

Testing the AUDI2000 colour-difference formula for solid colours using some visual datasets with usefulness to automotive industry

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ABSTRACT

Colour-difference formulas are tools employed in colour industries for objective pass/fail decisions of manufactured products. These objective decisions are based on instrumental colour measurements which must reliably predict the subjective colour-difference evaluations performed by observers' panels. In a previous paper we have tested the performance of different colour-difference formulas using the datasets employed at the development of the last CIE-recommended colour-difference formula CIEDE2000, and we found that the AUDI2000 colour-difference formula for solid (homogeneous) colours performed reasonably well, despite the colour pairs in these datasets were not similar to those typically employed in the automotive industry (CIE Publication x038:2013, 465-469). Here we have tested again AUDI2000 together with 11 advanced colour-difference formulas (CIELUV, CIELAB, CMC, BFD, CIE94, CIEDE2000, CAM02-UCS, CAM02-SCD, DIN99d, DIN99b, OSA-GP-Euclidean) for three visual datasets we may consider particularly useful to the automotive industry because of different reasons: 1) 828 metallic colour pairs used to develop the highly reliable RIT-DuPont dataset (Color Res. Appl. 35, 274-283, 2010); 2) printed samples conforming 893 colour pairs with threshold colour differences (J. Opt. Soc. Am. A 29, 883-891, 2012); 3) 150 colour pairs in a tolerance dataset proposed by AUDI. To measure the relative merits of the different tested colour-difference formulas, we employed the STRESS index (J. Opt. Soc. Am. A 24, 1823-1829, 2007), assuming a 95% confidence level. For datasets 1) and 2), AUDI2000 was in the group of the best colour-difference formulas with no significant differences with respect to CIE94, CIEDE2000, CAM02-UCS, DIN99b and DIN99d formulas. For dataset 3) AUDI2000 provided the best results, being statistically significantly better than all other tested colour-difference formulas.

Keywords: Colorimetry, Colour-Difference Formulas, STRESS, CIE94, CIEDE2000, AUDI2000

1. INTRODUCTION

Colour-difference formulas are mathematical equations providing a non-negative number ΔE from the tristimulus values of two colour samples, taking also into account in some cases the specific illuminating and viewing conditions under the two colour samples are visually observed. The main goal of most colour-difference formulas is the quantity ΔE is in good agreement with visually-perceived colour differences by observers' panels ΔV , considering pairs of colour samples in any region of color space observed under any viewing condition (e.g. different light sources, luminance levels, backgrounds, etc.). It can be noted that ΔV is the average subjective answer from human observers, related to the output of our human visual system. However, ΔE is an objective physical colour measurements usually performed by instruments. Obtaining successful colour-difference formulas for industrial applications is a challenge for modern advanced colorimetry because human visual colour processing is not well known in many aspects.

Traditionally, colour-difference formulas have been proposed on the basis of visual experiments performed using homogenous colour samples; that is, colour samples without any visual apparent pattern of non-uniformity or visual texture. These samples are usually designed as “solid colours” in industrial applications. However, nowadays it is necessary to develop colour-difference formulas with successful predictions of visually-perceived colour differences for much more complex visual stimuli (e.g. two colour images).^{1,2} More specifically, the automotive industry needs successful colour-difference formulas for pass/fail decisions of samples employed in different parts or a car, which are usually produced by different manufacturers. This kind of samples may be not homogeneous in colour, exhibiting also additional appearance attributes like gloss, coarseness, glint, etc. Currently, total differences in sample pairs exhibiting appearance attributes additional to colour are also under consideration.³

In a previous paper⁴ we have analyzed the performance of the AUDI2000 colour-difference formula⁵ proposed for the automotive industry, in comparison with other advanced colour-difference formulas currently available. In this study⁴ we considered the experimental visual datasets of colour pairs employed at the development of the last CIE-recommended colour-difference formula, CIEDE2000^{6,7}, which is now a joint CIE/ISO standard,⁸ and a simplified version of the AUDI2000 colour-difference formula⁵ (the AUDI2000 formula without flop terms, designed here as AUDI2000nf), in agreement with the fact that colour pairs used at CIEDE2000 development were homogenous colours; that is, homogeneous colour samples without goniochromatic (flop) effects. We found⁴ that AUDI2000nf provided good results beside the characteristics of the colour samples used at CIEDE2000 development were enough different to those commonly employed by the automotive industry (metallic samples allowing very small colour tolerances). The goal of our current paper is to complement these results on the performance of AUDI2000nf and other advanced colour-difference formulas using three new experimental datasets, which may be particularly interesting to the automotive industry because of different reasons. Specifically, one of the three datasets in our current paper includes colour pairs of metallic samples, another one printed samples with very small (threshold) color differences, and the third one is a dataset of metallic homogeneous colours with their corresponding tolerances proposed by AUDI.

