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AI-Based Attendance Web Application with Autofill OTP Authentication

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ABSTRACT :

Technological advancements have revolutionized how routine tasks are managed, particularly within the realm of education. This research introduces an Attendance Management System (AMS), a comprehensive web-based application engineered to optimize the attendance tracking process for educational institutions. The AMS leverages artificial intelligence and digital automation to streamline attendance recording by integrating an OTP-based authentication system. This method ensures enhanced security and accuracy by verifying each student's identity in real-time, eliminating potential issues associated with manual record-keeping, such as inaccuracies and unauthorized check-ins. Additionally, location validation has been incorporated, verifying the student's presence within a designated area to further uphold the integrity of the attendance process.

The implementation of AMS brings numerous benefits to educational settings, as evidenced by this research. By automating attendance, the AMS significantly reduces manual effort, allowing faculty to focus on more meaningful interactions with students. Furthermore, the system facilitates efficient data management and comprehensive reporting capabilities. Attendance records are maintained in a structured, easily accessible format, allowing administrators to quickly generate attendance reports, track attendance patterns, and manage data without the need for physical records. This not only enhances transparency but also improves overall accountability within the institution.

The AMS's user-friendly interface, coupled with real-time data access, empowers both students and faculty. Students can monitor their attendance records and receive instant feedback, enabling them to stay informed about their attendance status. Faculty members benefit from real-time updates and secure access to data, allowing them to view and manage attendance effortlessly from any device.

Keywords: Technological advancements, Attendance Management System (AMS), Web-based application, Attendance tracking process, OTP-based authentication, Unauthorized check-ins, Integrity of attendance process, Artificial intelligence, Real-time data access

Introduction :

As educational institutions continue to grow and adapt, the need for efficient and accurate attendance management in schools and colleges has become more critical than ever. Traditional attendance systems often rely on manual processes, requiring significant time and effort from both teachers and students. These methods are not only prone to error and susceptible to manipulation but can also be frustrating and cumbersome to manage, especially for larger groups. To tackle these ongoing challenges, this study introduces an AI-powered Attendance Management System (AMS), designed to streamline attendance tracking and bring a more reliable, user-friendly solution to the classroom.

The proposed AMS leverages advanced technologies, including OTP (One-Time Password) authentication, to safeguard the attendance process. By using unique, time-sensitive codes sent directly to the user, the system ensures a secure and fraud-resistant check-in experience, significantly enhancing data integrity. This digital approach to attendance prevents common issues like proxy attendance and inaccuracies, which are often associated with traditional methods. Students can feel assured that their records accurately reflect their participation, while teachers are freed from the tedious task of manual tracking, allowing them to focus more on teaching and engaging with their students.

While previous studies have underscored the value of digital technology in improving the accuracy and efficiency of attendance tracking, many current solutions lack the level of security and usability needed for today's educational environments. Our AMS goes beyond basic digital functionality by incorporating real-time location validation, ensuring that students are actually present in the designated area when marking their attendance. This feature not only supports the integrity of the attendance system but also adds a layer of accountability and transparency to the entire process.

Motivation of the Project

AI Attendance System: Real-Time Identity Verification

The AI Attendance System introduces a transformative solution for attendance management, merging digital interaction with real-time identity verification. This system allows users to log attendance seamlessly, leveraging AI to establish a secure and contactless environment. Designed to verify student or employee presence through unique OTP-based authentication and location validation, it ensures robust data security while promoting ease of use. Unlike traditional methods of attendance, which may involve manual entry or swipe cards, the AI Attendance System provides a more efficient, secure, and user-friendly approach.

This technology embodies a step towards human-first, AI-powered interaction, catering to a wide range of applications in both educational institutions and professional environments. In today's world, with an emphasis on online learning, remote work, and hybrid setups, the AI Attendance System is an ideal solution for monitoring attendance in real time. It supports a more inclusive environment by providing a streamlined way to manage attendance across multiple locations, enabling efficient and error-free record-keeping.

