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Evaluation of parameters of color profile models of LCD and LED screens

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Abstract. The purpose of the research relates to the problem of parametric identification of the color profile model of LCD (liquid crystal display) and LED (light emitting diode) screens. The color profile model of a screen is based on the Grassmann's Law of additive color mixture. Mathematically the problem is to evaluate unknown parameters (numerical coefficients) of the matrix transformation between different color spaces. Several methods of evaluation of these screen profile coefficients were developed. These methods are based either on processing of some colorimetric measurements or on processing of technical documentation data.

1. Introduction

The luminescence color of each screen pixel is programmed with the code *RGB* (*R* – Red, *G* – Green, *B* – Blue) each component of the code defines desirable luminescence intensity of red, green and blue respectively [1]. Mathematical description of color profile of a screen is defined with the screen profile coefficients (SPC) X_r, X_g, X_b, Y_r, Y_g, Y_b, Z_r, Z_g, Z_b. The screen profile matrix binds the values of the *RGB* code and the color coordinate values *XYZ* of the image shown on the screen [2]:

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} X_r & X_g & X_b \\ Y_r & Y_g & Y_b \\ Z_r & Z_g & Z_b \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}, \begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} X_r & X_g & X_b \\ Y_r & Y_g & Y_b \\ Z_r & Z_g & Z_b \end{bmatrix}^{-1} \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}. \quad (1)$$

The color gamut of the screen based on three-component color formation principle is approximated by the triangle on either *xy*- or *u*'*v*'-chromaticity diagram. The CIE (International Commission on Illumination) introduced the following formulae to translate from the color coordinates system *XYZ* to the (*x*,*y*)- or (*u*',*v*')-chromaticity coordinates system [2]:

$$x = \frac{X}{X+Y+Z},\ y = \frac{Y}{X+Y+Z},\ X = \frac{xY}{y},\ Z = (1-x-y)\frac{Y}{y},$$

$$u' = \frac{4X}{X+15Y+3Z},\ v' = \frac{9Y}{X+15Y+3Z},\ X = \frac{9Yu'}{4v'},\ Z = \frac{3Y(4-u')}{4v'} - 5Y,$$

$$u' = \frac{2x}{6y - x + 1{,}5}, \quad v' = \frac{4{,}5y}{6y - x + 1{,}5}, \quad x = \frac{4{,}5u'}{3u' - 8v' + 6}, \quad y = \frac{2v'}{3u' - 8v' + 6}. \tag{2}$$

The screen manufacturers do not specify the numerical values of the screen profile coefficients X_r, X_g, X_b, Y_r, Y_g, Y_b, Z_r, Z_g, Z_b in the technical documentation. Thus, a technique of evaluation of these values is necessary.

2. Color spaces transformation

Basically all mathematical expressions which are used to compute the evaluations of the SPC contain the basic conversions (1), (2), which bind the color coordinate values of the different color spaces. The figure 1 shows the color space transformation general rules which are essential to evaluate the SPC.

