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Gender Classification from Facial Images - Performing the classification of Gender from the facial Images and implementing the same on the Real Time

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Abstract: ***Gender recognition is one of the aspects which is of massive interest for many industries, be it surveillance, biometrics or information gain. As a result of its immense importance, many techniques were proposed in the last years. Different methods have been accessible depending on the benchmark they set for further research in the same area. In this context, this paper gives an overview of the techniques, datasets, and classifiers required to reach the same goal.***
Keywords: Face Detection, Gender Classification, Haar Cascade, Adaboost, SVM, CNN

I. INTRODUCTION

Recognizing gender has now become a fundamental step in many human-machine interactions. It can be applied to marketing, security, and all other fields where identifying gender makes it better for tackling the further aspects of the given task. Gender prediction is the gateway tool for any application which takes advantage of it to improve their functionality by doing targeted interaction with the gender of its preference. Classifying gender may also be useful in other applications, where eliminating false identification on the basis of mismatched gender could be of use to the motive of that application. One of the oldest techniques doing the task of gender recognition makes this a binary classification. It was done by Mustafa et al. [1]. Being a binary problem, it doesn't guarantee high accuracy. After detecting a face in a still image, it identifies only one gender and sets the other gender as default. The model is trained by training data and then it predicts the gender of test data. Training the model seems obvious but a technique that tried to challenge it is KNN (K-Nearest Neighbour) [7]. This technique believes in not training the data, instead of that every time the input feature data is compared to the data present in training data and the result is made according to that. This technique is different but its computational cost is high and accuracy is not very high. The breakthrough in this research area came when Moghaddam et al. [3] proposed a method in which they used Support Vector Machine(SVM) for gender classification based on facial images. Now, other researchers could arise from here combining SVM with some popular descriptors. Local Binary Pattern(LBP) is among one of the descriptors, first used by Yang et al. [3]. It provides slightly better discriminative power along with computational simplicity. But its accuracy is 78.91%. A better method to perform the same task of detecting Gender is using SVM and AdaBoost [8]. Zhang et al. [9] improved the accuracy up to 92.5% using the same. In still images, sometimes the person's face can be somewhat misaligned, it performs face alignment first, and texture normalization is also done on the same. In texture normalization, a part of the face is separated, and operations are performed for enhancing the texture [14] [18]. Mesh filter is applied to the face using the essential features of eyes, nose and other facial points. It gains the high efficiency of detecting gender with the error rate of 3.4% [18]. One of the latest techniques used in vision-based gender detection is using Convolutional Neural Networks. Earlier, CNN was used with HOG [4] for performing classification. FERET Dataset was used giving an Accuracy of about 96% [4]. Now it is combined with appearance-based 72 features to produce better results. AdaBoost is also coupled with the descriptor along with this technique. Datasets used to test the methods/algorithm were LFW, FERET, and SoF (Specs on Faces) with 200 images each. This technique produces a lot better results than any of the previous methods currently in use with an error margin of 0.5% using FERET dataset.

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II. LITERATURE SURVEY

A. Binary Classification using Haar Cascade

Various techniques for detecting gender from facial images focus on extracting features and training the classifier on a dataset. Then, the classifier is tested on test dataset, and it outputs the predicted gender. For performing the detection of the facial image, it is required to pick the features from the face present in that Image. To achieve the extraction of facial features, most common approach is Geometry based. According to which, a face is bounded by an eclipse and distance of eyes for the central line, length of eyebrows, position of other landmarks. The calculated distances and ratios are used to identify the images and classify them [2].

Mustafa et al. [1] used a simple method by detecting a region of interest(ROI) by assigning positive to the facial images and negative to other areas in a still image. This way, it becomes a simple binary problem. This technique uses a detector (Haar classifier detector) found in OpenCV. It uses INRIA and CVC CER 01 dataset to train the classifier. It does not guarantee high accuracy rate, which is usually an issue when we make it a binary problem [1][6].