2. METHODS

2.1 Tested colour-difference formulas

Many colour-difference formulas have been proposed after CIE recommended CIELUV and CIELAB in 1976. Currently CIELUV and CIELAB are two joint ISO/CIE standards.^{9,10} In particular, many CIELAB-based colour-difference formulas like CMC¹¹, BFD¹², DIN99b¹³ or DIN99d¹³ have been successfully employed in different industrial applications. The DIN99b colour-difference formula has also been designated latter by Witt as DIN99o.¹⁴ From improvements achieved by different CIELAB-based colour-difference formulas, CIE decided to recommend the CIE94¹⁵ and CIEDE2000⁶ colour-difference formulas in 1995 and 2001, respectively. Also advanced colour-difference formulas based on the CIECAM02 colour-appearance model (e.g. the CAM02-SCD¹⁶ and CAM02-UCS¹⁶ formulas) and OSA-UCS colour space (e.g. the OSA-GP-Euclidean¹⁷ formula) are relevant color-difference formulas currently under test in different applications. The AUDI2000nf (AUDI2000 with no-flop) colour-difference formula⁵ is also a CIELAB-based colour-difference formula defined as follows:

$$\Delta E_{AUDI2000nf} = \sqrt{\left(\frac{\Delta L^*}{S_L}\right)^2 + \left(\frac{\Delta C_{ab}^*}{S_C}\right)^2 + \left(\frac{\Delta H_{ab}^*}{S_H}\right)^2} \quad (1)$$

$$S_L = 0.002C_{ab}^* + 0.33 \quad ; \quad S_C = 0.014C_{ab}^* + 0.27 \quad ; \quad S_H = 0.004C_{ab}^* + 0.30 \quad (2)$$

where ΔL^* , ΔC_{ab}^* and ΔH_{ab}^* are the CIELAB lightness, chroma and hue differences, respectively; and S_L , S_C and S_H are the weighting functions for lightness, chroma and hue, respectively. It can be noted that the structure of AUDI2000nf and CIE94 colour-difference formulas is the same, although their corresponding weighting functions are different. More specifically, while the S_L function in AUDI2000nf is a chroma-dependent function, in CIE94 $S_L=1.0$. We can also note that the S_C and S_H functions in AUDI2000nf are about 1/3 those proposed in CIE94, respectively.

More detailed information on currently available colour-difference formulas and their corresponding performances can be found in recent review papers.¹⁸

2.2 Performance of colour-difference formulas

The strength of the relationship between the visual colour-differences ΔV obtained in a given experiment and the ΔE values corresponding to the predictions made by a colour-difference formula has been measured in different ways.¹⁹⁻²¹ For this purpose here we have employed the *STRESS* index²⁰ defined as follows:

$$STRESS = 100 \left(\frac{\sum_{i=1}^N (\Delta E_i - F \Delta V_i)^2}{\sum_{i=1}^N F^2 \Delta V_i^2} \right)^{1/2} \quad F = \frac{\sum_{i=1}^N \Delta E_i^2}{\sum_{i=1}^N \Delta E_i \Delta V_i} \quad (3)$$

where N is the total number of colour pairs in the dataset, and F is a constant scale factor trying to put in a common scale the magnitudes of computed (ΔE_i) and perceived (ΔV_i) colour differences in the $i=1, \dots, N$ colour pairs. *STRESS* values are always in the range 0-100. Low *STRESS* values indicate good performance of a colour-difference formula. For the experimental combined dataset employed at CIEDE2000 development,⁷ best currently available colour-difference formulas provide *STRESS* values around 25-30 units.²² The main advantage of the *STRESS* index is that it allows to know whether two colour-difference formulas are or not statistically significantly different with respect to a given dataset of visual data. Specifically, from the *STRESS* values of two colour-difference formulas A and B , the next interesting conclusions can be achieved from values of parameter R :

