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Colour progression scales balanced to constant depth colours

This paper proposes a solution to the problem of colour map designing on CRT monitors. Colour progression scales and ranges of constant depth colours are computed using the basic cell of colour processing which is a combination of the new colour appearance model CIECAM02 and the colorimetric model of monitor (Berns' GOG).

This paper also presents practical side of designing colour progression scales balanced to constant depth colours, defining parameter of vivid level of projecting scales and showing CIECAM02 model calculation formulas in reverse mode.

The new colour appearance space connected with *JCh* colour attribute correlates (lightness – *J*, chroma – *C*, and colour – *h*) determined in colour appearance model CIECAM02 *) is an useful tool which makes it possible to design colour progression scales and ranges of constant depth colours characterized by high homogeneity. Homogeneity of scales means that equal changes of colour attribute correlates correspond to equal changes of colour appearance.

Colour progression scales balanced to constant depth colours are scales for which corresponding with each other steps of scales create ranges of constant depth colours perceived as lying at the same level of visibility.

Cartography usually assumes that quantitative (and sometimes ordering) information is well passed on by means of colour progression scales and qualitative information by means of constant depth colours (A. Robinson, 1995). Change of colour progression is being achieved by simultaneous change of lightness and chroma – along with the decrease of the level of lightness the value of chroma increases. Constant depth colours characterize by changeability of only one colour attribute – hue (A. Makowski, 1966). Combination of colours of the same depth and colour progression scales make possible to create complex

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*) CIECAM02 – Color Appearance model (CAM) approved in 2003 by CIE (Commision Internationale d'Leclerage) – International Light Commission – an institution brought into existence to ensure standardization of phenomenon sonnected with the nature of light.

hierarchic images combining possibility of differentiation and ordering the elements of an image. In this way, it is possible to create thematic maps of complex information concerning qualitative as well as quantitative features of objects and phenomenon being presented.

Makowski in his „Podstawa technologii..." (1976) described how to create colour progression scales deriving from the circle of constant depth colours. According to assumed by him cylindrical space of colours interpretation creating colour progression scales based on the circle of constant depth colours amounts to describing truncated cone with axis of rotation covering axis of rotation of the cylinder (Fig. 1).

CIECAM02 colour appearance model is out of necessity a simplification of colour perception. Not every phenomenon connected with the process of perception has been recognized so well to be presented as a model. The main function of CIECAM02 model is to give possibility to predict the colour appearance (which means to define it in the perceptual colour space) at variable conditions of observation. Each colour stimulus being observed appears in specific context. In this case context means every parameter which influences on the appearance of colour generated by stimulus being observed. Sometimes the psychological context can be distinguished as a separate thing defining cognitive factors, determining the colour appearance, and observational context which includes following parameters: size and shape of the stimulus, local and global environment, state of adaptation of observer's eye and other. CIECAM02 model respects only the observational context.

Possibility of examining a colour stimulus in connection with a context in which it appears is very useful in graphical map designing. Colours appear on the map in complex configurations. The map itself can be printed on various substrates or displayed on a screen with particular characteristics and seen at different lighting in changeable environment. All of these contributes to the inconstancy of the context in which a particular colour stimulus is perceived and influences the final colour appearance.

In CIECAM02 model structure two distinct stages of conducting the calculation can be distinguished: determining reaction of cones after adaptation at transition from conditions of map observation context to conditions of reference context and determining correlates of perceiving colour attributes. Therefore CIECAM02 in forward mode allows making CIE *XYZ* (or derivatives) tristimulus values conversion to correlates of colour attributes. In reverse mode on basis of attribute colour correlates it is possible to determine CIE *XYZ* the tristimulus values generating such colour appearance. However, in forward mode as well as in reverse mode only the observational context is respected. Determining CIE *XYZ* the tristimulus values guaranteeing equal colour appearance makes it possible to execute a colour *via* different imaging mediums (screens, printers etc.) if the values fit into the colour gamut of them. It is practical useful to make certain about the ability to execute a particular colour without any distortion (which is determined by colour gamut of the imaging medium) before designing the scale of colours. Model calculation formulas in reverse mode, which has application in determining colour scales as well as boundaries of colour gamut are shown in appendix 1.

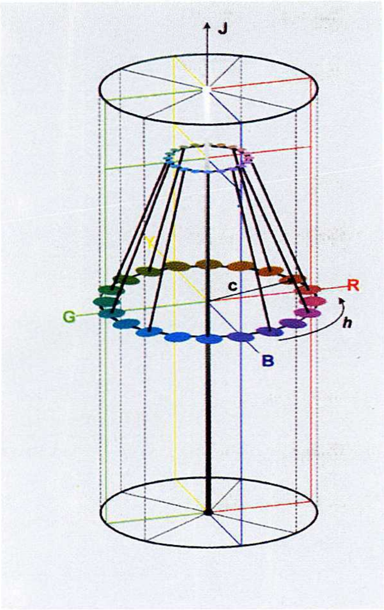

Fig. 1. Geometric interpretation of position of colour progression scales points deriving from equal depth colours

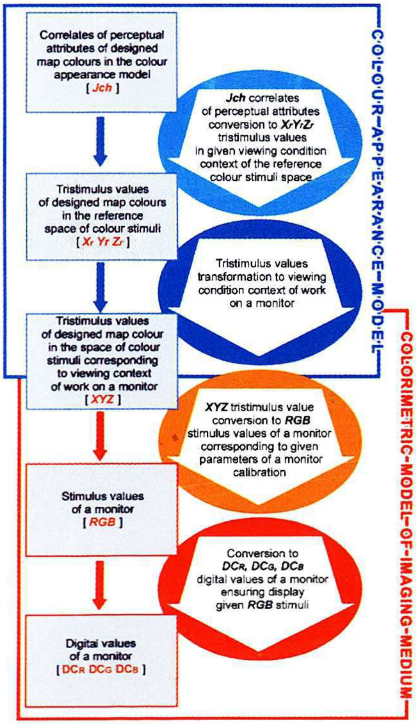

Fig. 2. Scheme of transition from perceptual colour atributes correlates *JCh* to monitor digital alues DAC: DC_R, DC_G and DC_B, ensuring display the closest colours as regards appearance

