Employee Management System with AI-based Attendance
(Project Report)

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1 Introduction

This project is an Employee Management System that uses AI to automatically mark attendance through facial recognition. Tracking employee attendance is an essential task for any organization, as it ensures operations run smoothly and prevents fraud. Traditional methods, like signing attendance sheets or using punch cards, are time-consuming and prone to errors. Even modern systems, such as fingerprint scanners, have issues like hygiene concerns and the risk of buddy punching, where someone marks attendance for another person.

To solve these problems, this system uses advanced face recognition technology to identify employees and mark their attendance quickly and accurately. It reduces errors, saves time, and eliminates the chances of fraud. In addition to attendance tracking, the system also manages other tasks such as handling employee profiles, salaries, and promotions, making it a complete solution for employee management.

This report explains how the system works, the challenges it addresses, and its benefits for organizations. By replacing outdated methods with this AI-based solution, businesses can simplify attendance tracking and improve overall efficiency.

2 Problem Statement

In the past, attendance was recorded manually using registers or punch cards. This method was time-consuming and prone to errors. Later, fingerprint scanners were introduced, but they also have risks, such as the possibility of fraud if someone else uses another person's fingerprint. Therefore, it is essential to have a system that can automatically mark attendance without effort and eliminate any chance of fraud.

3 Solution

The solution is an advanced Employee Management System that leverages facial recognition technology to automate attendance. It eliminates traditional challenges like errors, fraud, and hygiene concerns, ensuring seamless and secure attendance marking. Additionally, the system manages other HR-related processes such as salary calculations, promotions, and employee profiles, providing an all-in-one tool for organizational management. With its AI-driven approach, this system enhances accuracy, saves time, and increases transparency across the organization.

4 Literature Review

The manual attendance system has several significant drawbacks. It is unreliable because it depends on human input leading to inaccuracies and errors in recording employee attendance. The system is inefficient, requiring considerable time and effort to manage, and lacks real-time monitoring capabilities, which delays the identification of absent employees. Additionally, it is vulnerable to fraud and manipulation compromising attendance records' accuracy. The manual system complicates

audits, making it difficult to maintain transparent, accessible records for verification, and results in unrecoverable losses due to employees' failure to properly maintain registers. Furthermore, the administrative burden placed on HR and management detracts from more critical tasks, ultimately affecting overall efficiency and service delivery[1].

5 Project Scope

This project aims to develop a comprehensive Employee Management System that automates attendance tracking using AI-based facial recognition technology. The system will also encompass functionalities like employee registration, salary and promotion management, and profile handling. Designed to meet the needs of organizations of all sizes, the system ensures secure and efficient data handling while supporting scalability as the organization grows. By integrating AI into traditional management practices, the system provides a holistic solution to optimize administrative tasks.

6 Objectives

The primary objectives of this project are as follows:

- To develop an efficient and user-friendly Employee Management System that simplifies attendance tracking and overall employee management.
- To leverage AI-based facial recognition technology for accurate and automated attendance marking, eliminating the risk of fraud and reducing manual intervention.
- To streamline HR processes such as salary calculation, promotion management, and employee profile handling, improving operational efficiency.
- To support organizational growth by providing a scalable solution capable of managing increasing numbers of employees securely and effectively.
- To deliver a modern, all-in-one platform tailored to meet the dynamic and evolving needs of businesses.

7 Benefits

- **Save Time:** Makes tracking attendance and managing employee data quicker and easier by reducing manual work.
- **Grows with the Organization:** The system can handle more employees as the company expands and keeps data secure.
- **Clear and Transparent:** Employees can check their attendance and performance anytime by generating reports.
- **Simplifies Manager Tasks** Combines all employee management processes in one place, making it more accurate and easier to manage.

8 Project Features

8.1 Non AI functionalities

1. User e.g. Manager, Finance Manager, and Employee can successfully access the system.
2. Add, delete, update, and search employee records.
3. Manage salaries and promotion histories.
4. View and edit employee profiles.
5. Capture employee photos during the registration process.
6. Allow employees to view their salary details and profiles.

8.2 AI Functionalities

8.2.1 Facial Recognition

Real-time camera-based facial detection and recognition to identify employees.

