An Efficient Real time Product Recommendation using Facial Sentiment Analysis

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***Abstract*—Image recognition based on deep learning has made successful attempts in solving Computer Vision problems. Deep learning algorithms have primarily contributed to face detection, facial expression recognition, age and gender determination tasks. The performances of the algorithms have been evaluated by the researchers and they are made available as cloud services. By accessing the cloud, application developers can incorporate the already tested algorithms in their work and pay for the utilized service. Amazon Rekognition is a web service which provides highly accurate facial analysis and more suitable for facial recognition. Amazon Rekognition includes a simple, easy-to-use API that can quickly analyze any image file that's stored in Amazon S3. This paper explains the necessary steps to utilize the service to build an application for a retail store. The application captures the customer faces, performs facial analysis and recommends appropriate products by displaying the targeted advertisements. With the facial analysis responses of recognition algorithm, a decision block is devised to select the appropriate content to be displayed. The application is tested with anonymous images and performance is appreciable.**

Keywords—facial sentiment analysis, face detection, age & gender estimation, facial expression analysis, Amazon rekognition

I. INTRODUCTION

Image recognition is a significant phase in image processing that tends to identify objects, people, places, and actions in images. Using machine vision technologies in combination with a camera and appropriate software computers are trained to achieve image recognition.

Image recognition performs a variety of visual tasks, such as annotating the content of images with meta-tags, searching for image content in a library, controlling autonomous robots, automating car driving and accident avoidance systems. Recent applications of image recognition include smart photo library building, consumer targeted advertisement, design of assistive devices for visually impaired and physically challenged people.

The process of image recognition process involves gathering and organizing data, and building a predictive model to recognize images. Computer can perceive an image as a raster or vector image. Raster images contain a sequence of pixels with discrete numerical values for colors. Vector images can be considered as set of color-annotated polygons. Organizing data refers to arranging the data for classification and feature extraction. The primary step in image classification is to extract important information by omitting the unwanted data. Feature descriptor techniques such as Scale-Invariant Feature Transform (SIFT), Haar-like features, Histogram of Oriented Gradients (HOG), Speeded Up Robust Feature (SURF) and Binary Robust Independent Elementary Features (BRIEF) are used to mine significant information from a image. The principle of machine learning algorithms is to treat these feature vectors as points in a higher dimensional space. It determines the planes or surfaces (contours) and separates the higher dimensional space in such a way that all examples belonging to a particular class lie on one side of the plane or surface. To build such predictive model deep learning uses neural networks. The neural network is a similar to biological network of human brain to estimate output for a given huge amount of unknown inputs using activation functions. Suitable learning algorithm should be selected to recognize the images. Some of the algorithms suggested for image classification in recognizing images are support vector machines (SVM), neural networks, decision trees, K-nearest neighbors (KNN) and logistic regression. The image recognition model is trained with large volumes of training images and tested with unknown samples to assess the performance of the model.

Automated facial recognition systems have the capability to identify individuals from their facial features such as position of nose, eyes and mouth. These characteristics are further analyzed and compared to stored identify to authenticate a person.

Facial expression analysis involves measurement and recognition of expression. Automation of facial expression prediction consists of face detection, facial feature extraction and facial expression recognition.

Human beings can recognize the objects by seeing them with less effort. Given an image, making the machines to recognize and understand the object is a challenging task. To solve this problem, over the year's computer scientists have researched in Artificial Intelligence, more specifically in machine learning called deep learning. Today deep learning is used in applications like speech recognition, image recognition, natural language processing and recommendation systems. Deep learning systems undergo huge amount of training over an extended period of time to learn and perform the specific task. Image recognition

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system works with extensive labeled training images and correlates the labels with images. It iterates with the training process till the confidence level of the expected output is satisfactory. Deep learning uses neural networks to learn and predict with the confidence score of what object it thinks in the image.

The organization of the paper is done as follows: Section II discusses the various techniques used to build facial recognition. Section III presents the application of facial recognition in various sectors. Section IV introduces the features of Amazon Rekognition system. Section V presents an application for retail store.