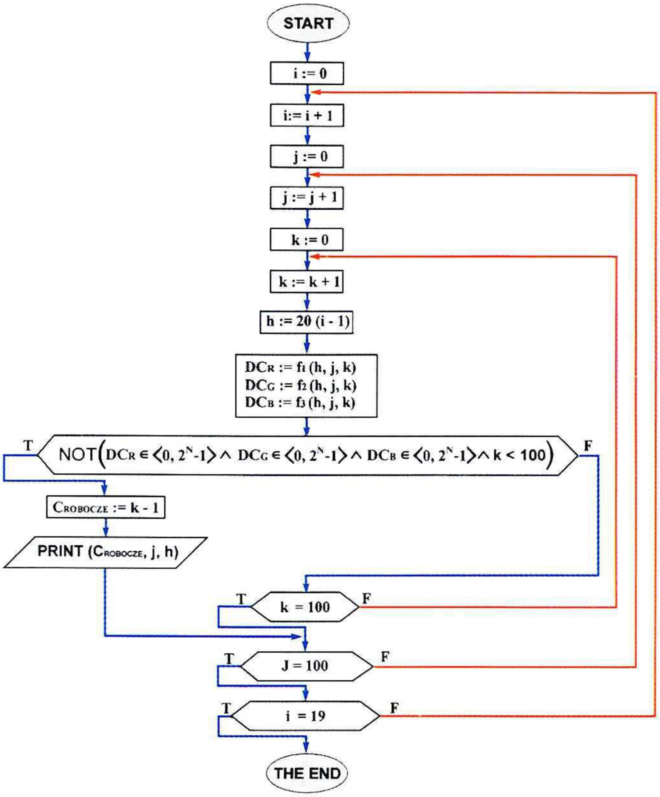

Fig. 3. Logical diagram of stages of conducting GBD points calculation using iterative method for given value of hue angle *h* in CIEMCAM02 model

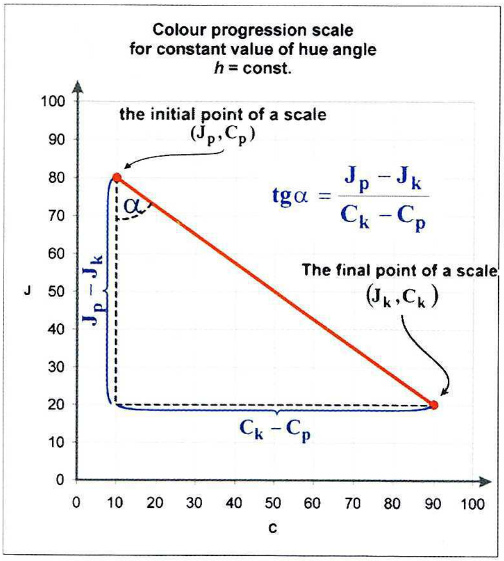

Fig.4. Colour progression scale line. Angle α defines vivid level of projected scale

Determining the colour gamut of source monitor

The source monitor is the one on which the map project is being created. In case of designing the colour progression scale specific situation is being dealt with. Colours of every scale are located exactly in half-plane of constant value of hue angle h in CIECAM02 colour appearance model. In this case it is essential to determine colour gamut boundaries exactly in those half-planes.

To do so it is necessary to define two models: CIECAM02 colour appearance model in which observation context is connected with conditions of observation on particular monitor and colorimetric model of monitor. Simplified Berns' GOG model *) was assumed which was expanded with colour temperature of screen white point (T_c). In this expanded Berns' model the essential parameters were determined with proper calibration and spectrophotometric measurements.

GBD points**, located in half-planes of constant hue angle of developed colour scales ($\Delta h = 20°$), were determined exact to change of lightness attribute correlate $\Delta J = 1$ and chroma attribute correlate $\Delta C = 1$. It means that for each value of colour angle h maximum values of chroma attribute correlate C (exact to integer values of chroma attribute correlate) were found for values of lightness attribute correlate J from 0 to 100 with unitary change. Determining maximum values of chroma attribute correlate C consists in calculation compatible with scheme of digital values input needed to project equal colour appearance shown on Fig. 2. This process is iterative lead in accordance with the scheme shown on Fig. 3.

That is how colour gamut boundaries were determined for the source monitor (ECOMO Elsa 850 calibrated to $T_c = 6500$ K). However, so-called source monitor is the one on which the original map is being created. The locus of colour gamut boundaries of this monitor is shown on figures from Fig.5 to Fig.7 in the form of red lines – progression scales with maximum intensity.

Practical side of designing colour progression scales balanced to constant depth colours

In perceptional colour space [JCh] of CIECAM02 model colour progression scales are executed through choosing points equally placed on straight line lying in half-plane of constant hue angle h. Gradient of this line in relation to lightness axis (angle α) can be recognized as a measure of colour scale vivid level (Fig. 4).

