



A New Computer-aided Technique for Planning the Aesthetic Outcome of Plastic Surgery

Andrea Bottino, Aldo Laurentini

DAUIN - Politecnico di Torino



Measuring and improving attractiveness

- “ Beauty is an elusive concept that has been debated for centuries
- “ It is a research field in psychology, anthropology, evolutionary biology, behavioural and cognitive sciences, aesthetic and reconstructive plastic surgery
- “ Many empirical rating studies have demonstrated that human perception of facial attractiveness is essentially data-driven, and largely irrespective of the perceiver
- “ These findings suggest using objective facial measures for assessing beauty, acquired using CV techniques.



Goal of our work

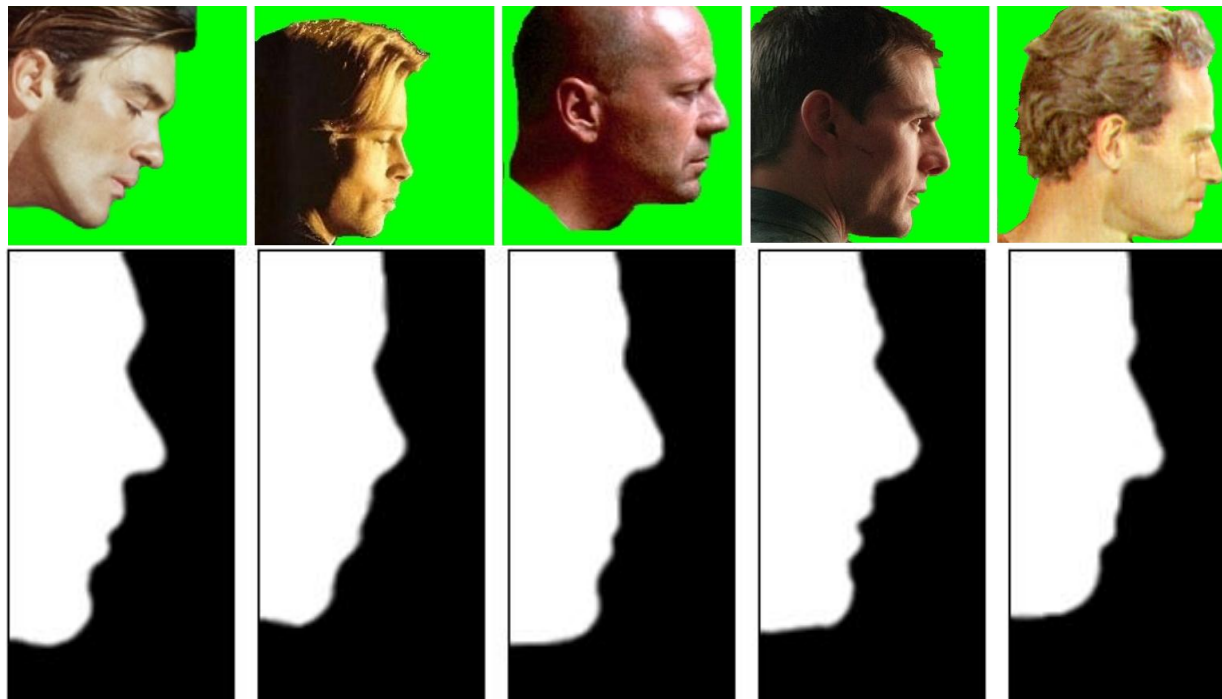
- “ Our goal is not beauty rating, but approaching harmonious shapes, which is simpler
- “ Several empirical results support the idea that there is not a unique beauty prototype
- “ Average faces are usually rated attractive, but very attractive faces are not average
- “ Beauty ratings have been found largely independent on ethnicity, but faces rated beautiful can be rather different, as well as their proportions, in different ethnic groups, or even within these groups

Our approach to beautification

- “ Our approach is to consider many attractive face prototypes, and to suggest surgical procedures able to approach the prototypes closer to the patient's face
- “ Then we propose the following general approach to face feature beautification:
 - . consider a particular face feature, and compare the face of the patient with many faces rated beautiful, excluding that particular feature;
 - . find, minimizing some convenient metric in the face space, the nearest attractive face (or faces);
 - . blend the feature of the nearest attractive face (or faces) with the original face, automatically suggesting what with high probability is an aesthetic improvement.

