Automatic Prediction of Age-group from Frontal Facial Images

B. Abirami, T. S. Subashini

Abstract— Methods to automatically assess the age group of a person using his/her frontal facial image are proposed in this paper. This work is done for three major ethnicities: African, American and Asian with five different age-groups such as (1-10 years), (11-30 years), (31-50years), (51-70 years), (71-100 years). The performances of the classifiers were tested with face images of African, American and Asian population belonging to both genders. For this, first the facial parts such as the left eye, right eye, nose, mouth etc., are detected using the well-known Viola Jones Object Detection technique.450 sample images of the FERET database were considered for this study. Histogram of Gradient (HoG) and face-structure features are extracted and modeled using ANN and SVM. The efficiency of the proposed methods was tested with the facial images of various races belonging to different age-group and gender. Artificial neural network gave an accuracy of 92.10% whereas support vector machine gave an improved accuracy of 94.60%.

Keywords: Face detection, face-structure features, HoG features, ANN, SVM.

I. INTRODUCTION

A number of researchers have worked on automatic face detection/recognition whose applicability could be seen in various domain including biometric authentication, surveillance etc. Certain human traits are unique such as, face, palm print, fingerprint, iris etc., and researchers belonging to various domains such as psychology, forensics, computer-science, medicine, etc. have turned their attention towards automatic human trait detection and analysis. Any human-computer interaction (HCI) device first tries to estimate the age and gender. Computer vision and image processing technology helps to analyze frontal facial images to accurately predict a person's "physiological age-group", gender and race. This work aims to find a set of descriptors that can represent and highlight distinct information, which is used to build models for identifying one's age-group.

This paper is divided into five sub divisions. Section 2 deals with literature review and Section 3 with the proposed methodology and section 4 deals with experimental results, and conclusion of the work is given in Section 5.

II. LITERATURE REVIEW

Age estimation using image processing and machine learning techniques is being researched over the years and this section gives an overview of the works on automatic age estimation done so far.

Most of the works on age estimation using frontal facial image uses the well-known Viola and Jones [1] method to detect the face and various face parts. Viola and Jones method is very efficient in detecting face with very less computational time. It employs Adaboost classifier and can detect face region from images under different condition such as illumination, pose, color, etc.

To predict age, facial features viz., face edge, wrinkle features, the length between left eye and right eye, the distance between nose and eyes, the distance between eyes and jaw etc., which represent the shape of the face are extracted in [2].

The work in [3] tries to determine the age by comparing face features of the subject under testing with the faces of many people whose age are already known and by making a series of comparative search, the final decision is made about the age of the person under consideration.

The authors in [4] developed a method to detect the age-group from facial images using neural networks. They created their own face database of persons ranging from 1 to 85 years. Wrinkle densities and facial feature ratios were considered as features for classification and the performance was appreciable.

DCT features and SVM classifier were employed in [5] for real-time estimation of age and gender. DCT is invariant to illumination variation as well as varied facial expressions.

The author in [6] developed a real time age and gender estimation system based on SURF features. For this, first the face was detected using Stacked Trimmed Active Shape Model (STASM). 76 SURF features were obtained from the extracted face region and classified using SVM.

The work in [7] first detects the wrinkle areas from face images for extracting features. Each face image is then clustered using Fuzzy C-means algorithm for predicting the age of a person.

The authors in [8] used biologically inspired features (BIF) and SVM classifier to determine the age group, gender, and race of a given person using his/her normalized face image. The face is first normalized for pose and photometric corrections. Experimental results show that BIF is efficient in accurately predicting the age-group of a person from his/her face.

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The authors in [9] explored the application of neural networks to estimate age from real face image. A special tool developed by the authors to manually locate 94 points in each face. This tool also saves the located points with their (x, y) coordinates in a text file and the origin is assumed to be located at the end of the right eyebrow. The facial features were fed to the as Multi-layer perceptron neural networks (MLP) for classification.

Our proposed method aims to identify the age-group of a person from his/her frontal face image using face structure features and HoG features. The classifiers SVM and ANN are used to model these features and the performance are compared to determine the efficacy of the proposed method.

