DOI: https://doi.org/10.24113/ijoscience.v5i7.163

A Review of Different Techniques of Age Estimation from Human Face

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***Abstract*- Age changes cause major variations in the appearance of human faces. Due to many lifestyle factors, it is difficult to precisely predict how individuals may look with advancing years or how they looked with "retreating" years. This paper is a review of age variation methods and techniques, which is useful to capture wanted fugitives, finding missing children, updating employee databases, enhance powerful visual effect in film, television, gaming field. Currently there are many different methods available for age variation. Each has their own advantages and purpose. Because of its real life applications, researchers have shown great interest in automatic facial age estimation. In this paper, different age variation methods with their prospects are reviewed. This paper highlights latest methodologies and feature extraction methods used by researchers to estimate age. Different types of classifiers used in this domain have also been discussed.**

Keywords: Age Estimation Methods, Age Variation, Image Processing, Face Tracking.

I. INTRODUCTION

Aging is an unavoidable natural process during the lifespan of a person. Human faces are subject to change mainly due to three reasons viz. age, gender and ethnic group. As the age seems to be the main cause of the facial changes, it has come to the forefront.

Compared with other facial variations, aging effects has three unique characteristics: [2]

- The aging progress is uncontrollable: It cannot be advanced or delayed and it is slow and irreversible.
- Personalized aging patterns: Every people have different aging effect. The aging pattern of each person depends on his/her genes as well as many external factors, such as health, lifestyle, weather conditions, etc.
- The aging patterns depend on time: The face status at a particular age will affect all older faces, but will not affect those younger ones.

The problem of Age classification from the facial images is very captivating, but also the demanding one because age of human varies based on the various factors which may be internal factors or external factors. Internal factors vary age include gender, genetics etc. while the external factors that affect the age include lifestyle, drugs, ethnicity, etc. and these two factors could make it complicated to perfectly formulate the human growth pattern. It is also worth mentioning that age prediction has been useful in the different systems such as demographic classification, Age Specific Human Computer Interaction (ASHCI) and image datasets indexing etc.

II. REVIEW OF LITERATURE

The age determination algorithm was first stated by Lobo and Kwon [1] used geometric ratios and skin wrinkles to make a distinction between babies and other groups and classified the age into three categories: babies adult and old. They achieved performance rate of less than 68% to

identify children was below 68%. Their work says that high resolution images are required for the good prediction.

Eliminating the limitations of Kwon and Lobo, Horng et al. [2] proposed a model that includes the different approaches to solving the wrinkles features and geometric ratios. They have used neural network to do classification and attained the accuracy of 81.6% for 230 test images.

Hayashi et al. [3], predicted age and gender based on the facial wrinkles. They used histogram equalization to enhance the wrinkles features and then shorter and the longer wrinkles are extracted using DTHT (Digital Template Hough Transform). Finally, age and gender are predicted by using a look-up table. They used 300 images ranging from 14 years to 65 years of age. They have achieved 27% of accuracy on the age prediction and 83% on gender estimation.

Lanitis et al. [4] focused on the different facial parts: whole face (including hair), internal face (excluding hair), lower part of face, upper part of the face. His work was limited to only 0 to 35 years of age. Experimental results showed that the region around the eyes is most crucial for age prediction and the upper facial part minimizes an error.

Chen, Yi-Wen, et al. [5] used Lucas-Kanade image alignment method for locating52 features points and constructed an active appearance model (AAM) using them. Then, texture features are sent to the SVM after facial image warping to predict the level of each group. Finally, average recognition of 81.1% has been achieved using gray scale value and but when applied Sobel detection method, they got 87.8% of recognition rate and achieved 82.2% of recognition rate after combining the gray image with the edge image.

Tonchev, K., et al.[6] developed a system consisting of Face Detection using Haar-like features and the Convolution Neural Network (CNN), Normalization of face, Subspace Projection for noise reduction by a combination of algorithms Spectral Regression and Principal Component Analysis and Support Vector Machine for the of age group prediction.

Khryashchev et al. [7] presented an algorithm for features extraction using local binary pattern and SVM classification. They have used MORPH, FG-NET and their own database to present experimental results and predict the comparison of humans and machines.

Weixing, et al. [8] extracted features by three methods. First, texture features, i.e. uniform local binary pattern (ULBP) using Gabor wavelet transform, secondly, facial partition based on the ASM approach and third, ratio feature based on facial skin areas and wrinkles region are extracted. They have used FG-NET database and self made face database for the training and testing. Adaboost based binocular location method is used to label the eye position. Finally, strong SVM classifier is employed according to three extracted features above and their method reached a recognition rate of 85.75% with the 180 × 180 resolution images.

Guo, Guodong, et al. [9] developed a Probabilistic Fusion Approach (PFA) that produce higher age estimation performance and fuses regression and classification process. In their system both SVM and SVR work sequentially. Intermediate decision using SVR results then sent to the SVM classifier for the multi-class classification of age.

