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Real-Time Face Detection and Recognition System

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Abstract

This paper proposes a cloud-based facial recognition system for automated attendance management in educational institutions. The system leverages Amazon Web Services (AWS) such as Lambda, DynamoDB, S3, and Amazon Rekognition to perform facial recognition and record student attendance. A Python-based GUI serves as the frontend, offering features for capturing attendance and allowing admin operations like resetting or starting new attendance sheets. Face prints are stored and matched via AWS Rekognition, and attendance records are saved on the cloud. The proposed system aims to eliminate proxy attendance and streamline the entire process, ensuring security, scalability, and real-time performance.

Introduction

This project proposes a cloud-based facial recognition system that addresses the limitations of traditional attendance methods like manual registers and fingerprint scanners [1], [12]. Using Amazon Web Services (AWS) as the backend and a Python-Tkinter GUI for the frontend, it enables contactless, real-time identity verification that is scalable, secure, and efficient. Key AWS services include Amazon Rekognition for face matching, S3 for image storage, DynamoDB for record-keeping, and Lambda for serverless computation. The system benefits institutions with large-scale attendance needs by reducing administrative overhead, improving hygiene, and ensuring high accuracy [14]. It supports two user types, regular users for marking attendance and administrators for managing records. The project focuses on modular design, ease of integration, and low maintenance, making it suitable even for organizations with limited IT capabilities. Overall, it combines AI, cloud infrastructure, and user-friendly design to offer a future-ready attendance solution [5], [7].

Background and Motivation

In educational settings, recording student attendance is an essential but often tedious administrative task. Traditional practices such as calling roll numbers or signing attendance sheets are not only time-consuming but also susceptible to manipulation, such as proxy attendance. Biometric fingerprint systems attempted to address this, but concerns about hygiene and contact during health crises like COVID-19 made them less favorable [10].

The latest developments recently in artificial intelligence have provided advancements in facial recognition technology, particularly in the field of computer vision [3], [6]. On integrating cloud computing infrastructure, it allows the implementation of solutions scalable, secure, and real-time systems for attendance management [15]. IoT-based architectures and portable

devices have also given an important contribution to connectivity and live data processing [21], [26], [27]. AWS was also shown to exhibit a different feature set allowing developers to create cost-effective and highly efficient event-driven systems. This prompted the development of a smart facial recognition system hosted on AWS to eliminate manual tracking and improve efficiency in institutions.

Problem Statement

Manual attendance methods and traditional biometric systems are limited in terms of scalability, speed, and reliability. These methods do not support real-time verification, centralized storage, or seamless integration with modern digital systems. Furthermore, during pandemics, contact-based systems pose health risks. A secure, real-time, and contactless system capable of working in a distributed cloud environment is required.

Problem Statement

The objective of this research is to develop a fully functional cloud-based facial recognition system for managing student attendance. The system aims to create a real-time facial recognition model utilizing AWS Rekognition to accurately detect and identify students. A secure backend will be designed to store face prints and attendance records safely. Additionally, a simple and efficient Python-based graphical user interface (GUI) will be developed to allow smooth interaction with the system. The system will also include features for admin access, enabling management of attendance sheets such as resetting or starting a new sheet. Finally, daily attendance records will be stored securely in AWS S3 to ensure reliable data management and access.

Significance of the Proposed System

Our proposed system promotes an automatic, scalable, and hygienic approach to attendance management with instant verification and no physical interaction needed. It would seamlessly scale to accommodate childcare institutions since it employs a cloud-native architecture. It fosters digital transformation in education, reduces faculty workload, and offers high data integrity. Other IoT-cloud-integrated systems in different domains have shown great scalability and reliability, thus adding weight to our approach's feasibility [23], [25].

Scope of Project Work

The system is designed for educational institutions but can be extended to workplaces or events. It provides basic functionalities face detection, attendance marking, GUI-based user interaction, and admin panel but can be upgraded in the future to include mobile app support, advanced reporting, or AI analytics.

Feasibility Analysis

Technically and economically, the system is feasible. It uses AWS free-tier services for development and testing. The required Python libraries and AWS SDKs are publicly available. The system performs well under basic institutional settings with reliable face detection under normal lighting conditions.

Organization of the Report

This paper is organized into five main sections. Section 1 introduces the problem and objectives. Section 2 covers the literature review. Section 3 explains the system architecture and working. Section 4 outlines the expected outcomes and Section 5 concludes the study with future scope.

Literature Review

Overview of Existing Attendance Systems

Traditional systems like registers or RFID cards are widely used but fall short in managing large class sizes or remote learning scenarios. RFID cards can be exchanged, and physical registers lack real-time validation [16]. Some systems utilize fingerprint biometrics; however, they involve contact and are often hindered by physical damage or hygiene concerns [4], [5], prompting alternatives like face recognition-based attendance systems [9].