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*) Berns' GOG model – (Gain-Offset-Gamma model) – colorimetric model of a monitor. It includes two stages. The first stage is nonlinear transformation of digital values DC inputs to DAC (digital to analog converter) to values of device dependent stimulus – RGB monitor – using parameters: gain a, offset b and nonlinear relationship γ for each of three RGB channels. The second stage is linear transformation in which RGB stimulus values dependent on a device are being transformed to device independent tristimulus CIE XYZ values. First stage is called determining tone reproduction curve (KRT) and second stage is called determining transferring matrix (MT). Due to proper calibration (setting optimal level of offset and gain) this model undergoes convenient simplfication. Additional parameter has been assumed – colour temperature T_c of monitor screen white point.

**) GBD points – (Gamut Boundary Descriptors) – points of colour gamut boundary discreet recording. Intermediate values are interpolated in various ways.

The first level of each designed colour progression scale is white colour ($J_p = 100$, $C_p = 0$), where J_p and C_p are initial values of lightness attribute correlate and chroma attribute correlate, respectively (see Fig. 4). Since human optical system is the most sensitive to changes of lightness of perceiving colour, an assumption was made that scale levels are defined with decimal changes of lightness attribute correlate J. As a result, besides zero lightness (black), nine levels of chromatic scales and white colour ($J = 100$) were distinguished. Changing the final value of chroma attribute correlate C_k of the last scale step it is possible to influence the angle of gradient α thereby creating for the same numerical hue attribute correlate h scale of higher and lower colour vivid.

Figures from Fig.5 to Fig.7 present CJ graphs of three scales: scale 1, scale 2, scale 3 which differ with angle of gradient α of straight line due to which they were determined. Scale 1 runs from the initial point (Fig. 4) to point $J = 10$, $C = 50$, scale 2 to point $J = 10$, $C = 70$ and scale 3 to point $J = 10$, $C = 90$. The illustration has been presented for three different colour angels: $h = 0°$, $h = 120°$ and $h = 260°$. Those values were chosen in order to present diversity of locus of colour gamut boundaries (progression scale with maximum intensity is shown with red colour). Boundary for $h = 0°$ characterize with maximum value of chroma being achieved for medium level of lightness, boundary for $h = 120°$ for high level of lightness and boundary for $h = 260°$ for low level of lightness. Illustration of colours lying on the boundary of colour gamut with the same lightness values as for progression scales ($J = 90, 80, 70, 60, 50, 40, 30, 20$ and 10) has been placed on the left side of the graph. Illustration of the three had designed colour progression scales have been placed on the right side of the graph.

Maximum value of chroma attribute correlate C for colour progression scale for $h = 0°$ (Fig. 5) is being achieved for medium values of lightness attribute correlate (J is equal to about 45). Colours of scale 1 do not achieve significant vivid (comparing to the scale of maximum intensity for particular monitor presented on the left side of the figure). However, in natural way, it can have higher number of degrees. For instance for changes of lightness attribute correlate of $\Delta J = 10$ it will include 8 degrees of change of colour progression scale possible to execute on the monitor. Scale 2 is the one with medium level of vivid. The scale colours are more attractive to an observer. However, less degrees of the scale can be executed on the monitor. Scale 3 is the one with relatively high level of vivid. Degrees of colour of high lightness values are similar to colours of colour gamut boundaries, but then the scale begins to move away from the maximum values. This scale is the shortest and includes 6 degrees of colour. The higher the degree of vivid the bigger differences occurs between its next levels. It makes it easier to distinguish them.

Maximum value of chroma C for colour progression scale of $h = 120°$ (Fig. 6) is being achieved for high lightness values (J is equal to more less 80). In this case, like before (for $h = 0°$), the scale with the lowest level of vivid includes more degrees of colours and the scale with highest level of vivid includes less of them. Colours in scale 3 are generally speaking more vivid and more attractive visually and colour differences between them are bigger. Because of the high level of maximum value of chroma, none of the scales does not significantly bring closer to colours of maximum chroma scale. To balance colour progression scale of hue $h = 120°$ to equal depth colours with equivalent colours of

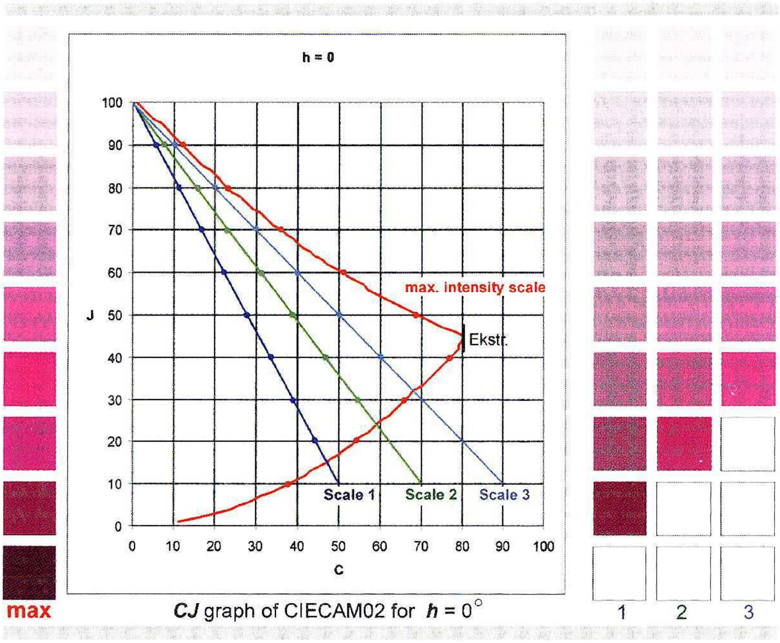


Fig. 5. Colour progression scales at colour hue angle $h = 0°$. Additionally locus of a colour gamut bondary of source monitor in half-plane of hue angle defining maximum possible values to execute chroma is shown by red line

