Legibility of Web Page on Full High Definition Display

Conference Paper · December 2013

DOI: 10.1109/ACSAT.2013.108

CITATIONS
3

READS
4,333

3 authors, including:

Mazlina A. Majid
Universiti Malaysia Pahang
131 PUBLICATIONS **1,250** CITATIONS
SEE PROFILE

Balsam Abdul Jabbar Mustafa
Universiti Malaysia Pahang
26 PUBLICATIONS **46** CITATIONS
SEE PROFILE

Legibility Of Web Page On Full High Definition Display

Ahmad Affendi Hashim*, Mazlina Abdul Majid† and Balsam A. Mustafa‡
*†‡*Faculty of Computer Systems and Software Engineering*
Universiti Malaysia Pahang
Gambang, Pahang, Malaysia
**affendi.hashim@gmail.com*
†*mazlina@ump.edu.my*
‡*balsam@ump.edu.my*

***Abstract*—This paper explored the impact of legibility on full high definition (Full-HD) liquid crystal display (LCD) for video display terminal (VDT). A total of 117 participants were tested for legibility of 13 colour combinations based on more than 90-year-old Le Courier Table of Legibility. The participants first completed a survey online, then they were presented to a text designed using Wilkins Rate of Reading Test. The text is seeded with spelling errors in some of the words. The Participants then counted the number of words that have spelling errors, and recorded it to measure the legibility of the colour combinations. The results proved that Le Courier table of legibility is not suitable with the Full-HD LCD.**

***Keywords*-Web page; Legibility; Guidelines; Colour combinations; Web text;**

I. Introduction

Webpages are a collection of Extensible Markup Language (XML) like tags that are used to control the display of the content 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 [1], [2], [3]. 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 [4] and Nielsen [5] 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 [4], [5]. One of the factors influencing the web text legibility is the colour combination, which greatly influences the legibility and level of readability [6]. 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 raised is whether the existing guidelines are still valid. In case it is not, then what is the right guideline to be followed for these more advanced VDTs?

II. Web Page Colour Combinations

Previous research results [7], [8], [9], [10], [11], [12], [13], [14] 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 of 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 resulted from the absence of these light waves [13]. The measurement of the light wave is in wavelength. The figure 1 shows the relationship between eye sensitivity and colour wavelength and colour luminosity.

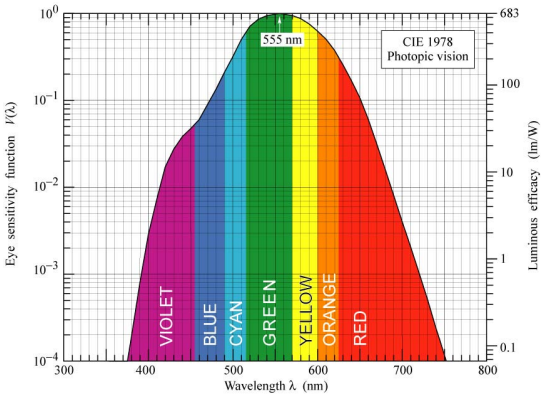

Figure 1. The Relationship Between Eye Sensitivity and Colour Wavelength and Colour Luminosity

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 to make constant changes in the lens curvature, which causes the eyes to tire quickly [13]. According to the literature [7], [15], [10], [16], [13], [8], [17], there are two main factors in colour combinations that influence 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.

III. Current Guidelines

Considerable research has been 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 [8], [18]. Albeit the results from earlier research support 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 [19].

UsabilityNet 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 [3]. 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 compared to other colour combinations and they recommend using black text on a plain high contrast background [2]. Generally, a high-contrast between the text and background colour makes the reading task easier [8], [18], [2], [3].

Figure 2. Le Courier 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 [10]. In contrast, Liquid Crystal Display (LCD) is a subtractive colour computer display [16]. Nevertheless, the suitability of Le Couriers Table of Legibility as a guideline for LCD is still unknown.

The rest of the paper is organized as follows: the following section describes the method used in this study, followed by the results and the discussion.

IV. Research Method

In this section, the experimental design, colour combination used, participants, apparatus, and the procedure used in the experiment will be discussed.

A. Experimental Design

This study examines the legibility of a webpage in terms of suitability of colour combinations for text and background. The research questions that this study tried to answer is: which colour combination is the most legible for reading web pages?

The participants were presented to a series of texts each with different colour combination. Every piece of text contains several spelling errors that participants have to identify and count. Spelling errors detected represent the dependent variable and it is used to determine the legibility of the colour combinations. The independent variable is a set of colour combinations in Le Couriers Table of Legibility.

B. Treatments with Colour Combinations

The colour combinations used in this experiment are based on Le Couriers Table of Legibility. The 13 Colour combinations in Le Couriers Table of Legibility are examined using randomly 5 sets of text, designed by using Wilkins Rate of Reading Test. The Wilkins Rate of Reading Test has been chosen because it is designed to make reading visually stress while minimizing the linguistic and semantics aspects of reading [20].