II. Related Work

Age of a person can be inferred by observing distinct patterns emerging from the facial appearance. Age synthesis is the process of rerendering a face image with natural aging and introducing rejuvenating effects on the individual face. Age estimation is done by automatically labeling a face image with the exact age in years or specifying the age group [1]. This particular age estimation system can be interfaced with camera to warn or deny children access to adult Web sites or restricted movies]2]. A heuristic approach is used to simulate face with creases and aging wrinkles to create texture details on the given face [3], [4]. The technique is simple to implement but takes time to generalize the rendering process. Cloning facial expressions shows improvement in photorealistic effect. It tries to capture and clone face attributes in target image which can be used for recognizing facial expressions [5] or aging skin details [6]. Another approach called Merging Ratio Images (MRI) [7], extends the Ratio Image (RI) concept to multiple face attributes representation. Merge expression RI [8], illumination RI (quotient image) [9] and agingRI [10] are also used for photo realistic face rendering.

Based on face features from neighboring age groups, a novel Bi-level Dictionary Learning based Personalized Age Progression (BDL-PAP) method has been suggested and formulated to learn the aging dictionaries [11]. An elaborate overview of state-of-the-art advances in biometric demographic feature analysis has been provided [12].

An investigation on the impact of facial expressions on automatic age estimation has been carried out and a new graphical model has been proposed interlinking the age/expression labels and the extracted features [13].

Recently, a faster RCNN [14], has been proposed and proved impressive results on various face detection compared to existing algorithms. The technique focuses on image representation extraction from two consecutive convolution layers. Local feature extraction is done through one layer followed by pooling of extracted features in the second layer [15]. For robust facial expression recognition, a biologically inspired sparse-deep simultaneous recurrent network (S-DSRN) has been illustrated [16]. A detailed discussion on various face recognition algorithms and recommendation of application specific facial recognition techniques has been provided [17]

A joint estimation of facial components such as gender, expression and ethnicity have been demonstrated [18]. Self-Organizing Maps and Gabor patterns are used to build efficient face recognition systems [19]. Local Binary Patterns are used for facial recognition application. Also fusing Discrete Cosines Transform with Local Binary Patterns for feature extraction has provided promising results in face recognition [20].

Using Convolutional Neural Network for facial expressions recognition has been demonstrated [21]. Emotions of human are learned using deep Convolution Neural Network (CNN) and the intensity changes on a face during emotion are illustrated [22]. Two facial images: facial gray scale images and their corresponding local binary pattern (LBP) facial images, are taken and processed by deep neural network. The outputs are fused in a weighted manner. Softmax classification has been used for assessing the result of final recognition [23]. Automatic facial expressions recognition system based on deep network framework has been presented [24]. The technique uses autoencoders and the SOM-based classifier. Results prove that a better representation of facial expression can be achieved using autoencoders.

A multimodal 2D+3D facial expression recognition (FER) system with deep fusion convolutional neural network has been demonstrated with feature extraction subnet, a feature fusion subnet, and a softmax layer [25]. Facial feature extraction methods adopted for gender recognition in the past decades has been surveyed [26]. Automatic face analysis using 3-D shape representation has been developed [27] and its invariance to facial expression has been demonstrated. The technique uses a combination of statistical shape modeling and non-rigid deformation matching.

III. Recent Applications of facial recognition

Majority of facial recognition use-cases appear to fall into three major categories:

- ***Security:***

Deep learning algorithms are used by the companies to identify fraud detection, to avoid the traditional passwords for authentication and to improve the ability to distinguish between a human face and a photograph.

- ***Healthcare:***

To track patient medication consumption and support pain management procedures, machine learning algorithms are merged with computer vision to perform the tasks effectively.

- ***Marketing:***

With ethical considerations, marketing is expanding the domain of facial recognition innovation to study the customer's behavior.

IV. Amazon Recognition Web Service

Amazon has released web service on Image Recognition based on deep learning algorithms. They are completely integrated with other AWS services, highly secure and accurate. It also provides fully managed service supporting the inclusion of new images for the applications. This service provides a simple and easy to use API that can quickly analyze any image or video file stored in cloud storage.

Given an image to the Rekognition API, the service can identify objects, people, text, scenes, and activities. Amazon Rekognition helps in accurate facial analysis and facial recognition. The provided API can detect, analyze, and compare faces which helps in user verification, person counting and user cataloging.

Amazon Rekognition is based on the same proven, highly scalable, deep learning technology developed by Amazon's computer vision scientists to analyze billions of images.

Amazon Rekognition can detect faces in images and stored videos. With this API one can get information about where faces are detected in an image or video, facial landmarks such as the position of eyes, nose and mouth. It has the ability to detect gender, age and emotions such as happy, sad, or surprise from facial images.