$$R = \left(\frac{STRESS_A}{STRESS_B} \right)^2 \quad (4)$$

- The colour-difference formula A is significantly better than B when $R < F_C$
- The colour-difference formula A is significantly poorer than B when $R > (1/F_C)$
- The colour-difference formula A is insignificantly better than B when $F_C \leq R < 1$
- The colour-difference formula A is insignificantly poorer than B when $1 < R \leq (1/F_C)$
- The colour-difference formula A is equal to B when $R = 1$

where F_C is the critical value of the two-tailed F distribution with 95% confidence level and $(N-1, N-1)$ degrees of freedom. It is important to emphasize that new colour-difference formulas should be only proposed to the scientific and industrial communities for general adoption when it is proved that they achieve statistically significantly better results than other previous colour-difference formulas for different reliable visual experimental datasets. For example, this was the case of the CIEDE2000 colour-difference formula.^{6,7,22}

2.3 Experimental datasets

As mentioned before, in this paper we have analyzed the performance of AUDI2000nf and other relevant colour-difference formulas with respect to three different visual experimental datasets.

First, we analyzed the 828 individual colour pairs originally employed for the development of the RIT-DuPont dataset.²³ This is a dataset obtained from colour pairs of metallic samples placed in specific directions of CIELAB colour space around 19 regions.²⁴⁻²⁵ The colour pairs were visually assessed by a wide number of non-defective observers with respect to a gray anchor pair with 1.02 CIELAB units, and the results found were originally reported as average tolerances (T50) with their corresponding lower and upper fiducial limits. These original RIT-DuPont data were used for the development of both the CIE94 and CIEDE2000 colour-difference formulas. However, the data on the 828 individual colour pairs employed in the RIT-DuPont experiment have been available only recently.²³ This dataset of individual colour pairs may be interesting for the automotive industry because the samples are metallic, highly reliable, and with moderate supra-threshold colour-difference magnitudes.

Taking into account that very small colour differences are usually managed by the automotive industry, we have considered useful to study a recent dataset with threshold colour-differences. The Huang et al. visual dataset²⁶ has 893 colour pairs of high resolution printed samples, which are placed around 17 color centers. The colour differences in these colour pairs are in the range 0.1 to 5.3 CIELAB units, with an average value of 1.1 CIELAB units. Using a pass/fail psychophysical method, each one of these colour pairs was visually assessed 3 times by a panel of 16 non-defective

observers. While visual differences in all 828 RIT-DuPont individual colour pairs have the same magnitude, in these 893 colour pairs the average visually-perceived colour differences reported by the observers' panel are different.

Finally, we have analyzed a set of colour tolerances for solid colours provided by AUDI at 25 colour centers (colour measurements in a perpendicular direction to the surface of the samples).⁵ These colour tolerances were used for the study of a colour-difference formula previous to AUDI2000, and are specified in the Appendix of this paper. As we can see, in this dataset the first 12 centers are nearly achromatic, and their corresponding tolerances are provided in the L^* , a^* , and b^* coordinates. The colour tolerances of the remaining 13 centers are given as ΔL^* , ΔC_{ab}^* and ΔH_{ab}^* values. From the Table in the Appendix, considering the positive and negative signs of the tolerances with respect to each center, it is possible to obtain a total of 150 colour pairs, which have been considered here as an useful dataset to test different colour-difference formulas.

3. RESULTS AND DISCUSSIONS

Figure 1 shows *STRESS* results for the 828 individual colour pairs in the RIT-DuPont dataset²³ and the different tested colour-difference formulas. As we can see, for this dataset the best colour-difference formula (lowest *STRESS* value) was CIEDE2000, with a remarkable low *STRESS* value of 23.1 units. This is not a surprising result taking into account that RIT-DuPont was one of the four datasets employed for the development of CIEDE2000. We can also note that the CIE94, AUDI2000nf, CAM02-UCS and DIN99d formulas provided very similar *STRESS* values to the one obtained by CIEDE2000, but values for CIELUV and CIELAB are considerably higher (i.e. considerable worse performance).

