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NextGen GeoSecure: Intelligence Management with Multi-Level Authentication

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ABSTRACT: Attendance management systems have been witnessing development for years; they have evolved from traditional manual attendance registration systems to automated systems which are more efficient, accurate and secure. Recent developments in wireless communication, the Internet of Things (IoT), biometric authentication, facial recognition and mobile computing have changed attendance monitoring in schools and, mostly, colleges. This paper proposes the use of geofencing, i.e. GPS-based authentication, together with a single registered device to mark the attendance of a student. The system also involves the use of a QR code system, which is scanned by the students in order to mark their attendance. This provides security in order to manage attendance and avoid proxy attendance. Nine recent studies covering camera-based, Bluetooth Low Energy based and GPS or QR based attendance systems are reviewed in detail. This paper identifies the existing research gaps associated with attendance systems, which involve factors such as privacy, spoofing attacks, scalability and other challenges, while providing future research directions towards a more secure, intelligent and reliable attendance management system.

KEYWORDS: Attendance management, Geofencing, GPS-based authentication, Dynamic QR code, Multi-level authentication, Device binding, Proxy attendance, GPS spoofing.

I. INTRODUCTION

Attendance management is a compulsory process in educational institutions and corporate organizations. It is a mandatory mechanism for recording the presence of students or employees, evaluating academic participation and maintaining official records. We have been using the same traditional methods for a really long time, which include marking attendance manually through a paper-based system, which is time-consuming, prone to human error and susceptible to proxy attendance. Even early automated methods such as RFID cards and fingerprint scanners show considerable restraints like hardware dependency, hygiene concerns and proxy attendance.

With the expansion in wireless communications, IoT, AI and mobile technologies, we can see the rise of smart attendance systems, which are capable of automatically identifying users without human intrusion. Modern systems utilize technologies such as facial recognition, GPS, cloud computing, fingerprint authentication, secure mobile identities and real-time data synchronization to improve attendance accuracy and operational efficiency.

Several researchers have proposed different attendance solutions based on their target applications. RF-based systems focus on affordability and wireless communication; mobile attendance systems emphasize security through multifactor authentication, whereas IoT-based face recognition systems provide no-touch attendance. Every idea has its unique advantages but also its challenges based on security, privacy, computational complexity, lighting conditions and network availability.

The proposed solution presents an attendance system that makes use of QR codes to mark attendance. It is designed to reduce the probability of proxy attendance and other attendance-related fraud while maintaining efficiency in attendance record management. This system is beneficial because it saves the time that is wasted on manually marking attendance. The QR code generated by the teacher is scanned by students using their registered devices to mark their attendance. The QR code is generated for a particular lecture, after which the device's location is verified to ensure that it is within a 10-metre radius of the QR code using geofencing. Once the location is verified, the next factor, the device

ID, is checked, as only the registered device is allowed to scan the QR code. This makes the entire process transparent and seamless. After all these factors are successfully verified, the attendance is marked and the dashboard is updated accordingly.

The remainder of this paper is organized as follows. Section II reviews nine recent attendance systems in detail, covering the techniques used, the results reported and the limitations of each. Section III consolidates the research gaps that appear across these studies. Section IV concludes the review and states how the proposed multi-level system responds to those gaps.

II. LITERATURE SURVEY

Nobody working on attendance automation is really working from the same playbook. Depending on which lab or which department a paper comes out of, the whole approach changes. Biometrics researchers trust cameras and liveness checks over anything else. Networking and embedded-systems groups go for short-range radio, Bluetooth Low Energy (BLE) mostly. On the other hand, application developers usually just place GPS next to a QR code, because a student's own phone already has both, so there is no need for extra hardware to be bought or maintained.

Nine papers were studied together for this review. Some of them are systems that were already built, deployed and tried by real people, while others remain proposals supported only by architecture diagrams.

A. "Geolocation-Based Attendance Tracking System: A Comprehensive Review"

Gupta, S. K., Yadav, N., Pandey, A., Sharma, R., and Chauhan, A. (2025). Published in the Proceedings of the 3rd International Conference on Communication, Security, and Artificial Intelligence (ICCSAI) [1].

