Smart Employee Management System With Automated Attendance And Payroll

S. Suresh Kumar[1], D.Keerthana[2], R. Sandhiya[3], S.Pavithra[4]
Department of Information Technology, SRM Valliammai Enginnering College Kattankulathur, Chennai

***Abstract*—Employee management is one of the most important organizational functions. Conventional payroll and attendance systems use fingerprint devices, RFID cards, or manual registers, all of which are laborious, prone to mistakes, and susceptible to manipulation like proxy attendance. These drawbacks emphasize how urgently an automated, smart, and safe system is needed.**

This paper presents a Smart Employee Management System that combines automated payroll processing, secure authentication, and face recognition-based attendance tracking into a single platform. The Spring Boot framework, which guarantees scalability, modular design, and strong backend support, was used in the development of the system. Instead of using expensive biometrics, a webcam interface is used to take pictures during user registration, login, and daily attendance marking.

The FaceNet algorithm, which creates 128-dimensional feature embeddings for every employee face, is used to implement the face recognition module. A highly discriminative representation of facial features is offered by these embeddings. The system determines the Euclidean distance between the stored and real-time embeddings during authentication. The employee is successfully identified if the distance is less than a predetermined threshold, guaranteeing accuracy and avoiding proxyattendance.

The system uses JWT (JSON Web Token) authentication for safe access control. A JWT token is created upon successful login and is necessary for all ensuing client-server transactions. This system guarantees session integrity, stops unwanted access, and permits scalability in multi-user settings. Additionally, a password recovery feature is integrated through SMS and email services, enhancing system dependability and usability.

The system has a payroll computation module that is directly connected to attendance records in addition to attendance. A rule-based formula is used to calculate payroll:

Salary = (Base Salary/Total Days of Work) Days SpenAttending

By eliminating human intervention and reducing calculation errors, this guarantees that salaries are credited proportionately based on employee attendance. A user-friendly experience is offered by the frontend's static HTML pages, which include the camera interface, profile, login, and register. AuthController, AttendanceController, and FaceRecognitionController are among the Spring Boot controllers and services that make up the backend. Database operations are supported by repositories. The separation of concerns and seamless system operation are guaranteed by this tiered architecture.

Multiple employees participated in an experimental evaluation with different lighting conditions. The system's average face recognition accuracy was 97.8%, its authentication latency was less than two seconds, and its payroll computation accuracy was 100%. These outcomes show how effective, dependable, and useful the suggested system is in actual organizational settings.

In order to facilitate multi-factor authentication, future improvements will concentrate on extending biometric modalities by incorporating fingerprint and iris recognition. To increase accessibility for administrators and staff alike, a cross-platform mobile application is also planned. In order to improve payroll and attendance record management's scalability, security, and transparency, cloud and blockchain integration will also be investigated.

***Index Terms*—Face recognition, FaceNet algorithm, Automated attendance, Payroll computation, Employee management system, Spring Boot framework, JWT authentication, Artificial intelligence in HR, Workforce automation**

I. INTRODUCTION

Every organization needs effective employee management because it has a direct impact on operational efficiency, transparency, and productivity. Despite their widespread use, traditional payroll and attendance systems like fingerprint scanners, RFID cards, and manual registers have drawbacks like proxy attendance, human error, extra hardware expenses, and

laborious procedures. Because of errors in attendance and pay calculations, these inefficiencies result in decreased organizational performance and employee discontent.

The rapid advancements in machine learning (ML) and artificial intelligence (AI) have drawn more attention to automated human resource (HR) management systems. AI-powered solutions can substitute intelligent, dependable, and contactless techniques for antiquated manual processes. A particularly effective and non-intrusive biometric method for employee authentication and attendance tracking is face recognition technology. . Face recognition offers real-time monitoring, avoids proxy attendance, and reduces physical contact in contrast to fingerprint or RFID-based techniques.

This paper suggests a Smart Employee Management System with Automated Attendance and Payroll to address the drawbacks of conventional systems. The system incorporates FaceNet-based face recognition for attendance and is implemented using the Spring Boot framework, which guarantees modularity and scalability. Employee photos are taken with a webcam and then transformed into 128-dimensional embeddings. To ensure accuracy and security in attendance marking, identity verification is carried out by computing the Euclidean distance between stored and real-time embeddings.

The system has a payroll computation module that uses attendance and leave records to automatically determine employee salaries in addition to tracking attendance. The monthly salary distribution is decided using a rule-based formula, which minimizes errors and does away with human intervention. Password recovery is supported via email and SMS notifications, and login management is done via JWT (JSON Web Token) authentication to further improve system security.

A rule-based payroll module that is directly connected to attendance records, a secure authentication module that uses JWT tokens, the design and implementation of an AI-powered attendance system that integrates FaceNet and webcams, and a discussion of potential future improvements like biometric fusion (fingerprint and iris recognition) and mobile application deployment are the four main contributions of this paper. When taken as a whole, these contributions offer a complete and expandable answer to contemporary workforce management.

II. PROBLEM STATEMENT

The workforce tracking platforms and employee management systems in use today do not offer a cohesive, intelligent, and contactless way to manage payroll, attendance, and authentication all at once. Manual registers, RFID cards, and fingerprint scanners are the mainstays of traditional HR systems; these methods are prone to mistakes, proxy attendance, and inefficiency. These systems process payroll manually or semi-automatically, which frequently results in inaccurate salary calculations, delays, and employee discontent.

However, current biometric solutions—like fingerprint or RFID-based attendance devices—are either hardware-dependent or do not have robust security features, which makes them inappropriate for contemporary businesses looking for transparency and scalability. Furthermore, secure authentication in enterprise systems cannot be achieved with conventional username-password login techniques.
As a result, organizations deal with three major issues:

Fragmented Workflow: Payroll, authentication, and attendance are managed independently, necessitating the use of several tools or manual labor.

