IMAGE PROCESSING LABORATORY

Red Eye Removal

Tony Meccio

Overview

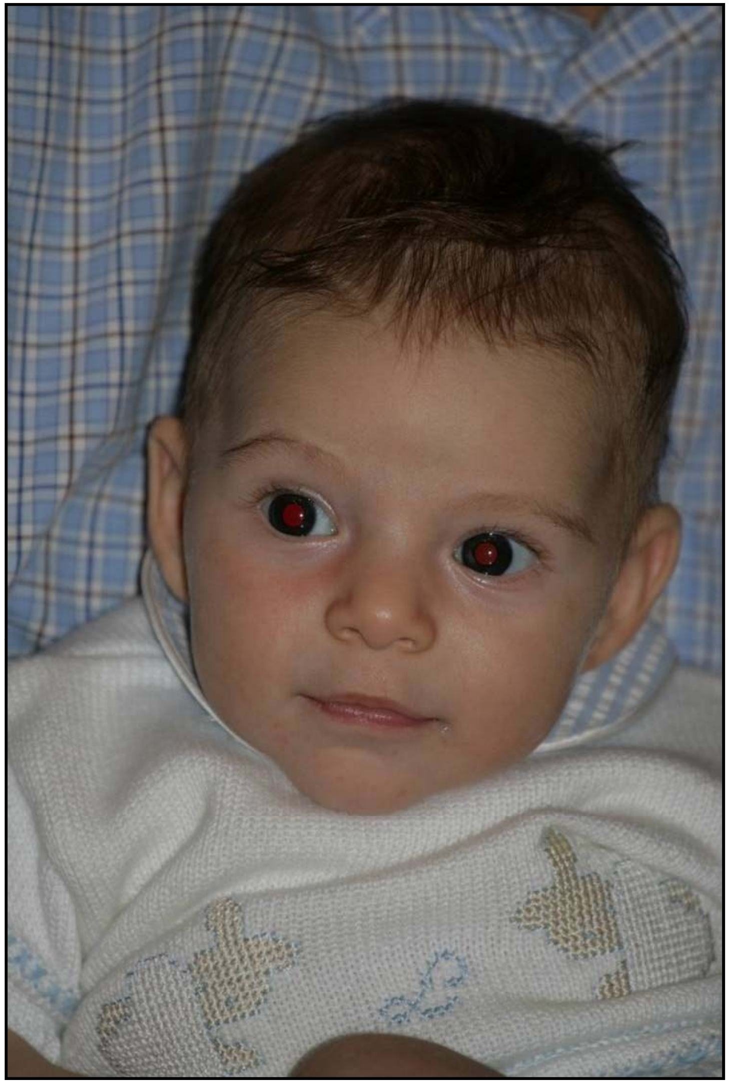
- Introduction to the Red Eye problem
- Red Eye prevention
- Red Eye detection
    - Semi-automatic methods
    - Automatic methods
- Red Eye correction
    - Desaturation
    - Inpainting techniques
- False positives and unnatural corrections
- Red Eye removal examples

The Red Eye problem

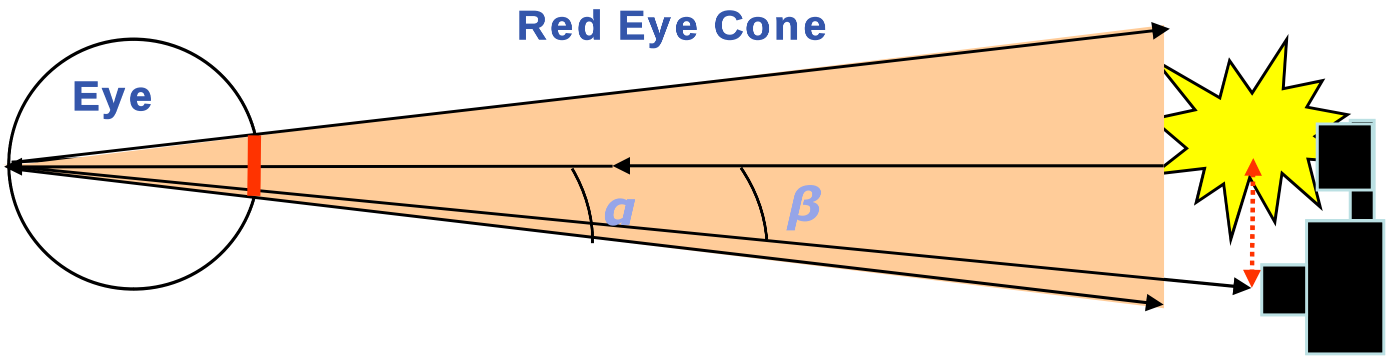
The Red Eye phenomenon is a well-known problem which happens when taking flash-lighted pictures of people.

The pupils in the picture appear red instead of black.

This happens more often when using compact, consumer-oriented cameras.

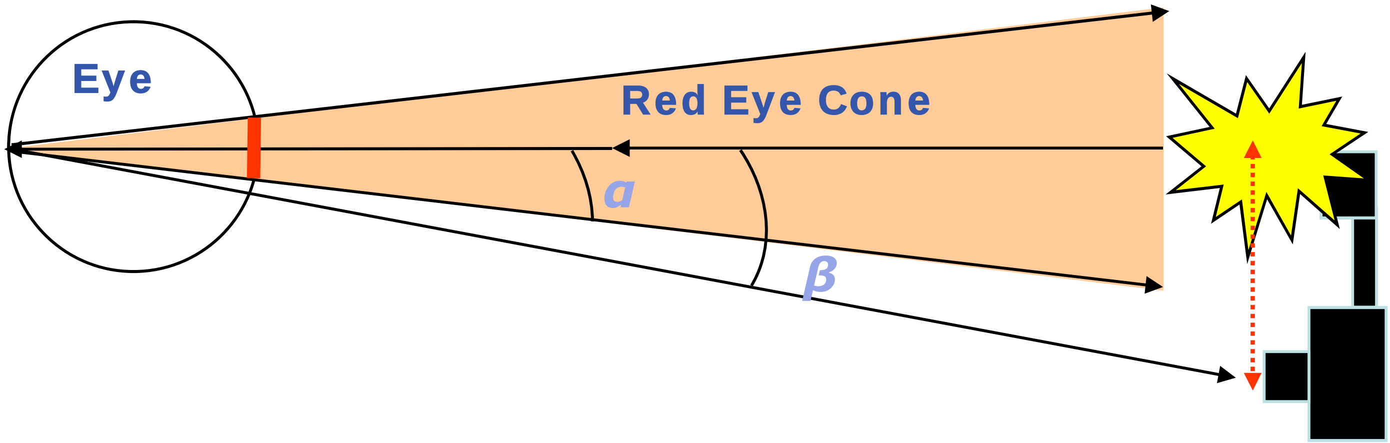


Why the Red Eye?



- The red eye cone shines from the flashed eye back at the flash with an angle ***α***;
- Its red color is caused by the reflection of the flash off the blood vessels of the retina;
- The camera will record this red hue if the angle ***β*** between the flash and the camera is **not greater than *α***.

Red Eye prevention



- If the equipment allows it, the flash can be spaced further away from the sensor in order to **increase *β*** (not possible on compact devices);

- One or more additional flashes before picture acquisition make the iris tighten and **decrease *α***;

- This methods reduce the probability of the Red Eye phenomenon but **don't remove it entirely**.