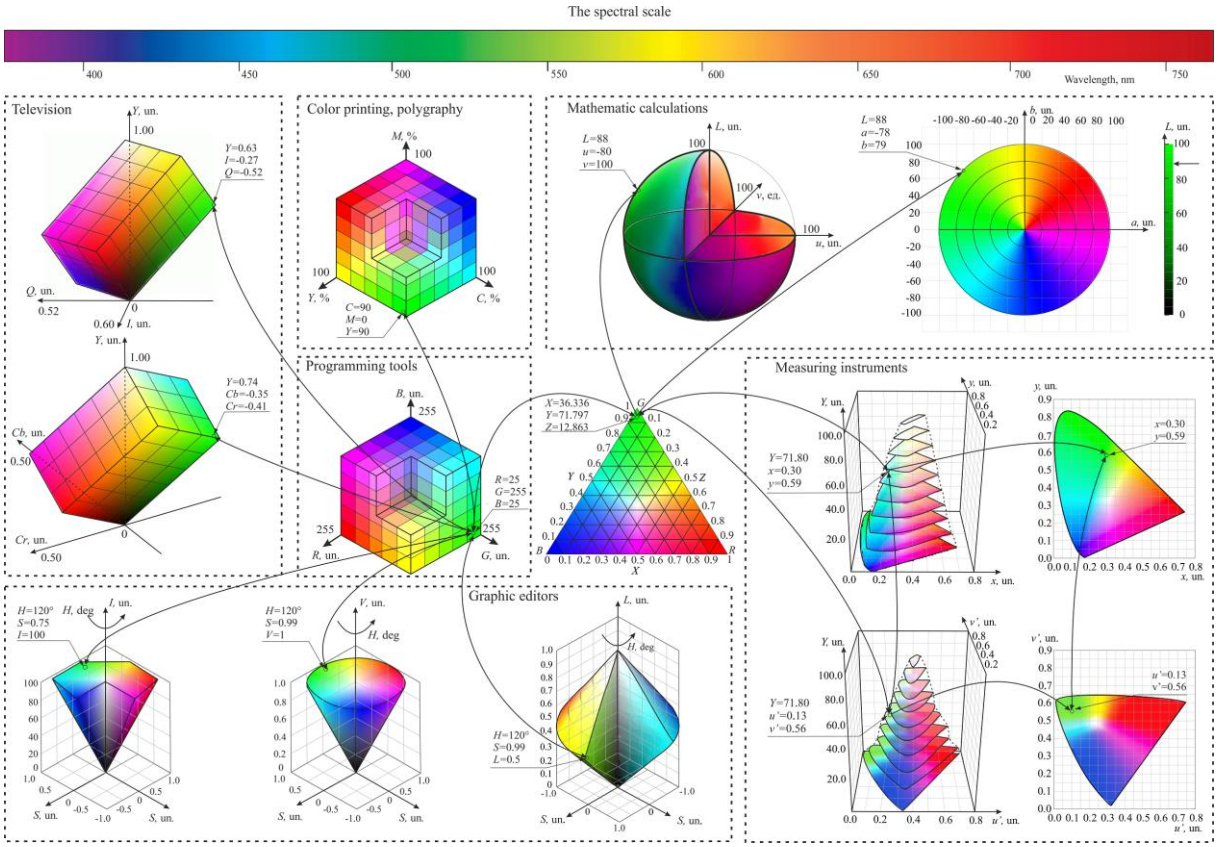

Figure 1. The color space transformation rules.

The following methods are proposed to compute the evaluations of the SPC:

- on the basis of colorimetric computations using data of manufacturer's technical documentation;
- on the basis of colorimetric experiments using the measuring instruments which allow to obtain the chromaticity coordinate values in different color spaces [3-5].

3. The evaluation of the SPC using the *xy* plane technical documentation data

Usually manufacturer specifies in the technical documentation some values of chromaticity coordinates on the *xy* chromaticity diagram, namely coordinates (x_R,y_R), (x_G,y_G), (x_B,y_B) of vertices of the color triangle, and also chromaticity coordinates of the white point (x_W,y_W). There is the way to obtain SPC values via these data by solving the following equations:

$$x_R\left(\hat{X}_r + \hat{Y}_r + \hat{Z}_r\right) = \hat{X}_r = \frac{x_R}{y_R}\hat{Y}_r \;,\; y_R\left(\hat{X}_r + \hat{Y}_r + \hat{Z}_r\right) = \hat{Y}_r = \frac{y_R}{x_R}\hat{X}_r \;,\; x_G\left(\hat{X}_g + \hat{Y}_g + \hat{Z}_g\right) = \hat{X}_g = \frac{x_G}{y_G}\hat{Y}_g,$$

$$y_G\left(\hat{X}_g+\hat{Y}_g+\hat{Z}_g\right)=\hat{Y}_g=\frac{y_G}{x_G}\hat{X}_g,\ x_B\left(\hat{X}_b+\hat{Y}_b+\hat{Z}_b\right)=\hat{X}_b=\frac{x_B}{y_B}\hat{Y}_b,\ y_B\left(\hat{X}_b+\hat{Y}_b+\hat{Z}_b\right)=\hat{Y}_b=\frac{y_B}{x_B}\hat{X}_b,$$

$$x_W\left(\hat{X}_r+\hat{X}_g+\hat{X}_b+\hat{Y}_r+\hat{Y}_g+\hat{Y}_b+\hat{Z}_r+\hat{Z}_g+\hat{Z}_b\right)=\hat{X}_r+\hat{X}_g+\hat{X}_b,$$

$$y_W\left(\hat{X}_r+\hat{X}_g+\hat{X}_b+\hat{Y}_r+\hat{Y}_g+\hat{Y}_b+\hat{Z}_r+\hat{Z}_g+\hat{Z}_b\right)=\hat{Y}_r+\hat{Y}_g+\hat{Y}_b. \quad (3)$$

