IEEE Access
Multidisciplinary ⋮ Rapid Review ⋮ Open Access Journal

Received 28 October 2023, accepted 5 December 2023, date of publication 12 December 2023, date of current version 18 December 2023.

Digital Object Identifier 10.1109/ACCESS.2023.3341493

RESEARCH ARTICLE

Graphical Contents and Health Websites Readability

EHSAN ELAHI[1,2] AND JORGE MORATO[1]
[1]Department of Computer Sciences and Engineering, University Carlos III of Madrid, 28911 Madrid, Spain
[2]Department of Computer Science and Information Technology, The University of Lahore, Lahore 54000, Pakistan
Corresponding author: Ehsan Elahi (Ehsan.elahi@alumnos.uc3m.es)

ABSTRACT Health-related websites provide valuable information, resources, and support for individuals seeking to improve their health and make informed decisions about their well-being. Graphical content makes websites visually appealing and helps create a positive first impression. Relevant and high-quality graphical content can immediately capture visitors' attention and make the website more attractive and memorable. However, irrelevant graphical content on web pages also indicates poor readability, distracting readers from the text's focus. This paper's primary objective is to assess the effect of irrelevant or low-quality graphical content on the readability of a health-related website. The relevance of graphical content on a website was computed using a tool proposed in our previous research. A user study comprised of end-user evaluation and heuristic evaluation by readability experts was conducted using a variety of question categories. Both evaluation methods yielded comparable results, confirming that the pertinent graphical content enhances the readability of the web page. This research will help web designers improve the quality of their websites by contemplating only the relevant content of a website rather than relying on expert opinion.

INDEX TERMS Graphical content, health websites, readability, relevancy, evaluation.

I. INTRODUCTION

Health websites offer a wealth of information on various health topics, diseases, conditions, treatments, and preventive measures. They can help individuals understand their health concerns, learn about healthy lifestyles, and make informed decisions about their well-being [1]. Websites increase accessibility to healthcare information, especially for those with limited access to healthcare services or who cannot consult with medical professionals directly [2], [3]. They bridge the information gap, allowing individuals to educate themselves and make informed decisions about their health.

The readability of an article is the simplicity with which a reader can comprehend it. This paper will focus on health-related websites' graphical content and their relevance in web readability. Graphical content is a visual representation of something. Graphical content is typically more effective than text alone in terms of readability because people no longer have the time to sit down and read extensive material [4], [5], [6]. It is well-established that the brain can process graphical content more quickly than written and spoken information [7], [8], [9], [10], [11]. Visual information conveys more than just figurative and physical words [12]. Visuals capture our interest more than a string of words ever could. Visual material may express passion and expertise far more quickly and efficiently than textual information on a web page. However, appropriate implementation is essential to realizing the impact of visual material on a health website [13].

Not all graphical contents are appropriate for enhancing the comprehension and readability of the accompanying text, such as decorative images or images that website authors improperly selected. In addition, various parameters, such as the image's resolution, aspect ratio, color combination, font size, etc., can affect the readability of graphical content. Content Accessibility Guidelines (WCAG) have proposed different guidelines (text alternatives, color contrast, use of color, text font, etc.) for addressing these issues [14], [15], [16]. The image is used on a page that is relevant to the page and enhances the health page's readability.

The associate editor coordinating the review of this manuscript and approving it for publication was Ali Kashif Bashir.

Comparable methods for assessing the textual content of the World Wide Web are presented [17], [18]. To our knowledge, there are no techniques that measure the graphical content relevancy of websites from a readability angle. This paper computes the relevance of graphical content on health-related websites. The cosine similarity approach is used to assess how relevant the information collected from photographs is to the text of the site using Google Vision Services and optical character recognition. Twenty health websites were analyzed using this approach, and the findings show that pages with pictures that are irrelevant to the page's context have lower relevance ratings, while pages with images that are related to the page's context receive better scores. To test the hypothesis that relevant pictures may improve online readability, we polled visitors of four out of twenty websites after first determining their relevance.

In previous research, we computed the relevancy of fifty educational websites' non-text images using the proposed automatic tool [19]. In this paper, we have computed the relevancy of health websites using the proposed tool and the concept that relevant pictures may improve online readability was tested. The hypothesis was validated by a user survey.

This paper will have the following outline: In the next part, we will go through the relevant literature and point up several research questions. Image relevance is measured in Section IV, and the hypothesis is discussed in Section III. The assessment procedure is outlined in Section V. Section VI covers the outcomes of the assessment, while Section VII summarizes the paper's main conclusions and makes suggestions for moving forward.

II. LITERATURE REVIEW

In the related work to measure web readability, many researchers concentrated on the readability of website text and employed diverse user evaluation techniques. In previous research, we calculated the relevancy of fifty educational websites using the proposed automatic tool. This strategy integrated algorithms that collected text from photos and analyzed text from websites to determine relevance [19]. Miniukovich et al. [20] provided findings from a study on the automated and discretionary use of 39 online readability recommendations. The readability of fifty online pages was tested using eye-tracking with dyslexic and ordinary readers. The findings indicated that twenty-two criteria are associated with comprehension. The comparison of programmed and human-based outcomes revealed a complex structure: computations outperformed or were on par with human experts in evaluating website pages based on explicit guidelines, particularly those concerning low-level aspects of website page readability and text organization. On the other hand, some guidelines regarding deciphering and comprehending website page content require human judgment. These outcomes contribute to characterizing a guideline that lays the groundwork for future design valuation approaches.

