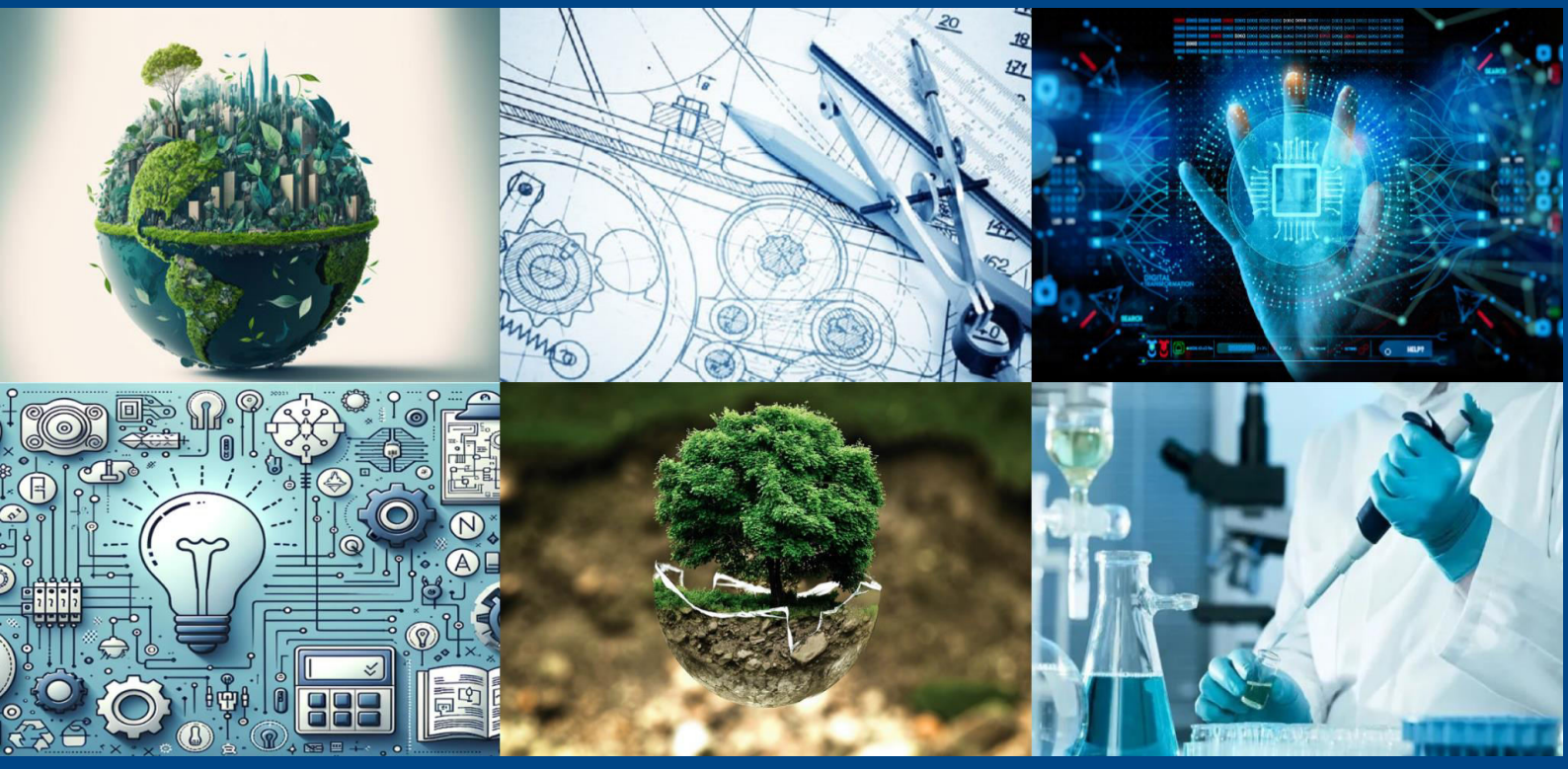
ISSN: 2582-7219

International Journal of Multidisciplinary Research in Science, Engineering and Technology