Red Eye detection

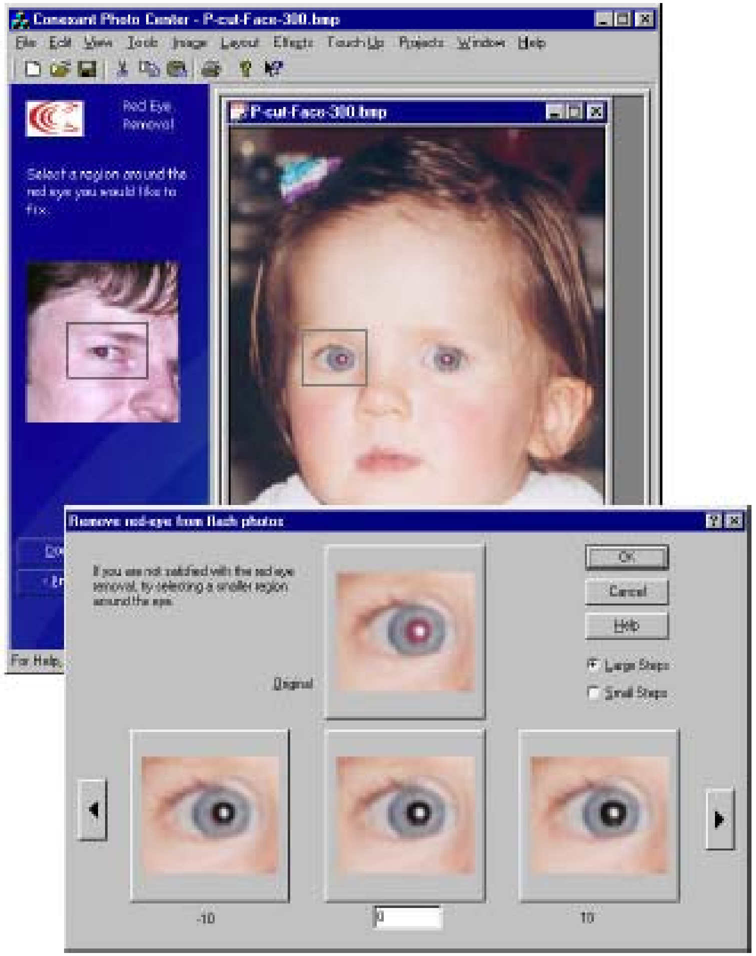
Most of the times, red eyes must be removed during post-processing.

For red eyes to be successfully removed, they must be first **detected** then **corrected**.

Methods are classified according to the detection phase:

- **Semi-automatic methods** ask the user to manually localize the red eyes;
- **Automatic methods** detect the red eyes themselves.

Semi-automatic methods


Conexant Photo Center - P-cut-Face-300.bmp
File Edit View Tools Image Layout Effects TouchUp Projects Window Help
Red Eye Removal
P-cut-Face-300.bmp
For Help,
Remove red-eye from flash photos
OK
Cancel
Help
Original
-10
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Select a region around the red eye you would like to fix.

If you are not satisfied with the red eye removal, try selecting a smaller region around the eye.

● Large Steps
○ Small Steps

The eyes are manually selected using a visual interface (Adobe **Photoshop** ®, Corel **Paint Shop Pro** ®, **ACD See** ®, etc.)

Pros:

- Eyes are easy to localize for men.

Cons:

- It may be difficult to have such an interface on a mobile device;
- Automatic methods are easier to use and more appealing.

Automatic methods

Automatic methods attempt to find red eyes on their own. The task is harder than it may seem:

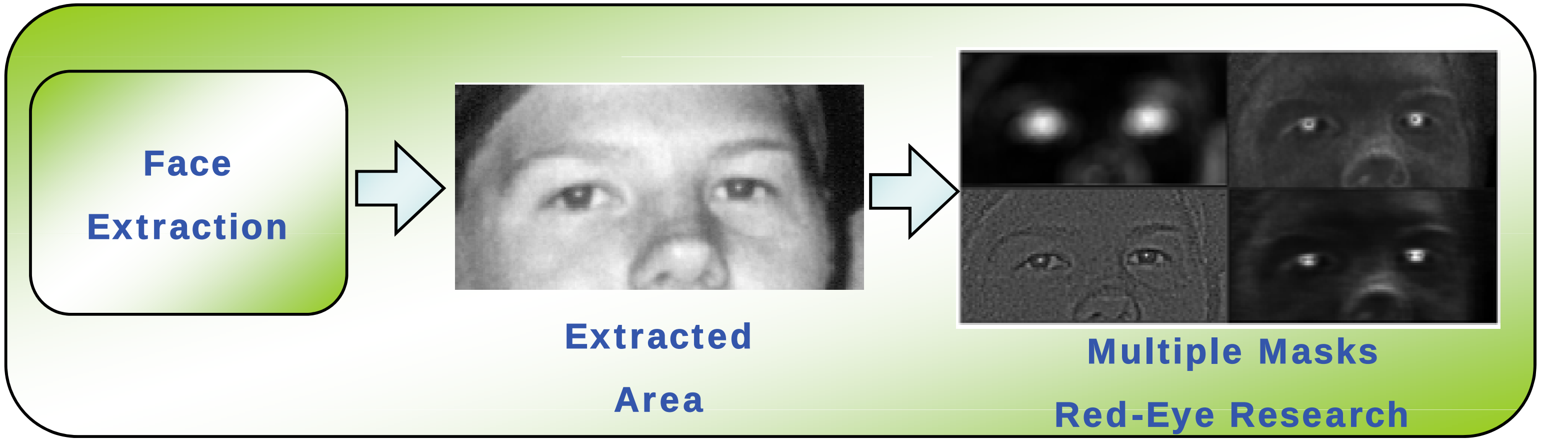
No “perfect” Red Eye detection method has been developed yet.

Automatic methods extract features from images in order to identify red eyes. Different methods work on different features:

- Face detection
- Eye detection
- Skin detection
- Flash-noFlash comparison

Face-based methods

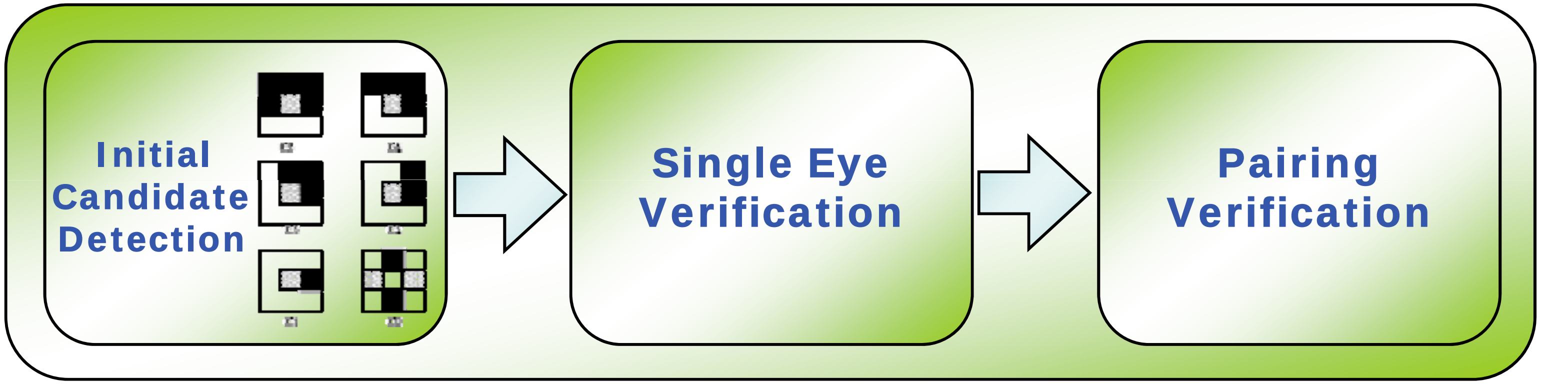
- Faces are looked for using a **multiple feature object based** approach;
- Once the face features have been found then the research is **restricted to red pixels**.



