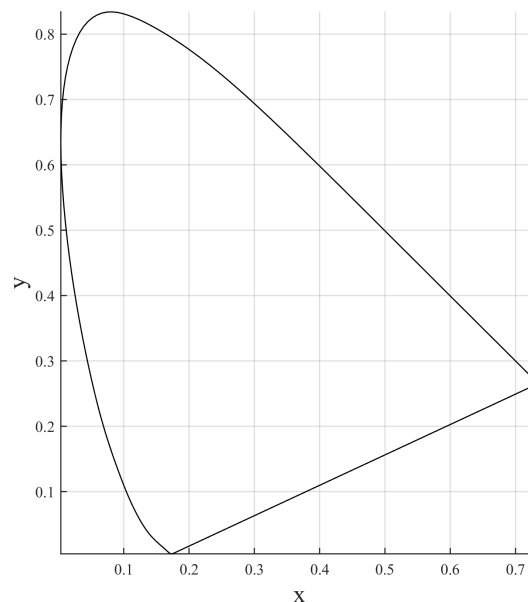


Foundations of Multimedia technologies test examples

1. 5 point Explain how can we define a color dependent color space mathematically! Why do we need a white point for the definition?
2. 5 point What is the definition of luminance, hue and saturation perceptual parameters in a television color measure system?
3. 20 point The RGB \rightarrow XYZ transform matrix for the ITU-709 HDTV system is defined as:

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} 0.4124 & 0.3576 & 0.1805 \\ 0.2126 & 0.7152 & 0.0722 \\ 0.0193 & 0.1192 & 0.9505 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}_{ITU-709}$$

- (a) 10 point Calculate the xy chromaticity coordinates of the RGB primaries and the white point! Mark the location of these points in the horse-shoe diagram below, and illustrate the gamut of the color space (i.e. the location of the reproducible colors)!



- (b) 10 point The ITU-709 RGB coordinates of an arbitrary color C are given as

$$C = \begin{bmatrix} 0 \\ 0.635 \\ 0.635 \end{bmatrix}.$$

Calculate the luminance and the color difference components ($Y, R - Y, B - Y$) of this color, illustrate its location in the $B - Y, R - Y$ coordinate system and calculate the hue and saturation of the given color point!

4. 10 point Describe the role and characteristics of Gamma-correction (Opto-electronic Transfer Function, OETF) and illustrate the process with a block diagram! The explanation should include the aspects, concerning the choice of bit/sample (quantization bit depth) and perceptual quantization!

5. 10 point Illustrate the Gamma-correction process with a block diagram! How are luma and chroma components calculated in the HDTV system, where the RGB transform matrix is given as

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} 0.4124 & 0.3576 & 0.1805 \\ 0.2126 & 0.7152 & 0.0722 \\ 0.0193 & 0.1192 & 0.9505 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}_{ITU-709}$$

and the Gamma-correction curve reads

$$V' = \begin{cases} 4.500V & V < 0.018 \\ 1.099V^{0.45} - 0.099 & V \geq 0.018. \end{cases}$$

6. 10 point What is chroma-subsampling, why was it introduced and what does the chroma subsampling scheme notation indicates? List and describe several common chroma subsampling schemes, used in practice?
7. 5 point What considerations lead to the introduction of interlaced television system? The explanation should include perceptual aspects of choosing the frame rates in SD systems.
8. 5 point What is the common SD sampling frequency in European and American systems? What considerations lead to this choice?
9. 5 point What was the common motivation behind creating the HDTV and UHDTV standards? List some improvements of UHDTV compared to HDTV!
10. 5 point Calculate the optimal viewing distance for a HDTV display with the aspect ratio of 16:9 and the diameter being 60 inches (153 cm) in case of watching a full HD content with 1080 active lines!
11. 5 point Calculate the active bitrate of a $1920 \cdot 1080/30/P$ format HD video stream if the chroma components are subsampled with a sampling scheme 4:2:2 and components are represented in 10 bits/sample!
12. 10 point Draw and analyze the block diagram of a feedback differential quantizer and the corresponding decoder! Explain, why feedback structure is used in the encoder side instead of the more simple feedforward structure!