Recent systems introduced QR code scanning and mobile app check-ins, but they rely heavily on mobile availability and stable connectivity [19]. These methods still require manual validation and are susceptible to manipulation.

Role of Cloud Computing and Facial Recognition in Smart Attendance

The elastic setting, scalability, and high availability offered by cloud computing make it an excellent solution for real-time applications. AWS, in particular, provides an infrastructure-agnostic platform for developers to build their systems. Works done previously on embedded IoT devices and nano-electronic architectures with machine learning provide additional evidence for integrating intelligent edge computing with cloud systems [21], [22]. On the other hand, facial recognition uses deep learning techniques to analyze facial features and accurately authenticate individuals. Together, the two constitute a strong combination to provide contactless, real-time, and automated solutions for attendance systems [6], [11], [12].

AWS Rekognition is a robust service that provides facial detection, comparison, and indexing. With the help of Lambda functions, these tasks can be automated on image capture events [12]. DynamoDB ensures low-latency storage and retrieval of face metadata. S3 offers highly durable object storage for archival of attendance logs.

Research Gaps

Most of the existing systems don't have real-time processing and have poor scaling. Moreover, there are some systems that do not integrate cloud automation. IoT frameworks in both the environment and industrial domains have indicated that applying similar real-time, distributed designs to facial recognition attendance could fill these gaps [26], [27]. This project solves the problem by offering a cloud-native system that can operate seamlessly in real-time environments with high accuracy and automation [14].

Area	Gaps Identified	Ref.
Real-Time Processing	Many systems do not offer instant verification and logging capabilities.	[7],[8], [9]
Cloud Integration	Systems often use standalone facial recognition without leveraging cloud platforms.	[12], [18]
User Interface (UI/UX)	Limited or no GUI for real-time monitoring, admin control, or user interaction.	[13]
Admin Controls & Automation	Lack of features like automated report generation, sheet reset, or backup.	[10]
Scalability	Non-cloud systems struggle with performance as user base grows.	[2], [19]
Cost and Customization	Many commercial solutions are expensive and not adaptable to institution-specific needs.	[17], [20]

Conclusion of Literature Review

The literature reviewed clearly indicates that while many existing attendance systems offer partial solutions, they often fall short in terms of automation, scalability, accuracy, and user experience. Biometric systems such as fingerprint recognition have improved accuracy but fail to meet hygiene standards and remote accessibility needs. Similarly, most facial recognition implementations are either limited to localized setups or lack essential features like cloud integration and real-time processing. To address these gaps, the proposed solution focuses on developing a cloud-based facial recognition attendance system. It utilizes Amazon Rekognition for accurate and fast face matching, AWS Lambda for serverless backend logic, DynamoDB for storing face metadata and attendance logs, S3 for secure archival of attendance records, and a Python GUI for user interaction and administrative control. This holistic approach ensures the development of a smart, scalable, and secure attendance system that meets the demands of modern academic and organizational environments.

System Architecture

The architecture of the Cloud-Based Facial Recognition Attendance Management System is designed to integrate seamless user interaction with robust cloud-based backend services. It is broadly divided into three components: User Interfaces, Python GUI Application, and AWS Cloud Infrastructure.

Frontend Design

The frontend of the system is a graphical user interface (GUI) developed in Python using the Tkinter library. It includes a "Start Camera" feature that launches the webcam and displays the live feed to the user. A "Capture Attendance" button is provided to take a snapshot and trigger the backend processing for facial recognition and

attendance marking. The interface also includes a status display that shows the student's name, the current time, and a success message upon successful recognition. Additionally, an attendance count feature is integrated to display the number of students marked present. The system also offers an admin panel with secure login, providing administrators with options to either clear the current attendance sheet or start a new one.

The interface ensures ease of use with minimal training required. It abstracts the backend complexity, presenting only essential controls to users and administrators.