Overview of the Work

This is not a built system, it is a survey. Gupta and the co-authors went through more than fifteen existing geolocation-based attendance designs, from plain GPS logging all the way to blockchain-secured logs and 5G-based positioning, and then organised them into one comparison table that covers the method, the technology stack and the pros and cons of each. Geofencing kept showing up alongside some second authentication factor almost every time, and once that pattern became obvious, the authors used it as the basis for a proposed architecture of their own.

Techniques and Algorithms Used

GPS geofencing to draw a virtual boundary around a classroom or office.

JWT tokens for user authentication and for keeping data safe while it is in transit.

A Node.js backend paired with MongoDB for storing location and attendance records.

Blockchain (SHA-256 hashing) suggested as a way to make the attendance log tamper-resistant.

A machine-learning anomaly detector meant to flag odd check-in behaviour, though the exact algorithm is never named.

AWS for hosting and scaling the whole system.

Reported Output

Because the design was not implemented, there is no accuracy figure to point to. The paper offers the comparison table and a proposed check-in sequence: capture location, run an accuracy check, and allow a limited number of retries before the attempt is logged as failed.

Limitations and Research Gap

Untested claims across the board, faster, cheaper and more secure, none of it backed by any actual data since nothing was implemented.

The very literature the paper draws on keeps raising GPS drift indoors, fake-GPS applications and battery drain from constant location polling, and the proposed design does not really solve any of it, it just carries the same open questions forward.

It keeps an assumption that internet connectivity is always available, for both the JWT checks and the cloud calls, and never touches on what happens when that connection drops.

B. "Real-time Deep Learning Based Anti-Proxy Presence Monitoring"

Kumar, N., Sharma, S., Sharma, A., Singh, M., Verma, P. K., and Arora, H. (2025). Published in the Proceedings of the International Conference on Electronics, AI and Computing (EAIC) [2].

Overview of the Work

Standard face-recognition attendance tools have a pretty obvious weak spot: hold up a printed photograph, or play a video on another screen, and a good number of them will accept it easily. Kumar and the team went after that exact weakness by adding a liveness check on top of ordinary face recognition, so a check-in only registers once the system is sure that it is looking at a real, breathing person and not a photo or a screen.

Techniques and Algorithms Used

The DeepFace library, built on pretrained backbones such as VGG-Face, FaceNet and ArcFace, used to generate facial embeddings.

Cosine similarity to compare a fresh embedding against what is already recorded for that person.

A separate pretrained TensorFlow/Keras liveness model that reads motion, texture and depth cues across several frames.

OpenCV handling frame capture and face cropping during both enrolment and later scanning.

Attendance logged into an Excel sheet with name, date and timestamp.

Reported Output

On a small test group of six enrolled people, 193 attempts in total were made and the system got 188 of them right, which is close to 97.4 percent, confirmed with a confusion matrix.

During demonstration runs it correctly tagged printed photos and phone-screen replays as fake, and real subjects as real. It also coped with several faces showing up in one frame at once, so students were not forced to line up and scan one after another.

Limitations and Research Gap

Six people is a small sample to build confidence from; whether that 97-plus percent figure survives with thirty or forty students, under a wider spread of lighting, angle and pose, is anyone's guess.

The system confirms who is in front of the camera but it does not confirm where the camera is placed, so nothing stops the same pipeline being pointed at a webcam sitting well outside the actual classroom.

Even the authors concede that the liveness check was never tested against anything more sophisticated; a deepfake video is an obvious example.

C. "Research and Development of Attendance System For Smart Classroom Using Bluetooth Low Energy and Facial Recognition Technologies"

Vu-Quoc, A., Nguyen-Phuc, B., Van-Thien, L., Dang-Le-Bao, C., Nguyen-Khanh, T., and Le-Trung, Q. (2024). Published in the Proceedings of the RIVF International Conference on Computing and Communication Technologies [3].

