Facial Recognition App on AWS for Employee and Visitor Tracking

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Abstract— This paper presents the design and implementation of a cloud-based facial recognition system, using Amazon Web Services for employee authentication and visitor management. The system would make use of several AWS's services: which includes Rekognition for carrying out facial analysis, use of Lambda for serverless computing, S3 to store, DynamoDB in managing databases, and lastly, API Gateway to support secure API endpoints. The proposed solution achieves fast and high accuracy in discriminating between enrolled employees and unregistered visitors while offering scalability and real-time performance. The implementation includes the use of a React-based frontend interface to allow intuitive user interaction with real-time authentication results. Experimental results have proved employee recognition to be a success and successful prevention against unauthorized access.

***Keywords*— Amazon Rekognition, AWS, Cloud architecture, Face recognition.**

I. Introduction

One of the most revolutionary solutions to modern security and authentication systems is facial recognition technology. It has changed the concept of access control and identity verification in recent times. Traditional authentication methods, including ID cards, PIN codes, or biometric fingerprints, face scalability issues, as well as those related to security and user experience. Facial recognition technology has the ability to bypass all such limitations. The only drawback, however, is that these systems, until now, have high costs to the infrastructure, high computing requirements, and complex maintenance that limits their adoption by most organizations.

Cloud computing platforms, such as Amazon Web Services, or AWS, for example, innovatively provided a solution to the previous constraints. Cloud-based approaches offer elastic scalability, low up-front investment through pay-as-you-go pricing models, and managed services, thereby removing the overhead of maintenance. They offer more security features and compliance certifications to make it safe, worldwide availability with minimum latency, and updates in performance. This places cloud-based facial recognition systems as the cost-effective, reliable, and scalable option for any organization.

This work relies on AWS services to architect a complete cloud-based face recognition system. Some key components include Amazon Rekognition for deep learning-based image analysis, AWS Lambda for serverless computing, Amazon S3 for secure and scalable storage, DynamoDB for NoSQL database services, and Amazon API Gateway for the protection of communication between the various components of the system. Together, these services offer an architecture that supports real-time processing, seamless integration, and scalable deployment.

The proposed system covers a variety of use cases across different industries: enhanced access control and visitor management in corporate security, patient identification in healthcare, attendance tracking in education, personalized services in retail, and secure facility access for government institutions. Latest advancements in deep learning and cloud computing further expedited such systems with an accuracy rate higher than 99% while performing the tasks in real-time.

The paper aims to develop a a scalable facial recognition solution in AWS using its services, creating secure registration and authentication processes, creating a friendly frontend user interface, and evaluating performance in terms of accuracy and efficiency of the system. Proposed architecture and methodology represent one important step closer to modern security solutions, which consist of cloud-based facial recognition systems, offering organizations with a practical, scalable approach instead of using traditional methodologies.

The rest of the paper is structured as follows: Section II discusses the system architecture and methodology, Section III covers implementation details, Section IV reports on experimental results and performance analysis, and Section V concludes the work with future research directions.

II. Literature Review

Kodali et al. [1] introduce a novel cloud-based attendance system using AWS Rekognition, distinguished by its efficient architecture that serves peak traffic, especially in educational environments. The proposed solution uses some of the AWS services in combination: Lambda functions, S3 buckets, DynamoDB, and Rekognition API for achieving an accuracy of above 99.8% under challenging conditions. Operating around $28.04 monthly with 180 students across 8 courses, the system is proved cost-effective while removing manual record-keeping and fraud through biometric authentication. The serverless design shines at managing concurrent requests during peak times, surpassing traditional solutions based on EC2. The implementation proves to have robust performance with partial visibility and different angles, offering a tamper-proof and transparent attendance management system.

Chowanda et al. [2] designed a cloud-based face recognition attendance system based on the use of machine learning in tracking employees. Their architecture includes cloud storage for the database and trained models. This allows them to update and access models smoothly without the need for local retraining. It uses a React JS frontend and a Python FastAPI backend. The face detection is done with the use of MTCNN, the facial landmark extraction using FAN, and feature extraction through FaceNet embedding. The cloud implementation will update the models to reflect changes in facial appearance over time with data processing and storage in the cloud. Their experiments were successful in obtaining some outstanding accuracies of 100 percent for training and 99.90 percent for validation on 16 employees plus an unknown class, but many different cloud operations led to execution times ranging from 6 to 38.5 seconds, leaving much scope to be optimized to actually enjoy true real-time performance.