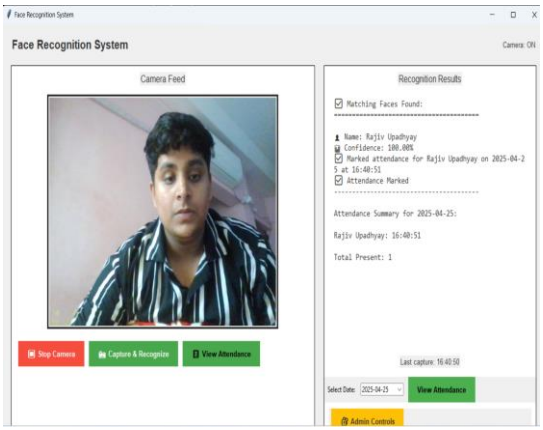

Fig 1: Python GUI layout showing buttons and camera feed

Comparison process

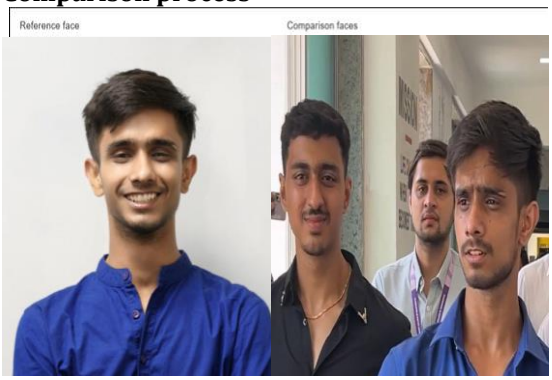

Fig 1.1: Comparison of reference and actual image

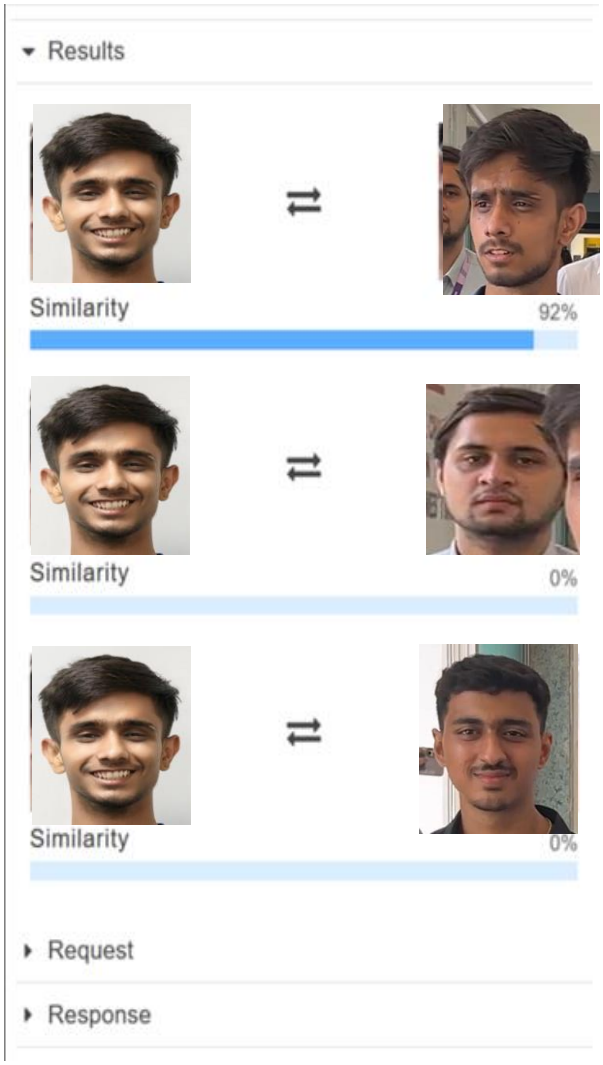

Fig 1.2: Comparison of reference and actual image

Backend Cloud Services

AWS Lambda

Executes code in response to camera image submissions. It performs backend logic for matching faces and updating records without needing server provisioning.

Amazon Rekognition

Used to compare the live-captured image with stored face data. It uses deep learning to evaluate the similarity score and confirms a match when thresholds are satisfied.

DynamoDB

Stores face encodings and attendance logs. It offers high-speed access, scalability, and is optimized for serverless applications.

Amazon S3

Stores generated Excel sheets of attendance logs. The sheets are stored with timestamps to allow historical record-keeping and data backup.

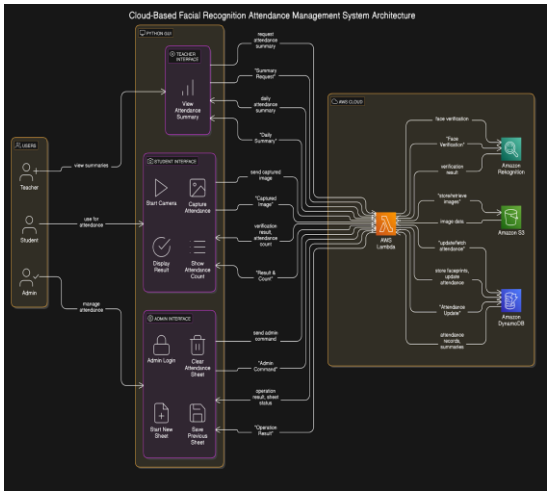

Fig -2: System Architecture Diagram

Workflow and Functional Modules

The system workflow includes:

1. **Initialization**: GUI starts and loads camera feed
2. **Face Capture**: When "Capture Attendance" is clicked, the image is saved
3. **Face Verification**: Image is sent to Lambda → Rekognition → Compared with face prints in DynamoDB
4. **Attendance Record**: If matched, attendance is recorded and confirmation displayed
5. **Sheet Management**: Admin can clear records or start new sheets; old data is moved to S3

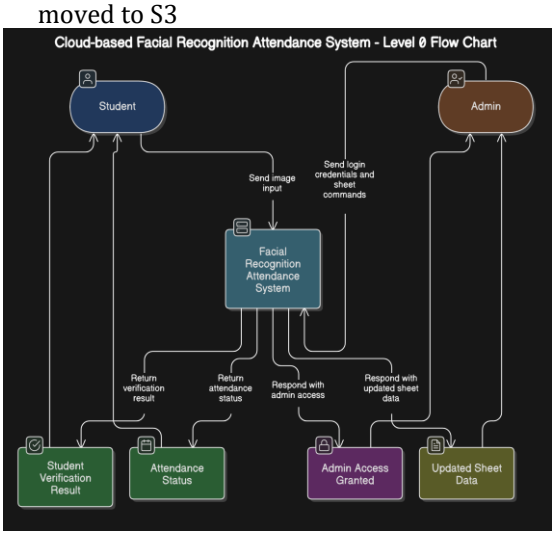

Fig -3: Workflow Diagram

System Output And Benefits

Although the system is currently at the conceptual stage, it is fully capable of performing real-time face recognition with high accuracy. It effectively eliminates the problem of proxy attendance, reduces the manual workload for instructors, and provides secure, scalable data storage through AWS services. The system also offers a seamless and user-friendly interface, ensuring a smooth experience for both students and administrators. The expected system outputs include a GUI screen displaying the student's name, time, and date upon successful recognition, the display of the number of students marked present, and the automatic storage of daily attendance sheets on AWS S3 in .xlsx format.

Expected Outputs

The system is designed to deliver live facial recognition with real-time status displays on the GUI. It supports real-time attendance marking in the cloud, generates Excel files containing student names along with the date and time of attendance, and archives these daily attendance sheets securely in Amazon S3. Additionally, after each successful recognition, the system updates and displays the attendance count to the user.

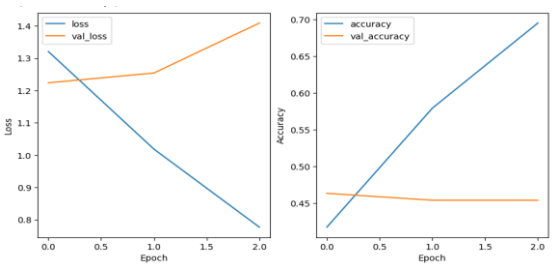

Fig -4: Accuracy/Loss Graph

Benefits

The proposed system offers several key benefits. It ensures efficiency by providing automated, fast, and reliable attendance management. Being completely contactless, it eliminates the need for any physical interaction, making it hygienic and safe. Security is enhanced through cloud-based storage supported by AWS IAM access controls. Scalability is another major advantage, as the system can handle classrooms of various sizes without experiencing latency issues. Furthermore, it guarantees data integrity by preventing proxy attendance and ensuring that all records are accurate and auditable.

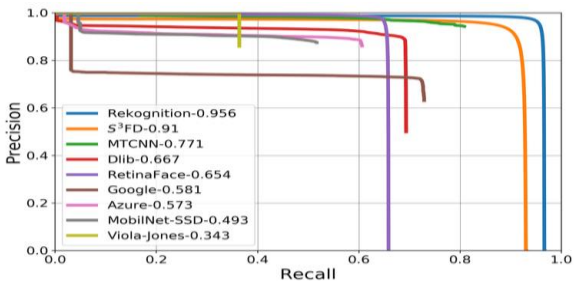

Fig -5: Model comparison graph

Conclusion

The paper purportedly presents in detail, a new software development project that enhances modern attendance systems with facial recognition through a cloud platform. Future works can also draw on advancements in IoT-driven monitoring and data security in multimedia systems and biomedical sensing applications [23], [24], and [25]. Since AWS services are leveraged, scalability and reliability are assured, while Python GUI translate as user-friendly interface. As good as this is in anti-proxy attendance, it is working to minimize administrative effort while keeping the data in the cloud. Future work could include association with Learning Management Systems (LMS), accessibility through a mobile app, and advanced analytics dashboards.

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