Tan et al. [21] compared the effectiveness and efficiency of heuristic evaluation and user testing when evaluating four diverse commercial websites. User testing and heuristic evaluation both addressed comparable usability problems. For example, an analysis of the sternness of discovered problems and a declining return analysis model on the relationship between newly exposed matters and the number of users and assessors employed revealed a significant correlation. These significant differences between the two approaches suggest that they should complement one another rather than compete.

Another study was conducted mostly consisting of document graphical contents captured by cameras with different degrees of distortion. Every document's graphical content has been evaluated according to two distinct metrics: readability and quality, each by a separate person. Further offered to illustrate the relationship between document picture quality and readability are various statistical studies based on Shapiro-Wilks and Wilcoxon tests, as well as a thorough normalized cross-correlation analysis. The quality and readability varied slightly depending on the population distributions, according to the results. On the other hand, the correlation between quality and readability was 0.99, suggesting that, according to human perception, there is a strong association between the two [22], [23].

A second study revealed the findings from the early phases of a program to create a set of recommendations to assist web developers in producing more meaningful image descriptions. First, the findings of a survey of current recommendations for describing images in ALT-text for low vision and dyslexic people are presented. The results of interviews with low vision persons about the type of information they want in descriptions are then given [24].

A readability enhancement technique for low-light graphical contents based on the dual-tree complex wavelet transform (DTCWT) was presented by Sun and Jung [25]. Using wavelet coefficients, contrast enhancement and noise reduction for low-light graphical contents were carried out. In order to preserve fine details and make full use of the dynamic range, lighting adjustment must be done first. To achieve both contrast enhancement and noise reduction, first divide the image into high-pass and low-pass sub-bands using DTCWT. Then, execute contrast-limited adaptive histogram equalization and a nonlinear transform in the respective high-pass and low-pass sub-bands. Lastly, color correction was used to address the issue of color distortion brought on by contrast augmentation. Results show that, in terms of both subjective and objective evaluations, the suggested method performs better in contrast enhancement, noise reduction, and color reproduction than state-of-the-art methods.

How to make websites more accessible to readers of varying ages was the subject of separate research. This analysis focused on eight fixed reading factors: the style of text, text dimension, the width of the text, headers, designs, vibrancy; shading contrast; blank area; line dispersion, and text style. Researchers modify these eight factors to study how people of different ages use online apps [26].

Several researchers have conducted studies on evaluating web images from different angles. These include assessing web readability in accordance with established guidelines [20], measuring the various quality factors that affect the readability of the image [22], measuring the use of ALT-text and ALT attributes [24], evaluating low-light images [25], and assessing readability based on factors such as content, style, structure, and design [26]. However, none of the previous research focuses on measuring the relevance of graphical content on health websites. This paper focuses on a proposal to compute the relevance of graphical content on health websites and a user study with various evaluation questions.

III. HYPOTHESIS

Different parameters, such as the image's resolution, aspect ratio, color combination, font size, etc., can affect the readability of graphical content. Various guidelines (text alternatives, color contrast, use of color, text font, etc.) have been proposed to address these issues in the literature. The image is used on a page that is relevant to the page and enhances the health page's readability. The main idea of this paper is that graphical content can make health websites easier to read when the images are relevant to the text on the page. When used on health websites, images should help show what the page is about in a more precise way. This can be done with relevant and suitable graphical content. Images not belonging to a website could make it hard to read. So, the main hypothesis can be broken down into two smaller ones:

- Images that go with the text on a health page can make it easier to read.
- The website is hard to read because it uses a lot of pictures that have nothing to do with the text.

IV. METHODOLOGY

The relevancy of graphical content with the health web page's text was measured using our automatic relevancy measuring technique [13]. After measuring relevance, a user study has been conducted to validate the hypothesis. To compute the relevance of an image, the following steps have been followed:

A. CORPUS CREATION

Corpus creation is the first step. We used an image web scraping method to take pictures from twenty consumer health websites that were randomly chosen and listed in Appendix [27]. There are almost 451 pictures, and 277 of them are text photos. In this study, we looked at images with and without text. After collecting the images, Optical Character Recognition (OCR) is used to pull the text from each graphic in the corpus. Tesseract with.Net Framework with programming language C# is used because it is more precise, accurate, and efficient. It includes slight skew correction and orientation detection [28]. In Fig. 1, for example, the confidence value is 0.80, which is good, and the text that was taken out is ''Uninsured adults (in millions) Uninsured any time in past 12 months 2008 2009 Uninsured more than 12 months jan-mar 2010''. In Fig. 2, however, the OCR system didn't perform well because the text overlaps the background picture, and there is not enough difference between the text's colour and the background's colour. The aspect ratio and word size are not chosen with enough care. In this case, the program's trust level is 0 and the information taken from the graphics is ''bAjk Hfjfh j hsd ohf Zrg wik Okh jj hiji Kkh''.

