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GENDER RECOGNITION AND AGE DETECTIONUSING HUMAN FACIAL FEATURES

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Abstract: One of the active study fields in recent years is the extraction of information from the human face. Numerous investigations on the identification of the most prevalent face variety, including age and gender, have been done. The approach for automatically determining a person's age and gender from their face is suggested in this paper and is based on convolutional neural networks and support vector machines. The four steps of this method are face detection, pre-processing, feature extraction, and classification. A variety of convolutional neural networks have been trained to detect faces in live feed and also determine their age and gender are part of our system. Our model was trained using Adience benchmark dataset for age and gender prediction available on Kaggle, which has produced positive results.

Keywords: **Convolution neural network, Support Vector Machine, Face Detection, Multi-Task Cascaded Convolution Neural Networks, Principal Component Analysis, Adience benchmark dataset.**

1. INTRODUCTION

Numerous real-world applications, such as behavior research, online advertising, social understanding, identity verification, video surveillance, human computer interface, and many others, depend on age and gender information. Despite their many applications, it can be difficult to automatically determine a person's age and gender from facial pictures. The project's objective is to create a gender and age predictor that uses deep learning& machine learning concepts on the Adience Dataset to roughly guess the gender and age of the person (face) in live feed using a flask-made web application from live video feed.

The predicted gender may be one of 'Male' and 'Female', and the predicted age may be one of the following ranges-

(0– 3), (4 – 6), (8 – 13), (15 – 20), (25 – 32), (35 – 43), (45 – 53), (60 –150).

It is already known that predicting age and gender of a person by just seeing its face is a difficult task for even a human. There are numerous problems that we faced during this research work. First is illumination i.e., not adequate lighting in the space at time of input (video/image acquisition). Second are foreign objects (like glasses, masks, hair, etc.) in between the subject face and camera cause's poor results [1]. Third is Frontal Face i.e., face rotations in and out of planes affects the results, hence, subject should face the camera directly instead of having a sideways gaze.

2. LITERATURE SURVEY

In the field of machine learning and computer vision, numerous studies and research work have been done on human age and gender detection. In this section, a brief overview of the work done by previous studies on age and gender detection is shown.

For Face Detection, we started by using the method proposed by Viola and Jones [2], which provided good performance in real time. However other research [3], demonstrate that when there are greater variances in human faces, this approach deteriorates dramatically in real-world applications. Inspired by CNN performance, several studies [4] proposed numerous CNN-based face detection approaches as a result of this. For face detection, we employed MTCNN [5], because it shows that performance has improved significantly when MTCNN is used, and it also performs better in real-time application.

For Gender Recognition, various techniques, such as facial photographs [6], hand images, and pose/body images [7], can be used to identify gender. By extracting two different sorts of characteristics, gender recognition is

accomplished [8, 10]. The first type of feature extraction is geometric-based features, which describes the elements of the shape and position of the face using geometrical principles. It also discovers the locations of facial points. Second type of feature extraction is appearance-based features. For Age Detection, two different types of features are extracted from the facial photos [8, 9, 10].
(i) Wrinkle Features: The f5 properties are estimated. Additionally, as we age, facial wrinkles are increasingly obvious. (ii) Geometric Features: These characteristics are based on ratios of different face feature data (e.g., eyes, nose, mouth, chin, etc.).

Ref. [11] is one of the most popular research papers in age and gender classification using a neural network; it shows that usage of deep trained neural networks can dramatically increase performance. Also, Reference [11] suggested using deep CNN on the Adience dataset, which is effective for recognizing low resolution facial expressions. However, it faces challenges to identify the face image if there is some rotation or tilt.

ML algorithms are also used for age and gender detection, such as Support Vector Machine (SVM), Naïve Bayes algorithm, K-means clustering. K-means method is employed in reference [9] to identify age groupings. SVM is used for image classification in reference [12, 13, 14], and it provides good accuracy. PCA is used which is employedin reference [15] to accomplish dimensionality reduction in order to produce better and quicker results.

