Digital Face Beautification

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1 Introduction

Beauty has fascinated human beings from the very dawn of mankind. In particular, the beauty of the human face has inspired countless artists, poets, and philosophers. Several psychological studies indicate that facial attractiveness is a universal notion, transcending the boundaries between different cultures, since there is a high cross-cultural agreement in facial attractiveness ratings among raters from different ethnicities, socio-economic classes, ages, and gender. [Perrett et al. 1994; Jones 1996]. Quite recently, using supervised learning techniques, researchers succeeded in producing a trained model capable of generating facial attractiveness ratings that closely conform to those given by human raters [Eisenthal et al. 2006].

This sketch presents a novel method for *digital face beautification*: given a frontal photograph of a face (a portrait), our method automatically increases the predicted attractiveness rating of the face. The main challenge is to achieve this goal while introducing only minute, subtle modifications to the original image, such that the resulting "beautified" face maintains a strong, unmistakable similarity to the original, as demonstrated by the pair of faces shown in Figure 1. The effectiveness of the proposed method was experimentally validated by a group of test subjects who consistently rated the modified faces as more attractive than the original ones.

Professional photographers have been retouching and deblemishing their subjects ever since the invention of photography. It may be safely assumed that any model that we encounter on a magazine cover today has been digitally manipulated by a skilled, talented retouching artist. Since the human face is arguably the most frequently photographed object on earth, a tool such as ours would be a useful and welcome addition to the ever-growing arsenal of image enhancement and retouching tools available in today's digital image editing packages. The potential of such a tool for motion picture special effects and advertising is also quite obvious.

Figure 1: An input facial image (left) and the face generated by our method (right). The changes are subtle, yet their effect is significant.

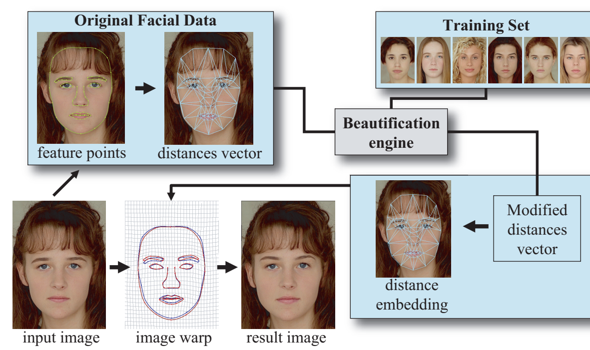

Figure 2: Our digital face beautification process.

2 Method Overview

Given a portrait, we identify a variety of predetermined facial locations and compute a set of distances between them (see Figure 2). These distances define a point in a high-dimensional "face space". We then search the face space for a nearby point that corresponds to a more attractive face. The key component in our search is an automatic facial beauty rating machine: a Support Vector Regressor, f_b, trained on a database of female faces with accompanying facial attractiveness ratings collected from a group of human raters, as described by Eisenthal *et al.* [2006]. Once such a point is found, the corresponding modified facial distances are embedded in the plane and serve as a target to define a 2D warp field which maps the original facial features to their new, "beautified" locations.

Let $\mathbf{v}$ denote the normalized distance vector extracted from an input facial image. The goal of the beautification process is to generate a *nearby* vector $\mathbf{v}'$ with a higher "beauty score" (predicted attractiveness rating) $f_b(\mathbf{v}') > f_b(\mathbf{v})$. We experimented with two complementary techniques to achieve this objective: one is based on weighted K-nearest neighbors (KNN) search, the other is an SVR-driven optimization.

KNN search: We found that an effective way of beautifying a face, while maintaining a close resemblance to the original is to modify the distance vector of the face in the direction of the "beauty-weighted" average of the K nearest neighbors of that face. We found the beauty score of faces modified in this manner to be typically higher than those resulting from moving towards the global unweighted average.

SVR-based beautification: The second method we experimented with is a numerical optimization treating the SVR-based beauty rating function as a *potential field* over the high-dimensional "face space". Thus, f_b is used directly to seek feature distance vectors with a higher beauty score. Whereas the KNN-based approach only produces convex combinations of the training set samples, SVR-based optimization is limited by no such constraint.

References

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