The system (3) contains eight equations and nine variables: $\hat{X}_r$, $\hat{Y}_r$, $\hat{X}_g$, $\hat{Y}_g$, $\hat{X}_b$, $\hat{Y}_b$, $\hat{Z}_r$, $\hat{Z}_g$, $\hat{Z}_b$. To solve the simultaneous (3) we need to use the ninth equation:

$$\hat{Y}_r+\hat{Y}_g+\hat{Y}_b=1, \quad (4)$$

which describes the screen white color balance.

The joint solution formula of the equations (3) and (4) may be presented as:

$$\hat{X}_r=\frac{x_R}{y_R}\hat{Y}_r,\ \hat{X}_g=\frac{x_G}{y_G}\hat{Y}_g,\ \hat{X}_b=\frac{x_B}{y_B}\hat{Y}_b,\ \hat{Y}_r=1-\hat{Y}_g-\hat{Y}_b,\ \hat{Y}_g=\left(\frac{x_W}{y_W}-\frac{x_R}{y_R}+\left(\frac{x_R}{y_R}-\frac{x_B}{y_B}\right)\hat{Y}_b\right)\Bigg/\left(\frac{x_g}{y_g}-\frac{x_R}{y_R}\right),$$

$$\hat{Y}_b=\frac{\frac{1-x_W}{y_W}+\frac{x_R-1}{y_R}+\frac{x_Wy_R-y_Wx_R}{x_Gy_R-y_Gx_R}\cdot\frac{y_G}{y_W}\cdot\left(\frac{1-x_R}{y_R}+\frac{x_G-1}{y_G}\right)}{\frac{x_Ry_B-y_Rx_B}{x_Gy_R-y_Gx_R}\cdot\frac{y_G}{y_B}\cdot\left(\frac{1-x_G}{y_G}+\frac{x_R-1}{y_R}\right)+\frac{1-x_B}{y_B}+\frac{x_R-1}{y_R}},$$

$$\hat{Z}_r=\hat{Y}_r\left(\frac{1-x_R-y_R}{y_R}\right),\ \hat{Z}_g=\hat{Y}_g\left(\frac{1-x_G-y_G}{y_G}\right),\ \hat{Z}_b=\hat{Y}_b\left(\frac{1-x_B-y_B}{y_B}\right). \quad (5)$$

4. The evaluation of the SPC using the plane *u'v'* technical documentation data

The chromaticity coordinate values (u'_R,v'_R), (u'_G,v'_G), (u'_B,v'_B) of the triangle color gamut vertices in the red *R*, green *G* and blue *B* colors respectively and also the chromaticity coordinate values (u'_W,v'_W) of the screen white point which the manufacturer specifies in the technical documentation are the initial data to evaluate the SPC. In this case the evaluations of the SPC may be presented as:

$$\hat{X}_r=\frac{9u'_R}{4v'_R}\hat{Y}_r,\ \hat{X}_g=\frac{9u'_G}{4v'_G}\hat{Y}_G,\ \hat{X}_b=\frac{9u'_B}{4v'_B}\hat{Y}_B,\ \hat{Z}_g=\frac{3\hat{Y}_g\left(4-u'_G\right)}{4v'_G}-5\hat{Y}_g,\ \hat{Z}_b=\frac{3\hat{Y}_b\left(4-u'_B\right)}{4v'_B}-5\hat{Y}_b,$$

$$\hat{Y}_g=\left(det\begin{pmatrix}u'_W & u'_R\\ v'_W & v'_R\end{pmatrix}-\hat{Y}_b\,det\begin{pmatrix}u'_B & u'_R\\ v'_B & v'_R\end{pmatrix}\right)\Bigg/det\begin{pmatrix}u'_G & u'_R\\ v'_G & v'_R\end{pmatrix},\ \hat{Y}_r=1-\hat{Y}_g-\hat{Y}_b,\ \hat{Z}_r=\frac{3\hat{Y}_r\left(4-u'_R\right)}{4v'_R}-5\hat{Y}_r,$$

