# Lab 3. Färg

# Del 3- Laboration Svarsdokument

**Spara detta dokument som .pdf dokument innan ni lämnar in det på Lisam.**

*Studenternas namn och LiU-ID: (Max 2 studenter per grupp):*

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*Inlämningsdatum:*

*Version 1*

1. **Working with Spectral Power Distribution**

**Uppgift 1.1)**

XYZ values for CIED65:

X= 95.0437

Y= 100

Z= 108.8818

**Uppgift 1.2)**

**XYZ values for R1, under CIED65:** X=40.0489, Y=49.7395, Z=26.6104

**XYZ values for R2, under CIED65:** X= 40.0489, Y=49.7395, Z=26.6104

**Uppgift 1.3)**

**XYZ values for R1, under f11:** X= 41-6587, Y=53.3569, Z=16.3345

**XYZ values for R2, under f11:** X= 53.9818, Y=63.4675, Z=20.7173

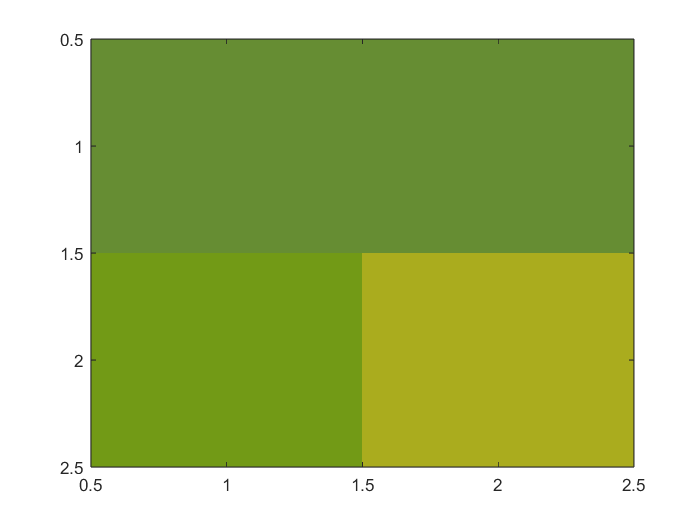
**Uppgift 1.4)**

In 1.2: The phenomenon is called metamerism. Its perceived as the same color under different reflectance while using the same illumination CIED65.

In 1.3: The same is not for the color using the f11 illumination

**Uppgift 1.5)**

Insert the figure here: (You can save this figure using File in the window, and then save as…, *yourfilename.png*. It is ok to scale down the image after inserting it in words)



What has happened to the white point in the xy chromaticity diagram when changing the light source?

The white point moves depending on the light source.

Generally the white point moves closer to the blue/violet part of the chromaticity diagram in correspondence to higher temperatures.

Does that show in the colors?

Yes, the CIED65 illumination resulted in a darker color in comparison to the f11 illumination.

**Uppgift 1.6)**

Explain briefly what color matching functions (, and ) are and what they represent.

They represent the color matching sensitivities of a standard observer. They are the spectral sensitivity curves of three linear lights yielding the tristimulus values X, Y and Z. Its used because the sensitivity of the L, M and S cones aren’t known exactly.

**Uppgift 1.7)**

Explain why the CIEY-value of a light source is always equal to 100 by referring to Equation 1.4 in the theory document.

The illumination is normalized so that the completely white surface always gives Y = 100. Yn represents the white point, which is the brightest spot, therefore Y = 100

1. **Dot-on-Dot and Dot-off-Dot Halftoning**

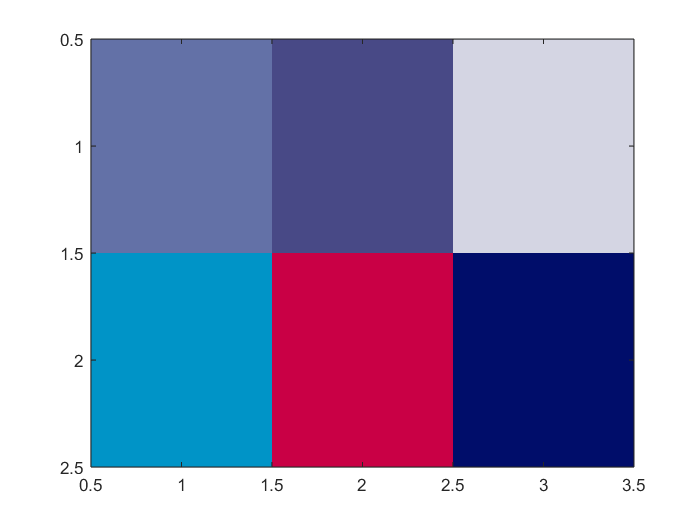
**Uppgift 2.1)**

Write the XYZ-values for dot-on-dot and dot-off-dot in the below table:

|  |  |  |  |
| --- | --- | --- | --- |
|  | X | Y | Z |
| Dot-on-dot | 43.915 | 44.89 | 68.43 |
| Dot-off-dot | 31.60 | 30.48 | 54.20 |

