

## Color Palette associated with Color Discrimination and Clustering for the Elderly and Normal Vision People

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**ABSTRACT** – Color is a powerful tool to communicate both direct and indirect information. It enhances readability, attracting attention and emotion. However, the use of color to deliver sophisticated information is still in challenge. This paper proposes an algorithm to generate color palettes to convey the message of group information comprising various levels of detail and interrelation. The algorithm is based on color data such as contrast ratio, lightness, chroma, hue, color distance. The results provide the color palettes associated with color discrimination and clustering for the elderly and normal vision people. This contributes to an improved visual experience in digital media, content, printing, and user interface, with particular relevance for the visual representation of group information, including status management and informational categorization.

**KEY WORDS** -- color palette, color discrimination, group information, low vision, analogous colors, contrast

### 1. Introduction

Color has a profound impact on human perception, emotion and behavior. Elderly people are particularly sensitive to color due to age-related changes in vision. Given the increasing proportion of senior citizens in aging societies, the design of color necessitates careful consideration of age-related visual changes and their implications to ensure optimal accessibility and functionality for well-being. A well-chosen color can evoke specific emotions, enhance user experience, convey messages, assist in attracting attention and create visually appealing compositions [1].

Researchers have investigated the use of color for the elderly in a number of studies. These studies have shown that older adults prefer colors that are high in contrast and low in complexity [2] – [3].

Generating color palettes is an essential aspect of design, influencing the overall aesthetic and appeal of numerous visual creations. Good color palettes also enhance legibility for optimal function and information accessibility. Several algorithms have been developed to automate the process of generating color palettes, offering various approaches and considerations, aiming to produce harmonious and visually pleasing color combinations. The overview of the conventional techniques are as follows [4] – [11].

- Rule-based approaches utilize predefined rules or guidelines to generate color palettes. These rules may consider color harmony concepts, such as analogous or specific color combinations known to evoke certain moods or emotions. Rule-based

algorithms provide a structured approach to palette generation, ensuring consistency with established design principles.

- Color-theme-based approaches generate color palettes based on specific color themes, such as complementary, analogous, and triadic color schemes. These algorithms typically start with a base color and then select additional colors that adhere to the chosen color scheme. The resulting color palette is guaranteed to have a harmonious and aesthetically pleasing arrangement of colors.
- Neural network-based approaches have gained traction in color palette generation due to their ability to learn and capture complex patterns in color relationships. These algorithms are often trained on large datasets of images and their corresponding color palettes. The trained neural network can then generate new color palettes based on the learned patterns.

In addition to these approaches, there are various online tools [12] - [19] that can generate color palettes based on different input parameters, such as color relationships, mood, and color harmony. These tools can be helpful for designers seeking quick and easy palette generation.

However, some particular tasks require communication of group information which are still a research challenge. The complication is that the colors need to be discriminated and clustered at the same visualization. That is to say,

- discriminate text color from background color.

- discriminate between background colors of the same group information while keeping analogous color appearing of group information.
- discriminate colors between group information.
- clear distinct between groups but smooth distinct within the group of information.
- support color variations between group and within group information.

Therefore, this research proposes the color palettes associated with color discrimination and clustering for the elderly and normal vision people. The algorithm is based on contrast ratio, color difference, brightness difference, lightness, chroma, hue, color distance (difference in sensation), and lightness difference. The color palettes resulting from commonly black text are described to facilitate a variety of applications. This will be useful for visual appeal of digital media, printing, user interface and contents related to communicating group information such as status management, group information categorization.

## 2. Methodology

The aim of our proposed color palettes is to provide color discrimination in parallel with categorization for the elderly and normal vision people. The 8-bit sRGB colors are analyzed based on the color information and the criteria of legible visual acuity to the target group. Our case study focuses on the black text over the color palette background. The overview of the proposed color palette generation is illustrated in Figure 1.

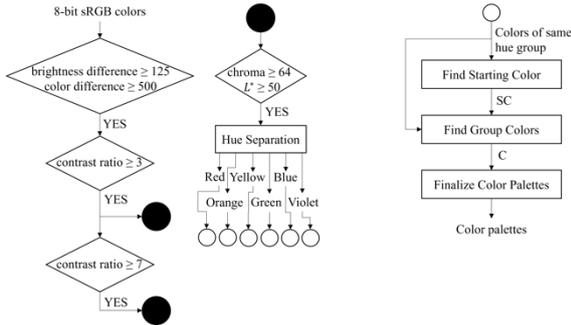


Figure 1. Overview of the proposed color palette generation.