Eye-based methods

Similar to face detection, but **more complex** because the features are less evident:

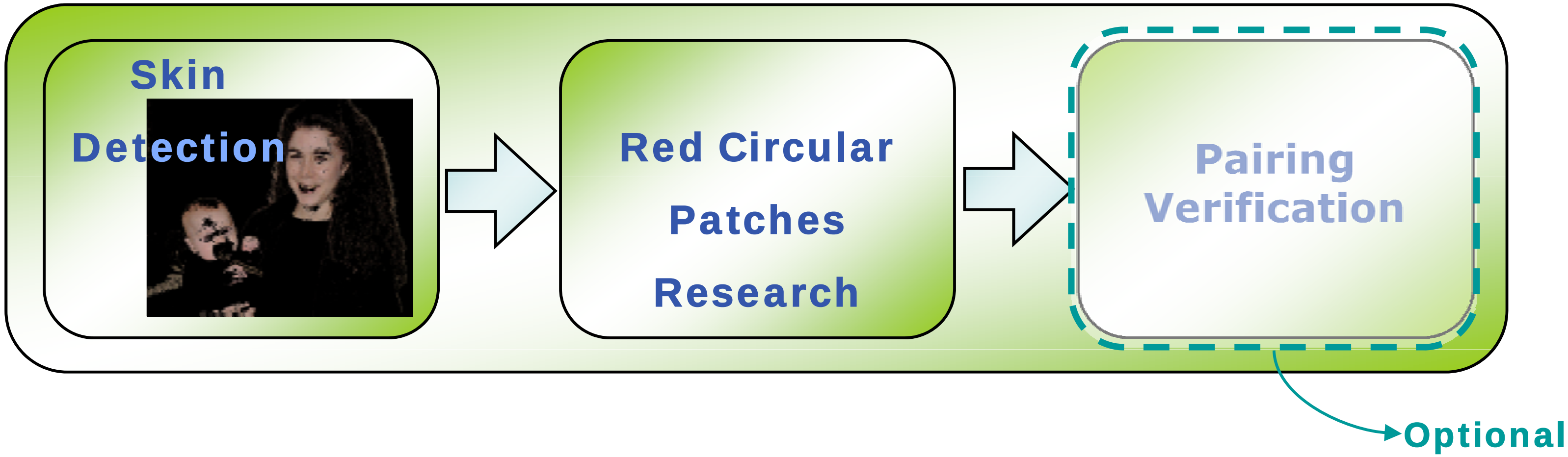
- Eyes are seeked, matching **fixed templates at different resolutions** with regular eyes present into the images, or looking for red pixels using **computed color LUTs**.



Skin-based methods

- **Skin** is detected first by pixel colors;
- **Red circular patches** near the skin are then looked for.

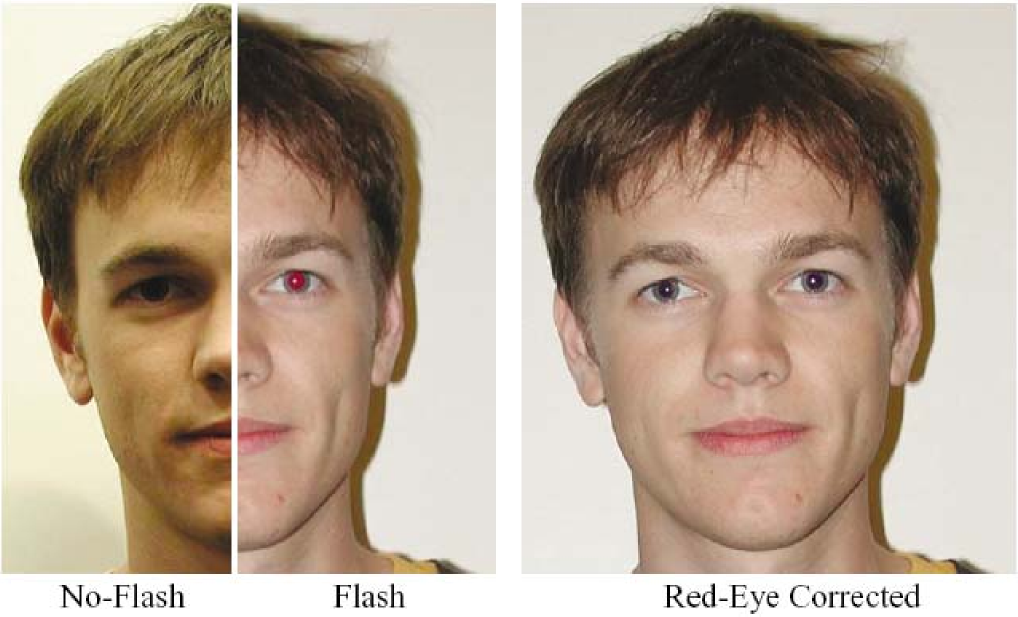
This approach is simpler and does not take into account the presence of more complex features.



Flash-noFlash methods

- Two different pictures, **one with flash and one without**, are acquired one after the other;

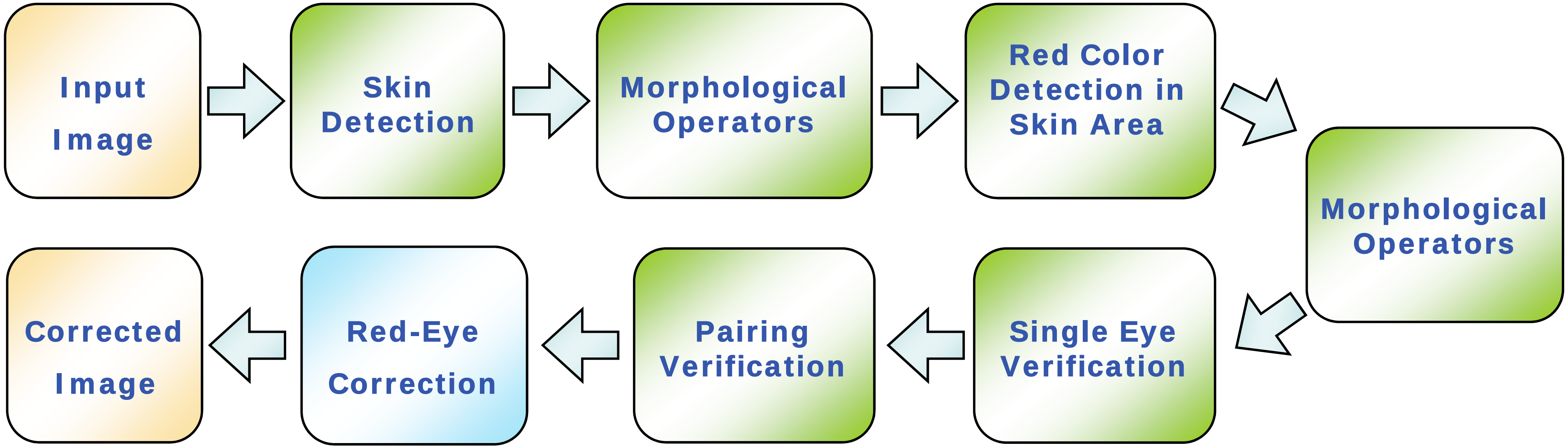
- Red eyes are detected as patches whose color is **red in the “flash”** image and **black in the “nonflash”** image.