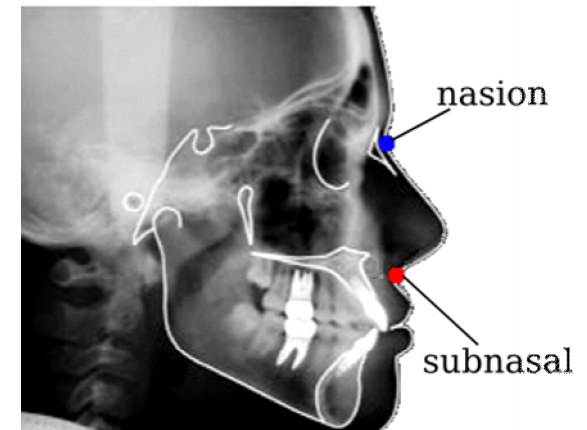
Application to plastic surgery planning

- “ Suggesting effective nose surgery on the basis of profiles
- “ Nose is one of the most distinctive face features and object of many plastic procedures
- “ The nose shape dominates the 2D face profile → the general approach will be applied to 2D profiles



Profile beautification

- “ Database of attractive or harmonious profiles (*reference database*)
 - populated with profile shots of people in neutral expression, not wearing glasses or beard
- “ The candidates have been rated from 1 (unpleasant) to 10 (beautiful) in order to select the most attractive profiles
- “ Profiles have different size and orientation:
 - normalization is based on the position of two landmark points (nasion and subnasal) which are automatically found on the subject's silhouette

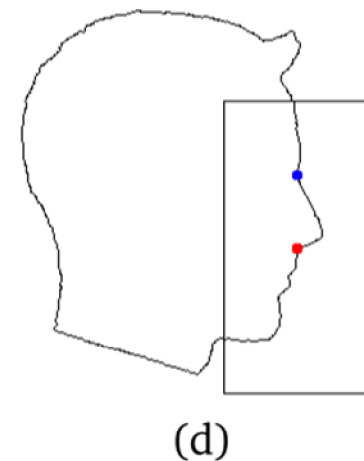
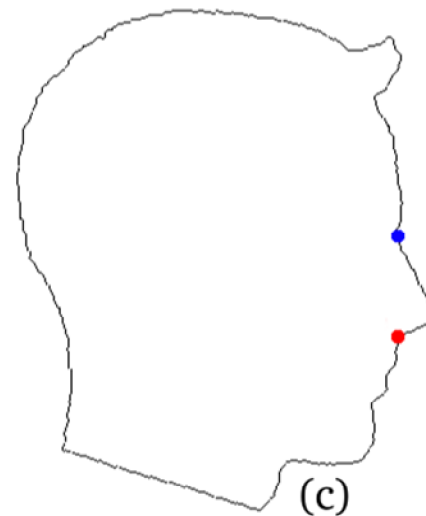
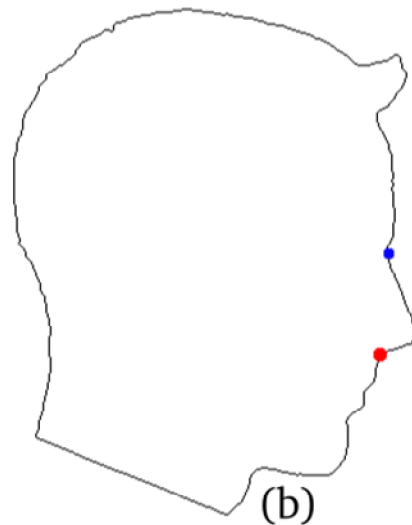


Profile beautification

- ” The outline of the algorithm is the following:
- . patient's and reference faces profiles are extracted and normalized;
 - . the nose is removed from all profiles;
 - . profiles are compared by means of a suitable similarity measure in order to find the reference face most similar to the patient's face (best candidate);
 - . the nose of the best candidate is substituted to that of the patient with a suitable morphing