Refer to Web Content Accessibility Guidelines (WCAG) 2.0 [20], the visual presentation of text should have at least 7:1 of contrast ratio in order to provide enough contrast between text and its background for people with low vision. However, the contrast ratio is reduced to 3:1 as a minimum acceptable contrast for normal vision. Therefore, the 8-bit sRGB colors are filtered by a contrast ratio of 7:1 for the elderly and 3:1 for normal vision people with at least a brightness difference of 125 and color

difference of 500 for readability according to World Wide Web Consortium (W3C) as shown in the left part of Figure 1. Equations (1) - (4) describe the formula to calculate contrast ratio, color brightness and color difference.

$$\text{Contrast Ratio} = \frac{(L_1+0.05)}{(L_2+0.05)} \quad (1)$$

Where,  $L_1$  and  $L_2$  are the relative luminance of the lighter and darker of the colors, respectively. The relative luminance ( $L$ ) is the relative brightness of any point in a color space, normalized to 0 for darkest black and 1 for lightest white. For the sRGB color space, the relative luminance of a color is defined as shown in Equation (2).

$$L = 0.2126R + 0.7152G + 0.0722B \quad (2)$$

Where,  $R$ ,  $G$  and  $B$  are defined as:

- if  $R_{sRGB} \leq 0.03928$  then  $R = \frac{R_{sRGB}}{12.92}$   
else  $R = \left(\frac{R_{sRGB}+0.055}{1.055}\right)^{2.4}$
- if  $G_{sRGB} \leq 0.03928$  then  $G = \frac{G_{sRGB}}{12.92}$   
else  $G = \left(\frac{G_{sRGB}+0.055}{1.055}\right)^{2.4}$
- if  $B_{sRGB} \leq 0.03928$  then  $B = \frac{B_{sRGB}}{12.92}$   
else  $B = \left(\frac{B_{sRGB}+0.055}{1.055}\right)^{2.4}$

and  $R_{sRGB}$ ,  $G_{sRGB}$ ,  $B_{sRGB}$  are the red, green and blue values in 8-bit sRGB color space divided by 255, respectively. The contrast ratio ranges from 1 to 21.

$$\text{Color Brightness} = \frac{299R+587G+114B}{1000} \quad (3)$$

Where,  $R$ ,  $G$ ,  $B$  are the values of red, green and blue in 8-bit sRGB color space with values of 0-255, respectively. Note that this algorithm is taken from a formula for converting RGB values to YIQ values. This brightness value gives a perceived brightness for a color which ranges from 0 to 255.

$$\begin{aligned} \text{Color Difference} = & (Max(R_1, R_2) - Min(R_1, R_2)) + \\ & (Max(G_1, G_2) - Min(G_1, G_2)) + \\ & (Max(B_1, B_2) - Min(B_1, B_2)) \end{aligned} \quad (4)$$

Where,  $R_1$ ,  $G_1$ ,  $B_1$  and  $R_2$ ,  $G_2$ ,  $B_2$  are the values of red, green and blue in 8-bit sRGB color space with values of 0-255 for the first color and the second color, respectively. Color difference ranges from 0 to 765.

Figure 2 shows the example results of contrast ratio of 3:1 and 7:1 for black text. The higher the value of contrast ratio is, the better visual discrimination we have.

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contrast ratio of 3:1

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contrast ratio of 7:1

Figure 2. The example results in contrast ratios of 3:1 and 7:1.

Next (the process in the middle part of Figure 1), the colors are investigated in chroma ( $C_{ab}^*$ ) and lightness ( $L^*$ ) of CIELAB color space. The CIELAB color space is a perceptually uniform color space defined by the International Commission on Illumination (CIE) in 1976 that describes colors in terms of lightness ( $L^*$ ), and chromaticity ( $a^*$  and  $b^*$ ). This means that the distance between two points in CIELAB corresponds approximately to the perceived difference in color between those two points. CIELAB is designed to be relatively independent of the specific device or lighting conditions. For chroma, it is a component of chromaticity which specifically refers to the saturation or intensity of a color. A high chroma indicates a vivid and saturated color, while low chroma suggests a duller, more neutral color. The chroma is calculated from  $a^*$  and  $b^*$  in CIELAB system by using Equation (5). The colors with at least 50% of the maximum values for both chroma and lightness are passed to the next step, i.e.,  $C_{ab}^* \geq 64$  and  $L^* \geq 50$ .

$$C_{ab}^* = \sqrt{a^{*2} + b^{*2}} \quad (5)$$

Then the colors are separated in hues of red, orange, yellow, green, blue and violet. After that (the process in the right part of Figure 1), the algorithm starts to find the group colors (C) in each of these hues by first seeking for the starting color (SC). Figure 3 illustrates the process to find the starting color (SC). In the same hue group, the colors with minimum  $L^*$  ( $L^* = L_{min}^*$ ) are selected to find the color with minimum hue ( $h = h_{min}$ ) and minimum chroma ( $C_{ab}^* = C_{ab_{min}}^*$ ), respectively for the first SC. Next, the algorithm looks for the next three hue values in a positive direction. If they are found and less than maximum hue ( $h_{min} + 3 < h_{max}$ ), the minimum hue will be updated ( $h_{min} = h_{min} + 3$ ) and then find the minimum chroma ( $C_{ab}^* = C_{ab_{min}}^*$ ) to obtain the next SC till the criteria is not satisfied. The last SC will be the color of maximum hue ( $h = h_{min}$ ) with minimum chroma ( $C_{ab}^* = C_{ab_{min}}^*$ ). At this stage, we will obtain the starting colors of the hue group in order to find the group colors in the next stage.

