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PERFORMANCE EVALUATION OF LOSSLESS COMPRESSION FOR IMAGES IN MOBILE RESPONSIVE WEB USING PARTICIPANTS' OBSERVATION AND THURSTON RATING

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Abstract

Compressing graphic-related content and multimedia elements like logos, objects, banners, and image data is undoubtedly necessary for a mobile responsive website. In image compression, redundant and/or irrelevant information is eliminated whilst the leftover is resourcefully encoded. However, selecting the compression technique or choice of appropriate method in handling image compression requires caution so as not to toss away non-redundant information and relevant fragments of image files in a bid to compress. This study investigates the functional performance and variation of a lossless method for compressing images in the mobile responsive web. Participants-based experimental observation was adopted for research instrumentation, using the Thurston scale of rating to design a close-ended instrument for data collection. A simple clustering technique was used to select seventy-five (75) information technology and computing practitioners with a specialty in web development and graphic design from Ogun East Senatorial District in Nigeria; however, only fifty (50) practitioners were available as expert judges for Thurston rating on electronically administered research instrument. The results show average mean values of 3.78, 3.46, and 3.05 using decision rule in SPSS to validate the three research questions respectively, which depict distinct aesthetic effects and graphic quality of lossless compression, as well as notable improvement in web page size and browser loading time when using lossless compression for all images in mobile response website.

Keywords: *Compression, Images, Lossless, Responsive Web, Thurston Rating*

INTRODUCTION

Compression is concerned with the file encoding process and computational technique to transform and/or suppress graphics, images, and other multimedia elements to compatible file types; thereby reducing required storage space in the device and minimizing execution time by system processor. Image compression is quite necessary for a mobile responsive website because redundant and/or irrelevant information is eliminated whilst the leftover is resourcefully encoded (Agustsson et al., 2019). Improving the resolution and image scaling modalities now accounts for a partial increase in the amount of digital image data, which requires proper management in the information system; just as it is imperative for tertiary health care like teaching hospitals to produce up to a terabyte of image data on yearly basis (Zhang et al., 2022a). Enhancing the network connectivity within business premises of multinational organisations, as well as interconnectivity to intranet clients and applications requires fast and efficient transfer of image data in high quality. For instance, electronic customers' records and transaction ledgers are being created to allow transfer and access to sales orders and images through the Internet.

Nowadays, web development and domain hosting have taken to the dynamism of mobile responsive websites due to emerging digital telephony and communication technology. A mobile responsive website has adaptability and platform independence features to provide the same experience to web users regardless of their device type or internet source. It usually conforms to the standard dimension of a video terminal or screen, in terms of interface intuitiveness, interactivity, and page layout when a typical website is loaded and viewed through a browser on a computer system, as well as portable devices like a smartphone, tablets and so on (Berg et al., 2021).

Compression of images and graphics-related content for web pages allows a reduction of file size to minimize the time taken to load web pages; compressed images and multimedia graphics also consume less storage volume on the web server (Townsend et al., 2020).

However, selecting the compression technique or choice of appropriate method in handling image compression requires caution so as not to toss away non-redundant information and relevant fragments of image files in a bid to compress. Thus, evaluating the effects of lossless compression on the graphic and image quality of mobile responsive web is the focus of this study, because the choice of lossless compression technique has a resultant effect on operational flow and usage effectiveness of mobile responsive website (Jeong et al., 2023).

The scope of this study considers the necessity to measure the improvement in web experience for mobile phone users by performance evaluation in content layout, adaptability of device width, and loading time when using lossless compression for images on the web. Hence, the study was further guided by the following research questions:

(i) What are the effects of lossless compression on the graphic quality of the website?

(ii) Is there any improvement in content layout when using lossless compressed images?

(iii) How is the web performance varied on mobile phones with lossless compression?

RELATED WORK

A multi-level decomposition approach for lossless compression in medical imaging was provided a comparative analysis of computational parameters (Zhang et al., 2021). The proposed scheme had a trait of novelty but shared a similar context with the wavelet kind of file compression. However, comparing the convectional lossless compression method with novel schemes is associated with the acquisition process of image data by a main digital or a mere digitized source. Ruan et al. (2021) also explored the structural pattern of the image domain in multi-scale dimensions, prompting the model design to handle parallel generation of picture elements (pixels) with higher resolution while the extracted samples were conditioned in low resolution (Metizer et al., 2020).