One of the most significant advantages of this system is its potential for versatile functionality. Its future applications are not limited to classrooms but can extend to the corporate sector, remote work setups, or any scenario requiring secure, verifiable attendance. As the technology evolves, AI-driven attendance tracking could pave the way for expanded applications in biometric-based security, multi-platform integration, and enhanced user accessibility. This project sets a new standard for digital interaction by eliminating the need for physical attendance tracking, offering a future-proof, adaptive solution for attendance management.

2.1. Brief description

AI-Based Attendance Web Application: Real-Time Gesture Recognition and Location Verification

The **AI-based Attendance Web Application** aims to revolutionize the way attendance is taken in classrooms, leveraging cutting-edge AI and computer vision technologies to make the process more efficient, secure, and accessible. The system combines real-time gesture recognition and location verification to ensure accurate attendance marking without the need for traditional physical interaction. Students can authenticate their attendance using hand gestures, eliminating the need for manual roll calls or physical devices.

Core Technology: The system integrates advanced technologies like real-time gesture recognition using OpenCV and MediaPipe libraries to capture and interpret hand movements through a camera. Additionally, students' location is verified using geolocation APIs to confirm their presence within the designated classroom area. The system ensures that only students who are physically present in the classroom can mark their attendance, adding an extra layer of security to the process. The gesture recognition will allow students to register attendance by performing predefined gestures, such as a wave or a hand raise, which are translated into digital actions.

The **AI-based Attendance Web Application** enhances the learning environment by offering an interactive and modern solution to traditional attendance systems. It uses AI to detect and validate the user's presence, making attendance-taking more efficient and accurate. The system ensures seamless integration between hand gestures and location verification, allowing for touch-free and hands-free interaction. This approach is particularly beneficial in educational environments, where the goal is to engage students while maintaining a high level of security and accuracy. Additionally, the system will cater to students with disabilities by providing an inclusive, touch-free, and hands-free experience.

In addition to its innovative gesture-based attendance system, the platform offers enhanced features such as OTP-based verification for added security, ensuring that only authorized students can mark their attendance. Furthermore, the application provides a more flexible and adaptable solution for different learning environments, whether virtual or physical classrooms.

In conclusion, the **AI-based Attendance Web Application** represents a significant advancement in education technology. It not only streamlines the attendance-taking process but also ensures that it is secure, inclusive, and efficient. By integrating real-time gesture recognition and location-based validation, the system supports the evolving needs of modern classrooms and makes education more accessible, secure, and interactive for students and teachers alike.

Problem Statement :

With the rapid shift toward digital and remote learning environments, traditional attendance management systems in educational institutions have begun to reveal significant limitations. Conventional methods, such as manual roll-calls or physical logbooks, are not only time-consuming but also prone to human error, making it increasingly difficult to maintain accurate and up-to-date records. These outdated systems often fail to provide real-time data, leading to delays in attendance verification and difficulties in tracking students' engagement and participation. Additionally, they lack security, which can result in unauthorized check-ins, manipulation of attendance records, or attendance fraud.

In hybrid and remote learning environments, where students and teachers may not always be physically present in the same space, these traditional attendance methods are no longer viable. The need for a more streamlined, secure, and efficient solution has become evident. The absence of a system that can seamlessly track attendance across different settings—whether in-person, online, or hybrid—makes it challenging for both educators and students to manage attendance effectively. This is particularly critical in today's educational landscape, where flexibility, data integrity, and security are essential for maintaining smooth operations and fostering a productive learning environment.

As educational institutions increasingly adopt online and hybrid learning models, there is a pressing demand for an automated, secure, and accessible attendance management system. Such a system must not only ensure the accuracy of attendance tracking but also provide real-time data access for students and teachers. It should be easy to use, allowing students to check in without the need for physical interaction or cumbersome processes. Furthermore, the system should incorporate features that ensure the security of attendance data, such as preventing unauthorized check-ins or fraudulent activities. By offering an efficient, secure, and user-friendly solution, this system can enhance productivity, improve data integrity, and facilitate better engagement in the educational process—whether in physical classrooms, virtual learning environments, or hybrid settings.

Workflow Diagram :

The diagram outlines the workflow of an AI-based Attendance Management System, beginning with the initiation of the application, where users access the platform via secure login. Upon logging in, the system requests OTP-based authentication to verify identity, ensuring that attendance entries are valid. The location validation process then confirms that the user is within an approved area, adding another layer of security.