III. PROPOSED METHODOLOGY

The work is done in three parts. First part face detection is done. For this, the well-known Viola Jones Object Detection technique is employed to detect face and face parts namely left eye, right eye, nose, mouth etc. Second part of this work is related to feature extraction. This work proposes an algorithm to classify a person as belonging to any of the five age-groups based on HoG features and face-structure features. As the age increases, the face structure changes and this idea is exploited in this work and nine face-structure features are extracted. Histogram of Gradients (HoG) gives information on local appearance as well as shape of a face and so in this work, 81 HoG features from the face region is obtained and in total 90 features are used for detecting the age-group. In the third and final step ANN and SVM classifiers are used for detecting the age-group and the their performances were tested with the face images of African, American and Asian subjects belonging to different group and gender.

Fig. 1 shows samples face images of African, American and Asian population belonging to five different age-groups considered for this study. People belonging to different age-group will have distinguishing features and these features were able to classify the people. The performance of the proposed age-group identification system was tested with two classifiers namely ANN and SVM. The block diagram of the proposed age-group detection method is given in Fig. 2.

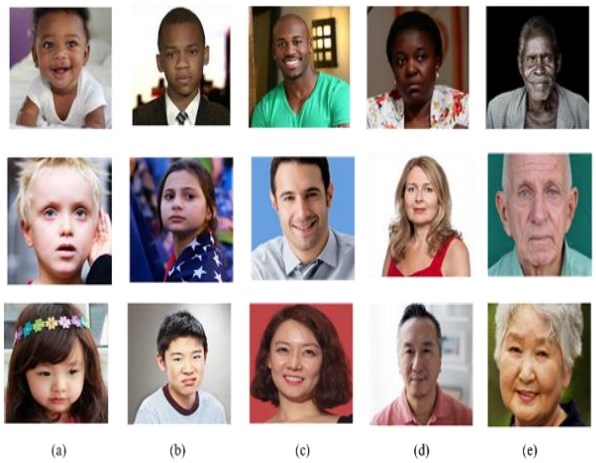

Fig.1 Sample images for African, American and Asian subjects belonging different age-groups a) 1-10 years, b) 11-30 years, c) 31-50 years, d) 51-70 years and e) 71-100 years

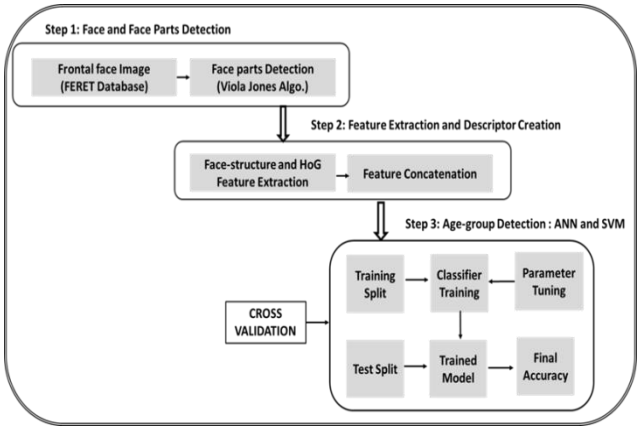

Fig.2. Block diagram for proposed methodology

Step 1: Face and Face parts Detection

In first step face images are collected from FERET dataset, face parts can be detected by using Viola Jones algorithm

For calculating the face-structure features, the overall face region and various face parts are detected by well-known Viola Jones algorithm. Fig.3 shows the sample images of face and facial parts detected using Viola Jones object detection algorithm.

Step 2: Feature Extraction

Generally, the existing solutions normally use a single type of descriptor, however in our proposed method; a face image is represented by a collection of global and local features extracted from various regions across the image.

Global feature namely the Face-Structure Feature employed in this work captures the changing structure of the face due to aging and the local feature namely, HoG gives information on the local appearance as well as shapes of face parts.