$$\hat{Y}_b=\frac{v'_B}{v'_W}\cdot det\begin{pmatrix}det\begin{pmatrix}u'_G & u'_R\\ v'_G & v'_R\end{pmatrix} & det\begin{pmatrix}4-u'_G & v'_G\\ 4-u'_R & v'_R\end{pmatrix}\\ det\begin{pmatrix}u'_W & u'_R\\ v'_W & v'_R\end{pmatrix} & det\begin{pmatrix}4-u'_W & v'_W\\ 4-u'_R & v'_R\end{pmatrix}\end{pmatrix}\Bigg/det\begin{pmatrix}det\begin{pmatrix}u'_G & u'_R\\ v'_G & v'_R\end{pmatrix} & det\begin{pmatrix}4-u'_G & v'_G\\ 4-u'_R & v'_R\end{pmatrix}\\ det\begin{pmatrix}u'_B & u'_R\\ v'_B & v'_R\end{pmatrix} & det\begin{pmatrix}4-u'_B & v'_B\\ 4-u'_R & v'_R\end{pmatrix}\end{pmatrix} \quad (6)$$

5. The evaluation of the SPC using the measurement results obtained in the *xy* parameters

When the manufacturer does not specify the chromaticity coordinates (x_R,y_R), (x_G,y_G), (x_B,y_B) of the triangle color gamut vertices and the chromaticity coordinates (x_W,y_W) of the white point in the screen technical documentation the evaluations of the SPC can be obtained by the experimental measurements of the screen colorimetric features in the parameters of the color plane *xy*. In this case the evaluations of the SPC may be presented as:

$$\begin{bmatrix} \hat{X}_r \\ \hat{X}_g \\ \hat{X}_b \\ \hat{Y}_g \\ \hat{Y}_b \\ \hat{Z}_r \\ \hat{Z}_g \\ \hat{Z}_b \end{bmatrix} = \begin{bmatrix} d_{11} & d_{12} & d_{13} & d_{14} & d_{15} & d_{16} & d_{17} & d_{18} \\ d_{21} & d_{22} & d_{23} & d_{24} & d_{25} & d_{26} & d_{27} & d_{28} \\ d_{31} & d_{32} & d_{33} & d_{34} & d_{35} & d_{36} & d_{37} & d_{38} \\ d_{41} & d_{42} & d_{43} & d_{44} & d_{45} & d_{46} & d_{47} & d_{48} \\ d_{51} & d_{52} & d_{53} & d_{54} & d_{55} & d_{56} & d_{57} & d_{58} \\ d_{61} & d_{62} & d_{63} & d_{64} & d_{65} & d_{66} & d_{67} & d_{68} \\ d_{71} & d_{72} & d_{73} & d_{74} & d_{75} & d_{76} & d_{77} & d_{78} \\ d_{81} & d_{82} & d_{83} & d_{84} & d_{85} & d_{86} & d_{87} & d_{88} \end{bmatrix}^{-1} \begin{bmatrix} x_1 R_1 \\ R_1(1-y_1) \\ x_2 R_2 \\ R_2(1-y_2) \\ x_3 R_3 \\ R_3(1-y_3) \\ x_4 R_4 \\ R_4(1-y_4) \end{bmatrix}, \tag{7}$$