Figure 4 shows the algorithm to process each starting color (SC) for finding the group colors (C). The colors

from the same hue group are calculated for delta  $E_{ab}^*$  ( $\Delta E_{ab}^*$ ) and lightness difference (delta  $L^*$  or  $\Delta L^*$ ) with each SC in CIELAB color space.

Delta  $E_{ab}^*$  is a kind of color difference perceived by humans (color difference in sensation) which is determined by the color distance measuring the change in visual perception of two colors as shown in Equation (6).

$$\Delta E_{ab}^* = \sqrt{(L_2^* - L_1^*)^2 + (a_2^* - a_1^*)^2 + (b_2^* - b_1^*)^2} \quad (6)$$

Where,  $L_1^*$ ,  $a_1^*$ ,  $b_1^*$  and  $L_2^*$ ,  $a_2^*$ ,  $b_2^*$  are the values of lightness ( $L^*$ ),  $a^*$  and  $b^*$  in CIELAB color space of the first and the second colors, respectively.

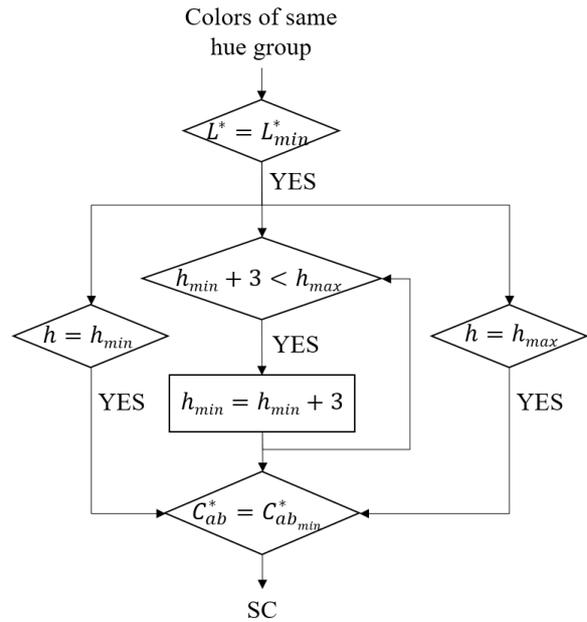


Figure 3. The process of finding starting color (SC) from the colors of same hue group.

The colors that have the same hue value with SC and have  $\Delta E_{ab}^*$  at least 5 and  $\Delta L^*$  at least 1, will be processed to filter only the minimum  $\Delta L^*$  ( $\Delta L^* = \Delta L_{min}^*$ ).

The threshold of color distance ( $\Delta E_{ab}^*$ ) is set to 5 to differentiate the difference in sensation of colors in the same group.

Then, the color with minimum  $\Delta E_{ab}^*$  ( $\Delta E_{ab}^* = \Delta E_{ab_{min}}^*$ ) will be the member of group colors. The process updates the SC with the latest member of group colors ( $SC = C$ ) and repeats the process of calculating  $\Delta E_{ab}^*$  and  $\Delta L^*$  till no color is found for the new SC. In the case that there is no color satisfied the minimum criteria of  $\Delta E_{ab}^*$  and  $\Delta L^*$ , the hue value is expanded to  $h_{SC} + 2$  for more similar colors to repeat the process of criteria of  $\Delta E_{ab}^*$  and  $\Delta L^*$ .

The lightness difference ( $\Delta L^*$ ) in this process is varied from 1 to 4 for level of color variation within the color group.

We do the process for all the rest minimum  $\Delta L^*$ , i.e., at least 2, 3, 4 and consequently obtain the sequential member colors for color groups that originate from each SC of the process of “Finding Starting Color” in Figure 1. All the group colors for minimum  $\Delta L^*$  of 1, 2, 3, 4 are finalized (the last process of “Finalize Color Palettes” in Figure 1) to find the final color palette by separating into a number of color levels in each color group. If the numbers of color levels are the same, the highest and high  $\Delta L^*$  will be selected. If the highest or high  $\Delta L^*$  are the same, the more flexible color group, i.e., compatible with more color levels and compatible within group color will be chosen.

