EcoCoin-An incentivised way to go Green using Amazon Rekognition

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***Abstract*—The Internet of Things (IoT) has spurred urban growth and increased environmental pollution. This paper introduces EcoCoin, a mobile app that rewards college students for sustainable actions. It emphasizes automated facial recognition's role in enhancing attendance systems by reducing errors and saving time, thereby boosting security, transparency, and efficiency. In addition, it explores how facial recognition can deliver personalized ads based on expressions, improving the retail experience with real-time recommendations. The paper concludes with an overview of AWS cloud services' advanced features, underscoring their utility for developers to incorporate sophisticated image and video analysis, showcasing technology's role in achieving social goals.**

***Index Terms*—Amazon Web Services, Cloud Storage, Face recognition, Serverless Computing**

I. Introduction

EcoCoin represents a meticulously developed mobile application aimed at motivating and incentivizing college campus students to actively engage in sustainable and environmentally friendly practices. This innovative platform heralds a paradigm shift in the approach to promoting sustainability within collegiate environments by gamifying environmentally conscious behaviors. Students are empowered to accumulate valuable coins by meticulously documenting and uploading brief videos showcasing specific eco-friendly actions undertaken within the confines of the campus premises. These actions encompass a spectrum of simple yet impactful efforts, including the conscientious management of energy consumption by shutting off fans and lights, responsible waste disposal practices involving the collection and proper disposal of litter in designated receptacles, and active participation in campus greening initiatives such as tree planting efforts. The accrued coins serve as incentives for students, augmenting their enthusiasm and commitment toward sustainable practices by offering attractive discounts on a diverse array of campus amenities.

In terms of technical infrastructure, EcoCoin relies on the robust capabilities of cutting-edge AWS cloud services for its seamless and secure operation. This includes the utilization of Amazon S3 for the secure archival of video and image content, while Amazon Rekognition is leveraged for precise facial recognition within uploaded video files. The integration of AWS Lambda facilitates the seamless processing of video uploads, thereby triggering Rekognition. Furthermore, Amazon DynamoDB serves as the backbone for the streamlined management of user data and coin balances, ensuring optimal data organization and retrieval efficiency. Lastly, Amazon Cognito is used for robust user authentication, bolstering the overall security posture of the application. This cohesive integration of AWS services not only underpins the scalability and reliability of the EcoCoin platform but also augments its performance, culminating in a gratifying and immersive user experience. Ultimately, EcoCoin serves as a catalyst for fostering a culture of sustainability and environmental stewardship within the university community, exemplifying the transformative potential of technology in advancing societal objectives.

Fig. 1. India's first garbage cafe in Chattisgarh State

II. Related Work

A study by [1] introduces a prototype system that takes advantage of deep learning and cognitive analytics to improve verification and authentication in the log-in systems. This system, facilitated by a Flask server, interacts with Amazon's Rekognition to authenticate users based on submitted images, eliminating the need for traditional usernames and passwords. Achieving a remarkable accuracy rate 100%, the system

Fig. 2. People collecting waste for free food as an incentive

redirects users to their respective feeds upon authentication, showcasing its effectiveness and user-friendliness. This novel authentication method not only enhances security but also improves efficiency and user experience in access control systems.

Another study by [2] focuses on the development of a real-time face recognition-based attendance system, emphasizing the role of AI in improving attendance monitoring efficiency. This research underscores the importance of face recognition technology in overcoming the limitations of traditional attendance systems. By integrating AI methodologies such as deep learning and convolutional neural networks, alongside algorithms such as OpenCV and HaarCascade, the system enhances face recognition accuracy. The integration of cloud services, particularly with AWS, further optimizes system performance. Notable contributions include noise-resistant face recognition, image resolution enhancement, and liveness detection techniques, showcasing the system's robustness in practical implementation for attendance recording.

Moreover, a cloud-based face recognition attendance system proposed in a study, which offers a reliable, tamper-proof solution for attendance tracking, is of particular interest [3]. This system, leveraging AWS Rekognition and a serverless architecture, automates manual record-keeping, thereby reducing human involvement and ensuring high accuracy and real-time performance. By addressing the challenges of traditional attendance management systems, such as time consumption and error proneness, this system provides a scalable, accurate, and efficient solution for educational institutions. Using lambda functions for various tasks, including face indexing, detection, recognition, and automatic cleaning of S3 buckets, the system demonstrates high accuracy and real-time performance, showcasing its potential to improve security, transparency, and efficiency in attendance tracking processes.

