Purpose: to colorize a black white image with marks

# Take a colored image, and convert it to black and white

Convert to YUV format, and only count in intensity channel Y, and ignore the color channels U and V. convert the Y channel back to RGB channel and save to black and white images.

# Manually mark the black and white image

I used Photoshop to mark the black and white image using color scribbles. I chose the following two coloring methods

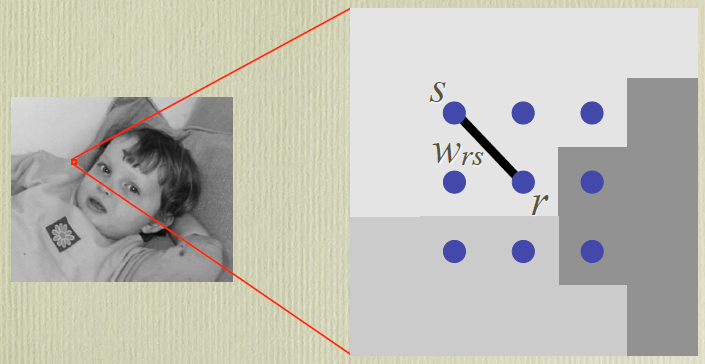
1. Constrained to keep their original colors
2. Free to choose other colors for comparison

# To convert the black and white images from format to format, where stands for intensities, and and contain relevant color information.

# To find the matrix such that is minimized:

|  |  |
| --- | --- |
|  |  |

Subject to constraints: , where are all marked pixels and are marked color.



In order to solve the above constrained minimization problem, I reshaped the color matrix U from

dimension matrix

To

dimension vertical vector

with , and M and N are number of rows and columns of input image

The above problem is equivalent to find , such that

* For each colored pixel , set the U value using the given color:, which can be written in the vector form:
* For each uncolored pixel , set the U value to be the weighted average value of neighbor pixels.

Where the weight function is defined as

With being the variance of the intensity values in the window around pixel **r** with size 1

The above equation can be re-written in the vector form:

Combining the above two cases, the constrained problem is equivalent to solve the following linear system

|  |  |
| --- | --- |
|  |  |

Where A is a sparse matrix with

* If is colored, then
* If is not colored, then

and

Step 3: Solving the linear system (2) gives us the color channel in the vector form

then convert the vector into a matrix form.

Note:

* The color channel can be calculated in the same way as U color channel
* The Y intensity channel is calculated to be the black and white intensities

Step 4: Convert the colorized image from YUV format to RGB format

To colorize videos

Step 1: Manually extract frames of images from video

I manually extract frames from the source video based online converter. Frame for every XXX

Step 2: Convert the colored frames into black and white

Step 3: Manually mark selected black and white images. Normally I mark 1 frame for every 10 frames

Step 4: Colorized the marked black and white images

It follows the same procedures as colorizing the still black and white images. Note: we may propose different colors from those in the source video

Step 5: Colorize the marked black and white frames based on colored frame. For example, colorize frame 1 to frame 9 based on the colorized frame 0

1. Convert both colored image (e.g. frame 0) and black and white image (e.g. frame 1) from RGB format to YUV format
2. For each pixel in the black and white image, loop through each pixel on the colored image, such that where the Y channel of black and white frame and colored frame is minimized. In particular, difference betweenand is minimized.
3. Set and
4. Convert the colorized frame (e.g. frame 1) from YUV format back to RGB format
5. Perform 1 to 4 for frame 1 to frame 9

Step 6: Manually convert the colorized frames into gif format