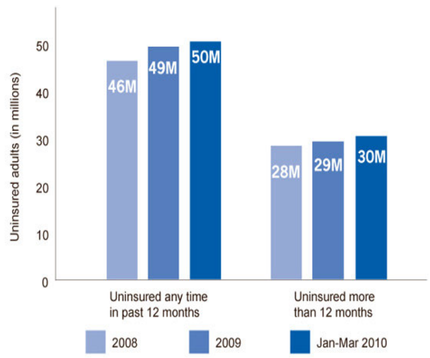


FIGURE 1. Good quality image.

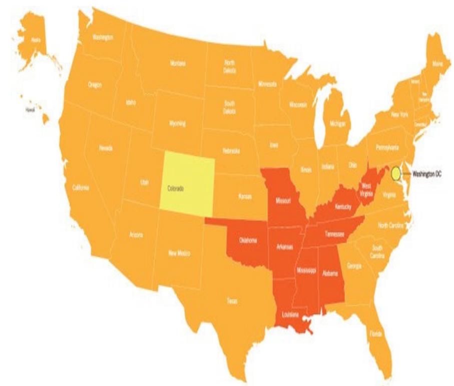


FIGURE 2. Bad quality image.

For non-text images, Google Vision AI services are used [29]. This service identifies objects, and faces, and reads printed and handwritten text from non-text images. It puts labels on images and quickly sorts them into millions of already-made groups. The service also gives you a confidence score showing the results' accuracy.

B. DATA PRE-PROCESSING

Preprocessing has been carried out after the text has been extracted from the website to clean the data and set it in a predictable and analyzable manner in preparation for relevance assessment. These preparatory measures have been taken:

1. Tokenization - Texts extracted from the webpage are tokenized to identify terms; this is the initial step in text processing. Tokens, or words acquired after partitioning crude text, facilitate comprehension of a specific situation or the development of a model for NLP.

2. Stop Words Removal - These convey minimal or no information and are typically removed so computation can consider only significant words. Therefore, we incorporated a list of stop words such as 'is', 'the', 'and', 'are', 'an', 'a', etc., into our technique. All token words have had their similarity implemented iteratively, and any token words found in this list have been removed.
3. Stemming and Lemmatization - We used lemmatization stemming to reduce the inflection of words in the extracted data from a web page by matching their root structure. A common word has a single root-base structure but can take numerous forms. For instance, "eat" is a root-base word, and eating, eaten, and eats are different forms of the same word. Lemmatization and Stemming aid in the development of root structures.
4. Uniform Case - Given that the management of information on a machine is case-sensitive, extracted data must be converted into a uniform case. Similar words with distinct meanings, such as Apple and apple, are manipulated differently by algorithms. Thus, we should construct the information in a similar case, preferably in lowercase.
5. Elimination of Punctuation Letters - Letters are $, !, ?, '', etc. The programming language C# function provides access to the punctuation character list. Punctuation marks have been removed because no information regarding semantic similarity was provided.
6. Removal Non-ASCII Letters - Similar to punctuation letters, non-ASCII letters do not contribute to semantic similarity detection.

C. FEATURES EXTRACTION

After cleaning the text labeling, and categorizing the images, the primary characteristics of the text and images are extracted. During this phase, Natural Language Processing techniques are used to calculate the text's (sentence or word sequence) representation as a numeric vector. In this phase, Term Frequency, Word2Vec, and Synonym Search techniques were implemented in the following order:

- Finding Synonyms: Words similar to every term have been found, and word2vec was used in our method. After steaming, a group of words was sent to word2vec as input, and a list of their alternatives was made.
- Term frequency: The frequency of a term is calculated by dividing the number of times it appears in the text by the total number of words. The information extracted from images without text is linked to a number that indicates how closely each term is related to the text on the page. Using a cosine similarity measure, vectors for images and website text containing identical or linked words will be similar. This is exactly what we see.

D. RELEVANCY COMPUTATION

This study's primary objective is to determine how pertinent the extracted information from graphical content is to the website's text. Relevancy is the consistency of a consumer's request with information on a page. Utilizing the cosine similarity strategy, the relevance between two vectors is determined. Thus, information extracted from graphical contents and webpage text is defined by what is known as vectors of term frequency. As an illustration of the cosine calculation, the relevance between the image in Fig. 1 and the text on its web page is 0.69. If this score is required, it is determined after computing the relevancy of each graphical content and calculating the average of their relevancies. Fig. 3 depicts the workflow of image relevance computation.

V. EVALUATION

Once the relevancy of health websites is computed, an evaluation has been performed consisting of the different steps as shown in Fig.4 that validate the hypothesis relevant graphical content on health websites can enhance web readability. The following steps are to be followed in the evaluation design:

A. OBJECTIVE

The primary objective of this evaluation is to test the hypothesis that relevant images can improve user web readability.

B. ENVIRONMENT

Using Google Forms, an online survey has been conducted. Experts and users can evaluate the website from any location.

C. MATERIALS

In this study, we have considered twenty health websites listed in the Appendix. According to the proposed methodology, the two web pages with the highest relevance score and the two with the lowest relevance score were chosen for this study. The authors then created a second version of these webpages to conduct an A/B assessment with the webpages, as detailed in the process.

For instance, Fig. 6 depicts a screenshot of one of the original web pages with graphical content; in the meantime, a new webpage is generated specifically for this study to conduct the A/B assessment without the graphical content depicted in Fig. 5.