8.2.2 Attendance Automation

Matches recognized faces with the database to mark attendance and associate it with the correct employee profile.

9 Functional Flow

9.1 Login

This feature allows employees, managers, and finance managers to securely access the system. Users enter their credentials like username and password that are provided when while manager registers the employee or finance manager but in the case of the manager, he/she has already assigned his credentials to log in. Once logged in, they can access their specific dashboard based on their role, like managing tasks or viewing personal information. This feature ensures only authorized users can access the system to keep data safe and secure.

9.2 Add Employee

This feature allows the Manager to register a new employee in the system. During the registration process, key details such as the employee's name, Phone no, email, and date of birth are also required. Moreover, the system captures the employee's photo in real time using a built-in camera, which is stored in the database for facial recognition purposes of attendance. A username and password are also assigned to that new employee for successful access the system. All the information of new employees will be stored in the database by a simple registration process, it saves time and reduces errors, making it easier for organizations to add new employees efficiently.

9.3 Delete Employee

This feature allows the Manager to remove an employee's record from the system. This is useful if an employee leaves the company or their information is no longer needed. When using this feature, all details related to the employee, including their profile and attendance records, are securely deleted from the database. It ensures that only current employee data is stored making management easier and more efficient.

9.4 Update Employee

This feature allows Manager to make changes to an employee's information. For example, if an employee's contact details change, this feature allows the manager to quickly edit their record in the system. It ensures that all employee data stays accurate and up-to-date, helping the company maintain clear and reliable records.

9.5 View Employee

This feature allows managers to see detailed information about any employee in the system. This includes their details like name, contact info, and email. With this feature, it's easy to quickly access and review employee data whenever needed helping to manage tasks more efficiently and keep everything organized.

9.6 Pay Salary

This feature makes it easy for the finance manager to manage the employee's salary. Finance managers calculate salaries based on work and attendance of employees. This feature helps to make sure that salary is paid successfully and also paid on time with fewer mistakes.

9.7 View Salary

This feature allows employees to check their salary details easily. They can see information related to their salary. This feature helps employees remain informed about their earnings and ensures salary comes successfully in every month.

9.8 Give Promotion

This feature allows managers to update an employee's position or salary when they are promoted. In this case, the designation of the employee changes along with the salary package. All the information related to designation must be updated in the database. It also keeps a clear history of promotions, helping the company track employee progress and maintain updated records.

9.9 View Promotion

This feature allows the employee to view his/her designation along with updated salary and view his/her progress from day one. It ensures that the system maintains all the records.

9.10 Mark Attendance

This feature automatically records when an employee is present by using face recognition. The system captures the employee's face through a camera, matches it with the stored data, and marks them as present. This process is quick, and accurate, and ensures there is no chance of fraud or mistakes, making attendance tracking easy for employees and managers.

9.11 View Attendance

This feature allows employees to check attendance records. Employees can see their attendance, including the days they were present, absent, or late. Managers can view attendance for all employees to track overall attendance performance. This feature makes it simple to keep track of attendance and ensures everyone has updated information.

10 Workflow for AI-Based Detection

10.1 Methadology

This project employs a facial recognition-based attendance system that uses OpenCV for image preprocessing and face recognition for face detection and recognition. The methodology integrates several key components: face data preprocessing, known face encoding storage, real-time recognition, and attendance logging. Below is the detailed workflow:

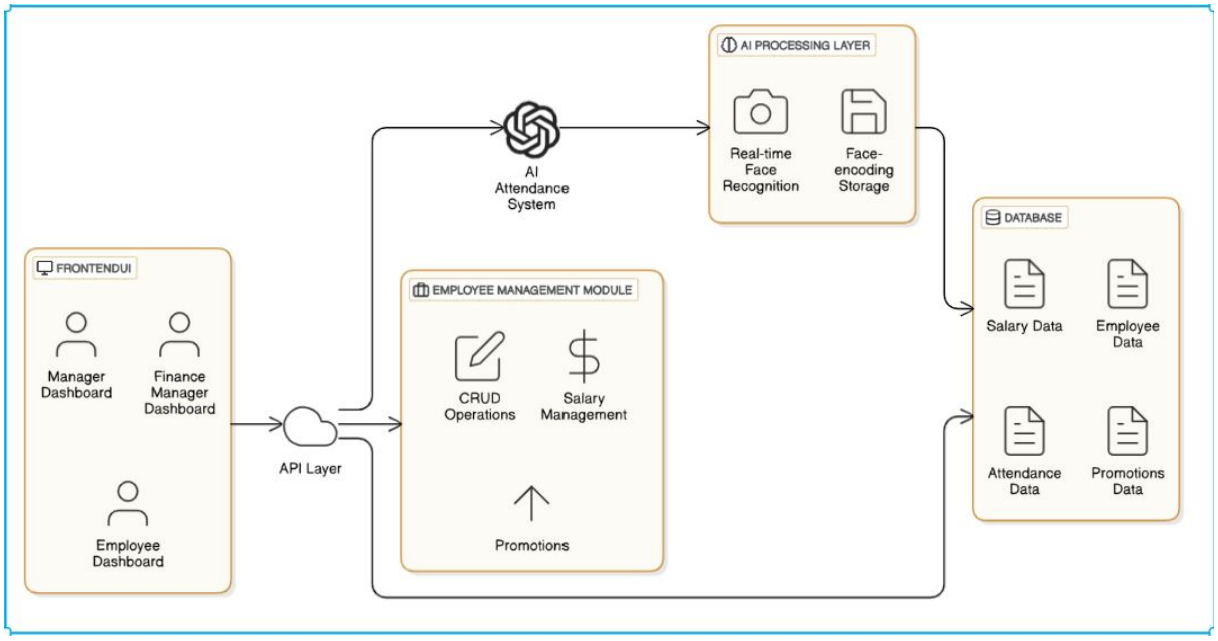

Figure 1: Architectural Diagram of Project

10.1.1 Data preparation and Encoding

The system uses pre-collected images of employees fetched from the database where employees are registered and their images are present in the database. First, it fetches all employees along their image links and stores them in the list for further encoding. Each image corresponds to an individual employee and is associated with their name. These images are loaded, converted to **RGB**, and processed using the face recognition library to generate face encodings (numerical representations of facial features).

These encodings are stored in a .pkl (Pickle) file called **known-faces-encodings.pkl**. Pickle files efficiently serialize and save Python objects (such as lists or arrays), making the system faster because it avoids re-encoding the same faces every time the program runs.
Why Use Pickle Files?

- It saves computation time: Once encodings are stored in a .pkl file, the system can directly load them instead of re-computing encodings every time.
- Ensures consistency: The saved encodings act as a reference for comparison during real-time face recognition.

10.1.2 Image Preprocessing with OpenCV

The program uses OpenCV (Open Source Computer Vision Library) for preprocessing the video feed from a webcam.OpenCV is lightweight and optimized for real-time image and video processing.Its integration with face recognition ensures smooth processing and compatibility with various camera feeds. Key steps include:

- Denoising: A Gaussian Blur is applied to reduce image noise, which helps in better face detection.
- Resizing: The image is resized to 25% of its original size for faster processing without compromising accuracy.
- RGB Conversion: OpenCV captures images in BGR format, but the face recognition library requires RGB format, so the conversion is performed.

10.1.3 Real-Time Face Detection and Recognition

The program continuously captures frames from the webcam using cv2.VideoCapture(). Each frame undergoes:
Face Detection: The ***CNN model*** in the face recognition library identifies facial regions in the frame. This is more accurate than traditional Haar cascades or ***HOG-based models***.
Face Encoding: Encodings are generated for detected faces in the frame. These encodings are compared against the pre-saved encodings from the .pkl file.
Matching and Thresholding: The system uses `face_recognition.compare_faces()` to match live face encodings with known encodings. The similarity is evaluated using a distance threshold (`FACE_DISTANCE_THRESHOLD = 0.5`). A lower threshold ensures high accuracy by rejecting

unclear matches. If a match is found, the name of the person is retrieved; otherwise, the label `"Unknown"` is assigned.