Raghuwanshi P. et al [2] The paper by Prashis Raghuwanshi discusses the transformative possible behind embedding Generative AI with IoT-based cloud computing. It lists some of the core cloud technologies that include Amazon EC2, Google App Engine, and Microsoft Azure as some of the key sources that provide the basis for hosting IoT applications. The research is carried out on a mixed-methods approach, both a qualitative literature reviews and a quantitative case study, to assess the performance metrics for instance data processing speeds as well as security risks. This Generative AI has key findings, on one hand, contributing to decision-making and resource-allocation benefits in IoT systems. However, on the other side, it portrays challenges of promise data privacy as well as security vulnerabilities required with advanced governance frameworks. This paper explores an interdisciplinary approach on managing these challenges; with the view of proposing the framework for the integration of these technologies in a secure and efficient manner.

Feng et al. [3] offers a cloud-based class attendance system, CABCFR, that exploits the power of cloud computing along with face recognition technology to efficiently track multi-user attendance in educational environments. The system employs OpenCV for face detection and tracking, and it employs Baidu Cloud to store the face database and to execute face recognition with matching scores. Built on a client-server architecture, the system allows simultaneous check-ins from multiple The server handles TCP/IP connections that link client and Baidu Cloud to facilitate communication between students and other clients via this service. The registration module utilizes a cloud database. Use of student ID as index into the student's file results in 98.4 percent recognition performance. The system demonstrates effective performance in processing attendance of 27 students within approximately one minute. It has features such as voice synthesis for name confirmation and comprehensive management of attendance records through MySQL databases on virtual machines. The cloud-integration allows it to scale and be accessible so faculty can handle attendance anywhere while ensuring data is stored and processed centrally.e.

Pattnaik et al. [4] conducted a comparative study of AI-based face recognition techniques for the attendance system, particularly considering cloud-based solutions using AWS Recognition API. The results revealed that AWS Recognition outperformed with an accuracy of 100% when compared to local methods such as LBPH (70%) and a face_recognition library that had an accuracy of 99.38%. The cloud-based system performed excellently without using any additional resolution enhancement algorithms under low-light and mask-wearing scenarios. Implementation was done using a Flask-based web application that interacted with AWS cloud services, where the face data was stored in S3 buckets and further processed using deep neural networks to create unique face IDs and feature vectors. The cloud architecture of the system made it very suitable for educational institutions and organizations looking for contactless attendance solutions with real-time tracking of attendance and automated updates to the database along with email notifications.

Zaware et al. [5] describes a cloud-integrated face recognition attendance system that relies on Azure Cloud services for backend processing and DLib's ResNet model for face detection. The system scans images taken through mobile phones or webcams by HTTP requests and faces that are identified are automatically recorded into Google Sheets. Their realization achieves 89% precision when testing with 5 faces at once, further showing scalability by integration through the cloud. The system is more cost-effective and time-efficient than the older methods since it scans the attendance of numerous students within nearly 10 minutes. They have good prospects in automation for managing attendance but say there is a limitation of side view face detection and dependency upon environmental conditions, thus promising future integration with the ERP systems of institutions and pointing out the requirement for quality training data in improving its accuracy in tricky scenarios.

Jha et al [6] present a comprehensive comparative analysis of cloud-based face recognition services. It has been specifically examined for AWS Rekognition, Azure Face API, and Google Cloud Vision. These websites were analyzed based on several parameters that involved pose variations, expressions, lighting conditions, and accessories using datasets from Yale and robotics.csie.ncku.edu.tw. In experiments, they find that AWS Rekognition shows superior performance with a high average confidence score of 98.95% and a score of 87.24% for Azure Face API especially in multi-face tracking as well as detail display. The results of the experiment indicate how efficiently AWS Rekognition has been designed to handle several situations, which include: pose - 98.68%, changes in illumination - 97.645%, detecting facial expressions - 99.99%, identifying accessories - 99.68%, and multi-face recognition - 98.76%. The authors state that further work is the incorporation of AWS Rekognition into CCTVs and public cameras in real time for surveillance and security.