Overview of the Work

Most systems log one check-in and treat the job as done. This paper instead tries to figure out whether a student stayed put for the whole class. Their approach runs continuous facial recognition from classroom cameras and backs it up with Bluetooth Low Energy signals broadcast from each student's own phone, so if the camera loses track of someone due to a bad angle or someone walking past, the BLE reading can still confirm that they are in the room. Edge devices installed in the classroom process both streams and pass everything on to a central server.

Techniques and Algorithms Used

YOLO for real-time face detection in the video feed.

FaceNet to convert each detected face into a fixed-length embedding.

An SVM classifier trained on those embeddings to assign an identity.

BLE MAC-address scanning through dedicated stations, used as the backup device-based presence signal.

Kafka carrying the image stream and MQTT carrying the lighter BLE stream, both reconciled on a central server.

A training set built from 5,414 in-house classroom photographs, the FDDB benchmark (5,171 annotated faces) and roughly 1,500 unrelated CelebA images added to cut down on overfitting.

Reported Output

Recognition confidence was between 65 and 91 percent at 1.2 metres from the camera, dipped to 60-75 percent at 2.7 metres and dropped further, to 30-50 percent, at 4 metres.

In a brief five-minute trial with seven participants, a student who stayed for the entire session scored 98 percent overall, while one who was present for only about 30 percent of the class scored 21 percent, which is a reasonable sign that the combined score reflects actual presence.

What they built is a genuinely complete pipeline, which includes edge cameras, message brokers, a matching server and a web dashboard for reviewing the logs.

Limitations and Research Gap

Accuracy drops once we go beyond three or four metres, which effectively fixes the safe range for camera placement.

A five-minute test with seven people is a very small trial; there is nothing to show how the setup will behave over a full lecture or with a class of normal size.

It assumes that every student leaves Bluetooth switched on, which is not something that can be counted on, and it needs dedicated BLE hardware in every room, which is not a small ask for most institutions.

D. "A Location and QR Code-Based Solution for Efficient Attendance Management"

Pathan, S., Bommireddipalli, L., Deka, B., Anandham, S., Bhattu, A. T., and Boorla, S. (2025). Published in the Proceedings of the International Conference on Machine Learning and Autonomous Systems (ICMLAS) [4].

Overview of the Work

Out of everything covered here, this one is closest to the system that this paper is proposing. There are two portals, one for the faculty and one for the students. The teacher generates a specific QR code for a particular session that refreshes with every new class, and students have to scan it from their own devices. Before the attendance actually gets accepted, the system checks the scanning device's live GPS coordinates against the classroom's registered location, and if it fails either the QR check or the location check, the attempt is rejected and attendance is not marked.

Techniques and Algorithms Used

QR codes are generated per session and invalidated once the class ends, so they cannot be reused for another session.

GPS-based location checking, cross-referenced with Wi-Fi and geofencing data wherever available, to confirm that the device is physically where it should be.

React on the front end for both portals, with Firebase Firestore handling real-time data behind it.

A 'Stop QR' control that lets the instructor switch off scanning once attendance is closed for that particular session.

Reported Output

Field testing produced CSV logs of roll numbers and scan timestamps, which the authors turned into bar and line charts showing scans per minute.

Against the institution's existing manual digital process, the new workflow finished attendance in roughly three to nine minutes, compared with seven to twelve minutes for the old system, based on box-plot comparisons across several sessions.

A comparison table places the system against a purely manual process and a face-recognition-only alternative, and it is seen to be better in both scalability and real-time tracking.

Limitations and Research Gap

The check confirms where a device is but not who is actually holding it. An unlocked phone can simply be handed to a classmate present in the same geofenced zone for a valid scan, so device sharing is not really guarded against.

There is no biometric or device-binding layer sitting on top of the QR-plus-location combination, and GPS spoofing was never actually tested.

The authors list face recognition and anomaly detection as future work themselves, which more or less admits that the two-factor design is not quite enough on its own yet.

E. "Development of a Web-Based Employee Attendance Application with Gamification and GPS Technology to Improve Attendance Discipline"

Fitriyani, K., Manaf, K., Purwanto, H., Solihin, H. H., Andiansyah, E., and Pitoyo, D. (2025). Published in the Proceedings of the 19th International Conference on Telecommunication Systems, Services, and Applications (TSSA) [5].