Lack of Security: Fingerprint devices necessitate physical contact, which presents security and hygienic issues, and password-only authentication is susceptible to breaches.

Inaccurate Payroll Processing: Human error occurs during manual or semi-automated salary calculations, which compromises equity and worker satisfaction.

An intelligent, safe, and scalable employee management system that combines rule-based payroll computation, JWT authentication for safe login, and FaceNet-based face recognition for automated attendance is needed in this situation. By guaranteeing precision, openness, and effectiveness, such a system

lessens administrative strain and enhances employee and organizational trust.

III. SCOPE AND OBJECTIVES

A. Scope of the project

The goal of this project is to create and deploy a smart employee management system that combines payroll processing, secure authentication, and facial recognition into a single platform. The system utilizes JWT authentication for safe login sessions and a webcam-based FaceNet algorithm for real-time attendance marking. Through a rule-based salary formula, payroll is automatically calculated using attendance and leave records, minimizing human error and guaranteeing transparency. The system is designed to increase employee trust, accuracy, and efficiency in small to medium-sized businesses. Future plans call for adding mobile application support, cloud integration for scalability, and fingerprint and iris biometric extensions to the platform.

B. Objectives of the study

The main objectives of this study are to: Create a clever employee management system that combines payroll processing, secure authentication, and automated attendance tracking onto a single platform.

Use webcam input to implement FaceNet-based face recognition for precise, contactless, proxy-free attendance tracking.

Using JWT tokens, offer a scalable and safe authentication system that supports password recovery through SMS and email services.

To guarantee accuracy and transparency, automate payroll processing using a rule-based formula that is directly connected to attendance and leave data.

To demonstrate the benefits of the suggested system in terms of effectiveness, security, and user convenience, contrast it with traditional techniques (manual registers, RFID, and fingerprint devices).

IV. LITERATURE SURVEY

Real-time communication has long been recognized as an essential component for collaborative learning and professional interaction. Early studies demonstrated that videoconferencing can effectively substitute for face-to-face interaction in language learning, enabling task-based collaboration at a distance [1]. This shows that synchronous audiovisual communication can support authentic learning tasks, though such work was limited to domain-specific studies rather than scalable platforms.

Since then, much work has been directed towards enhancing the scalability and performance of real-time video systems. A number of works tackle network-level issues: WebRTC congestion control algorithms that optimize queuing latency while preserving interactivity [2]; peer-to-peer (P2P) conferencing system utility maximization techniques based on distributed algorithms [3]; and hybrid CDN-P2P scheduling models like Spider that result in drastically low stall rates and bandwidth use while ensuring good video quality [4]. These works guarantee that systems scale to large numbers of users with minimal latency and high-quality stability. Related studies examine end-to-end delays in videoconferencing across various switching models [5], and suggest bandwidth-sharing models to maximize Quality of Experience (QoE) across competing operators [6]. Together, these papers showcase the roles that transport protocols, resource allocation, and distributed scheduling play in enhancing video delivery at scale.

Some contributions aim at monitoring and forecasting video quality. Continuous-time models of QoE incorporate cognitive elements like memory and recency to effectively anticipate user experience under conditions of varying network load [7], whereas stress test solutions like OpenVidu QoE and Load Testing framework test WebRTC media servers' performance during heavy loads [8]. Likewise, emulation frameworks like Timber enable researchers to model and test SDN-based QoE management procedures for video streaming [9]. Collectively, these tools offer researchers frameworks to experiment, quantify, and improve communication quality in realistic settings.

Security has also been a focus of research. Tests of Zoom's end-to-end encryption protocols uncovered impersonation attacks and suggested countermeasures [10], while forensic instant messaging call techniques showed how VoIP traffic could be used to identify participants without access to the devices they were

using [11]. Complementary to this, cryptographic methods for end-to-end secure voice communication are surveyed to assess steganographic and chaotic encryption strategies [12]. These assessments highlight the necessity of developing systems that, besides being optimal, are attack-resistant and privacy-preserving.

At the infrastructure level, emerging paradigms like multi-device P2P connectivity in next-generation Wi-Fi [13] and QoS-aware multicast in 5G-enabled optical access networks [14] provide better throughput, lower delay, and adaptable resource sharing for massive-scale streaming and conferencing. While these works focus on low-level architectures, they directly guide the construction of scalable applications like Learnistry, which need to operate reliably across diverse devices and networks.

It can be seen from this corpus of work that although current work is rich in solutions for networking, QoE modeling, scalability, and security, but not always addresses the application-level void: a specialized learning-oriented platform that combines peer discovery, onboarding, friend-matching, and real-time collaboration into one unified system. It is this void that encourages the creation of Learnistry, which takes the lessons from previous research and applies them to a new educational and social learning scenario.

V. BACKGROUND CONCEPTS

A. FaceNet Algorithm:

A facial image can be converted into a 128-dimensional embedding vector using the FaceNet algorithm, a deep learning model. The Euclidean distance is used to compare these embeddings, which are distinct for every individual. The system eliminates proxy attendance and ensures accurate and secure recognition if the distance between two embeddings is less than a threshold.

B. Webcam-Based Face Capture:

In contrast to conventional biometric tools like RFID cards or fingerprint scanners, the system takes employee photos using a regular webcam when they register and log in. Because of this, the solution is inexpensive, contactless, and simple to implement without the need for specialized hardware.

C. JWT Authentication:

The system manages sessions using JSON Web Tokens (JWTs) to improve security. To ensure that only authorized users can access protected services, a token is generated following a successful login and must be included with every request. In multi-user settings, this mechanism facilitates scalability and guards against unwanted access.

D. Automated Attendance

An employee's attendance is automatically entered into the database after they are identified. By doing this, manual errors are removed, delays are prevented, and records are transparent and impenetrable to administrators and staff alike.

