Human Age Estimation Techniques Using Facial Features

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Abstract- This paper summarizes different techniques used for estimating the age of a human being using face detection. There are several facial features that differentiate individuals from one another. These features vary with the growth of a particular person. So using these features we can estimate the age of an individual. Using face recognition and identification of facial features, there are several techniques for age estimation that are briefly described in this paper.

Keywords: Age Estimation, Age Prediction, Age Progression etc.

I. INTRODUCTION

In the recent year, estimation of age from facial images has become more important in the field of computer vision. Detection of face is an important phase of numerous tasks regarding computer vision, such as retrieval of images, detection of shot, surveillancing video, etc. This approach is having its main goal as localization of objects to a previously defined class in a digital image. Regarding human faces, it is complex to discover features and characteristics able to analyze the varying individual appearance that instances of object often have (e.g., rotation of faces in all three directions, many people having glasses, moustaches, beards, etc). Among different proposed approaches, Viola and Jones’ method is one of the most successful approaches to perform real-time detection of face.

A. Face Detection

There is a very simple description of the face detection task: an image is given, the ultimate goal is to differentiate regions first that represents human faces and secondly those that represent any other type of region. However, several factors as poses, illumination and different imaging conditions are significantly increasing the challenges of this apparently simple task. According to different authors of their work related to object detection, there are four different categories of image detection methods, which can be briefly described as:

1) Method based on Knowledge- These types of approaches mainly represent an expert system that encrypt the sensibility of human about the typical patterns of a human face. Typically, several significant regions are being detected as eyes, nose, mouth etc. and their respective relationship between these detected features are used to decide whether they result a face or not.

2) Method based on feature invariant- According to the paradigm of structural pattern recognition, these methods are used to find the stable face structure that must be irrespective of varying poses, illumination, viewpoints or facial conditions.

3. Methods based on template matching- these methods are used to characterize the facial appearance. Several face patterns are stored in these methods. These patterns can be either a complete or different separate sub-regions. Later, the matching is being performed between an input image and the stored templates which provides the probability of a particular region containing a human face.

4. Methods based on Appearance- In contrast to template matching techniques, in these models machine learning techniques are used to extract different facial features instead of having human perception. These models are further used in classification phase through different functions, or by nonlinear surfaces. Viola and Jones have used a large scale of weak features, in which average difference between rectangular image regions is considered.

II. STEPS INVOLVED IN AGE ESTIMATION

A. Progression of Human Age

Age progression is having its aim to manipulate and upgrade any image by computer or manually for the identification of victim or lost people with enforcement of law. This technique is basically used in enhancing the police investigation and
manual drawing involved in any particular criminal activity. When the photos are outdated and fade out, natural aging of the subject faces can be predicted by professionals and reproduction of updated face images is done, utilizing all individual information, such as facial characteristics, their lifestyle, occupation, and gender etc.

Age synthesis done by machine is enhancing the efficiency of works done by professionals and meanwhile satisfying the needs of aesthetics by providing more photo-realistic facial effects. There are two popular synthesis algorithms as follows:

Implicit Statistical Synthesis Algorithm: This algorithm focuses on the analysis of appearance, which simultaneously considers synthesis of shape and texture and often based on statistical methods.

Explicit Mechanical Synthesis Algorithm: This algorithm focuses on the texture analysis, which is basically related to skin aging.

1). Implicit Statistical Synthesis Algorithm
Lanitis et al. [1] use Active Appearance Model [2], to form aging functions for young faces having their age under 30 years, in which the shape and texture variations are extracted using PCA from a set of training data. Age normalization and various other improvement can be done using this aging model. Figure 1. shows the Active Appearance Model example and the simulation on aging appearance resulted by Lanitis’s method.

2). Explicit Mechanical Synthesis Algorithm
Geometric details between different surfaces of two objects can be transferred as presented by Shan et al. [3]. They had shown their result as geometric details of surface can be extracted without knowing the reflectance of surface. After alignment, cloning can be applied to the geometric details to render other surfaces. Using this method, simulation can be done on both aging and rejuvenating of facial images. Figure 2. shows the corresponding result before and after simulation.

B. Prediction of Human Age
Age prediction is process in which the age of unseen facial images can be estimated with the use of a training set. The estimation is totally based on the training database images. Among researches done in field of age prediction, Kwon and Lobo [8] were first who proposed a method by which input face images can be classified into any of the following three age group categories: first is for babies, second is for young adults and lastly for senior adults.

Geometric ratios and skin wrinkle analysis were the root element of their study. Distinction of babies from adults was done by geometric ratios, i.e. first computed from facial features. And separation of babies from adults is done using ratio of the respective distance between the two eyes to the respective distance between the eyes and nose. After that, detection and measurement of skin wrinkles using snakelets were distinguished seniors from young adults and babies. Finally, age category is judged by application of a fusion rule.

Kwon and Lobo were having 100% accuracy on classification of these input data. There were several issues in their research as first, only 47 images were taken for testing, making it hard to analyze and second, there was just three age groups categories. Finally, for performing wrinkle analysis, a relatively high resolution image was required (at least 256 x 256).

To overcome the shortcomings of Kwon and Lobo, a relatively fast and more reliable system for age group classification was proposed. They had used a different approach to solve geometric ratios and
wrinkle analysis but having same fundamentals. 230 experimental images were passed to neural networks which were used to perform classification, having accuracy of 81.6%. However, there were still only three age groups as previous.

