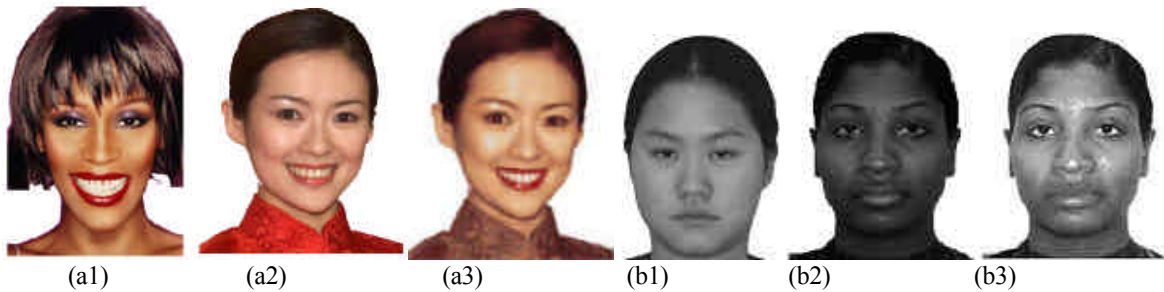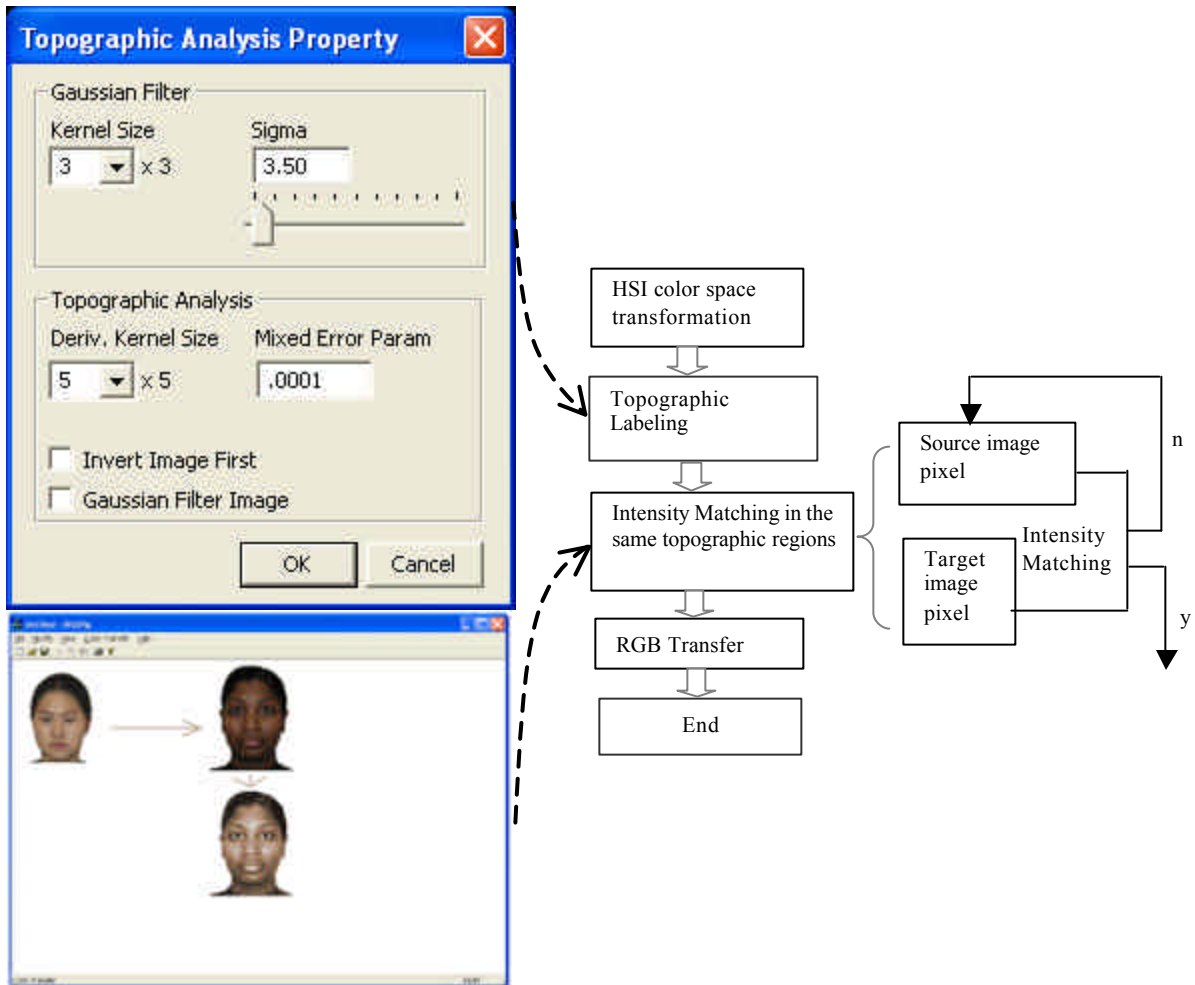# Topographic-based Facial Skin Color Transfer