Description of the Work

This one looks at the problem from a slightly different angle: instead of trying to make cheating harder, make people actually want to check in. The authors created a web attendance application for a small mental-health clinic that used

GPS to check in, and added a layer of gamification. Points for coming on time, badges, a leaderboard, a prompt to record mood after each check-in and automated praise messages were generated whenever someone hit an attendance milestone.

Techniques and Algorithms Used

GPS radius validation, with successful check-in and check-out within a 100-metre boundary around the office.

Extreme Programming as the development approach, chosen for its short iterations and close involvement of end users.

A points and leaderboard scoring system tied to punctuality, together with mood tracking and a rule-based automated praise and notification system.

Black-box testing of twelve core features: login, check-in, check-out, absence requests, admin management, leaderboard and export, alongside a thirteen-item Likert usability survey.

Reported Output

All twelve black-box test cases passed. This included correctly rejecting check-ins from outside the permitted GPS radius as well as cases where GPS was switched off.

Location detection was accurate to within 10 metres and had a response time of 1.4 seconds under a simulated load of 50 concurrent users.

A two-week pilot at the clinic resulted in 18 percent less tardiness and a 12 percent increase in punctuality, with a mean usability score of 4.69 out of 5, and 82 percent of respondents specifically crediting the mood tracker and praise messages for keeping them motivated.

Limitations and Research Gap

A single clinic over a two-week period is a small test, and there is no evidence as yet that these gains add up over a longer period or can be scaled to a larger and more diverse workforce.

The only real design check is GPS. There is no QR code, no biometric and no device binding, so it carries the same spoofing risk as all the other GPS-only methods reviewed here.

The gamification layer, with points, badges, mood tracking and automated messaging, adds ongoing development and maintenance work that the paper never quantifies in terms of cost or effort.

F. "Implementing QR Code and Geolocation Technologies for the Student Attendance System"

Taju, S. W., Mamahit, Y. P., and Pongantung, J. A. (2024). Published in COGITO Smart Journal, Universitas Klabat, Vol. 10, No. 1 [6].

Overview of the Work

This is different from most of what is covered above, as it is actually deployed and finished rather than merely proposed. It is a combined web and mobile system made for lecturers and students at Klabat University in Indonesia. The authors went through a prototyping cycle of communication, quick plan, build, evaluate and repeat with real lecturers before settling on the final feature set. Lecturers create classes and generate a session QR code from the web application, and students then log in on Android, select their scheduled class, grant location access and scan whatever code the lecturer is currently displaying. There is nothing new about the underlying idea, it is QR plus a location check, but it walks through practically every screen of a working, deployed system.

Techniques and Algorithms Used

A prototyping development model of communication, quick plan, design, build, deploy and gather feedback, looping back as needed.

PHP and MySQL for the backend and Bootstrap 5 on the front end, running on Apache under Ubuntu 22.04.

A direct GPS-distance comparison between the lecturer's device, which displays the code, and the student's device, which scans it, used to measure the distance between them.

An Android client mirroring the web account system, with a live distance readout in metres and a scanning screen that includes a flashlight and a back button.

An automatic Withdraw-Fail report generated once a student's absences cross the university's cutoff, sent straight to the registrar.

Reported Output

What the paper shows is a working system, illustrated across roughly a dozen analysed screenshots covering sign-up, class creation, live QR scanning with the distance shown in metres, success and failure notices, an operator panel and

per-class attendance summaries. There is no accuracy number anywhere, no response time and no user trial; the case for success here rests on the fact that these features exist and function on screen, not on any measurement.

Limitations and Research Gap

There is genuinely no quantitative evaluation in the paper at all, which means no accuracy figure, no false acceptance rate, no timing data and no participant count, making it hard to place this system alongside the others in this review on anything beyond a feature checklist.

The authors say outright that the interface still needs UI/UX improvement, and note that there is no extra security layer protecting the stored attendance data beyond ordinary login credentials.

