Feature based Age Prediction for Face Recognition

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Abstract

Face recognition is currently highly researched area of computer vision and pattern recognition. Age changes cause major variations in the appearance of human faces. In this paper, we propose a new aging scheme, which is ultimately to be used in face recognition applications. It will provide to reduce the memory space and processing times. This proposal requires only one input image of a subject and produces an age progressed image of the person at a particular target age.

To implement this training-based approach, over 300 high quality facial images ranging from 18 years to 70 years in age were collected from the Internet. An age prediction function is a relationship between a facial image and its corresponding age. Given a single image of the subject and a target age, we construct a new image of the subject to reflect the new age. Such an image will be useful to predict a person's aged face for use in face recognition systems.

1. Introduction

The proposed approach is based on the presence of a common trend in the aging process that occurs across the whole population. We determine this global trend. A set of input images that have been normalized for illumination effects, facial expression, pose and shape variability. Support Vector Machines (SVM's) is applied for predicting the age of a given facial image. The SVM is trained to learn a global aging function for the entire population (represented by a database of images). A good quality image indicates high resolution (at least 100*150), a well-lit face with little or no expression or out-of-plane rotation that is essential for the method to work well. If the face is clearly visible in the image, the age prediction and synthesis system will be more accurate. Various practical applications could benefit from an automated aging system like the one described in this paper.

The most common usage for such a system would be to assist in the capture of wanted fugitives. This system would be useful for predicting a suspect's current or future portraits. A special case of the above application would be to predict the current facial appearance of children missing for several years. Automated software to produce their age-progressed portraits would be practical and useful. Our methodology is applicable to this application, but would require the collection of an appropriate database for training the SVM. Image variability due to changes in age easily confounds current face recognition systems. Faces of subjects might look more "similar" to faces in their own age group causing misclassifications during the recognition phase. This concern could easily be dealt with by normalizing all faces to a single age. Normalization would eliminate any variability due to age changes.

2. Database normalization

First, 33 feature points were manually located in all images and the mean face shape was determined by averaging each of these feature points. Next, a simple warping procedure was applied to align all faces to the mean face shape. The mean face size was selected to be 116*160 pixels _ sufficient resolution to retain enough wrinkle detail for learning purposes. Finally, the images were transformed to the same dynamic range by histogram fitting to achieve illumination invariance.

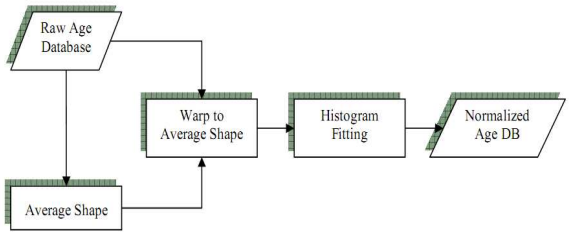

Figure 1. Block diagram of the normalization process

Since images in database contained very few shadows and secularities, due to good lighting conditions, simple histogram fitting was sufficient to normalize for illumination. Figure 1 illustrates the database normalization process in a block diagram.

3. Source and description of training database

There are numerous frontal images freely available on the Internet. However, it is next to impossible to find the age of a subject in the image. Scanned images from albums of family and friends are not a reliable source, due to the wide variation in the facial appearance of the pictures as well as the picture-taking conditions.

The advantages of collecting images of celebrities from the Internet include:

1. Abundant sources of celebrity images are readily available on the Internet.
2. It is easy to determine the age of the celebrity in the image, since these are generally dated and the celebrities' birthdates are simple to find.
3. Since professional photographers took most of the images, their quality and resolution are satisfactory for our purposes.

Input Color image is shown in figure 2. Face region is extracted by cropping tool. The crop image is shown in figure 3.

Figure 2. Input Color Image

Figure 3. Cropped Image

Gray scale converting and resizing are performed in the next step. Figure 4 shows the gray image and figure 5 describes the resize image, respectively.

Figure 4. Gray image

Figure 5. Resize image

Database is constructed by using cropped images. Figure 6 shows the some images in database. Mean face or average face is described in figure 7.

