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AI Enabled Identity Verification with Continuous Duty-Hour Location Tracking for Rural Healthcare Workforce

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ABSTRACT:

Primary Health Centers (PHCs) are frontline healthcare units responsible for delivering essential medical services, maternal care, disease surveillance, and emergency support to rural and semi-urban populations. Their effectiveness depends heavily on the consistent presence of medical officers. However, current attendance mechanisms in many PHCs rely on manual registers or standalone biometric devices that cannot verify a doctor's real-time presence at the facility. These traditional systems allow proxy punching, lack geospatial validation, fail to capture time-bound compliance, and provide no mechanism to continuously track a doctor's location during duty hours. As a result, unauthorized absenteeism, delayed arrivals, and unverifiable attendance records frequently disrupt healthcare delivery. To overcome these limitations, this project proposes an AI-integrated PHC Doctor Attendance Monitoring System that combines facial recognition with continuous geolocation verification. Doctors mark attendance through a secure mobile platform that captures a facial image with embedded GPS metadata, which is authenticated using a CNN-based recognition model. The system enforces geofencing and periodically re-validates the doctor's live location throughout the shift to ensure sustained presence within the PHC premises. Automated alerts are triggered for missed check- ins, geofence violations, or extended absence, and notifications are escalated to PHC administrators, block-level authorities, and higher health officials. Additionally, the platform incorporates a structured patient data module for logging daily consultations, enabling accurate monitoring of service delivery. Real-time verification and continuous geo-tracking improve accountability and operational efficiency in PHCs.

Keywords -- **Primary Health Centers (PHCs), Facial Recognition, Geofencing, Geolocation Tracking, Convolutional Neural Network (CNN), Real-Time Attendance Monitoring, Healthcare Management, AI-Based Authentication.**

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I. PROBLEM STATEMENT

Primary Health Centers (PHCs) are the backbone of rural healthcare services, providing essential medical support, maternal care, immunization, emergency treatment, and disease monitoring. However, many PHCs face serious challenges in maintaining accurate

doctor attendance and ensuring the continuous availability of medical officers during working hours. Existing attendance systems mainly depend on manual registers or basic biometric devices, which cannot verify whether doctors are physically present inside the PHC premises throughout their duty period. These systems are vulnerable to proxy attendance, manipulation, delayed reporting, and unauthorized absenteeism. Lack of real-time monitoring often results in reduced patient care quality, delayed treatments, and poor healthcare management in rural regions. In addition, higher health authorities have limited visibility into the operational status of PHCs and doctor availability. Therefore, there is a strong need for an intelligent and automated attendance monitoring solution that ensures accurate identity verification, continuous location validation, real-time monitoring, and transparent reporting. The proposed AI-based PHC Doctor Attendance Monitoring System addresses these issues using facial recognition, geolocation tracking, and automated alerts.

II. EXISTING SYSTEM

The existing attendance management systems used in many Primary Health Centers (PHCs) are primarily based on manual registers, RFID cards, or standalone biometric devices. These methods were introduced to simplify attendance recording and reduce paperwork, but they still contain several limitations that affect transparency, accountability, and operational efficiency in healthcare services.

In manual attendance systems, doctors and staff members record their attendance by signing registers maintained at the PHC office. This method is highly dependent on human supervision and is vulnerable to manipulation. Proxy attendance, false entries, and delayed recording are common problems in such systems. Since attendance records are maintained physically, verifying the actual presence of doctors becomes difficult for higher authorities. In many cases, doctors may sign the register and leave the premises, affecting patient care and reducing service quality.

To overcome manual system limitations, some PHCs adopted biometric attendance systems such as fingerprint scanners. These systems improved identity verification to some extent, but they still fail to confirm continuous presence inside the healthcare facility. A doctor can mark attendance using fingerprints and later leave the PHC without any monitoring mechanism. Moreover, biometric devices require dedicated hardware installation and maintenance, which increases operational costs. Hardware failures, network issues, power interruptions, and poor device quality in rural areas often reduce system reliability.