10.1.4 Attendance Logging

If a recognized face is detected, the person's name and timestamp are logged into a CSV file named after the current date (e.g., 2024-12-15.csv), also marked attendance in the database using SQL query, when the face is matched it marks the attendance of the corresponding employee in the database table named attendance with attendance status present. This database and the CSV file act as a permanent record of attendance for the day, with each entry containing the employee's name and the time they were marked present. If the face is not recognized means if the captured face is not registered then it shows "Unknown" on the screen and can not mark attendance as that employee is not registered in the database

Multithreading for Efficiency: To ensure real-time performance, the attendance logging process runs in a separate thread using Python's threading module. This prevents delays in the main loop while accessing and writing to the file.

10.1.5 Graphical Interface

- Bounding boxes are drawn around detected faces using OpenCV. Recognized faces are highlighted in green, while unrecognized ones are shown in red.
- The labels (names) and the employee ID are displayed above each detected face for user clarity.

10.1.6 Testing and Training Data

- A separate set of images (`test_photos`) is used for evaluation.
- Each individual in the test dataset can have multiple images to simulate real-world scenarios and variations.
- Each training image is loaded and processed using `face_recognition.load_image_file()`.
- Face encodings are generated using `face_recognition.face_encodings()`. These encodings are 128-dimensional numerical representations of facial features.
- These encodings, along with their corresponding names, are stored in separate lists (`known_face_encodings` and `known_face_names`) for further use.

10.1.7 Evaluation Metrics

To evaluate the performance of the model, the following metrics were used:

Accuracy: Accuracy measures the proportion of correctly predicted instances (both positive and negative) out of the total instances. It is calculated as:

$$\text{Accuracy} = \frac{\text{True Positives} + \text{True Negatives}}{\text{Total Instances}}$$

Accuracy is a general performance metric but can be misleading for imbalanced datasets.

Precision: Precision measures the proportion of true positive predictions out of all instances predicted as positive. It is calculated as:

$$\text{Precision} = \frac{\text{True Positives}}{\text{True Positives} + \text{False Positives}}$$

Precision is critical in asthma prediction to minimize false alarms in diagnosing asthma cases.

Recall: Also known as sensitivity or true positive rate, recall measures the ability of the model to correctly identify all positive instances. It is calculated as:

$$\text{Recall} = \frac{\text{True Positives}}{\text{True Positives} + \text{False Negatives}}$$

The recall is significant for asthma prediction to ensure that no high-risk patients are missed.

F1-Score: The F1-score is the harmonic mean of precision and recall, balancing the two metrics. It is beneficial for imbalanced datasets. The formula is:

$$\text{F1-Score} = 2 \cdot \frac{\text{Precision} \cdot \text{Recall}}{\text{Precision} + \text{Recall}}$$

A higher F1 score indicates better performance in identifying asthma cases while balancing false positives and false negatives.

10.2 Results

10.2.1 Confusion Matrix

- A confusion matrix is constructed using confusion_matrix() from scikit-learn.
- To show the performance of the system in correctly or incorrectly identifying individuals.
- Rows represent the true labels.
- Columns represent the predicted labels.
- Each cell contains the count of occurrences for that combination.

The Accuracies F1 score, precision and recall values of this model is given below:

Metric	Value
Accuracy	0.85
Precision	0.86
Recall	0.74
F1 Score	0.79

Table 1: Model Evaluation Metrics

The confusion matrix is displayed as a table, with rows and columns labeled with the names of individuals and "Unknown" shown in figure 2