Fig. 3 Face parts detected in sample images of (a) African, (b) American and (c) Asian origin belonging to different age and gender

Face-Structure Feature Calculation

After detecting the face region and face parts, namely left eye, right eye, nose mouth etc using the Viola Jones Object Detection technique the information allowing for facial discrimination is extracted and these data are then used to recognize the age.The nine face-structure features extracted are given below.

fsf1 = length between RE and N/ length between RE and N

fsf2 = length between RE and M/ length between LE and M

fsf3 = length between RE and N/ length between RE and M

fsf4 = length between LE and N/ length between LE and M

fsf5 = length between RE and LE/ length between N and M

fsf6 = length between LE and RE/ length between LE and N

fsf7 = length between LE and RE/ length between LE and M

fsf8 = length between RE and N/ N height

fsf9 = N height/ length between N and M

Where,

RE is Right Eye; LE is Left Eye; N is Nose; and M is Mouth and fsf1 to fsf9 represents the nine face structure features.

Histogram of Oriented Gradients (HOG)

High frequency regions such as edges and corners give more information about the object shape when compared to low frequency regions such as uniform and plain regions. Magnitude of the gradients is large at the corners and edges of an image and the histogram of the gradients (HoG) could be used as features.

HOG gives information on local appearance as well as shapes of objects. For finding out the HoG features the image is divided into small blocks and histogram of oriented gradients of each block, is computed. In total 9 face-structure features and 81 HoG features were combined to create a 90-dimension feature vector and fed to SVM and ANN classifiers.

Step 3: Age Detection using SVM and ANN

Support vector machine (SVM) is widely used supervised classifier that is well suited for two class problems. The principle of SVM is that, it constructs a hyper-plane in a high dimensional feature space. The feature points which lie on the hyper-plane is considered as support vectors which are used for classification and regression tasks. ANN is a widely used pattern classification model which is a fully connected network in which weights are associated with each connection. It consists of three layers namely input layer, hidden layer and output layer. A detailed explanation of SVM and ANN is given in [10].

IV. EXPERIMENTAL RESULTS

The performances of the classifiers were tested with the face images of African, American and Asian population belonging to five different age-groups. In each age-group we are taking 22 images for both male and female. Totally 450 images were collected, which comprises of 22 face images under each of the five age-group category and the resolution of each image is 240*360. Of the total 450 samples taken, 330 images were used in training the classification model. For training, equal numbers of face samples were taken in each of the five categories. The remaining images were employed for testing purpose.

4.1 Performance of ANN classifier

Multi-layered perceptron was implemented for the purpose of training. The confusion matrix obtained for different classes, namely African, American and Asian for a network structure of 90 input neurons, 10 hidden neurons and 5 output neurons. The best result is obtained with parameters viz., 300 epochs, learning rate of 0.17 and Lavenberg Marquadt training algorithm.

Table 1: Accuracy for ANN

Age- Group in Years	African	American	Asian
1-10	94.4	90.0	90.0
11-30	96.6	93.3	90.0
31-50	95.5	92.2	94.4
51-70	96.6	88.8	90.0
71-100	95.5	87.7	86.6
Average Accuracy	95.72	90.4	90.2

Table 2: Sensitivity for ANN

Age- Group in Years	African	American	Asian
1-10	93.3	86.6	96.6
11-30	96.6	93.3	90.0
31-50	93.3	90.0	93.3
51-70	96.6	90.0	86.6
71-100	90.0	93.3	83.3
Average Sensitivity	93.98	90.65	89.97

Table 3: Specificity for ANN

Age- Group in Years	African	American	Asian
1-10	95.0	91.6	86.66
11-30	96.6	93.3	90.0
31-50	96.6	93.3	95.0
51-70	96.6	88.3	91.6
71-100	98.3	85.0	88.3
Average Specificity	96.65	90.32	90.31

Table 1 shows the Accuracy of ANN in identifying various age groups belonging to three different ethnicities. The overall accuracy ANN in correctly identifying the various age -groups irrespective of the race is 92.10. Table 2 shows the sensitivity of ANN in identifying various age groups belonging to three different ethnicities and the overall sensitivity ANN in correctly identifying the various age-groups irrespective of the race is 91.53. Table 3 depicts the specificity of ANN in identifying various age groups belonging to three different ethnicities and the overall specificity ANN in correctly identifying the various age-groups irrespective of the race is 92.43.