Hayashi[9] had considered facial wrinkles as main component for the age and gender estimation. They had used a database of 300 individual images having age range as from 15 to 64 years, taken under well managed conditions. First extraction of skin regions from the facial images was performed, followed by equalization of histogram for upliftment of wrinkles. Then, both the shorter and longer wrinkles on the facial image were extracted using Digital Template Hough Transform, a special Hough transform. Finally, age and gender estimation was done by a look-up table. Hayashi et al. had faced the difficulty in extraction of wrinkles from female faces having ages between 20 and 30 because of makeup.

Lanitis [10] had studied that in automatic age estimation, different facial parts were having a significant importance. His investigation classified complete facial portion as: the complete face (hairline included), the complete internal face (hairline excluded), and finally the upper and the lower part of the face. Figure 2. [11], illustrates the different facial portions described.

2). Aging using medical face measurements

The facial aging modeling has been done by medical statistics and the facial deformation having medical aspects. The facial structures, different variance of bones, changes occurred in skin texture, presence of wrinkles etc. are all directly related to the growth of human age.

Pitanguy[13] had reported a robust correlation between age and the respective variation of some parameters as height and width of female, that of nose and forehead. As a resulted output, geometric ratios are used to build a numerical model to analyze aging of facial images and in facial images of female, simulation of aging changes is done by a warping technique [13].

However, in many cases, changes in shape were captured and the resulted output was not satisfactory enough. Having an ultimate aim of simulating facial portion, Koch[14] had mingled and upgraded various methods from geometric modeling technique, analysis using finite training set data, and several processing applied on image to represent realistic three dimensional view images of a situation that occur after surgery. It is well proved that, this model contains versatility in its characteristics and because of this prime feature it is useful to many applications.
A novel animation algorithm for facial images is recently proposed by Hussein [12]. It uses two different techniques which combine deformation of facial images that is all based on the anthropometrical theory and simulation of wrinkle on facial images, which is called as Bidirectional Reflectance Distribution function. The main idea of work is to capture two different characteristics of $F$ with upcoming years for any given neutral face, $F$. The first characteristic is geometric deformation of facial details like texture of skin given in $F$ after recorded passing years. The second feature is anthropometric changes in facial data that is developed in the anthropometrical environment of face measurement.

Then, for carrying out facial aging, warping of two techniques is done together to any particular person’s facial image. Hussein states that wrinkles play a vital role for interpretation of facial gesture and expressions instead of besides its role in determination of age. Main focus of his work is to perform simulation of realistic aging for facial images using medical aspects regarding deformation of facial image and wrinkle appearance. First, presence of wrinkles, Second, texture variation of skin and Third, changes occurs in facial shape are three root elements for performing facial aging.

**D. Estimation of Human Age**

After proper representation of an aging feature, the next phase is the estimation of age. Approaches for age estimation fall into two different categories: a) based on classification; and b) based on regression.

1). Based on classification

The performance of different classifiers used for estimation of age has been evaluated by Lanitis et al. [4]. These classifiers include various approaches as first is nearest neighbor method, second is the ANN model, a classifier based on quadratic functions and many more. AAMs method is used to represent the facial images. He had used 400 images for experiment, in which age of person selected must vary under 35 years. Finally, he had concluded that classifier based on quadratic function has better performance result as compared to nearest neighbor method but lower than that of ANN model.

Guo[5] had used a large dataset of 8,000 images to perform estimation of age using support vector machine. He had reported a mean error of 5.553 years for women and 5.52 years for male. This mean varies with database used as it is higher for FG-NET aging database as 7.16 years as concluded by Kanno[6]. In his approach he had achieved 80% accuracy on total 110 facial images of male using artificial neural network.

Ueki [7] had built up total 11 Gaussian models using the EM Algorithm in a low-dimensional feature space. The test image is applied to each Gaussian model and similarities are tested to classify the exact age group. In their system, accuracy of about 50% and 43% is achieved for male and for female respectively under classification of age group using age range of five years. And similarly, accuracy using age range of 10 years is 72% and 63% for male and female respectively. For range of 15 years it is 82% and 74% accordingly.

2). Based on regression

Using 50 raw model attributes, Lanitis et al. [1] had proposed three different formulations function for the aging process. These are linear function, quadratic function, and cubic function respectively. A genetic algorithm is used for training of facial images with varying ages by which learning of optimal model attributes is done. Solution of all regression problems and speed up achievement for optimization process is accomplished using Expectation Maximization (EM) algorithm.

Guo [5] had chosen classifier and regressor as support vector machine and SVR respectively and their performance had been compared using the same set of input data. Using their experiments, they had concluded that performance of SVMachine much better than that of SVR. Using data as resulted by experiments, we can conclude as whether age estimation based on classification is better or worse than that based on regression approach.

In further study, a new and much more robust regressor technique, called as Locally Adjusted Robust Regressor has been invented by Guo[5]. They had just shown that if we combine a classifier and a regressor, then significantly better performance can be achieved. Using this combination approach, the corresponding mean error can be reduced as 5.155 and 5.305 years for women and male on the YGA database technique, and 5.075 years for both on the FG-NET aging database technique, respectively.

**III. REFERENCES**