Shirsat et al. [7] proposes a cloud-based system for criminal detection and recognition using CCTV footage, which overcomes the time-consuming manual process presently followed by law enforcement using Microsoft Azure Cognitive Services and Face API. The two methodologies studied in this research are the hybrid approach that combines local face detection with cloud-based recognition to reduce costs, and the fully cloud-dependent solution that offers more accuracy but at increased expense. The cloud-based system employs up to 64 faces per frame face detection in Azure, and with that, works fine on systems with modest hardware specifications while requiring only adequate internet connectivity: 10+ Mbps. The authors mention that although this approach is costlier, it gives better accuracy and less overhead in local processing than traditional approaches such as HAAR cascade classifiers, which makes it very suitable for government agencies with reliable internet infrastructure.

Masud et al. [8] proposed a face recognition system that has been designed for IoT - cloud environments. The authors presented tree-based deep learning models, namely single-tree and parallel-tree architectures, improving the efficiency and accuracy of face recognition tasks. Their approach aims to It aims to achieve high precision with low computational complexity; hence, it can work in real-time, preferably in smart cities. Also, the study includes detection using CNN-based face detecting, utilizing AWS cloud for IoT-integrated data-processing services, achieving a validation accuracy of 98.81% for efficient classification by Haar Cascade and MTCNN detector.

Joodi et al. [9] presented a classification model for face detection with the use of Amazon Web Services (AWS) cloud infrastructure. The CNN-based model classifies faces in permission and non-permission classes through the use of Haar Cascade and MTCNN detectors. This example illustrates that cloud services can be effectively used to deploy scalable and efficient facial recognition models for big volumes of real-time data.

Chowdary et al. [10] used the AWS Lambda, S3, and Rekognition services in a serverless architecture to develop a real-time facial emotion recognition system. They highlighted the efficient preprocessing of images and used FER2013 and AffectNet for evaluation. The system is very simple and scalable for facial emotion recognition and has demonstrated the utility of AWS services in real-time applications through the efficient cloud-based processing approach toward the analysis of emotions.

III. System Architecture and Methodology

The proposed system adopts a serverless architecture using multiple AWS services to deliver an efficient, scalable, and secure facial recognition and authentication solution. The architecture, as depicted inFig. 1, comprises four main layers: Storage, Processing,Database, and Interface.

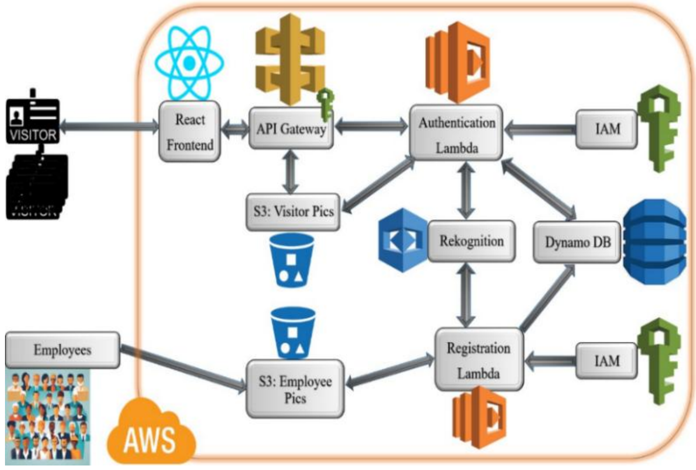

Fig.1. System Architecture

A. Storage Layer

The storage layer utilizes Amazon S3 to ensure a safe and scalable image. Photos of registered employees and verification requests for visitors are kept in different S3 buckets. Strict controls for data integrity and security purposes are ensured by IAM policies.

