High Accuracy Imaging Colorimeter

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We present a new approach to 2D-imaging colorimetry yielding significantly improved measurement accuracy for virtually all sample sources [1]. It combines two important innovations. The first is to use a camera equipped with six optical filters instead of the commonly used three or four channels. This filter extension clearly improves the fitting to the three human eye's color matching functions (CMF). However, simply extending the number of filters, i.e. the number of data acquisition channels is only one step to improve the measurement accuracy. Here we present how the performance of a six filter CCD-camera can be further enhanced using an advanced matrix optimization based on a set of training sources. Matrix correction methods are often used to correct display measurements. Generally, there are three primaries of the display that are mixed to give the test color, i.e. there is a limited variation in spectra. The matrix method [2] is frequently applied to measure displays but if the spectrum is completely unknown, still significant errors can occur for different stimuli.
In our approach, assumed that the types of spectral sources can be anticipated, a set of representative training sources is used to determine a 3x6 adaption matrix that minimizes errors across this set. This means, the spectral responsitivities of the channels are no longer required but instead, the tristimulus values of the training sources have to be known. In principle, this optimization can be performed for any specific derivative color space or output parameter. Fig. 1 compares an xyz-optimization with the CMF-optimization [1].

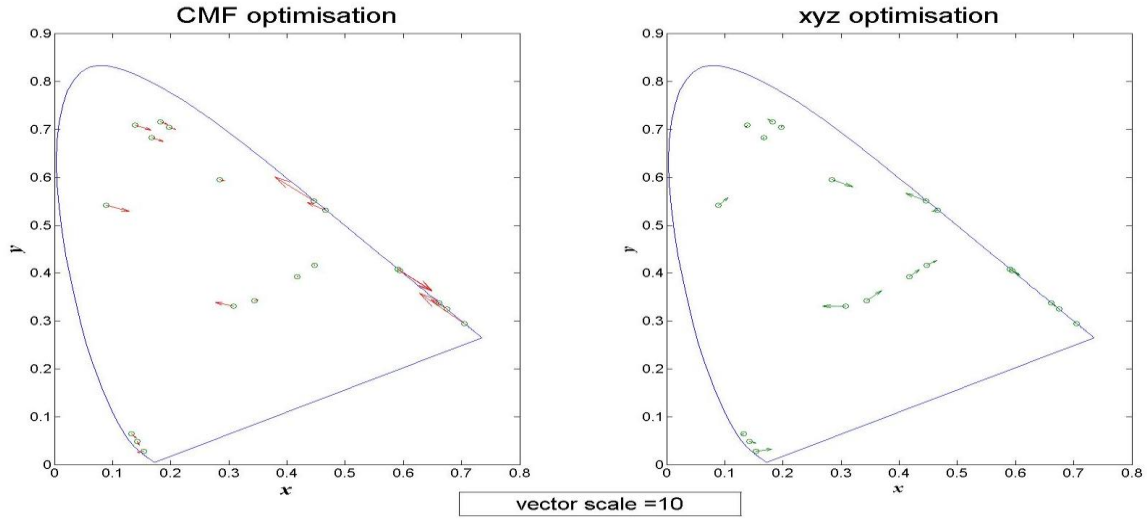

Figure 1 - Color difference vector plot of training sources (represented by circles) [1]. For clarity the vectors are scaled by a factor of 10.

The plot on the left side of Fig. 1 shows the results derived from a least squares matching of the CMFs. Some sources amongst the training set show large errors, indicated by large vectors, whereas others are rather small. In contrast, the xyz optimization, shown on the right side, reduces large errors at the expense of the smaller ones. This means, a significantly better overall performance is obtained. Compared to many of today's standard devices, 6-filter devices optimized by the proposed matrix optimization yield significantly improved accuracy especially for measurements of a variety of different LED colors, without the need of recalibrating to specific samples.

References

1. R. Young, J. Neumeier, *SID Symposium Digest*, vol. 33, p. 538 (2014).
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