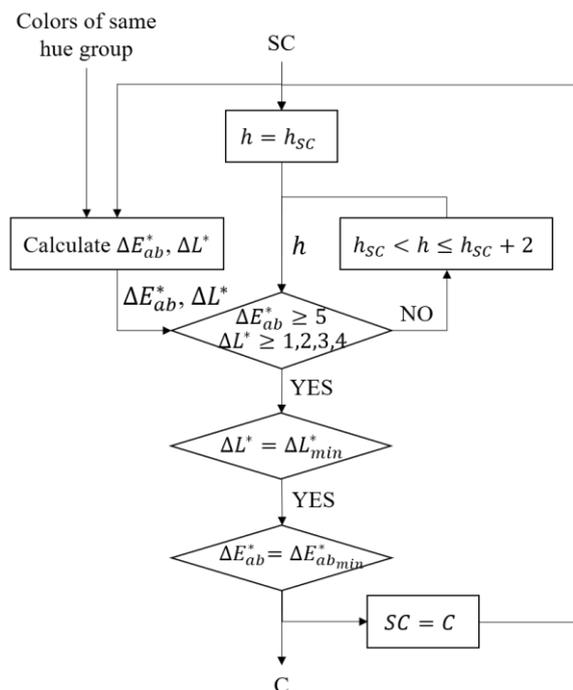


Figure 4. The algorithm of finding group colors (C).

### 3. Results and Discussion

According to the proposed approach, the 8-bit sRGB colors are calculated for the color information comparing to the black color (black text). The total of 16,777,216 ( $2^{24}$ ) colors as the input to the process are filtered out with brightness difference, color difference, contrast ratio, chroma and lightness to be 404,502 colors for the elderly (minimum contrast ratio of 7) and 600,087 colors for normal vision people (minimum contrast ratio of 3). The results of color palettes categorized by the number of different levels in group color for the elderly and normal vision people are summarized in Figure 5 and Figure 6, respectively.

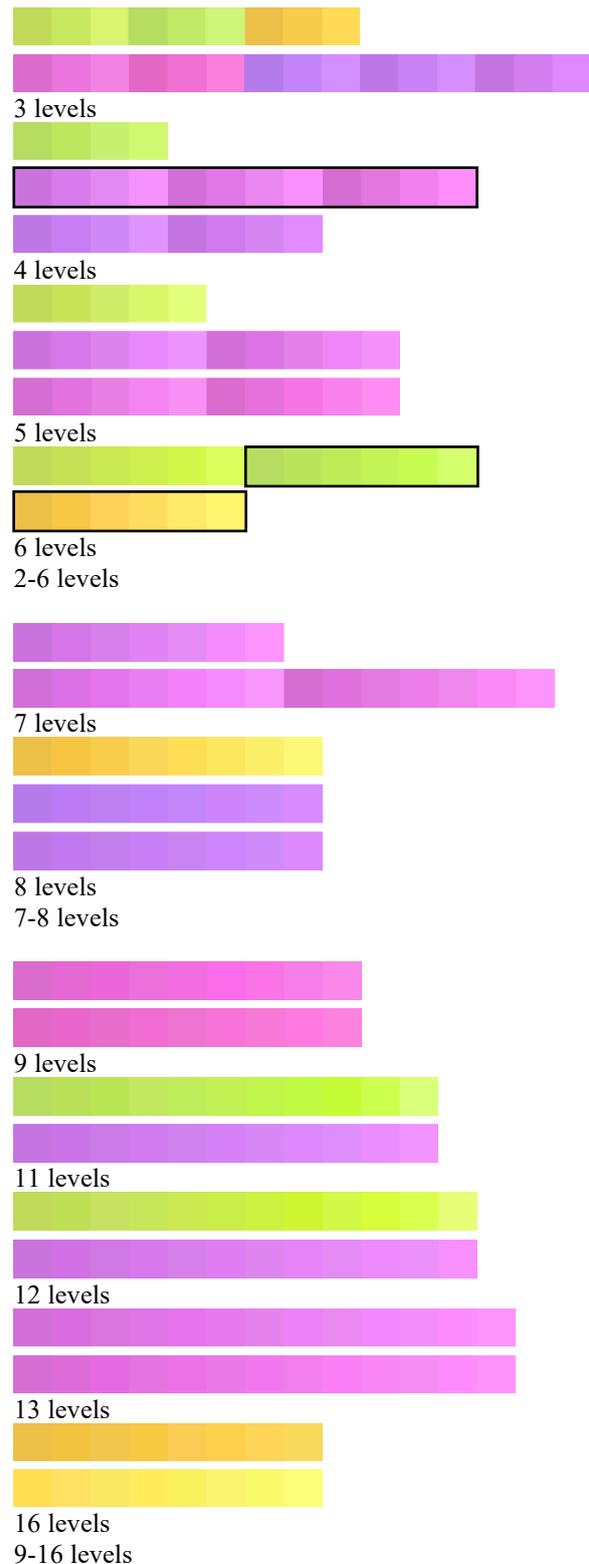


Figure 5. Color palettes of different numbers of levels in group color for the elderly.

