

A Survey on Face Analysis and Its Applications (Face Recognition & Facial Age Estimation)

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Abstract: Face Recognition is a widely used research area that is being carried out by researchers in order to use it in different areas. The reason is its sole importance in a number of applications like face detection in crime scenes by the videos of the CCTV cameras, biometrics, authentication in customer relationship etc. A problem that arises in face recognition is that because of complex features like wrinkles, facial expressions, aging, the face of a person is sometimes not recognized by the system. If a fine approach is achieved which can estimate the correct age of a person despite of the aging factors which affect the image, then most of the problems in the face recognition would be solved. This review paper provides a detailed survey of the various state of art techniques of age estimation which are helpful in face recognition.

Keywords: age estimation; face; face recognition; face analysis; features.

1. Introduction

There are many features which can be obtained from a human face like age, expression, gender, race, and posture. Age estimation from the various features obtained from face has become an important topic now a days because of its various applications in different fields like security and privacy, surveillance, electronic vending machines, forensic science, criminal investigation, entertainment industry, and cosmetology [15]. Despite of so much work that has been carried out in this field, but nobody has still been able to produce a correct age estimation mechanism which is full proof and unaffected by all the intrinsic factors such as shape and size of face changes with passing time and external factors like style of being, dietary patterns and outer environment. To add to the factors that hamper correct age estimation are surgical facial scars, birth marks, dense facial hair growth and cosmetics.

Human face gives large scale variation in the way someone ages as features and patterns of aging are not identical between individuals according to the environment they are living and according to the dietary habits [1]. The face ages differently during different period of time. The shape of the face modifies as a person becomes adult from being a child. Then, wrinkles appear as the person starts getting old. The pace of change in the shape of face is less [2]. Wrinkles are also caused when a person smile. Facial expressions also matter a lot during the age estimation. Gender is another factor which is very important.

The remaining part of this review paper is organized as follows: Section 2 explains the importance of face recognition and age estimation. Next Section describes the basic steps that are followed during facial age estimation. Fourth Section gives insight of the standard databases that are being used by different researchers. Section 5 introduces a number of different used by various authors for age estimation. Section 6 finally concludes the problems that arises in age estimation during face recognition and also provides the possible solution for the same.

2. Motivation

The importance of age estimation is immense in various face recognition applications. Now we will discuss some of the fields where face image analysis is used.

2.1 Crime Scene Investigation

Now days, CCTVs are installed at most of the places but they are often of poor quality. If at a place, a crime occurs, the first thing that is checked is the CCTV footage. It is often seen that it is difficult to identify the individuals. If there is a mechanism that we could estimate the age or age group of the criminal with accuracy, it will be easier to identify him.

2.2 Searching of Individuals

Image repositories can be indexed based on age. This will help to easily search for an individual especially if we know the age of the person to be searched.

2.3 Biometric authentication

Like fingerprints, face can also be used a biometric authentication at offices for attendance, at ATM's for access to money, in various electronic gadgets which are holding our precious data etc. so that our precious data is saved from unauthorized access. Although, aging is a barrier in the accuracy of face recognition systems used for security. The solution to this problem is however, to create such face recognition systems which are age invariant.

2.4 Monitoring

Now a days, monitoring is very important as there is a lot of irrelevant content that is available on the websites which the children should not again. Again, such systems can be installed at the vending machines such that based on their age; they cannot take the things like alcohol, bear, knives which could harm them.

3. Facial Age Estimation process

The general steps followed in all age estimation mechanisms are represented in figure 1 and are described as:

3.1 Taking Input:

The first step is to take the input. The input can be extracted from a stored image from the database or by capturing it in real time. Image can also be extracted from a video.

3.2 Preprocessing:

This step is useful in removing the redundant information from the input image. Also, it highlights the significant portion by cropping the image and normalizes its contrast, smoothening, brightness etc.

3.3 Feature Extraction:

In this step, various shape and texture features are extracted from the preprocessed image. The commonly used methods for feature extraction are entropy encoding features, textural features, Extended Local Binary Pattern, wrinkle density, Linear Discriminant Analysis (LDA), Bio-inspired features etc [15].

