Still Not Readable? An Interactive Tool for Recommending Color Pairs with Sufficient Contrast based on Existing Visual Designs

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ABSTRACT
Most contrast checking tools allow designers to verify if a set of colors satisfy the minimum contrast requirements for text and background colors. However, such tools usually do not provide the designer with any clues on how the colors should be adjusted to ensure enough contrast. This demo shows our web-based contrast tool which suggests how existing set of colors could be adjusted to satisfy minimum contrast requirements while maintaining the gist of the original visual design.

Author Keywords
Web design; low vision; color contrast; readability.

CSS Concepts
• **Human-centered computing~Graphical user interfaces**

INTRODUCTION
Enough contrast between the text in the foreground and the background is a prerequisite for perceiving text visually. Contrast can be explained as the difference between two colors. Enough contrast is necessary for all users, but the contrast requirements are increasingly stringent when viewed with reduced visual acuity or with color vision deficiencies, or when viewed under unfavorable lighting conditions such as reading printed text in the dark, reading dim displays or glossy displays with glare due to reflections. More contrast is also needed with smaller fonts compared to text with larger fonts. Accessibility audits of public websites show that a lack of contrast is still a common challenge despite well-defined minimum criteria [2, 11] such as the criteria outlined in W3C WCAG [16]. One may speculate that one reason for lack of color contrast is the absence of suitable design tools. Most design tools do not have built in contrast checking mechanisms [17], and the special purpose contrast checking tools that are commonly used are mostly performing validating, giving a pair of colors a pass or fail.

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We implemented a web-based tool that intends to stimulate designers to more easily select text-background colors pairs that adhere to minimum contrast requirements while maintaining the original visual profile. The designer uploads a snippet of the design as an image. The tool analyses the image and identifies the foreground and background colors and next suggest alternative color pairs that adhere to minimum contrast levels.

RELATED WORK
The literature on interfaces for color selection is limited. Documented studies include the exploration of bimanual color selection [4], a study of the effects of visual color representations in color pickers [1, 3], color palettes that compensate for color blindness [15], interfaces for making color schemes [5, 6] and comparing colors under different lighting conditions [7].

Tools with built in contrast checking support has also been proposed where valid colors are highlighted after a first color has been selected based on the RGB-color space [9, 12], HSV color space [10, 13], CIElab [8]. ACE is another tool based on similar ideas [14]. None of the existing tools suggest how to correct an existing color profile.

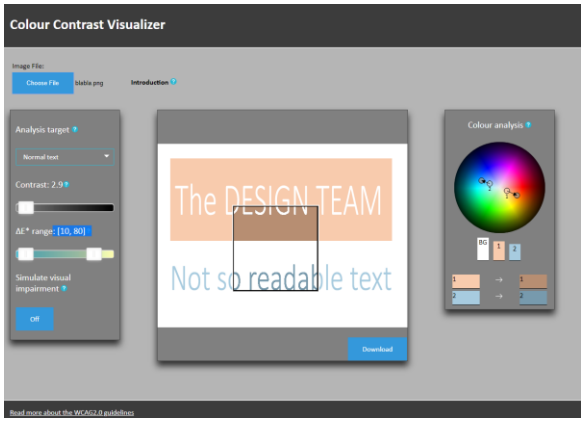

Figure 1. The contrast tool with a design snippet loaded and contrast corrected area (contrast level 3).

THE CONTRAST TOOL
For practical reasons colors are represented using the hue, saturation and brightness (HSB) model. The tool assumes

that the perception of a color scheme and a color identify predominantly depends on the hue choices. The most widely used color schemes include monochrome (one hue), analogous (approximately 30 degrees hue difference between colors), complementary (180 degrees difference in hue) and triads (90 degrees hue difference). The hue values are thus fixed while the contrast levels are corrected by adjusting the intensity and saturation levels of the color pairs. The adjusted colors are found by searching the color space for the closest colors with brightness and saturation settings for a given hue pair that results in the required contrast level according to the WCAG2.1 guidelines [16].

