Image & Video Processing

Assignment 1

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Contents

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1 Point Operations [20 points]

1.1 Tone mapping & Linearization [2 points]

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1.2 Color correction [4 points]

1.3 Histograms [1 point]

1.4 Histogram Equalization [5 points + 2 Bonus]

1.5 Manual histogram equalization [2 points]

1.6 Thresholding & matting [4 points]

1.7 How many bits is enough [2 points]

2 Bonus: use your own pictures [3 points]

(a) Original `ferrari.jpg`.

(b) `ferrari_lin.jpg`. Linearized contrast

(c) `ferrari_bri.jpg`. Scaled brightness

(d) `ferrari_con.jpg`. Exponential contrast.

Figure 1: Tonemapping procedure comparison.

```
im = imread("./media/ferrari.JPG");
im = double(im)./255;
imwrite(uint8(255.*im), "./out/1.ferrari.jpg");

% 1.1 Map pixels to 0-1 range and linearize image back
im_lin = im.^2.2;
imwrite(uint8(255.*im_lin), "./out/1.ferrari_lin.jpg");

% 1.2 Increase brightness
im_bri = im.*2;
imwrite(uint8(255.*im_bri), "./out/1.ferrari_bri.jpg");

% 1.3 Enhance contrast using exponential function
im_con = im.^0.7;
imwrite(uint8(255.*im_con), "./out/1.ferrari_con.jpg");
figure()
imshow([im, im_lin,im_bri,im_con], []);
```

Figure 2: Matlab code performing various intensity transformations on the image `ferrari.jpg`.

3 Reproducing the results

In the `src` folder you can find a `Makefile`. Run `make` to execute the matlab scripts and store the results in the `src/out` folder.
Alternatively you can run individual scripts e.g `make src/script1.m`.

(a) Original image (b) Pixel-based correction (c) Gray-world assumption correction

Figure 3: Color correction procedures comparison.

```
im = imread("./media/white_balance_input.jpg");
im = (double(im)./255);
imwrite(uint8(255.*im), "./out/2.wb.jpg");

channelmean = mean(mean(im))
% 2.1 Pixel-based correction
figure()
imshow(im);
coords = int32(ginput(1));
px_color = im(coords(2), coords(1), 1:3);
gain = px_color./channelmean;
im_pxcorr = im.*gain;
imwrite(uint8(255.*im_pxcorr), "./out/2.wb_pxcorr.jpg");

% 2.2 Gray-world assumption
gain = 0.5./channelmean;
im_gwa = im.*gain;
imwrite(uint8(255.*im_gwa), "./out/2.wb_gwa.jpg");

figure()
imshow([im, im_pxcorr, im_gwa])
```

Figure 4: Matlab code performing various intensity transformations on the image `ferrari.jpg`.