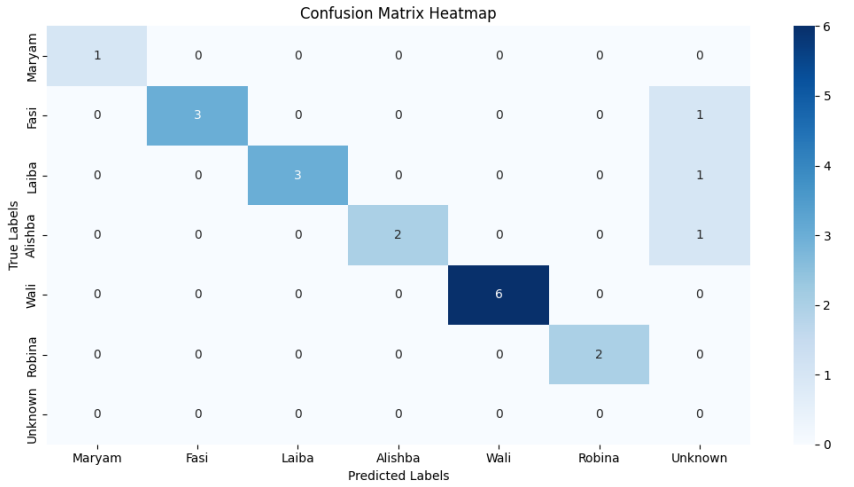

Figure 2: Confusion matrix of the dataset

Since the confusion matrix shows irregularities and the accuracies are not very high, we train our model on more images. This helps to optimize the model, improve its performance, and increase its accuracy. After training on more images our model shows this kind of accuracy:

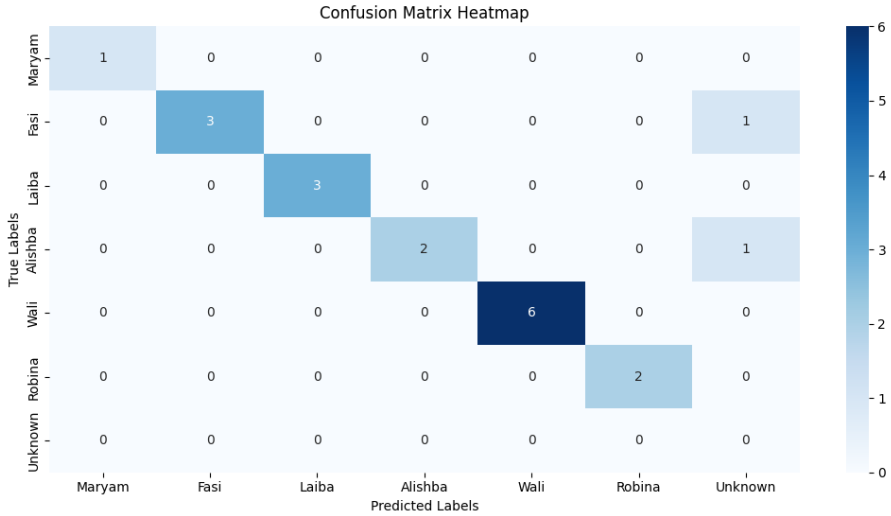

Figure 3: Confusion matrix after raising Accuracies

After training the model with a larger set of images, the system becomes better at recognizing and distinguishing between faces. The more diverse the training images, the more the model can learn

about different variations in facial features, such as different angles, lighting, or expressions. This improvement leads to higher accuracy in identifying faces, reducing errors, and ensuring the model is more reliable in real-world scenarios. As a result, the detection capability is optimized, meaning the model is now better at recognizing faces even in challenging conditions.

Metric	Value
Accuracy	0.89
Precision	0.86
Recall	0.87
F1 Score	0.81

Table 2: Model Evaluation Metrics

To summarize, by increasing the training data and optimizing the model, the system's face detection performance has improved. The higher accuracy, precision, recall, and F1 score indicate that the model is now more reliable in correctly identifying individuals. As the model continues to evolve with more data and refinement, its performance will continue to improve, ensuring better recognition results and more efficient face detection.

11 Conclusion

In conclusion, **Employee Management System with AI-based attendance system** uses AI-based facial recognition to automatically track employee attendance. By replacing traditional methods like manual registers and fingerprint scanners, the system reduces errors and prevents fraud. It also helps with other tasks like managing employee profiles, salaries, and promotions, making overall HR management more efficient.

Through testing and improvements, the system's performance in recognizing faces has significantly improved. After training with more images, the system became better at identifying employees accurately, as shown by higher accuracy, precision, recall, and F1 scores.

This AI-powered system simplifies attendance tracking and other HR tasks, making it easier to manage employee data. It's also scalable, meaning it can grow as a company expands. Overall, this system helps businesses save time, reduce errors, and improve transparency in managing employees.

The system not only solves the problems with traditional attendance methods but also offers a complete solution for employee management. As it continues to improve, it can further enhance the efficiency of business operations.

References

[1] Ulrich Oscar Cupido. *The implementation of a time and attendance system at Stellenbosch Municipality: a change management perspective*. PhD thesis, Stellenbosch: Stellenbosch University, 2011.