where: $\hat{Y}_r = 1-\hat{Y}_g-\hat{Y}_b$, $d_{11}=R_1(1-x_1)$, $d_{12}=G_1(1-x_1)$, $d_{13}=B_1(1-x_1)$, $d_{14}=x_1(R_1-G_1)$, $d_{15}=x_1(R_1-B_1)$, $d_{16}=-x_1R_1$, $d_{17}=-x_1G_1$, $d_{18}=-x_1B_1$, $d_{21}=R_1y_1$, $d_{22}=G_1y_1$, $d_{23}=B_1y_1$, $d_{24}=(R_1-G_1)(1-y_1)$, $d_{25}=(R_1-B_1)(1-y_1)$, $d_{26}=R_1y_1$, $d_{27}=G_1y_1$, $d_{28}=B_1y_1$, $d_{31}=R_2(1-x_2)$, $d_{32}=G_2(1-x_2)$, $d_{33}=B_2(1-x_2)$, $d_{34}=x_2(R_2-G_2)$, $d_{35}=x_2(R_2-B_2)$, $d_{36}=-x_2R_2$, $d_{37}=-x_2G_2$, $d_{38}=-x_2B_2$, $d_{41}=R_2y_2$, $d_{42}=G_2y_2$, $d_{43}=B_2y_2$, $d_{44}=(R_2-G_2)(1-y_2)$, $d_{45}=(R_2-B_2)(1-y_2)$, $d_{46}=R_2y_2$, $d_{47}=G_2y_2$, $d_{48}=B_2y_2$, $d_{51}=R_3(1-x_3)$, $d_{52}=G_3(1-x_3)$, $d_{53}=B_3(1-x_3)$, $d_{54}=x_3(R_3-G_3)$, $d_{55}=x_3(R_3-B_3)$, $d_{56}=-x_3R_3$, $d_{57}=-x_3G_3$, $d_{58}=-x_3B_3$, $d_{61}=R_3y_3$, $d_{62}=G_3y_3$, $d_{63}=B_3y_3$, $d_{64}=(R_3-G_3)(1-y_3)$, $d_{65}=(R_3-B_3)(1-y_3)$, $d_{66}=R_3y_3$, $d_{67}=G_3y_3$, $d_{68}=B_3y_3$, $d_{71}=R_4(1-x_4)$, $d_{72}=G_4(1-x_4)$, $d_{73}=B_4(1-x_4)$, $d_{74}=x_4(R_4-G_4)$, $d_{75}=x_4(R_4-B_4)$, $d_{76}=-x_4R_4$, $d_{77}=-x_4G_4$, $d_{78}=-x_4B_4$, $d_{81}=R_4y_4$, $d_{82}=G_4y_4$, $d_{83}=B_4y_4$, $d_{84}=(R_4-G_4)(1-y_4)$, $d_{85}=(R_4-B_4)(1-y_4)$, $d_{86}=R_4y_4$, $d_{87}=G_4y_4$, $d_{88}=B_4y_4$.

6. The evaluation of the SPC using the measurement results obtained in the *u'v'* parameters

In this case the evaluations of the SPC must be presented as:

$$\begin{bmatrix} \hat{X}_r \\ \hat{X}_g \\ \hat{X}_b \\ \hat{Y}_g \\ \hat{Y}_b \\ \hat{Z}_r \\ \hat{Z}_g \\ \hat{Z}_b \end{bmatrix} = \begin{bmatrix} d'_{11} & d'_{12} & d'_{13} & d'_{14} & d'_{15} & d'_{16} & d'_{17} & d'_{18} \\ d'_{21} & d'_{22} & d'_{23} & d'_{24} & d'_{25} & d'_{26} & d'_{27} & d'_{28} \\ d'_{31} & d'_{32} & d'_{33} & d'_{34} & d'_{35} & d'_{36} & d'_{37} & d'_{38} \\ d'_{41} & d'_{42} & d'_{43} & d'_{44} & d'_{45} & d'_{46} & d'_{47} & d'_{48} \\ d'_{51} & d'_{52} & d'_{53} & d'_{54} & d'_{55} & d'_{56} & d'_{57} & d'_{58} \\ d'_{61} & d'_{62} & d'_{63} & d'_{64} & d'_{65} & d'_{66} & d'_{67} & d'_{68} \\ d'_{71} & d'_{72} & d'_{73} & d'_{74} & d'_{75} & d'_{76} & d'_{77} & d'_{78} \\ d'_{81} & d'_{82} & d'_{83} & d'_{84} & d'_{85} & d'_{86} & d'_{87} & d'_{88} \end{bmatrix}^{-1} \begin{bmatrix} 15u'_1R_1 \\ R_1(9-15v'_1) \\ 15u'_2R_2 \\ R_2(9-15v'_2) \\ 15u'_3R_3 \\ R_3(9-15v'_3) \\ 15u'_4R_4 \\ R_4(9-15v'_4) \end{bmatrix}, \tag{8}$$