(Supplemental Materials)
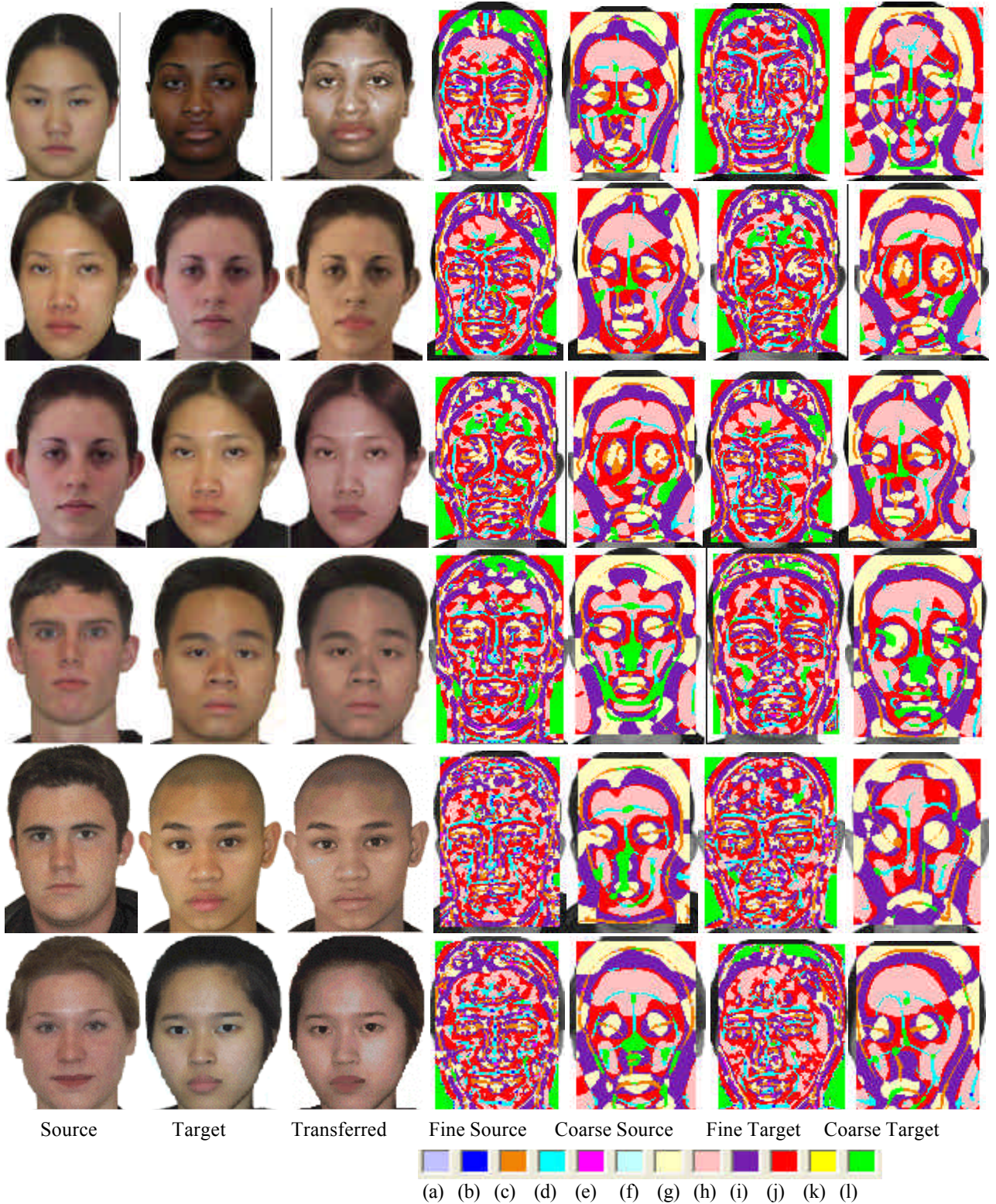
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(a1)	(a2)	(a3)	(b1)	(b2)	(b3)

