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Age and Gender Detection System using Raspberry Pi

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***Abstract*— Since the rise in social media and interactive systems in recent decades, the automatic classification of age and gender has become relevant to most of the social platforms and human-computer interactions. To achieve this task, many methods are implemented, but somehow those are not effective with real-world images as most of the models are trained using images of limited dataset taken from lab settings which are generally constrained in nature. Such images do not contain variations of appearance which are usually observed in images of the real world such as social networks, online repositories, and websites. In this paper, we try to improve the performance by making use of the deep convolutional neural network (CNN). The proposed network architecture uses Adience benchmark for gender as well as age estimation and its performance are much better with real-world images of the face. Here in this paper, a suitable method is described for the detection of a face at real-time and estimation of their age and gender. It first detects whether a face is there or not in the image captured. If it is present, the face is detected and the region of face content is returned using colored square structure and returns their age and gender as a result. The convenient and easy hardware implementation for this method is by utilizing a Raspberry-Pi kit and camera, as it is a minicomputer of credit card size. To build an effective age and gender estimator, the concept of Deep Convolution Neural Network is used. The input data contains different age groups of male and female face images. Over captured faces' feature extraction are compared with this input data to evaluate the age as well as the gender of the person.**

***Keywords*— Raspberry Pi, Human face detection, OpenCV, Age, and Gender detection, Convolutional Neural Network.**

I. INTRODUCTION

Most of the existing algorithms for face detection have achieved a higher rate of recognition but they need adequate time to detect the faces in the given frame. For real-time applications, this processing speed seems certainly insufficient. The simple and cost-effective system for face detection and gender and age estimation is necessary.

The enhancement in performance of several applications like recognition of a person and interaction of human and computer can be achieved by faster recognition of faces and effective evaluation of age and gender. Automatic age and gender estimation involve evaluating exact gender type and age/age group of the person.

Recognizing human age and gender is an important task since different age group and different gender people respond differently to certain situations.

The understanding of human face image processing is a crucial task. Automatic estimation of age requires evaluating the age group of a person. A dense representation of labels for the age group is adopted in the task of evaluating the exact age group of the person. Earlier existing most of the systems used labels which divides age groups roughly (children, young, adult, elder). The proposed system divides the age group labels into eight classes (eg. 0-2, 4-6, 8-13, and so on). This paper demonstrates the problem of automatic identification of gender by exploiting the physiological aspects of the face. Two main components for building an effective age and gender estimator are facial feature extraction and estimator learning. In addition, an effective age and gender classification process can improve the performances of many different applications, including recognition of person and interface of human and computer.

In Real Time applications, the image is captured and the face is detected and the region of a face is returned with the computed values of age and gender. The system is tested across a standard face database, which consists of several images with and without noise and blurring effects. The efficiency of the system is calculated by the rate of face detection. The proposed system shows excellent performance efficiency by recognizing the faces even from low quality and slightly blur images.

The main advantages of the proposed system are keeping track of faces and along with that estimating the approximate age group and gender in real time. The processor namely raspberry pi is of low cost, smaller in size and provides a good execution speed for real-time processing. Another advantage of this system is, it detects more than one face from the window capturing the video. The system efficiency is measured in terms of face detection rate.

II. RELATED WORK

In paper [1], the Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), Local Binary Pattern (LBP) algorithm are used. The system which has been proposed works well on images which have low resolution also. From the face image, 21 features are considered and Quadratic Discriminant Analyzer (QDA) is used to categorize the exact gender. In paper [2], distinct aging models are learned for distinct human beings based on a sequence of age-ascending face images for the same human being. In paper [3], Image-based method and structural-based method are proposed for automatic face detection. The principle component analysis (PCA) is used to extract a different facial feature. The Viola-Jones is used for a visual object detection framework to achieve high face detection. In this page [4], the Viola-Jones and Neural network methods are used for face detection. Which is many times faster than any other previous methods. Neural networks are used for classifying the candidate image to faces or non-faces. In this paper [5], Group-Adaptive System, Feature Extraction Base Face Recognition, Hog Features, and Viola-Jones are used for face detection and gender classification purpose. In paper [6], computer vision and machine learning approach based on Convolutional Neural Network (CNN) is used to detect face and extract various facial feature. In paper [7], the Deep Conventional Neural Networks and GoogleNet with the help of Caffee deep learning framework are used for gender and age groups of the facial images captured from the camera. In paper [8], for face recognition PCA and SVM methods are used.

The survey revealed that we require a system, which shows magnificent performance efficiency and also must detect face for poor quality images. Hence, in the proposed system real-time image is captured from a video stream using Raspberry camera. For face detection, viola-jones uses HAAR feature based cascade classifier algorithm. The age and gender are classified using a convolutional neural network.