No-Flash Flash Red-Eye Corrected

This approach has several drawbacks:

- The dimension of the buffer must double;
- The two images may be mis-aligned;
- The subject(s) may move between acquisitions.

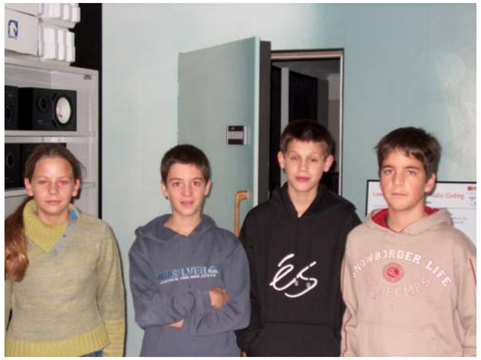
An algorithm in detail



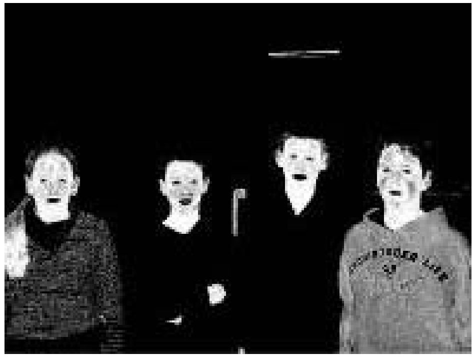
The Algorithm is **Skin Feature Extraction** based.

- First the **skin is extracted and morphologically modified** to blob the enhanced areas;
- Then a successive red color detection is performed to find **red eyes in the skin areas**;
- The red regions are then **dilated, eroded and analyzed** to identify the Red-Eyes pairs.

