

Age Progression using Image Morphing

Nhat Rich Nguyen

Computational Photography - UNC Charlotte

Abstract. Age progression is the process of modifying a photograph of a person to represent the effect of aging on their appearance. I proposed to create an application that displays the entire age progression of people face throughout their life time. Given a portrait picture of an adult, the application shows how the person change from a baby face into an elder face. An interactive application with a shape blending and color blending parameters demonstrates the various results of the method.

1 Introduction

We sometimes want to see how our face changed through ages from a baby until now. More interestingly, we wonder how our face would progress as we get old. The two main age progression categories are child into adult and adult into old age. Combining the two categories is also possible, as a child may become an adult, and then continue to old age. In motion pictures, there are movies in which children physically become adults such as *Big*, *13 Going on 30*. The opposite process of age progress is age regression, which shows how a person gets younger. An overview of the fictional age progression of Bruce Lee, a legendary Asian actor, is shown in Figure 1.

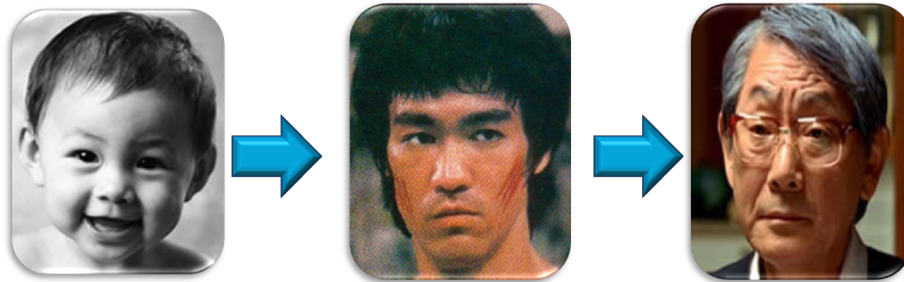


Fig. 1. Overview of the (fictional) age progression of Bruce Lee, a famous Asian actor.

The project utilizes several techniques which have been taught in the Computational Photography course. First, image morphing, the main contribution of the project, is emphasized in the course since there has been a lecture dedicated

to the morphing technique. Second, several image processing methods may be used to align the input images, acquire features points, and build the user interface as an interactive application. Third, facial recognition is also an important contribution to the project. While implementing the facial recognition method is out of the scope of this project, acquiring the method's results can be done by manually clicking corresponding facial points.

2 Methods

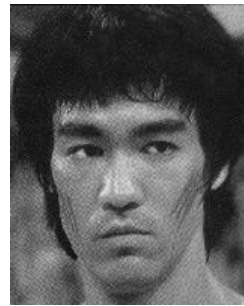
The age progression can be done using image morphing, a popular digital image processing algorithm. Although the output image may be not as realistic as an artist's drawing, it serves as good approximation of the age progression. Moreover, image morphing includes several parameters that allows the users to control the appearance of the output image. Image morphing from a baby to an adult is described with sample images in the following sections:

2.1 Pre-process Input Images

Given an input image of an adult, we apply a couple of pre-processing techniques to get the image ready for morphing. First, the input image is converted into grayscale, which contains only one intensity layer. The RGB color image can also be morphed, but is not emphasized in this project. Second, the image is cropped so that it has the same size as a pre-defined baby image. The cropped grayscale image and the pre-defined baby image are shown in Figure 2.



(a) The baby image



(b) The grayscale image

Fig. 2. Pre-process input image.

2.2 Correspond Feature Points

The correspond feature points of the baby and adult face can be acquired automatically or manually. Harris corner detector can possibly be used to detect

human facial features [4]. A recent method by Arivazhagan can also be used to accomplish such automatic task [2]. However, implementing both of the above methods is out of the scope of this project. For the sake of simplicity, we manually correspond 71 the features points for each face using *cpselect()* function in Matlab. The corresponding feature points are show in Figure 3.

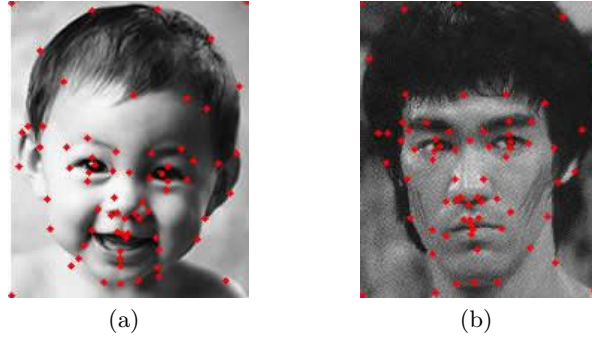


Fig. 3. Corresponding features points.

2.3 Construct Delaunay Triangulation

A grid is constructed over the corresponding features point from the previous section. To optimize the grid, we utilized the Delaunay Triangulation algorithm [3]. We implement the algorithm in Matlab using *delaunay()* function, and visualize using *triplot()* function. The result is the grid to capture the relationship of the feature points. The grids are show in Figure 4.