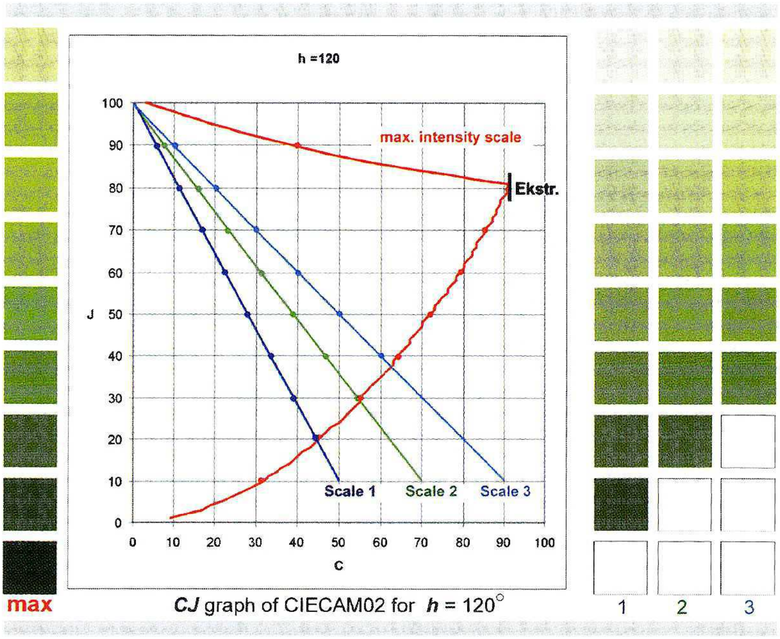


Fig. 6. Colour progression scales at colour hue angle $h = 120°$. Additionally locus of a colour gamut boundary of source monitor in half-plane of hue angle defining maximum possible values to execute chroma is shown by red line

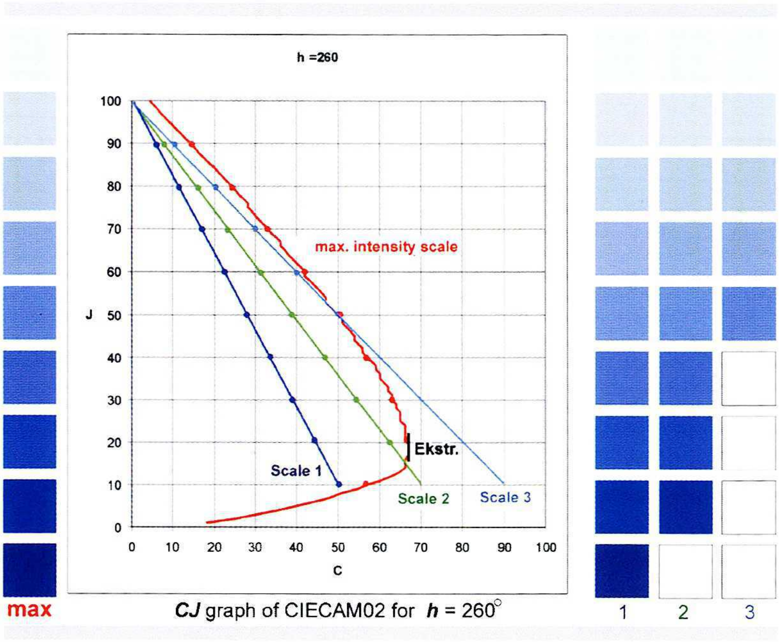


Fig. 7. Colour progression scales at colour hue angle $h = 260°$. Additionally locus of a colour gamut boundary of source monitor in half-plane of hue angle defining maximum possible values to execute chroma is shown by red line

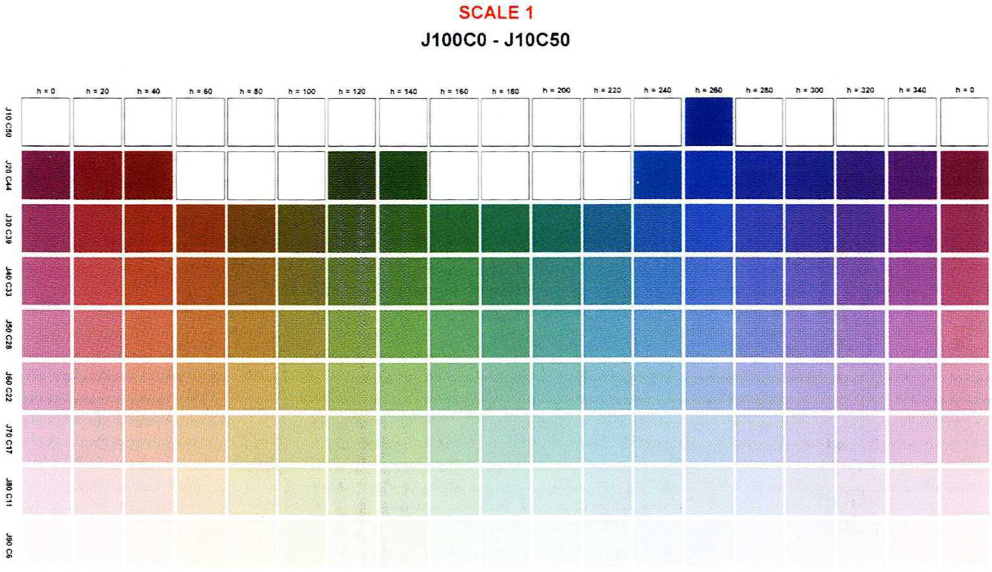
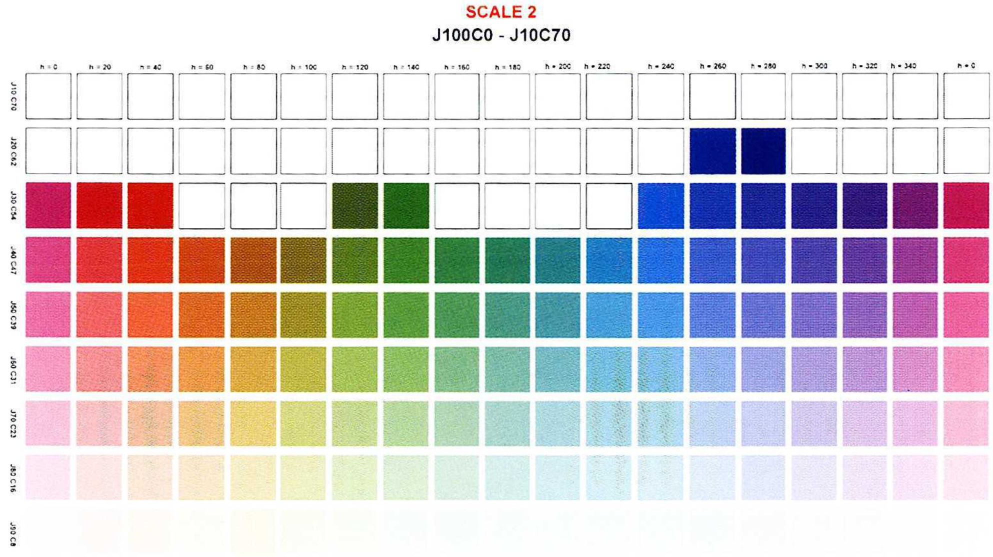