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.206 **Volume 8, Issue 3, March 2025**

© 2025 IJMRSET | Volume 8, Issue 3, March 2025| DOI: 10.15680/IJMRSET.2025.0803101

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

AI-Powered Doctor Attendance Tracking for Healthcare Efficiency

Dr.M.Senthilkumar, Dr.K.Baskar, S.Sedhuram, M.Vasikaran, V.Vikram

Professor, Dept. of AI&DS, Kongunadu College of Engineering and Technology, Trichy, Tamil Nadu, India

Associate Professor, Dept. of AI&DS, Kongunadu College of Engineering and Technology, Trichy, Tamil Nadu, India

UG Student, Dept. of AI&DS, Kongunadu College of Engineering and Technology, Trichy, Tamil Nadu, India

UG Student, Dept. of AI&DS, Kongunadu College of Engineering and Technology, Trichy, Tamil Nadu, India

UG Student, Dept. of AI&DS, Kongunadu College of Engineering and Technology, Trichy, Tamil Nadu, India

ABSTRACT: In modern healthcare, keeping track of doctor attendance and service delivery in real-time is essential for improving efficiency and accountability. This project introduces an AI-powered centralized digital platform that connects Primary Health Centers (PHCs), Upgraded PHCs, and Sub-Centers with the Deputy Director of Health Services (DDHS). The system allows real-time tracking of doctor attendance, sends automated absenteeism alerts, and provides performance analysis to help enhance healthcare management across different divisions. To ensure secure and fraud-proof authentication, the system uses face recognition and location-based verification, meaning doctors can only log in when connected to an authorized healthcare facility network. Additionally, AI-driven anomaly detection and predictive analytics help identify unusual login patterns, potential absenteeism, and workload imbalances. The system also includes automated reporting and AI-powered insights, helping healthcare administrators make data-driven decisions. By integrating secure authentication, AI-powered fraud detection, and real-time monitoring, this project offers a scalable, efficient, and intelligent solution for managing the healthcare workforce. The proposed system boosts transparency, accountability, and service quality while minimizing manual efforts in attendance tracking.

KEYWORDS: AI-powered healthcare, doctor attendance monitoring, Absenteeism alerts, face recognition, predictive analytics, anomaly detection, digital health management.

I.INTRODUCTION

Ensuring that healthcare professionals are available, accountable, and efficient is essential for delivering high-quality medical services, especially in public healthcare facilities such as Primary Healthcare Centers (PHCs), Upgraded PHCs, and Sub-Centers. A reliable attendance tracking system plays a crucial role in maintaining service continuity, managing workforce distribution, and optimizing resources. However, traditional attendance methods—such as manual registers, RFID cards, and biometric fingerprint scanning often fall short. These systems are vulnerable to manipulation, unauthorized access, and proxy attendance, leading to delays in tracking absences, mismanagement of healthcare staff, and disruptions in patient care.

To overcome these challenges, this project introduces an AI-powered doctor attendance tracking system that enhances transparency, security, and workforce efficiency. By integrating facial recognition, GPS-based location validation, AI-driven fraud detection, and automated absentee alerts, the system ensures real-time and secure authentication. The frontend is developed using React.js, while Node.js with Express.js powers the backend. TensorFlow.js is utilized for AI-driven facial recognition, and MySQL serves as the primary data storage solution, ensuring seamless and efficient operation.

The system enforces authentication by verifying both facial identity and physical presence at the healthcare facility. The facial recognition module, built with TensorFlow.js, captures and processes real-time facial images to accurately verify doctors' identities, preventing proxy attendance or unauthorized access. Simultaneously, GPS-based location validation confirms that doctors are physically present at their assigned facility, preventing remote check-ins or location spoofing.

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If either verification fails, the system prompts re-authentication, ensuring a secure and fraud-resistant attendance tracking mechanism.