Gunay et al. [10] exercised Local Binary Pattern (LBP) for the feature extraction and LBP histograms is produced for each image by splitting the image into n regions and feature vector are generated to classify the image into one of the predefined classes of age using K-Nearest Neighbors (KNN) and provided the accuracy of 80%.

Mohammad Ali et al. [11] proposed Histogram of Oriented Gradients (HOG) features based age group estimation algorithm. This algorithm provides the histogram of oriented gradients in the local parts of image and features are computed from the several different regions such as eye-corners, forehead, near cheekbones and below the eyes to make a feature vector and then probabilistic neural network (PNN) classifier is used for age group prediction.

Izadpanahi et al. [12] classified the age group using three classifiers SVM classifier, neural network classifier (NN) and density based linear classifier (LDC). Geometric feature first finds facial landmarks and calculates the six biometric ratios by using those seventeen landmarks After extracting the biometric ratios, these ratios are used by the classifiers to categorize the images into five different age groups, namely AG1 (0-2), AG2 (3-7), AG3 (8-19), AG4 (20-39), AG5 (40-60). He has achieved a success rate of 98% in classifying the babies (0-2) from other age groups.

Ren C. et al. [13] presented a method that involves two stages: one was the image preprocessing and enhancement stage and another is face detection with the Adaboost

algorithm using Haar-like features and then SVM categorized the images in one of the age groups and achieved the success rate of 76% in set1 and 93% in set 2. So the average recognition rate achieved was 84.5%.

Weixin Li et al. presented an algorithm based on Sparse Representation based Classification (SRC) in [14] which chooses human age in a hierarchical manner. After image preprocessing, Local Binary Patterns (LBP) method is used to extract texture features and then Active Shape Model (ASM) for shape features. But SRC required a lot of training samples of each class, so Ordinal Hyper-planes Ranker (OHR) was used to improve age estimation results.

Liu, Li et al. [15] utilized Active Appearance Model for extracting the features so that these features could be used to train the classifier with the Gaussian Radian Basis Function kernel (RBF). Since, feature space was so large, so they used Principle Component Analysis (PCA) to reduce the length of feature space. In the last step, SVM classifier categorize the age into one of the five groups based on the training dataset.

Ueki, Kazuya et al. in [16], presented a method based on the combination of two-phased approaches named 2DLDA and LDA. LDA discovers a projection for maximizing the ratio between the class scatter and within the class and also extract features. They used a WIT database for the various lighting images and attained the accuracy rate of

46.3% for 5-year range, 76.8%for 10-year range and 78.1% for 15-year range age-group.

Sarita Jain and Dr. A.J. Patil et al. [17] In this work, age prediction model has been intended to predict the age from the input facial images. From this work, it can be concluded that our method improves significantly over existing age prediction methods. Our system processes include preprocessing of input image, filtering, face and facial part detection, edge detection, features extraction, train the classifier by sending extracted features to the k-NN classifier and finally, testing is done for the test data by passing it to classifier in order to obtain the results. From the experimental results achieved, it can be concluded that the k-NN classifier produces better for the age-group prediction.

From the experiments and research, it has been observed that some of the aspects could not be accomplished within the extent of this work and therefore these can be suggested for the future work. From the results obtained, it is recommended that proposed age-group prediction algorithm could be effectively employed in many applications such as Age-Specific Human Computer Interaction, web application in order to prevent the under-age from, not to have access or from buying the adult contents or materials, and Security and Surveillance system for locating animals.

Vikas et al. [18] using facial features we can classified the age by using two categories which have been constructed for features: Global features, local features. Among global features, many researchers are used Active appearance models (AAM) is frequently. But it Causes of many drawback that they don't provide any information about features of skin and wrinkles. Many researchers are also used Based on the classification of wrinkle features .But it suffers setback in case of scar on face. Due to causes scar area a large (highest) number of edge points will come and that can lead to misconception. To eliminate this problem local and global both features are used for estimate the age. But there is one more hindrance due to which the correct estimation is measurably affects and this is less tackled by researchers for face non- uniform illumination.

Geng et al [19] proposed an automatic age estimation method named AGES (AGing pattErn Subspace). The basic idea is to model the aging pattern, which is defined as the sequence of a particular individual's face images sorted in time order, by constructing a representative subspace. The proper aging pattern for a previously unseen face image is determined by the projection in the subspace that can reconstruct the face image with minimum reconstruction error, while the position of the face image in that aging pattern will then indicate its age. In the experiments, AGES and its variants are compared with the limited existing age estimation methods (WAS and AAS) and some well-established classification methods (kNN, BP, C4.5, and SVM). Moreover, a comparison with human perception ability on age is conducted. It is interesting to note that the performance of AGES is not only significantly better than that of all the other algorithms, but also comparable to that of the human observers.