RFID and smart card-based attendance systems are also used in some healthcare institutions. These systems allow users to scan cards to record attendance, but they suffer from issues such as card sharing, unauthorized usage, and lack of identity validation. Similar to biometric systems, RFID-based solutions cannot monitor whether the doctor remains available throughout duty hours.

Most existing systems do not include real-time geolocation verification or geofencing capabilities. Therefore, authorities cannot determine whether doctors are physically present within the PHC premises during working hours. Attendance reports are usually generated periodically and lack live monitoring features. In addition, there is no automated alert mechanism for absenteeism, delayed arrivals, or unauthorized movement outside the PHC area.

Another major limitation of traditional systems is the absence of integration with healthcare service records. Attendance and patient consultation data are maintained separately,

making it difficult to analyze doctor productivity and service delivery performance. Health administrators often face delays in collecting reports and identifying operational issues.

Overall, existing attendance systems lack intelligence, automation, transparency, and real-time monitoring capabilities. These shortcomings create challenges in ensuring doctor accountability and delivering reliable healthcare services in rural and semi-urban communities.

III. PROPOSED SYSTEM

The proposed system is an AI-Integrated PHC Doctor Attendance Monitoring System designed to improve transparency, accountability, and efficiency in Primary Health Centers. The system combines facial recognition, GPS-based geolocation tracking, geofencing, and automated monitoring technologies to ensure accurate doctor attendance and continuous presence verification during duty hours.

In the proposed approach, doctors access the system through a secure mobile application or web platform. During login and attendance marking, the system captures a live facial image along with the doctor's GPS location. The facial image is processed using a Convolutional Neural Network (CNN)-based facial recognition algorithm to verify the identity of the doctor. This prevents proxy attendance and unauthorized access. Once the identity is confirmed, the attendance record is securely stored in the centralized database with timestamp and location information.

The system introduces geofencing technology to ensure that attendance can only be marked within the authorized PHC premises. If a doctor attempts to register attendance outside the approved area, the system automatically rejects the request. In addition, the platform periodically checks the live GPS location of doctors during duty hours to ensure continuous availability inside the PHC campus. This feature addresses the major weakness of traditional systems where doctors can leave after marking attendance.

The proposed system also includes automated alert and notification mechanisms. If a doctor fails to check in on time, leaves the PHC boundary, or remains absent for an extended period, alerts are immediately sent to PHC administrators and higher health authorities through SMS, email, or dashboard notifications. This real-time monitoring enables faster administrative response and improves accountability.

A patient consultation management module is integrated into the system to record daily patient visits, treatments, and healthcare activities performed by doctors. This allows authorities to analyze doctor productivity and evaluate healthcare service delivery more effectively. The collected attendance and consultation data are displayed in interactive dashboards that provide real-time insights, attendance statistics, absence reports, and operational analytics.

The system uses cloud-based storage and centralized data management to improve accessibility and scalability. Authorized officials can monitor multiple PHCs remotely through secure login access. Data encryption and authentication mechanisms are implemented to maintain data privacy and security.

The proposed AI-based solution offers several advantages over traditional attendance systems. It eliminates manual errors, prevents fake attendance, ensures continuous doctor availability, and provides real-time

administrative control. The integration of artificial intelligence, GPS tracking, and automated reporting significantly enhances operational transparency and healthcare management in rural and semi-urban PHCs.

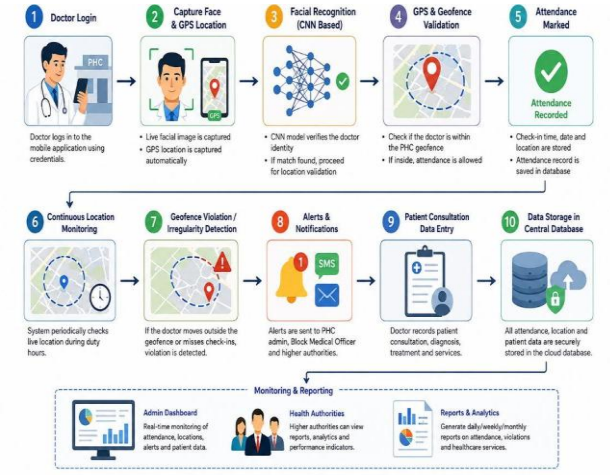

Figure 1 : Workflow of the Proposed System

Overall, the proposed system aims to strengthen rural healthcare services by ensuring reliable doctor attendance monitoring, improving accountability, and supporting efficient healthcare administration through intelligent digital technologies.