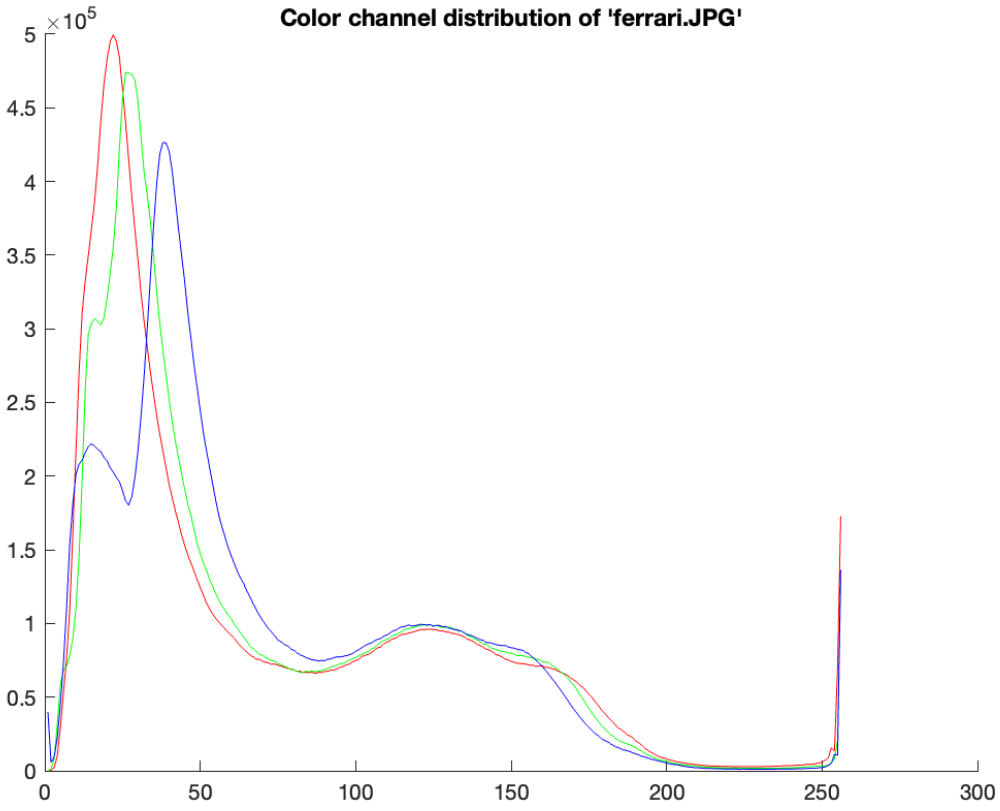


Figure 5: Color channel distribution of the image `ferrari.JPG`.

(a) Original image.

(b) Chroma Key mask.

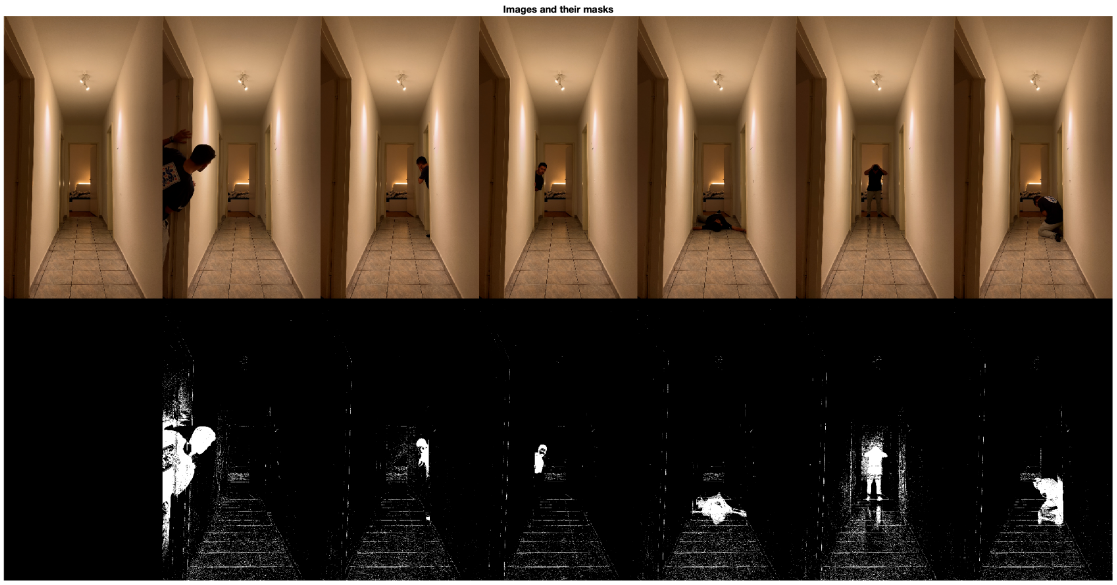
(c) Background image.

(d) Composited result image.