Fig. 2, show that the image data is stored in two buckets which are employee-image-storages and visitor-image-storages

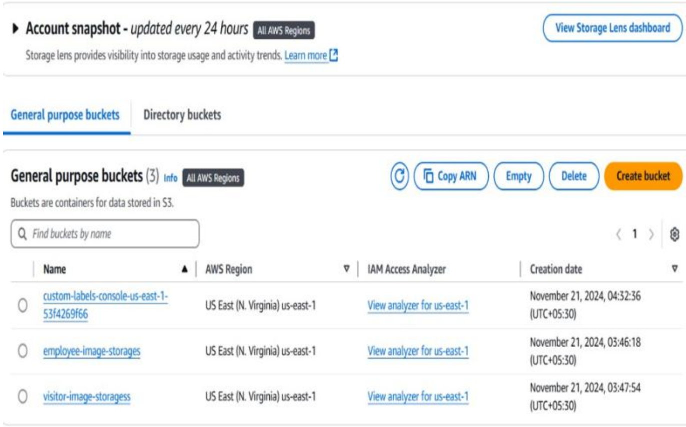

Fig 2. Shows the image data is stored in S3

B. Processing Layer

The processing layer holds AWS Lambda that runs serverless functions in registration In Fig 3 and authentication processes. This layer performs analysis and comparison of faces from images with the help of Amazon Rekognition and IAM roles secure service interaction. Real-time processing ensures timely and accurate responses.

Fig. 3 Shows the employee registration in Lambda

C. Database Layer

It uses Amazon DynamoDB as the layer for the database in order to store details of employees and authentication logs. It is a NoSQL database, which supports data of users with native encryption and provides fast access and is highly scalable. In Fig 4 the images of employees are uploaded and give a value to it from the S3 buckets

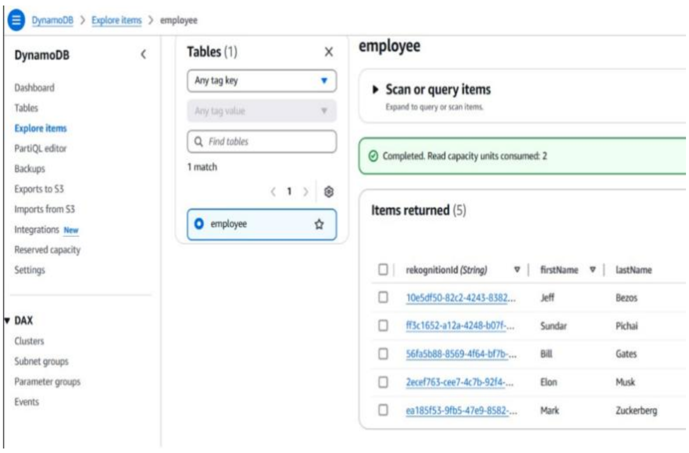

Fig. 4 Shows the employee images in DynamoDB

D. Interface Layer

The interface layer comprises Amazon API Gateway that exposed and created RESTful API endpoints, enabling the whole different parts of the system to communicate smoothly with one another. Frontend is on the bases of React that provided it with real-time interactions with responses in its interface.

IV. Implementation

The implementation of our cloud-based facial recognition system integrates multiple AWS services into a cohesive authentication solution, focusing on security, scalability, and real-time performance.

A. System Infrastructure

The system's foundation relies on AWS services working in concert. Amazon S3 provides encrypted storage through two distinct buckets: one for employee registration images and another for authentication requests. DynamoDB serves as the primary database, with a schema optimized for facial recognition queries using EmployeeID as the partition key and FaceID as the sort key. The infrastructure implements IAM roles following the principle of least privilege, ensuring secure service interactions

B. Face Recognition Pipeline

There are two major workflows that are associated with our face recognition pipeline; these are related to the registration and authentication workflows. For registration, the images undergo preprocessed quality checking procedures and then are relayed to Amazon Rekognition. The system retains the collections of faces in Rekognition, thus holding all employee facial data at the ready to be rapidly queried. The authentication pipeline ensures face recognition utilizes metrics of quality such as resolution, pose, and lighting prior to checking against the registrant employee list by means of thresholds of thresholds that qualify the threshold level of confidence.

C. Serverless Architecture

AWS Lambda functions handle both registration and authentication processes. The registration function manages employee onboarding, including face detection, quality validation, and database record creation. The authentication function coordinates with Rekognition for face comparison and implements access control logic. Both functions incorporate error handling and logging through CloudWatch for monitoring.