**Uppgift 2.2)**

Insert the figure here: (You can save this figure using File in the window, and then save as…, *yourfilename.png*. It is ok to scale down the image after inserting it in words)

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Is there a noticeable difference between dot-on-dot and dot-off-dot? For example, which one is darker? Why?

Dot-off-dot is darker because it doesn’t leave any space for the none values to show (white/paper).

**Uppgift 2.3)**

Could you use this function in all applications? Is this function device independent?

No, as the white spot for different devices can vary, the RGB values would then also vary. Meaning that the function is device dependent.

1. **Color Halftoning According to Demichel**

**Uppgift 3.1)**

**Notice,** Column 1 in the below table should be filled by your calculations in **uppgift 4** in the preparation part of this lab.

Fill column 2, Test 1, by your results using C1, M1, Y1 and K1.

Fill column 3, Test 2, by your results after simulating misregistration.

**Describe also** which channels and how many pixels and in each direction, you chose to simulate misregistration.

|  |  |  |  |
| --- | --- | --- | --- |
| **Ink** | **Demichel** | **Test 1** | **Test 2** |
| *None* | 0,0189 | 0,1628 | 0,1662 |
| *Only C* | 0,081 | 0,0765 | 0,0752 |
| *Only M* | 0,126 | 0,1351 | 0,1327 |
| *Only Y* | 0,189 | 0,2090 | 0,2031 |
| *Only K* | 0,021 | 0,0191 | 0,0183 |
| *Only C & M (Blue)* | 0,054 | 0,0648 | 0,0584 |
| *Only C & Y (Green)* | 0,081 | 0,0858 | 0,0895 |
| *Only C & K* | 0,009 | 0,0096 | 0,0101 |
| *Only M & Y (Red)* | 0,126 | 0,1126 | 0,1172 |
| *Only M & K* | 0,014 | 0,0185 | 0,0198 |
| *Only Y & K* | 0,021 | 0,0120 | 0,0100 |
| *C & M & Y* | 0,054 | 0,0509 | 0,0514 |
| *C & M & K* | 0,006 | 0,0021 | 0,0018 |
| *C & Y & K* | 0,009 | 0,0206 | 0,0225 |
| *M & Y & K* | 0,014 | 0,0201 | 0,0233 |
| *C & M & Y & K* | 0,006 | 0,0007 | 0,0002 |

**Uppgift 3.2)**

Now, compare column 1, 2 and 3 in this table. Are Demichel’s equations a good model of the reality? Does it work reasonably well even when misregistration occurs?

Columns 2 and 3 show very similar values, although a small error occurs when comparing. Demichel works reasonably well but has a much larger error in comparison to the other two columns.

**Uppgift 3.3)**

What would have happened in case of misregistration if all the four printing colors had had the same screen angle? Would Demichel’s equation be applicable? Why not?

If all four colors had the same angle, misregistration would still occur but might be less visually noticeable. Demichels equation would not be applicable to this scenario as the misregistration with the same screen angles would not significantly alter the color separation relative to each other.

1. **Color Adjustment in CIELAB**

**Uppgift 4.1)**

Why do the images seem to be inverted?

The images seem to be inverted because they represent color separations used in printing, with each channel corresponding to a different ink color. Lighter areas in the C, M, Y and K channel indicate that less ink will be applied. Whereas darker areas indicate the more ink will be applied.

**Uppgift 4.2)**

Insert the image corresponding to L+20 here: (ok to scale down the image)

En bild som visar ryggradslös, fjäril, Lepidoptera, insekt

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Insert the image corresponding to L-20 here: (ok to scale down the image)



What attribute (among lightness, contrast, hue, and saturation) has been changed.

In these images the difference is in the amount of light that is applied to the image.

**Uppgift 4.3)**

Insert the image when you change the sign of **a\*** here: (ok to scale down the image)

En bild som visar ryggradslös, fjäril, insekt, Lepidoptera

Automatiskt genererad beskrivning

Insert the image when you set **a\*=0** here: (ok to scale down the image)

En bild som visar gul, insekt, solros, ryggradslös

Automatiskt genererad beskrivning

Did you expect the results? (answer by looking at Fig. 1.5 in the theory document to see what the a-axis represents).