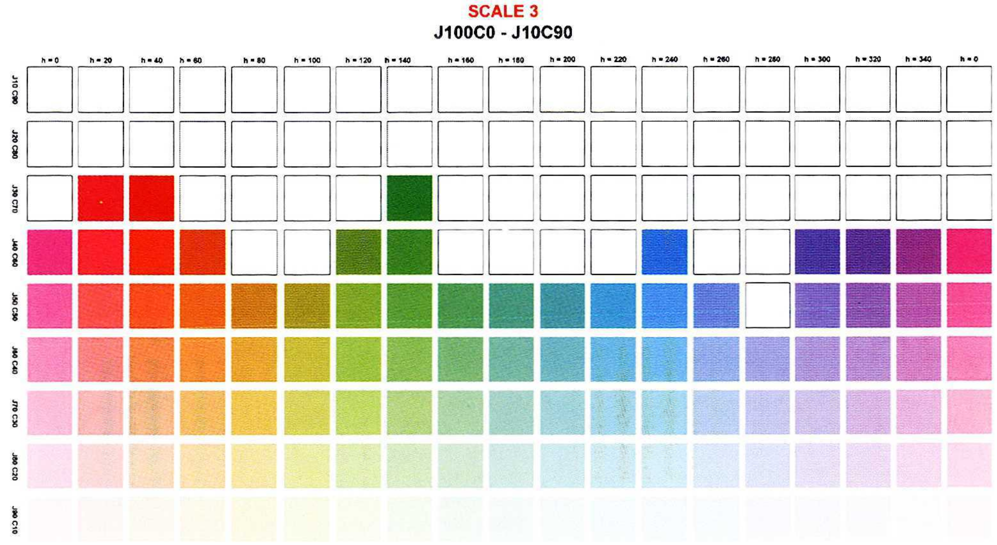
Fig. 8. Colour progression scales balanced to constant depth colours at hue angle changes $\Delta h = 20°$ calculated for the last scale step at point $J = 10$, $C = 50$ ($\alpha = 29.05°$)



SCALE 2

J100C0 - J10C70

Fig. 9. Colour progression scales balanced to constant depth colours at hue angle changes $\Delta h = 20°$ calculated for the last scale step at point $J = 10$, $C = 70$ ($\alpha = 37.87°$)



SCALE 3

J100C0 - J10C90

Fig. 10. Colour progression scale balanced to constant depth colour at hue angle changes $\Delta h = 20°$ calculated for the last scale step at point $J = 10$, $C = 90$ ($\alpha = 45.00°$)

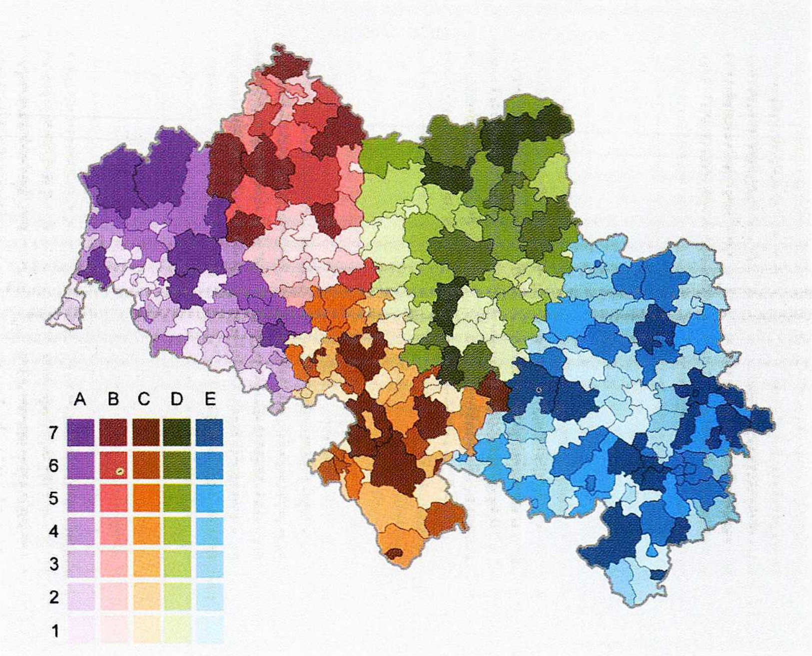


Fig. 11. Choropleth maps based on colour progression scale balanced to constant depth colours