In addition, the success of deep learning in image recognition is highlighted in a paper focusing on tasks such as facial recognition, facial expression recognition, and age and gender determination [4]. This paper emphasizes the availability of these algorithms as cloud services, enabling developers to integrate them seamlessly into their applications. Feature descriptor techniques such as SIFT, HOG, and SURF are discussed to extract valuable information from images, and machine learning algorithms treat feature vectors as points in a higher-dimensional space to build predictive models using neural networks. The paper also acknowledges the importance of automated facial recognition systems in identifying individuals based on facial features and expressions, demonstrating the potential to improve retail experiences through real-time product recommendation systems based on facial sentiment analysis. This system utilizes deep learning algorithms and integrates cloud-based services like Amazon Rekognition for accurate facial recognition, providing targeted ads to customers based on their facial expressions and sentiments, thus enhancing the retail experience.

Furthermore, a specialized facial recognition system for identical twins is presented in a paper that uses machine learning, image processing, and deep learning algorithms to distinguish between identical twins [5]. The system, trained on a dataset of 40 images of 20 pairs of twins and storing extracted features on the Amazon public cloud, demonstrates the challenge of identifying identical twins due to their genetic similarities. The proposed system accurately distinguishes between identical twins using advanced algorithms and cloud technology, enhancing the accuracy and reliability of twin identification. Comprising two modules, the Training Module and the Testing Module, the system trains on a local dataset of twin images, extracts features using frameworks like OpenCV, Keras, TensorFlow, and CNN, and stores features on the AWS Public Cloud. During testing, random images are compared with stored features to accurately identify twins, showcasing promising results in accurately identifying identical twins and providing three possible outputs. Twins found, Same person found, or Different person found, highlighting its robustness and reliability in twin identification scenarios.

III. Proposed Methodology

A. Overview of AWS services used

1) Amazon Cognito: Amazon Cognito is a robust identity management service offered by Amazon Web Services (AWS), designed to authenticate, authorize, and manage user access for mobile and web applications. Provides developers with a comprehensive set of tools to handle user registration, authentication, and account recovery, eliminating the need to build these capabilities from scratch. Significantly, Amazon Cognito integrates seamlessly with other AWS services, enabling developers to easily secure access to resources and manage user data. Its scalability, reliability, and flexibility make it an essential component for applications that require secure user authentication and management.

2) Simple Storage Service (Amazon S3 Bucket): An Amazon S3 bucket is a storage container in the Amazon Simple Storage Service (S3) cloud storage platform. It serves as a highly scalable, secure, and durable storage solution for various types of data, including images, videos, documents, and backups. S3 buckets are globally unique and can be accessed over the Internet using unique URLs. Their significance lies in providing businesses and developers with a reliable storage

infrastructure that can scale to store large amounts of data while ensuring high availability and durability. S3 buckets are integral to many cloud-based applications, serving as a central repository for storing and retrieving data, facilitating data sharing and collaboration, and enabling seamless integration with other AWS services for data processing and analysis.

3) Amazon Lambda Function: An AWS Lambda function is a serverless compute service that allows developers to run code without provisioning or managing servers. It enables users to upload their code and execute it in response to various events, such as changes in data, user actions, or system state, without the need to manage infrastructure. Lambda functions are highly scalable, automatically scaling to handle the workload without requiring manual intervention. They also offer cost efficiency, as users only pay for the computation time consumed by their functions. The significance of Lambda functions lies in their ability to streamline application development by abstracting away infrastructure management, allowing developers to focus on writing code. They facilitate the creation of event-driven, scalable applications that can respond rapidly to changing demands, making them a valuable tool in modern cloud computing environments.

4) Amazon Rekognition: Amazon Rekognition is a deep learning-based image and video analysis service provided by Amazon Web Services (AWS). Designed for developers to incorporate advanced image and video analysis capabilities into their applications without requiring deep machine learning expertise. Rekognition can identify objects, people, text, scenes, and activities in images and videos, as well as detect inappropriate content. Its significance lies in its ability to enhance the functionality of applications by providing powerful computer vision capabilities, such as facial recognition, object detection, and content moderation, which can be used for a wide range of applications, including security, content management, and user engagement. Rekognition's ease of use, scalability, and integration with other AWS services make it a valuable tool for developers seeking to add sophisticated image and video analysis features to their applications.