3. METHODOLOGY

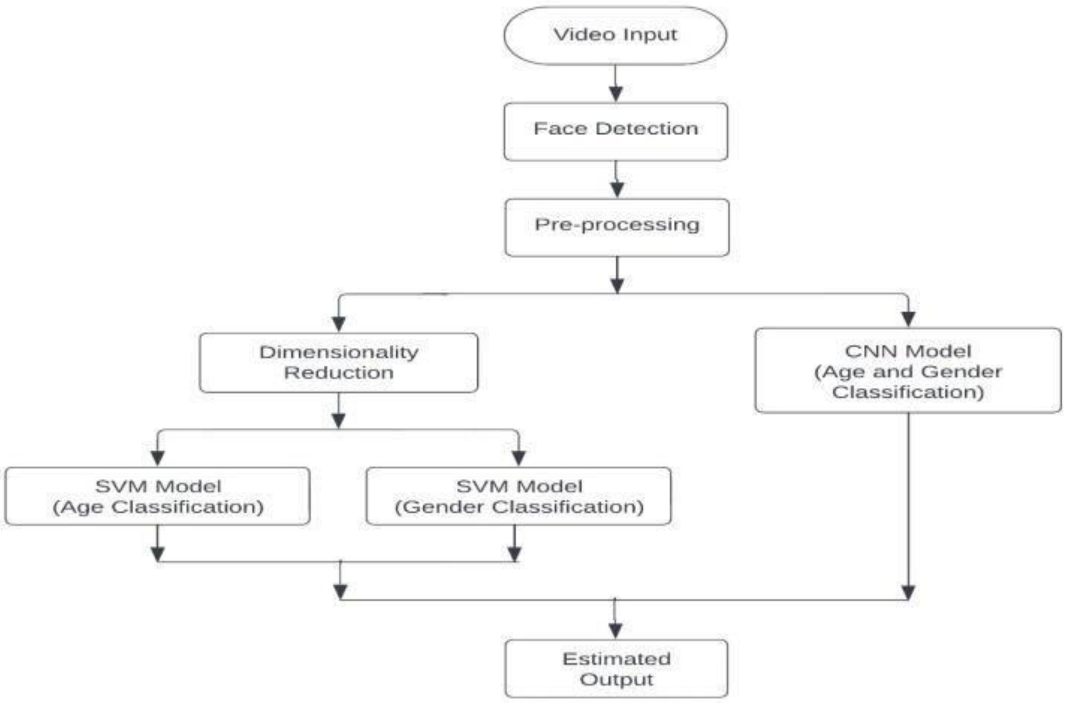

Fig. 1. Proposed Methodology

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3.1. Data Acquisition

The Adience benchmark dataset is used as our dataset for detecting the age and gender in images. The Adience dataset consists of 26,580 256×256 color facial images of 2,284 subjects, with eight age group classes:(0– 2), (4 – 6), (8 – 13), (15 – 20), (25 – 32), (38 –
43), (48 – 53), (60 –100).

We use the in-plane face alignment approach to align the faces. Age classification is tested using a standard five-fold, subject-exclusive cross-validation process, and the results are averaged to obtain the final age group classification.

Fig.2. Sample Images from Adience Benchmark Dataset

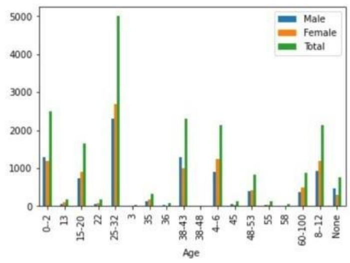

Fig.3. Combined Age and Gender Dataset

3.2. Face Detection

We utilized MTCNN for facial detection (multi-Task Cascaded CNN) [5]. It is capable of Landmark detection, which is the recognition of additional face features like the eyes and mouth. The network uses a cascade structure with the networks: The image is first rescaled to a variety of different sizes (referred to as an image pyramid). The first model (Proposal Network, or P-Net), which proposes candidate facial regions, is followed by the second model (Refine Network, or R-Net), which filters the bounding boxes, and the third model (Output Network, or O-Net), which proposes facial landmarks.