To further enhance security, the system employs AI-powered anomaly detection. Using Long Short-Term Memory (LSTM) networks and Generative Adversarial Networks (GANs), it analyzes login behaviors, timestamps, and location history to detect suspicious activity—such as repeated late check-ins, unauthorized remote logins, or inconsistencies in attendance records. If irregularities are found, the system triggers real-time alerts, notifying administrators through Twilio SMS and SMTP-based email alerts. This enables swift intervention and ensures compliance with attendance policies.

A centralized administrative dashboard, built with React.js, provides healthcare administrators, including the Deputy Director of Health Services (DDHS), with a real-time overview of attendance logs, absentee trends, and compliance metrics. The dashboard features interactive data visualization tools that help track attendance patterns, generate reports, and facilitate data-driven workforce decisions. Additionally, the system's predictive analytics module leverages historical attendance data to forecast absenteeism trends, enabling proactive workforce planning and resource allocation to prevent staff shortages.

By automating attendance tracking, reducing fraudulent practices, and utilizing AI for real-time monitoring, this system offers a secure, efficient, and data-driven solution for healthcare workforce management. The integration of facial recognition, GPS-based validation, AI-powered fraud detection, and real-time reporting ensures that doctors are accountable and available where they are needed most. Ultimately, this innovative approach improves operational efficiency, enhances workforce transparency, and contributes to better patient care delivery.

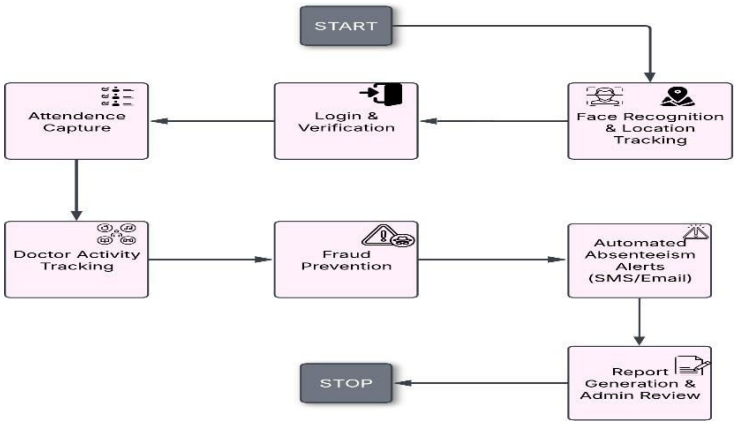

FIGURE 1. ARCHITECTURE DIAGRAM

II. LITERATURE SURVEY

Efficient healthcare workforce management is essential for high-quality service delivery, particularly in ensuring the presence and accountability of doctors in healthcare facilities such as Primary Healthcare Centers (PHCs), Upgraded PHCs, and Sub-Centers. Traditional methods like manual registers and biometric systems have long been used for tracking doctor attendance. However, these systems are prone to errors, inefficiencies, and fraudulent practices, including proxy logins and unauthorized remote access. To address these challenges, AI-driven attendance tracking systems have emerged as transformative solutions. By utilizing advanced technologies such as face recognition and location-based verification, these systems enhance transparency, improve operational efficiency, and eliminate fraudulent practices in healthcare workforce management. Additionally, AI-powered systems provide real-time attendance tracking, enabling administrators to monitor workforce presence accurately and ensure accountability. This innovative approach not only optimizes workforce management but also enhances overall healthcare service delivery by ensuring that doctors are present and available when needed [1].

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AI-powered attendance systems are widely used across various sectors, including educational institutions, corporate offices, and healthcare settings. These systems track employee movements, analyze work patterns, and generate attendance reports in real time. By automating the monitoring process, AI significantly reduces manual intervention, minimizes human errors, and enhances the accuracy of attendance records. Additionally, AI systems provide automated alerts and notifications, enabling administrators to take timely action in cases of absenteeism or prolonged inactivity. This proactive approach ensures consistent workforce availability and prevents disruptions in healthcare service delivery. Furthermore, the integration of AI-driven attendance monitoring systems allows for efficient workforce allocation, optimizing the doctor's availability and enhancing overall productivity in healthcare settings [2].

