

A Study on Colour Combination Guidelines for Text and Background in Web Legibility Perspective

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Abstract. Nowadays, webpages are widely used to disseminate information or as an online application to replace the old paper based form. Since webpages are flexible and simple for the web developer to design and use a variety of colour combinations, font types and font sizes, guidelines seem very important in helping a web designer to design an aesthetically appealing and legible webpage. However, the guidelines developed are based on earlier research that was mostly done using old Video Display Technologies (VDT). The latest generation of VDT is capable of displaying sharper images with its high-resolution technologies. The differences in the display technologies have made this area of research very important for a restudy. This paper will explore the current guidelines and determine what is necessary to ensure web text legibility through choosing the right colour combinations to be used as well as fonts and background colour.

Keywords: Webpage; Legibility; Guidelines; Colour combinations; Web text;

1 Introduction

Webpages are a collection of Extensible Markup Language (XML) like tags that are used to control how the contents should be displayed on web browsers. The webpage is very flexible so that web designers can choose a combination of a variety of colours for the fonts and backgrounds. Since designing a webpage is so flexible, many recommendations and guidelines are available to help webpage designers choose a suitable combination of colours to ensure the legibility of a webpage [3,22,23]. The legibility of a webpage is very important because it affects how useful the webpage is to the user. The previous eye tracking research done by Duckett [6] and Nielsen [15] supports this claim. Based on their research findings, users actually scan the webpage for the relevant contents or keywords. They then rate the webpage as not useful to them if they cannot find the relevant keywords about the information they are looking for [6,15]. One of the factors influencing

the web text legibility is the colour combination, which greatly influences the legibility and level of readability [14]. Nowadays, with VDT being capable of producing high quality and sharper images with its high-resolution technologies, this could provide more flexibility in the colour combinations compared to the existing guidelines. Therefore, the question of whether the existing guidelines are still valid, or, if not, what is the right guideline to be followed for these more advanced VDTs, still needs to be answered.

2 Literature Review

This paper focuses mainly on why choosing the right colour combination is very important and the existing guidelines available for the web designer.

2.1 Webpage Colour Combination

Previous research results [2,7,8,12,13,17,21,24] have proven that users usually prefer colours that have strong contrast, and, mostly, they prefer pure black and pure white. This colour combination is very good but limits the choices in making the web page aesthetically appealing.

The texts on screen are based on light waves. White is generated by a combination of equal intensities of red, green, and blue light waves, while black is the absence of these light waves [21]. The measurement for the light wave is in wavelength. The figure below shows the relationship between eye sensitivity and colour wavelength and colour luminosity.

Fig. 1: Relationship between eye sensitivity and colour wavelength and colour luminosity

From figure 1, green proves to be the most sensitive to our eyes while red and violet proves to be the least. A different wavelength means that the curvature of the lens in the human eye has to change accordingly. Blue and red colour combinations necessitate the eyes making constant changes in the lens curvature, which causes the eyes to tire quickly [21]. According to the literature exploration [2,9,12,20,21,7,5], there are two main factors in colour combinations that influencing legibility; colour contrast and colour polarity. Colour contrast is more focused on contrast ratio of relative luminance of the colours. On the other hand, colour polarities are divided into two types - negative polarity and positive polarity. Negative polarity is where the text colour is lighter than the background colour. For example, white on black while positive polarity is vice-versa.

Colour combination exploration has shown that choosing the right colour combination is very important not just for legibility but also for long screen reading duration.

2.2 Existing Guidelines for Webpage Colour Combinations

Considerable early research was done to determine the best colour combinations and the least legible colour combinations. Jacob Nielsen suggests that for optimal legibility, it requires colour combinations that have high contrast, such as black and white [7,16]. Albeit the results from earlier research supports this claim, this recommendation decreases the level of aesthetics and colour preferences as not everybody prefers black and white. This claim is proven based on the top 500 websites ranked by traffic data by Alexa, in which most of the webpages apply colours other than black and white as the main colours for the background and text [1].

A few of the existing standard guidelines indicate how to choose the best colour combinations for displaying the text and background on the screen. The World Wide Web Consortium (W3C) is an international community in which the member organisations, a full-time staff and the public, work together to develop a web standard. They developed the Web Content Accessibility (WCAG) guideline that covers a wide range of recommendations for making web content more accessible [3]. Referring to the guideline, WCAG suggests that the contrast ratio for the text and the background is at least 4.5:1. Equation (1) shows the formula for calculating the contrast ratio.

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

- L_1 is the relative luminance of the lighter colours, and
- L_2 is the relative luminance of the darker colours

The rationale for the ratio 4.5:1 is based on a 3:1 contrast colour ratio. For the minimum acceptable contrast for normal observers in the population, according to the ANSI standard and the empirical findings, a visual acuity of 20/40 is associated with a contrast sensitivity loss of roughly 1.5, thus requiring a contrast

ratio $3 * 1.5 = 4.5$ to 1 for 20/40 users [3]. Another organisation that is also researching and developing usability guidelines is UsabilityNet. This is a project funded by the European Union to provide resources and networking for usability practitioners, managers, and EU projects. By referring to their guidelines, patterned backgrounds are the worst choice since they make text difficult to read [23]. Usability.gov is another organisation that strongly supports this recommendation. Usability.gov is a website containing primary government sources for information concerning usability and user-centred design, and is managed by the U.S. Department of Health and Human Services. According to their findings, reading black text on a plain white background is up to 32% faster and they recommend using black text on a plain high contrast background [22]. Generally, a high-contrast between the text and background colour makes the reading task easier [7,16,22,23].