A special performance was recorded in the parallel inference of the compression process at the decoding phase when a practical guide was provided for parallelization scheme implementation, which was aimed at enhancing image compression runtime based on the auto-regressive model (Zhang et al., 2022b). Nevertheless, the sampling efficiency was not measured by experimental analysis. The bit rate needed to achieve better performance in most conversion tasks is quite invariant by transformation which is attributed to data augmentation (Dubois et al., 2021). Belime et al (2023) conducted an extensive experimental analysis of the lossy image by an alternative method of compression, to improve the throughput and accuracy with limited storage capacity; thus, corroborating the results and enhancing the findings presented in (Hoogeboom et al., 2019).

Discriminator of non-binary quantization is conditioned on local image representation which was obtained through auto encoders with more efficacies by joint optimization distortion and statistical inference (Gulrajani et al, 2017). Knowledge distillation was leveraged for neural ideas for image compression by which an intermediate representation of features is produced; yielding a very efficient compression task that proved the possibility of tuned learned attributes to serve several downstream (Matsubara et al., 2022).

Adequacy in optimal quantization was found in the compression framework by (Kingma et al., 2019) for the joint photographic expert group (JPEG); in line with the autoregressive corroboration of the image compression model presented in analytical research (Minnan & Singh, 2020).

Significant decrement in the volume of data being experienced when using the lossy method of compression for graphics and images alike brings about consideration for lossless compression technique in most recently carried out studies (Jeong et al., 2023). Relevant findings and the drawback being reported by earlier scholars bring recent research directions in image compression, identifying autoregression of local model as a workable combination with latent variable model to produce semantically coherent images (Muckley et al., 2023).

MATERIALS AND METHODS

This study adopts quasi-experimental and descriptive techniques; participants' observations and Thurston's rating were instrumental to this research design. This was considered to enable the researchers to align experimental data to a few selected expert judges, as a sample of the population for study by which inference can be made.

Data were captured electronically to determine performance variability of lossless images in the mobile responsive web through participants' observation as a research instrument, and the Thurston rating scale was used to evaluate research data.

Computing and information technology practitioners with specialties in graphic design and web development are the population for this study. Fifty (50) respondents were used as expert judges, being the sample size for this study by which cluster sampling technique was used to select twenty-five (25) practitioners each from Ijebu Ode Local Government and Odogbolu Local Government areas respectively. Content validity of the research instrument was also established with the experts in related fields, to ensure its proper coverage of research questions.

RESULTS AND DISCUSSION

The analytical technique of evaluating research data in this study bears a direct relationship with the problem statement, to accomplish the objectives of this study and provide answers to research questions with seven (7) points rating according to the Thurston scale which ranges as follows: 7-Excellently Done; 6-Perfectly Yes; 5-Exactly Possible; 4-Very Well.

3-Averagely Good; 2-Partially Okay; 1-Not too sure.

Thurston rating is a nominal scale inclined research instrument that uses seven (7) points scoring or weighted criteria, which may be adapted to specific research direction by the scholars. The minimum or lowest point of one (1) denotes the smallest value in the criterion or opinion of the respondent, while the maximum or highest point of seven (7) denotes the biggest value in the criterion or opinion of the respondent.

Thurston scale was designed for research instrumentation of this study, which involved the selection of fifty (50) expert judges on subject matter for experimental assessment by participants' observation in the design, principles, and usage of web graphics, particularly for enterprise domain names where mobile responsive websites are hosted and accessed.

Each of the evaluation yardsticks being segmented on the research instrument for validating their associated and related research question is numerically and serially labelled as an “item”. The number of judges that scored the minimum point of one (1) for each item and ditto for the maximum point of seven (7) in each segment of the research question are shown in Tables 1 to 3 respectively. The mean value for minimum or maximum points was obtained by dividing the product of the frequency of judges that scored a particular point and point value, by the total number of judges.

Then, computational analysis of research data was done using version 20 of Statistical Package for Social Sciences (SPSS) software, while the presentation of results was done using descriptive statistics with frequencies and charts as shown in Table 1, table 2, table 3, and figure 1, figure 2, figure 3 respectively:

Table 1 Research question one (I):

Item / Judges	Max Pt (7)	Min Pt (1)	Judges X Max Pt (7)	Judges X Min Pt (1)	Mean Value (7)	Mean Value (1)	Avg. Mean Value
Item 1	15	5					
Item 2	12	-					
Item 3	16	-	455	6	9.1	0.1	3.78
Item 4	12	-					
Item 5	10	1					

Figure 1 Graphical validation of research question one

Table 2 Research question two (II):

Item / Judges	Max Pt (7)	Min Pt (1)	Judges X Max Point	Judges X Min Point	Mean Value (7)	Mean Value (1)	Avg. Mean Value
Item 1	8	3					