The integration of facial recognition and location-based verification has revolutionized secure and efficient authentication for attendance tracking. Facial recognition technology verifies user identity before granting access to the system, preventing unauthorized logins and reducing the risk of proxy attendance. Moreover, GPS-based location verification ensures that doctors are physically present at their designated healthcare facilities during duty hours, enhancing location accuracy and minimizing fraudulent practices. Studies on geofencing and network-based authentication in various sectors, including corporate offices, educational institutions, and financial services, have shown positive results in preventing unauthorized access. By combining facial recognition with GPS-based verification, AI-powered attendance systems create a highly secure and fraud-resistant environment, ensuring that only authorized personnel can log in and authenticate their presence. This approach not only enhances security but also strengthens the accountability [3].

One of the key advantages of AI in attendance tracking is its ability to detect anomalies and prevent fraudulent activities. Advanced deep learning models, such as Long Short-Term Memory (LSTM) networks and Generative Adversarial Networks (GANs), are widely used in fraud detection systems across industries, including cybersecurity and financial services. These AI models efficiently identify suspicious activities, such as logins from unauthorized locations, repeated failed authentication attempts, and inconsistencies in attendance patterns. Applying similar anomaly detection methodologies in healthcare workforce management ensures real-time monitoring of doctor attendance and immediate flagging of irregularities. This proactive fraud detection capability helps healthcare administrators respond quickly to security threats, enforce accountability, and maintain accurate attendance records. By integrating AI-powered fraud detection systems, healthcare facilities can effectively eliminate fraudulent attendance practices, enhance data integrity, and ensure that doctors are present and accountable during duty hours [4].

The adoption of automated attendance monitoring systems has been growing in educational institutions, corporate offices, and healthcare settings. AI-powered attendance tracking systems are capable of monitoring employee movements, analyzing work patterns, and generating attendance reports in real time. These systems not only improve accuracy but also reduce manual errors associated with traditional attendance tracking methods. Studies have shown that automated attendance tracking enhances operational efficiency, increases workforce productivity, and optimizes resource utilization. Furthermore, AI systems provide real-time alerts and notifications to healthcare administrators, enabling timely intervention in cases of absenteeism or prolonged inactivity. By replacing manual registers and biometric authentication with AI-driven solutions, healthcare facilities can enhance workforce management, optimize doctor availability, and improve overall service quality. This approach not only streamlines attendance tracking but also contributes to better patient care and resource allocation in healthcare settings [5].

An effective notification and reporting system is crucial for real-time workforce management in healthcare. Automated reporting tools generate attendance summaries, absenteeism alerts, and compliance metrics, providing healthcare administrators with comprehensive insights into workforce performance. AI-powered dashboards visualize attendance patterns, absentee trends, and productivity metrics in an easy-to-understand format, enabling data-driven decision-making. These intelligent reporting systems enhance transparency and accountability, ensuring that healthcare facilities maintain accurate and reliable attendance records. Additionally, AI-driven analytics help administrators identify trends, detect anomalies, and optimize workforce allocation, leading to improved staff management and operational efficiency. Research in business intelligence and healthcare analytics suggests that the integration of AI-driven reporting tools significantly enhances decision-making and productivity. By leveraging real-time data visualization and automated reporting, healthcare administrators can make informed decisions, implement strategic policies, and improve overall workforce performance. This comprehensive approach to attendance tracking and reporting ensures that healthcare facilities maintain a productive and accountable workforce, ultimately leading to better healthcare service delivery [6].

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III. PROPOSED METHODOLOGY

The proposed system introduces an innovative AI-powered solution designed to transform how doctor attendance is tracked and managed in healthcare facilities. By leveraging facial recognition technology, GPS location verification, AI-driven fraud detection, and automated reporting, this system delivers a secure, efficient, and transparent approach to workforce management. Built with a modern technology stack comprising React.js for the frontend, Node.js with Express.js for the backend, TensorFlow.js for AI models, and MySQL for data storage, the solution ensures real-time accuracy and reliability while maintaining a seamless user experience.

