TSMAD26/DIPWG5-09.4C

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

Recommendation on S-52 Color Calibration Procedure

Submitted by:	Northrop Grumman Corp.
Executive Summary:	IHO S-52 should avoid specification of process implementation and focus on required performance and verification tests. The guidance on color calibration process provided in S-52 Annex B is essentially unchanged since 1997. It describes an analytical model only valid for CRT monitors. Since that time, the same information is now published in international standards that cover CRT, LCD and other display technologies. Some manufacturers have developed non-analytical processes capable of meeting the verification test requirement. S-52 4.2.3 – add reference to international standards for color management. S-52 clause 5.2.4 - delete (replace with n/a) S-52 Annex B – delete annex and references in the body text PresLib – remove sw utilities for color calibration.
Related Documents:	TSMAD26_DIPWG5-09.4A Calibration Guidelines for Displays in S-52 TSMAD26/DIPWG5-09.4B Comments about S-52 Colour Calibration Formula
Related Projects:	

Introduction / Background

S-52 has provided Annex B PROCEDURE FOR INITIAL CALIBRATION OF COLOUR DISPLAYS and Annex C PROCEDURE FOR MAINTAINING THE CALIBRATION OF DISPLAYS, as well as software utilities for color calibration that are essentially unchanged since 1997.

The guidance on color calibration process provided in S-52 describes an analytical model that is only valid for CRT monitors. At the time IHO published it in 1997, CRT's were the only feasible display technology for ECDIS. By 2000, when ECDIS developers began working with LCD monitors, they found that the software provided by IHO produced results that failed verification tests. Two papers have been submitted to DIPWG5 on this subject 09.4A and 09.4B.

Analysis/Discussion/Conclusions

IHO has been publishing information on color calibration that is of little value in an age when CRT displays have become rare. The information is misleading to those new to the subject, because IHO documents do not always make it clear that it is only intended for use on CRT displays.

The text of Appendix B is incorrect:

> "(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.)"

The guidance on color calibration process provided in S-52 Annex B describes an analytical model only valid for CRT monitors. Since that time, the same information is now published in international standards that cover CRT, LCD and other display technologies. Some manufacturers have developed non-analytical processes capable of meeting the verification test requirement, for example by repeating cycles of adjustment and verification measurement. Other manufacturers have combined analytical and non-analytical processes.

IHO S-52 should avoid unnecessary specification of process implementation and focus on required performance and verification tests. S-52 clause 5.2.4 should be revised to point to the relevant international standards for color management as examples. Annex B should be deleted. The software utilities for color calibration distributed by IHO with the PresLib should be removed from the PresLib distribution. This is a task for DIPWG.

A markup of S-52 text with these revisions is provided in Annex 1 of this paper.

Recommendations

During the current revision effort, S-52 clause 5.2.4 should be revised to point to the relevant international standards as examples and Annex B should be deleted. The software utilities for color calibration distributed by IHO with the PresLib should be removed from the PresLib.

Justification and Impacts

The recommended change will avoid the need for future revision of this section as new display technologies or new processes are developed. It will avoid duplicating in an IHO standard the standards for color management published by international technical standards bodies. It will avoid misapplication of a CRT calibration process to other display technologies.

The recommended change has no impact on required performance or on the color verification tests. It does not impact Annex C PROCEDURE FOR MAINTAINING THE CALIBRATION OF DISPLAYS

Action Required of DIPWG

DIPWG is invited to:

a. endorse the findings of this paper

b. direct the recommended changes in the revised S-52 (See Annex 1)

ANNEX 1 Markup of S-52

4.1 General

The ECDIS manufacturer can use any technology to build his display as long as his display fulfils the requirements of this specification. It is known that at least displays based on CRT, TFT or LCD can be made to fulfill the requirements of this standard. The colours are specified in CIE (Commission Internationale de l'Eclairage) xy chromaticity coordinates and luminance L. *CIE colour coordinates are used because any other colour specification, such as RGB, is specific to a particular monitor and so cannot be specified either in relative or in absolute terms*. The ECDIS colour scheme based on specification of colour tokens and color conversion tolerances and tests are described in sections 4.2.6 and 5.2.3. ~~Procedures for converting these CIE coordinates to RGB values for the ECDIS display are described in sections 4.2.6, 5.2.3 and 5.2.4 below, and in Annex B. It is strongly recommended that these procedures be followed.~~

~~The ECDIS manufacturer may use other methodology if he wishes, however the colours of features on the ECDIS display should appear the same as would be obtained by following the procedures in this document.~~

4.2.3 Display calibration and verification

The ECDIS display should be calibrated initially in order to transform the CIE colour table coordinates to screen coordinates. The main components of the ECDIS display are the monitor and the image generator. Both the monitor and the image generator used to drive the ECDIS display can be calibrated together as a colour generating unit. Another alternative is to calibrate separately both the monitor and image generator. ~~This process is described for CRT screens in Annex B1, and software for processing calibration and converting CIE colour coordinates to RGB, with worked examples, is included in the Presentation Library~~.

The following international standards describe methods for calibration of a monitor's RGB values to produce an output. Other methodologies may be followed, but the same verification test requirements apply regardless of method.