As the a-axis represents the green and red, the result is as expected. If a = 0, then the green and red values are not represented. And if a is a negative value, then it would increase in the green component and decrease in the red component.

What attribute (among lightness, contrast, hue, and saturation) of the color do we change when switching sign of **a\*** or **b\***?

Switching the signs of a and b will primarily change the hue attribute.

**Uppgift 4.4)**

Insert the image when you multiply **a\*** and **b\*** by 0.5here: (ok to scale down the image)

En bild som visar fjäril, ryggradslös, Lepidoptera, insekt

Automatiskt genererad beskrivning

Insert the image when you multiply **a\*** and **b\*** by 3here: (ok to scale down the image)

En bild som visar ryggradslös, blomma, fjäril, Lepidoptera

Automatiskt genererad beskrivning

What attribute (among lightness, contrast, hue, and saturation) of the color do we change when scaling **a\*** and **b\***?

When scaling a and b we primarily change the saturation attribute. By scaling them we alter the

Amplitude of the color components.

1. **Light sources, CIEXYZ and CIELAB**

**Uppgift 5.1)**

XYZ values for CIED65:

X= 95,0437

Y= 100

Z= 108,8818

XYZ values for Tungsten60W:

X= 112,9853

Y= 100

Z= 28,5810

XYZ values for plank90k:

X= 97,0578

Y= 100

Z= 141.1759

Insert the figure showing the color of these three light sources here: (ok to scale down the image)

En bild som visar Rektangel, gul, design

Automatiskt genererad beskrivning

Are the colors of these three light sources what you expected?

Yes they are as expected. The Tungsten has a larger X-value, which corresponds to the red in RGB, and therefore it has a warmer color (yellow/orange/red). While the plank90k has a larger Z-value, corresponding to the blue in RGB, and therefore is colder (blue).

**Uppgift 5.2)**

Insert Figure 1 here: (ok to scale down the image)

En bild som visar Rektangel, Färggrann, kvadrat, mönster

Automatiskt genererad beskrivning

What light source it seems to have been used in the above figure?

Tungsten, seeing as it has a more yellow/orange component (warmer).

Insert Figure 2 here and specify: (ok to scale down the image)

En bild som visar Färggrann, Rektangel, kvadrat, mönster

Automatiskt genererad beskrivning

What light source it seems to have been used in the above figure?

This is the plank90k, seeing as the blue color is stronger than the in the figure below (colder)

Insert Figure 3 here: (ok to scale down the image)

En bild som visar Färggrann, Rektangel, kvadrat, mönster

Automatiskt genererad beskrivning

What light source it seems to have been used in the above figure?

The remaining CIED65

**Uppgift 5.3)**

Why are the color differences between the color of the objects under **Tungsten** and **plank90k** larger than those under the other two pairs of light sources?

The two light sources have different color temperatures, (Plank90k = colder, Tungsten = warmer) and different power distribution. Meaning that the objects will reflect and absorb the light differently.

**Uppgift 5.4)**

You can see in the plot that all light sources have the same Y-value. What is this value?

The Y-value is 100.

**Uppgift 5.5)**

How do the positions of the color (XYZ) of the objects move when the illumination is changed? Do you agree that, when the illumination is changed, we get completely different positions in the XYZ space?

Yes, they are in a different position. The objects that are under the Tungsten60W (red) light are very far away from objects under the plank90K (blue) light.

**Uppgift 5.6)**

What is the CIELab values of light sources and why?

From Figure 1.15 you can see that the value for light is represented by L. It is defined as the non-linear perceptual response to brightness and luminance. Referring to equation 1.13 we can see that L is only affected by the Y-values. Meaning that it only represents light.

**Uppgift 5.7)**

How do the positions of the color (Lab) of the objects move when the illumination is changed? Do you agree that the position of each object is almost constant independent of the illumination?

Yes, the objects are gathered in a cluster of three in most places. One from each light source.

**Uppgift 5.8)**

Discuss at least two differences between CIEXYZ and CIELAB.

CIELAB is normalized in all values XYZ. While CIEXYX is only normalized in the Y-value.

CIELAB can have negative values to represent different colors, while a negative XYZ-value means that the color can’t be represented in the gamut of colors.

**Glöm inte att spara dokumentet som *.pdf* innan ni lämnar in det på Lisam.**