4.2 Performance of SVM classifier

SVM with the polynomial kernel is used for the classification of face image into any of the three races namely African, American or Asian. 330 images were used for training the network 30 for validation and 90 images were used for testing the trained network.The overall accuracy obtained is 94.69%.

Table 4: Accuracy of SVM

Age- Group in Years	African	American	Asian
1-10	97.7	95.5	93.3
11-30	97.7	92.2	94.4
31-50	96.6	92.2	93.3
51-70	97.7	95.5	94.4
71-100	94.4	93.3	92.2
Average Accuracy	96.82	93.74	93.52

Table 5: Sensitivity of SVM

Age- Group in Years	African	American	Asian
1-10	96.6	96.6	93.3
11-30	100	93.3	96.6
31-50	93.0	90.0	86.6
51-70	96.6	96.6	90.0
71-100	90.0	93.3	86.6
Average Sensitivity	95.24	93.96	90.62

Table 6: Specificity of SVM

Age- Group in Years	African	American	Asian
1-10	98.3	95.0	93.3
11-30	96.6	91.6	93.3
31-50	98.3	93.3	96.6
51-70	98.3	95.0	96.6
71-100	96.6	93.3	95.5
Average Specificity	97.62	93.64	95.07

Accuracy of SVM in identifying various age groups belonging to three different ethnicities and the overall accuracy is shown in Table 4. The overall accuracy SVM in correctly identifying the various age -groups irrespective of the race is 94.69. Table 5 gives the sensitivity of SVM in identifying various age groups belonging to three different ethnicities and the overall sensitivity of SVM in correctly identifying the various age-groups irrespective of the race is 93.27. Table 6 depicts the specificity of SVM in identifying various age groups belonging to three different ethnicities and the overall specificityof SVM in correctly identifying the various age-groups irrespective of the race is 95.44.

The SVM classifier was able to identify positive samples with an overall sensitivity of 93.27% and false samples with an overall specificity of 95.44%

The graph in Fig.4 compares the results obtained through ANN and SVM, and it can be concluded that performance of the SVM is far superior than ANN in identifying the age of a person from his/her facial image.

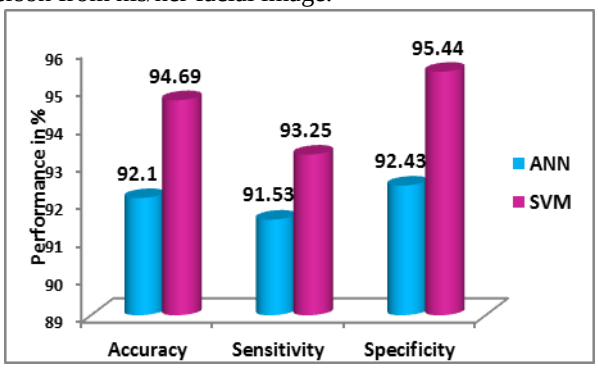

Fig. 4. Graph comparing the performance of ANN and SVM classifiers

V. CONCLUSION

In this paper, two different methods to automatically estimate the age-group of a person using frontal facial images was proposed. To ascertain that the proposed methods work for different ethnic groups three major ethnicities viz., African, American and Asian are considered in this work. After detecting the face region and face parts, namely left eye, right eye, nose, mouth etc., using the Viola Jones Object Detection technique from the images, the information allowing for facial discrimination is extracted and these data are then used to categorize a person as belonging to any of the five age groups namely (1-10 years), (11-30 years), (31-50years), (51-70 years), (71-100 years). Both the experiments were able to provide the solution to the problem of age identification, but on comparing the results obtained through ANN and SVM, it can be concluded that the performance of the SVM approach is far superior than ANN. Accuracy achieved in ANN was 92.10% and in SVM was 94.69%.

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