. 6). The portal also contains a verified-attendance ledger with duplicate and breach alerts, and the Excel export.

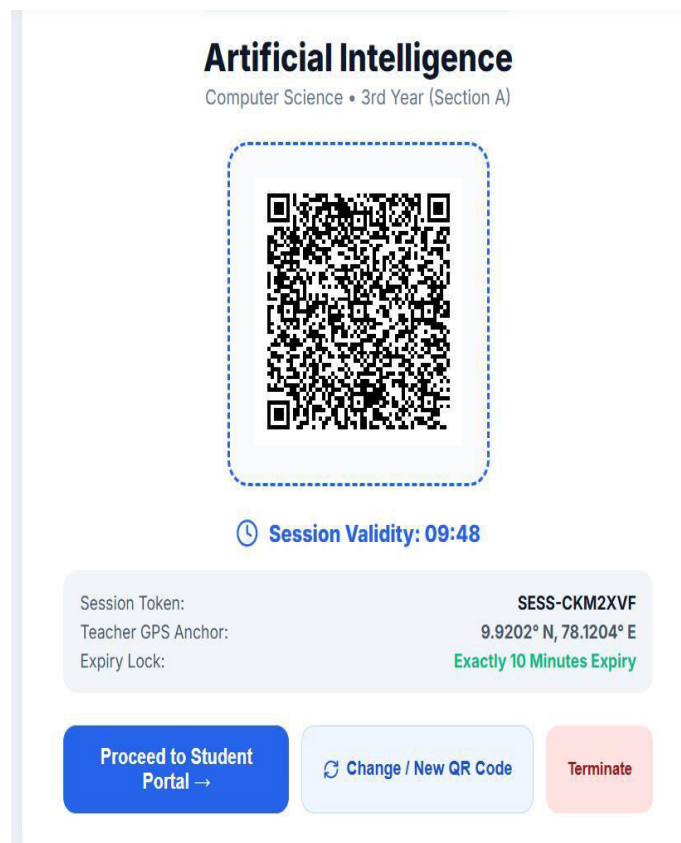


Fig.4.Dynamic QR code generation on the faculty portal

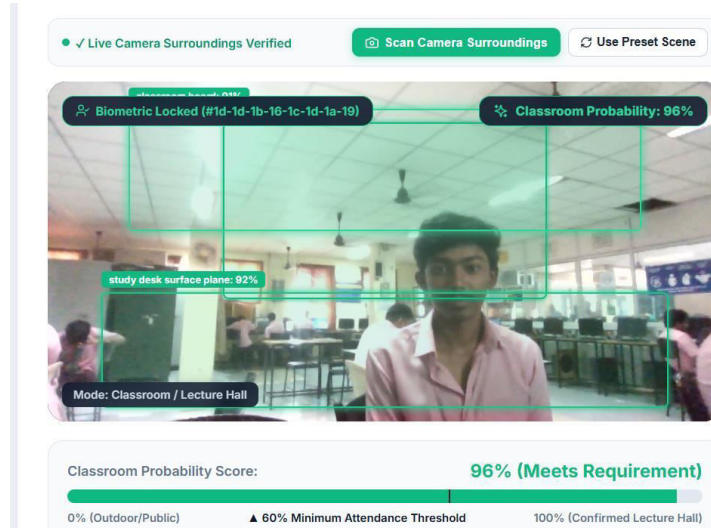


Fig.5.AI classroom surroundings verification on the student portal



Fig.6. Subject-wise attendance donut charts.

B. Geofence and AI Surroundings Tests

The geofence and the AI tier were tested with example locations around the teacher's anchor (9.9202° N, 78.1204° E); the distances in Table II were calculated by the Haversine function of the system. A point 12.5 m from the anchor was accepted, while points at 23.4 m, 74.2 m and 348.1 m were rejected. The cafeteria and outside-campus scenes supplied with the system scored 42% and 34%, below the 60% threshold, and were rejected.

TABLE.II. GEOFENCE AND AI SURROUNDINGS TEST RESULTS

Test case	Tier	Measured value	Outcome
Inside classroom	GPS geofence	12.5 m	Accepted
Corridor outside hall	GPS geofence	23.4 m	Rejected
Cafeteria	GPS geofence	74.2 m	Rejected
Hostel block	GPS geofence	348.1 m	Rejected
Cafeteria scene	AI vision	42% confidence	Rejected
Outside-campus scene	AI vision	34% confidence	Rejected

C. Verification Layers and Response Codes

Each layer returns a specific rejection code, so the student and the faculty member can see why an attempt failed. Table III lists the layers, the condition to pass and the code returned. A record is stored with status Verified only when all layers pass.

TABLE.III. VERIFICATION LAYERS AND REJECTION CODES

Layer	Condition to pass	Rejection code
1 Time: QR expiry	Scan within 10 minutes	EXPIRED_QR_SESSION
1 Time: token match	Scanned id equals active id	INVALID_QR_SESSION
2 Space: geofence	Distance of 20.0 m or less	PROXIMITY_FAILED
3 AI vision	Confidence of 60% or more	AI_CHECK_FAILED
4 Audit: roll number	Not already registered	ALREADY_REGISTERED
4 Audit: face signature	Similarity below 82%	DUPLICATE_FACE_DETECTED

D. System Testing

Unit tests covered faculty authentication, the token-expiry logic (scans before and after the ten-minute window), and the Haversine function with coordinate pairs at known separations. Functional tests followed the full workflow from faculty login to analytics and export, and confirmed that scans after expiry, scans beyond 20 m, scenes below 60% confidence and repeated roll numbers are rejected.

Integration tests checked the exchange between the React frontend, the Express API and the JSON store, including correct storage of sessions and records. In performance observations the QR decoder and the AI overlay stayed responsive on ordinary laptops and phones, and the charts and workbook were generated without noticeable delay.

E. Discussion and Limitations

The results are based on a controlled test environment and example locations, so they show that the layers work as designed but do not give field accuracy for a full campus. Indoor GPS accuracy varies between devices, the COCO-SSD model detects general object classes rather than a specific room, and the face signature is a lightweight comparison and not a certified biometric. The JSON store is suitable for a prototype but not for large deployments.

V. CONCLUSION AND FUTURE ENHANCEMENT

This paper presented an AI powered attendance management system that combines a ten-minute dynamic QR code, a 20 m Haversine geofence, browser-based classroom detection and a duplicate-prevention ledger. The tests show that each layer rejects the failure it is meant to catch, and the system adds subject-wise analytics and an Excel audit report without extra hardware.

In future work the JSON store will be replaced by a production database, session tokens will be signed with a server secret, liveness detection will be added to the AI tier, and the geofence will use the accuracy value reported by the Geolocation API. A progressive web app and role-based access for students, faculty, HODs and auditors are also planned.

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