AND9334/D

Color Correction Matrix Usage in Sensor Studio

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APPLICATION NOTE

Overview

This document provides an overview of the color correction matrix that is used in the SensorStudio evaluation software. The document is not intended to be a tutorial for deriving a color correction matrix. The document will provide information to convert the supplied color correction matrix into a device-independent color space (CIE XYZ).

Color Correction Matrix

The purpose of the color correction matrix in SensorStudio is to transform camera RGB values into RGB values suitable for viewing on a display. The camera RGB data is expected to vary linearly with exposure. The camera RGB data is also normalized. This includes white balance and black level correction.

The color correction matrix can be expressed as a 3x3 matrix as shown in Equation 1 below. The 'cc' is used to denote the color corrected RGB values.

$$\begin{pmatrix} R_{CC} \\ G_{CC} \\ B_{CC} \end{pmatrix} = \begin{pmatrix} a11 & a12 & a13 \\ a21 & a22 & a23 \\ a31 & a32 & a33 \end{pmatrix} \begin{pmatrix} R_{CAMERA} \\ G_{CAMERA} \\ B_{CAMERA} \end{pmatrix} \quad \text{(eq. 1)}$$

The relationship between linear RGB values and the XYZ values for a display may be expressed by a 3x3 matrix as shown in Equation 2 below. Equation 2 is computed such that RGB values of 100 will produce XYZ values corresponding to Illuminant D65. (RGB values equal to 100 correspond to those values which would be obtained for a perfectly reflecting, spectrally non-selective object located in the scene and illuminated by daylight at a correlated color temperature of 5,500 Kelvin.) The matrix given in Equation 2 is based on the CCIR Rec. 709 (HDTV).

$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix} = \begin{pmatrix} 0.41214 & 0.35768 & 0.18036 \\ 0.21251 & 0.71535 & 0.07214 \\ 0.01932 & 0.11923 & 0.94988 \end{pmatrix} \begin{pmatrix} R_{CC} \\ G_{CC} \\ B_{CC} \end{pmatrix} \quad \text{(eq. 2)}$$

To compute a color correction matrix for the camera whose output is directly compatible with a device-independent color space such as CIE XYZ, cascade the results of Equations 1 and 2.

Example Color Correction Matrix

The following sets of color correction matrix coefficients were computed for Interline Transfer CCD products and are implemented in SensorStudio. The example sets of color correction matrix coefficients correspond to the 3x3 matrix in Equation 1. The matrix converts camera RGB values (D50) into RGB values based on the CCIR Rec. 709 (HDTV). The coefficients are also dependent upon the IR-cut filter transmission data that was used in the calculation. Cascading an example matrix with Equation 2 will produce a color correction matrix with output in CIE XYZ.

The following sets of color correction matrix coefficients apply to both the Bayer color filter pattern and the Sparse color filter pattern. There are two sets of color filter array (CFA) – Gen1 CFA and Gen2 CFA.

Gen1 CFA Devices

- KAI−01050 (−CBA)
- KAI−01150 (−CBA or –PBA)
- KAI−02050 (−CBA)
- KAI−02150 (−CBA or –PBA)
- KAI−04050 (−CBA or –PBA)
- KAI−08050 (−CBA or –PBA)

1.75815	−0.49027	−0.26788
−0.19781	1.36582	−0.16800
0.21167	−0.84224	1.63057

Gen2 CFA Devices

- KAI−01050 (−FBA)
- KAI−01150 (−FBA or –QBA)
- KAI−02050 (−FBA)
- KAI−02150 (−FBA or –QBA)
- KAI−04050 (−FBA or –QBA)

1.609774	−0.486341	−0.123434
−0.212176	1.532584	−0.320408
0.077655	−0.768204	1.690549

Gen2 CFA Devices

- KAI−08051 (−FBA, −FXA, −QBA or –QXA)

1.595753	−0.476962	−0.118791
−0.201963	1.511913	−0.309950
0.078553	−0.729681	1.651128

Gen1 CFA Devices

- KAI−16050 (−CXA or –PXA)
- KAI−29050 (−CXA or –PXA)

1.61673	−0.40321	−0.21351
−0.17718	1.36415	−0.18697
0.17376	−0.445	1.60167

Gen2 CFA Devices

- KAI−16050 (−FXA or –QXA)
- KAI−29050 (−FXA or –QXA)

1.59327	−0.40003	−0.19324
−0.20214	1.45308	−0.25094
0.10820	−0.76306	1.65487

Gen1 CFA Devices

- KAI−02170 (−CBA or –PBA)
- KAI−04070 (−CBA or –PBA)

1.58947	−0.39252	−0.19696
−0.13829	1.29576	−0.15747
0.13161	−0.64129	1.50968

Gen2 CFA Devices

- KAI−02170 (−FBA or –QBA)
- KAI−04070 (−FBA or –QBA)

1.508631	−0.386366	−0.122265
−0.136752	1.352568	−0.215816
0.050764	−0.599392	1.548628

Gen1 CFA Devices

- KAI−16070 (−CXA or –PXA)

1.55429	−0.35465	−0.19964
−0.11303	1.27316	−0.16013
0.11427	−0.58609	1.47182

Gen2 CFA Devices

- KAI−16070 (−FXA or –QXA)

1.447288	−0.311429	−0.135859
−0.145714	1.334572	−0.188858
0.061099	−0.528920	1.467821

Gen1 CFA Devices

- KAC−06040−CBA
- KAC−12040−CBA

1.528800	−0.418920	−0.109880
−0.274660	1.527000	−0.252340
0.002970	−0.731280	1.728310

Gen2 CFA Devices

- KLI−2113 (−RAA)

1.53236	−0.38047	−0.15188
−0.14424	1.32805	−0.18381
0.00883	−0.66326	1.65443

Gen2 CFA Devices

- KAI_11002 (−FBA or –QBA)

1.54624	−0.42947	−0.11677
−0.16610	1.43593	−0.26982
0.04549	−0.63964	1.59415

Gen2 CFA Devices

- KLI−4104 (−RAA)

1.49837	−0.35122	−0.14715
−0.12511	1.27902	−0.15391
0.00596	−0.60056	1.59460

Gen2 CFA Devices

- KLI−8023 (−RAA)

1.52057	−0.36110	−0.15947
−0.13315	1.31159	−0.17843
−0.00772	−0.64123	1.64895

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