Geolocation Based Attendance Tracking System

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Abstract — *Attendance has long been an integral aspect of institutions and organizations, serving as a fundamental measure of engagement, participation, and accountability within educational and professional settings. There are two common methods for the said job. First being the traditional pen and paper method, this method is popularly used but is also a cumbersome process, which takes a lot of time and manual effort, also it being difficult to maintain the records and high changes of proxy attendances. While the second method is the automated attendance which fills almost all the gaps of the first method, by using various technologies We'll be integrating GPS and Geofencing technology to make the attendance system more feasible, precise, and flexible and bringing about accountability and transparency. This paper uses location as a proof of attendance and proposed a new time and attendance system based on location.*

Keywords: GPS, Geofencing, Location, Time-stamps, Attendance management system, IMEI.

1. Introduction

Location-based applications have gained significant importance in recent years due to advancements in mobile technology, GPS accuracy, and cloud-based data management. Traditional attendance and monitoring systems such as manual registers and RFID-based identification increasingly face limitations related to cost, security, and reliability. A geofence is an imaginary geographic boundary that can be entered or exited by a mobile device or RFID tag. Radio frequency identification, Wi-Fi, GPS, or cellular data are used by an app or other location-based service called geofencing to launch a specific marketing campaign. As organizations move toward digital transformation, the need for automated location-aware solutions have emerged as a practical alternative for enhancing operational efficiency.

The "Geolocation based attendance tracking system" project addresses this need by leveraging Geofencing technology within virtual an Android application to automate the attendance process. Geofencing involves setting up virtual boundaries around specific geographic areas, such as classrooms or campus zones. This project aims to utilize GPS data from students' mobile devices to record their entry or exit from these predefined zones.

The proposed system is developed using Flutter for cross-platform mobile app development, Firebase for real-time data storage and user authentication, and Google Maps API for defining geofencing zones. Flutter ensures seamless performance across Android and iOS, while Firebase provides secure, real-time updates of attendance logs. The Google Maps API enables the creation of specific geographical boundaries, ensuring that attendance is recorded only when employees are physically present at designated locations. Together, these technologies create a reliable, automated system tailored for managing attendance in remote and field-based work settings.

2. Literature Review

1. In this section, we review some related technologies and previous works on the topic of location-based application. During our research for this project, we encountered several significant papers and articles that provided insights into the functionality and scope of our objectives. Here are some of the papers and their key points that we extracted from those papers we extensively studied –

2. The paper titled [1] discussed in detail how, the system replaces the traditional Identification Card by a mobile application. The application was installed on users mobile. A unique user ID and location (GPS coordinate) was associated with the application. A time and attendance software was installed on workstation for

process the data receive from user mobile and store the information (time, entry and leaving) to the Database.

3. The work in [2], provided insights on RFID-based attendance systems where attendance is completed by placing an RFID card on an RFID reader is a common approach. However, a crucial challenge with RFIDs is that students are unable to mark their attendance on days when they have lost or forgotten their ID cards, as RFID tags are embedded in the user's ID card. RFIDs are relatively expensive, and susceptible to buddy-punching, as users can fraudulently help their colleagues mark their attendance.

4. While the paper [3], proposed Geofencing technology which enables location-aware research by defining a virtual border around a geographic area. A smartphone can detect incidents of entering or leaving the geofenced area, and each of these events can trigger an action, which depends on the application that uses geofencing. Compared to geo-tracking, geofencing can be perceived as less intrusive. For example, if the location of interest is the participant's home, using geofencing will not expose the home address, but researchers can still send notifications and conduct surveys when people leave or enter the home.

5. [4] discussed, how the proposed system checks GPS coordinates, and if they fall within the designated geofence boundary, attendance is logged. To store attendance records, the system uses the Firebase cloud system, which functions as a Backend Service. This method improves accuracy by enabling real-time storage in documents structured like JSON. Staff and administrators can access this stored data for continuous monitoring and analysis,

6. Paper [5] have used Geo-Location API as supported by Google APIs 10 or higher which would allow the use of app in devices starting from Gingerbread itself. They have used an Apache Server with PHP & MySQL support for remote database use. The data transaction from or to the database occurs with the help of PHP scripts and in the form of JSON objects