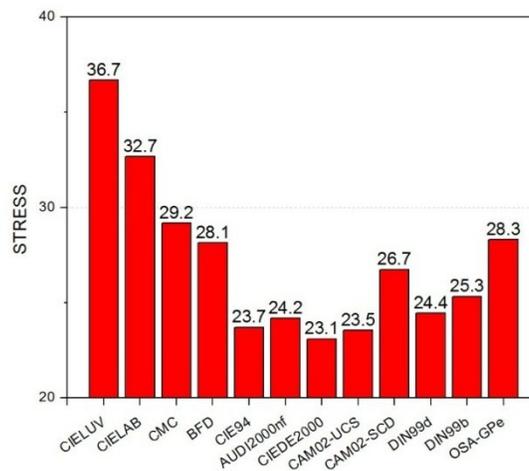


Figure 1. *STRESS* values for the RIT-DuPont 828 individual colour pairs²³ and different colour-difference formulas.

Table 1 shows R (or $1/R$) values (see Eq. 4) corresponding to the square of the *STRESS* values from any two tested colour-difference formulas (F-test). Specifically, values above the diagonal line in Table 1 are the square of the *STRESS* values from the formula in the first column divided by the square of the *STRESS* values from the formula indicated in another column. Values below the diagonal line in Table 1 are the reciprocal of their corresponding ones above the diagonal. In Table 1 the cells marked in green (red) colour indicate that the colour-difference formula in the first column is (is not) statistically significantly different than the one in the corresponding column, assuming a 95% confidence level. At this confidence level, from the number of colour pairs in this dataset, the confidence interval for the F-test is $[F_c; 1/F_c] = [0.87; 1.15]$. Reading Table 1 by rows, the cells colour immediately indicate us whether the colour-difference formula in the first column is or not significantly better or worse than the colour-difference formulas in the other columns. For example, from Table 1 we can say that the CIEDE2000 colour-difference formula is statistically significantly better than CIELUV, CIELAB, CMC, BFD, CAM02-SCD, DIN99b and OSA-GPe; CIEDE2000 is not statistically significantly different than CIE94, AUDI2000nf, CAM02-UCS and DIN99d; no colour-difference formula is significantly better than CIEDE2000 (i.e. there are no red cells in the row corresponding to the CIEDE2000 formula).

From Figure 1 and Table 1 we can say that for the RIT-DuPont 828 individual colour pairs,²³ the colour-difference formula AUDI2000nf provides enough satisfactory predictions in comparison with the ones made by other modern colour-difference formulas. Specifically, for this dataset the AUDI2000nf formula is not significantly worse than any other tested formula, it is significantly better than CIELUV, CIELAB, CMC, BFD, CAM02-SCD and OSA-GPe, and not significantly different than CIE94, CIEDE2000, CAM02-UCS, DIN99b and DIN99d. The CAM02-SCD formula performed worse than CAM02-UCS for this dataset, in agreement with previous results.²²

Table 1. *R* (or 1/*R*) values (see Eq. 4) for the RIT-DuPont 828 individual colour pairs²³ and any two tested colour-difference formulas. The green (red) cells indicate that the colour-difference formula in the first column is (is not) statistically significantly better (95% confidence level) than the one in another column. Cells with no color indicate colour-difference formulas without statistically significant differences. Significance interval: $[F_c; 1/F_c] = [0.87; 1.15]$.

RIT 828	CIELUV	CIELAB	CMC	BFD	CIE94	AUDI2000nf	CIEDE2000	CAM02-UCS	CAM02-SCD	DIN99d	DIN99b	OSA-GPe
CIELUV	1.00	1.26	1.58	1.70	2.39	2.30	2.52	2.43	1.88	2.25	2.10	1.68
CIELAB	0.79	1.00	1.25	1.35	1.90	1.82	2.00	1.93	1.49	1.79	1.66	1.33
CMC	0.63	0.80	1.00	1.08	1.51	1.46	1.59	1.54	1.19	1.43	1.33	1.06
BFD	0.59	0.74	0.93	1.00	1.41	1.35	1.48	1.43	1.11	1.33	1.23	0.99
CIE94	0.42	0.53	0.66	0.71	1.00	0.96	1.05	1.02	0.79	0.94	0.88	0.70
AUDI2000nf	0.43	0.55	0.69	0.74	1.04	1.00	1.10	1.06	0.82	0.98	0.91	0.73
CIEDE2000	0.40	0.50	0.63	0.67	0.95	0.91	1.00	0.96	0.75	0.89	0.83	0.67
CAM02-UCS	0.41	0.52	0.65	0.70	0.99	0.95	1.04	1.00	0.78	0.93	0.86	0.69
CAM02-SCD	0.53	0.67	0.84	0.90	1.27	1.22	1.34	1.29	1.00	1.20	1.11	0.89
DIN99d	0.44	0.56	0.70	0.75	1.06	1.02	1.12	1.08	0.84	1.00	0.93	0.75
DIN99b	0.48	0.60	0.75	0.81	1.14	1.10	1.20	1.16	0.90	1.07	1.00	0.80
OSA-GPe	0.60	0.75	0.94	1.01	1.42	1.37	1.50	1.45	1.12	1.34	1.25	1.00