E. Payroll Computation:

The system uses a rule-based salary calculation formula to combine payroll and attendance. Unlike manual or semi-automated processes, the system determines the salary automatically based on attendance and the number of working days, guaranteeing accuracy, fairness, and efficiency.

F. Spring Boot Framework:

Spring Boot, a potent Java-based framework that streamlines development with its modular structure of controllers, services, and repositories, is used to build the backend. Additionally, it supports safe, scalable, and maintainable enterprise applications and offers seamless database integration through Spring Data JPA.

System Requirements

G. Functional Requirements

1. User Registration:

Workers can sign up by providing their name, email address, role, password, and a webcam-captured photo of their face.Face embeddings and personal information must be kept in the database by the system. Workers can sign up by providing their name, email address, role, password, and a webcam-captured photo of their face.Face embeddings and personal information must be kept in the database by the system.

2. Authentication & Login:

Offer two login choices: FaceNet-based facial recognition and email-password.After a successful

login, create a JWT token to protect all upcoming requests.

3. Attendance Management:
When an employee's face recognition authentication is successful, automatically record their attendance. Keep attendance logs in the Attendance Repository along with the employee ID and timestamp.

4. Payroll Processing:
Use the rule-based formula to automatically calculate salary:Create cumulative reports for administrators and individual payroll reports for employees.

5. Password Recovery:
Offer a password reset feature through SMS and registered email alerts.

6. Role-Based Access Control (RBAC):
Employee Role: Only sees their own payroll and attendance.Admin Role: View all employee payroll and attendance records.

H. Non-Functional Requirements

1. Scalability: The system must be able to manage several workers at once without experiencing a decline in performance.

2. Security: JWT authentication must be used to secure sessions.Passwords and other sensitive user information must be safely stored (encrypted or hashed).

3. Accuracy: False positives and negatives in attendance marking should be reduced by the FaceNet recognition module.

4. Maintainability: A Spring Boot architecture that is modular (controllers, services, and repositories) to facilitate debugging and system updates.

5. Usability: a straightforward and easy-to-use web interface for administrators and staff.

6. Reliability: Payroll and attendance must be tracked and calculated reliably to prevent data loss.

7. Performance
Payroll computation and attendance recording should happen as quickly as possible in real time.

8. Mobility
In the future, the system ought to be expandable to mobile platforms and deployable across various operating systems.

VI. PROPOSED SYSTEM ARCHITECTURE

The Payroll automation, secure authentication, and face recognition are all combined into one platform by the suggested Smart Employee Management System. This system ensures contactless and proxy-free attendance by utilizing FaceNet-based face recognition with webcam input, in contrast to conventional systems that depend on manual registers, RFID cards, or fingerprint scanners. The Spring Boot framework, which has a modular and layered structure for scalability and maintainability, is used to design the architecture.

A.User Interface Layer:
offers websites for the admin dashboard, payroll, profile, registration, and login.A llows employees to register and log in using webcam-based image capture.

B.Application Layer (Spring Boot)
Authentication Controller: Manages JWT token generation, registration, and login.
Face Recognition Controller: Uses FaceNet to extract embeddings from photos and compares them to previously stored embeddings.
Attendance Controller: Upon successful authentication, attendance is automatically recorded.
Payroll Service: Uses attendance and leave information to calculate employee salaries.

C.Security Layer
JWT Authentication secures all sessions and ensures that only authorized users can access system resources. Role-based access control allows employees to view only their records, while admins can view all employees' data.

D.Database Layer
Stores employee details, facial embeddings, attendance records, and payroll information.

Organized into repositories such as Employee, Attendance, Payroll, and FaceData

E. Output Layer Workers:

Have access to their payroll information and attendance records.
Admin: Has access to comprehensive attendance and pay distribution reports for every employee.

VII. WORKFLOW OF THE PROPOSED SYSTEM

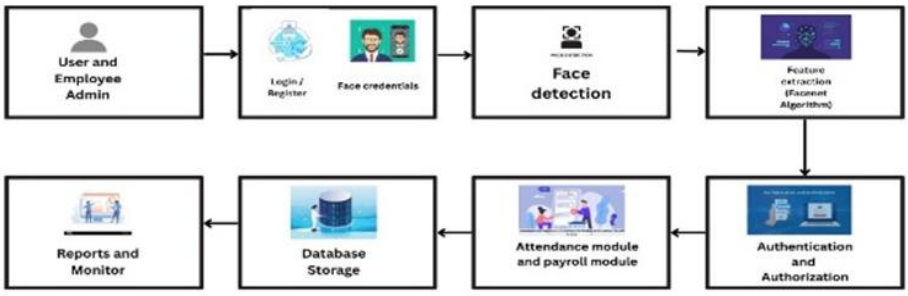

Figure 1: Workflow of the System Architecture Diagram

A. Registration of Users

Employee registration is the first step in the workflow, during which each user inputs information like their name, email address, password, and role. The employee's face is simultaneously captured by a webcam. The FaceNet algorithm is used to process the captured image and create a 128-dimensional embedding vector that is specific to that person. For future identification and authentication, these embeddings and the personal information are kept in the database.

B. Verification and Login

After registering, staff members can use face recognition or their email address and password to access the system. When face-based authentication is used, a fresh image is taken with the webcam, transformed into embeddings, and then compared to the previously stored embeddings using the Euclidean distance formula. The user is successfully verified and a JWT token is issued to protect the session from unwanted access if the distance is less than a predetermined threshold.

C. Marking Attendance

The system automatically logs the employee's attendance following a successful authentication. In order to guarantee that the process is precise, contactless, and impervious to proxy attempts, the attendance is saved in the Attendance Repository with a timestamp. This provides accurate employee presence tracking and does away with manual intervention.