3.4 Classification:

Various classifiers are then used to estimate the image's age group. After estimating the age group, exact age is estimates. These classifiers are first trained with a dataset so that they can easily predict the age of an input image.

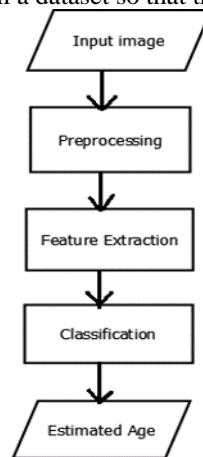


Figure 1: Flowchart of age estimation Process

4. Facial Aging Databases

Many databases of face images have been collected and published over the past few decades in order to resolve the issue pertaining to age estimation and face recognition. Some of the popularly used databases are YGA database [3], Face and Gesture Recognition Research Network (FG-NET) database [5], UvA-NEMO Smile Database [11], MORPH database [6], Vietnamese Longitudinal Face (VLF) Database [9], Waseda human-computer Interaction Technology-DataBase (WIT-DB) [14], Iranian Face Database [15].

5. Related works in Facial Age Estimation

Sung, Joo, Lee and Park [16] compared various methods and found out that GHPF gives the best results among Sobel filter, difference images, IHPF, GHPF, Haar DWT, and daubechies DWT [16]. Viola and Jones proposed an algorithm to detect face from the whole 2D image in 2004 [7]. It was further used to segment different parts of the face like eyes, nose, lips, upper body and hands also.

Gabor filters are another important tools to do facial landmarking and this is done by Dibeklioglu et al. [8]. The proposed method is able to find landmarks even if the image is of low-resolution, suffers from small rotations, occlusions occurred because of facial hairs or change in facial dynamics. Method proposed by them first classifies the age group of the subject and then refines the estimation to the exact age. This reduces the chances of errors and gives more accurate results. Lin et al. [24] also used Gabor filters along with orthogonal locality preserving protections to propose a novel system to automatically estimate the age. It uses adaboost classifier along with region based clustering algorithm for the age estimates.

Sungatullina et al. [17] proposed a new MDL (multiview discriminative learning) for detecting age invariant face recognition from face images. This mechanism is better suited for age estimations as it is invariant to aging. It relies on local features which are more robust to changes. The features used are scale invariant feature transform, gradient orientation pyramid, and local binary patterns. Using these features, different types of other local features were projected which helped in recognition. Lu et al. [10] introduced a new method for age estimation by using CCA (Canonical correlation analysis). This method makes use of both shape and texture feature as according to the both these features are complementary to each other in providing the crucial information to estimate the correct image of a person. Multiple linear regression function is then used to extract the exact age form the fused image.

Sindhu et al. [20] had presented a novel fake detection approach based on software that can be used to detect various forms of fraudulent access attempts in multiple biometric systems. This novel approach has very low complexity which makes it suitable for real world problems.

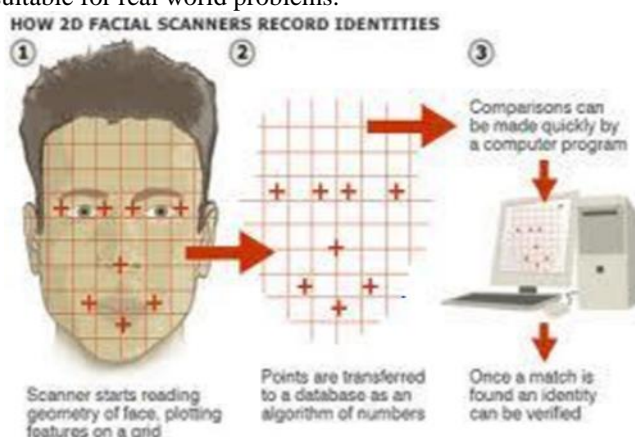


Figure 2 : Fraudulent Access Attempts protection [21]

Hadid et. al. [18] proposed a novel algorithm for detection of face and face recognition. This method can be successfully deployed for age estimation also. It uses both local and global features to do the detection and recognition. SVM classifiers were used to segment the frontal faces that too in gray scale intensities and the proposed method proved to be better than other techniques available in this field.