D. DEPENDENT AND INDEPENDENT VARIABLES

In this instance, the dependent variables are levels of comprehension ranging from poor to exceptional with other two possible values fair and good being used. This understanding is contingent on the following independent variables:

- The graphical content type - graph, diagram, flowchart, photograph
- The visual quality of graphical content
- The connection between pictures and paragraphs

E. PARTICIPANTS

A total of 252 final users (potential readers) volunteered for final user testing (Men = 126 and Women = 126), and 32 readability specialists (Men = 16 and Women = 16) volunteered for the heuristic research (developers from various software businesses in Pakistan). On the one hand,

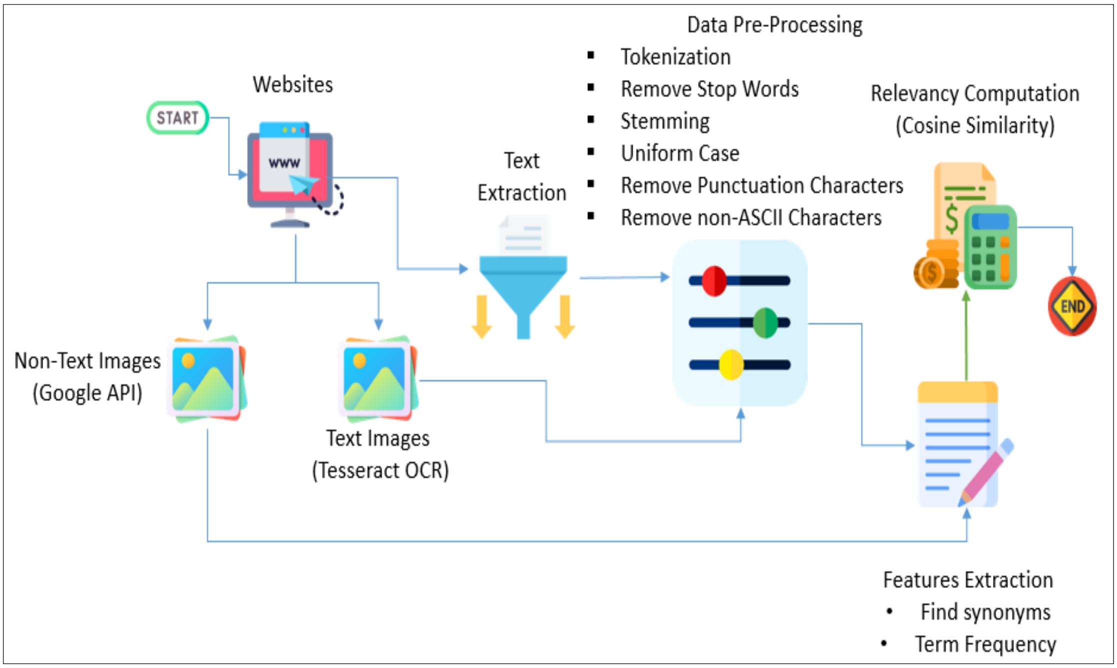


FIGURE 3. Relevancy computation workflow.

