Implementation of Age Synthesis and Estimation Via Face Image

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ABSTRACT

Human age, as an important personal trait, can be directly inferred by distinct patterns emerging from the facial appearance. Computer-based age synthesis and estimation via faces have become particularly prevalent topicsy because of their explosively emerging real-world applications, such as forensic art, electronic customer relationship management, security control and surveillance monitoring, biometrics, entertainment, and cosmetology. Age synthesis is defined to rerender a face image aesthetically with natural aging and rejuvenating effects on the individual face. Automatic age-progression is the process of modifying an image showing the face of a person in order to predict his/her future facial appearance. Age estimation is defined to label a face image automatically with the exact age (year) or the age group (year range) of the individual face. During growth, aging is affected in two main forms, one is the size and shape variation and the other is the textural variation. In this paper, we use the textural variation of the face during the growth, which appear more in the adulthood in the form of wrinkles.

Keywords- Face aging, age estimation, age synthesis, age progression, geometry features

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1. INTRODUCTION

As a “window to the soul”, the human face conveys important perceptible information related to individual traits. The human traits displayed by facial attributes, such as personal identity, facial expression, gender, age, ethnic origin, and pose, have attracted much attention in the last several decades from both industry and academia since face image processing techniques yield extensive applications in graphics and computer vision fields.

There are two basic tasks in this field, computer-based age synthesis and estimation, that are described as follows:

- **Age synthesis**: Rerender a face image aesthetically with natural aging and rejuvenating effects on the individual face.
- **Age estimation**: Label a face image automatically with the exact age (year) or the age group (year range) of the individual face.

As our aim is to determine the age of a person, we can concentrate on the features that can be extracted for age estimation. As we all know, age of a person affect his face in two main forms. One is the Geometrical Feature Variation where the size and shape of the face changes as he grows. If we use this information of the face, we can see that this change is gradual and most of the size variation stops at certain age. Even worse condition occurs in some case where the facial size gradually decreases when he reaches the old age. So using this method of Geometrical Feature Variation is challenging. But of course, this method can be used to classify the age broadly into three main classifications like baby, youth and adult.

Age-progression is the process of deforming the facial appearance of a subject shown in an image, in order to predict how the face of the person will look like in the future. The ability to produce accurate age-progressed images is important in a number of key applications including the localization of missing children, the development of age-invariant face recognition systems, and automatic update of photographs appearing in smart documents (i.e., smart id cards).
2. EXISTING METHOD

In [1], authors proposed a new framework for face-image-based automatic age estimation. A manifold learning method was introduced for learning the low-dimensional age manifold. The Support Vector Machine and Support Vector Regression methods were investigated for age prediction based on the learned manifolds. To improve the age estimation performance and robustness, a Locally Adjusted Robust Regressor (LARR) was also designed. Anil Kumar Sao and B. Yegnannarayna [3] proposed analytic phase based representation for face recognition to address the issue of illumination variation using trigonometric functions. To decide the weights to the projected coefficients in template matching, eigen values were used.

Authors in [2] combined the local and holistic facial features for determining the age. They used combined features that roughly classify a face as young (0-20) or adult (21-69). In most of the previous studies the age groups are not arranged properly. Another related work in the age estimation selects discriminative features to estimate face age. Lanitis et al. [8] propose a model-based age-progression methodology. In this context, parametric functions that relate the model-based representation of faces and ages are established and used as the basis for implementing age estimation and age-progression. Because the parametric representation of faces discards high-frequency information, this approach is not ideal for generating high-resolution age-progressed images. This approach is more appropriate for modeling distinct age-related facial transformations like shape variations and major texture variation. A number of researchers also describe methods based on aging functions defined either in relation with 2D faces [4, 5] or 3D faces [6, 7].

3. AGE SYNTHESIS AND AGE ESTIMATION

3.1 FEATURES EXTRACTION USING VIOLA JONES METHOD

Face detection has been regarded as the most complex and challenging problem in the field of computer vision, due to the large intra-class variations caused by the changes in
facial appearance, lighting, and expression. Such variations result in the face distribution to be highly nonlinear and complex in any space which is linear to the original image space.
Paul Viola and Michael Jones presented a fast and robust method for face detection which is 15 times quicker than any technique at the time of release with 95% accuracy at around 17 fps. The technique relies on the use of simple Haar-like features that are evaluated quickly through the use of a new image representation. Based on the concept of an “Integral Image” it generates a large set of features and uses the boosting algorithm AdaBoost to reduce the over-complete set and the introduction of a degenerative tree of the boosted classifiers provides for robust and fast interferences. The detector is applied in a scanning fashion and used on gray-scale images, the scanned window that is applied can also be scaled, as well as the features evaluated.