7. The proposed geofencing-based attendance management system automates attendance tracking by verifying students' real-time location within a geofenced boundary and capturing a live selfie as proof. Live selfie capture prevents proxy attendance, with all data securely stored. Encryption and access control protect user privacy, and real-time analytics provide attendance insights [6]

8. The paper provides an in-depth overview of geofencing technology and its role in advancing IoT-based location services. It explains how geofencing creates virtual geographic boundaries that trigger automated actions when IoT devices enter or exit those zones. The author reviews core positioning technologies such as GPS, RFID, and indoor tracking systems, and highlights how edge computing, AI, and machine learning significantly improve accuracy, prediction capability, and processing efficiency. [7]

3. Proposed System

Geo-fencing is a feature in software application/program that uses the global positioning system (GPS) or radio frequency Identification (RFID) to define geo-graphical boundaries. In our proposed application have used the Global Positioning system (GPS) technology. The application monitors, when the mobile devices or other physical objects enter or exit an established geofenced area, and accordingly provides alerts or notifications. Geofencing executed on the mobile devices includes, continuous positioning of the mobile device as well as the continuous matching of mobiles position with a set of geofences.

The client interface (UI) is planned to be natural, permitting representatives to see their participation status, track area history, and get notices. The dashboard interface for a geolocation-based worker participation and following framework serves as the central center where chairmen and supervisors can see, analyze, and oversee real-time information on worker participation and areas.

A] Architecture

a) Employee/Student Dashboard:

Dashboard of the user will record the daily attendance also the Time-stamps of Entry and Exits, containing the time and date at which the user has entered the geofence and when he left. It also includes notifications of check-in/out reminders & Permissions for accessing the location of the device which is most crucial in order to get the coordinates of the location of the device as well as it will request background access, so that the movement of user device can be checked whether it is inside the Geofence or not.

b) Admin Panel:

Manage the number of valid users & defines the geofences, it also provides insights of Attendance in order to generate summaries & export in the format of either CSV or PDF. It also provides a real-time status display of user devices to track them and their positions within Geofences.

c) Geofence Creation & Configuration:

The Admin defines the geofence boundaries using latitude, longitude, radius, through mapping APIs or polygon geofences depending on site shape:

- Circular geofence: simple radius-based.
- Polygon geofence**:** custom-shaped.

After defining a geofence the metadata of the geofence which is generally the coordinates i.e. Latitude and Longitude are recorded in the database, for the purpose of matching it with the coordinates of user's location.

d) Location Tracking & Detection Module

Application utilizes OS-level geofencing services, for Android - Google Location Services API. While for iOS - Core Location Framework Configure detection triggers, OnEnter → User enters geofence area, OnExit → User leaves geofence area. Optimize for battery usage by using *passive and significant change location events* instead of continuous GPS polling.

e) Attendance Logging Mechanism

The basic algorithm used in the system is as follows:

- Start

1. → User Login → Location Permission Granted?
2. → if [Yes] →Did the user Enter the Geofence?
3. →if [Yes] → Auto Check-In → Log Time-stamp
4. → [No] → Wait for Event
5. → Exit Geofence?
6. → [Yes] → Auto Check-Out → Log Time-stamp

- End

On geofence entry :

The Application validates user by authentication through login IDs assigned during registration. And checks entry timestamp , while marking "Present" and store coordinates & time.