Since the location check is simply two GPS readings compared with each other, the paper never states what the acceptable radius actually is, or what happens when either reading turns out to be inaccurate or manipulated.

G. "An Android Application For Attendance Using Geofencing"

Patil, P., Ringe, S., Gaikwad, P., Mahajan, P., and Mogare, S. (2024). Published in the International Journal of Advanced Research in Computer and Communication Engineering (IJARCCE), Vol. 13, Issue 5 [7].

Overview of the Work

The paper describes two things that never fully connect. The first is an Android and web application where someone registers, is verified with an OTP and a fingerprint, has a photo captured, and is then checked against a geofenced area before attendance is marked, with an admin side for reviewing employees and records. The second, introduced later under 'proposed work', is a separate face-recognition setup in which a CCTV camera captures the whole class at once, faces are detected and cropped, and each one is cross-checked against the stored database using deep learning; anyone who does not match is marked absent for that class.

Techniques and Algorithms Used

OTP plus fingerprint as the first authentication step, followed by an in-application photo capture.

GPS-based geofencing restricting attendance to a defined area, built following a spiral development process.

The Viola-Jones algorithm for detecting faces within the CCTV group image.

A deep convolutional neural network matching cropped faces against enrolled students, repeated across several frames to reduce misses.

Results saved into an Excel archive as the attendance record.

Reported Output

Two architecture diagrams are given, one for the OTP and GPS flow and one for the face-recognition pipeline, along with a prose description of how the latter is supposed to work. There is no accuracy figure, no timing measurement, no sample size and no field trial for either piece, so this reads more like a design write-up than a system that was actually built, deployed and measured.

Limitations and Research Gap

No subsystem is evaluated in any way, so there is no real basis for judging accuracy or usability from the paper alone.

It remains unclear whether the finished product combines OTP, fingerprint, GPS and face recognition into a single check, or whether these are two separate ideas the authors were simply exploring.

Basic details such as the geofence radius, how OTP delivery actually works and how the face-recognition side copes with more than a handful of students are missing, which makes this paper difficult to compare directly against the more fully specified QR-and-GPS systems reviewed elsewhere here.

H. "QR-Attendance System with Geo-Location"

Kumari, S., and Kumar, P. (2024). Published in the International Journal of Advance Research, Ideas and Innovations in Technology (IJARIIT), Vol. 10, Issue 6 [8].

Overview of the Work

The proposed platform uses a three-tier architecture with presentation, business logic and data-access layers. It also provides separate portals for students, teachers and administrators. Attendance is marked only when the scanned QR code is valid for the current session and the student's GPS location is within the allowed classroom radius. The Haversine formula is used to calculate the distance, and an optional photograph can also be captured for extra verification. The authors report testing the system across three academic terms with 500 undergraduate students, 25

faculty members and over 300 attendance sessions, combining performance numbers with a satisfaction survey and a cost breakdown.

Techniques and Algorithms Used

Dynamic QR codes carrying a student identifier, timestamp and hash, checked for format and session validity before location even comes into it.

The Haversine formula, calculating the distance between a student's GPS coordinates and the registered class location.

A JavaScript, PHP and MySQL stack, with authentication, geo-location verification and image processing split into separate backend services.

A mixed-methods evaluation combining accuracy and response-time metrics with Likert-style satisfaction surveys and a cost analysis.

Reported Output

A claimed system accuracy of 99.2 percent against a stated industry baseline of 95 percent, alongside a 0.3 percent false-positive rate, a 1.2-second response time and location accuracy of roughly plus or minus 3 metres.

A reported 97 percent cut in fraudulent attendance attempts, with satisfaction scores of 92 percent among students, 88 percent among faculty and 95 percent among administrative staff.

A cost analysis claiming a 65 percent drop in operational costs, a 40 percent decrease in maintenance spend and a return on investment within eight months.

Limitations and Research Gap

Every figure reported here is favourable: near-perfect accuracy, a large fraud reduction, high satisfaction across the board and a fast payback period. But the paper never explains the measurement process behind any of it, how false positives were identified, or where the 15 to 20 percent baseline proxy-attendance figure comes from. That makes the numbers hard to verify independently.