Li et. al. [19] introduced an approach centered on ordinal discriminative feature learning to make the age estimates. It preserves the facial information so that it is not affected by the aging process. By reducing the non-linear and rank correlation, this method reduces the redundant information which enables it to provide an efficient solution.

Dibeklioğlu et. al. [21] stated the importance of facial dynamics in addition to appearance information. The authors used dynamic feature such as a person's smile, expression of frown to detect the age of a subject. Various techniques those were used to extract features are Local Binary Patterns, gradient-based encoded aging features, intensity-based encoded aging features.

Anwarul et al. [23] proposed a review for state of art techniques used for Face Recognition with Accuracy. It provides accurate methods for face analysis which can be used for real world applications.

Kamra et al. [15] compared the state-of-art techniques in the field of Facial Age Estimation along with their accuracies and results. Table 1 is the summarized depiction of these comparisons.

Table 1: Summarization of techniques and approaches of state-of-art techniques [15]

Sno	Author Name and Year of Publication	Paper Title	Database	Results	Technique/Type of Feature
1	Geng et al (2007)	Automatic age estimation based on facial aging patterns	FG NET and Morph	MAE 6.77 and 8.83	AGing pattern Subspace(AGES) is introduced
2	Koruga et al (2011)	Application of modified anthropometric model in facial age estimation	Randomly selected 20mimages from FG-NET	N/A	Anthropometric model ratios are used
3	Ylioinas et al. (2012)	Age classification in unconstrained conditions using LBP variants	Images of Groups database	Accuracy 51.7%	Variants of LBP are used to estimate age groups
4	Choi et al (2011)	Age estimation using a hierarchical classifier based on global and local facial features	FG-NET	MAE: 4.65	hybrid features and a hierarchical classifier are combined
5	Bekhouche et al. (2016)	Facial age estimation using bsif and lbp	FG-NET and PAL database	MAE 6.34	BSIF and LBP are used for feature extraction and SVR for regressor

6	Duong et al. (2011)	Fine Tuning Age-estimation with Global and Local Facial Features	FG-NET	MAE 4.74	It is shown that local feature extraction should be used for fine and global for refined estimation
7	Lanitis et al. (2002)	Toward automatic simulation of aging effects on face images	NA	MAE 7.68	Statistical face model is used
8	Lu et al. (2011)	FG-NET	Fusing shape and texture information for facial age estimation	MAE 5.75	Canonical Correlation Analysis (CCA) is used to fuse shape and texture features
9	Jana et al (2015)	NA	Age Estimation from Face Image Using Wrinkle Features	MAE 8	Wrinkle feature is used along with clustering algorithms for classification
10	Liang et al. (2014)	FG-NET	A hierarchical framework for facial age estimation	MAE 4.97	Wrinkle density, Uniform LBP, facial distance ratios used
11	Dibeklioglu et al (2012)	UVA NEMO smile database	A smile can reveal your age Enabling facial dynamics in age estimation	MAE: 4.81 (± 4.87)	Dynamic features are extracted through movement of parts of face during smile and LBP for appearance feature
12	Dibeklioglu et al (2015)	UVA-NEMO smile database and UVA NEMO disgust database	Combining Facial Dynamics With Appearance for Age Estimation	MAE: 4.33-4.77 (Range of the MAE after using different feature extraction methods)	Four different appearance feature extraction methods are analysed in combination with dynamic features
13	Guo et al (2012)	Lifespan and FACES	A study on human age estimation under facial expression changes	6.19 and 8.11 (best of all alternatives tried)	correlation-discrimination pairing is used for training

6. Conclusion and Future Scope

In this paper, we have reviewed many works that were introduced in the field of face analysis and extended applications. It covers methods both from the researches done for age invariant estimations and age variant estimations. Although a lot of work has been done in the field but still some research gaps are found such as hundred percent error free age estimations. The estimations done in all the papers are just approximate but none of them is completely accurate. The reason for the same is a number of barriers such as changes that occur because of wearing spectacles, wrinkles, illumination, aging etc. These areas need to be explored upon to achieve more and more perfection.

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