Figure 2 shows *STRESS* results for the 893 colour pairs in the Huang et al. threshold experiment²⁶ and the different tested colour-difference formulas. Note that for all colour-difference formulas the *STRESS* values in Figure 2 are considerably higher than those shown in previous Figure 1. The main explanation for this result is that all available colour-difference formulas perform considerably worse for datasets with very small (threshold) colour differences, a previously reported problem which is currently under study by CIE TC 1-81 “Validity of formulae for predicting small colour differences” (Chairman: K. Richter, Germany). Figure 2 also shows that the best predictions for Huang et al. experimental dataset are provided by the OSA-GPe colour-difference formula, followed by DIN99b, AUDI2000nf and DIN99d colour-difference formulas (in this order), while predictions made by CIELUV and CIELAB are considerably worse.

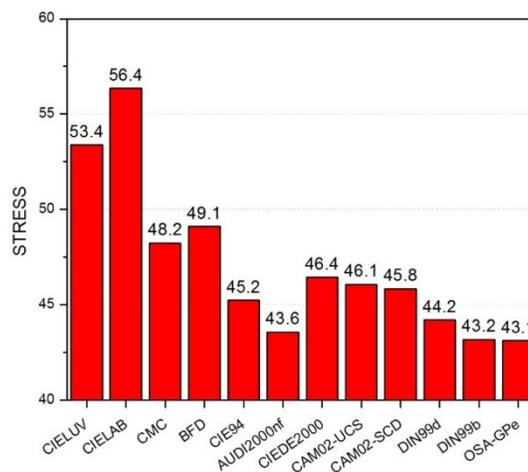


Figure 2. *STRESS* values for the Huang et al.²⁶ 893 colour pairs and different colour-difference formulas.

More specifically, Table 2 shows F-test results indicating statistically significant differences among predictions made for this threshold visual dataset by the different tested colour-difference formulas. As we can see, CIELUV and CIELAB are not statistically significantly different, but they are statistically significantly worse than all other tested colour-difference formulas. Regarding the performance of the AUDI2000nf colour-difference formula for this threshold dataset, we can see that this formula is not statistically significantly different than most of the best currently available colour-difference formulas: CIE94, CIEDE2000, CAM02-UCS, CAM02-SCD, DIN99d, DIN99b and OSA-GPe.

Table 2. Idem to Table 1, but considering the results from the 893 colour pairs in Huang et al.²⁶ dataset. At 95% confidence level the significance interval for this dataset is: $[F_c; 1/F_c] = [0.88; 1.14]$.

BIGC-TCD 893	CIELUV	CIELAB	CMC	BFD	CIE94	AUDI2000nf	CIEDE2000	CAM02-UCS	CAM02-SCD	DIN99d	DIN99b	OSA-GPe
CIELUV	1.00	0.90	1.22	1.18	1.39	1.50	1.32	1.34	1.36	1.46	1.53	1.53
CIELAB	1.11	1.00	1.36	1.32	1.55	1.67	1.47	1.50	1.51	1.63	1.70	1.71
CMC	0.82	0.73	1.00	0.97	1.14	1.23	1.08	1.10	1.11	1.19	1.25	1.25
BFD	0.85	0.76	1.04	1.00	1.18	1.27	1.12	1.14	1.15	1.23	1.29	1.30
CIE94	0.72	0.64	0.88	0.85	1.00	1.08	0.95	0.96	0.97	1.05	1.10	1.10
AUDI2000nf	0.67	0.60	0.82	0.79	0.93	1.00	0.88	0.89	0.90	0.97	1.02	1.02
CIEDE2000	0.76	0.68	0.93	0.89	1.05	1.14	1.00	1.02	1.03	1.10	1.16	1.16
CAM02-UCS	0.74	0.67	0.91	0.88	1.04	1.12	0.98	1.00	1.01	1.09	1.14	1.14
CAM02-SCD	0.74	0.66	0.90	0.87	1.03	1.11	0.97	0.99	1.00	1.08	1.13	1.13
DIN99d	0.69	0.62	0.84	0.81	0.95	1.03	0.91	0.92	0.93	1.00	1.05	1.05
DIN99b	0.65	0.59	0.80	0.77	0.91	0.98	0.86	0.88	0.89	0.95	1.00	1.00
OSA-GPe	0.65	0.59	0.80	0.77	0.91	0.98	0.86	0.88	0.88	0.95	1.00	1.00