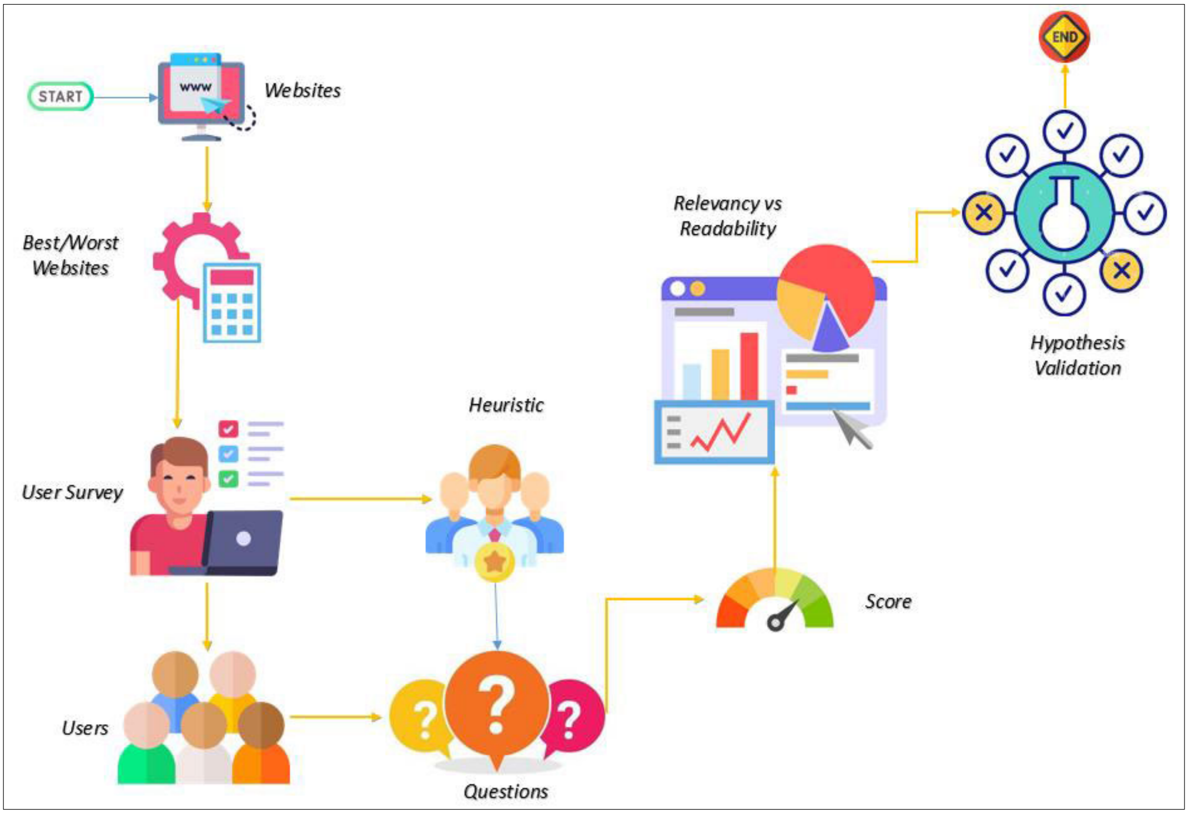


FIGURE 4. Workflow of evaluation design.

the prospective reader's research participants were medical professionals. Doctors and nurses from several Pakistan hospitals were invited to participate. They were hired based on a profile developed by studying an agent test of the customer population. All users met the following inclusion criteria: they were non-readability specialists and non-power clients,

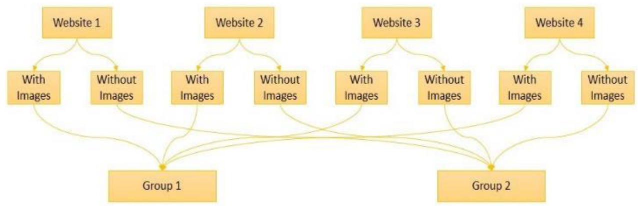
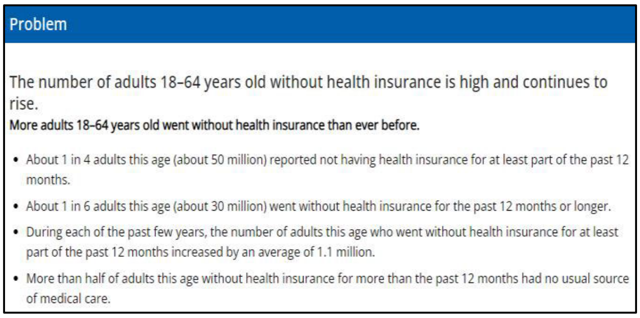


FIGURE 5. Allocation of websites for group evaluation.


Problem

The number of adults 18–64 years old without health insurance is high and continues to rise.

More adults 18–64 years old went without health insurance than ever before.

- About 1 in 4 adults this age (about 50 million) reported not having health insurance for at least part of the past 12 months.
- About 1 in 6 adults this age (about 30 million) went without health insurance for the past 12 months or longer.
- During each of the past few years, the number of adults this age who went without health insurance for at least part of the past 12 months increased by an average of 1.1 million.
- More than half of adults this age without health insurance for more than the past 12 months had no usual source of medical care.

FIGURE 6. Webpage without images.

meaning they had no online valuation experiences but did have some experience using the internet.

On the other hand, the heuristic examination was conducted by readability specialists. Participants in this study had to meet specific criteria to be included, including having taken graduate-level courses in human-computer interaction, harsh website architecture characteristics, and having been instructed in and taking part in at least one heuristic web review project. This is consistent with the idea that since primary evaluators provide better findings, they should be employed for heuristic evaluation [30]. Emails were sent to medical users and business professionals, inviting them to participate in the study. The invitation was also posted and publicized on various social media sites.

F. PROCEDURE

In this evaluation procedure, a set of questions have been asked from experts and users. Questions asked from the users are related to the images on the websites and it is more specific to the hypothesis that relevant graphical content could increase web readability. This investigation was carried out with two distinct groups. First, we gave half of the experts and consumers two websites (with graphical content and without graphical content). The remaining half of the experts and consumers were given a different set of websites (with and without graphical content) as shown in Fig. 5. During the evaluation procedure, users and experts were able to elucidate any questions or concerns. Experts and consumers evaluated the compatibility of graphical content with the website and the responses to questions. The collected user feedback was used to evaluate the relevance of images to the page's text and their readability.

G. QUESTIONNAIRE

In the user survey, different categories of questions, including control questions, questions about the user's comprehension, and questions about the user's emotions, have been posed to validate the hypothesis.

For instance, think about the best website in Fig. 6, which does not have any useful graphics. Please answer the following questions:

i. The webpage explains the health assurance of adults.
ii. How many people were without insurance in 2008?
iii. Which months have been included in the analysis of health insurance data?
iv. How many adults were without insurance in 2009?
v. In which year is the maximum number of people without health insurance?
vi. How many adults were without insurance in 2010?
vii. In which year is the minimum number of adults without health insurance?
viii. Define the age interval in which adults have high health risks without health insurance.

Please answer the following questions about the same homepage, as illustrated in Fig. 7, with appropriate graphical content:

i. The webpage explains the health assurance of adults.
ii. How many people were without insurance in 2008?
iii. Which months have been included in the analysis of health insurance data?
iv. How many adults were without insurance in 2009?
v. In which year is the maximum number of people without health insurance?
vi. How many adults were without insurance in 2010?
vii. In which year is the minimum number of adults without health insurance?
viii. Define the age interval in which adults have high health risks without health insurance.
ix. The newly added graphical content enhances my understanding of the website's content.
x. I prefer a website with relevant graphical content (Website shown in Fig. 7).