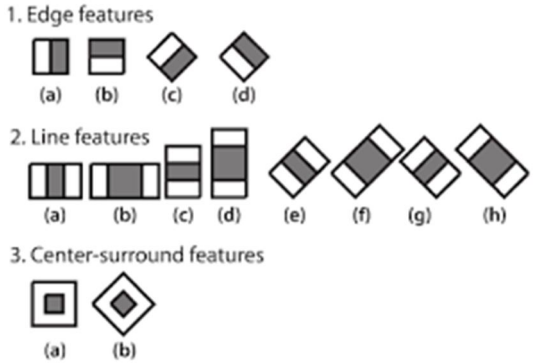

Fig. 1. Haar Cascading

B. K-Nearest Neighbour

One of the techniques for detecting gender is K-NN algorithm also known as the Nearest Neighbor algorithm. In this algorithm, the model is not trained according to the dataset of the feature [7]. Instead of that every time the input feature data is compared to the data present in training data, and the result is made according to that. In this algorithm, as the name suggests K nearest neighbor of the feature data is found from the already presented dataset [20]. And the probability of all the class is found. Here class refers to the number of different classification which is to be made. In the case of gender recognition, the classification is to be done in between two classes 'Male' and 'Female'. So, in this classification, if more than k/2-data sets of any the class is present then that class will be our output [7].

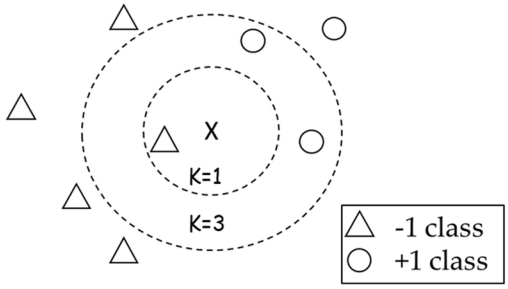

Fig. 2. KNN

1) Advantages

a) Robust to noisy training data.
b) Effective if the training data is large.

2) Disadvantages

a) Need to determine of parameter K (number of interest neighbors).
b) No clarification on Distance-based learning, which type of distance to use and which attribute to use for best results.
c) This algorithm has high Computation cost as we have to compute the distance of our feature data to all k-training samples around it.

C. SVM with Local Binary Patterns (LBP)

The Local Binary Patterns, LBP is the technique of Computer Vision, which provides the ability to read Texture Spectrum Models.

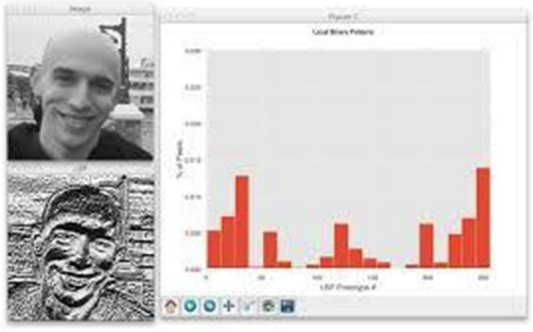

Fig. 3. Local Descriptors

Moghaddam et al. [3] proposed a method in which they used Support Vector Machine(SVM) for gender classification based on facial images. Use of SVM [10] [12] [14] proved to be a real boost in increasing accuracy in determining gender and achieved the error rate of 3.4% [19]. It led to a lot of other researchers in the same field by combining it with other descriptors which encode gender-related information. One of the most popular descriptors was Local Binary Pattern(LBP) used by Yang et al. [3]. The immense popularity of LBP was due to its excellent discriminative power and computational simplicity. LBP along with Discrete Cosine Transform provide results with 78.91% accuracy only [5] [13].

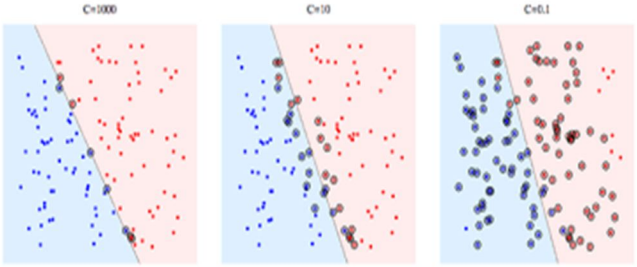

Fig. 4. Classification

D. SVM with AdaBoost

Much more improvised method to perform the same task of detecting Gender is using SVM and AdaBoost [8]. Zhang et al. [9] improved the accuracy up to 92.5% using the same. It is a binary process of classification and follows the same methodology of including face detection in the image and perform face alignment [6] [11]. The process of texture normalization is done to improve the results. In texture normalization, a part of the face separated and operations are performed for enhancing the texture [14] [18]. Mesh filter is applied to the face using the basic features like eyes, nose and other facial points. After the Real AdaBoost, a statistical two layered learning algorithm is applied to the images to perform classification even on the marginal differences [18].