The tool design goals were convenience and simplicity of use and data transparency of the color correction. We therefore implemented the contrast tool as a browser application using JavaScript allowing it to easily run on most computing platforms. The user first loads a snippet of the design (see Figure 1) and then specifies the desired luminosity level as defined in WCAG [16]. The tool analyses the image and identifies the most prevalent color as the background, and other colors as foreground text. These identified colors are displayed as a color palette as well as on a color wheel. The tool displays the loaded design snippet with a rectangular box showing the resulting design with the proposed corrections applied to the original design. The user can move this rectangle to explore the effect of the change throughout the design snippet.

Figure 2. A low contrast design snippet.

The movable preview is intended for working with several color contrast pairs in the same design. The original snippet used in this example is shown in Figure 2, namely a complementary color scheme with white text on a pastel orange background and blue text on a white background.

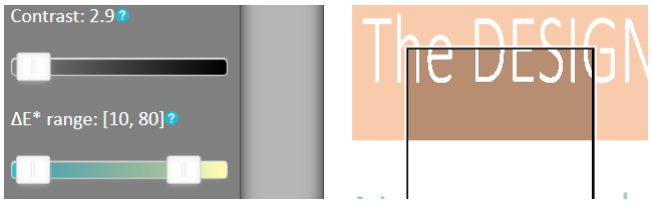

Figure 3. Increasing the contrast level to 7 results in stronger corrections.

The user may also interactively alter the contrast level. Figure 3 shows the effect of increasing the luminosity from 3 to 7. The suggested contrast corrections are updated accordingly. Consequently, the pastel orange has become dark brown and the light blue has become dark blue.

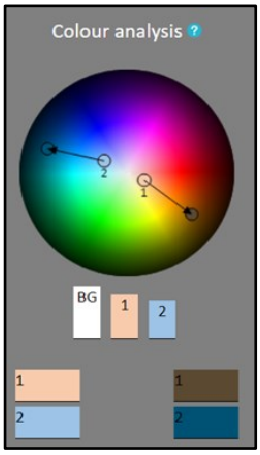

Figure 4. Color space visualization of contrast corrections, proportion of colors in the design and original colors (left) and corrected color samples (right).

The tool shows the palette of identified colors together with the proposed contrast corrected colors (see Figure 4). By hovering over these colors, the designer gets more detailed information about the colors including the color vector and contrast information (see Figure 5).

Figure 5. Browsing details about the colors by hovering over the color samples.

The suggested contrast corrections preserve the hues of the original colors while searching for brightness settings that makes the result satisfy minimum contrast requirements. If no brightness setting results in a satisfactory contrast level the search continues along the saturation dimension. Figure 4 also shows how this process is visualized using a color wheel with brightness along the radial direction. The arrows show the connections between the original colors and the corrected colors. In this example both colors should be made darker while maintaining their hues.

CONCLUSIONS

An interactive color contrast tool was presented. The tool helps the designer adjust existing color choices such that they adhere to minimum color contrast requirements. Our goal is to achieve more accessible webpages by providing designers with better tools. The current tool is exclusively visual. Future work involves making a non-visual color contrast tool that can be used with a screen reader. The tool can be found at https://www.cs.hioa.no/~frodes/ccv.

REFERENCES

[1] Kristian Brathovde, Mads Brændeland Farner, Fredrik Krag Brun, and Frode Eika Sandnes. 2019. Effectiveness of Color-Picking Interfaces among Non-Designers, In *Proceedings of the 16th International Conference on Cooperative Design, Visualization and Engineering 2019* (CDVE 2019), LNCS, Springer, (in press).