Finally, Figure 3 shows *STRESS* results for the 150 colour pairs derived from the AUDI tolerance dataset shown in the Appendix and the different tested colour-difference formulas, while Table 3 shows the corresponding statistical significance (F-test) results.

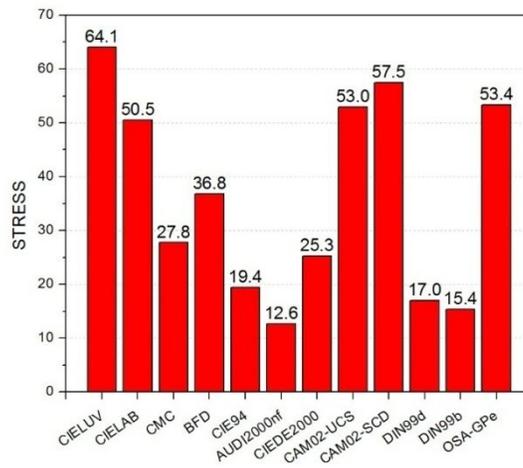


Figure 3. *STRESS* values for the 150 colour pairs derived from AUDI tolerance dataset shown in the Appendix.

Table 3. Idem to Tables 1 and 2, but considering the results from the 150 colour pairs in the AUDI tolerance dataset shown in the Appendix. At 95% confidence level the significance interval for this dataset is: $[F_c; 1/F_c] = [0.72; 1.38]$.

AUDI	CIELUV	CIELAB	CMC	BFD	CIE94	AUDI2000nf	CIEDE2000	CAM02-UCS	CAM02-SCD	DIN99d	DIN99b	OSA-GPe
CIELUV	1.00	1.61	5.33	3.03	10.90	25.68	6.43	1.46	1.24	14.17	17.34	1.44
CIELAB	0.62	1.00	3.32	1.89	6.78	15.98	4.00	0.91	0.77	8.82	10.79	0.90
CMC	0.19	0.30	1.00	0.57	2.05	4.82	1.21	0.27	0.23	2.66	3.25	0.27
BFD	0.33	0.53	1.76	1.00	3.59	8.47	2.12	0.48	0.41	4.67	5.72	0.48
CIE94	0.09	0.15	0.49	0.28	1.00	2.36	0.59	0.13	0.11	1.30	1.59	0.13
AUDI2000nf	0.04	0.06	0.21	0.12	0.42	1.00	0.25	0.06	0.05	0.55	0.68	0.06
CIEDE2000	0.16	0.25	0.83	0.47	1.70	4.00	1.00	0.23	0.19	2.20	2.70	0.22
CAM02-UCS	0.68	1.10	3.64	2.07	7.45	17.55	4.39	1.00	0.85	9.69	11.86	0.99
CAM02-SCD	0.81	1.29	4.29	2.44	8.78	20.68	5.18	1.18	1.00	11.41	13.97	1.16
DIN99d	0.07	0.11	0.38	0.21	0.77	1.81	0.45	0.10	0.09	1.00	1.22	0.10
DIN99b	0.06	0.09	0.31	0.17	0.63	1.48	0.37	0.08	0.07	0.82	1.00	0.08
OSA-GPe	0.69	1.11	3.70	2.10	7.56	17.82	4.46	1.01	0.86	9.83	12.03	1.00

Figure 3 shows that best predictions for the AUDI homogeneous colour dataset were achieved by the AUDI2000nf colour-difference formula, as it would be expected. From Table 3, it can be even noted that AUDI2000nf is significantly better than any other tested colour-difference formula. The DIN99b, DIN99d and CIE94 colour-difference formula also provided satisfactory predictions for this dataset. However the CAM02-UCS, CAM02-SCD and OSA-GPe colour-difference formulas achieved very bad results, even worse than those provided by CIELAB. This was an unexpected result, completely different to the one found for the two other analyzed datasets (see Figures 1 and 2). In a first analysis we found that removing colour pairs with $L_{10}^* < 5$ in AUDI dataset the *STRESS* values for CAM02-UCS, CAM02-SCD and OSA-GPe decreased more than 23 units (i.e. for very dark colours these formulas have a very bad performance).