Ranjan Jana, Debaleena Datta and Rituparna Saha et al. [22] In this paper, a new methodology for estimating age of a person is described. The proposed method conveys a robust technique which estimates the age of a person from a set of face images with different age. Initially, most significant features such as distances between different facial objects, analysis of wrinkle area are considered. It is noticed that wrinkle area feature gives the best result to

estimate a person's age compared to the other features. So, wrinkle area analysis is quite useful procedure to estimate the actual age of a person. The obtained results are significant and remarkable. Faces with spectacle creates problem for proper eye and eyeball detection. Images should be of a frontal view image with uniform light on each part of the face. Images should contain single human face only and forehead should be clear of hair. So, it needs to be extended further which will consider more facial feature that can improve the accuracy of age estimation. This research work can be used for prediction of future faces.

III. FACIAL AGE ESTIMATION

Each age estimation system follows a general process as shown in figure 1. This process undergoes 4 basic steps for estimating age:

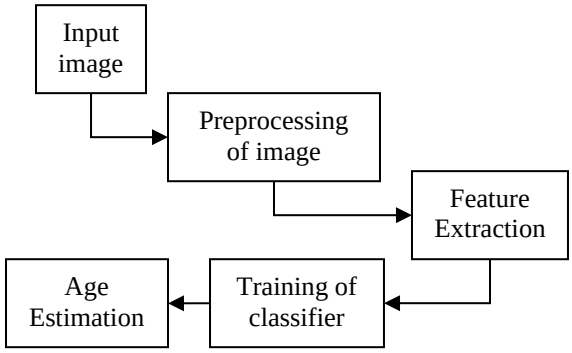

Figure 1 Age estimation process

Image/Input capturing: It includes fetching face from a database, or can be captured in real time. Other forms of input can be a video frame, or an entire video.

Preprocessing: It includes extracting the useful frame from the input if it is video frame. Detecting and cropping the face from the input image. Sometimes normalization of images is done before further processing, it can be contrast stretching, smoothening of image etc.

Feature Extraction: Extracting the features which will be needed according to the approach used. Some common feature extraction methods are, Local Binary Pattern, Bio-inspired features, Intensity encoding features, Linear Discriminant Analysis (LDA) etc.

Classification: It is generally done in two steps, coarse and fine. Classifiers are trained through training images by extracted features and the actual age of image. Age groups are predicted by using trained classifiers. After estimation of age group classifiers are used to fine tune the estimation to age.

Table 1 compares and summarizes some of the existing approaches and techniques that were introduced by different researchers.

Author name	Title Name	Results
Choi et al. [20]	Age estimation using a hierarchical classifier based on global and local facial features	MAE 4.65
Guo et al.[21]	A study on human age estimation under facial expression changes	MAE 6.19 & 8.11
Jana et al.[22]	Age Estimation from Face Image Using Wrinkle Features	MAE 8
Geng et al. [23]	Automatic age estimation based on facial aging patterns	MAE 6.77 & 8.83
Dat TienNguyen et al. [24]	Proposed an age estimation method using a weighted multi-level local binary pattern (wMLBP) based on a fuzzy-logic system. Finally, the age is estimated using a SVR method.	Experimental result is performed on PAL dataset and achieved about 6 MAE.
Liua et al. [25]	Proposed an approach using feedforward mechanism that is able to discover the most informative and reliable parts of a given face for improving age and gender classification	Experimental result is performed on Adience and MORPH dataset and achieved approx. 85% of accuracy and approx. 3 MAE.
Qawaqneh et al. [26]	Proposed an age and gender	Overall accuracy is calculated as

	classification from speech and face images by using deep neural networks	63.78% for Adience database.
Soumaya et al. [27]	Proposed age estimation from a facial images based on autoencoders. Autoencoder is an artificial neural network used for unsupervised learning of efficient coding.	Mean Average Error rate showing a value of 3.34% for MORPH dataset and 3.75% for FG-NET.

IV. CONCLUSION

Most research in the area of age prediction is limited by the good choice of database used and the size of the database. Some researchers have only focused on the certain age groups, while some have employed the wide range of classification. Due to the lack of quality database, a universal age prediction function for the wide range of ages is yet to be developed.

In this paper recent works in the field of age estimation was discussed. Many researchers had contributed and are still working in this field. Though there is number of problems in existing systems that need to be addressed such as occlusion created by spectacles, cap or facial hairs, uneven illumination. However some of the problems like non frontal pose, collection of images along with their age on large scale have already been solved but still have room for improvement. Researchers are working hard to use automatic age estimation in other research fields as well one of its example is Age Invariant Face Recognition. Automated systems can be installed in vehicles to restrict under age drivers to drive a vehicle. In general, different facial age estimation approaches and algorithms can be used to get effective results in different real life scenarios. This paper also gives comparative study of different research work done in the field of age detection by facial images.

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