The system utilizes facial recognition technology powered by TensorFlow.js to authenticate doctors through live facial scans, providing secure and accurate identity verification. This contactless authentication method eliminates the risk of proxy attendance and unauthorized logins, significantly enhancing security and accountability. Additionally, GPS location verification confirms the doctor's physical presence at the designated healthcare facility, preventing remote check-ins or location spoofing.

By combining facial recognition with location validation, the system guarantees that attendance is recorded only when doctors are present at the correct location, ensuring accountability and workforce integrity. To further strengthen security and safeguard attendance data, the system continuously monitors login patterns using AI-driven anomaly detection. Advanced algorithms, including Long Short-Term Memory (LSTM) networks and Generative Adversarial Networks (GANs), analyze login behaviors to identify unusual patterns, repeated failed authentication attempts, or suspicious activities.

These models detect irregularities such as multiple logins from different locations, inconsistent check-in times, or unauthorized access attempts. If abnormal behavior is identified, the system immediately flags the activity and sends real-time alerts to administrators via Twilio SMS and email notifications, enabling swift action and minimizing risks to workforce integrity Beyond fraud detection, the system is engineered to provide intelligent and intuitive workforce management.

A centralized dashboard, built with React.js for a dynamic and user-friendly interface, empowers healthcare administrators with real-time insights into doctor attendance, absenteeism trends, and overall workforce productivity. The dashboard features interactive graphs, predictive analytics, and automated alerts, allowing administrators to quickly identify patterns, optimize staff scheduling, and proactively address absenteeism to maintain optimal service delivery. In the event of a missed check-in or unauthorized login attempt, instant notifications are triggered, ensuring timely intervention and minimizing operational disruptions Security and data privacy are top priorities.

The system ensures robust data protection with AES-256 encryption for secure data transmission and storage, as well as role- based access control (RBAC) to manage data visibility according to user roles. Multi-factor authentication (MFA) is integrated to provide an additional layer of security, ensuring that only authorized users can access the system. Moreover, the solution is compliant with relevant data protection regulations, safeguarding personal information and ensuring data privacy.

The system is built to be scalable and adaptable, supporting deployment across multiple healthcare facilities with ease. It features cloud-based synchronization for centralized data management and real-time updates, ensuring consistent and accurate attendance records across all locations. Recognizing potential challenges, the system includes offline attendance logging, allowing records to be securely stored and synchronized once connectivity is restored, ensuring data continuity even during network disruptions.

By combining facial recognition, GPS-based location verification, AI-powered fraud detection, and automated workforce analytics, this system delivers a reliable, intelligent, and future-ready solution for healthcare attendance management. It not only tracks doctor presence with precision but also empowers administrators with data-driven insights to optimize staff scheduling, enforce compliance, and enhance workforce productivity. This solution sets a new standard for smart healthcare workforce management, ensuring transparency, accountability, and improved service delivery across healthcare facilities.

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IV. TECHNOLOGIES USED

1. **React.js:** React.js is a widely-used JavaScript library for building dynamic and interactive user interfaces, particularly for single-page applications. It allows developers to create reusable UI components, streamlining development and enhancing efficiency. Leveraging a virtual DOM, React.js ensures high performance and seamless UI updates. Maintained by Facebook, it is known for its flexibility, speed, and ease of integration with other libraries or frameworks. React is ideal for developing responsive, scalable web applications that deliver a smooth user experience.