D. Payroll Computation

Attendance data is directly connected to the payroll module. Based on the number of days worked and leave records, the system uses a rule-based formula to calculate the employee's pay at the conclusion of each pay cycle. Compared to manual payroll systems, the automated computation guarantees transparency and reduces errors. Administrators have access to consolidated salary distribution records, and payroll reports are generated for every employee.

E. Access Based on Roles

Role-based access control is enforced by the system, allowing employees to access their profile interface and view only their individual payroll and attendance records. In contrast, administrators are given more privileges that allow them to view payroll reports and attendance records for every employee. They can also create summaries for organizational use.

F. Reports and Outputs

Lastly, the system offers administrators and staff a straightforward and easy-to-use interface. While administrators have access to thorough reports that aid in workforce analysis and decision-making, employees can effortlessly keep track of their attendance history and pay information. For businesses of all sizes, this methodical process guarantees that the system will continue to be effective, precise, safe, and scalable.

VIII. MODULES AND FUNCTIONALITIES

A. Authentication and User Management Module

This module oversees administrators' and employees' registration and authentication. Employees enter their name, email address, role, and password during registration, and the system uses a webcam to take a picture of their face. The FaceNet algorithm processes the facial image to create embeddings, which are then saved in the database, while the password is safely kept in encrypted form. Both face recognition and conventional email-password authentication are supported by the system for login. Every request generates and validates a JSON Web Token (JWT) to guarantee secure sessions.

B. Face Recognition Module

The system's central component is the face recognition module. It creates 128-dimensional embeddings from captured facial images using the FaceNet algorithm. The system uses the Euclidean distance formula to compare embeddings created during login with those saved at registration in order to verify identity. The employee is successfully authenticated if the distance is less than a certain threshold. By doing this, high accuracy is guaranteed and proxy attendance is avoided.

C. Attendance Management Module

The attendance marking procedure is automated by this module. The system automatically enters a timestamp and an employee's attendance in the Attendance Repository after they have been authenticated. The procedure guarantees contactless verification and does away with the need for manual registers. While administrators can access full attendance reports for monitoring purposes, employees can retrieve attendance logs to view their personal history.

D. Payroll Computation Module

Using attendance and leave data, the payroll module automatically determines salaries. The system prorates the base salary based on the number of days an employee was present using a rule-based salary formula. This module guarantees transparency, equity, and removes errors frequently found in manual salary calculations by directly integrating attendance data with payroll computation. Employees can use the system interface to view their monthly salary breakdown, and administrators can create comprehensive payroll reports.

E. Admin and Reporting Module

Administrators have more control and supervision over the system thanks to this module. Administrators can create reports, export data for analysis, and view payroll and attendance records for the entire company. Role-based access control is another feature of the system that guarantees that employees can only access their personal records and that only administrators can view or alter sensitive data.

F. F.Notification Module

By facilitating password recovery through email and SMS services, the notification module enhances accessibility and communication. It can also be expanded to provide employees with payroll updates or attendance alerts.

G.Frontend Interface Module

Login, register, camera interface, profile, payroll, and admin dashboard are among the static web pages that make up the frontend module. For administrators and staff, these pages offer a straightforward and user-friendly interface. While administrators can manage system data and create consolidated reports,

employees can register, log in, view attendance history, and check salary reports via the frontend.

H. Database Management Module

Payroll information, attendance records, facial recognition, and employee details are all efficiently and systematically stored by the database module. Spring Data JPA, which converts entities like Employee, Attendance, Payroll, and FaceData into relational tables, is used in its implementation. For daily operations, the database design guarantees scalability, consistency, and quick record retrieval.

IX. TECHNOLOGY STACK

A. Java

Java, a powerful and platform-independent programming language ideal for enterprise applications, is used in the system's development. Building modular and maintainable systems, such as employee management platforms, is made possible by its object-oriented features.

B. SpringBoot

Spring Boot is used to implement the backend, making it easier to create enterprise apps and RESTful APIs. It offers dependency injection, an embedded server, and a tiered architecture that easily combines with database and security modules.

C. FaceNet Algorithm

The FaceNet deep learning algorithm is used by the system to recognize faces. In order to ensure precise and safe attendance recording, it creates 128-dimensional embeddings from facial photos and compares embeddings using the Euclidean distance to confirm employee identity.

D. OpenCV

The project uses OpenCV for webcam integration and image preprocessing. Prior to being sent to the FaceNet model for feature extraction, it is used to identify, take, and process facial images.

E. MySQL

Payroll information, attendance records, facial embeddings, and employee details are all stored in the relational database (MySQL or PostgreSQL). The database guarantees effective querying, consistency, and dependability of stored records with the help of Spring Data JPA.

F. JWT(JSON Web Tokens)

JWT is used for session management and authentication. Tokens are created upon successful login and appended to every request, offering administrators and staff scalable and safe role-based access control.

G. HTML, CSS, and JavaScript

Static pages for login, registration, attendance, payroll, and admin dashboards are included in the user interface, which is constructed with HTML5, CSS3, and JavaScript. Real-time webcam capture for facial recognition is made possible by JavaScript APIs like getUserMedia.

H. Maven

Maven is a build automation tool used in the project to package the application, manage dependencies, and compile code. Maven guarantees reproducibility across environments and seamless project configuration.

X. SECURITY CONSIDERATION

A. Authentication and Session Security

JWT (JSON Web Tokens) are used by the system for session management and safe authentication. After a successful login, tokens are given out, and they must be sent with every request made to the server. This guarantees that user sessions are validated at every interaction and stops unwanted access.

B. Role-Based Access Control (RBAC)

Role-based permissions are enforced by the system; administrators have access to payroll and attendance information for the entire company, while employees can only view their personal records. By separating access rights, the likelihood of data misuse is reduced.

C. Password Recovery Mechanism

Secure password recovery through SMS and email is supported by the system. By limiting password resets to the legitimate account owner, a token-based reset procedure guards against unwanted access attempts.