BLACK ON YELLOW
GREEN ON WHITE
RED ON WHITE
BLUE ON WHITE
WHITE ON BLUE
BLACK ON WHITE
YELLOW ON BLACK
WHITE ON RED
WHITE ON GREEN
WHITE ON BLACK
RED ON YELLOW
GREEN ON RED
RED ON GREEN

Fig. 2: Le Couriers table of legibility.

Another guideline that is focused on legibility is Le Couriers table of legibility; Figure 2. It is a well-established colour guideline suitable for printed materials. This guideline has been proved not suitable for Cathode Ray Tube (CRT) displays due to CRT is integrative colour computer displays [12]. In contrast, Liquid Crystal Display (LCD) is a subtractive colour computer display [20]. Nevertheless, the suitability of Le Couriers table of legibility as a guideline for LCD is still unknown. The results from the previous research can be used as guidance when selecting the best colour for the text and respective background. Based on the results it seems quite difficult to form a conclusion as to which colour combinations are best. However, based on Table 1 below, numerous researchers have come to the conclusion that black and white is the best colour

combination. Table 1 below summarises the method used in their research and the results.

Table 1: Summary of research done previously on colour combinations

Author(s)	Summary of method of studies	Results	
		Most Preferred Colour	Least Preferred Colour
Shieh and Lin (2000)	To rate text-background colour on a ten-point scale with the aesthetic appearance.	Blue on Yellow	Purple on Red
Camgoz et al. (2002)	To ask subjects to select the colour square they preferred from the 8 most saturated background colours presented.	Blue was the most preferred hue regardless of background shown. Foreground colour with maximum brightness and saturation levels were more preferred than any other colours.	
Shieh and Ko (2005)	To rate icon-background colour combinations on a five-point scale with subject preference.	Red on black	Cyan on green
Huang (2006)	To rate text-background colour combination on a five-scale with subject to preference.	Achromatic background colours with any text colours.	Saturated blue, or red background colours with any text colours.

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Table 1: Summary of research done previously on colour combinations

Author(s)	Summary of method of studies	Results	
		Most Preferred Colour	Least Preferred Colour
Huang (2012)	To rate icon-background colour combinations on a seven-point scale with subjective aesthetic preferences. The recommended colour combinations were those with high rating consistencies and high rating score.	Light cyan on dark green; yellow on dull blue; & dull green on pale green.	Dark green on greyish red; deep-greenish yellow on purple; greyish purple on dark purple; dark greyish yellow on dark green; light-greyish blue on strong purple; dark green on greyish-red; & greyish blue on dark green.
Erdogan (2008)	124 students to rate 45 web pages designed with a different combinations of fonts, font-sizes and a different combinations of back-ground/foreground colours on a five-point scale	Dark text on light background or black foreground with white background is the most preferred.	Dark text on dark background; & red on blue.
Kelly and Gregory (2011)	Participants with normal colour vision to rate combinations of 702 foreground/back-ground colours presented on PowerPoint slide on 3-point scale.	Dark text on light background or black foreground with white background is the most preferred.	Cyan on magenta; & green on red

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Table 1: Summary of research done previously on colour combinations

Author(s)	Summary of method of studies	Results	
		Most Preferred Colour	Least Preferred Colour
Relo and Marcos (2011)	By recording eye movements and questionnaire. Participants were asked to choose which colour combination they preferred	Prefer strong contrast. Pure black font with pure white background.	
Ferrari and Short (2002)	Participants answered a set of questionnaire and are given 3-point scale.	Black on white	Red on green
Buchner et al (2009)	Participants were asked to read a series of short stories and mark the error by clicking the word that had an error.	Positive polarity. Dark text with light background.	Negative polarity
Vanderschantz (2009)	Rate-of-error test conducted followed by four question survey	Black on white	Yellow on black
Timpany (2011)	Participants were presented with text with the same font and colour combination and were asked to make a comparison.	Black on white; & blue on white	Yellow on black

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Table 1: Summary of research done previously on colour combinations

Author(s)	Summary of method of studies	Results	
		Most Preferred Colour	Least Preferred Colour
Humar et al (2008)	Participants were asked to identify the characters displayed in the centre of the screen generated by multiple combinations of background and foreground colour combinations.	White on black	Yellow on white
			Concluded

3 Conclusion and Future Direction of Webpage Colour Design

Albeit there have been many studies in this area of research, most of the researchers used CRT displays as part of their experimental setup instead of LCD[2,7,8,12,13,17,21,24]. This, however, might mean that the results from the previous researches are not accurate when applied to the more advanced VDT, such as LCD, which can display images with very high resolution. Nevertheless, these sharp images can lead to other problems [10]. From the literature exploration, we found that black and white can be concluded as the best colour combination for webpage. Since LCD has many advantages compared to CRT displays in respect to weight, size, less environmental impact, and can display high resolution images, LCD is becoming more popular and many major computer manufacturing companies have stopped producing CRT displays. Consequently, whether the existing guidelines are still valid for use with these more advanced VDT is still unknown. We suggest that further research is required that focuses on VDT display capabilities, such as its high resolution. This is important since it visually provides a different visual experience compared to the old VDT. To test the current guidelines on font, font size, and colour combinations on a Full High Definition display requires a new research. Therefore, we would like to investigate whether the existing guidelines are still valid. Otherwise, a new study will be explored in developing a new guideline that is suitable for the new VDT.

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