2. **Express.js:** Express.js is a powerful and minimalist web application framework for Node.js, designed to facilitate the development of robust web servers and APIs. It offers flexible routing, middleware support, and efficient HTTP request handling. Known for its simplicity and scalability, Express allows developers to organize application logic with ease. Its modular structure supports integration with numerous libraries, enhancing functionality and performance. Express.js is the go-to choose for building fast, scalable backend systems and RESTful APIs

3. **Node.js:** Node.js is a high-performance JavaScript runtime built on Chrome's V8 engine, enabling server-side execution of JavaScript. Its non-blocking, event-driven architecture makes it highly efficient for handling concurrent requests, ideal for scalable network applications. Node.js supports full-stack development by allowing the use of JavaScript on both client and server sides. Renowned for its speed and scalability, Node.js is widely used for developing APIs, real-time applications, and microservices.

4. **TensorFlow.js:** TensorFlow.js is an open-source JavaScript library that lets developers build and run machine learning models directly in the browser or on Node.js. It supports creating, training, and deploying neural networks using JavaScript, making it ideal for web-based AI applications. TensorFlow.js works with both pre-trained and custom models and uses GPU acceleration for fast computations. This enables real-time predictions and interactive AI experiences, bringing powerful machine learning capabilities to web development.

5. **MySQL:** MySQL is an open-source database system that stores and organizes data in tables. It uses SQL (Structured Query Language) to easily add, retrieve, and manage data. Known for its speed and reliability, MySQL is widely used in web applications. It handles complex queries and transactions securely, ensuring data is safe and consistent. It also works well with popular programming languages like JavaScript, Python, and PHP, making it a top choice for backend development.

6. **Firebase:** Firebase is a cloud-based platform that sends real-time notifications to users on web and mobile apps. It's great for push notifications, alerts, and in-app messaging.

7. **SMTP:** SMTP is used to send email notifications securely over the internet. It allows apps to send automated emails like alerts, password resets, or updates directly to users' inboxes

V. RESULT AND DISCUSSION

The AI-powered healthcare workforce management system revolutionizes doctor attendance tracking by providing real-time, secure, and accurate monitoring across healthcare facilities. Traditional attendance methods, such as manual registers and RFID cards, are prone to errors, manipulation, and inefficiencies, making workforce management challenging. To address these issues, the system leverages facial recognition technology and GPS-based location validation to ensure that doctors are physically present at their assigned healthcare facility. Built with a modern tech stack using React.js for the frontend, Node.js with Express.js for the backend, TensorFlow.js for AI models, and MySQL for data storage, the solution delivers a seamless and reliable attendance management experience.

The system captures facial images using a mobile device's camera and processes them using TensorFlow.js to compare them against pre-registered facial data, ensuring secure and contactless attendance verification. Additionally, GPS-based location validation checks the doctor's physical location during attendance marking, preventing remote check-ins or location spoofing. By combining these two methods, the system guarantees that attendance is recorded only when the doctor is physically present at the healthcare facility, ensuring accountability and accuracy.

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The system also utilizes AI-driven anomaly detection to analyze attendance patterns and identify irregular behavior's such as frequent late arrivals, early departures, or unauthorized check-ins. Using Generative Adversarial Networks (GANs) for fraud detection and Long Short-Term Memory (LSTM) models for predictive analytics, the system intelligently detects suspicious activities and sends real-time absenteeism alerts to administrators. This approach enhances transparency and accountability in healthcare workforce management while enabling proactive decision-making for staffing and scheduling.

A key feature of the system is its real-time reporting and analytics dashboard, developed with React.js for a dynamic and user-friendly interface. It provides administrators with detailed attendance logs, workforce performance insights, and predictive trends, enabling data-driven decision-making. The system also sends instant alerts about absenteeism and anomalies through Twilio SMS and SMTP email services, ensuring that administrators are notified immediately for quick action. Additionally, the system supports customizable alert settings, allowing administrators to define attendance thresholds and receive automated reports tailored to their requirements.

The system is designed to be scalable and flexible, supporting multiple healthcare facilities and adapting to future technological advancements. It can integrate with cloud-based storage for centralized management and leverage AI-driven workforce optimization models to improve shift planning and resource allocation. Additionally, the system supports remote attendance tracking for doctors conducting virtual consultations, ensuring accurate monitoring and reporting of the healthcare workforce.