Item 2	11	8					
Item 3	9	3	343	16	6.9	0.3	3.46
Item 4	9	1					
Item 5	12	1					

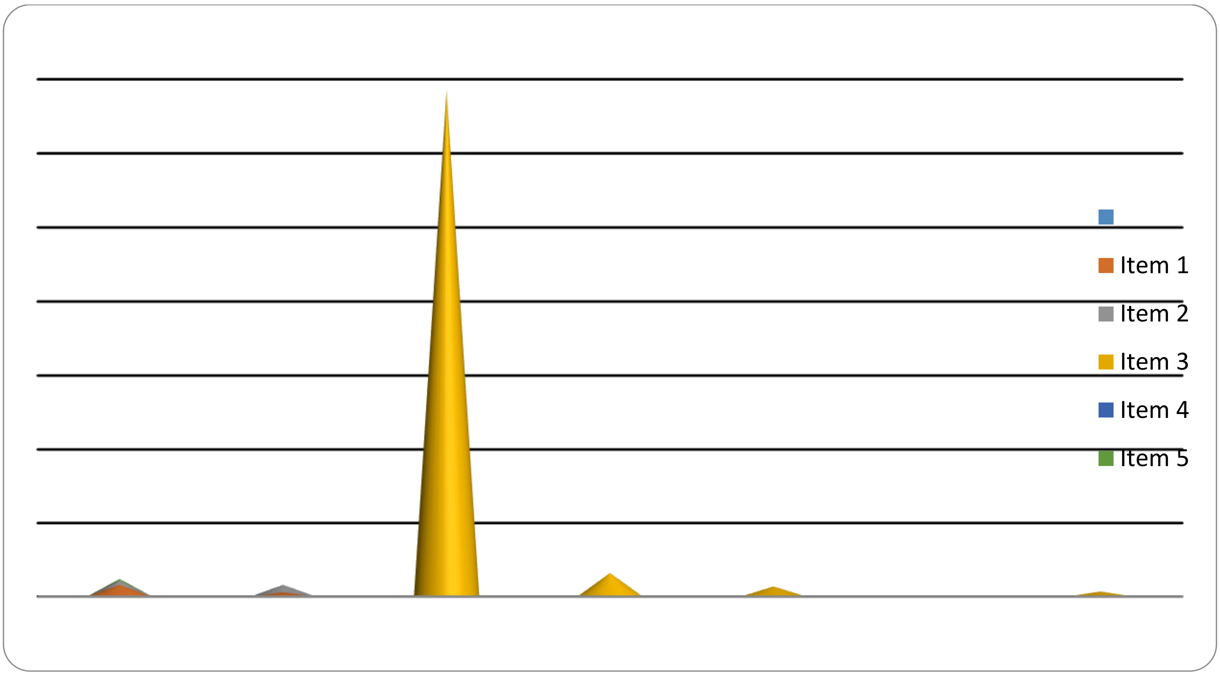

Figure 2 Graphical validation of research question two

Table 3 Research question three (III):

Item / Judges	**Max Pt (7)**	**Min Pt (1)**	**Judges X Max Point**	**Judges X Min Point**	**Mean Value (7)**	**Mean Value (1)**	**Avg. Mean Value**
Item 1	10	2					
Item 2	14	1					
Item 3	8	1	294	6	5.9	0.1	3.00
Item 4	10	2					