where: $\hat{Y}_r = 1-\hat{Y}_g-\hat{Y}_b$, $d'_{11}=R_1(4-u'_1)$, $d'_{12}=G_1(4-u'_1)$, $d'_{13}=B_1(4-u'_1)$, $d'_{14}=15u'_1(R_1-G_1)$, $d'_{15}=15u'_1(R_1-B_1)$, $d'_{16}=-3u'_1R_1$, $d'_{17}=-3u'_1G_1$, $d'_{18}=-3u'_1B_1$, $d'_{21}=R_1v'_1$, $d'_{22}=G_1v'_1$, $d'_{23}=B_1v'_1$, $d'_{24}=(R_1-G_1)(9-15v'_1)$, $d'_{25}=(R_1-B_1)(9-15v'_1)$, $d'_{26}=3R_1v'_1$, $d'_{27}=3G_1v'_1$, $d'_{28}=3B_1v'_1$, $d'_{31}=R_2(4-u'_2)$, $d'_{32}=G_2(4-u'_2)$, $d'_{33}=B_2(4-u'_2)$, $d'_{34}=15u'_2(R_2-G_2)$, $d'_{35}=15u'_2(R_2-B_2)$, $d'_{36}=-3u'_2R_2$, $d'_{37}=-3u'_2G_2$, $d'_{38}=-3u'_2B_2$, $d'_{41}=R_2v'_2$, $d'_{42}=G_2v'_2$, $d'_{43}=B_2v'_2$,

$d'_{44}=(R_2-G_2)(9-15v'_2)$, $d'_{45}=(R_2-B_2)(9-15v'_2)$, $d'_{46}=3R_2v'_2$, $d'_{47}=3G_2v'_2$, $d'_{48}=3B_2v'_2$, $d'_{51}=R_3(4-u'_3)$, $d'_{52}=G_3(4-u'_3)$, $d'_{53}=B_3(4-u'_3)$, $d'_{54}=15u'_3(R_3-G_3)$, $d'_{55}=15u'_3(R_3-B_3)$, $d'_{56}=-3u'_3R_3$, $d'_{57}=-3u'_3G_3$, $d'_{58}=-3u'_3B_3$, $d'_{61}=R_3v'_3$, $d'_{62}=G_3v'_3$, $d'_{63}=B_3v'_3$, $d'_{64}=(R_3-G_3)(9-15v'_3)$, $d'_{65}=(R_3-B_3)(9-15v'_3)$, $d'_{66}=3R_3v'_3$, $d'_{67}=3G_3v'_3$, $d'_{68}=3B_3v'_3$, $d'_{71}=R_4(4-u'_4)$, $d'_{72}=G_4(4-u'_4)$, $d'_{73}=B_4(4-u'_4)$, $d'_{74}=15u'_4(R_4-G_4)$, $d'_{75}=15u'_4(R_4-B_4)$, $d'_{76}=-3u'_4R_4$, $d'_{77}=-3u'_4G_4$, $d'_{78}=-3u'_4B_4$, $d'_{81}=R_4v'_4$, $d'_{82}=G_4v'_4$, $d'_{83}=B_4v'_4$, $d'_{84}=(R_4-G_4)(9-15v'_4)$, $d'_{85}=(R_4-B_4)(9-15v'_4)$, $d'_{86}=3R_4v'_4$, $d'_{87}=3G_4v'_4$.

7. The evaluation of the SPC based on the measurement results obtained in the *XYZ* parameters

Some colorimetric measurement instruments allow obtaining coordinates in the color space *XYZ*. Using such instruments, the evaluation of the SPC may be presented as:

$$\begin{bmatrix}\hat{X}_r\\ \hat{X}_g\\ \hat{X}_b\\ \hat{Y}_r\\ \hat{Y}_g\\ \hat{Y}_b\\ \hat{Z}_r\\ \hat{Z}_g\\ \hat{Z}_b\end{bmatrix}=\begin{bmatrix}R_1&G_1&B_1&0&0&0&0&0&0\\0&0&0&R_1&G_1&B_1&0&0&0\\0&0&0&0&0&0&R_1&G_1&B_1\\R_2&G_2&B_2&0&0&0&0&0&0\\0&0&0&R_2&G_2&B_2&0&0&0\\0&0&0&0&0&0&R_2&G_2&B_2\\R_3&G_3&B_3&0&0&0&0&0&0\\0&0&0&R_3&G_3&B_3&0&0&0\\0&0&0&0&0&0&R_3&G_3&B_3\end{bmatrix}^{-1}\begin{bmatrix}X_1\\Y_1\\Z_1\\X_2\\Y_2\\Z_2\\X_3\\Y_3\\Z_3\end{bmatrix}. \quad (9)$$