4. CONCLUSION

We have tested the performance of the AUDI2000 without flop (AUDI2000nf) colour-difference formula together with other 11 modern colour-difference formulas for 3 different experimental datasets which may be relevant for the automotive industry because of different reasons (e.g. metallic samples, threshold color differences, colour pairs already used by AUDI company). Our tests were based on *STRESS* values with their corresponding F-tests allowing to know on the statistically significance of the results found from different formulas. In overall the results found by AUDI2000nf are considerably satisfactory and promising. This result was not completely unexpected bearing in mind that AUDI2000nf is enough similar to the CIE94 colour-difference formula, which was a CIE-recommended formula just a few years ago.

5. APPENDIX

Next Table shows the CIELAB coordinates (columns 2 to 6) for 25 colour centers (solid colours) used by AUDI,⁵ assuming D65 illuminant and CIE 1964 standard colorimetric observer. For each colour center, columns 7 to 11 show tolerances in different CIELAB coordinates. From these independent tolerances we can obtain 150 colour pairs (25 centers x 3 tolerances x 2 directions per tolerance), all of them with the same visual difference.

Center	L^*_{10}	a^*_{10}	b^*_{10}	$C^*_{ab,10}$	$h_{ab,10}$	$\pm\Delta a^*_{10}$	$\pm\Delta b^*_{10}$	$\pm\Delta L^*_{10}$	$\pm\Delta C^*_{ab,10}$	$\pm\Delta H^*_{ab,10}$
Y9B	0.90	0.30	-0.30	0.42	315.00°	0.30	0.30	0.30		
Y5K	3.00	1.60	-8.00	8.16	281.31°	0.30	0.30	0.30		
Y5L	3.50	1.70	-8.30	8.47	281.58°	0.30	0.30	0.30		
Y3K	4.30	7.80	-0.70	7.83	354.87°	0.30	0.30	0.30		
Y6D	10.20	-7.30	4.00	8.32	151.28°	0.30	0.30	0.30		
Y5G	17.30	-4.20	-5.90	7.24	234.55°	0.30	0.30	0.30		
Y6U	39.30	-0.20	6.10	6.10	91.88°	0.30	0.30	0.30		
Y5E	54.40	-2.50	4.20	4.89	239.24°	0.30	0.30	0.30		
90E	88.20	-0.70	5.70	5.74	97.00°	0.30	0.30	0.30		
RAL 9001	90.30	1.30	8.00	8.10	80.77°	0.30	0.30	0.30		
Y6H	91.50	-12.90	-0.80	12.92	183.55°	0.30	0.30	0.30		
Y9G	93.70	-1.00	7.60	7.67	97.50°	0.30	0.30	0.30		
Y5D	5.00	-1.00	-10.80	10.85	264.71°			0.30	0.50	0.30
RAL 1015	85.50	2.30	17.60	17.75	82.55°			0.30	0.50	0.30
Y4C	5.20	10.70	-18.30	21.20	300.31°			0.30	0.50	0.30
RAL 1014	80.20	2.90	26.10	26.26	83.66°			0.30	0.50	0.30
Y6G	89.50	-12.20	24.80	27.64	116.19°			0.40	0.70	0.40
Y5M	26.70	8.30	-34.10	35.10	283.68°			0.40	0.80	0.50
Y3E	20.00	39.30	24.60	46.36	32.04°			0.40	0.90	0.50
Y1A	85.60	-0.50	53.00	53.00	90.54°			0.40	1.00	0.60
RAL 3000	35.96	51.88	40.96	66.09	38.29°			0.40	1.20	0.60
Y1B	77.80	-3.40	66.30	66.39	92.94°			0.50	1.20	0.60
Y3D	28.30	54.90	40.90	68.46	36.69°			0.40	1.20	0.70
Y2C	41.60	49.20	51.90	71.51	46.53°			0.40	1.30	0.70
Y3H	35.20	60.10	49.80	78.05	39.65°			0.40	1.40	0.70

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