VI. RESULTS

The automated tool was used to calculate the relevance scores of twenty health websites, and the results were classified into three distinct ranges. The extracted data from six out of twenty websites matched the text of the websites between 50 and 60% of the time. As shown in Fig. 8, this relevancy score ranged from 61 to 70% for eleven websites, while three websites contained images that were 71 to 80% pertinent to their websites. We have evaluated four selected websites, of which two have the highest relevancy score and two have the lowest relevancy score among the twenty targeted websites. The outcomes were examined and compiled for statistical presentation.

Based on the findings obtained from user results, it is observed that webpage 1, mainly comprising pertinent

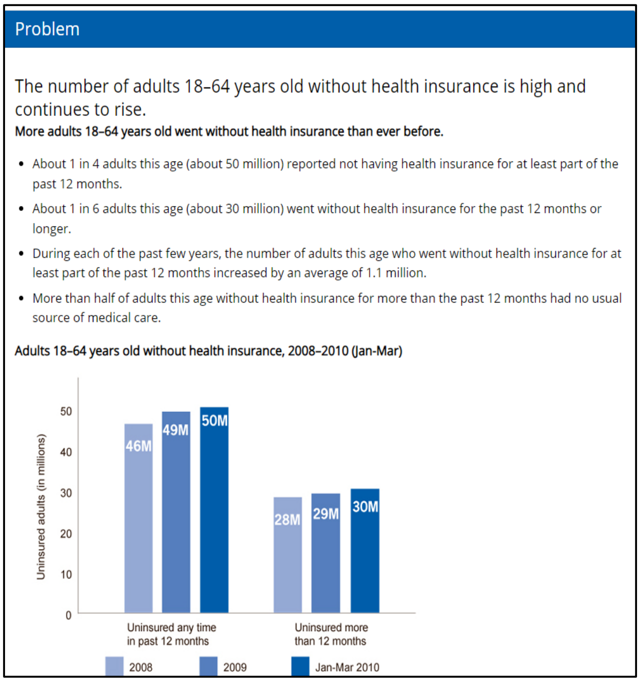


FIGURE 7. **Webpage with images.**

FIGURE 8. **Automatic relevancy computation.**

graphical content, exhibits a readability score, a ratio of correct answers to the total number of questions, of 48.57% in the absence of photos, however, the inclusion of images raises the score to 78.71%. The findings indicated that the inclusion of relevant graphical content was most effective in enhancing comprehension of the webpage. Conversely, users encountered difficulties in grasping the concept of the homepage when images were absent. The situation was analogous for webpage 3 as well. The webpage without photos obtained a readability score of 52.33%, however, the inclusion of images on the same webpage resulted in a higher readability score of 71.6%. In contrast, it was shown that websites including irrelevant graphics were perceived as relatively more comprehensible by users who were presented with text-only versions, as opposed to those who were exposed to the graphical information. Based on the findings, it can be observed that the second page, excluding any images, exhibits a readability score of 49.11%. However, when considering the presence of images, the readability score slightly increases to 50.01%. Similar was the case with webpage 4. The webpage without photos achieved a readability score of 47.67%, however, the inclusion of images on the same webpage resulted in a slightly higher readability score of 48.13%. The findings indicate that the presence of irrelevant images has a detrimental impact on readability, as depicted in Fig. 9. Users perceived more properly and quickly when irrelevant pictures were deleted.

FIGURE 9. **User-based readability scores with and without graphical contents.**

The expert evaluations did not differ significantly. Page 1 without graphical content has a readability score of 48.61%, while Page 1 with graphical content has a score of 77.20%. The readability score for page 3 without images is 53.13%, while the score for page 3 with images is 72.10 percent.

A page without graphical content has a readability rating of 50.13%, while a page with graphical content has a readability rating of 51.6%. As shown in Fig. 9, Page 4 without irrelevant

FIGURE 10. **Readability experts-based readability scores with and without graphical contents.**

graphical content has a readability score of 47.05%, while the same page with graphical content has a score of 46.20 %.

We have seen that the final user evaluation findings closely match the results of the evaluation by readability experts, and we have also seen the websites that have high relevancy scores also have high readability scores. On the other hand, Users understand websites quickly in the case of relevant graphical content as compared to irrelevant graphical content in the user survey, as shown in Fig. 11. So, the results validate the hypothesis that relevant images could enhance web readability.

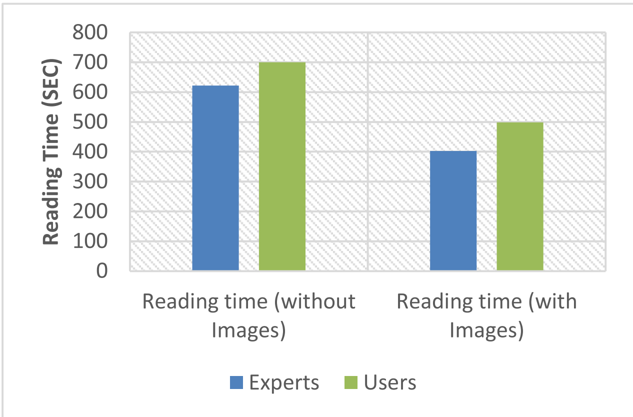


FIGURE 11. Readability time with and without images.