8. The evaluation of the SPC using the measurement results obtained in the color space *Yxy* parameters

Some colorimetric measurement instruments allow obtaining coordinates in the color space *Yxy*. Using such instruments one can evaluate the SPC as follows:

$$\begin{bmatrix}\hat{X}_r\\ \hat{X}_g\\ \hat{X}_b\\ \hat{Y}_r\\ \hat{Y}_g\\ \hat{Y}_b\\ \hat{Z}_r\\ \hat{Z}_g\\ \hat{Z}_b\end{bmatrix}=\begin{bmatrix}R_1&G_1&B_1&0&0&0&0&0&0\\0&0&0&R_1&G_1&B_1&0&0&0\\0&0&0&0&0&0&R_1&G_1&B_1\\R_2&G_2&B_2&0&0&0&0&0&0\\0&0&0&R_2&G_2&B_2&0&0&0\\0&0&0&0&0&0&R_2&G_2&B_2\\R_3&G_3&B_3&0&0&0&0&0&0\\0&0&0&R_3&G_3&B_3&0&0&0\\0&0&0&0&0&0&R_3&G_3&B_3\end{bmatrix}^{-1}\begin{bmatrix}Y_1x_1/y_1\\Y_1\\Y_1(1-x_1-y_1)/y_1\\Y_2x_2/y_2\\Y_2\\Y_2(1-x_2-y_2)/y_2\\Y_3x_3/y_3\\Y_3\\Y_3(1-x_3-y_3)/y_3\end{bmatrix}. \quad (10)$$

9. The evaluation of the SPC using the measurement results obtained in the color space *Yu'v'* parameters

Some colorimetric measurement instruments allow us to obtain coordinates in the color space *Yu'v'*. In this case, to evaluate the SPC three colors encoded as $R_1G_1B_1$, $R_2G_2B_2$, $R_3G_3B_3$ must be projected randomly on the screen and then the respective coordinate values $\left(Y_1,u_1',v_1'\right),\left(Y_2,u_2',v_2'\right),\left(Y_3,u_3',v_3'\right)$ measurements must be obtained. The evaluation of the SPC must be presented as:

$$\begin{bmatrix} \hat{X}_r \\ \hat{X}_g \\ \hat{X}_b \\ \hat{Y}_r \\ \hat{Y}_g \\ \hat{Y}_b \\ \hat{Z}_r \\ \hat{Z}_g \\ \hat{Z}_b \end{bmatrix} = \begin{bmatrix} R_1 & G_1 & B_1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & R_1 & G_1 & B_1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & R_1 & G_1 & B_1 \\ R_2 & G_2 & B_2 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & R_2 & G_2 & B_2 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & R_2 & G_2 & B_2 \\ R_3 & G_3 & B_3 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & R_3 & G_3 & B_3 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & R_3 & G_3 & B_3 \end{bmatrix}^{-1} \begin{bmatrix} 9Y_1u_1'/4v_1' \\ Y_1 \\ \left(3Y_1\left(4-u_1'\right)/4v_1'\right)-5Y_1 \\ 9Y_2u_2'/4v_2' \\ Y_2 \\ \left(3Y_2\left(4-u_2'\right)/4v_2'\right)-5Y_2 \\ 9Y_3u_3'/4v_3' \\ Y_3 \\ \left(3Y_3\left(4-u_3'\right)/4v_3'\right)-5Y_3 \end{bmatrix}. \quad (11)$$

10. Conclusion

There are several different methods of evaluation of screen profile coefficients of either LCD or LED display. The choice of computation method of the SPC depends on availability and features of colorimetric instruments [6-10].

The mathematical method computational complexity which is applied for all mentioned above methods to evaluate the screen profile coefficients is practically equal. Obtained results may be used by engineers who are designing modern indication equipment based on LCD- or LED-panels.

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