[2] Agency for Public Management and eGovernment (Difi). 2014. Digital barriers on Norwegian web pages 2014. Retrieved August 6, 2009 from https://uu.difi.no/tilsyn/statistikk-og-undersokelser/digitale-barrierar-pa-norske-nettstader-2014

[3] Sarah A. Douglas and Arthur E. Kirkpatrick. 1999. Model and representation: the effect of visual feedback on human performance in a color picker interface. *ACM Trans. Graph.* 18, 2 (April 1999), 96-127. DOI: http://dx.doi.org/10.1145/318009.318011

[4] Berto Gonzalez and Celine Latulipe. 2011. BiCEP: bimanual color exploration plugin. In *CHI '11 Extended Abstracts on Human Factors in Computing Systems* (CHI EA '11). ACM, New York, NY, USA, 1483-1488. DOI: https://doi.org/10.1145/1979742.1979795

[5] Barbara J. Meier, Anne Morgan Spalter, and David B. Karelitz. 2004. Interactive color palette tools. *IEEE Computer Graphics and Applications* 24, 3 (2004), 64-72. DOI: https://doi.org/10.1109/MCG.2004.1297012

[6] Giovanni Moretti and Paul Lyons. 2002. Tools for the selection of colour palettes. In *Proceedings of the SIGCHI-NZ Symposium on Computer-Human Interaction* (CHINZ '02). ACM, New York, NY, USA, 13-18. DOI: http://dx.doi.org/10.1145/2181216.2181219

[7] Katharina Reinecke, David R. Flatla, and Christopher Brooks. 2016. Enabling Designers to Foresee Which Colors Users Cannot See. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems* (CHI '16). ACM, New York, NY, USA, 2693-2704. DOI: https://doi.org/10.1145/2858036.2858077.

[8] Frode Eika. Sandnes. 2016. Understanding WCAG2.0 color contrast requirements through 3D color space visualization. *Studies in health technology and informatics* 229 (2016), 366-375. DOI: https://doi.org/10.3233/978-1-61499-684-2-366

[9] Frode Eika Sandnes. 2017. On-screen colour contrast for visually impaired readers. In: *Information Design: Research and Practice.* Alison Black, Paul Luna, Ole Lund and Sue Walker (eds.). Routledge, 405-416.

[10] Frode Eika Sandnes. 2018. An image-based visual strategy for working with color contrasts during design. In *Proceedings of the International Conference on Computers Helping People with Special Needs* (ICCHP), LNCS Vol. 10896, Springer, Cham, 35-42. DOI: https://doi.org/10.1007/978-3-319-94277-3_7

[11] Frode Eika Sandnes. 2018. *Universell utforming av IKT-systemer* (2nd. ed.). Universitetsforlaget, Oslo.

[12] Frode Eika Sandnes and Anqi Zhao. 2015. An interactive color picker that ensures WCAG2. 0 compliant color contrast levels. *Procedia Computer Science* 67 (2015), 87-94. DOI: https://doi.org/10.1016/j.procs.2015.09.252

[13] Frode Eika Sandnes and Anqi Zhao. 2015. A contrast colour selection scheme for WCAG2.0-compliant web designs based on HSV-half-planes. In *Proceedings of the 2015 IEEE International Conference on Systems, Man, and Cybernetics* (SMC 2015). IEEE, 1233-1237. DOI: https://doi.org/10.1109/SMC.2015.220

[14] Garreth W. Tigwell, David R. Flatla, and Neil D. Archibald. 2017. ACE: A Colour Palette Design Tool for Balancing Aesthetics and Accessibility. *ACM Trans. Access. Comput.* 9, 2, Article 5 (January 2017), 32 pages. DOI: https://doi.org/10.1145/3014588.

[15] Luigi Troiano, Cosimo Birtolo, and Maria Miranda. 2008. Adapting palettes to color vision deficiencies by genetic algorithm. In *Proceedings of the 10th annual conference on Genetic and evolutionary computation* (GECCO '08), Maarten Keijzer (Ed.). ACM, New York, NY, USA, 1065-1072. DOI: https://doi.org/10.1145/1389095.1389291

[16] W3C, WCAG2.1. Retrieved August 6, 2009 from https://www.w3.org/TR/WCAG21/

[17] Montgomery Webster. 2014. Integrating color usability components into design tools. *interactions* 21, 3 (May 2014), 56-61. DOI: https://doi.org/10.1145/2591512