Figure 1. Color transfer: (a1) source black face image; (a2) target Asian face image; (a3) color-transferred result from (a1) to (a2). **Transfer intensities** from the source image (b1) to the target image (b2). Transferred result is shown in (b3).


Figure 2: Facial skin color transfer at work

| Source | Target | Transferred | Fine Source | Coarse Source | Fine Target | Coarse Target |

(a) (b) (c) (d) (e) (f) (g) (h) (i) (j) (k) (l)

Figure 3: Facial Skin Color Transfer: From left to right: Column 1: Source images; Column 2: Target images; Column 3: Color transferred results from sources to targets; Column 4: Topographic labeled regions for source images (fine regions); Column 5: Coarse regions of source images; Column 6: Fine regions of target images; Column 7: Coarse regions of target images; The topographic regions are labeled by colors: (a) Peak; (b) Pit; (c) Ridge; (d) Ravine; (e) Ridge Saddle; (f) Ravine Saddle; (g) Convex hill; (h) Concave hill; (i) Convex saddle hill; (j) Concave saddle hill; (k) Slope hill; (l) Flat.

| | Source | Target | Transferred result | Source | Target | Transferred result |
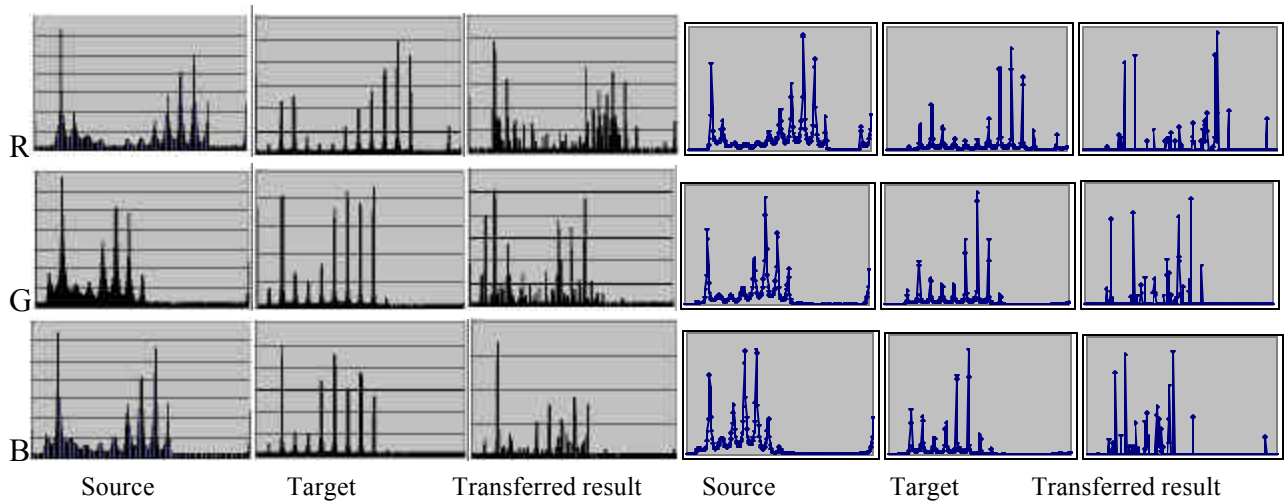
Figure 4. Histogram transfer as the result of color transfer: Histogram is usually an objective visual tool to better analyze the distributions of the datasets. We conducted the statistics to analyze the histogram distribution in RGB components for each testing image before and after the color transfer. This figure shows two examples obtained from images of Figure 3 (second row) and Figure 3 (fifth row). As we can see from the graphs, the general tone of the source image is transferred to the target image (i.e., the shape of the histogram of the resulting image is more similar to the source image than the target image).

Table 1: Psychological Test For Subjective Evaluation

	Own-race correct-recognition rate		Other-race correct recognition rate	
Test I (Original)	83.3%	(False Positive: 16.3%)	50.0%	(False Positive: 38.3%)
Test II (Color-transferred)	75.0%	(False Positive: 23.3%)	66.7%	(False Positive: 27.3%)

Seventy-two frontal face images were collected for our test, which include different racial characteristics such as male, female, white, black and Asian people. A psychological test was conducted by 12 volunteers from different races (students, faculties and psychologists including 4 whites, 4 blacks and 4 east-Asians).

(1) Test-I:
Test Method: Each viewer was given 9 original facial images (including 3 whites, 3 blacks and 3 east-Asians), and was asked to read the same set of face images in two weeks interval. Note that each viewer was given different set of 9 images.
Experiment Result: 10 out of 12 viewers were able to remember the 3 faces of their own race correctly, and 6 out of 12 viewers able to recognize all 6 other-race faces. All the viewers identified the facial races of 9 images correctly.
(2) Test-II:
Test Method: Each viewer was given a new set of 9 facial images, including 3 own-race face images and 6 other-race face images which were processed by changing the skin color from 6 other-race colors to viewer's own-race color. Each viewer was asked to read the set of 9 images in two weeks interval.
Experiment Result: 9 out of 12 viewers were able to recognize the 3 own-race faces correctly, 8 out of 12 viewers were able to remember 6 other-race face images. All the viewers identified the facial races of 9 images correctly.

Our color transfer tool works well for the psychological research. The preliminary result shows that the facial skin color is one of the aspects to influence race-related face identification and memorization. Since all the viewers were able to identify the races correctly no matter whether the color was changed or not, color is not a major component to determine the race-related facial traits (or identity), however, facial color does affect people's memorization and recognition.

Comparison to other color transfer method (Welsh's method):

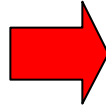Source Image   Target Image   =

Result of Our Method   Result of Welsh's Method

Source   Image

Target Image

Result of Our Method

Result of Welsh's Method