When an image that contains a face as input is provided to DetectFaces API, Amazon Rekognition detects the face in the image, analyzes the facial attributes of the face, and then returns a percentage confidence score for the face and the facial attributes detected in the image.

Rekognition can locate faces within an image and using facial characteristics it can recognize emotions, demographic details, facial landmarks and image quality. These features help in building application that performs user sentiment analysis.

Given an image with face/faces *DetectFaces* API returns the facial details of the image. It detects the number of faces in the image and returns the detailing parameters of each face present in the image.

Table I lists the parameters of facial details returned by image recognition API.

TABLE I. FACIAL DETAILS CAPTURED BY THE API

Facial Details	Parameters
Facial Landmarks	X,Y position of Eyes, Nose, Mouth, Eye Brows
Demographic	Age Range, Gender
Emotions	Happy, Sad, Angry, Calm, Surprise, Confused, Disgusted etc., with confidence scores
Other Attributes	Face BoundingBox, Has beard, mustache, Sunglasses isSmiling, isMouth-open, isEyesOpen Pose information
Image Quality	Brightness, Sharpness

V. BUILDING AN APPLICATION USING WEB SERVICE

A. AWS Process

Fig. 1 explains the sequence of steps required to access the API provided by Amazon. To utilize the service one should create an account in AWS.

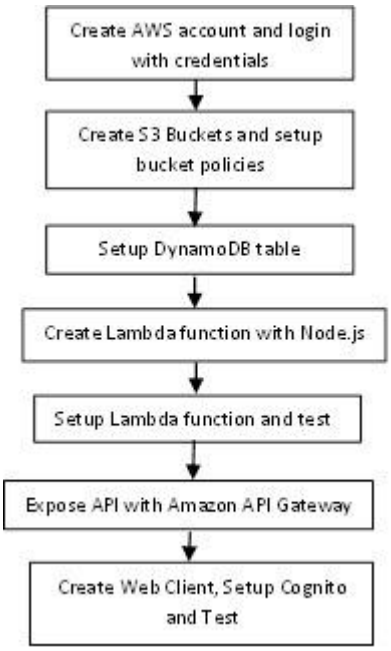

Fig. 1 Steps to be performed in AWS

B. Application Development

The application has used the web service of Amazon to personalize content to the user based on demographic and sentimental analysis on the user facial image. This application is suitable for any retail stores as a part of marketing strategy. Fig. 2 shows the phases in the application development.

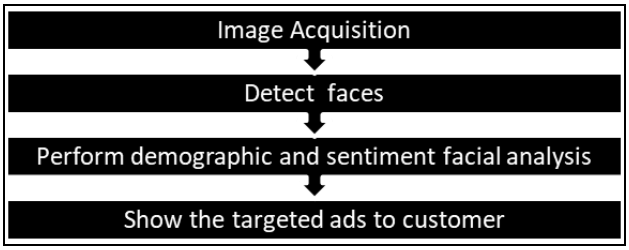

Fig. 2 Phases in Facial Sentiment Analysis

Live customer image is captured through a camera, image is analyzed to detect faces in the image and facial details are extracted by using Image Recognition API. The responses of API are analyzed by decision logic to dynamically display the targeted ads in the screen, further viewed by the customer.

The application process flow is shown in Fig. 3.

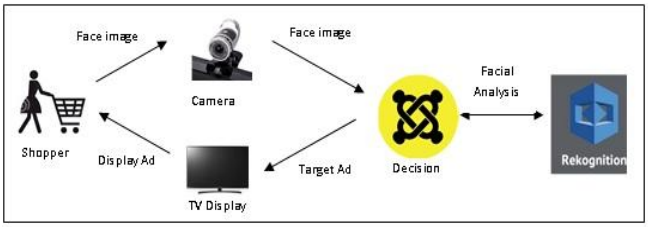

Fig. 3 Application Process Flow

Fig. 4 explains the complete flow of the process. Customer image is captured and stored in the S3 bucket. Using the lambda function, the captured image is given as input to DetectFaces API. The API responses with the analyzed facial details are stored in DynamoTable for future

reference. From the response of API, suitable target ads are displayed to the customer.

