Colorimetry
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2nd Practical Session – Metamerism

The goal of this lab session is to understand MATLAB functions and see in practice the phenomenon of metamerism.

Instructions:

1. Write a function 'rad2XYZ' to calculate the CIE 1931 XYZ tristimulus values from radiance values (see testData.mat file). The function should be able to calculate XYZ values from radiance spectra with any increment of wavebands (1 nm, 5 nm, 10 nm etc.) and either of the CIE CMFs (2deg or 10deg). The different increment value should be taken in account in the calculation. Comment your steps and results in the script.

   Hint: Provide the waveband information and choice of CMF as an input along with the radiance value, interpolate the identified CIE CMFs to match the radiance values and adjust the XYZ calculation to take in account the increment step. (Helpful MATLAB function: interp1, if, elseif, else).

2. Write a function 'XYZ2xy' to calculate the CIE xy chromaticity coordinates from CIE XYZ values (from Q1). Comment your steps in the script. (Helpful MATLAB function: sum (dimension: row)).

3. Write a function 'xy2uv' to calculate the CIE u'v' chromaticity coordinates from CIE xy chromaticity coordinates (from Q2). Comment your steps in the script.

4. Write a function 'xy2CCT' to calculate the Correlated Color Temperature (CCT) from CIE xy values (from Q2). Comment your steps in the script.

   Hint: $CCT(x,y) = -449n^3 + 3525n^2 - 6823.3n + 5520.33$
   where $n = (x - 0.3320)/(y - 0.1858)$

5. Read the spectral reflectance data of the colored objects from the file 'spectral_data.mat' and plot these spectral reflectance data. Comment your observations regarding metamerism.

6. Plot the spectral power distribution of A, D65 and F11 standard illuminants from the file 'illuminants.mat'.

7. Write a function to calculate the CIE XYZ values from reflectance values for a particular illuminant, where the Y value should not cross 100 for any input.

   Tips: Follow the same algorithm as in Q1. Include the illuminant information along with the reflectance values in the function input.
   Calculate the XYZ values of the illuminant and reflectance*illuminant separately using the function rad2XYZ. Normalize the resulting XYZ values of reflectance*illuminant such that the Y value equals 100 for the illuminant.

8. Plot surfaces samples from Q5 in the CIE 1931 chromaticity diagram by considering A, F11, and D65. Can you detect metamerism in this case? Further, plot the surfaces samples in the u'v' chromaticity diagram by considering A, F11, and D65. Can you detect metamerism in this case?
   Hint: Use the function ref2XYZ for calculating the XYZ values.

9. Write a function 'XYZ2Lab' to calculate the CIELAB values from XYZ values. Use the formula as explained in CIE DS 014-4.3 pdf file.

10. Calculate the CIE 1976 L*a*b* (CIELAB) values of the colors obtained in Q5:
    a. Obtain the CIELAB color difference (color distance) between the two surfaces under each illuminant.
    b. For which surfaces and under which illuminant did you observe a metamerism case? Justify.