A Display Calibration Technique based on Invariant Human Colour Mechanisms

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Abstract

When human observers are asked to adjust a coloured light such that it appears neither red nor green, or such that it appears neither yellow nor blue, most colour-normal observers have no difficulty in making these adjustments. Furthermore, these colour appearance judgements are not significantly influenced by language or age [Saunders and van Brakel 1997] and individual differences in colour sensitivity are not reflected in the unique hues settings [Webster et al. 2000]. The human colour system seems to be able to calibrate itself so that there is a remarkable agreement across observers in relation to these unique hue judgements. Here we show how we can use the invariance of these unique hue judgements to develop a colour calibration technique for display devices which eliminates the need for an external calibration standard or a measurement device.

1 The Problem

If the same image is viewed on two different display devices (display #1 and display #2, see fig. 1), the colours are likely to look different due to the different physical characteristics and/or different contrast/brightness settings of the two display devices. This problem, namely to communicate colour verdically across different platforms, is often addressed by providing device profiles based on the information given by manufacturers or using standardised colour spaces (e.g. sRGB). We propose a different inexpensive and user-friendly solution available to the low-tech end-user which is solely based on perceptual colour judgements.

2 The Calibration Process

The Colour Calibration Process comprises three stages: (1) obtaining hue judgements on a specific hardware setup, (2) the building of a device profile for the specific hardware setup, and (3) the derivation of the colour correction transformation (A).

(1) The hue judgements are obtained by using a hue selection task [Wuerger et al. 2005]; the observer (viewing display #1) is asked to select from an annulus of coloured patches that patch that is 'neither yellow nor blue' (to obtain unique red and unique green) or 'neither red nor green' (to obtain unique yellow and unique blue). These hue judgements provide us with the unique-hue-loci in non-linearised, device-dependent RGB space (last row in figure 1).

(2) Since we know that the unique hues are linear mechanisms in CIE space (and any linear transformation of this device-independent space; [Wuerger et al. 2005]) we can estimate the non-linearity, the gain, and the offset of display #1 from these unique-hue-judgements. This information is saved, together with the unique hue settings, in the device profile of display #1.

(3) A similar device profile can be built for display #2; it contains the loci of the unique hues in linearised RGB space for this particular display (see figure 1, upper row). Now we need to find the transformation (A) which maps the two sets of unique-hue judgments (one obtained on display #1 and one obtained on display #2) into each other. After this transformation A has been applied to the RGB values on display 1, the colours on display #1 will look identical to the colours on display #2, hence achieving the desired colour correction.

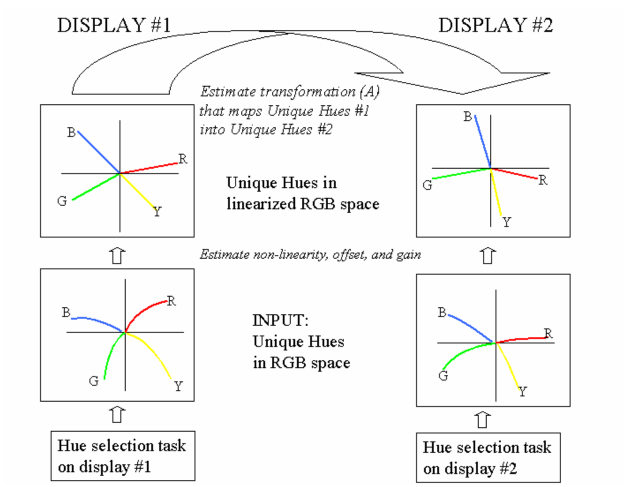

Figure 1: Transformation from display #1 to display #2 derived from unique hue judgements.

3 Conclusions

We have shown that, from a small number of perceptual colour judgements, we can derive a sufficient amount of information to characterise the physical properties of a typical visual display device (e.g. a CRT). Our novel calibration technique may be useful for the low-end user who does not possess the technical know-how or the necessary calibration devices to ensure a veridical colour reproduction.

4 References

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