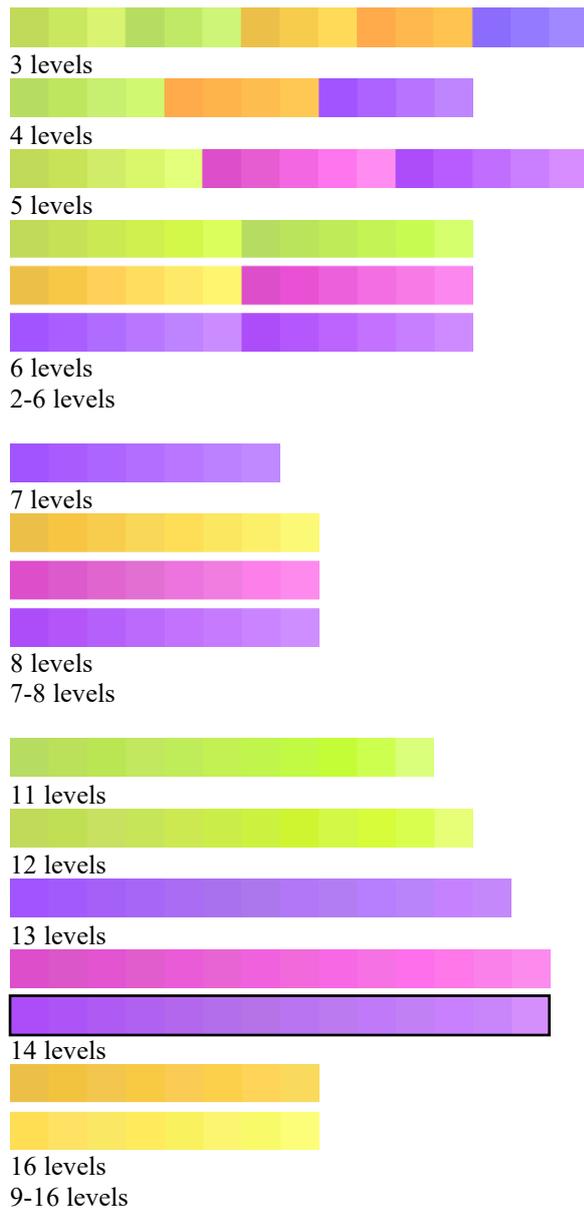


Figure 6. Color palettes of different numbers of levels in group color for normal vision people.

Table 1 illustrates the example of color information shown in Figure 5, i.e., violet 4 levels (the middle color palette in 4 levels shown with black border), green and orange 6 levels (the last 12 colors of color palette in 6 levels shown with black border) for the elderly, and the color information shown in Figure 6 of violet 14 levels (the bottom color palette in 14 levels with black border) for normal vision people. We can see that the contrast ratio (CR), color difference (CD), brightness difference (BD), lightness ( $L^*$ ), chroma ( $C_{ab}^*$ ) and  $\Delta E_{ab}^*$  are all satisfied by the criteria. For  $\Delta L^*$ , this example shows the highest  $\Delta L^*$  of color levels for the first 12 colors in Table 1, i.e., minimum  $\Delta L^*$  of 4. From the example of these violet 4 levels, we can see that each starting color has three differences in hue value, i.e., 145, 148, 151, respectively with the same minimum lightness of 61.57.

In green 6 levels shown in Table 1, the same hue value of 39 can produce the colors that satisfy all criteria. However, in orange 6 levels, the algorithm needs to expand the hue within two more values in a positive direction for more similar colors to satisfy the criteria, i.e., 22, 24, 26, 28, respectively.

When the number of color levels increases, the lightness difference ( $\Delta L^*$ ) usually decreases in order to obtain more satisfied color variations as shown in violet 14 levels (the last 14 colors in Table 1). The value of  $\Delta L^*$  is reduced to 1.18 with  $\Delta E_{ab}^*$  of 5.14 for most of colors in the group.

Table 1. The example of color information for violet 4 levels, green and orange 6 levels for the elderly, and violet 14 levels for normal vision people.