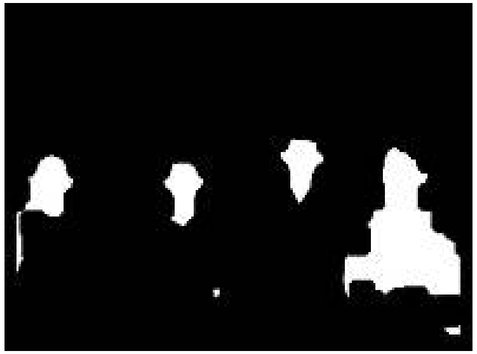
Example



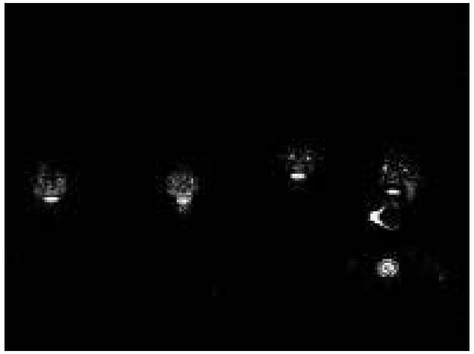
Input Image



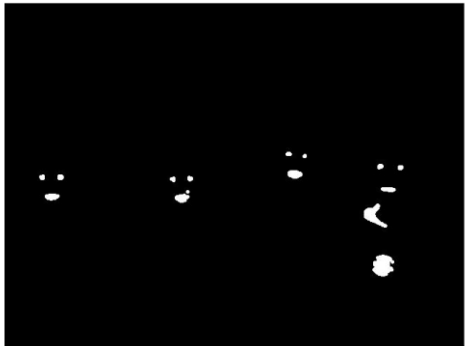
Skin Detection



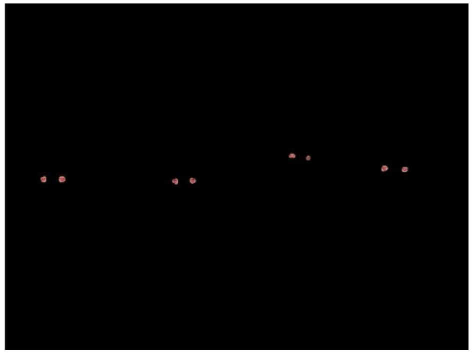
Morphological Operators



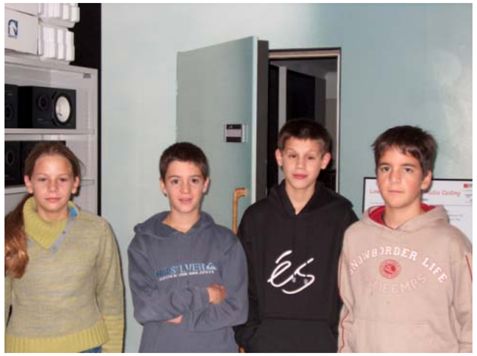
Red Color Detection in Skin Area



Morphological Operators

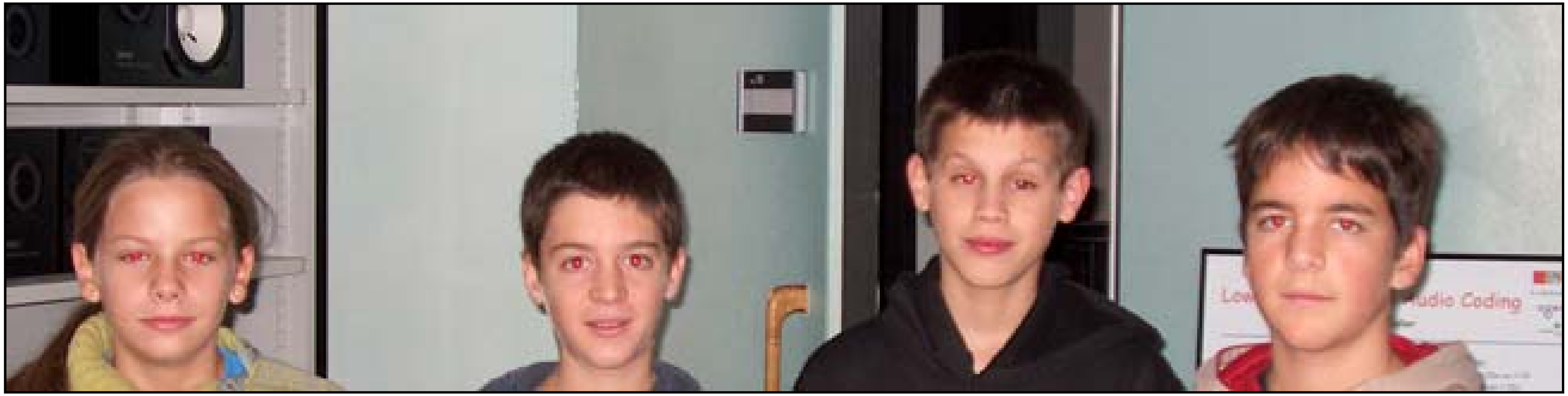


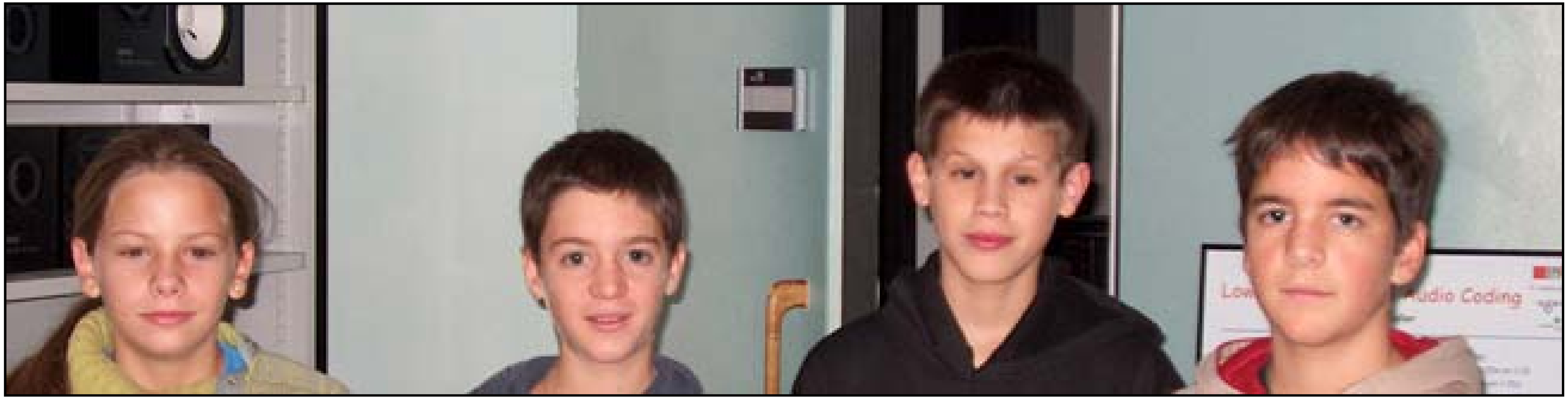
Pairing Verification



Corrected Image

Input/Output comparison





Algorithm drawbacks

- Unable to perform single red eye detection;

- The skin detection is performed over the whole image (slow);

- Big (slow) morphological operators permit to get good results only on small images (less than 1 Mpixels): it would require even bigger (and slower) operators to operate on larger images.

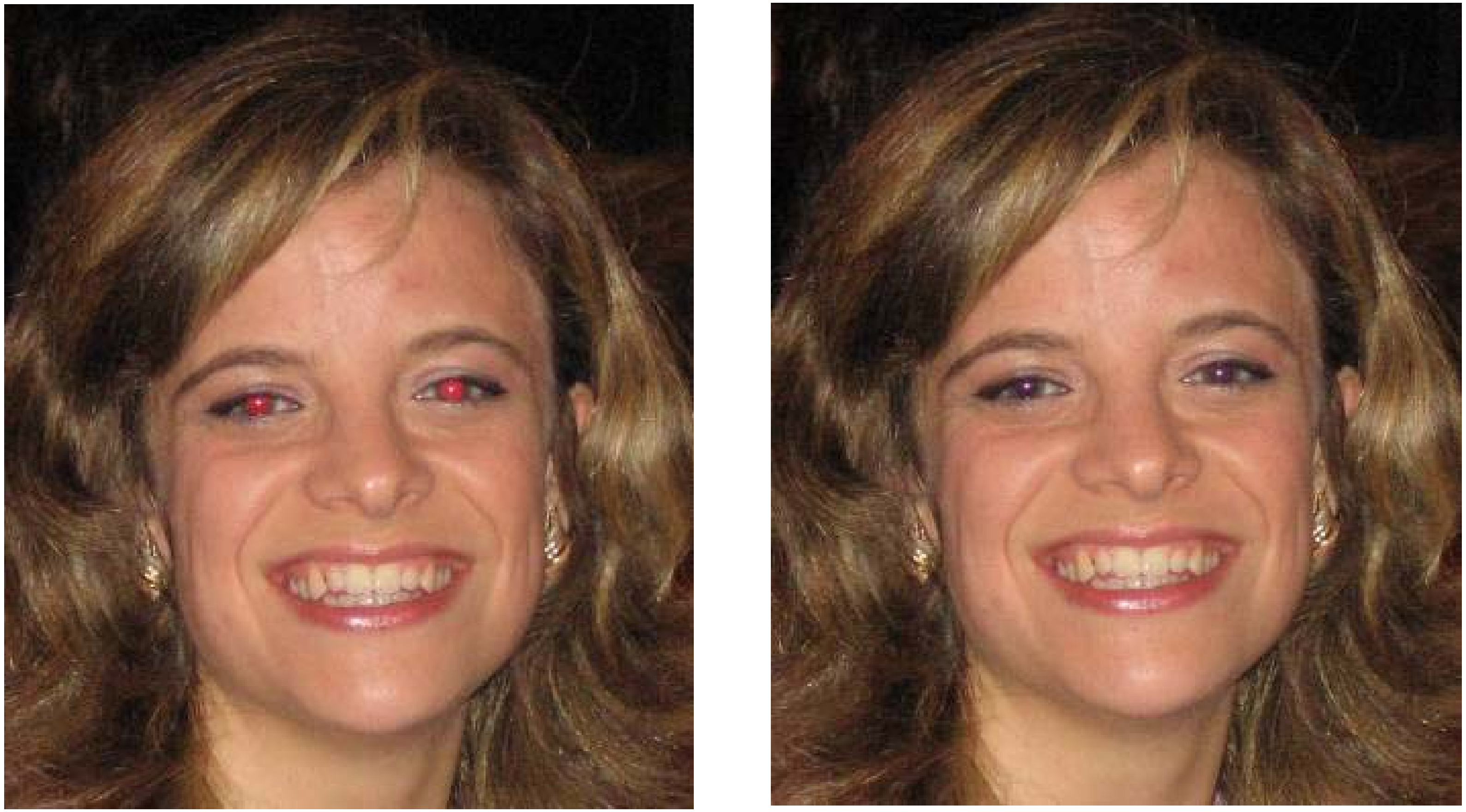
Red eye correction

Once red eyes have been detected, they must be corrected.

Red eye correction is **quite simpler** than detection, but there are more difficult cases than others.

Correction may vary from simple **desaturation** to **complete reconstruction** of iris and pupil.

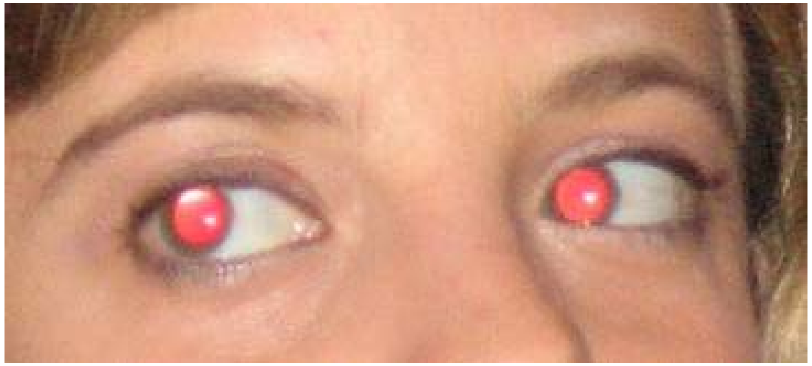
Desaturation



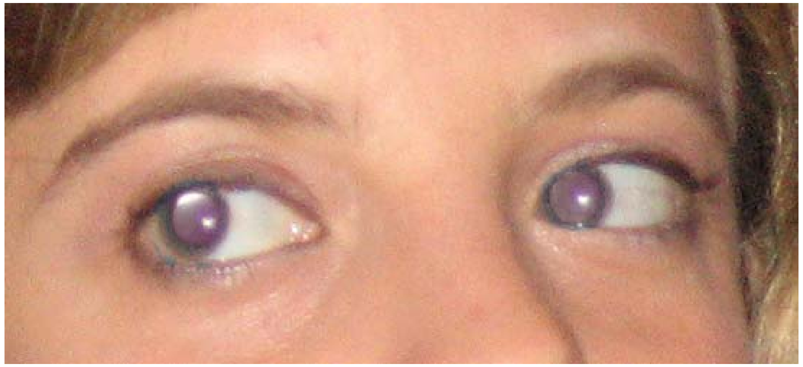
Desaturation means **lowering / zeroing the chrominance** components while mantaining the luminance component.