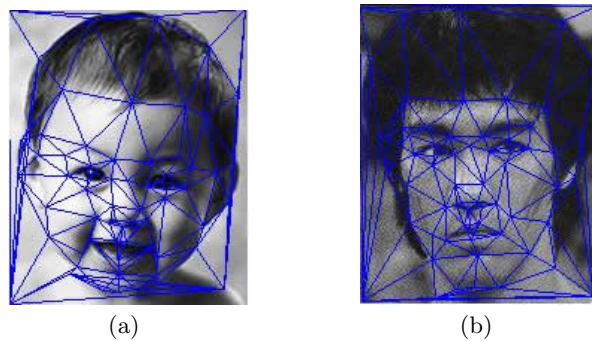


Fig. 4. Construct Delaunay Triangulation.

2.4 Calculate weighted average grid

The average grid served as the destination grid for both of the baby and the adult images. The weighting factor is added to each grid to regulate the influence of each grid to the destination grid. Manipulating the weight of each grid can produce various shape of the output image. We call this weighting factor 'shape blending' in our project. For this particular examples, we use shape blending $a = 0.4$ so that the baby facial structure is more emphasized. This process can be described as the below equation:

$$\mathbf{Grid}_{destination} = (1 - a) * \mathbf{Grid}_{baby} + a * \mathbf{Grid}_{adult} \quad (1)$$

where a is the shape blending. The average grid is show in Figure 5.

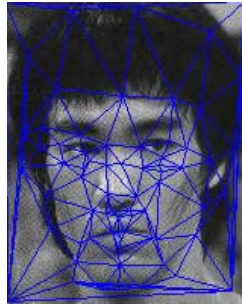


Fig. 5. Calculate weighted average grid. Note that the grid is the combination of the facial relationship in both baby and adult faces.

2.5 Warp Images

Image warping can be done as a linear interpolation in a triangular region basis [4]. To implement this step in Matlab, we utilize the *griddata()* function in addition to calculate the displacement from the baby grid to the destination grid. Every pixel in each triangle of the destination grid is mapped to an pixel on the baby grid. Similar process can be done on the adult image. The warped images are show in Figure 6.

2.6 Cross-dissolve

Cross dissolve is a popular digital image processing that gives an illusion of one image fades into another image, given that the two images are aligned. In the previous step, the wrapped images are satisfied this condition, so we can use cross-dissolve to morph one image to another. Weighting factor can be used to regulate the influence of one wrapped image over another. We call this weighting

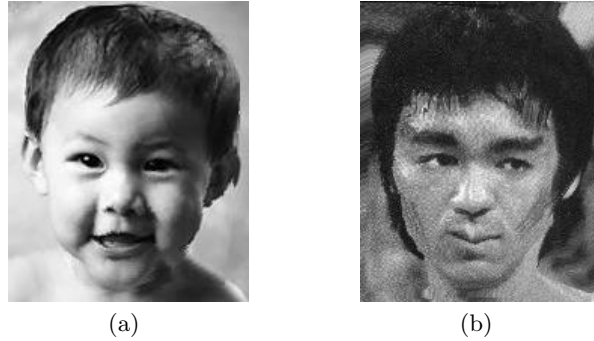


Fig. 6. Warp images into the destination grid.

factor 'color blending', or b . For example, if we want the output image to look more like a baby, then color blending should go toward the wrapped baby image. In this particular instance, we want the output to be Bruce-like, so color blending is toward the wrapped adult image. The output image is shown in Figure 7.

$$\mathbf{Image}_{output} = (1 - b) * \mathbf{Wrapped Image}_{baby} + b * \mathbf{Wrapped Image}_{adult} \quad (2)$$

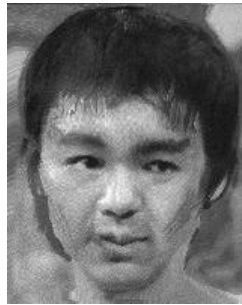


Fig. 7. The output image maintains the Bruce Lee appearance while having the facial structure similar to a baby.

The morphing from an adult to an aged person is accomplished similarly with the steps mentioned above. The result image, the old Bruce Lee, is shown in Figure 8.

3 Experiments

3.1 Parameters Tuning

Changing the value of shape blending a and color blending b can create various interesting output images. We have developed an interactive application



(a) Image of an aged person.



(b) Old Bruce Lee

Fig. 8. The output image maintains the Bruce Lee appearance while having the facial structure similar to an aged person.



Fig. 9. The (fictional) age progression of Bruce Lee.

where the user can manipulate these blending factors. As the user controls each blending factor in a slide bar, the program gives feedback in real-time. The graphical interface of the program is shown in Figure 10. For those who are interested, a video demonstrating the interacting can be viewed in YouTube via <http://www.youtube.com/watch?v=ThC7NwHRknA>.

3.2 Application

Age progression can be used extensively in several applications. For example, it is widely used as a forensics tool by the law enforcement. Age progression can be used to show the likely current appearance of a missing person from a photograph many years old.