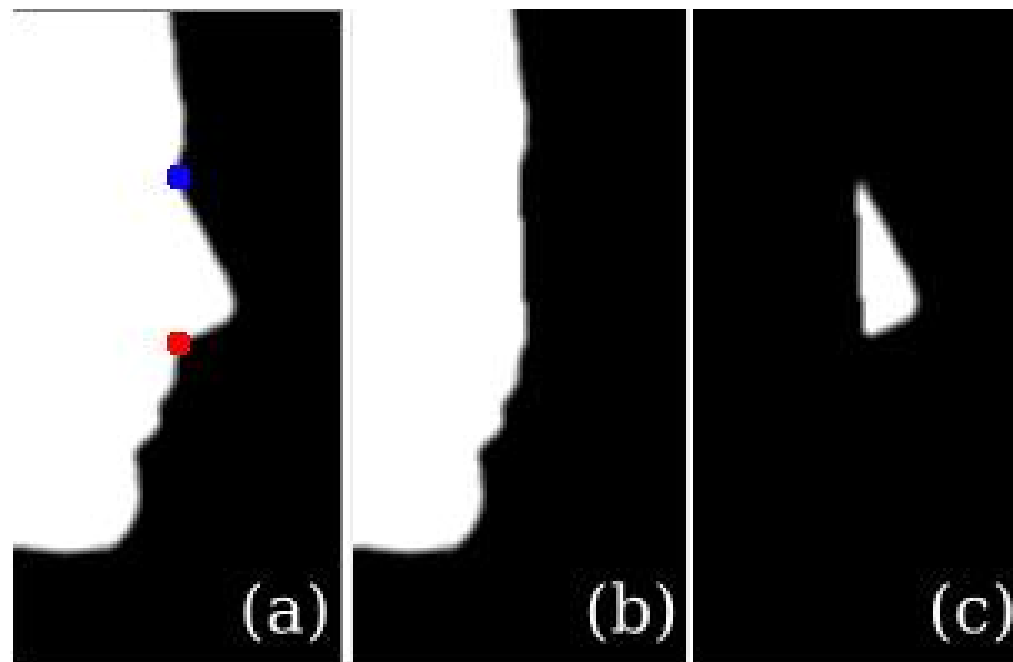
Profile extraction and normalization

- “ Silhouettes of the heads are extracted through background subtraction Profiles are transformed into a *normalized profile* enclosed within a fixed area of interest (*standard area*) where the two landmarks are vertically aligned in two predefined position



Nose removal

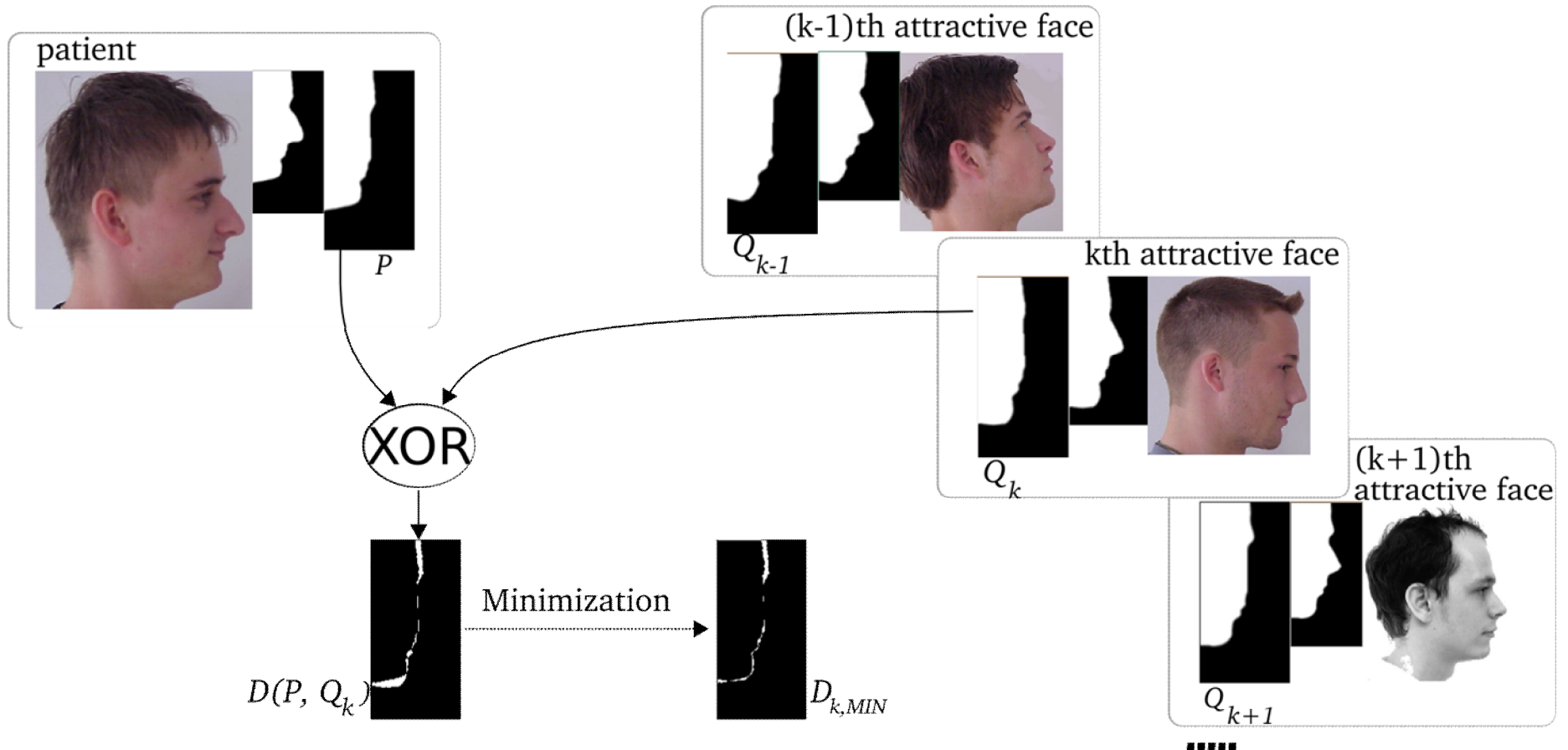
- “ The nose is removed from the normalized profile by simply deleting all contour points in between nasion and subnasal and connecting them with a straight line