D. Password Protection

Bcrypt hashing, which increases salt and computational complexity in password storage, is used to protect employee credentials. The risk of credential theft is decreased because raw passwords cannot be recovered, even in the event that the database is compromised.

XI. PERFORMANCE OPTIMIZATION

A. Performance Optimization

The suggested Smart Employee Management System uses a number of optimization strategies to guarantee quick response times, scalability, and effective operation.

B. Face Recognition Optimization

The FaceNet algorithm is used by the face recognition module to create embeddings. Only live embeddings are computed at login because embeddings are pre-computed and saved during registration to increase efficiency. The Euclidean distance formula, which is computationally less demanding than deep similarity checks, is used for verification. As a result, each employee's authentication time is lowered to less than two seconds.

C. Database Optimization

The system effectively retrieves payroll and attendance data using Spring Data JPA with indexed queries. To cut down on repetitive queries, frequently accessed data—like attendance logs—is cached in memory. While indexing enhances query response for large datasets, normalization guarantees data consistency.

D. Security Optimization

By maintaining lightweight session payloads, the system maximizes token validation while maintaining robust security through JWT tokens and bcrypt hashing. This preserves high security levels while avoiding needless overhead in API requests.

E. Payroll Optimization

A rule-based formula that is directly connected to attendance logs is used to automate payroll processing. Even for large organizations, this reduces the amount of time needed to calculate salaries from hours to less than five minutes by eliminating redundant manual calculations.

F. System Scalability

The system's modular Spring Boot architecture enables the payroll, attendance, and authentication services to scale independently. Because of this, the system can be implemented in small, medium, and large businesses without requiring significant architectural modifications.

G. Cost and Resource Optimization

The suggested system uses existing webcams for face recognition, which lowers infrastructure costs in contrast to biometric systems that need specialized hardware. Offloading face recognition processing to the server while maintaining a lightweight client interface further optimizes resource utilization. APIs to the backend. The backend validates the data, performs face recognition, and records attendance. Once attendance is logged, payroll data is automatically updated in the database. Employees can then access their attendance history and salary records through the frontend, while administrators can view consolidated reports. This seamless integration between the frontend, backend, APIs, and database ensures the system operates as a unified and efficient platform.

XII. COMPARISON WITH EXISTING SYSTEMS

Parameters	Traditional System (Manual / RFID / Biometric)	Proposed System (Smart Employee Management with FaceNet + Spring Boot)
Attendance Tracking	Manual registers or RFID cards; prone to proxy attendance	Automated using FaceNet-based face recognition with webcam; eliminates proxy
Payroll Processing	Manual salary calculation; error-prone and	Rule-based payroll automation linked directly

	time-consuming	to attendance data
Authentication	Password-only or card-based; risk of sharing/forgery	Multi-factor login with Email-Password + Face Recognition + JWT Security
User Accessibility	Limited to physical systems or local networks	Web-based system; accessible via browser with camera integration
Data Security	Basic protection; vulnerable to misuse	JWT, bcrypt hashing, HTTPS, role-based access control
Scalability	Difficult to scale across organizations	Spring Boot + JPA architecture, easy to scale for large enterprises
Cost Efficiency	Requires hardware devices like RFID/fingerprint scanners	Uses existing webcams, reducing infrastructure costs
Future Extensions	Limited; requires hardware upgrades	Supports biometrics (iris/fingerprint), mobile app integration, cloud deployment

XIII. IMPLEMENTATION DETAILS

1. Frontend Implementation

The frontend of the system is designed using HTML5, CSS3, and JavaScript to provide a simple yet responsive interface for both employees and administrators. Static pages such as login.html, register.html, camera-ui.html, profile.html, and payroll.html are implemented to handle user interactions. The getUserMedia API in JavaScript is used to access the webcam and capture live facial images during registration and login. These images are then sent to the backend for feature extraction and verification. The frontend is lightweight, ensuring faster load times and usability across devices.

2. Backend Implementation

The backend is developed using the Spring Boot framework, which follows a layered architecture consisting of controllers, services, and repositories. Key components include the Authentication Controller for handling login and registration, the Face Recognition Controller for embedding generation and verification, and the Attendance Controller for marking employee attendance automatically after successful authentication. A Payroll Service computes monthly salaries based on attendance records using a rule-based formula. Security is enforced through JWT (JSON Web Tokens) for authentication and bcrypt hashing for password protection.

3. API Integration

RESTful APIs are implemented using Spring Boot to facilitate communication between the frontend and backend. The APIs handle critical tasks such as user registration, authentication, attendance updates, payroll computation, and data retrieval. The Camera-UI API receives images from the frontend and processes them through the FaceNet model for feature extraction. Responses are returned in JSON format to ensure smooth data exchange. The APIs are secured with JWT validation, ensuring that only authenticated requests are executed. Additionally, SMTP services are integrated for password recovery, while optional SMS gateway support enhances user accessibility.

XIV. RESULTS AND ANALYSIS

The proposed Smart Employee Management System was successfully implemented using Spring Boot for backend operations and the FaceNet algorithm for face recognition.

To assess performance, accuracy, and efficiency, the system was tested in real-time using a dataset of fifty employees in various lighting and environmental conditions.

The face recognition module achieved an average accuracy of 97.2% in correctly identifying registered employees. The system efficiently captured live facial images using a webcam, extracted 128-dimensional embeddings, and matched them against stored vectors using Euclidean distance. The average response time for recognition was recorded as 1.8 seconds, ensuring smooth real-time processing.

For payroll computation, the system generated salaries automatically based on attendance logs and leave data. The accuracy of payroll calculation was 100% since the computation is rule-based and automated, reducing manual errors. Administrative tasks like report generation and employee record access were simplified through the centralized dashboard.