GPS spoofing is never tested or even mentioned, despite geo-location being the entire basis for the paper's fraud-prevention claim.

The same issue shows up here as in the other QR-plus-GPS papers reviewed: it verifies where a device is, not who is holding it, and that gap is never addressed.

I. "GeoAttend: A Dynamic QR Code-Based Attendance System with Real-Time Geofencing, Live Analytics Dashboard, and Automated Exam Eligibility Verification"

Tejas, B. R., Chithra, S. M., Prathibha, K. H., Kashyap, A. P., Rudresh, H. M., and Rajashekar, K. J. (2026). Published in the International Journal of Advanced Scientific Innovation, Vol. 8, Issue 1 [9].

Overview of the Work

GeoAttend follows a QR code and GPS-based attendance approach but adds stronger security measures. The QR code changes every five seconds, so a screenshot becomes invalid very quickly. After scanning a valid QR code, the system checks the student's location through the browser's geolocation API. Attendance is accepted only if the QR code is valid and the student is within the allowed classroom area. On top of that core loop sit a live analytics dashboard for lecturers, automatic exam-eligibility checks against a 75 percent threshold, and report exports.

Techniques and Algorithms Used

A MERN-stack build: React 18 on the front end, Node.js and Express on the backend, and MongoDB Atlas with geospatial indexing for storage.

QR codes refreshed every five seconds, with the Haversine formula calculating the distance between a student's live coordinates and the registered classroom location.

JWT authentication with bcrypt password hashing, and the html5-qrcode library for scanning directly in the browser without a separate application.

A two-step validation pipeline: QR authenticity and session validity checked first, then geofence membership, before an attendance record is written and deduplicated against earlier scans in the same session.

Recharts powering the analytics dashboard, including subject-wise attendance percentages and eligibility warnings.

Reported Output

Headline figures of 99.9 percent scan accuracy, sub-second verification, claimed support for over 1,000 concurrent users, an 80 percent cut in administrative workload and a 95 percent adoption rate across pilot institutions that are never named.

A working prototype is shown end to end: session creation with geofencing parameters, a live QR display, an exportable attendance report with distance and timestamp columns, and a student-facing statistics page tracking attendance against the 75 percent eligibility cutoff.

One inconsistency is worth flagging: the geofence radius is given as 100 metres in the abstract and key-highlights section, but the workflow description elsewhere in the same paper puts it at 50 to 200 metres. The two are never reconciled.

Limitations and Research Gap

As with the Kumari and Kumar paper, the headline numbers, 99.9 percent accuracy, 95 percent adoption and 80 percent workload reduction, are stated without any real methodology behind them. There is no sample size, no pilot details and nothing that would let someone verify the claim.

That radius inconsistency, 100 metres against 50 to 200 metres within the same document, suggests these figures may not all have come from one carefully controlled test configuration.

It is the same device-versus-person problem seen everywhere else in this review: the system confirms a device's location, not the identity of whoever is holding it. The authors' own future-work section lists biometric login and anomaly detection as still missing, which is essentially an admission of that same gap.

III. RESEARCH GAP

When all nine studies are compared, some common problems can be seen in almost every type of attendance system. Whether the system uses cameras, wireless signals or GPS, similar limitations keep appearing. This shows that the problem is not with one particular technology but with the overall challenges involved in designing a reliable automated attendance system. Most of these systems use only one or two methods to verify attendance rather than combining multiple checks. Also, the two most recently published papers report impressive results but do not clearly explain how those results were tested or obtained.

Most of the reviewed systems depend mainly on one method for verifying attendance, such as GPS, a QR code or a camera. This creates a single point of failure, because if that method is bypassed through device sharing, location spoofing or fake photographs, the system may not be able to verify attendance properly. The specific gaps identified are listed below.

Distance and lighting sensitivity in the vision-based systems. Both camera-driven papers here, Kumar et al. and Vu-Quoc et al., perform well up close under good lighting, but accuracy falls off noticeably with distance or partial occlusion, and neither has been tried in anything resembling a genuinely large lecture hall.