VII. CONCLUSION

The graphical content is used on a page that is relevant to the page and enhances the health page's readability. Various techniques for evaluating the textual content of websites are discussed. To the best of our knowledge, however, no work has been conducted on computing the graphical content relevance of websites from a readability standpoint. This paper computes the relevance of graphical content on health-related websites using a tool proposed in our previous research. Google Vision Services and optical character recognition are used to extract data from graphical contents, and the cosine similarity method is used to determine the relevance of the extracted data to the webpage text. Using this method, twenty health websites were evaluated, and the results indicate that graphical contents that are extraneous to the context of the page result in lower relevancy scores, while graphical contents that are relevant to the context of the page result in higher relevancy scores. After measuring relevancy, we evaluated the hypothesis that relevant graphical content could increase web readability using a user survey by considering four websites out of twenty. The survey consists of different types of questions. The results show that the more the graphical content on a webpage is relevant to the webpage text, the better the readability score of the webpage in the user evaluation that verifies our hypothesis. This study focused on English language-based health-related websites. In the future, we will consider other domain applications and countries.

APPENDIX

Health Websites

No.	Website name	Name URL	Score
1	Centers for disease control and Prevention	cdc.gov	69
2	Everyday Health	everydayhealth.com	52
3	Healia	healia.com	56
4	Health finder	healthfinder.gov	54
5	Mayo Clinic	mayoclinic.com/hea lth-information	72
6	Medicine	Net.com medicinenet.com	53
7	My Optum Health	myoptumhealth.co m	68
8	Revolution Health	revolutionhealth.co m	63
9	Wrong Diagnosis	wrongdiagnosis.co m	57
10	Discovery of fit & health	health.discovery.co m	67
11	Family Doctor	familydoctor.org	64
12	Health.com	health.com	55
13	Health line	healthline.com	73
14	Med help	medhelp.org	66
15	Drugs.com	drugs.com/	61
16	Men's Health	menshealth.com/	67
17	Medline Plus	nlm.nih.gov/medlin eplus	69
18	NIH health	portal health.nih.gov	66
19	WebMD	www.webmd.com	75
20	Yahoo! Health	health.yahoo.net	63

ACKNOWLEDGMENT

The authors are grateful to the university for their support.

REFERENCES

[1] G. Allen, A. Milton, K. L. Wright, J. A. Fails, C. Kennington, and M. S. Pera, "Supercalifragilisticexpialidocious: Why using the 'right' readability formula in children's web search matters," in *Proc. Eur. Conf. Inf. Retr.*, Stavanger, Norway, 2022, pp. 3–18.

[2] Z. Jasem, Z. AlMeraj, and D. Alhuwail, "Evaluating breast cancer websites targeting Arabic speakers: Empirical investigation of popularity, availability, accessibility, readability, and quality," *BMC Med. Informat. Decis. Making*, vol. 22, no. 1, pp. 1–15, Dec. 2022.

[3] M. Pantula and K. S. Kuppusamy, "A machine learning-based model to evaluate readability and assess grade level for the web pages," *Comput. J.*, vol. 65, no. 4, pp. 831–842, Apr. 2022.

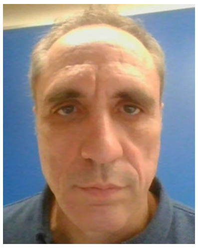
[4] Y. Hidayat, A. G. Rajkoomar, M. A. Qadeer, and L. G. D'Souza, "Osteoporotic vertebral fractures: An analysis of readability and quality of web-based information," *Cureus*, vol. 14, no. 6, pp. 6–14, Jun. 2022.

[5] P. K. Ojha, A. Ismail, and K. K. Srinivasan, "Perusal of readability with focus on web content understandability," *J. King Saud Univ.-Comput. Inf. Sci.*, vol. 33, no. 1, pp. 1–10, Jan. 2021.

[6] M. S. Al-Ak'hali, H. N. Fageeh, E. Halboub, M. N. Alhajj, and Z. Ariffin, "Quality and readability of web-based Arabic health information on periodontal disease," *BMC Med. Informat. Decis. Making*, vol. 21, no. 1, pp. 1–8, Dec. 2021.