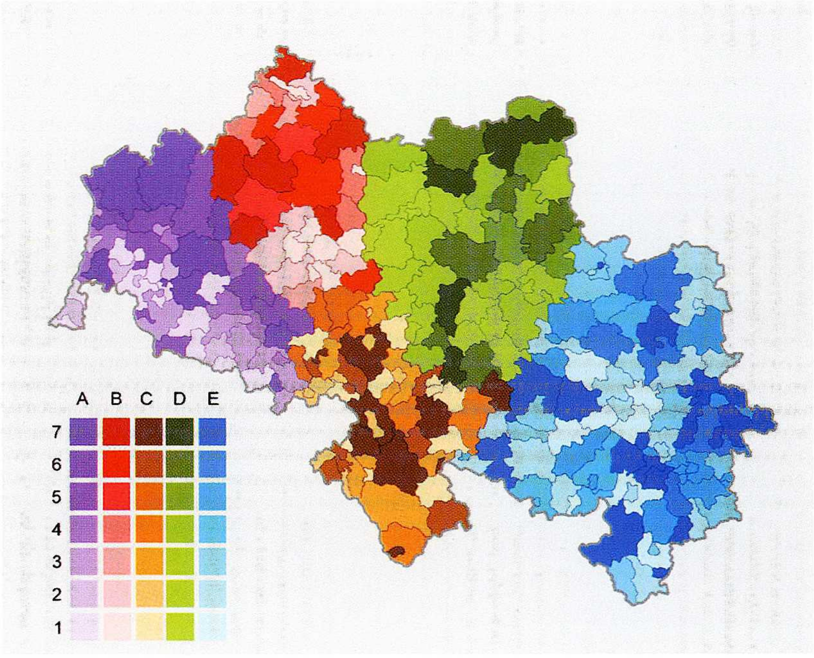


Fig. 12. Choropleth maps based on colour progression scale not balanced to constant depth colours

progression scales for other values of hue angle h – colours of that scale had to be reduced of some chroma.

For $h = 260°$ (Fig. 7) extreme value of chroma lies relatively low (for J equal to more less 20). Thanks to this fact colour progression scales do not move far away from the colours of maximum intensity. In this case scale 2 becomes definitely the best. It consists of 8 degrees retaining high level of colour vivid at the same time. Scale 3 is most similar to the colours of maximum chroma values possible to execute on particular monitor. However, it is limited to 5 degrees of lightness scale. Generally speaking low level of extreme value of chroma can be regarded as favourable situation in creating colour progression scales.

Illustration of colour progression scales balanced to equal depth colours has been presented on following figures (from Fig.8 to Fig.10). Number of levels of each scale is defined by the locus of the gamut boundary of colour source monitor. The boundary was determined in half-plane of hue angle h with respect to which particular scale was created.

Colour progression scales and series of equal depth colours find application in most methods of cartographic presentations because they make it possible to differ and order the elements of a picture of a map.

Figure 11 presents an example of applying colour progression scales balanced to equal depth colours in case of creating a cartogram To emphasize the difference similar picture of the map has been presented (Fig. 12) but created with applying colour progression scales not balanced to equal depth colours.

CONCLUSION

Combination of CIECAM02 colour appearance model and colorimetric model of monitor (Berns' GOG) make it possible to display designed colour scales on monitor screen without disturbing of displayed colours appearance according the bit depth precision. Scales designed in homogeneous perceptional colour space connected with CIECAM02 model guarantee retaining viewing levels and constant appearance of perceived colours. Moreover they make it possible to execute graphic project of a map properly. Now Cartographer's knowledge can be illustrated on a map in easy and effective way giving surety of receiving proper colour effect.

APPENDIX 1

CIECAM02 – formulas of the reverse model:

Input Data:

- Q or J
- M or C
- H or h
- X_W, Y_W, Z_W
- X_b, Y_b, Z_b
- X_{Wr}, Y_{Wr}, Z_{Wr}
- L_A
- Y_b / Y_W
- Q_W – calculated from a forward model
- A_W – calculated from a forward model
- surround parameters:

	c	F	Nc
Average	0,69	1,00	1,00
Dim	0,59	0,90	0,95
Dark	0,525	0,80	0,80

Another Data:

$$\mathbf{M}_{\text{CAT02}} = \begin{bmatrix} 0.7328 & 0.4296 & -0.1624 \\ -0.7036 & 1.6975 & 0.0061 \\ 0.003 & 0.0136 & 0.9834 \end{bmatrix}; \quad \mathbf{M}_H = \begin{bmatrix} 0.38971 & 0.68898 & -0.07868 \\ -0.22981 & 1.18340 & 0.04641 \\ 0 & 0 & 1 \end{bmatrix}$$

$$k = 1/(5L_A + 1); \qquad F_L = 0.2k^4(5L_A) + 0.1\,(1 - k^4)(5L_A)^{1/3}; \qquad n = Y_b / Y_W;$$

$$N_{bb} = N_{cb} = 0.725\,(1/n)^{0.2}; \qquad z = 1.48 + n^{1/2}$$

Q_W and A_W should be counted using forward model: $\begin{bmatrix} R_W \\ G_W \\ B_W \end{bmatrix} = \mathbf{M}_{\text{CAT02}} \begin{bmatrix} X_W \\ Y_W \\ Z_W \end{bmatrix}$;