5) Amazon DynamoDB: Amazon DynamoDB is a fully managed NoSQL database service provided by Amazon Web Services (AWS), designed to provide low latency and high performance access to data at any scale. It offers a flexible schema-less data model, allowing developers to store and retrieve data using key-value and document-based approaches. DynamoDB's significance lies in its ability to handle large amounts of data with high throughput and low latency, making it well-suited for applications requiring real-time access to data, such as gaming, IoT, and mobile applications. Its fully managed nature eliminates the need for manual administration, while its scalability and reliability ensure that applications can scale seamlessly to accommodate growing workloads. DynamoDB's integration with other AWS services further enhances its utility, enabling developers to build powerful and resilient applications with ease.

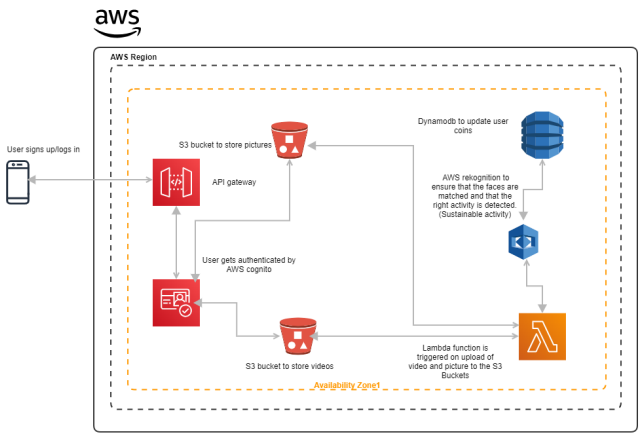

Fig. 3. Cloud architecture of proposed system

B. Cloud Architecture Diagram

The depicted AWS cloud architecture diagram (Fig.3) illustrates the intricate system design of a sophisticated application, presumably catering to user authentication, video and photo storage, face recognition, and user coin management. The diagram shows a user logging into the system, via a mobile device, initiating a sequence of events carried out by various AWS services. When the user registers, that is, when the user uses the app for the first time, they have to provide their institute email id, password, roll number, and phone number. When the user logs in they only have to provide their institute email id and password as their credentials are registered with Amazon Cognito userpool. After signing up or logging in, the user's credentials are authenticated by AWS Cognito. Once authenticated, the user can upload a video and a photo, which are automatically stored in dedicated Amazon S3 buckets, designated for videos and photos, respectively. These S3 buckets serve as secure repositories for user-generated content, ensuring data integrity and availability. Upon upload of the video and photo to the S3 buckets, the Lambda function is activated, which in turn invokes AWS Rekognition. AWS Rekognition takes center stage in the architecture, leveraging advanced machine learning algorithms to analyze uploaded content. Its primary objective is to ensure facial recognition by verifying that the faces in the uploaded photo and video match, thereby validating the user's identity. DynamoDB plays a pivotal role in updating the user's coin balance based on the outcomes of the Recognition analysis. If the system detects a match between the uploaded photo and video faces and identifies the performance of one of the specified sustainable actions, the user's coin balance is incremented accordingly. This seamless integration of AWS services ensures real-time updates to user data, providing a responsive and dynamic user experience.

C. Frontend Development

The frontend user interface (UI) of the EcoCoin mobile application is developed using React Native, a widely adopted

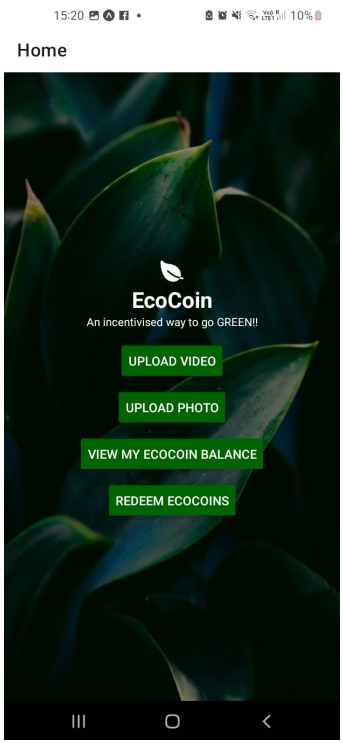

Fig. 4. Home screen.