C. Participants

The experiment is conducted at Politeknik Sultan Haji Ahmad Shah (POLISAS) Pahang. A total of 117 students are randomly selected, with an average of 18 years old, and taking several Diploma programs offered by the Politeknik. All participants have normal vision or have been corrected to normal vision.

D. Set up

A computer lab at POLISAS is used in this experiment. The computers equip with 24” monitor configured to use 1920x1080 resolution. All computers have Internet connection. Students used the computers to access the online survey and the texts and to record the number of errors in the texts with different colour combinations.

E. Procedure

The experiment measured the legibility of different colour combinations through reading and visual inspection task.

The participants asked to identify the spelling errors in the text given. The value of spelling errors identified is used as the dependent variable to evaluate the legibility of the colour combination. The process has to be repeated for each 13-colour combinations.

V. Results

Legibility for each colour combination is measured based on the correctness percentage during the text inspection process, by the participants. The more, near to correct number of wrong words detected the higher score it achieved. Analysis of Variance (ANOVA) is used to analyse and determine the significant improvement by comparing the number of errors in the text for each colour combination. In this process, the ranking of the best and the worst colour combinations in terms of legibility and how significant the legibility performance for each colour combination determined.

A. Legibility Measures

The legibility score for each colour combination was analysed using ANOVA. Table I presents the mean and standard deviations values for the percentage of correctly identified spelling error words for all colour combinations.

Table I
THE MEAN AND STANDARD DEVIATIONS VALUES FOR THE PERCENTAGE OF CORRECTLY IDENTIFIED SPELLING ERROR WORDS FOR ALL COLOUR COMBINATIONS

Background/Text	Mean	Std. Deviation
Yellow and Black	85.48	12.301
White and Green	93.84	11.221
White and Red	88.30	13.208
White and Blue	87.70	13.162
Blue and White	86.96	12.424
White and Black	87.62	13.284
Black and Yellow	85.95	13.767
Red and White	85.22	11.873
Green and White	85.19	16.170
Black and White	87.33	11.721
Yellow and Red	85.53	12.767
Red and Green	78.46	16.589
Green and Red	85.31	14.535

The higher mean score means the closer to the real number of spelling error words. This will be the dependant variables to determined the legibility level for each colour combination. A closer look at the result reveals that White background with green, as the text colour is the best with error detection rate (93.84 $\pm$ 11.221 %) followed by white background and red text (88.30 $\pm$ 13.208 %) and white background and black text (87.62 $\pm$ 13.284 %). The worst colour combination is the Red background with Green text (78.46 $\pm$ 16.589 %). Further ANOVA analysis however, revealed the significant difference for each colour combination.

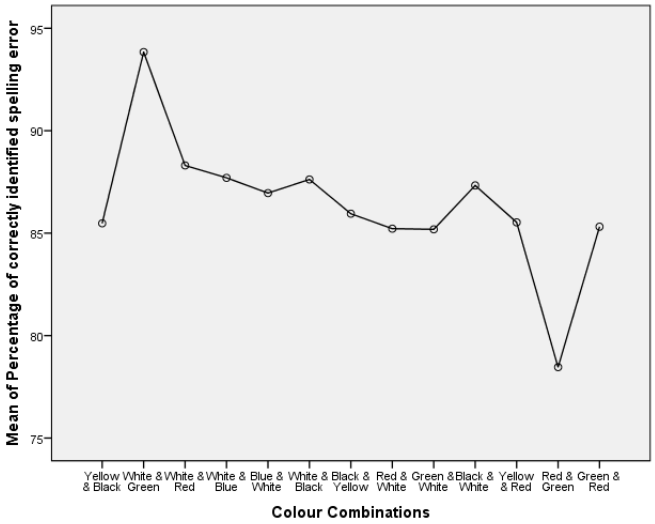

Figure 3. The Mean for Each Colour Combinations

Further ANOVA analysis revealed that there is no significant difference between colour combinations, except for Red and Green which is the worst colour combinations while White and Green and White and Red is the best colour combinations. Other colour combinations however have a mean value that is not significant between each others. Figure 3 is the graph representation for the mean for each colour combination.

VI. Discussion

This study investigates the impact of colour combinations on reading text on a web page. This study is focusing legibility of text presented. This study has proven two things; 1. Legibility is significantly affected by colour combinations although using the latest Full-HD LCD VDT. 2. The Le Couriers legibility table was not suitable to be used as reference when designing a web page.

The comparison between Le Couriers Table of Legibility, which still used until today, and the result from this study was presented in table II. A different order of colour combinations from this study and Le Courier table of legibility strongly suggests that the Full-HD LCD is more suitable to use the results obtained from this study.