$$D = F\left(1 - \frac{1}{3.6}\exp^{\left(\frac{-L_A - 42}{92}\right)}\right);$$

$$R_{Wc} = \left[\left(Y_W \frac{D}{R_W}\right) + (1 - D)\right] R_W; \; G_{Wc} = \left[\left(Y_W \frac{D}{G_W}\right) + (1 - D)\right] G_W;$$

$$B_{Wc} = \left[\left(Y_W \frac{D}{B_W}\right) + (1 - D)\right] B_W; \quad \begin{bmatrix} \rho_W \\ \gamma_W \\ \beta_W \end{bmatrix} = \mathbf{M}_H \mathbf{M}_{\mathrm{CAT02}}^{-1} \begin{bmatrix} R_{Wc} \\ G_{Wc} \\ B_{Wc} \end{bmatrix}$$

$$\rho_{\mathrm{Wa}} = \frac{400(F_L \rho_W / 100)^{0.42}}{[27.13 + (F_L \rho_{AW} / 100)^{0.42}]} + 0.1; \quad \gamma_{Wa} = \frac{400(F_L \gamma_W / 100)^{0.42}}{[27.13 + (F_L \gamma_W / 100)^{0.42}]} + 0.1;$$

$$\beta_{Wa} = \frac{400(F_L \beta_W / 100)^{0.42}}{[27.13 + (F_L \beta_W / 100)^{0.42}]} + 0.1; \; A_W = \left[2 \rho_{Wa} + \gamma_{Wa} + \frac{1}{20} \beta_{Wa} - 0.305\right] N_{bb};$$

$$Q_W = (4/\mathrm{c})(A_W + 4) F_L^{0.25};$$

Determined these values allow starting calculates of forward model

1. From Q obtain $J = \left(\dfrac{2.5 Q c F_L^{-0.25}}{A_W + 4}\right)^2$;
2. From J obtain $A = A_W \left(\dfrac{J}{100}\right)^{1/cz}$;
3. Using H determine values: h_1, h_2, e_1, e_2 – in analogical way to calculations in forward CIECAM97s model;
4. Calculate h – in analogical way to calculations in forward CIECAM97s model;
5. Calculate $e = \left(\dfrac{12500}{13} N_c N_{cb}\right)\left[\cos\left(h \dfrac{\pi}{180} + 2\right) + 3.8\right]$;
6. Calculate $C = M F_L^{-0.25}$;
7. Calculate $t = \left[\dfrac{C}{\sqrt{J/100}} (1.64 - 0.29^n)\right]^{1/0.9}$;
8. Calculate a and b

$$a = \frac{t(A/N_{bb} + 0.305)}{e\sqrt{1 + \tan^2(h)} + t\left(\frac{11}{23} + \frac{108}{23}\tan(h)\right)}; \text{ where } \sqrt{1 + \tan^2(h)}$$

is positive for: $h \in \langle 0°, 90° \rangle \cup (270°, 360°)$; and negative for: $h \in (90°, 270° \rangle$

$b = a \cdot \tan(h)$

9. Calculate $\rho_a, \gamma_a, \beta_a$

$$\rho_a = \frac{20}{61}\left(\frac{A}{N_{bb}} + 0.305\right) + \frac{41}{61}\frac{11}{23} a + \frac{288}{61}\frac{1}{23} b; \quad \gamma_a = \frac{20}{61}\left(\frac{A}{N_{bb}} + 0.305\right) - \frac{81}{61}\frac{11}{23} a - \frac{261}{61}\frac{1}{23} b;$$

$$\beta_a = \frac{20}{61}\left(\frac{A}{N_{bb}} + 0.305\right) - \frac{20}{61}\frac{11}{23} a - \frac{20}{61}\frac{315}{23} b$$

10. Calculate ρ, γ, β

$$\rho=\frac{100}{F_L}\left[\frac{27.13(\rho_a-0.1)}{400.1-\rho_a}\right]^{1/0.42};\ \gamma=\frac{100}{F_L}\left[\frac{27.13(\gamma_a-0.1)}{400.1-\gamma_a}\right]^{1/0.42};\ \beta=\frac{100}{F_L}\left[\frac{27.13(\beta_a-0.1)}{400.1-\beta_a}\right]^{1/0.42}$$

11. Calculate R_c, G_c, B_c: $\begin{bmatrix} R_c \\ G_c \\ B_c \end{bmatrix} = \mathbf{M}_{\mathrm{CAT02}}\mathbf{M}_H^{-1}\begin{bmatrix} \rho \\ \gamma \\ \beta \end{bmatrix}$

12. Calculate R, G, B: $R = R_c \Big/ \left[\frac{Y_W D}{R_W} + (1-D)\right]$; $G = G_c \Big/ \left[\frac{Y_W D}{G_W} + (1-D)\right]$;

$$B = B_c \Big/ \left[\frac{Y_W D}{B_w} + (1-D)\right]$$

13. Calculate X, Y, Z: $\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \mathbf{M}_{\mathrm{CAT02}}^{-1}\begin{bmatrix} R \\ G \\ B \end{bmatrix}$.

REFERENCES

[1] Berns R. S., Gorzynski M. E., Motta M. J., *CRT Colorymetry. Part I: theory and practice*, Color research and Application, vol. 18, No. 5, pp.299-314; 1993.

[2] Brewer C. A., *Guidelines for Selecting Colors for Diverging Schemes on Maps*, The Cartographic Journal vol. 33 no. 2 pp. 79-86; 1996a.

[3] CIE Publication 131-1998, The CIE 1997 Interim Colour Appearance Model (Simple Version), CIECAM97s; 1998.

[4] Li C., Luo M. R., *A uniform colour space based upon CIECAM97s*, http://www.colour.org/tc8-01/.