The algorithm trains on 11500 Chinese faces having a neutral expression and without any beard or strange hairstyle. The dataset includes 7000 male faces and 4500 female faces. It gains the high efficiency of detecting gender with the error rate of 3.13% [18]. Even with high accuracy this technique unable to maintain its performance in real time as it requires on neutral faces as mentioned.

E. Convolutional Neural Networks (CNN)

In our studies, it was found out that one of the latest techniques being used in vision-based gender detection in using Convolutional Neural Networks. There are majorly two methods of extracting features from the given face image to predict the gender. First is appearance-based which uses about 72 facial points as key features and second, is geometry based using specific regions of the face as local features. Using both these methods simultaneously minimizes the margin or error. Previously CNN was used with HOG [4] for performing classification. FERET Dataset was used giving an Accuracy of 96% [4].

Datasets used to test the methods/algorithm were LFW, FERET, and SoF (Specs on Faces) with 200 images each.

During the research period, we found out about some of the key features that distinguish between a male and a female are narrower eyes in males, distinct brow ridges, slightly thinner lips, wider jaws, etc.

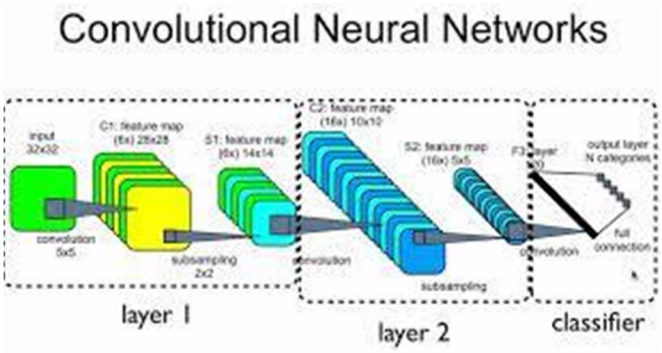

Fig. 5. Layers of CNN followed by Linear Classifier

The technique applies the lighting-invariant functions like SSR (Single Scale Retinex) to improve the low contrast possibility of an image to improve the accuracy of results. Then Cascaded Deformable Shape Model (CDSM) is used to detect and extract facial features like estimated landmarks of nose, eyes, mouth, lips, etc. Each "patch" or feature then becomes an input for a pre-trained CNN to the individual outputs of which, AdaBoost based score fusion mechanism is applied. It finally goes through a Linear Discriminant Classifier, and the final result is predicted.

This technique produces a lot better results than any of the previous methods currently in use with an error margin of 0.5% using FERET dataset.

III. OUR METHODOLOGY

We are using the best of the techniques studied above. The used technique uses CNN as its base for detecting faces.

Using dataset from IMDb, we have trained our model with 2500 labeled images and tested on 500 images. To implement the neural networks, we are using TensorFlow Framework and Keras Deep Learning Open Source Library.

Firstly, we train the model using the dataset images. This is a time taking process. During this training part, a model for identifying gender and detecting faces is created, if not already existing, otherwise the previous model is enhanced using backtracking. Then the model details are saved in a separate file. We use this file for testing our model so that we won't have to train the model every time we test it.

Our Neural Network Model has 2 hidden / intermediate layers with first hidden layer containing 128 nodes and second hidden layer containing 256 nodes.

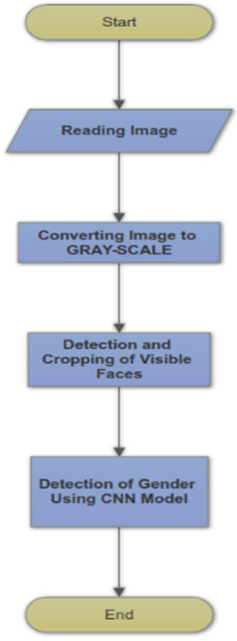

Fig. 6 Flow of code

During testing period, the image is passed as input to the code. And the image is converted to GRAYSCALE from COLOR in order to provide better illumination and contrast for better face detection. This image is passed to a CNN based face detector which returns the cropped face on which we can do processing.
face is then input to another neural network which classifies the face as a male or a female face by passing the results through hidden layers of CNN.