It is the best way to correct “easy” red eyes.

Washed-out irises



Washed-out irises

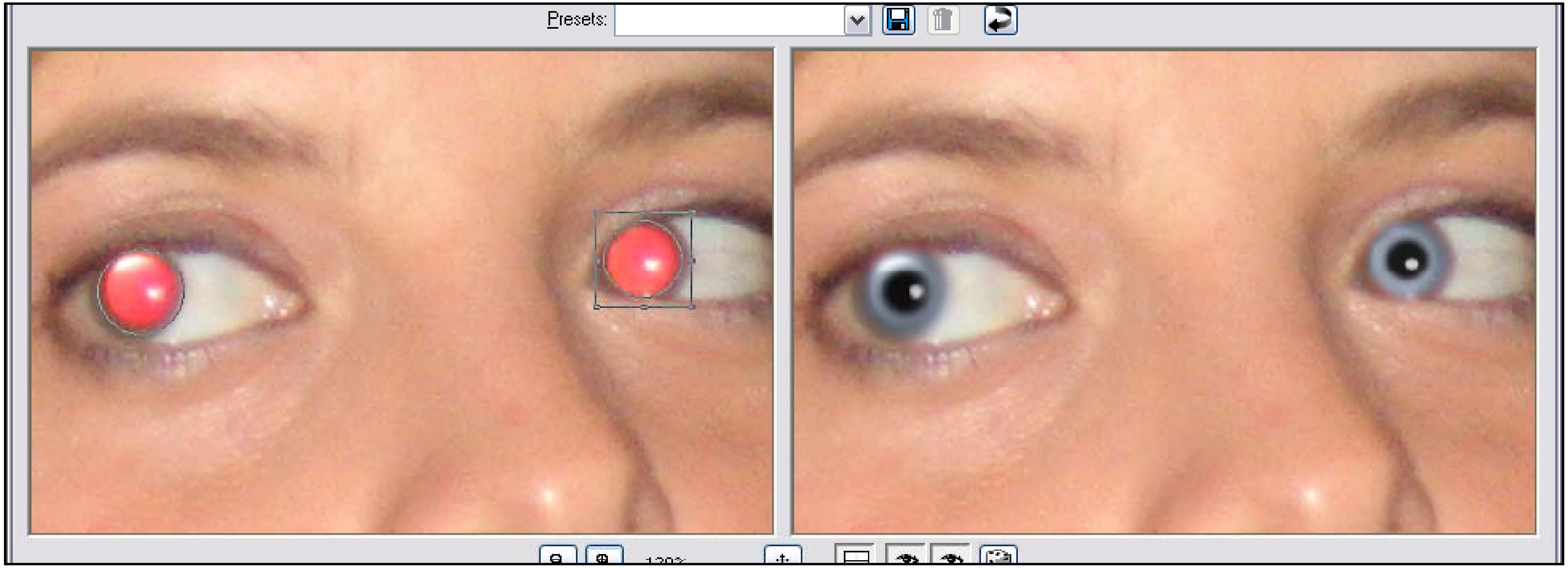


Wrong correction

Sometimes irises are **totally washed out** by reflected light. In these cases a simple desaturation or color correction is not enough.

It is necessary to use a more complex method to reconstruct a realistic image of the eye.

Inpainting techniques



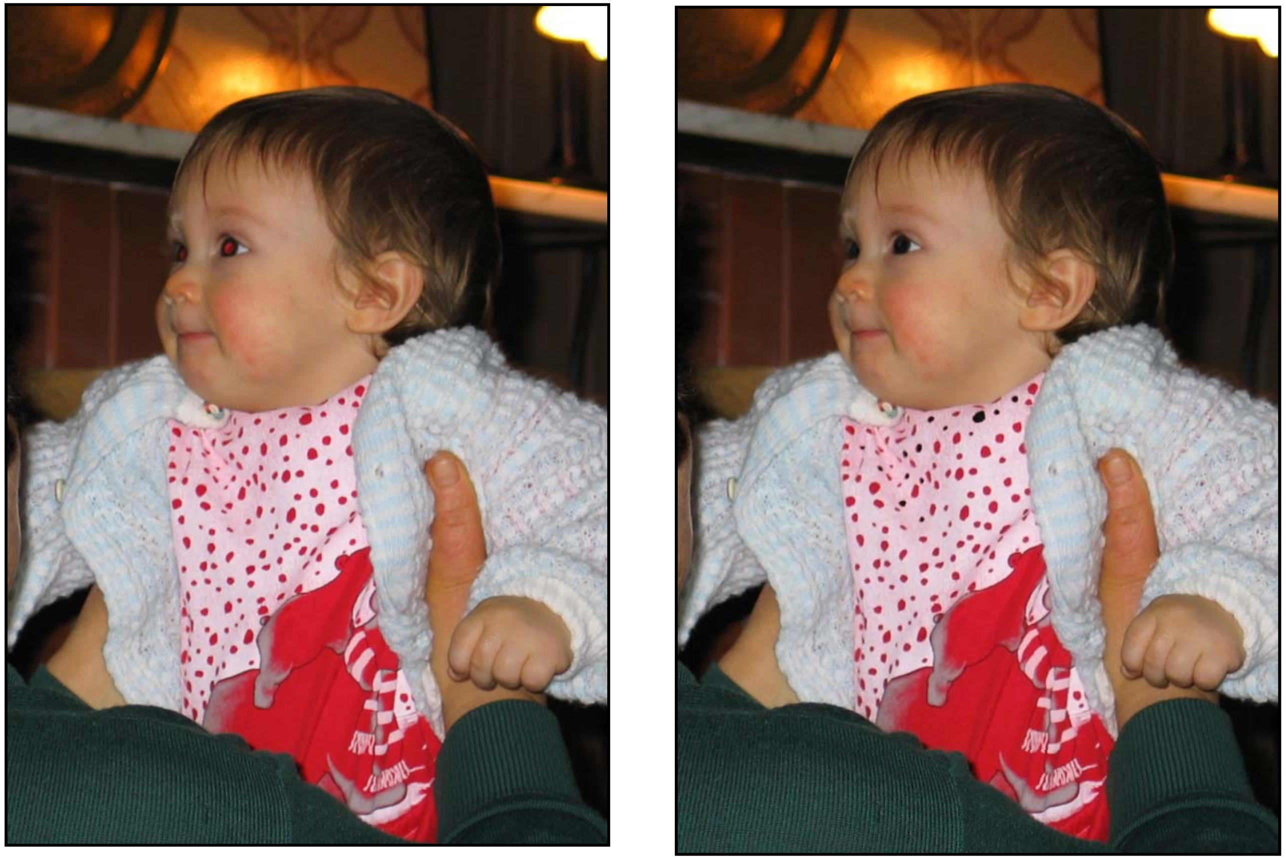
Some tools **completely reconstruct** the irises and the pupils to replace the red eye (Jasc Paint Shop Pro ®).