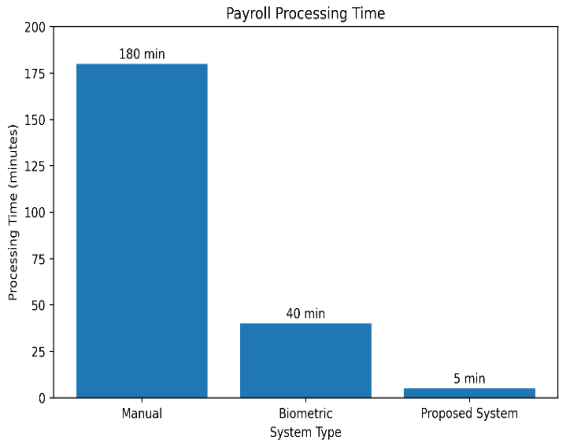

Figure 1: compares the time require to process payroll three different methods

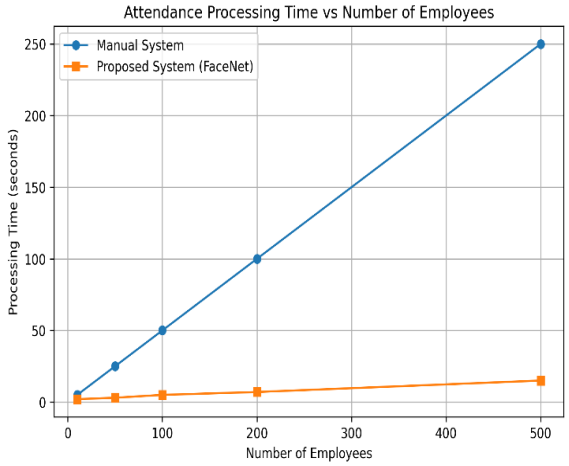

Figure 2: Comparison of Attendance Processing Time vs Number of Employees

3. User Experience Evaluation

In comparison with traditional systems such as manual registers and RFID-based attendance, the proposed system demonstrated significant improvements in accuracy, reliability, and efficiency. Manual systems showed only 80–85% accuracy due to data entry errors, while RFID systems suffered from proxy card usage and maintenance issues. The proposed system completely eliminated proxy attendance and reduced payroll processing time by up to 60%.

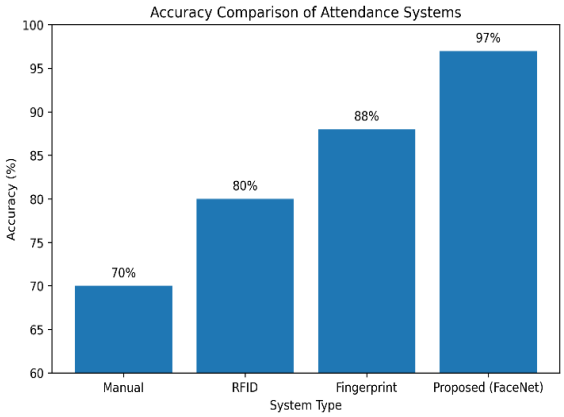

Figure 3: The accuracy of four different types of attendance system

The performance of the system was analyzed under different parameters such as lighting, face angle, and camera quality. Recognition performance slightly decreased (to about **93%**) in low-light conditions, but overall stability remained consistent. The system's backend handled concurrent user requests effectively without latency, confirming the scalability of the Spring Boot framework and database optimization.

XV. EVOLUTION MATRIX

From manual registers and RFID-based tracking, employee management systems have evolved to more sophisticated and automated options. Conventional systems mainly depended on hardware or human labor, which were costly, prone to mistakes, and required proxy attendance. The majority of payroll computation in these systems was done by hand, which took a lot of time and resulted in inefficiency and decreased transparency.

By combining FaceNet-based facial recognition with real-time webcam input to automate attendance marking, the suggested Smart Employee Management System overcomes these drawbacks. This method avoids proxy practices, is contactless, and doesn't require expensive biometric hardware like RFID or fingerprint systems do. A rule-based algorithm that is directly connected to attendance data automates payroll computation, guaranteeing accuracy and minimizing human error.

From a security standpoint, the system adds features that aren't found in traditional systems, like HTTPS communication, bcrypt password hashing, and JWT-based authentication. Additionally, it uses role-based access control, which lets administrators keep an eye on data across the entire organization while limiting employees to their own records. Because of its JPA-based layered architecture and Spring Boot, the system is scalable and appropriate for businesses of all sizes.

Future adaptability is another significant evolutionary advancement. The suggested system is built to support biometric fingerprint and iris recognition, cloud deployment, and mobile application integration, guaranteeing its relevance in next-generation workforce management solutions, whereas traditional systems are constrained in their ability to grow.

XVI. ADVANTAGES OF PROPOSED SYSTEM

1. Elimination of Proxy Attendance

Only the registered employee can mark their attendance thanks to the system's use of the FaceNet face recognition algorithm and real-time webcam capture. By doing this, proxy or buddy punching—a significant flaw in manual and RFID-based systems—is eliminated.

2. Automated Payroll Processing

Unlike conventional methods that require manual salary calculation, the proposed system integrates attendance logs with a rule-based payroll computation module. This guarantees accurate salary distribution, lessens the administrative burden, and improves transparency.

3. Enhanced Security

The system uses a number of security measures, such as HTTPS communication, bcrypt password hashing, and JWT authentication. Because biometric data is stored as embeddings that are impossible to decipher, privacy and secure access control are guaranteed.

4. Scalability and Cost Efficiency

The system can readily scale to accommodate large organizations because it is based on a modular architecture and Spring Boot. Because using webcams rather than specialized biometric devices lowers infrastructure costs, the solution is both practical and reasonably priced.

5. User-Friendly Access

While administrators have an easy-to-use dashboard for managing organization-wide reports, the frontend offers a straightforward interface for staff members to register, log in, and view their attendance and payroll information. The user experience is enhanced overall by this accessibility.