VII. Conclusion and Future Work

This study proves that colour combination still influence greatly even on Full HD LCD VDT that is capable displaying sharper images with more pixels density. This study also proves that Le Courier table of legibility for subtractive colour does not suitably for the Full HD LCD VDT.

Table II
COMPARISON OF LEGIBILITY TABLE THIS STUDY AND LE COURIER

Background/Text	This Study	Le Courier
White and Green	1	2
White and Red	2	10
White and Blue	3	5
White and Black	4	6
Black and White	5	3
Blue and White	6	1
Black and Yellow	7	13
Yellow and Red	8	11
Yellow and Black	9	4
Green and Red	10	7
Red and White	11	12
Green and White	12	9
Red and Green	13	8

Future work, will be investigating colour combination and the colour contrast. The different of colour contrast could be influencing the result from this experiment. In future research, subjective preference for legibility, aesthetics and retention should also be consider. It will make it more interesting to include user preference and general experience to this study. With these suggestions, a more suitable guideline can be producing.

ACKNOWLEDGMENT

The author would like to thanks Mrs. Latifah Sisam Head of Department of Mathematics, Science, and Computer, Politeknik Sultan Haji Ahmad Shah and the lecturers under her Mrs. Norsidah Othman and Mrs. Faezah Mohd Sa'oad for their cooperation in completing the survey for this study.

REFERENCES

[1] B. Caldwell, M. Cooper, L. G. Reid, and G. Vanderheiden. (2008, December) Web content accessibility guidelines (wcag) 2.0. [Online]. Available: http://www.w3.org/TR/WCAG20/

[2] U.S. Dept. of Health and Human Services. (2008, August) The research-based web design and usability guidelines, enlarged/expanded edition. [Online]. Available: http://www.usability.gov/guidelines/

[3] Usability Net. Usabilitynet: Design guidelines for the web. [Online]. Available: http://www.usabilitynet.org/tools/webdesign.htm

[4] J. Duckett, *Beginning html, xhtml, css, and javascript*. Wrox, 2011.

[5] J. Nielsen, "User interface direction for the web," *Communication for the ACM*, vol. 42, no. 1, 1999.

[6] R. Kulkarni, S. S. Ambarkar, and S. Dixit, "Empirical analysis of colors in indian web applications," *International Journal of Computer Applications*, vol. 20, no. 4, 2011.

[7] A. Buchner, S. Mayr, and M. Brandt, "The advantage of positive text-background polarity is due to high display luminance," *Ergonomics*, vol. 52, no. 7, pp. 882–886, 2009.

[8] Y. Erdogan, "Legibility of websites which are designed for instructional purposes," *World Applied Sciences Journal*, vol. 3, no. 1, pp. 73–78, 2008.

[9] T. G. FERRARI and C. Short, "Legibility and readability on the world wide web," *Bigital, Argentina*, 2002.

[10] I. Humar, T. Turk *et al.*, "The impact of color combinations on the legibility of a web page text presented on crt displays," *International journal of industrial ergonomics*, vol. 38, no. 11, pp. 885–899, 2008.

[11] S. Kelly and T. Gregory, "Typography in human-computer interaction," *Group*, 2011.

[12] L. Rello and M.-C. Marcos, "An eye tracking study on text customization for user performance and preference," in *Web Congress (LA-WEB), 2012 Eighth Latin American*. IEEE, 2012, pp. 64–70.

[13] C. Timpany, "The affect of type and colour on readability in print and screen based environments," in *World Conference on Educational Multimedia, Hypermedia and Telecommunications*, vol. 2009, no. 1, 2009, pp. 797–806.

[14] N. Vanderschantz, C. Timpany, D. Whitehead, and W. D. Carss, "A small scale study into the effect that text & background colour has on processing and self-correction rates for childrens' on-screen reading," 2010.

[15] R. H. Hall and P. Hanna, "The impact of web page text-background colour combinations on readability, retention, aesthetics and behavioural intention," *Behaviour & information technology*, vol. 23, no. 3, pp. 183–195, 2004.

[16] K.-K. Shieh and C.-C. Lin, "Effects of screen type, ambient illumination, and color combination on vdt visual performance and subjective preference," *International Journal of Industrial Ergonomics*, vol. 26, no. 5, pp. 527–536, 2000.

[17] M. CAMNALBUR and D. MUTLU, "Review about font typography on instructional design."

[18] J. Nielsen and H. Loranger, *Prioritizing web usability*. New Riders, 2006.

[19] Alexa. Top sites. [Online]. Available: http://www.alexa.com/topsites

[20] A. J. Wilkins, R. J. Jeanes, P. D. Pumfrey, and M. Laskier, "Rate of Reading Test®: its reliability, and its validity in the assessment of the effects of coloured overlays," *Ophthalmic and Physiological Optics*, vol. 16, no. 6, pp. 491–497, 1996. [Online]. Available: http://onlinelibrary.wiley.com/doi/10.1046/j.1475-1313.1996.96000282.x/abstract