[5] Li C., Luo M. R., Hunt R. W. G., Moroney N., Fairchild M. D., Newman T., *The Performance of CIECAM02*, Proc. IS&T/SID 10th Color Imaging Conference; 2002a

[6] Luo M.R., Hunt R. W. G., *The Structure of the CIE 1997 Colour Appearance Model (CIECAM97s)*, Color Res. App. 23, 138-146; 1998.

[7] Makowski A., *Estetyczny i użytkowy aspekt barwy na mapie*, Geodezja i Kartografia, 15, z. 4, 1966.

[8] Makowski A., *Podstawa technologii barwy w kartografii*, Wydawnictwo PW, 1976.

[9] Moroney N., Fairchild M., Hunt R. W. G., Li C., Luo M. R., Newman T., *The CIECAM02 Color Appearance Model*, www.hpl.hp.com Color Res. Appl; 2003.

[10] Morovič J., Luo M. R, *A Fundamentals of gamut mappings*, http://www.colour.org/tc8-03/survey/fund_gm.pdf, 1999.

[11] Park Seung-ok, Kim Hong-suk, Baek Jung-ki, *Optimum Brightness Level and Simplified Characterization of CRT Color Monitors*, Color Research and Application, 25(6), 408-415; 2000.

[12] Puszkarska J., *Influance of white point colour temperature set-up on cartographic pictures appearance displayed on CRT monitors*, Geodezja i Kartografia, t.L, z.2, s.99-118, 2001.

[13] Robinson A. H., Morrison J. L., Muehrcke P. C., Kimerling A. J., Guptill S. C., *Elements of Cartography*, 6th ed. John Wiley & Sons, INC., 1995.

[14] Rzeszut J., *Barwa w grafice komputerowej*, w: *Grafika Komputerowa – metody i narzędzia*, pod redakcją Jana Zabrodzkiego, WNT, 1994.

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Skale natężenia barwy zrównoważone do barw jednakowej głębi

Streszczenie

Nowa przestrzeń barw związana z percepcyjnym modelem barwy CIECAM02 pozwala na opracowanie skal natężenia barwy zrównoważonych do barw jednakowej głębi charakteryzujących się bardzo wysoką jednorodnością. Jednorodność ta oznacza, iż równym zmianom odpowiednika liczbowego atrybutu barwy odpowiadają równe zmiany spostrzeżeń barwy. Ponadto odpowiadające sobie stopnie tych skal tworzą szeregi barw jednakowej głębi, postrzegane jako leżące na tym samym poziomie widoczności. Pozwala to na tworzenie map o złożonym hierarchicznym obrazie prezentującym zarówno ilościową jak i jakościową informację. Percepcyjny model barw CIECAM02 jest modelowym uproszczeniem percepcji barw. Jego głównym zadaniem jest możliwość przewidywania odbioru barwy (a więc określania jej w percepcyjnej przestrzeni barw) przy zmiennych warunkach obserwacji. Jest to bardzo cenna cecha, gdyż obraz kartograficzny i jego reprodukcje charakteryzują się znaczną niestabilnością warunków obserwacji.

Opracowany odwrotny model CIECAM02 wraz z kolorymetrycznym modelem monitora (uproszczony na drodze właściwej kalibracji model GOG Bernsa) pozwala na opracowanie skal natężenia barwy zrównoważonych do barw jednakowej głębi przystosowanych do równoważnej reprodukcji barw na ekranie monitora CRT. Skale te mogą różnić się wyprowadzoną z modelu miara intensywności. Połączenie obydwu modeli pozwala również na prawidłowe uwzględnienie granic zakresu barwowego monitora już na etapie projektowania barw mapy.

Takie opracowanie barw mapy pozwala na właściwą realizację projektu graficznego mapy. Wiedza kartografa może być teraz zobrazowana na mapie w prosty i skuteczny sposób dający gwarancję otrzymania właściwego efektu kolorystycznego.

Иоанна Ярошевич

Уравновешенные шкалы цветов к атрибуту постоянной глубины цветов

Резюме

Новое цветовое пространство, связанное с перцепционной моделю цветов CIECAM02, разрешает разрабатывать шкалы интенсивности окраски уравновешенные к цветам одинаковой глубины, характеризующиеся очень высокой однородностью. Эта однородность обозначает, что

равным изменениям количественного эквивалента атрибута цвета соответствуют равные изменения наблюдений (замечаний) цвета. Кроме того соответствующие себе ступени этих шкал создают ряды цветов одинаковой глубины, воспринимаемые как лежащие на том же уровне видимости. Это даёт возможность разрабатывать карты со сложным иерархическим изображением, представляющим как количественную, так и качественную информацию. Перцепционная модель цветов CIECAM02 является модельным упрощением восприятия цветов. Её главной задачей является возможность предвидения приёма цвета (то есть определения его в перцепционном цветовом пространстве) при переменных условиях наблюдения. Это очень ценная черта, т. к. иерархическое изображение и его репродукции характеризуются значительной нестабильностью условий наблюдений.

Разработанная обратная модель CIECAM02 вместе с колориметрической моделью монитора (упрощенная путём правильной калибровки модель GOG Bernsa) разрешает разработать шкалы интенсивности окраски, уравновешенные к цветам одинаковой глубины, приспособленные к эквивалентной репродукции цветов на экране монитора CRT. Шкалы эти могут отличаться мерой интенсивности, выведенной из модели. Соединение обеих моделей разрешает также правильно учитывать границы диапазона цветового монитора уже на этапе проектирования цветов карты.

Такая разработка цветов карты даёт возможность правильно осуществлять графический проект карты. Знания картографа могут быть представлены сейчас на карте простым и эффективным способом, гарантирующим получение соответствующего колористического результата.