Once identity and location are verified, attendance is marked automatically in the system. The user interface provides a choice between functions, such as viewing attendance history, generating reports, or accessing real-time data. The processed attendance data is stored securely in the database, ready for retrieval by authorized users. Finally, the system renders the recorded data in a user-friendly format, enabling easy access to attendance records and administrative reporting.

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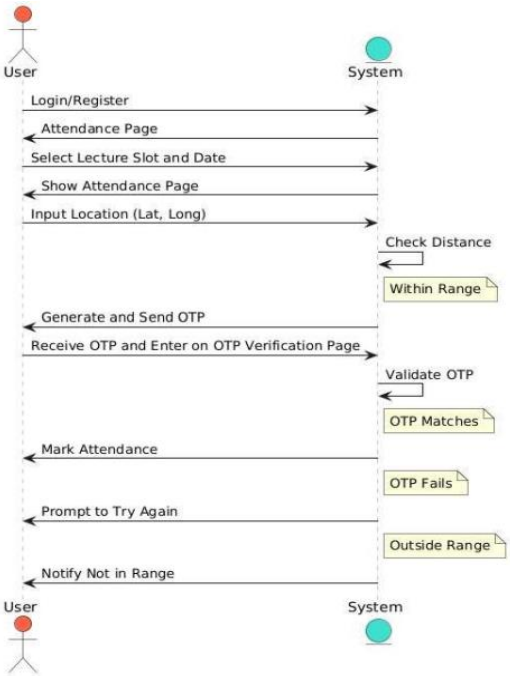

Fig. 1. Workflow Diagram

1.1. System Initialization

Required Equipment: The application initializes by loading essential libraries and dependencies like Flask, geolocation APIs, and security modules (e.g., Flask-Bcrypt).

User Interface Configuration: The login interface is set up with fields for registration and authentication, and parameters for secure session management are initialized.

1.2. User Authentication

Registration/Login: Users register or log in with a unique ID and password. Passwords are securely hashed using Flask-Bcrypt for added security.

Session Handling: Once logged in, users are given access to attendance marking features, maintaining session integrity for secure operations.

1.3. Attendance Marking

Select Lecture and Date: Students select the lecture slot and date for attendance.

Location Verification Prompt: Upon submitting their choice, students are redirected to a location verification page.

1.4. Location Verification

Location Prompt: Students are prompted to allow location access, retrieving their current latitude and longitude.

Location Validation: The system checks if the student's location is within a 50-meter radius of the predefined classroom coordinates to confirm presence.

1.5. OTP Generation and Email Verification

OTP Creation: If location verification is successful, the system generates a unique 6-digit OTP.

OTP Delivery: The OTP is sent directly to the student's registered email address.

1.6. OTP Validation

User Entry and Validation: Students enter the received OTP for verification.

Attendance Confirmation: If the OTP is correct, attendance is successfully recorded in the system. If not, the student can attempt re-entry.

1.7. System Updates and Real-Time Feedback

Attendance Dashboard: Both students and faculty can view attendance records in real-time, with options for reports and data export.

Error Handling and Feedback: Error messages and notifications are provided for incorrect OTPs, failed location verifications, or other issues.

Technical Details for Attendance Management System :

5.1. Defining the Fixed Classroom Location

- ***Predefined Coordinates:*** Each classroom's location will be associated with specific latitude and longitude values. For example, the coordinates for Classroom A might be 18.5204° N, 73.8567° E.
    - **Note: The actual coordinates for the target classroom (AISSMS Polytechnic Classroom) will be stored in the system.**
- ***Storage Options*:** These coordinates can either be stored in an SQLite database for dynamic use, or hardcoded into the system's configurat

5.2. Fetching Student's Current Location

- ***Location Permission**:* The system will prompt the student's device to allow access to its geolocation. This can be done using the navigator.geolocation API in modern web browsers or through mobile applications.
- ***Obtaining Latitude and Longitude*:** Upon granting permission, the geolocation API returns the student's current latitude and longitude, which will be used for location verification.
- ***Distance Calculation***