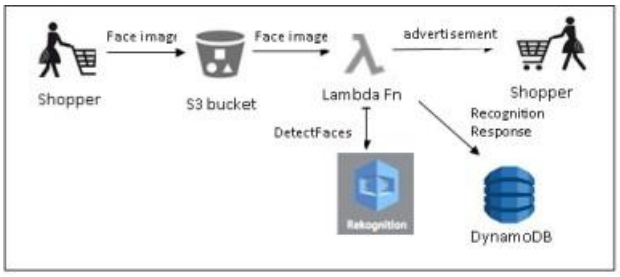

Fig. 4 Process Flow Description

The entire steps in building the application is shown in Fig. 5.

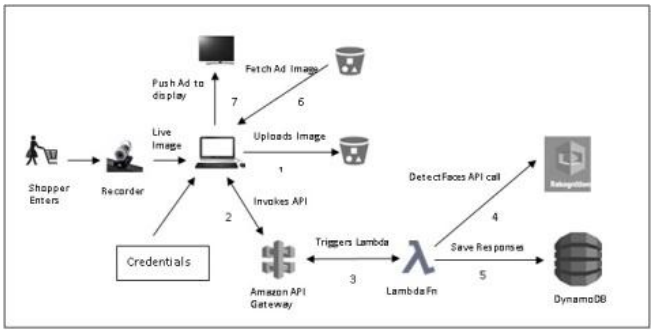

Fig. 5 Overall Architecture of the application

1. Create s3 bucket:

Amazon Web Services (AWS) provides an object storage service named as bucket. A bucket is a logical unit of storage in object in Simple Storage Solution S3. Buckets are used to store objects containing data with metadata describing the data.

- Using the credentials of Amazon Web Service access the storage S3 and create two buckets, one for storing the targeted ads and other for storing the captured customer image.
- Also set CORS configurations of S3 bucket. Cross-origin resource sharing (CORS) allows interacting with resources in a different domain and describes a way for client web applications to initiate such interaction. Amazon S3 with CORS support helps us to build rich client-side web applications and facilitates the access to Amazon S3 resources.

2. Create DynamoDB Table

This table is used to store the responses of DetectFaces API and provides analytic reports on customer demographic and sentiments. Amazon.com offers a fully managed proprietary NoSQL database service, DynamoDB as part of the Amazon Web Services. Create a DynamoDB table by selecting it from Database of Amazon Services. Name the table and set its primary key.

3. Create a lambda function

Code a lambda function in node.js that will process the image using Amazon Rekognition and return the appropriate ad content based on facial details analyzed.

- Create json package
- Install aws-sdk
- Install http
- Install uuid
- Write the lambda code in index.js

4. Set up lambda function in AWS

- Setup IAM roles for the lambda function
- Create an API in Amazon API Gateway to expose the lambda function to clients
- Initiate Call DetectFaces API.

The API response for sample image is listed in Table II.

TABLE II. API RESPONSE DETAILS

API Call Respose

detectFaces API Call Response:


```
{
  "FaceDetails": [
    {
      "AgeRange": {
        "High": 38,
        "Low": 23
      },
      "Beard": {
        "Confidence": 97.11119842529297,
        "Value": false
      },
      "BoundingBox": {
        "Height": 0.42500001192092896,
        "Left": 0.1433333307504654,
        "Top": 0.11666666716337204,
        "Width": 0.2822222113609314
      },
      "Confidence": 99.8899917602539,
      "Emotions": [
        {
          "Confidence": 93.29251861572266,
          "Type": "HAPPY"
        },
        {
          "Confidence": 28.57428741455078,
          "Type": "CALM"
        },
        {
          "Confidence": 1.4989674091339111,
          "Type": "ANGRY"
        }
      ],
      "Eyeglasses": {
        "Confidence": 99.99998474121094,
        "Value": true
      },
      "EyesOpen": {
        "Confidence": 96.2729721069336,
        "Value": true
      },
      "Gender": {
        "Confidence": 100,
        "Value": "Female"
      },
      "Landmarks": [
        {
          "Type": "eyeLeft",
          "X": 0.23941855132579803,
          "Y": 0.2918034493923187
        },
        {
          "Type": "eyeRight",
          "X": 0.3292391300201416,
          "Y": 0.27594369649887085
        },
```

```
            {
              "Type": "mouthLeft",
              "X": 0.24296623468399048,
              "Y": 0.4368993043899536
            },
            {
              "Type": "mouthRight",
              "X": 0.32943305373191833,
              "Y": 0.42591965198516846
            },
            {
              "Type": "leftEyeUp",
              "X": 0.23798644542694092,
              "Y": 0.28594088554382324
            },
            {
              "Type": "leftEyeDown",
              "X": 0.2404623031616211,
              "Y": 0.29718098044395447
            },
            {
              "Type": "rightEyeUp",
              "X": 0.3284870386123657,
              "Y": 0.27036795020103455
            },
            {
              "Type": "rightEyeDown",
              "X": 0.32978174090385437,
              "Y": 0.2812310755252838
            },
            {
              "Type": "mouthUp",
              "X": 0.2924160361289978,
              "Y": 0.407451868057251
            },
            {
              "Type": "mouthDown",
              "X": 0.29673251509666443,
              "Y": 0.46654582023620605
            }
          ],
          "MouthOpen": {
            "Confidence": 72.5211181640625,
            "Value": true
          },
          "Mustache": {
            "Confidence": 77.63107299804688,
            "Value": false
          },
          "Pose": {
            "Pitch": 8.250975608825684,
            "Roll": -8.29802131652832,
            "Yaw": 14.244261741638184
          },
          "Quality": {
            "Brightness": 46.14684295654297,
            "Sharpness": 99.9945297241211
          },
          "Smile": {
            "Confidence": 99.47274780273438,
            "Value": true
          },
          "Sunglasses": {
            "Confidence": 97.63555145263672,
            "Value": true
          }
        }
      ]
}
```