Figure 6. Some images in database

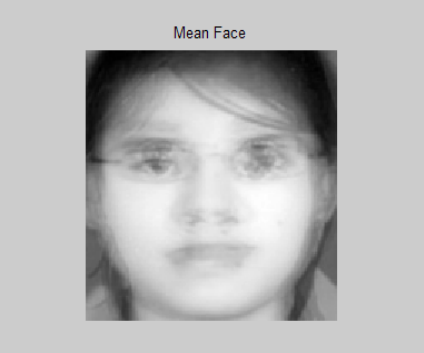

Figure 7. Mean Face

4. System Overview

A set of training images is used to learn a global relationship between the coded representation of the face and the actual age of subjects. Once this relationship has been established, it is possible to estimate the age of a previously unseen image. The relationship is also used to the estimate ages of the synthesized images. Some terms are defined first.

Age Progression: Age progression is the computer-generated manipulation of a photograph to make the subject appear several years older. In other words, it is the process of synthesizing new images of an individual at a future age given their current appearance.

Age Regression: Age regression is the process of synthesizing new images of an individual at an earlier age given their current appearance.

Age Prototype: An age prototype is a visual facial model of a particular age or small age group. It is an image that captures the main characteristics of that age group.

The method presented in this paper is broken down into two main stages, age prediction and age simulation.

Age prediction involves the use of SVM's for predicting the age of a given facial image. A database of facial images labeled by age was used to train the SVM for this estimation. To ensure that the variability of the images in the training set was only due to the age of the subject, we carried out a pre-processing step to normalize all images in the database for illumination, pose and facial expression. All images were also warped to the shape in order to localize the facial features (and wrinkle) at roughly the same location in the face. To simulate age changes in new facial images, we combined the aging function and a method to transfer wrinkle information between subjects. Given the original image and a target age, an optimization approach was used to perform age progression or regression. Optimization is carried out iteratively in the image synthesis process.

The proposed system is based on geometric ratios and skin wrinkle analysis. Geometric ratios were first computed from facial features to distinguish features from Personal Identification Card. The ratio of the distance between the eyes to the distance between the eyes and nose worked best as a geometric feature. This process involves three stages: First, Geometric ratios were computed from facial features to distinguish features from Personal Identification Card by detecting and measuring skin wrinkles. Second, verified between from the ID-Card image and the actual age image. Additionally, we have built up ID-Cards database. Finally, produced an age progressed image of the person at a particular target age by using age prediction function – a relationship between a facial image and its corresponding age.

In other words, given a single image of the subject and a target age, we construct a new image of the subject to reflect the new age. Such an image will be useful to predict a person's aged face for use in face recognition systems. The images in the normalized face database were masked using feature points in order to avoid hairlines since Lanitis found that their introduction had a negative effect on training for age prediction. The raw grayscale pixel values were then used as the feature space

The size of the facial image used for training was also evaluated. Intuitively, a larger image size will contain more wrinkle detail and age information and would be better for training. However, the dimensionality of the feature space grows significantly with increasing image size, requiring more training samples to train the SVM. Therefore, it was necessary to determine the smallest image size that captured all of the aging information. Images were resized using bilinear interpolation and all training images were normalized and cropped before presenting them to the SVR.

5. Conclusion

As part of our research, we collected the Aging Database, containing over 300 high quality images of subjects labeled by age and gender. Most of these images were obtained from the Internet Movie Database. Due to the application of makeup and possibly plastic surgery, it was found difficult to label the facial images of many female subjects which produced a significant difference in the actual and perceptual age. After image normalization, an age prediction function was established using the database to train a Support Vector Regression Machine. The prediction was accurate +/- 9 years on unseen images.

Finally, a simple yet powerful aging system was created that accurately aged an unseen individual based on the data in our database. The age simulations demonstrate that the method works well and is practical when applied to real-world images.

We propose several improvements and additions for further research. In conclusion, the approach in this paper is a stepping-stone to further research in the areas of age prediction and simulation of new facial images to reflect age changes.

9. References

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