The results, however, are often unrealistic and look like glass eyes.

False positives

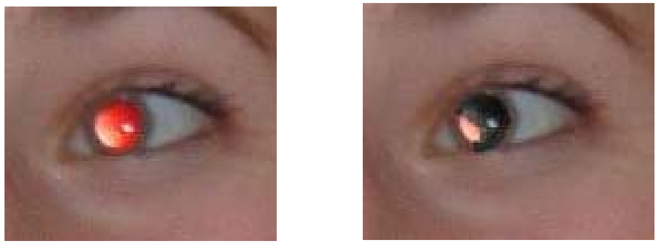
One of the biggest issue in red eye removal are **false positives** in the detection phase.

Unwanted corrections are much less desirable than missing ones.

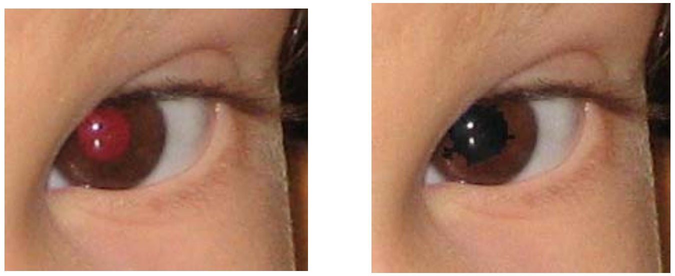


Unnatural corrections

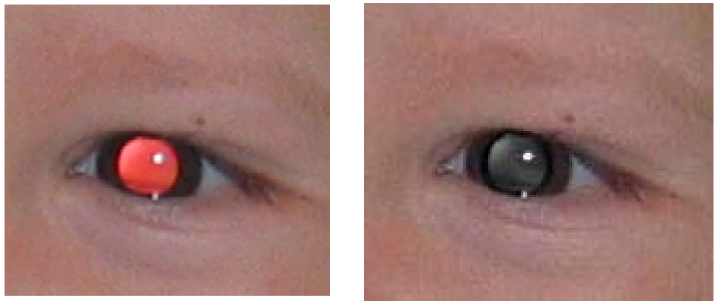
- Unnatural corrections are another important issue.
- The most common ones are:
  - **Partial correction:** only a portion of the red pupil has been corrected;
  - **Noisy correction:** the presence of heavy noise or jpeg compression can introduce false red pixels around the pupil and thus a strange correction is made over the iris;
  - **Wrong luminance correction**: in this case the disk has been correctly found but the correction is unnatural due to wrong luminance distribution.