[7] E. Halboub, M. S. Al-Ak'hali, H. M. Al-Mekhlafi, and M. N. Alhajj, "Quality and readability of web-based Arabic health information on COVID-19: An infodemiological study," *BMC Public Health*, vol. 21, no. 1, pp. 1–7, Dec. 2021.
[8] S.-T. Lim, M. Kelly, S. O'Neill, and L. D'Souza, "Assessing the quality and readability of online resources for plantar fasciitis," *J. Foot Ankle Surg.*, vol. 60, no. 6, pp. 1175–1178, Nov. 2021.
[9] Z. Wei, D. Liang, D. Zhang, L. Zhang, Q. Geng, M. Wei, and H. Zhou, "Learning calibrated-guidance for object detection in aerial images," *IEEE J. Sel. Topics Appl. Earth Observ. Remote Sens.*, vol. 15, pp. 2721–2733, 2022.
[10] A. C. Berg, T. L. Berg, H. Daumé, J. Dodge, A. Goyal, X. Han, A. Mensch, M. Mitchell, A. Sood, K. Stratos, and K. Yamaguchi, "Understanding and predicting importance in images," in *Proc. IEEE Conf. Comput. Vis. Pattern Recognit.*, Providence, RI, USA, Jun. 2012, pp. 3562–3569.
[11] I. Moya and J. García-Madariaga, "Is a video worth more than a thousand images? A neurophysiological study on the impact of different types of product display on consumer behaviour in e-commerce," in *Advances in Digital Marketing and eCommerce*. Carcavelos, Portugal: Springer, 2022, pp. 300–306.
[12] V. D. A. O'g'li and M. Y. E. O'g'li, "Use and importance of three-dimensional images in fields," *J. Ethics Diversity Int. Commun.*, vol. 2, no. 2, pp. 1–4, 2022.
[13] E. Elahi, J. L. M. Lara, and A. M. I. Maqueda, "Image relevance on websites and readability," in *Information Systems and Technologies*, vol. 1. Cham, Switzerland: Springer, 2022, pp. 286–295.
[14] E. Elahi, A. M. I. Maqueda, and J. L. M. Lara, "Web readability challenges," in Proc. Comput. Methods Syst. Softw. Cham, Switzerland: Springer, 2022, pp. 446–454.
[15] E. Elahi, A. Iglesias, and J. Morato, "Readability of graphical contents on world wide web (WWW)," in *Proc. 17th Iberian Conf. Inf. Syst. Technol. (CISTI)*, Jun. 2022, pp. 1–4.
[16] A. Panayiotou, "Media analysis: On the importance of everyday images," in *Organizational Ethnography*. Newbury Park, CA, USA: SAGE, 2021, pp. 110–128.
[17] D. Faten A. Dawood, "The importance of contrast enhancement in medical images analysis and diagnosis," *Int. J. Eng. Res.*, vol. 7, no. 12, pp. 21–24, Dec. 2018.
[18] E. Elahi, A. Iglesias, and J. Morato, "Web images relevance and quality: User evaluation," in *Proc. 5th Int. Conf. Comput. Sci. Softw. Eng.*, Oct. 2022, pp. 66–69.
[19] E. Elahi, A. Iglesias, and J. Morato, "Readability of non-text images on the world wide web (WWW)," *IEEE Access*, vol. 10, pp. 116627–116634, 2022.
[20] A. Miniukovich, M. Scaltritti, S. Sulpizio, and A. D. Angeli, "Guideline-based evaluation of web readability," in *Proc. CHI Conf. Human Factors Comput. Syst.*, New York, NY, USA, 2019, pp. 1–12.
[21] W.-S. Tan, D. Liu, and R. Bishu, "Web evaluation: Heuristic evaluation vs. user testing," *Int. J. Ind. Ergonom.*, vol. 39, no. 4, pp. 621–627, Jul. 2009.
[22] A. Alaei, R. Raveaux, D. Conte, and B. Stantic, "'Quality' vs. 'readability' in document images: Statistical analysis of human perception," in *Proc. 13th IAPR Int. Workshop Document Anal. Syst. (DAS)*, Apr. 2018, pp. 363–368.
[23] V. Govindaraju and S. N. Srihari, "Image quality and readability," in *Proc. Int. Conf. Image Process.*, vol. 3, Oct. 1995, pp. 324–327.
[24] H. Petrie, C. Harrison, and S. Dev, "Describing images on the web: A survey of current practice and prospects for the future," in *Proc. Human Comput. Interact. Int. (HCII)*, 2005, vol. 71, no. 2, pp. pp. 26–35.
[25] T. Sun and C. Jung, "Readability enhancement of low light images based on dual-tree complex wavelet transform," in *Proc. IEEE Int. Conf. Acoust., Speech Signal Process. (ICASSP)*, Mar. 2016, pp. 1741–1745.
[26] K. Rayner, "Eye movements and the perceptual span in beginning and skilled readers," *J. Exp. Child Psychol.*, vol. 41, no. 2, pp. 211–236, Apr. 1986.
[27] *Extract Images Tool*. Accessed: May 3, 2023. [Online]. Available: https://extract.pics
[28] D. Shivani and A. Singh, "Tesseract vs GOCR a comparative study," *Int. J. Recent Technol. Eng.*, vol. 2, no. 4, p. 80, 2013.
[29] *Google Cloud Vision API*. Accessed: May 4, 2023. [Online]. Available: https://cloud.google.com/vision
[30] J. Conradt, T. Eckert, P. Caserman, M. Schaub, and R. Bruder, "Towards a quality label for educational games and serious games," in *Proc. 15th Eur. Conf. Game-Based Learn. (ECGBL)*, Brighton, U.K., 2021, p. 151.

EHSAN ELAHI received the B.S. and M.S. degrees in computer science from FAST-NU, Pakistan, and the Ph.D. degree in computer science and technology from the University Carlos III of Madrid, Spain, in 2023. He is currently an Assistant Professor with the Computer Science Department, The University of Lahore, Pakistan. His research interests include web readability and accessibility, information retrieval, computer vision, human–computer interaction, natural language processing, and computer networks.



JORGE MORATO received the Ph.D. degree in library science from the University Carlos III of Madrid, Spain, on the topic of knowledge information systems and their relationship with linguistics. He is currently a Professor of information science with the Department of Computer Science, University Carlos III of Madrid. His research interests include NLP, information retrieval, web positioning, and knowledge organization systems.