IV. CONCLUSION

After studying various techniques for classification of gender, we decided to use the best technique. The results of our technique using mentioned datasets achieve results of up to 78% accuracy rate in very suave/mild training and limited resources.

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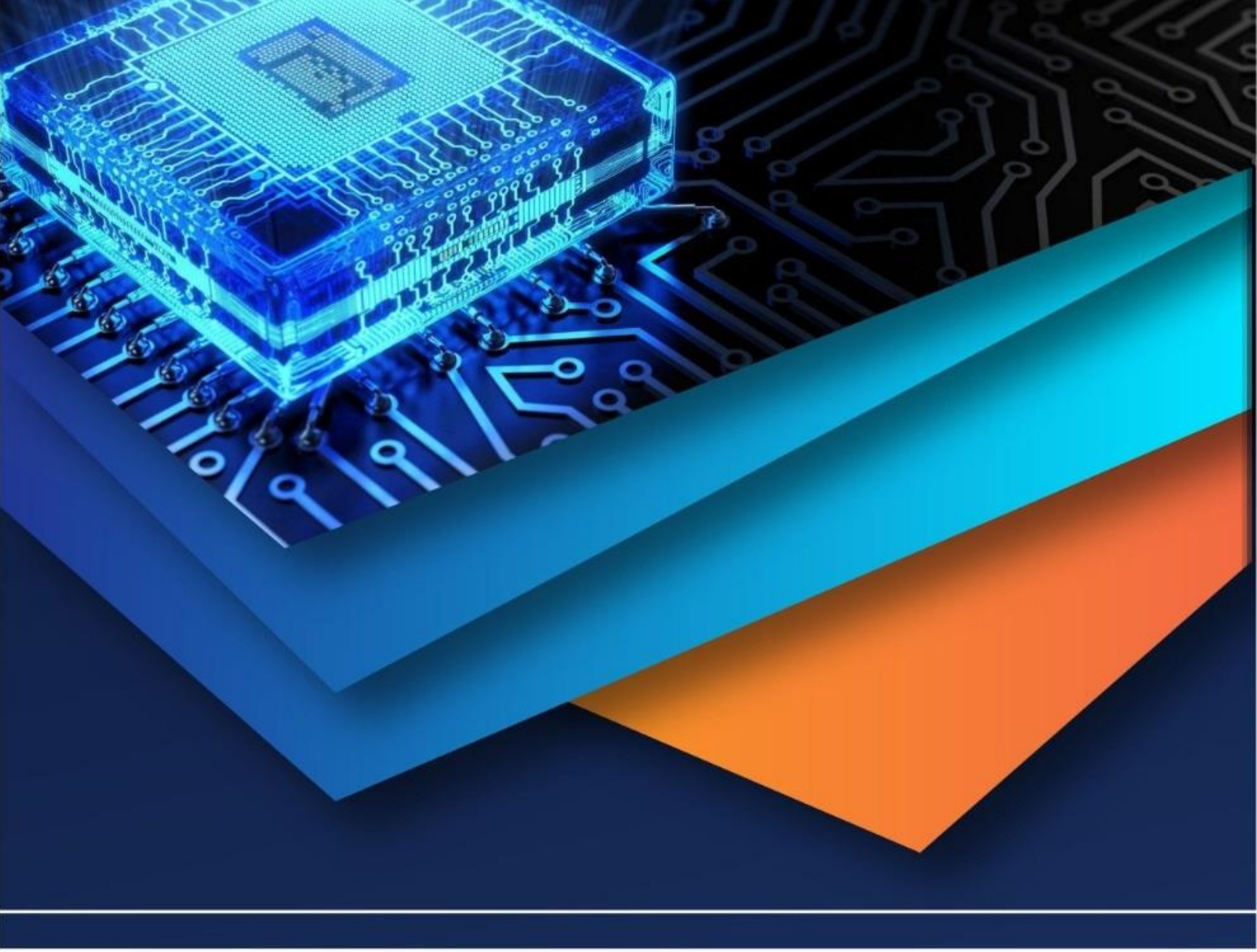

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