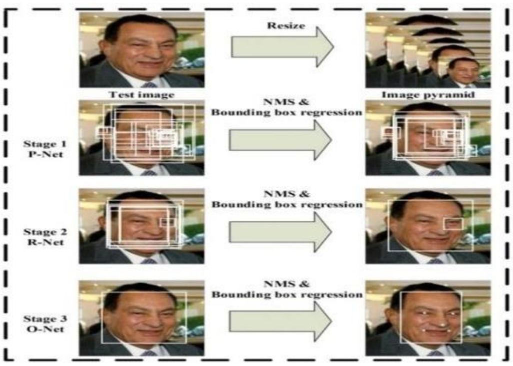

Fig.4. MTCNN process

The above image is taken from the paper [5], which provides a helpful summary of the three stages from top-to-bottom and the output of each stage left-to-right.

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3.3. Pre-Processing

3.3.1 Data Augmentation

Data augmentation is the technique of creating additional data points from current data in order to artificially increase the amount of data. By creating fresh and varied examples for training datasets, augmented data is enhancing the efficiency and outcomes of deeplearning models.

3.3.2 Data Normalization

The technique of projecting picture data pixels (intensity) to a preset range, such as [0, 1],is also known as data re-scaling**.** Here, we are normalizing our RGB images which are of data type uint8 and are in the range of [0, 255]. The new range will be [0, 1].

3.3.3 Dimensionality Reduction

Since Scikit-learn classifiers only accept training features in the form of 2D arrays, we are unable to directly feed RGB photos into any scikit-learn classifier. To solve this problem, we must flatten or restructure the 3D RGB images into a 1D array. However, a 256x256x3 RGB image can be flattened to create an array of the shape 1x196608 that has several properties.

We have performed dimensionality reduction technique by applying PCA (Principal Component Analysis)[17] in SVM model [12, 13]. Here in our project, we have taken the first 500 components which cover up to 90% information when summed up the individual component's variance. This means we have successfully reduced 196608 features to just 500 features by losing only 10% of the information from the dataset.

3.4 Model Building

After the preprocessing is done, the dataset is split for train and test purposes. Test size is 20% of the train size. We have created two models, first is using SVM algorithm andsecond is by using CNN model.

SVM Model

In order to swiftly categorize new data points, the SVM algorithm aims to determine the optimum line or decision boundary that can divide n-dimensional space into classes. The name for this ideal decision boundary is a hyper plane.

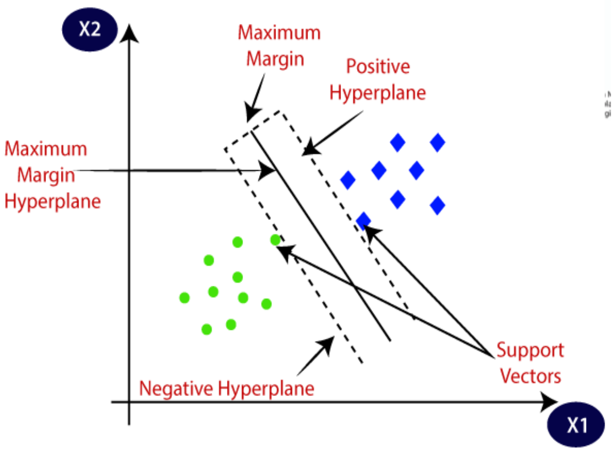

Fig.5. SVM

Now that the dataset has been generated, it's time to train many classifiers before selectingthe best one. Hyperparameter tuning will be used during classifier training.

Hyperparameter tuning is done using the Scikit-learn package referred to as GridSearchCV. We use GridSearchCV to automate the tuning of hyperparameters because doing it manually could take a lot of time and resources.

In our project we have created two different models, one for age and other for gender. Because SVM doesn't support multiclass classification natively. It supports binary classification.

CNN Model

A Convolutional Neural Network (ConvNet/CNN) [11] is a technique used in Deep Learning that takes an input image, assign distinct objects and elements value (learnable weights and biases), and be able to differentiate between them.

A ConvNet efficiently captures the spatial and temporal dependencies in a picture by using the right filters. The architecture performs better at fitting the picture dataset since fewer parameters are utilised and the weights can be reused.