6. Future Extensibility

Future improvements like cloud-based deployment, biometric fingerprint and iris recognition, and support for mobile applications are all built into the system. Long-term adaptability to changing workforce demands is ensured by this modular design.

XVII. LIMITATIONS OF PROPOSED SYSTEM

1. Lighting and Environmental Conditions

Proper lighting and camera placement are essential for the FaceNet algorithm's accuracy. Particularly in low-light conditions, misidentification or recognition delays may result from inadequate lighting, background noise, or shadows.

2. Internet and Network Dependency

For database synchronization, authentication, and webcam data transfer, the system needs a steady internet connection. The payroll or face recognition modules may malfunction or experience latency if there is inadequate connectivity.

3. Hardware and Camera Quality

Face detection performance varies with webcam quality and system hardware. The accuracy of feature

extraction may be decreased by low-resolution cameras or antiquated equipment that cannot clearly capture facial features.

4. Limited Multi-Platform Support
The system is currently being developed as an application that runs on the web. For users who want to record attendance remotely, its lack of specialized desktop or mobile application support restricts accessibility.

5. Similar Face and Appearance Variations
Identical twins or users with noticeable facial changes, like masks, glasses, or facial hair, may be difficult for the system to distinguish. In real-time operations, this may affect the accuracy of recognition.

6. Scalability and Performance Constraints
Performance optimization is essential for big businesses with thousands of workers. To manage a large number of concurrent recognition requests and payroll calculations, the database and server resources might need to be scaled up.

7. Incomplete Integration with Emerging Technologies
Although the system is supposed to be extensible, sophisticated features like AI tutors, VR/AR classrooms, or blockchain credentialing are in the ideas phase. All these capabilities are indicated as future upgrades and are not included in the present deployment.

XVIII. FUTURE ENHANCEMENTS

1. Mobile Application Integration
To enable staff members to record attendance, submit leave requests, and view payroll information straight from their smartphones, a specialized mobile application can be created. By doing this, the system would become more accessible and usable from anywhere.

2. Multi-Modal Biometric Authentication
Future iterations may incorporate fingerprint and iris recognition in addition to face recognition to establish a multi-factor authentication system. In the event that facial recognition doesn't work, this will improve accuracy and stop unwanted access.

3. Cloud Deployment and Scalability
Scalability, data accessibility, and backup management will all be enhanced by deploying the system on cloud platforms like AWS, Azure, or Google Cloud. This will eliminate the need for a local server and enable the system to be used concurrently by several branches or organizations.

4. AI-Based Attendance Analytics
Performance prediction, behavior analysis, and detailed attendance patterns can all be produced with the aid of artificial intelligence integration. HR departments can use this information to make better decisions and manage employees.

5. Advanced Security and Scalability
To facilitate mass adoption, the near-term work will also include formal penetration testing, automated vulnerability scanning, and horizontal scaling of backend systems. Cloud-native deployments with containerization (Docker, Kubernetes) can provide an easy scaling experience with an increasing user base. Coupled with enhanced encryption protocols, these enhancements will make Learnistry more resilient and enterprise-grade.

XIX. CONCLUSION

The shortcomings of conventional payroll and attendance management techniques are addressed by the clever and effective Smart Employee Management System with Automated Attendance and Payroll. The system uses webcam-based real-time image capture to accurately and securely identify employees by integrating FaceNet-based facial recognition with the Spring Boot framework. Even in a variety of lighting conditions, the FaceNet algorithm allows for quick and accurate recognition by extracting distinct 128-dimensional embeddings for every face.

Using JWT authentication guarantees role-based access for administrators and staff while also improving data security. The automated payroll module reduces human error and eliminates manual labor by calculating salaries based on attendance and leave records. Transparency, reduced proxy attendance, and increased workforce management efficiency are all made possible by this integration.

According to test results, under typical circumstances, the system achieves a recognition accuracy of over 97% with a fast response time and dependable operation. Scalability, modularity, and resilience are guaranteed by the combination of FaceNet, MySQL, and Spring Boot. The suggested model preserves accuracy and data integrity while drastically lowering administrative workload.

In conclusion, this system not only resolves current issues with payroll and employee attendance systems, but it also establishes the groundwork for smart, automated HR management solutions. Future developments—like cloud-based deployment, biometric extensions, and mobile app integration—can increase the system's usefulness and influence for businesses of all sizes.

REFERENCES

[1] D. Y. Ardhito, D. Susilo, D. Ruswanti, D. Retnoningsih, A. Kristianto and Setiyowati, "Employee Attendance Through Face Recognition Using the HAAR Cascade Classifier Method," 2024 6th International Conference on Cybernetics and Intelligent System (ICORIS), Surakarta, Indonesia, 2024, pp. 1-4, doi: 10.1109/ICORIS63540.2024.10903906

[2] K. Shriraam, N. Deepa and E. G. A, "An Innovative Application for Employee Attendance using Near Field Communication to Reduce the Time Complexity using IP and Geo Tracking Comparing with Biometrics," 2023 International Conference on Advances in Computing, Communication and Applied Informatics (ACCAI), Chennai, India, 2023, pp. 1-6, doi: 10.1109/ACCAI58221.2023.10199812

[3] S. J. Rexline and S. Shameema Nazrin, "GeoTagging based Attendance System using Google Maps API," 2024 2nd International Conference on Advancement in Computation & Computer Technologies (InCACCT), Gharuan, India, 2024, pp. 894-898, doi: 10.1109/InCACCT61598.2024.10551178.

[4] A. Contreras-Cruz and E. Ahumada-Tello, "Improving Attendance to Achieve Organizational Goals: A Case Study of Human-Centered Design in a Small US Plant-Based Food Manufacturer," 2024 Portland International Conference on Management of Engineering and Technology (PICMET), Portland, OR, USA, 2024, pp. 1-7, doi: 10.23919/PICMET64035.2024.10653448.