Color information of the example color palettes for the elderly.													
R	G	B	CR ≥ 7	CD ≥ 500	BD ≥ 125	H	L* ≥ 50	a*	b*	C <sub>ab</sub> ≥ 64	ΔE <sub>ab</sub> * ≥ 5	ΔL*	Color
202	115	221	7.01	538	153.10	145	61.57	51	-40	64.82	89.40	61.57	
216	124	235	8.00	575	164.16	145	65.88	53	-42	67.62	5.16	4.31	
227	137	244	9.15	608	176.11	145	70.20	51	-40	64.82	5.16	4.31	
244	147	254	10.45	645	188.20	147	74.51	53	-38	65.22	5.16	4.31	
210	111	216	7.01	537	152.57	148	61.57	54	-37	65.46	89.86	61.57	
223	120	230	7.97	573	163.34	148	65.88	56	-39	68.24	5.16	4.31	
234	134	240	9.17	608	175.98	148	70.20	54	-37	65.46	5.16	4.31	
249	144	255	10.46	648	188.05	148	74.51	56	-39	68.24	5.16	4.31	
213	110	211	7.00	534	152.31	151	61.57	54	-35	64.35	89.06	61.57	
228	118	224	7.97	570	162.97	151	65.88	57	-35	66.89	5.25	4.31	
243	128	239	9.15	610	175.04	151	70.20	59	-37	69.64	5.16	4.31	
254	142	249	10.45	645	187.69	151	74.51	57	-35	66.89	5.16	4.31	
182	221	97	13.50	500	195.20	39	83.14	-31	56	64.01	104.92	83.14	
186	228	92	14.34	506	199.94	39	85.49	-33	60	68.48	5.05	2.35	
191	235	89	15.24	515	205.20	39	87.84	-35	64	72.95	5.05	2.35	
195	243	85	16.27	523	210.64	39	90.20	-37	68	77.41	5.05	2.35	
200	251	82	17.38	533	216.49	39	92.55	-39	72	81.88	5.05	2.35	
213	255	109	18.35	577	225.80	39	94.90	-34	64	72.47	9.72	2.35	
236	192	72	12.20	500	191.48	22	79.61	4	64	64.12	102.22	79.61	
246	200	70	13.27	516	198.93	22	82.75	4	68	68.12	5.08	3.14	
255	209	89	14.52	553	209.07	22	85.88	4	64	64.12	5.08	3.14	
255	221	95	15.76	571	216.80	24	89.02	-2	64	64.03	6.77	3.14	
254	234	104	17.18	592	225.16	26	92.16	-8	64	64.50	6.77	3.14	
255	245	111	18.54	611	232.71	28	95.29	-13	64	65.31	5.90	3.14	
Color information of the example color palettes for normal vision people.													
R	G	B	CR ≥ 3	CD ≥ 500	BD ≥ 125	H	L* ≥ 50	a*	b*	C <sub>ab</sub> ≥ 64	ΔE <sub>ab</sub> * ≥ 5	ΔL*	Color
173	77	250	5.22	500	125.43	137	52.94	68	-70	97.59	111.03	52.94	
173	84	246	5.38	503	129.08	137	54.12	64	-67	92.66	5.14	1.18	
175	91	243	5.61	509	133.44	137	55.29	61	-63	87.69	5.14	1.18	
177	97	240	5.84	514	137.22	137	56.47	57	-60	82.76	5.14	1.18	
179	103	236	6.07	518	140.89	137	57.65	54	-56	77.79	5.14	1.18	
179	110	235	6.35	524	144.88	137	58.82	50	-53	72.86	5.14	1.18	
181	115	231	6.57	527	147.96	137	60.00	47	-49	67.90	5.14	1.18	
185	116	241	6.83	542	150.88	137	61.18	50	-53	72.86	5.14	1.18	
187	122	239	7.14	548	154.77	137	62.35	47	-49	67.90	5.14	1.18	
192	122	249	7.39	563	157.41	137	63.53	50	-53	72.86	5.14	1.18	
194	128	245	7.70	567	161.07	137	64.71	47	-49	67.90	5.14	1.18	
200	128	255	7.99	583	164.01	137	65.88	50	-53	72.86	5.14	1.18	
201	134	251	8.29	586	167.37	137	67.06	47	-49	67.90	5.14	1.18	
213	143	253	9.18	609	176.47	139	70.20	46	-45	64.35	5.18	3.14	

Figure 7 shows the example of 3D plot in CIELAB color space of violet 14 levels for normal vision people (the last 14 colors in Table 1) where  $L^*$  is increased according to the minimum threshold  $L^*$ .

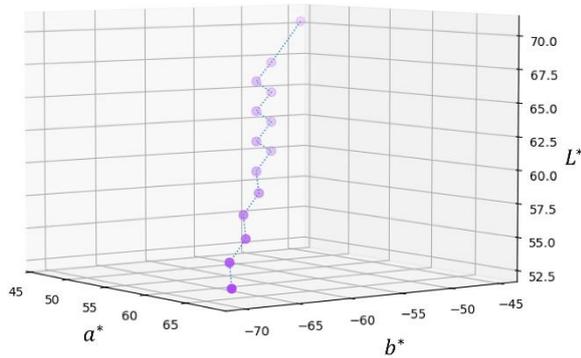


Figure 7. 3D plot of violet 14 levels in CIELAB color space.

The examples of grayscale palettes of green and orange 6 levels for the elderly in Table 1 are shown in Figure 8 with their lightness ( $L^*$ ) and contrast ratio (CR). Where, the grayscale is calculated by Equation (7). In our case, the color palette is compared with black color (text color) so the contrast ratio is proportional to the lightness ( $L^*$ ).

$$\text{grayscale} = 0.299R + 0.587G + 0.114B \quad (7)$$

Where,  $R, G, B$  are the values of red, green and blue in 8-bit sRGB color space with values of 0-255, respectively.