D. Frontend Integration

A React-based frontend provides the user interface, implementing real-time camera integration and immediate feedback on image quality. The system uses API Gateway to expose RESTful endpoints with proper security measures including request validation and throttling. Authentication flows handle various states and error conditions, ensuring a smooth user experience

E. Security and Optimization

Data in transit and at rest are encrypted, access control is complete, and audit logging is enabled. The system has mechanisms to prevent spoofing attempts at the face liveness detection level. Optimizations for performance include image preprocessing, connection pooling, and caching strategies. Cost optimization is achieved through careful resource management and auto-scaling policies.

Through this implementation, we have created a robust facial recognition system that effectively meets enterprise authentication requirements while maintaining operational efficiency and security standards. Fig. 1 illustrates the complete system architecture and interaction flow between components.

V. RESULTS

The system was evaluated through comprehensive testing scenarios to assess its performance and security features.

Fig 5. Shows the image upload functionality

In Fig 5. We can see that we are asked to upload facial pictures of people to authenticate them and check if they are visitors or employees

A. Employee Recognition

Fig. 6 and Fig 7. shows how the system successfully recognizes registered employees at various lighting conditions and angles with high confidence scores. The system proved to be accurate and reliable in employee identification, with consistent performance under different environments

Fig.6. Shows successful employee recognition

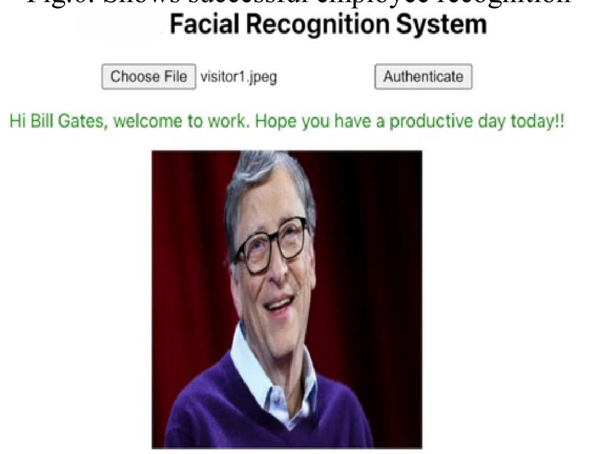

Fig.7. Shows successful employee recognition

B. Unauthorized Access Prevention

Fig. 8 and Fig. 9. shows how the system addresses unauthorized access attempts. The facial recognition system correctly identifies the unregistered individuals and denies them access, which goes to show how effective the system is in preventing unauthorized access.

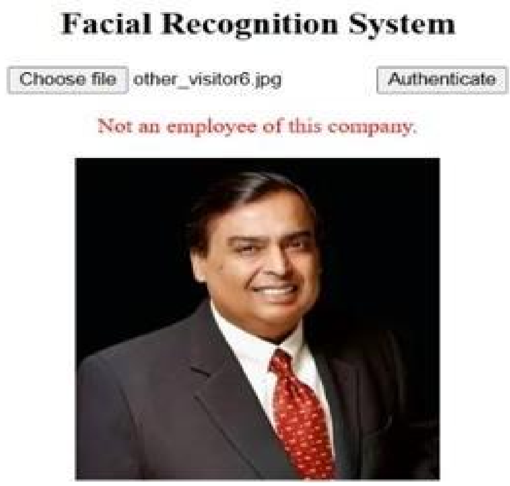

Fig.8. system response to unauthorized access attempt

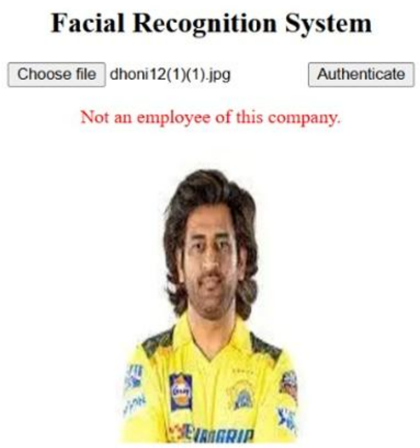

Fig.9. system response to unauthorized access attempt

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