Partial correction

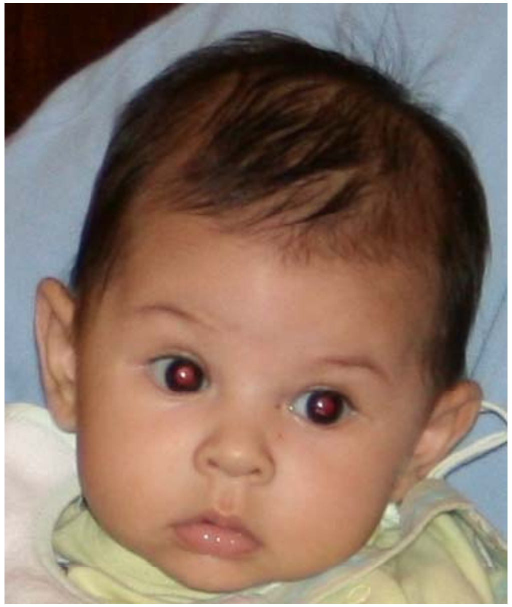


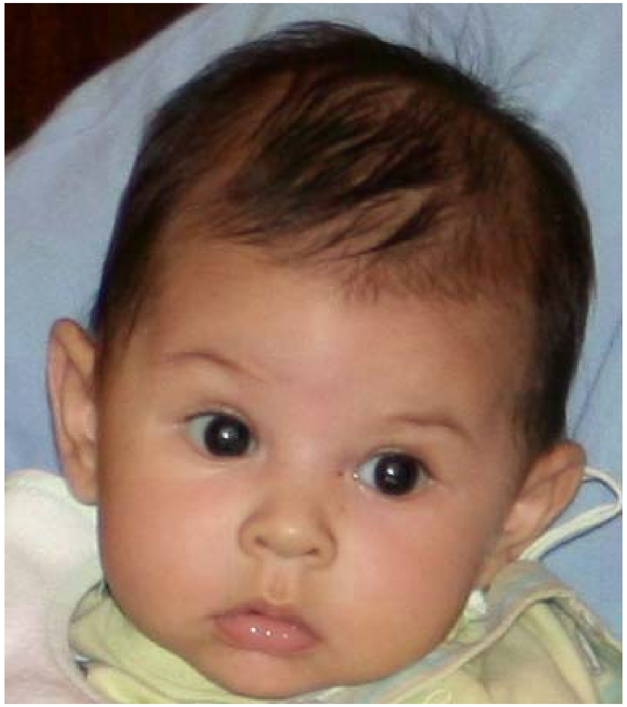
Noisy correction



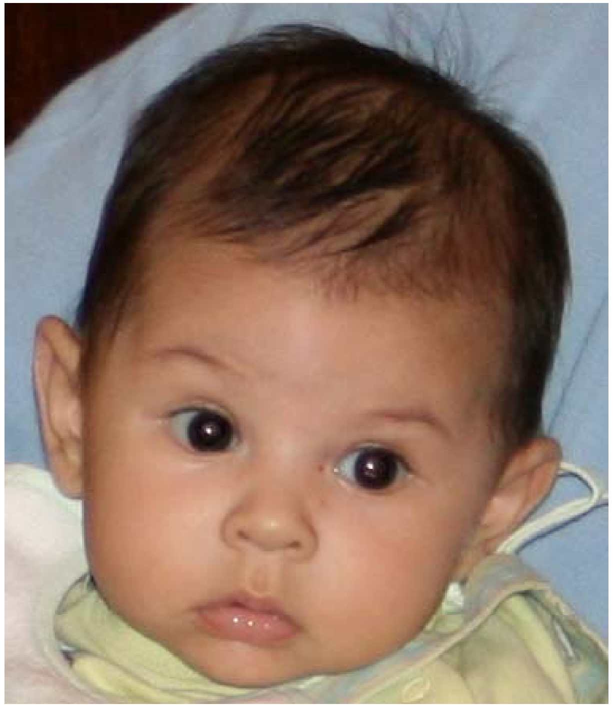
Wrong luminance correction

Red Eye removal examples





StopRedeyes®



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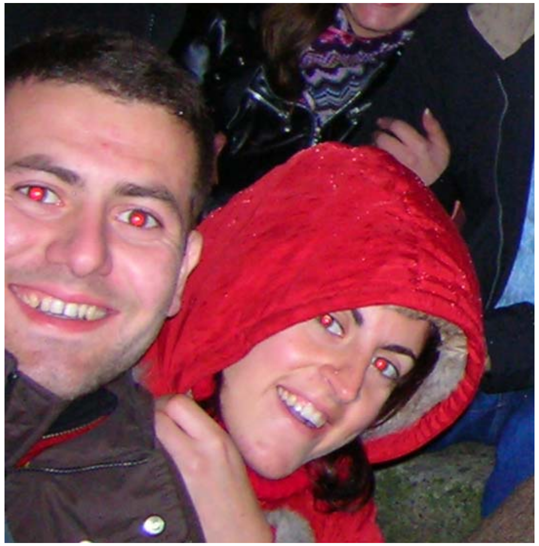
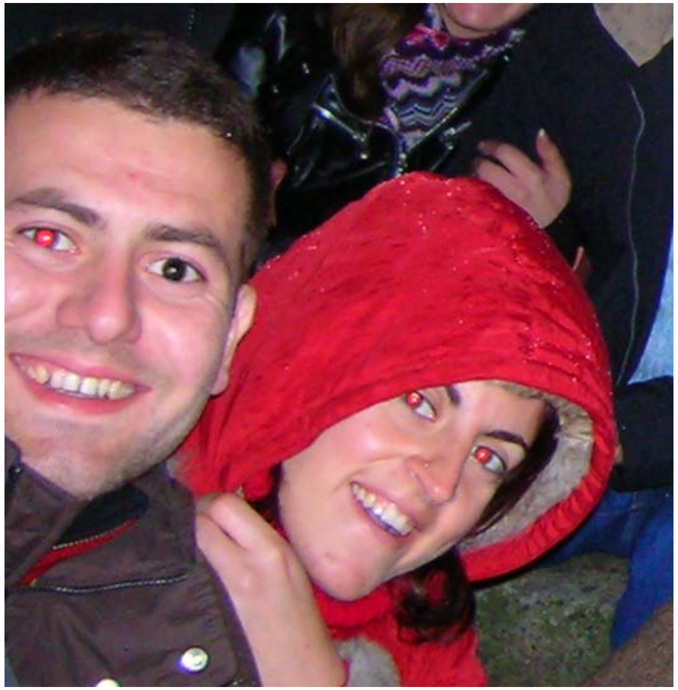
Red Eye removal examples





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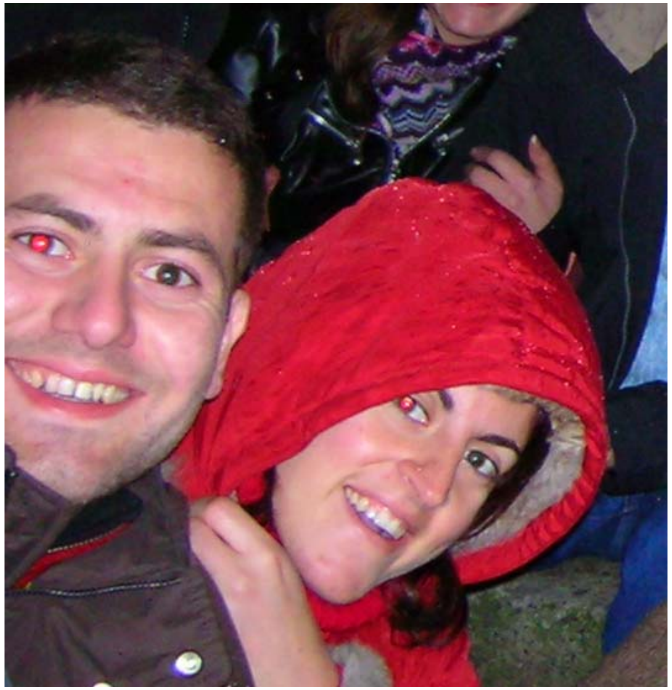

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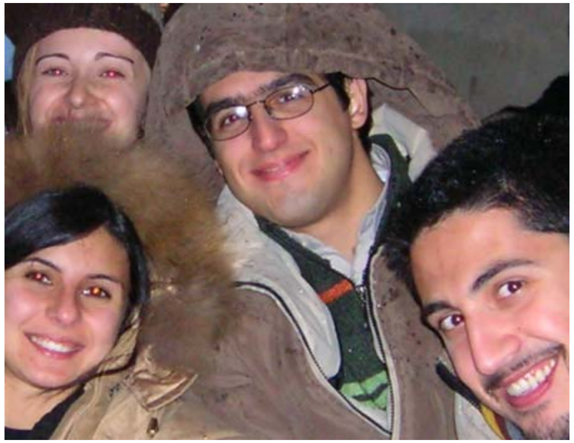
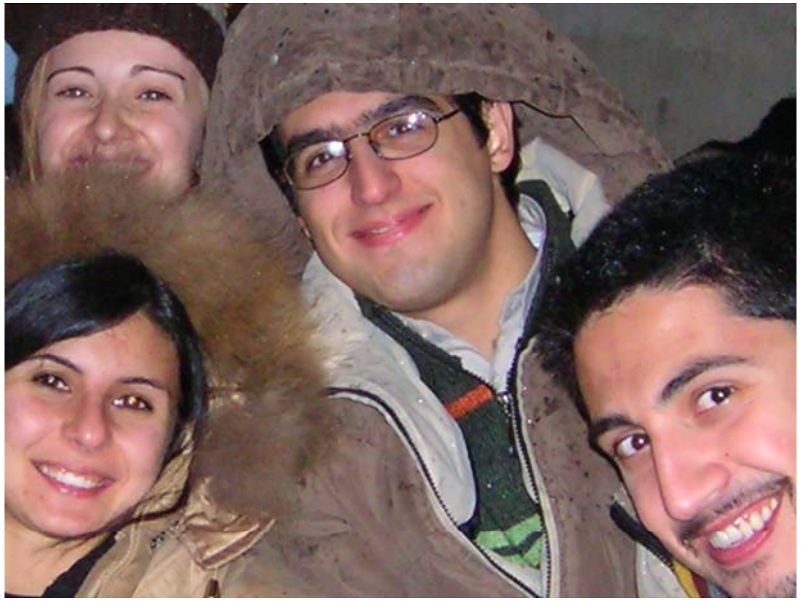
Red Eye removal examples





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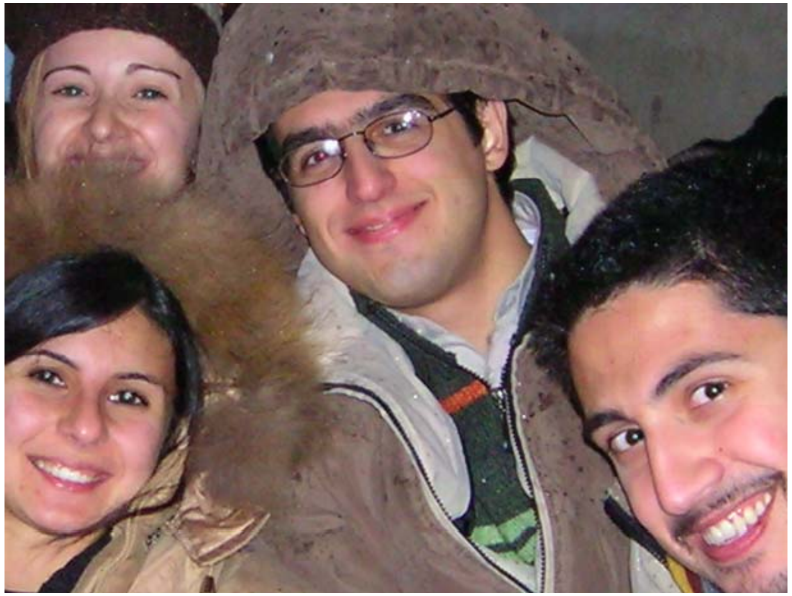

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