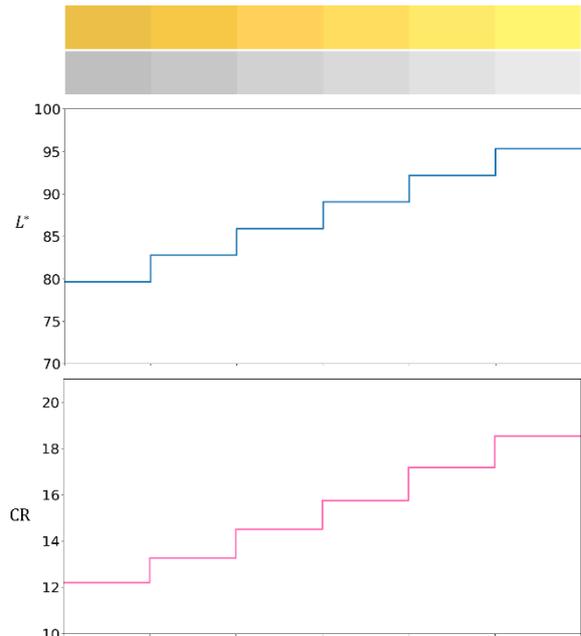
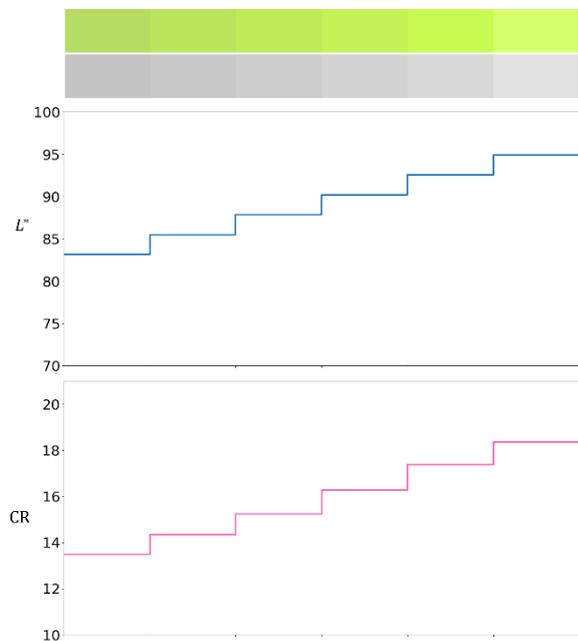


Figure 8. The grayscale palettes of green and orange 6 levels for the elderly in Table 1 with lightness and contrast ratio.

Figure 9 shows the use of color palette as background color with black text for violet 4 levels (the first 4 colors highlighted with red border in Table 1), green and orange 6 levels in Table 1 with contrast ratio (CR).

Black text on background color of color palette	CR
Reject due to quality	7.01
Reject due to similarity	8.00
Reject due to IEEE scope	9.15
Reject due to conference scope	10.45
Similarity checking	12.20
Blinding	13.27
2 <sup>nd</sup> round – can assign reviewer	14.52
2 <sup>nd</sup> round – under review	15.76
1 <sup>st</sup> round – can assign reviewer	17.18
1 <sup>st</sup> round – under review	18.54
Accept with major revision	13.50
Accept with minor revision	14.34
Accepted	15.24
Official Acceptance	16.27
Registered	17.38
Published	18.35

Figure 9. The example use of color palette as the background color of black text.

The text color can be discriminated against the background color. The higher the value of the contrast ratio is, the better discrimination between text and background we recognize.

The background colors of the same group information can be discriminated while keeping analogous color appearing on its group information. We can also easily distinguish colors between group information with smooth differentiation within the group of information. The results of color palettes for the elderly and normal vision people in Figures 5 and 6 are summarized in the link (<https://shorturl.at/emz9Z>) with RGB values for the usage. The results are separated into 6 sheets, i.e., 3 sheets for the elderly and other 3 sheets for normal vision people. The application used for normal vision people can also select the color palettes from the elderly sheets while the application used for the elderly is recommended to select the color palettes only from the elderly sheets. The proposed color palettes perform the color discrimination and categorization for the application of communicating hierarchical structure or multiple levels of information. Figure 10 shows example of using colors from the color palette for normal vision people to classify sound levels in decibel. The orange tone should be avoided due to hearing damage. Figure 11 shows another example of using color palette for the elderly to provide the information of blood lipid levels. All of these examples could be applied in infographic design or visual representation of data in website to facilitate effective information communication.

Extremely Loud	140 dB Fireworks, Rocket Launch
	130 dB Jet Engine
	120 dB Police Siren
	110 dB Trombone
Very Loud	100 dB Helicopter
	90 dB Hair Dryer
	80 dB Truck
Loud	70 dB Car
Moderate	60 dB Chat
	50 dB Rain
Faint	40 dB Refrigerator
	30 dB Whisper
	20 dB Rustle of Leaves
	10 dB Breath
	0 dB

Figure 10. The example use of color palette for normal vision people to classify sound levels in decibel.