Figure 6: Chroma key compositing.

```
im = imread("./media/cat.jpg");
imhsv = rgb2hsv(im);
im_spacebg = imread("./media/spacebg.jpg");

imwrite(im, "./out/6.cat.jpg")
imwrite(im_spacebg, "./out/6.spacebg.jpg")
im = (double(im)./255);
im_spacebg = (double(im_spacebg)./255);

% Lets the user select a pixel in the image to key out.
figure()
imshow(im);
coords = int32(ginput(1));
px_hsv = imhsv(coords(2), coords(1), 1:3);

%  Each channel may deviate of these amounts from the selected pixel.
hue_deviation = 0.05;
saturation_deviation = 0.1; % += 10% saturation
brightness_deviation = 0.4; % += 40% darker/lighter

% Creates the mask for each pixel whose channels are within the deviations
mask = ~((imhsv(:,:,1) > px_hsv(1) - hue_deviation) & (imhsv(:,:,1) < px_hsv(1) + hue_deviation) & .
        (imhsv(:,:,2) > px_hsv(2) - saturation_deviation) & (imhsv(:,:,2) < px_hsv(2) + saturation_d
        (imhsv(:,:,3) > px_hsv(3) - brightness_deviation) & (imhsv(:,:,3) < px_hsv(3) + brightness_d

im_mask = comp(ones(size(im)),mask,zeros(size(im)));
im_comp = comp(im,mask,im_spacebg);

imshow([im, im_mask, im_comp], []);
title("Original image, mask and composited image")
saveas(gcf,'out/6.image_mask_comp.png')

imwrite(uint8(255.*im_mask), "./out/6.mask.jpg");
imwrite(uint8(255.*im_comp), "./out/6.comp.jpg");


function res = comp(a,mask,b)
    % Masks image 'a' on top of image 'b'
    res = a.*mask + b.*(~mask);
end
```

Figure 7: Matlab code performing background replacement on image `cat.jpg`.



(a) Pictures and relative masks.

(b) Final composited image

Figure 8: Compositing myself mutiple times on the same cleanplate.

```
im = imread("./media/cat.jpg");
imhsv = rgb2hsv(im);
im_spacebg = imread("./media/spacebg.jpg");

imwrite(im, "./out/6.cat.jpg")
imwrite(im_spacebg, "./out/6.spacebg.jpg")
im = (double(im)./255);
im_spacebg = (double(im_spacebg)./255);

% Lets the user select a pixel in the image to key out.
figure()
imshow(im);
coords = int32(ginput(1));
px_hsv = imhsv(coords(2), coords(1), 1:3);

%  Each channel may deviate of these amounts from the selected pixel.
hue_deviation = 0.05;
saturation_deviation = 0.1; % += 10% saturation
brightness_deviation = 0.4; % += 40% darker/lighter

% Creates the mask for each pixel whose channels are within the deviations
mask = ~((imhsv(:,:,1) > px_hsv(1) - hue_deviation) & (imhsv(:,:,1) < px_hsv(1) + hue_deviation) & .
        (imhsv(:,:,2) > px_hsv(2) - saturation_deviation) & (imhsv(:,:,2) < px_hsv(2) + saturation_d
        (imhsv(:,:,3) > px_hsv(3) - brightness_deviation) & (imhsv(:,:,3) < px_hsv(3) + brightness_d

im_mask = comp(ones(size(im)),mask,zeros(size(im)));
im_comp = comp(im,mask,im_spacebg);

imshow([im, im_mask, im_comp], []);
title("Original image, mask and composited image")
saveas(gcf,'out/6.image_mask_comp.png')

imwrite(uint8(255.*im_mask), "./out/6.mask.jpg");
imwrite(uint8(255.*im_comp), "./out/6.comp.jpg");


function res = comp(a,mask,b)
    % Masks image 'a' on top of image 'b'
    res = a.*mask + b.*(~mask);
end
```

Figure 9: Matlab code performing background replacement on image `cat.jpg`.