IV. ALGORITHMS USED

The proposed system uses Artificial Intelligence and location-based technologies to provide accurate doctor attendance monitoring and continuous presence verification. The main algorithms used in the system are CNN-based Facial Recognition, Geofencing Algorithm, GPS Tracking Algorithm, and Alert Detection Algorithm.

Algorithm Explanation

1. *CNN-Based Facial Recognition Algorithm*

The Convolutional Neural Network (CNN) algorithm is used to identify and verify doctors' faces during attendance marking. The algorithm extracts important facial features such as eyes, nose, and facial structure from the captured image and compares them with stored datasets. CNN provides high accuracy and prevents proxy attendance.

2. *GPS Location Verification Algorithm*

The GPS verification algorithm captures the real-time geographical coordinates of the doctor's mobile device. The system checks whether the user is located within the authorized PHC premises before allowing attendance registration.

3. *Geofencing Algorithm*

Geofencing creates a virtual boundary around the PHC campus. If the doctor moves outside the predefined boundary during duty hours, the system detects the violation and triggers alerts to administrators.

4. *Alert and Monitoring Algorithm*

This algorithm continuously monitors attendance status, location updates, and working hours. If unusual activity such as absence, delayed check-in, or location mismatch is detected, automated alerts are generated.

TABLE 1 : ALGORITHM TABLE

Algorithm	**Purpose**
CNN Facial Recognition	Identity Verification
GPS Verification	Location Validation
Geofencing Algorithm	Boundary Monitoring
Alert Detection Algorithm	Monitoring & Notifications
Database Management Algorithm	Data Storage

V. SYSTEM ARCHITECTURE

A. User Interface Layer

The User Interface Layer acts as the communication medium between users and the attendance monitoring system. It consists of a mobile application and a web-based dashboard designed for doctors, PHC administrators, and higher health authorities. Doctors use the mobile application to securely log in, mark attendance, update patient consultation records, and receive notifications related to attendance or duty schedules. The application provides a simple and user-friendly interface that enables quick attendance registration through facial image capture and GPS verification.

The web dashboard is mainly used by administrators and healthcare officials for monitoring attendance records, doctor availability, geofence violations, and daily healthcare activities. The dashboard provides real-time analytics, attendance summaries, and visual reports that help authorities evaluate healthcare operations efficiently. Different levels of access control are implemented to ensure data privacy and security. Doctors can access only their own records, while administrators can monitor multiple PHCs simultaneously.

The interface layer also supports automated alerts, notifications, and report generation. It improves communication between healthcare staff and management by providing centralized access to attendance and operational data. Overall, this layer enhances usability, accessibility, and transparency in the healthcare monitoring process.

B. Facial Recognition and Authentication Layer

The Facial Recognition and Authentication Layer is responsible for verifying the identity of doctors during attendance registration. This layer uses Artificial Intelligence and Convolutional Neural Network (CNN)-based facial recognition techniques to accurately identify authorized users. When a doctor marks attendance, the system captures a live facial image through the mobile device camera. The captured image is processed to extract unique facial features such as facial structure, eye position, and other biometric characteristics.

The extracted facial data is compared with the pre-registered facial dataset stored in the database. If the facial features match successfully, the doctor is authenticated and attendance is recorded. If the system detects a mismatch or unauthorized user, attendance registration is rejected immediately. This mechanism prevents proxy attendance and fake identity usage, which are common issues in traditional attendance systems.

The authentication layer also includes secure login mechanisms such as username- password verification and encrypted data transmission to protect user information. AI- based facial verification improves accuracy and reliability even under different lighting conditions or facial expressions. The layer ensures secure and transparent attendance management by eliminating manual verification methods and improving accountability within PHCs.