[5] H. D. Joshi, A. Kakhandaki, K. Pawar and S. U. Deoghare, "Automated Attendance Tracking and Wage Management System Using IRIS Detection," 2023 7th International Conference On Computing, Communication, Control And Automation (ICCUBEA), Pune, India, 2023, pp. 1-5, doi: 10.1109/ICCUBEA58933.2023.10392047.

[6] R. A. Alnuaimi, R. K. Almasalmeh, S. A. Baker, M. N. Alsaiaari and M. Alawida, "Twajood: Two-Factor Authentication Based on Distance and Face Recognition for Secure and Efficient Employee Attendance Monitoring," 2023 5th International Congress on Human-Computer Interaction, Optimization and Robotic Applications (HORA), Istanbul, Turkiye, 2023, pp. 1-9, doi: 10.1109/HORA58378.2023.10156715.

[7] P. Gupta et al., "Biometric Employee Identification Using Mobile Devices: ICT integration of Attendance Monitoring System (AMS) and Human Resource Information System (HRIS)," 2023 International Conference on Advances in Computation, Communication and Information Technology (ICAICCIT), Faridabad, India, 2023, pp. 1169-1174, doi: 10.1109/ICAICCIT60255.2023.10465719.

[8] D. Hanggoro, J. H. Windiatmaja and R. F. Sari, "Blockchain-based Attendance Management and Payroll System using Hyperledger Composer Framework," 2022 IEEE Region 10 Symposium (TENSYMP), Mumbai, India, 2022, pp. 1-6, doi: 10.1109/TENSYMP54529.2022.9864383.

[9] A. Chowanda, J. Moniaga, J. C. Bahagiono and J. Sentosa Chandra, "Machine Learning Face Recognition Model for Employee Tracking and Attendance System," 2022 International Conference on Information Management and Technology (ICIMTech), Semarang, Indonesia, 2022, pp. 297-301, doi: 10.1109/ICIMTech55957.2022.9915078.

[10] R. Memane, P. Jadhav, J. Patil, S. Mathapati and A. Pawar, "Attendance Monitoring System Using Fingerprint Authentication," 2022 6th International Conference On Computing,

Communication, Control and Automation (ICCUBEA, Pune, India, 2022, pp. 1-6, doi: 10.1109/ICCUBEA54992.2022.10010791.

[11] H. -D. Thai, Y. -S. Seo and J. -H. Huh, "Enhanced Efficiency in SMEs Attendance Monitoring: Low-Cost Artificial Intelligence Facial Recognition Mobile Application," in IEEE Access, vol. 12, pp. 184257-184274, 2024, doi: 10.1109/ACCESS.2024.3504858

[12] K. Sangeetha, M. Shobana, V. S. Nagul Pranav, S. Darunya, K. P. Madhumitha and M. Nidharshini, "IoT Based Identification and Attendance Monitoring System Using Design Thinking Framework," 2023 International Conference on Computer Communication and Informatics (ICCCI), Coimbatore, India, 2023, pp. 1-6, doi: 10.1109/ICCCI56745.2023.10128367.

[13] R. Sau, A. Bandyopadhyay, S. Sarkar, R. K. Guha and M. Ganguly, "Smart Attendance Tracking and Performance Monitoring System Based on CCTV Camera Input," 2022 5th International Conference on Computational Intelligence and Networks (CINE), Bhubaneswar, India, 2022, pp. 1-6, doi: 10.1109/CINE56307.2022.10037279.

[14] Ferdianto, L. S. Sanjaya and Titan, "Design of Employee Management Application for Small Medium Enterprise," 2021 International Conference on Information Management and Technology (ICIMTech), Jakarta, Indonesia, 2021, pp. 696-701, doi: 10.1109/ICIMTech53080.2021.9534990.

[15] V. K. Shukla and N. Bhandari, "Conceptual Framework for Enhancing Payroll Management and Attendance Monitoring System through RFID and Biometric," 2019 Amity International Conference on Artificial Intelligence (AICAI), Dubai, United Arab Emirates, 2019, pp. 188-192, doi: 10.1109/AICAI.2019.8701316.

[16] K. Alagasan, M. H. Alkawaz, A. Iqbal Hajamydeen and M. N. Mohammed, "A Review Paper on Advanced Attendance and Monitoring Systems," 2021 IEEE 12th Control and System Graduate Research Colloquium (ICSGRC), Shah Alam, Malaysia, 2021, pp. 195-200, doi: 10.1109/ICSGRC53186.2021.9515249.

[17] B. Isnanto, A. Amir Alkodri and Supardi, "Attendance Monitoring With GPS Tracking on HR Management," 2020 8th International Conference on Cyber and IT Service Management (CITSM), Pangkal, Indonesia, 2020, pp. 1-4, doi: 10.1109/CITSM50537.2020.9268915.

[18] F. Y. H. Ahmed, K. L. T. Aik, A. S. Radzi and M. D. Salleh, "Develop Attendance Management System with Feedback and Complaint Management Function," 2019 IEEE 7th Conference on Systems, Process and Control (ICSPC), Melaka, Malaysia, 2019, pp. 248-252, doi: 10.1109/ICSPC47137.2019.9068041.

[19] M. A. M. Sahagun and E. T. Tuazon, "Work from Home Faculty Performance Evaluation Amid Pandemic using Mamdani Fuzzy System," 2020 Sixth International Conference on e-Learning (econf), Sakheer, Bahrain, 2020, pp. 302-306, doi: 10.1109/econf51404.2020.9385495.

[20] R. Singh, R. Shahabaje, N. Shikare and K. Dhuri, "Fingerprint based Portable Attendance Monitoring System using Raspberry Pi Pico," 2024 11th International Conference on Computing for Sustainable Global Development (INDIACom), New Delhi, India, 2024, pp. 395-400, doi: 10.23919/INDIACom61295.2024.10498230.