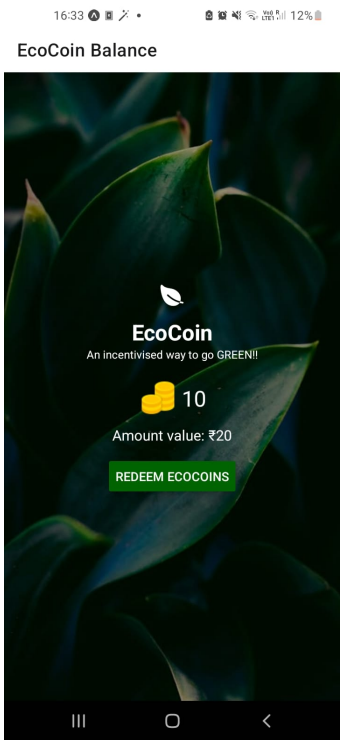

Fig. 5. Coin Balance screen.

JavaScript framework renowned for its ability to facilitate cross-platform development, ensuring seamless operation on iOS and Android devices. The application encompasses a series of screens, each meticulously crafted using a myriad of React Native components to engender a user-centric experience.

The Login and Signup screens serve as pivotal entry points, allowing students to authenticate using their institute email ID and password, or register by furnishing their institute email ID, password, roll number, and phone number, thereby ensuring access control and user authorization.

Upon successful authentication, users are seamlessly navigated to the Home screen, a central hub that houses a wide variety of functionalities. Here, students can upload videos showcasing their sustainable practices, upload their photo, monitor their current coin balance, and use earned coins for discounts or refunds. The Home screen acts as a focal point for app interactions, offering convenient access to essential features and enhancing user engagement.

Lastly, the Coin Balance and Redemption screen provides students with a comprehensive overview of their current coin balance and facilitates the redemption of coins for discounts on campus amenities. This screen not only incentivizes users to engage in environmentally friendly behaviors but also fosters a sense of reward, thereby encouraging continued participation in sustainable practices.

IV. Results

The AWS Lambda function known as 'testvid' serves as a comprehensive solution to process images and videos uploaded to an S3 bucket within the EcoCoin mobile app ecosystem. The function is designed to leverage AWS Rekognition for facial recognition tasks, while also integrating with DynamoDB for student data management.

The generatecollectlectionid function ensures the creation of unique collection IDs for each image, based on the S3 bucket name and object key. Meanwhile, the lambdahandler function acts as an entry point, extracting relevant information from S3 events to generate collection IDs for images.

The interaction with DynamoDB is a key component, as the function manages student information. For first-time uploads, a new record is created in DynamoDB, associating the student's ID with an initial coin balance of 0. For subsequent uploads, the function retrieves the existing student ID. If the student ID is already present in the table, the coin balance will not increase, which means that the user cannot upload the same video file more than once to earn coins.

The function also handles Rekognition tasks efficiently. Check for the existence of the Rekognition collection for each image and create it if necessary. Then it proceeds to index the face in the image using the generated collection ID and student ID.

In the case of video files, the function initiates a face search job using Rekognition to identify matching faces. The job ID is monitored to track the job's status until completion. If a

face match is found, the student's coin balance is incremented by 2 coins.

Upon updating the coin balance in the DynamoDB table, the image file and video file are automatically deleted from their corresponding S3 buckets.

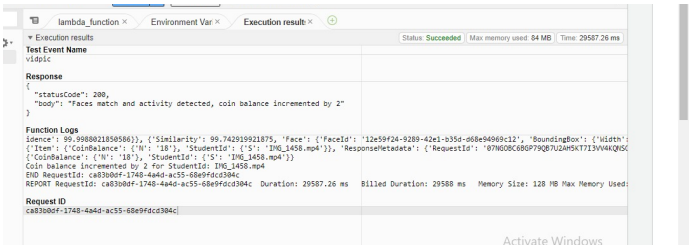

Fig. 6. Test Function

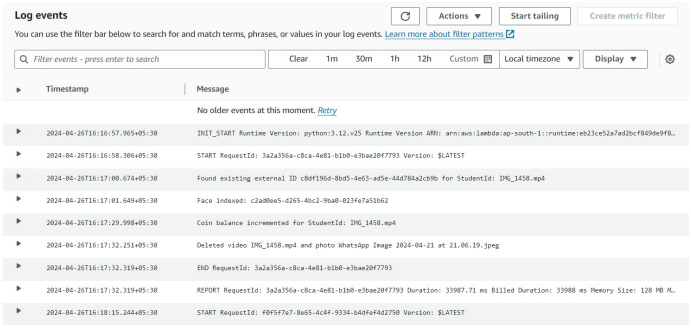

Fig. 7. CloudWatch Logs

The test function execution results and CloudWatch logs are shown in Figs. 6 and 7, respectively. The response from the execution of the test function indicates that the status code is 200, which typically means a successful execution. Furthermore, the response message states "Faces match and activity detected, coin balance increased by 2", implying that the Lambda function successfully processed the video file, detected matching faces, identified associated activities and increased the coin balance in the DynamoDB table 'StudentCoins' accordingly.