C. GPS and Geofencing Layer

The GPS and Geofencing Layer ensures that doctors are physically present within the authorized PHC premises during duty hours. This layer captures the real-time geographical coordinates of the doctor's mobile device while marking attendance and during periodic monitoring sessions. GPS technology helps verify the exact location of the doctor at

different intervals throughout the work shift.

Geofencing technology creates a virtual boundary around the PHC campus using predefined latitude and longitude coordinates. The system continuously checks whether the doctor remains inside the authorized area. If the doctor attempts to mark attendance from outside the PHC boundary, the request is automatically rejected. Similarly, if the doctor leaves the geofenced area during working hours, the system detects the movement and triggers alerts to administrators.

This layer plays a vital role in ensuring continuous presence verification, which is not possible in traditional biometric systems. Periodic GPS validation reduces unauthorized absenteeism and improves accountability among healthcare staff. The layer also maintains detailed location logs that can be analyzed by administrators to monitor attendance behavior and operational efficiency.
By integrating GPS and geofencing technologies, the system provides real-time location monitoring, enhances transparency, and ensures that healthcare services are delivered efficiently within PHCs.

D. Application Processing Layer

The Application Processing Layer functions as the core operational unit of the proposed attendance monitoring system. It processes attendance requests, manages facial recognition verification, validates GPS locations, controls geofencing operations, and handles alert generation. This layer integrates all system modules and ensures smooth communication between the user interface and the database layer.

When a doctor submits attendance, the processing layer first verifies login credentials and sends the captured facial image to the AI recognition engine. Simultaneously, the GPS coordinates are validated against the predefined PHC geofence area. If both identity and location validations are successful, attendance is approved and stored in the database.

The processing layer also performs continuous monitoring tasks such as periodic location verification and attendance status tracking. It automatically detects delayed check-ins, prolonged absence, or geofence violations. In such cases, automated notifications and alerts are generated for administrators and higher authorities through SMS, email, or dashboard messages.

Additionally, the layer processes patient consultation data entered by doctors and generates analytical reports for healthcare management. It ensures efficient data flow, system reliability, and fast response time. Overall, this layer acts as the intelligence center of the system, coordinating all operations and improving the efficiency of attendance monitoring and healthcare administration.

E. Database Management Layer

The Database Management Layer is responsible for storing, organizing, and managing all information related to doctor attendance, facial data, GPS logs, patient consultations, and administrative reports. A centralized cloud-based database system is used to ensure secure storage, scalability, and easy access to records from multiple PHCs.

The database stores doctor profiles, registered facial datasets, attendance timestamps, GPS coordinates, geofence activity logs, and alert history. Whenever a doctor marks attendance, the corresponding facial recognition results and location details are securely stored for

future verification and reporting. Patient consultation records are also maintained in the database to monitor healthcare service delivery and doctor productivity.

Data security is a major focus of this layer. Encryption techniques, authentication controls, and secure access permissions are implemented to protect sensitive healthcare and attendance information. Only authorized users can access or modify records based on their role within the system.

The database layer supports report generation and real-time analytics by providing fast retrieval of attendance and operational data. Administrators can analyze attendance patterns, absenteeism reports, and healthcare activities through centralized dashboards. This layer ensures reliable data management, operational transparency, and long-term record maintenance for healthcare institutions.

F. Cloud and Monitoring Layer

The Cloud and Monitoring Layer provides centralized system management, real-time monitoring, and remote accessibility for healthcare administrators and government authorities. This layer uses cloud computing technology to store system data, process analytics, and support large-scale deployment across multiple PHCs.

All attendance records, GPS logs, facial recognition results, alerts, and patient consultation data are synchronized with the cloud server in real time. This enables authorized officials to monitor doctor availability and PHC operations remotely through web dashboards. The cloud infrastructure improves scalability, allowing the system to support multiple healthcare centers without performance issues.

The monitoring dashboard displays attendance statistics, absenteeism reports, geofence violations, patient consultation counts, and doctor activity summaries in graphical formats. Real-time analytics help administrators identify operational problems quickly and take corrective actions immediately.