By leveraging facial recognition, GPS-based location validation, AI-driven fraud detection, predictive analytics, and automated notifications, the system ensures better workforce efficiency, improved transparency, and enhanced healthcare service quality. It eliminates manual errors, prevents attendance fraud, and optimizes resource allocation, ensuring that doctors are present when and where they are needed most. This intelligent and automated solution represents a groundbreaking leap in healthcare workforce management, delivering optimal workforce productivity and improved patient care

FIGURE 2. ADMIN DASHBOARD

Challenges and Future Enhancements

AI-powered doctor attendance tracking in healthcare comes with several challenges. One of the biggest concerns is privacy and data security, as storing biometric and location data must follow regulations like HIPAA and GDPR to prevent unauthorized access. Many hospitals and clinics still rely on manual registers and biometric fingerprint systems, making it difficult and expensive to switch to AI-driven solutions. Additionally, facial recognition technology can struggle with poor lighting, masks, or image quality, sometimes leading to incorrect identifications. Some doctors may also resist AI-based monitoring, feeling that it invades their privacy. Another major hurdle is the high cost of implementation, as setting up AI-powered attendance systems requires hardware, software, and continuous maintenance. In rural areas, internet connectivity issues can make real-time tracking unreliable, further complicating adoption

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To address these challenges, several improvements can be made. Advanced deep learning models, like Convolutional Neural Networks (CNNs), can enhance facial recognition accuracy, even in difficult conditions. Adding multimodal authentication, such as iris scanning, voice recognition, or fingerprint verification, can make attendance tracking more secure and prevent proxy check-ins. Blockchain technology can ensure attendance records remain tamper-proof, increasing trust and transparency. Predictive analytics can help forecast staff shortages, allowing hospitals to plan and optimize scheduling in advance. Edge AI technology can enable offline attendance tracking, ensuring that data is stored locally and synced once the internet connection is restored. For telemedicine, AI-powered systems can use gaze tracking and engagement monitoring to verify that doctors are actively participating in virtual consultations. By integrating these enhancements, AI-powered doctor attendance tracking can become a secure, reliable, and scalable solution that improves healthcare workforce management and patient care delivery.

VI. CONCLUSION

Managing doctor attendance across healthcare facilities has always been a challenge, especially with traditional methods like manual registers and RFID cards. These methods are often prone to errors, manipulation, and inefficiencies. To solve this problem, we're developing an AI-powered healthcare workforce management system that uses facial recognition and GPS-based location validation. This means that doctors' attendance is tracked accurately and securely, ensuring they're actually present at their assigned facility, not just logged in from anywhere.

The system is smart enough to detect unusual attendance patterns, like frequent late arrivals or early checkouts, using advanced AI models. It can even predict potential absenteeism by analyzing past trends. When something unusual is detected, real-time alerts are sent to administrators, helping them take quick action and maintain transparency and accountability.

One of the best parts of this system is the real-time reporting and analytics dashboard. Administrators can easily view detailed attendance records and gain insights into workforce performance, all powered by MySQL. Plus, they receive notifications through Twilio SMS and email, ensuring they're always in the loop about absenteeism or any suspicious activities. The alerts are fully customizable, so administrators can set their own rules and get automated reports that fit their needs.

Our solution is built to grow with the needs of the healthcare system. It supports multiple facilities and can integrate with cloud storage for centralized management, also ready to work with telemedicine platforms, making it easy to track attendance. This system is more than just about tracking attendance. It's about boosting workforce efficiency, improving transparency, and ensuring better healthcare service delivery. By eliminating manual errors, preventing proxy attendance, and optimizing resource allocation, we're helping healthcare facilities ensure that doctors are where they're needed the most.

With facial recognition, AI-driven fraud detection, predictive analytics, and automated notifications, our AI-powered system is transforming how healthcare workforce management is done. It's about making sure doctors are present, patients get the care they need, and administrators can manage everything smoothly and efficiently.

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