Best candidate search

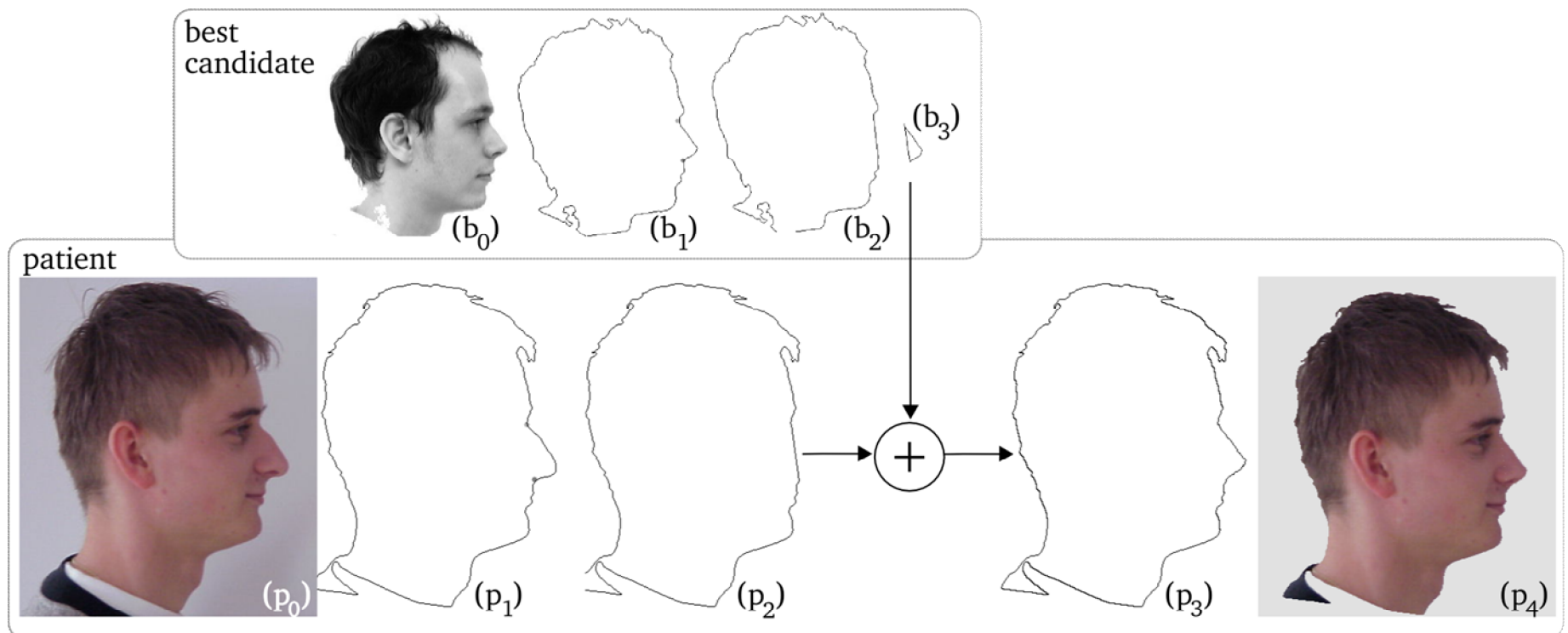
- ” → finding the most similar noseless profile in the reference DB
 - . Distance function: XOR of the two normalized noseless silhouette in the standard area. The distance is minimized by looking for the trasformation (involving translation, rotation, anisotropic scaling) that leads to the minimal distance

Best candidate search



Nose substitution and reconstruction

- “ Once the best candidate has been identified, its nose is applied to the patient's profile, giving a new (hopefully) beautified version of it



Experimental results



Experimental results



Experimental results



Conclusions

- “ This paper introduces a new general approach to planning plastic surgery procedures and presents a preliminary application.
- “ The main idea relies on the assumption that there are many attractiveness prototypes, where the single features may be rather different but harmonize with the other features
- “ We have presented a preliminary application, working on 2D face profiles, of a more general beautification approach

Future work

- ” Rate the beautified version of the incoming image in order to understand the correlation between attractiveness improvement and:
 - . Characteristics of the reference DB
 - ” Sex, ethnicity, age and attractiveness rating of the samples
 - . Similarity function (and its optimal value)
- ” Extend the approach in 3D

Questions?

