Paper for Consideration by the Digital Information Portrayal Working Group (DIPWG)

Concerns in Calibration Guidelines for Displays in S-52

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Executive Summary:	Using S-52 to perform an ECDIS Calibration of a display has numerous problems which can inhibit the successful calibration of a display. Incorrect representation of formula's, errors in the provided C code application and the actual method for calibration for LCD's yielding incorrect results all indicate the need for an updated and improved standard for ECDIS calibration that is commensurate with the current technology. Finally, the current verification procedure in S-52 uses primaries and linear algebra while the standard used by notification bodies uses the actual color combination to measure Lxy. The fix for said issues is presented in three parts. In the first instance, simple corrections to the formulas are suggested and no research needs to be done. For the issue of calibration of an LCD display further discussion is required and research needed to support a proper procedure. Lastly, the suggested method for verification of colours should match what is used in IEC 61174 L.3.
Related Documents:	S-52, Presentation Library, IEC 61174 L.3
Related Projects:	N/A

Introduction / Background

As a company decides to enter into the display industry, and provide ECDIS type displays they look to what is required to become ECDIS compliant. This is defined by the IMO, IEC, and IHO. The test is performed in accordance with IEC 61174 L.3. Immediately, the company is referred to S-52 where they find guidance on calibration and verification of a display for ECDIS type approval. Upon following this guidance, concerns were raised as to its accuracy.

In following the procedure as defined in the S-52 standard for colour calibration the math did not match what was measured and finally, it was found that notified bodies do not use math but rather colorimeters which measure L, x and y directly to do the actual calibration testing. This is in contrast to the statement in S-52 "There are no inexpensive instruments available that will directly measure and read out x, y, and L co-ordinates over the entire range of specified colour." This is part of the motivation for the use of measuring primaries and using linear algebra to calibrate.

Past activities: Notes on Achieving Night Colour Tables with LCD Displays – Matthew Cowan, Liquid Crystal Display (LCD) Monitors for ECDIS Applications Update Report – Matthew Cowan

Analysis/Discussion/Conclusions

LITERAL ACCURACY

1) Page 63 Equation 2 is incorrect it should read:

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = A \begin{bmatrix} L_r \\ L_g \\ L_b \end{bmatrix}$$

2) Page 63 "Z, Y, and Z can be calculated" is incorrect it should read: "X, Y, and Z can be calculated"

3) Page 64 Equation 2 and 3 (x= and y= respectively) are incorrect and should read:

$$x = \frac{X}{Z} \cdot \frac{1}{\left(1 + \frac{Y}{Z} + \frac{X}{Z}\right)}$$

$$y = \frac{Y}{Z} \cdot \frac{1}{\left(1 + \frac{Y}{Z} + \frac{X}{Z}\right)}$$

4) PresLib_e3.4_2008\Digital_Files\Colour_Calibration\COMPARE.C line 359 is incorrect and should read: denom = (Z * (1 + (Y / Z) + (X / Z)));

PRINCIPLE OF APPROACH

1) CALIBRATION

a. Page 53: "(Note that the specifications in this Annex are generally applicable to all types of monitors. Some sentences which apply only to CRTs are in italics.)" This statement is incorrect. The statements in the Annex are NOT applicable to Liquid Crystal Displays. The general approach outlined by the annex is:

i. B.2.3.3 Set the luminous intensity

ii. B.3.1 Measure each Primary xy at full drive strength

iii. B.3.2 Measure Gamma (aka Tone Response Curve, Electro-optic response etc) for each primary.

1. "Use a sensitive radiometer for this measurement (e.g. Graseby 370)." This measures Luminance and not xy

iv. B.4 Calculation to achieve Correct Color

This method has been proven to not be able to work for LCD's because the use of the primary colors will yield incorrect results due to the black offset. This is especially critical at low luminance levels. This has been confirmed again by both authors.

2) VERIFICATION

a. Page 57: "Note: The procedure of calibrating/verifying all three colour tables of an LCD instrumentally by the current method used for CRTs on the Day table alone, together with remote control of the calibration settings, should also be used for LCDs." This statement is incorrect as the procedure defined in B.5.4 item 1 and 4 declares:

i. "The Red, Green, and Blue colour components for each test colour should be sent to the monitor separately."

ii. "Calculate the x, y, and L for each colour measured using the procedure outlined in section B.6.2."

b. Page 60: "For LCD displays the instrumental test should be applied to all three colour tables (see first paragraph of B.5)." This is also incorrect as the instrumental method defined gives incorrect results for LCD's.

Recommendations

At a minimum, the LITERAL ERRORS should be corrected. With regard to the PRINCIPLE OF APPROACH, as Hannu suggests, most all notified bodies that he has had experience with do not use the methods outlined in S-52 and instead follows L.3 of IEC 61174. One of three possible solutions to correct the problems outlined above:

1) Remove all mention that any of the procedures are applicable to LCD's and put a warning that while the following procedure identifies a method applicable to CRT's the method should NOT be used for LCD's and it is left to the manufacturer to figure it out himself.
2) Rework the standard so that the procedures use xyL instead of Lr, Lg, Lb.
3) Develop a mathematical solution that works for LCD's and include it as a separate procedure from that of CRT.

Again, minimally, some warning should be given that due to the technology of LCD's the current procedures will result in incorrect results. I suggest option 2 so that we may move away from technology dependent measurements. And lastly, that above all whatever method is used to certify ECDIS displays for colour calibration is used to calibrate displays and is consistent with the S-52 standard.

With regards to who should do the work, dates, or meetings required to correct these issues I leave that to the judgement of the DIPWG.

Justification and Impacts

When an international organization distributes a standard and charges for the contents of said standard, they have a moral and social responsibility to ensure that the contents of the standard are accurate. There are typo's, incorrect equations, and incorrect code currently in the standard that have been confirmed by both names on the standard Hannu Peiponen and Matt Cowan.

Furthermore, the international organization responsible for the standard has an ethical and social responsibility to ensure the principles involved are true and not misleading to its audience. The standard contains misleading guidance with regard to calibration that should a company entering the industry wish to follow would result in incorrect data.

Action Required of DIPWG

DIPWG is invited to:

a. endorse the findings of this paper
b. stand-up a sub-working group to finalize changes to S-52