The rest of the paper is organized as: Section III describes about the Age and Gender detection system methodology. Section IV describes about the result and discussion of the proposed system. Section V mention about the conclusion.

III. METHODOLOGY

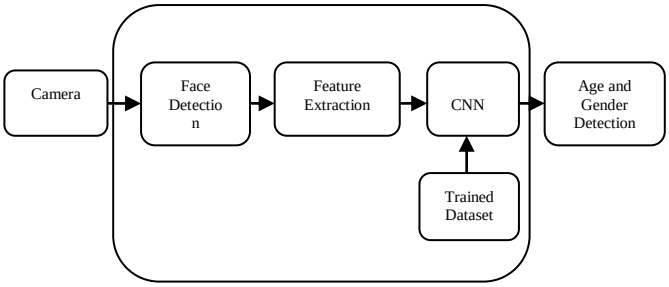

Figure 1: Dataflow diagram of the proposed system

In the proposed system, Open CV (Open Source Computer Vision) is an open source licensed library that includes many computer vision algorithms is used for face detection and feature extraction is shown in Fig 1. At first Raspberry, the camera captures the image in real time. If any faces are present, then it is detected by viola-jones. The viola-jones uses HAAR feature based cascade classifier algorithm to detect face and colored box will appear in the image around the face. Later the face features are extracted using AdaBoost classifier. The Proposed Network Architecture uses CNN for both ages as well as gender estimation. It is illustrated in the below Fig 2.

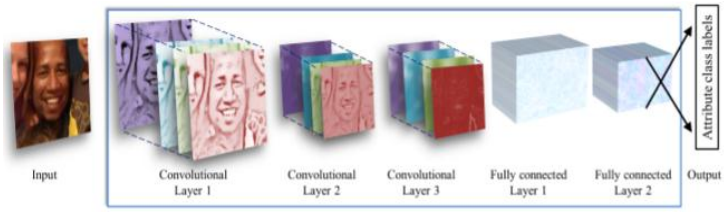

Figure 2: CNN Architecture

As more detail representation is shown in Fig 2. This network contains three convolution layers and two free connected layers with few neurons. The smaller network result helps to reduce the risk of over-fitting.

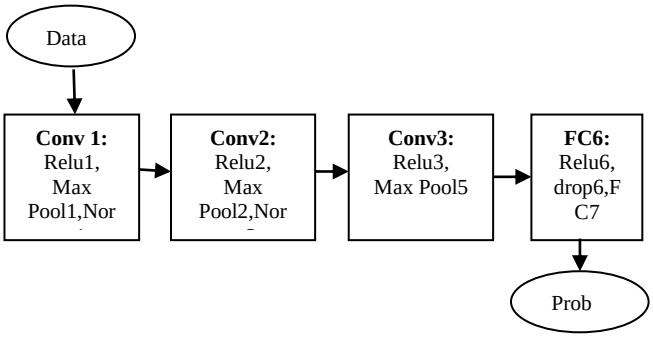

Figure 3: Schematic Diagram of Network Architecture.

The working procedure is as follows:
1. The first convolution layer consists of parameters as a kernel of 7 pixel size and a stride of 4 along with a rectified linear operated [ReLU] layer and max-pooling layer of 3 pixels of kernel size with stride of 2 pixel and local response normalization layer is applied which will result into application of 96 filters to the input image as shown in Fig.3.
2. The output image of the previous layer will be is then passed to the second convolutional layer. The second layer contains 5-pixel kernel along with ReLU layer and max-pooling layer, local response normalization layer with the same layer parameter as in the first layer is applied. Hence the image is passed through 256 filters in this layer.
3. The output of the second convolutional layer will be 256×14×14 blob which will be fed to the third convolutional layer of 3-pixel size kernel along with ReLU and max-pooling layer. The third convolutional layer will apply 384 filters.
The following fully connected [FC] layer will work as follows:
4. The first fully connected layer contains 512 neurons and ReLU along with a dropout layer. It receives the output image processed by third convolutional layer and 512 neurons produce output with dropout ratio of 0.5(randomly half of the neuron's output will be assigned value 0) to limit the risk of overfitting.
5. The output of the first fully connected layer is passed to the second fully connected layer. The second layer also has 512 neurons and dropout layer of 0.5 ratios.
6. The first fully connected layer maps the age and gender classes. The output of the second FC layer is passed to a software layer which will assign the probability for the class. In the case of age estimation, there are two classes and in gender estimation, there are eight classes. The captured images with maximal probability help out in prediction based on class.