3.2 AGE SYNTHESIS

Age prototypes are generated by merging the shape and intensities of faces belonging to the same age group. The face merging process is carried out independently for shape and texture. In the case of shape, the merging operation involves the calculation of the mean shape among a group of faces belonging to the same age group. In order to get noise-free prototypes, all faces to be merged are warped to a standard shape and the mean shape-normalized texture among the constituent faces is estimated. Figure 1 shows typical age prototypes for different age groups. In age prototypes derived using a large number of samples, individual facial characteristics are suppressed in favor of typical facial characteristics of subjects belonging to the corresponding age group. Differences between age prototypes describe typical age-related deformations between different age groups.

Given a previously unseen face to be age-progressed, estimate the difference between the age prototype corresponding to the current age of the subject in the given image and the age prototype at the target age. The estimated difference is added to the given face in order to obtain an estimate of the future facial appearance of the given face. During the age-progression process, warping operations are used so that operations involving texture are
carried out on shape-normalized faces. Resulting textures are inverse warped to the appropriate age-progressed shape.

Figure 1: Age prototypes for the age groups 0–5, 5–10, 20–25, 30–35, 40–45, 50–55, and 60–65 years.

3.3 Age Estimation

Age estimation is the determination of person’s age based on biometric features. Although age estimation can be accomplished using different biometric traits, this thesis is focused on facial age classification that relies on biometric features extracted from a person’s face. Age estimation will be more accurate when shape and skin features are taken into consideration. The basis of this thesis is a statistical analysis of facial features in order to classify the facial images according to corresponding age intervals.

*Ratio Analysis:* The primary facial features are located to compute the ratios for age classification. Four ratios are calculated for facial face database comprising young aged, middle aged and old aged adults. Age estimation classified ages from facial images into 3 age groups as babies, young adults and senior adults. Using the primary features of the human face such as eyes, nose, mouth, chin and virtual top of the head; mainly 6 different ratios are calculated to distinguish babies from young adults and senior adults. The secondary feature analysis with a wrinkle geography map to detect and measure wrinkles to distinguish seniors from babies and young adults. Finally, combined ratios and wrinkle information obtained from facial images to classify faces into 3 age groups. In babyhood, the head is near a circle. The distance from eyes to mouth is close to that between two eyes. With the growth of the head bone, the head becomes oval, and the distance from the eyes to
the mouth becomes longer. Besides, the ratio of the distance between babies’ eyes and noses and that between noses and mouths is close to one, while that of adults’ is larger than one.

The algorithm is as follows:

**Step 1:** Locating the primary features is very important step in extraction of features, and it can be automatically or manually. Automatically located the primary features. First of all central horizontal line of the image is found, then they found the eyes location, and finally nose and mouth location is found.

**Step 2:** Find the distance between the primary features.

**Step 3:** Find the ratios as follows

![Figure 2: Ratio 1](image1)

![Figure 3: Ratio 2](image2)

![Figure 4: Ratio 3](image3)

![Figure 5: Ratio 4](image4)

The first geometric feature is defined as
\[ R_{em} = \frac{D_{em}}{D_{ee}} \]

where \( D_{em} \) is the distance between the eyes and the mouth, and \( D_{ee} \) is the distance between two eyes’ iris. \( R_{em} \) in babies smaller than \( R_{em} \) in adults, because the baby’s faces is near a circle so \( R_{em} \) in adults becomes larger.

Second geometric feature is
\[ R_{enm} = \frac{D_{en}}{D_{nm}} \]

where \( D_{en} \) is the distance between the eyes and the nose, and \( D_{nm} \) is the distance between the nose and the mouth. The distance between the eyes and the nose of a baby is smaller than the distance between the eyes and the nose of an adult, so the value of \( R_{enm} \) becomes larger in adult faces. The values of these two ratios are used to recognize babies.

4. EXPERIMENTAL RESULT

We perform age estimation and age synthesis on the input image while extracting features of face image by using viola jones method. Different functions are applied to the given image using MATLAB. For performing operation train the system with different images it will show the extracted features of that image and then evaluate age estimation of the input image and then synthesis the input image specific age group as required.
5. Conclusion

In general, different age synthesis and estimation techniques and algorithms can be effectively applied to particular scenarios or applications. For face modeling, the appearance-based face model can be considered as a marriage of geometry-based model and image-based model, which shows more photorealistic effects aesthetically for age synthesis purposes. Shape synthesis is more effective for the age progression of young faces whose craniofacial growth and development are more dominant over skin aging. Texture synthesis is more effective for the face aging after adulthood when skin aging dominates and craniofacial growth slows down. Appearance synthesis is applicable to both cases since, usually, a statistical model will be available built on a large face aging database. Aging cues can be learned statistically for all aging stages and implemented to realistic age synthesis. But the most difficult part of appearance synthesis is the database collection and automatic face correspondence.
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