Lipids	Blood Lipid Levels (mg/dL)		
	Normal	Abnormal	Dangerous
Female-HDL	>40	<40	<40
Male-HDL	>50	<40	<40
LDL	≤130	>130	>160
Triglyceride	≤150	>150	>200
Total Cholesterol	≤200	>200	>240

Figure 11. The example use of color palette for the elderly to provide the information of blood lipid levels.

The efficacy of the color palette will be further investigated through future experiments involving its application in real-world scenarios, with participants including both normal vision and the elderly.

## 4. Conclusion

Color palettes are fundamental tools for visual communication and aesthetic creation, helping to evoke emotions, convey information, and establish consistent visual styles across a multitude of applications. Therefore, we proposed the color palettes to aid understanding and memory for representing complex data. The proposed algorithm to generate the color palettes is based on contrast ratio, lightness, chroma, hue, color distance, color and brightness differences to ensure clarity and readability for the elderly and normal vision people. The colors are employed to differentiate and categorize information for providing clear visual cues. The results enhance the visual experience across digital media, content, printing, and user interfaces, with particular significance for the visual representation of group information, notably in the context of status management and informational categorization.

## References

- [1] M. Hencová and V. Kotradyová, "Colour in the environment for older adults," *Architecture Papers of the Faculty of Architecture and Design STU*, vol. 28, pp. 15-23, 2023, doi: 10.2478/alfa-2023-0021.
- [2] Y. Liu, J. Kang, Y. Zhang, D. Wang, and L. Mao, "Visual comfort is affected by urban colorscape tones in hazy weather," *Frontiers of Architectural Research*, vol. 5, pp. 453-465, 2016, doi: 10.1016/j.foar.2016.10.001.
- [3] A. Torres, J. Serra, J. Llopis, and A. Delcampo, "Color preference cool versus warm in nursing homes depends on the expected activity for interior spaces," *Frontiers of Architectural Research*, vol. 9, pp. 739-750, 2020, doi: 10.1016/j.foar.2020.06.002.

- [4] M. Wijffelaars, R. Vliegen, J. J. Van Wijk, and E.-J. Van Der Linden, "Generating color palettes using intuitive parameters," In Proc. 10th Joint Eurographics / IEEE - VGTC Conference on Visualization, 2008, pp. 743–750.
- [5] J. Rael, "Colormoo: An algorithmic approach to generating color palettes," Senior thesis, Claremont McKenna College, Claremont, CA, 2014.
- [6] J. Delon, A. Desolneux, J.-L. Lisani, and A. B. Petro, "Automatic color palette," *Inverse Problems and Imaging*, vol. 1, no. 2, 2007, pp. 265-287, doi: 10.3934/ipi.2007.1.265.
- [7] P. Weingerl, A. Hladnik, and D. Javoršek, "Development of a machine learning model for extracting image prominent colors," *Color Research & Application*, 2020, doi: 10.1002/col.22485.
- [8] P. Weingerl, "Automated image-based user interface color theme generation," *Applied Sciences*, vol. 14, 2024, doi: 10.3390/app14072850.
- [9] R. M. Karim, T. Jeong, H. Ha, J. Ho, K. Lee, and H. J. Shin, "Improving user experience of color palette extraction by using interactive visualization based on hierarchical color model," *International Journal of Human-Computer Studies*, vol. 169, 2023, doi: 10.1016/j.ijhcs.2022.102924.
- [10] T. Chou and J.-Y. Shao, "Color palette generation of mixed color images using autoencoder," *Sensors and Materials*, vol. 36, no. 1, pp. 135-146, 2024, doi: 10.18494/SAM4537.
- [11] S.-C. Huang, "An efficient palette generation method for color image quantization," *Applied Sciences*, vol. 11, no. 3, 2021, doi: 10.3390/app11031043.
- [12] Adobe color. "Color wheel." Accessed: Apr. 10, 2025. [Online]. Available: <https://color.adobe.com/create/color-wheel>
- [13] F. Bianchi, "Coolors." Accessed: Apr. 10, 2025. [Online]. Available: <https://coolors.co>
- [14] ColorBox. Accessed: Apr. 10, 2025. [Online]. Available: <https://colorbox.io>
- [15] G. Aisch, "Colorpicker for data." Accessed: Apr. 10, 2025. [Online]. Available: <https://tristen.ca/hcl-picker/#/hcl/15/1.05/E7F76A/848C38>
- [16] C. Gramazio, "Colorgorical." Accessed: Apr. 10, 2025. [Online]. Available: <http://vrl.cs.brown.edu/color>
- [17] Paletton. Accessed: Apr. 10, 2025. [Online]. Available: <https://paletton.com>
- [18] Leonardo. Accessed: Apr. 10, 2025. [Online]. Available: <https://leonardocolor.io/theme.html>
- [19] Canva. Accessed: Apr. 10, 2025. [Online]. Available: <https://www.canva.com/colors/color-palette-generator>
- [20] Web Content Accessibility Guidelines (WCAG) 2.0. Accessed: Apr. 10, 2025. [Online]. Available: <https://www.w3.org/TR/WCAG20>