The confidence score confirms the presence/absence of facial feature in the image. High confidence scores confirm the presence of the particular facial feature.

5. Save the responses of API call in the DynamoDB Table. This storage is activated in the lambda code.
6. The decision logic written in the lambda code gets activated by the API responses. Based on the decision logic recommendation, target image is retrieved from S3 bucket.
7. The target image is pushed for display in the screen.

Creation of webpage to run the application

- Code an html client that uploads the image to bucket, calls the API fetching the ads from the bucket.
- Create identity for unauthenticated access to AWS resources from browser script.

VI Experimental Results

To test the application, few target images are uploaded in target-ad S3 bucket. The application is run by executing the created webpage. For experimental purpose, customer images are captured through webcam. The demographic details of the customer are retrieved by calling the API . The results of demographic details are processed to make the target ad decision. First the confidence score is checked to confirm the presence of face image. If human face is detected, then Age, Emotion, Gender, presence of Moustache, Sunglasses are used to decide the target image to be presented to the customer. Some of the decision logic applied in the proposed work is listed in Table III. The decision logic can be customized on the need of the shop.

TABLE III. Decision Logic of Target Image

Demographic Parameter	Value	Inference	Target Image
face confidence	Less than 80%	No human face	Default Image of the Shop
face confidence Age.Range	More than 80% 5-15	Kid	Ice cream
face confidence Age.Range Gender	More than 80% 15-40 Female	Lady	Cosmetic
Age.Range Gender Beard Confidence	15-35 Male More than 80%	Men	Trimmer
Age.Range Gender Emotions	15-30 Male/Female Confused	Men/Women	Yoga DVD

The proposed approach is experimented with 50 customers and was appreciated. Around 42 customers agreed with the response images and hence the accuracy rate is 84%. Sample customer images and the results of response images are shown in Fig. 6.

Customer Image	Target Ad Image
	
	

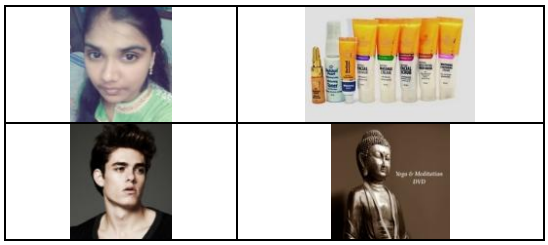

Fig. 6 Results of the application

VI. Conclusion

Face recognition technique has been traditionally associated with security sector, but today its need has expanded in retail, marketing and health. Automated face recognition system has gained focus in biometric research. Various algorithms and methods have been suggested for effective face recognition task. This paper analyzes the effectiveness of existing deep learning based face recognition algorithm which is provided as an abstraction. The algorithm is provided as cloud service and user is allowed to apply in their application by calling appropriate API in their code. Amazon Rekognition service provides API for recognizing facial details of the given image. The entire process involved in accessing this service is also explained in this paper. As an application, this service is utilized to display suitable ads to the customers in a retail store. The performances of the system are examined by testing with images captured in real time and responses are precise. The decision logic can be improved by surveying with more customers in a departmental store.

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