  Haversine Formula: To ensure accurate distance measurement, the Haversine formula will be used to calculate the great-circle distance between two points (i.e., the student's current location and the fixed classroom location) on the Earth's surface. This formula takes into account the curvature of the Earth, providing a more accurate result than simple Euclidean distance calculations**.**

  The Haversine formula is defined as follows:

$$a = \sin^2\left(\frac{\Delta\phi}{2}\right) + \cos(\phi_1) \cdot \cos(\phi_2) \cdot \sin^2\left(\frac{\Delta\lambda}{2}\right)$$

$$c = 2 \cdot \operatorname{atan2}\left(\sqrt{a}, \sqrt{1-a}\right)$$

$$d = R \cdot c$$

Formula to calculate the location of the student

Where:

- ϕ1,ϕ2\phi_1, \phi_2ϕ1,ϕ2 are the latitudes of the two locations in radians.
- λ1,λ2\lambda_1, \lambda_2λ1,λ2 are the longitudes of the two locations in radians.
- RRR is the Earth's radius (mean radius = 6,371 km).
- ddd is the distance between the two points in kilometers.
- This formula will be used to compare the student's current location with the predefined classroom location to ensure they are within the allowed distance (e.g., 50 meters) for attendance validation.

Tables and figures :

1.8. Technologies used

This table can list the software and hardware requirements needed for the implementation of the AMS.

Component	Description	Version
Programming language	Python	3.12.0
Framework	Flask	4.2.5
Database	SQLite	4.2.5
Frontend technologies	HTML, CSS, javascript	HTML5, CSS3, ES2023
Geolocation service	Geopy	2.3.0
OTP service	Twilio API	7.39.0

1.9. Expected Attendance accuracy

This table can compare the accuracy rates of traditional attendance methods versus the proposed AMS.

Method	Accuracy Rate
Traditional method	85%
Proposed AI-based Attendance System	99%

1.10. Time Efficiency analysis

This table can summarize the expected time savings when using the AMS**.**

Method	Accuracy Rate
Traditional method	7 minutes
Proposed AI-based Attendance System	2 minutes
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1.11. Feature Comparison of Attendance System

This table compares the features of traditional methods with those of AMS.

Feature	Traditional Method	AI-based AMS
OTP Authentication	No	Yes
Location Validation	No	Yes
Real-time Attendance Updates	No	Yes
Data Security	Low	High

Conclusion :

The AI-based Attendance Management System (AMS) introduces a revolutionary shift from traditional attendance tracking methods, offering a secure, efficient, and innovative solution to modern educational institutions. By leveraging advanced technologies such as OTP-based authentication and real-time location verification, this system ensures a more accurate and fraud-resistant attendance process. Gone are the days of manual roll calls or physical logbooks, which are not only time-consuming but also prone to human error. The AMS automates attendance tracking, eliminating the chances of mistakes while simultaneously saving valuable time for both students and educators.

One of the standout features of the AMS is its integration of OTP-based authentication. Students receive a One-Time Password (OTP) on their registered email or phone, which they must enter for successful attendance marking. This process guarantees that only the correct individual can mark their attendance, reducing the risk of proxy attendance or fraud. Furthermore, location verification ensures that the student is physically present within a defined radius of the classroom, adding an extra layer of security. This combination of technologies—OTP and location verification—significantly improves both the reliability and transparency of the attendance system.

The AMS also provides real-time data access, enabling both teachers and students to monitor attendance statistics and patterns. Through intuitive and user-friendly interfaces, the system enhances the user experience by allowing easy access to attendance records, class schedules, and notifications.

Teachers can quickly track student participation and attendance trends, which is vital for academic planning and progress tracking. For students, the ability to check and review their attendance status promotes transparency and encourages accountability. This streamlining of administrative tasks allows educators to focus more on their teaching and less on manual attendance management, improving overall classroom efficiency.
Furthermore, the shift to a digital-based attendance management system promotes operational sustainability. Traditional paper-based methods, such as physical registers, contribute to paper waste and increased environmental impact. The AI-based AMS reduces the need for physical attendance records, helping educational institutions significantly reduce their carbon footprint. By digitizing attendance tracking, the system supports educational institutions' sustainability initiatives and aligns with global efforts to minimize environmental impact.

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