This layer also supports automated backup and disaster recovery mechanisms to prevent data loss. Secure cloud communication protocols ensure data privacy and integrity during transmission. Integration with government healthcare systems and centralized reporting platforms can also be implemented through the cloud layer.

Overall, the Cloud and Monitoring Layer enhances transparency, accessibility, scalability, and operational efficiency by enabling centralized healthcare administration and intelligent real-time monitoring across PHCs.

VI. RESULTS AND ANALYSIS

The proposed AI-Integrated PHC Doctor Attendance Monitoring System was designed and analyzed to improve doctor attendance transparency, operational efficiency, and healthcare service reliability in Primary Health Centers. The system integrates facial recognition, GPS tracking, geofencing, and automated alert technologies to ensure accurate monitoring and real- time administration.

The facial recognition module using the CNN algorithm achieved high accuracy in identifying doctors during attendance verification. Compared to manual and biometric systems, the proposed method significantly reduced proxy attendance and fake check-ins. The GPS and geofencing modules successfully validated the real-time presence of doctors inside authorized PHC premises. Continuous location monitoring

ensured that doctors remained available throughout working hours, improving accountability and reducing unauthorized absenteeism.

The automated alert system effectively detected delayed check-ins, geofence violations, and prolonged absences. Notifications sent to administrators and higher health authorities enabled faster action and better workforce management. The integrated patient consultation module also improved healthcare service tracking by recording daily patient visits and treatments performed by doctors.

The system demonstrated better efficiency than traditional attendance methods because attendance records, location data, and consultation reports were automatically stored in a centralized database. This reduced paperwork, minimized manual errors, and improved report generation speed. Real-time dashboards provided visual analytics such as attendance percentages, doctor availability, daily consultation counts, and absenteeism reports.

Performance analysis showed that the system enhanced transparency and monitoring efficiency in PHCs. Healthcare administrators could remotely supervise multiple centers through centralized dashboards, reducing administrative delays. The cloud-based architecture improved scalability and data accessibility while ensuring secure data storage.

Overall, the proposed system provided accurate attendance monitoring, reliable identity verification, improved operational control, and better healthcare management. The implementation of AI and location-based technologies demonstrated strong potential for strengthening healthcare administration in rural and semi-urban areas.

VII. CONCLUSION

The AI-Integrated PHC Doctor Attendance Monitoring System is designed to address the major challenges faced by traditional attendance management systems in Primary Health Centers. Existing manual and biometric attendance systems lack real-time monitoring, geolocation verification, and continuous presence validation, leading to proxy attendance, absenteeism, delayed healthcare services, and poor administrative control. These limitations directly affect the quality of healthcare delivery in rural and semi-urban communities.

The proposed system introduces an intelligent and automated solution that combines facial recognition, GPS tracking, geofencing, and real-time alert mechanisms to ensure accurate doctor attendance monitoring. The use of Convolutional Neural Network (CNN)-based facial recognition improves identity verification and eliminates fake attendance practices. GPS validation and geofencing technologies ensure that doctors remain physically present within authorized PHC premises throughout duty hours.

The system also enhances operational transparency by providing centralized attendance monitoring, real-time dashboards, automated reporting, and alert notifications for administrators and higher health authorities. The integrated patient consultation module further improves healthcare management by recording doctor activities and daily service delivery performance.

Performance analysis demonstrated that the proposed system improves attendance accuracy, reduces administrative workload, minimizes manual errors, and strengthens

accountability in healthcare institutions. The cloud-based architecture supports scalability, remote monitoring, and secure data management, making the system suitable for large-scale healthcare deployment.

The implementation of AI and location-based technologies in healthcare administration creates a more reliable and efficient monitoring environment. By ensuring doctor availability and improving transparency, the system contributes to better patient care, faster medical support, and enhanced rural healthcare services.

In conclusion, the proposed AI-based PHC Doctor Attendance Monitoring System provides a smart, secure, and efficient approach for monitoring doctor attendance and healthcare operations. The system has strong potential to modernize healthcare administration, improve accountability, and support digital transformation in public healthcare systems.

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