CNN is specifically designed to process input images. Their architecture is then more specific. It is composed of two main blocks:

The first block uses convolution filtering to do template matching. A number of convolution kernels in the first layer filter the image, producing "feature maps" that are subsequently normalized (using an activation function) and/or shrunk.

The second block occurs at the end of all classification neural networks and is not a hallmark of a CNN. To produce a new vector at the output, the input vector values are converted (using a number of linear combinations and activation functions).

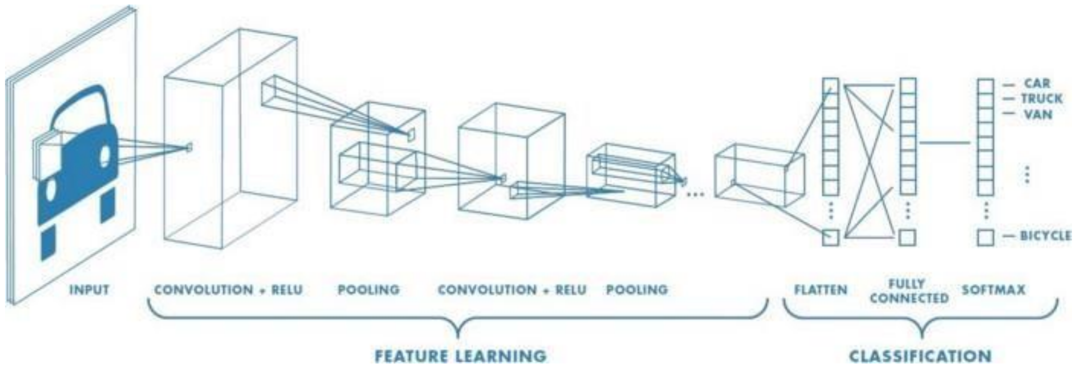

Fig.6. CNN

CNN layers

There are three types of layers that make up the CNN which are the convolutional layers, pooling layers, and fully-connected (FC) layers.

- **Convolutional Layer** - The first layer utilised to extract the different features from the input photos is this one.
- **Pooling Layer** - A Pooling Layer often comes after a Convolutional Layer. This layer's main goal is to lower the convolved feature map's size in order to save on computational expenses.
- **Fully Connected Layer** - The Fully Connected (FC) layer, which connects the

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neurons between two layers, is made up of the weights and biases as well as the neurons. This process flattens the input image from the preceding layers and feedsit to the FC layer.

4. RESULT ANALYSIS

The testing accuracy and validation accuracy of our model are checked, model loss is noted, and the confusion matrix is plotted. The misclassified images count of each type is also determined.

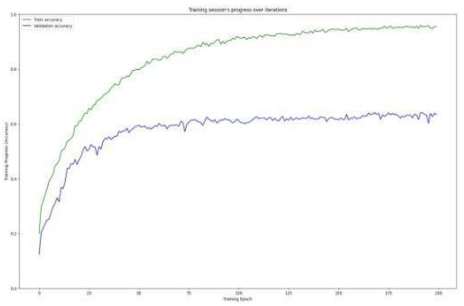

Fig.7. Training Accuracy v/s Validation Accuracy for Gender

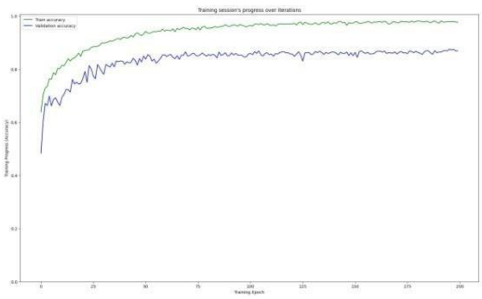

Fig.8. Training Accuracy v/s ValidationAccuracy for age

CONFUSION MATRIX:

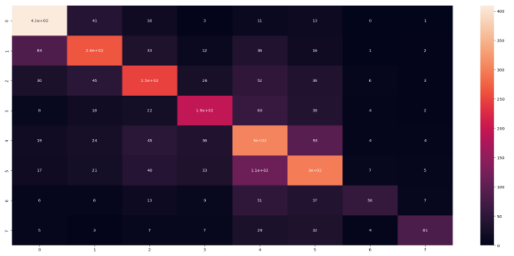

Fig.9. Confusion Matrix of SVM age

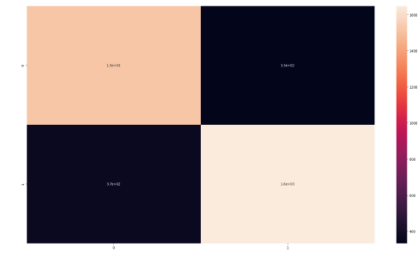

Fig.10. Confusion Matrix of SVM gender

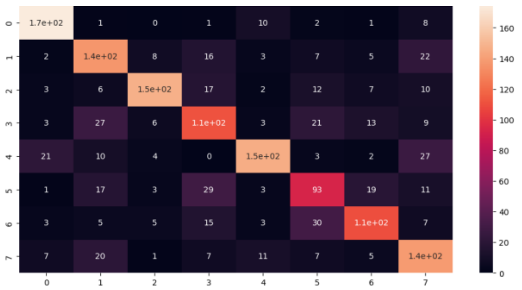

Fig.11. Confusion Matrix of CNN age

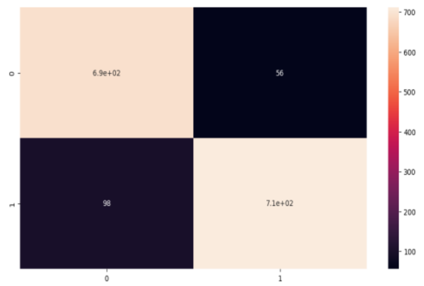

Fig.12. Confusion Matrix of CNN gender

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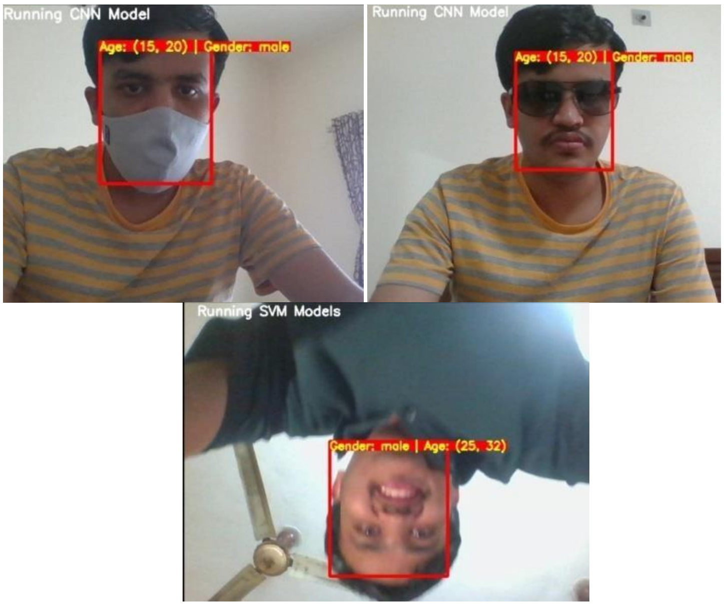
5. CONCLUSION

Accuracy of CNN model for Gender recognition is 90.10% and for Age detection it is 67.80% whereas accuracy of SVM model for Gender recognition is 81.74% and for Age detection it is 60%.

Thus, three important conclusions can be made from our results:

- First, even with the much lower size of modern raw image sets labelled for age and gender than when using the SVM model, CNN can be employed to offer better age and gender classification results.
- Secondly, when a person is wearing masks and goggles separately, we can accurately determine the person's age and gender.
- Additionally, when the face is turned upside down, we can estimate age and gender of the subject.



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Figures

[16] Figure 5: https://www.javatpoint.com/machine-learning-support-vector-machine- algorithm

[17] Figure 6: https://medium.com/@RaghavPrabhu/understanding-of-convolutional- neural-network-cnn-deep-learning-99760835f148