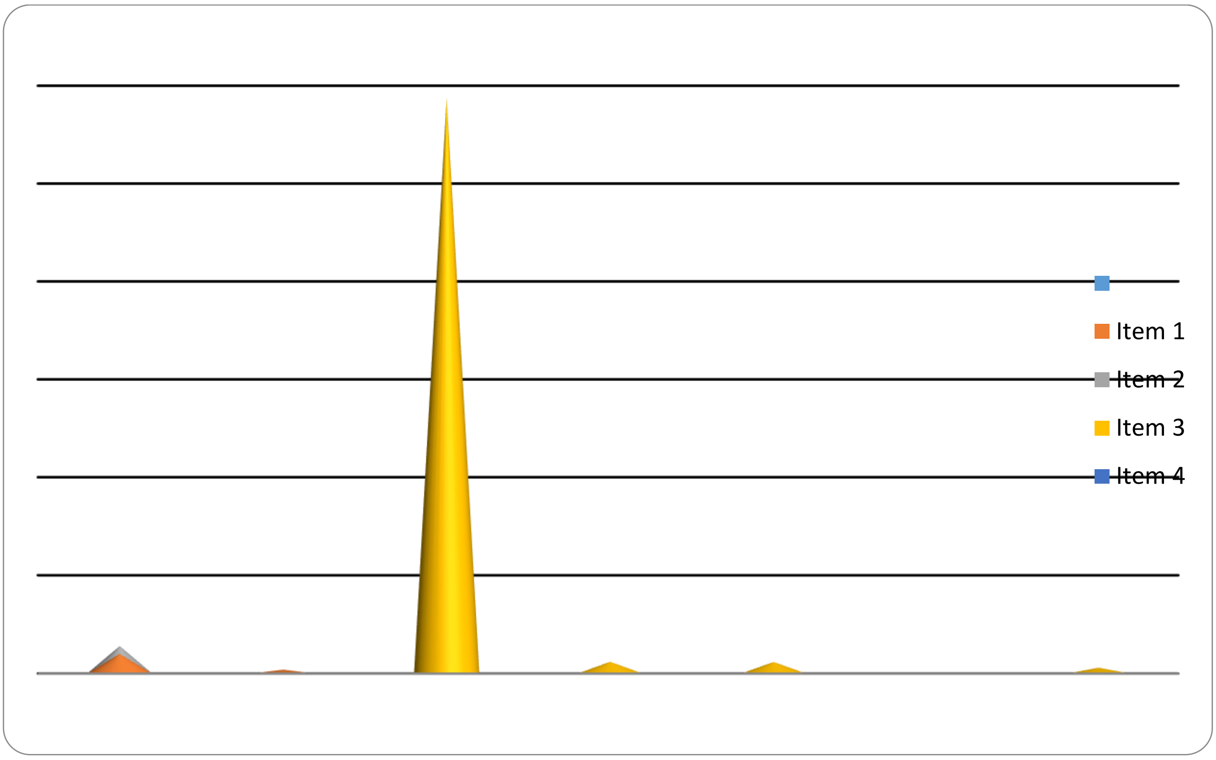

Figure 3 Graphical validation of research question three

The proportional views and stances of expert judges or respondents' opinions during experimental observations were analyzed, as presented through the tables and graphs above to validate conjectural propositions (i.e research questions) for this study. The average mean value was calculated, as the product of judge frequency for each observation item and rating point or category of rating scale divided by the total number of judges involved in the experiment.

Research question one (I) with Table 1 and Figure 1 shows that most of the respondents agreed to the point category of seven (7) on the Thurston scale. Furthermore, the difference between the mean value for the point category of seven (7) and the point category of one (1) validated the relevance of this research question to the study, while the average mean value (AMV) eventually provided an answer to research question number one, hence lossless compression has obvious effects on the graphic quality of the mobile responsive website, thus align with the postulation of Belime et al. (2023).

Research question two (II) with Table 2 and Figure 2 shows that most of the respondents agreed to the point category of seven (7) on the Thurston scale. Furthermore, the difference between the mean value for the point category of seven (7) and the point category of one (1) validated the relevance of this research question to the study, while the average mean value (AMV) eventually provided an answer to research question number two, hence there is a significant improvement in content layout in terms of page size and loading time when using lossless compression for all images on the website, thus ascertain the proposed evaluation in the work of Matsubara et al. (2022).

Research question three (III) with Table 3 and Figure 3 shows that most of the respondents agreed to the point category of seven (7) on the Thurston scale. Hence, the lossless compression technique is quite different from other types of compression techniques in terms of experimental performance because its browser request and media layout align quickly with execution time, as previously projected by the exploratory and predictive studies of Dubois et al. (2021).

CONCLUSION

The investigative and analytical perspective of this study unveiled enhanced variation in mobile usability with performance compatibility of lossless compression for images in responsive websites. Minimal loading time of web pages and intuitive layout of graphical contents align with regular styling for web elements without prejudice to smooth flow of web traffic. Significant reduction in file size of a typical image or web graphic is precisely attributed to optimisation effect of multimedia compression and is quite beneficial to smartphone users who often access websites via small bandwidth and low-speed internet to improve performance.

Unlike non-redundant portion of web images or multimedia content which is commonly lost when applying a lossy method of compression, just as it is experienced when the visible quality of an image suddenly dwindles; thereby compromising the users' experience and the integrity of the web interface design, involves distortion in multimedia content and images to a large extent. Lossless compression fills the gap of maintaining image quality while ensuring notable improvement in the loading time of web pages, bringing the exact internet browser's efficacy on computers to smartphone users for web images in the realisation of mobile response websites.

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