In the "Function Logs" section, it is observed that various log entries provide detailed information about the execution of the Lambda function. These logs include data such as confidence level, similarity of detected faces, face IDs, and student IDs associated with the detected faces. The similarity index of a detected face refers to a measure of how closely the detected face matches a reference face or a known face within a data set. In this case the Lambda function testvid has achieved a similarity index of roughly 99.78 percent, thus indicating a stronger resemblance between the detected face and the reference face, suggesting that they are more likely to be the same person.

In the context of Amazon Rekognition, a Face ID refers to a unique identifier assigned to each detected face during face detection and recognition processes. When Rekognition analyzes images or videos containing faces, it identifies individual faces within the media and assigns a distinct Face ID to each one.

The confidence level in detecting faces refers to the probability or certainty with which the system believes that a detected object in an image or video frame is indeed a face. It is a measure of the confidence or reliability of the face detection algorithm's prediction. In this case the Lambda function testvid has achieved a similarity index of roughly 99.99 percent. This suggests that the system is highly certain that the detected or recognized entity is indeed a face or a match.

In essence, confidence level, similarity index, and face ID are critical components in accurately and reliably detecting and recognizing faces. These parameters provide valuable insights into the confidence level of the system, the degree of similarity between faces, and the unique identification of individual faces, facilitating various face-related tasks such as verification, identification, and tracking.

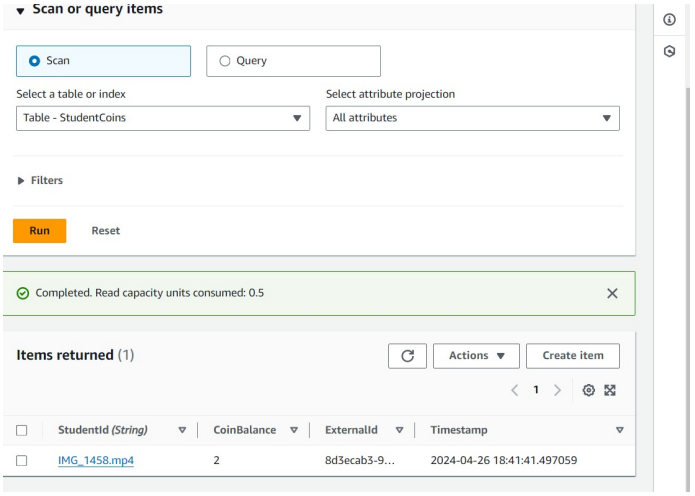

Fig. 8. DynamoDB table 'StudentCoins' with updated coin balance corresponding to the name of the uploaded video file and timestamp of when the video was uploaded (given that the video satisfied the required conditions) from the Lambda function 'testvid'.

Fig.8 shows the DynamoDB table with the updated coin balance corresponding to the name of the video file. If the video satisfies the required conditions, which include the detection of matching faces in the uploaded image and video, then the coin balance is incremented. If the video file (StudentID) already exists in the table, then the coin balance will remain the same, since the user cannot upload the same video to earn coins more than once.

V. Conclusion

In conclusion, the EcoCoin mobile application harnesses the power of AWS cloud services to incentivize and reward college campus students for engaging in sustainable, eco-friendly practices. The integration of AWS S3 for secure storage of multimedia content, AWS Lambda for efficient serverless processing, and AWS Rekognition for accurate face

comparison and detection ensures a robust and reliable system. EcoCoin has the potential not only to promote sustainable practices among college students but also to serve as a model for incentivizing positive behavior change in larger communities, contributing to a more sustainable and environmentally conscious future.

VI. Future Scope

The future scope of this project revolves around potential avenues for expansion and enhancement. One key aspect is the scalability of the app to accommodate a larger user base, possibly extending its reach beyond college campuses to other educational institutions or even community-wide initiatives. Furthermore, the integration of machine learning algorithms could further enhance the accuracy and efficiency of activity detection, providing more detailed insights into student behaviors. Furthermore, the app could be extended to include gamification elements, such as leaderboards and challenges, to increase student engagement and participation. Collaborations with businesses and organizations for coupons and discount codes could also be explored to offer a wider range of rewards and incentives, thus increasing participation and spirit among students.

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