CIE 122-1996
Technical Report: The Relationship between Digital and Colorimetric Data for Computer-Controlled CRT Displays

IEC 61966-3-2000
Multimedia systems and equipment - Colour measurement and management - Part 3: Equipment using cathode ray tubes, Edition 1

IEC 61966-4-2000
Multimedia systems and equipment - Colour measurement and management - Part 4: Equipment using liquid crystal display panels, Edition 1

4.2.4.3. Initial setting of the controls.

The controls should be set up in preparation for initial calibration~~, as described in Annex B section 1.3,~~ and their positions marked at that time (e.g. by a detent) so that they are recoverable.

5.2.3.1

1. The discrimination difference between any two colours displayed (except those with a tabular ΔE* less than 20 - see list ~~in Annex B 4.5~~) should be not less than 10 ΔE* units.

[insert table from B 4.5 here]

Token	**Colour x, y, L**	**Token**	**Colour x, y, L**	**ΔE***
DEPMD	(.27 .30 65) pale blue	CHWHT DEPDW UIBCK	(.28 .31 80) white	11
CHBRN	(.42 .45 30) brown	ADINF	(.41, .47. 35) yellow	14
DEPMS	(.24 .26, 55) medium blue	DEPVS UIAFD	(.22 .24 45) medium blue	17
DEPMD	(.27 .30 65) pale blue	CHGRF NODTA Ed 3.3 colours have greater ΔE	(.28 .31 45) faint grey	18

5.2.3.2 Instrumental calibration verification test. For CRT displays, an instrumental test to check that the results of the colour conversion calibration ~~described in Annex B1~~ are within tolerance should be made by displaying the colours of the Day colour table (restricted to colour pairs of tabular ΔE* greater than 20); measuring their CIE coordinates x,y and L; and applying a tolerance test. ~~The procedure is described in Annex B section 4.~~ For LCD displays the instrumental test should be applied to all three colour tables.

Note that since the tolerance test is intended solely to check successful colour calibration, and not to test colour maintenance at sea, this test should be performed on the bench in the manufacturer's or type-approval authority's plant under normal conditions of temperature, humidity and vibration.

~~Should the colour tolerances be tested independently (as by a type approval authority) without also carrying out colour conversion calibration, a slightly extended procedure is necessary, involving individual control of the R, G and B colours. This is also described in Annex B4.~~

"5.2.4 n/a ~~Software for colour calibration and tolerance verification Software is provided in the Presentation Library to compute the instrumental calibration results, the CIE to RGB conversion, and the tolerance checks.~~

ANNEX 2 Background Information

Color specification

Significant human testing was done during the late 1990's to establish a set of dusk and night colors for ECDIS defined using the long-established CIE-15.2 color model. It makes sense to continue verification testing using the same CIE color model as no better quantitative model for human visual perception is has been available and the general scientific and industrial community has followed this approach. Correspondingly, the necessary instruments for these luminance and color measurements are also widely available. The test requirements specified in IEC 61174 are very clear. S-52 establishes performance requirements but is not the governing specification of test methods. Note that the EU MED ("Wheelmark") refers to IEC 61174 as the international test standard. For type approval, the technical test methods are conducted as invoked by IEC 61174.

One of the more important developments in this field since 1997 was CIE's publication "Recommended system for mesopic photometry based on visual performance" (CIE 191-2010). This work is the culmination of nearly a decade of work on human visual perception in the low light conditions under which both rods and cones of the eye are active. It should motivate future work to adjust the specifications or the test methods used for ECDIS symbols in the dusk and night color tables. CIE has documented other work that specifies a correction to the color perception model when applied to very small symbols. This particularly affects symbols that are small compared with the 4-degree span of the targets on which CIE-15, particularly those using shades of blue (ARPAT for example). Most ECDIS symbols span less than 1-degree with significant detail much finer than that. ECDIS already defines color tokens for background area fills that are different than those used for foreground, i.e. symbols. So, a future revision of the color specifications would have limited impact.

Display technology

The calibration test results for one monitor cannot be applied to all monitors of the same design or even a group of monitors produced at the same time. A study of accumulated test data shows that, even for LCD's with digital video inputs, the random variation in color performance from unit-to-unit is large enough so that the cal data results from one unit cannot be applied to other monitors of the same model with confidence; although some would pass a verification test, a percentage will fail. Within the LCD panel, each of the many components in the light path can vary from batch-to-batch; there can be variations in the front glass, in the color filters and coatings applied and in the drive electronics integrated into the panel. The unit-to-unit variation is significantly larger for analog video LCD's and larger again for CRT's.

Studies have been conducted to understand the change in luminance and in color as a monitor ages. To provide an allowance margin for these changes over its service life, the initial accuracy of a new unit must meet the minimum accuracy specified in S52 as tested per 61174. This provides some confidence that the operational life of the monitor will exceed a minimum threshold. The color difference diagram is a more lax requirement but provides a simple and very practical functional check that can be performed aboard ship without special skill or training.

S-52 Revision

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feasible display technology for ECDIS. By 2000, when ECDIS developers began working with LCD monitors, they found that the software provided by IHO produced results that failed verification tests. Since that time, the same information is now published in international standards that cover CRT, LCD and other display technologies. Some manufacturers have developed non-analytical processes capable of meeting the verification test requirement, for example by repeating cycles of adjustment and verification measurement. Other manufacturers have combined analytical and non-analytical processes.

IHO S-52 can avoid unnecessary specification of process implementation and focus on required performance and verification tests. S-52 clause 5.2.4 should be revised to point to the relevant international standards as examples and Annex B should be deleted. The software utilities for color calibration distributed by IHO with the PresLib should be removed from the PresLib distribution.