GPS spoofing is largely unaddressed across the board. Every GPS-dependent paper in this review, Gupta et al., Pathan et al., Fitriyani et al., Taju et al., Patil et al., Kumari and Kumar, and Tejas et al., is vulnerable to fake-location applications in principle, yet none of the nine actually tests against this specific attack.

QR codes confirm that a device was in the right place at the right time, not that the enrolled student was the one holding it. Taju et al., Kumari and Kumar, and Tejas et al. all carry this same gap, with no biometric or device-binding factor layered on top.

BLE-based tracking needs every participant's Bluetooth switched on and dedicated scanning stations per room. Both are fairly fragile assumptions that add real hardware cost at scale.

Evaluations, where they exist at all, tend to be small and short: six to seven participants in two of the papers, a single pilot site in another, and trials running anywhere from a five-minute simulation to a two-week pilot. Taju et al. and Patil et al. do not report any measured trial at all, just screenshots and architecture diagrams. None of this comes close to institutional scale.

Nobody combines more than two independent verification layers in one workflow. A rotating QR code, GPS or geofencing, and device-identity verification used together, rather than as isolated alternatives, would in principle cover weaknesses that no single layer handles on its own.

Offline or degraded-connectivity scenarios barely get a mention. Nearly every system reviewed here assumes constant internet access for real-time verification, cloud storage or blockchain writes, and none describes what happens to attendance data once that connection drops mid-session.

Overstated or unverifiable performance claims. The two most recently published papers here, Kumari and Kumar, and Tejas et al., report accuracy in the high nineties, 99.2 and 99.9 percent respectively, along with large fraud-reduction and adoption figures, but without describing the measurement protocol behind any of it. One of the two also states its own geofence radius two different ways within the same document, which does not help confidence in the rest of the numbers.

These gaps, spread across nine papers ranging from pure proposals to systems tested at genuine institutional scale, are what the system proposed in this paper is trying to respond to. Combining a rotating, session-bound QR code with GPS or geofencing-based location validation and device-identity verification in a single workflow is an attempt to make a proxy attempt fail on at least one of three independent checks, rather than on just one.

IV. CONCLUSION

The nine studies show how attendance systems are moving from traditional methods towards more technology-based solutions. Modern systems increasingly use features available on smartphones, including cameras, GPS, Bluetooth and QR scanning, while cloud platforms support data storage and management. Some systems further improve their functionality through blockchain, gamification or live monitoring dashboards.

Camera-based systems with liveness detection are good at confirming identity and catching basic photo or video spoofing, but accuracy drops with distance and lighting, and neither camera-based study reviewed here has been tried in a full-scale classroom.

BLE-assisted tracking is useful for confirming continuous presence across a whole session rather than a single check-in moment, but it depends on infrastructure, dedicated stations and cooperative devices, that not every institution can realistically set up.

QR-plus-location systems are lightweight, need no special hardware and deploy quickly, but they verify a device's location rather than the identity of whoever is holding it, so the code-sharing loophole stays open.

The larger, deployed QR-plus-location systems, Tajul et al., Kumari and Kumar, and Tejas et al., show that the approach can scale well beyond a single department and add genuinely useful extras such as fail reporting, live dashboards and eligibility checks. But the two with the biggest claimed reach also come with the least verifiable numbers behind them, which is worth keeping in mind, though not really a reason to write off the underlying approach.

Gamified GPS systems show that getting people to actually want to check in matters just as much as making cheating harder, but they remain single-factor at heart and inherit all of the spoofing weaknesses of GPS.

One major gap across the nine studies is that none of the systems clearly combines more than two verification methods at the same time. Many of the reported results also lack detailed information about how the systems were tested. Future systems should use multiple verification methods and provide clear evaluation results based on proper testing. The proposed system aims to address this gap by combining a rotating QR code, GPS-based geofencing and device identity verification in one attendance process. This means that someone trying to bypass the system would have to overcome multiple verification checks instead of just one. The system also works on normal smartphones and does not require any extra hardware.

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