Our particular interest is to predict what a person would look like when they are younger and older. We also interest in finding what would Bruce Lee would look like if he lives on. Since there was very few Bruce Lee's baby photo, it would be fun to approximate what he would look like when he was young. The entire age progression of Bruce Lee can be achieve using this method with tuned blending factors. A series of age progression images are shown in Figure 9.

4 Conclusion

Give a person portrait picture, I developed an interactive application showing how the person change from a baby face into an elder face. Even though the realistic facial appearance of this application is limited, the output images reflect the change in facial structure, features as well as texture. Age progression is an interesting topic, I hope to study more about using computer vision and image processing for this field in the future. As for the project, I am pleased with the results while have fun playing with the application on different faces.

Reference

1. Age Progression. (2007, September). In *Wikipedia, the free encyclopedia*. Retrieved December 04, 2009, from http://en.wikipedia.org/wiki/Age_progression
2. Arivazhagan, S.; Mumtaj, J.; Ganesan, L., "Face Recognition Using Multi-Resolution Transform," Conference on Computational Intelligence and Multimedia Applications, 2007. International Conference on , vol.2, no., pp.301-305, 13-15 Dec. 2007
3. Lee D. T., Schachter, B. J., "Two algorithms for constructing a Delaunay triangulation," International Journal of Parallel Programming, Journal on, vol.9, issue 3, pp.219-242, 01 Jun 1980
4. Dyn, N. ; Levin, D.; and Rippa, S.; Data Dependent Triangulations for Piecewise Linear Interpolation IMA J Numer Anal 10: 137-154.
5. Trajkovic, M.; Hedley M.; Fast corner detection, Image and Vision Computing, Volume 16, Issue 2, 20 February 1998, Pages 75-87, ISSN 0262-8856, DOI: 10.1016/S0262-8856(97)00056-5.

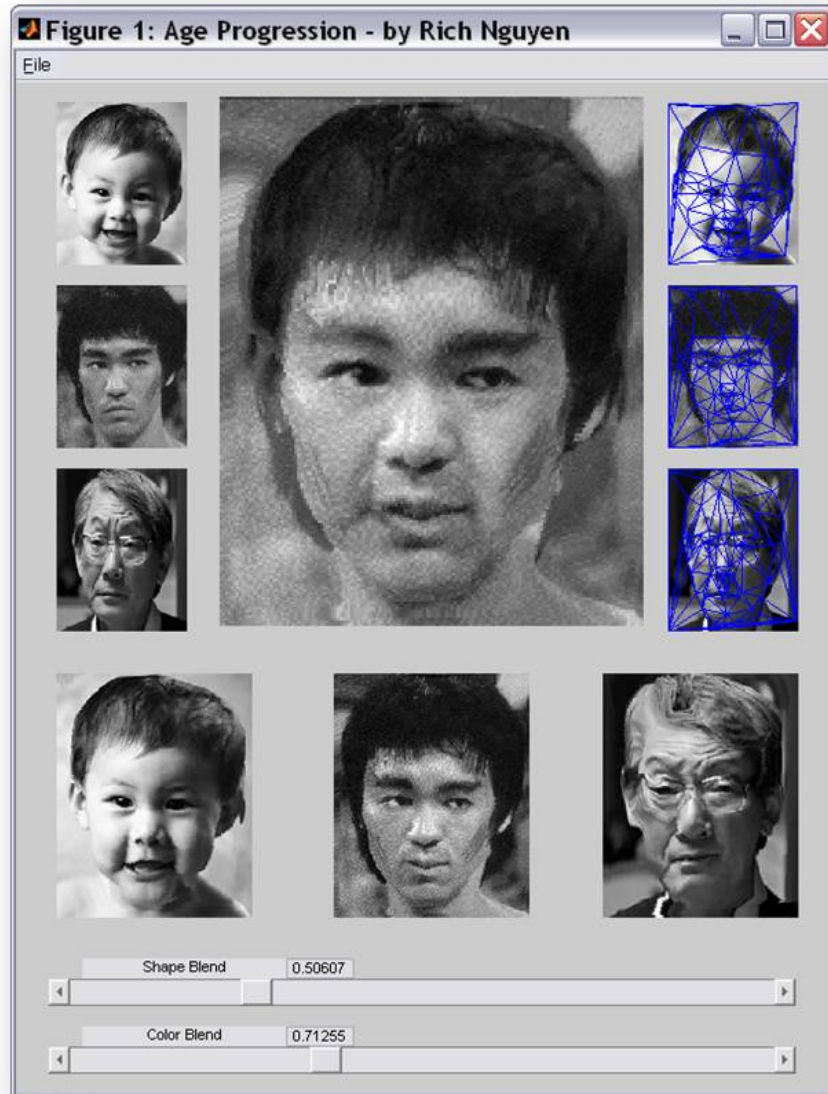


Fig. 10. The graphical user interface to interact with the blending factors. The upper left column contains the input images, the upper right column contains the grids on those images. Each of the bottom row images is the wrapped image of the input image. The output image is shown in the top center image. At the bottom, there are two slide bar for the user to manipulate the shape blending and color blending factor. Different values of these factors will results in various appearance of the output image.