3.1 Testing and Training

Initially, the models which are not pre-trained are not used. Where models of pre-trained have hundreds and thousands of frontal face images for face recognition used in training for network initialization. Instead, the network is trained using the images and labels available by the classification of age as well as gender through Adience Benchmark. We used this for our training because uploaded images without prior manual filtering are present on Advanced set. Adience images contain some images wherein head position, the quality of lightning conditions have extreme levels of variations. This again is compared with CNN implementations. Training is performed with 50 images batch size. Initially learning rate was e-3, after 10,000 iterations it is reduced to e-4.

We found the small misalignments in Adience images (motion blur, occlusions) can impact the resulting quality. This resolved by oversampling method, which feeds the network consisting of the same faces of multiple translations. The network is given with 227×227 crop image and five regions are extracted from it. Four from corners of 256×256 image and other is the centre of the face. All these images are provided along with their horizontal reflections to the network. The mean prediction value across these variations is taken as the final one.

IV. RESULTS AND DISCUSSION

The system is fed with facial images of different ages and gender. The network architecture defined in our system is applied in the process of face detection, age, and gender estimation.

The images are taken from the Rasberry Pi camera. The photos are in .jpg and .jpeg format of different image resolutions. The confusion matrix of age and gender detection is shown in Table 1.

Table 1: Confusion matrix for age and gender detection.

prediction → / actual ↓	YES	NO
YES	TP (15)	FN (2)
NO	FP (1)	TN (2)

We have tested our system with 20 input images and the above confusion, the matrix is drawn from that.

During testing for 15 images among 20 images, faces are correctly identified, age and gender are also correctly predicted (true positive). For 2 images, no faces were there and the prediction was no face detected (true negative). For 1 image, there was no face but still, a face was detected and the prediction was face found (false positive). For 1 image, the face was detected but the predicted age was not correct (false negative) and in another image, the face was detected but the predicted gender was not correct (false negative).

The accuracy of the proposed system is calculated as the total number of correct results predicted to the total number predictions. The accuracy is calculated using Eq.(1).

$$\text{Accuracy} = \frac{YY+YN}{YY+YN+XP+XN} \quad (1)$$

Where YY= True Positive, YN= True Negative, XP= False Positive, XN= False Negative. The calculated accuracy is 85%.

The precision of the proposed system is calculated as the number of positive class predictions to the sum of a total number of correct predictions. The precision is calculated using Eq.(2).

$$\text{Precision} = \frac{YY}{YY+YN} \quad (2)$$

The calculated precision is 88.23%.

Figure 4: Group image.

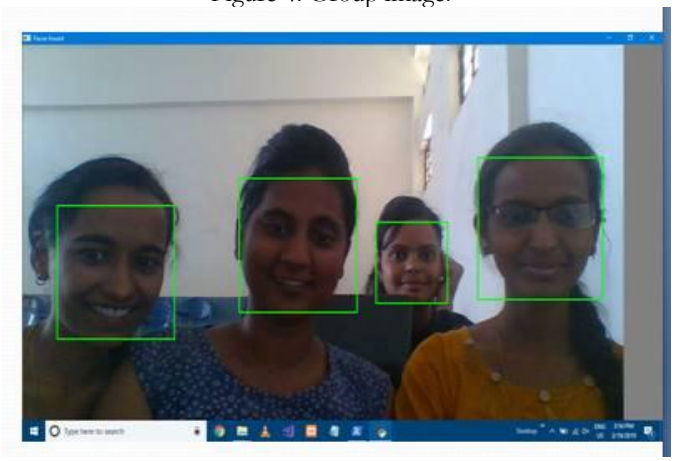

Figure 5: Multiple faces are detected.

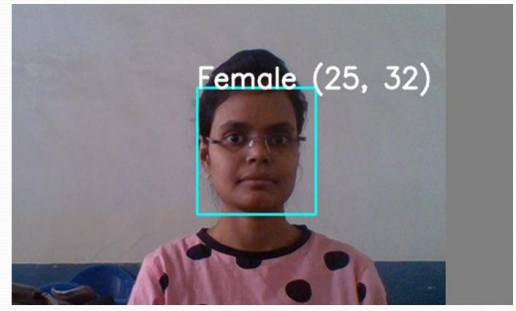

Figure 6: Age and Gender predicted.

V. CONCLUSION

The real-time image sensor detection and tracking of the face became a challenge for several researchers. This paper demonstrates a system which detects and tracks faces in real time and estimates age and gender. The CNN is used to provide enhanced results of age and gender estimation, even by considering limited training dataset of unconstrained labeled images for age and gender. The simplified network architecture will resolve the issue of over-fitting of data and will yield better results for other training datasets as well as testing real-time images. Detection of face techniques is employed in several applications like recognition of the face, extraction of facial features. With the progress, the detection of the face at real time in remote monitoring is helping in constructing efficient applications.

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