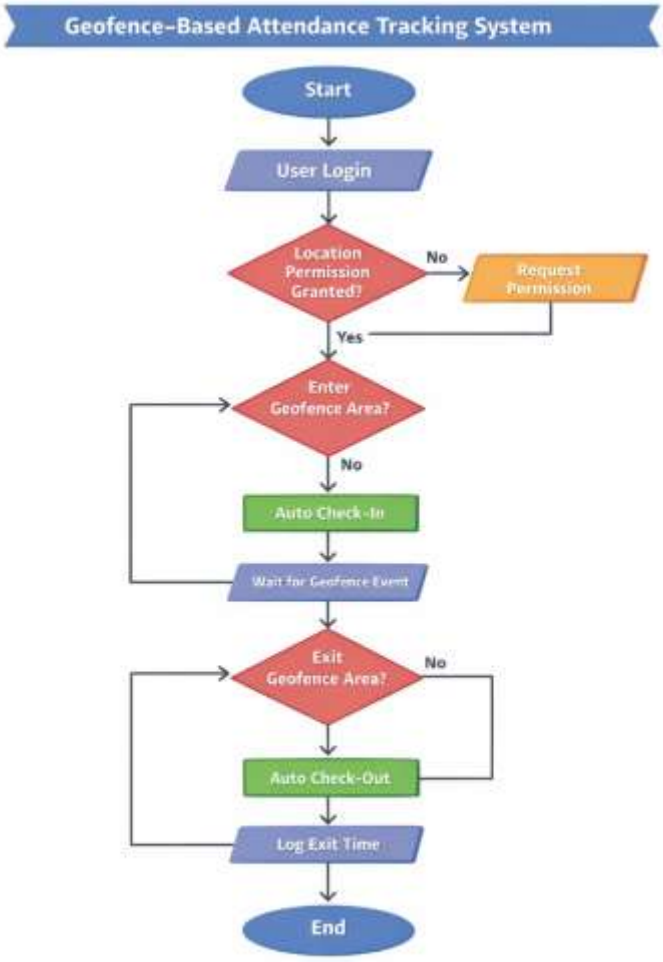
On geofence exit :

Log exit timestamp. calculate attendance duration / working hours.

f) Data Storage and Sync

Store attendance logs locally for offline mode, Auto-sync to server when internet connectivity is available, we have used a secure database of Firebase for storing the users, admin details and time-stamp records of user's activity.

B] Working Methodology



At the beginning the user needs to install and open the app and it must authenticate itself by logging in through the app. This ensures attendance is linked to the correct person. Then, the app checks whether location access permissions are allowed by the user/device. If *Yes* → the system proceeds. If *No* → the app requests the user to enable location permission.
Without permission, geofencing cannot function. The system continuously monitors the user's location in the

background using geofence services. It checks, is the user inside the predefined geofence area?

If *No* → the system keeps waiting until the user enters the area.

If *Yes* → the system moves to auto check-in.

Once the user enters the geofenced location, the system automatically marks their check-in time without needing manual attendance marking, reducing time fraud and eliminates forgetting to check in. After the user is checked in, the system keeps running in the background and waits for the next event, Has the user exited the geofence area?

If *No* → means the user is still present within the Geofenced area and the system continues monitoring.

If *Yes* → app proceeds to auto check-out.

The user's exit triggers an automatic check-out event and the system writes the exit timestamp into the attendance database

4. Comparative review of approaches

Existing literature presents several methodologies for geolocation-based attendance tracking, each varying in technological approach, accuracy, scalability, and privacy implications. Systems that rely primarily on RFID technologies offer quick identification but are susceptible to proxy attendance and require physical cards. Geofencing approaches enhance accuracy by validating presence through real-time location, though they may increase device battery usage depending on the tracking method.

Firebase-integrated systems introduce real-time synchronization and secure cloud-based availability of attendance logs, while AI-driven enhancements facilitate predictive monitoring and anomaly detection. Integrations such as biometric verification and live image capture further prevent impersonation but raise concerns regarding user privacy and secure data retention. Compared to traditional systems, advanced geolocation methods reduce administrative overhead and human error while expanding usability to remote or outdoor environments. However, challenges persist regarding GPS drift in dense urban regions, low signal reception, and battery efficiency. Optimization techniques such as passive tracking and significant change detection can mitigate these issues.

A collective review indicates that geofencing, combined with cloud computing and supplementary authentication methods, provides a balanced approach between usability, security, and reliability.

5. Conclusion and Future prospects

The geolocation-based attendance tracking system serves as a complete solution to the challenges presented by conventional attendance methods. By combining geofencing, GPS technology, biometric authentication, and AI-driven analytics, these systems ensure that attendance is always recorded accurately without the possibility of impersonation or proxy marking. The technology not only improves operational efficiency and transparency but also promotes accountability among users while reducing recurring administrative processes.

Organizations implementing such systems gain competitive advantages through improved workforce engagement, accurate performance management, and data-driven decision-making capabilities. As the technology continues to evolve with AI, IoT, and enhanced security features, geolocation-based attendance systems represent a significant step forward in effectively managing attendance and employee/student performance in an adaptable and future-ready

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