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A new method for analysing eye-tracking measurement data

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The Research

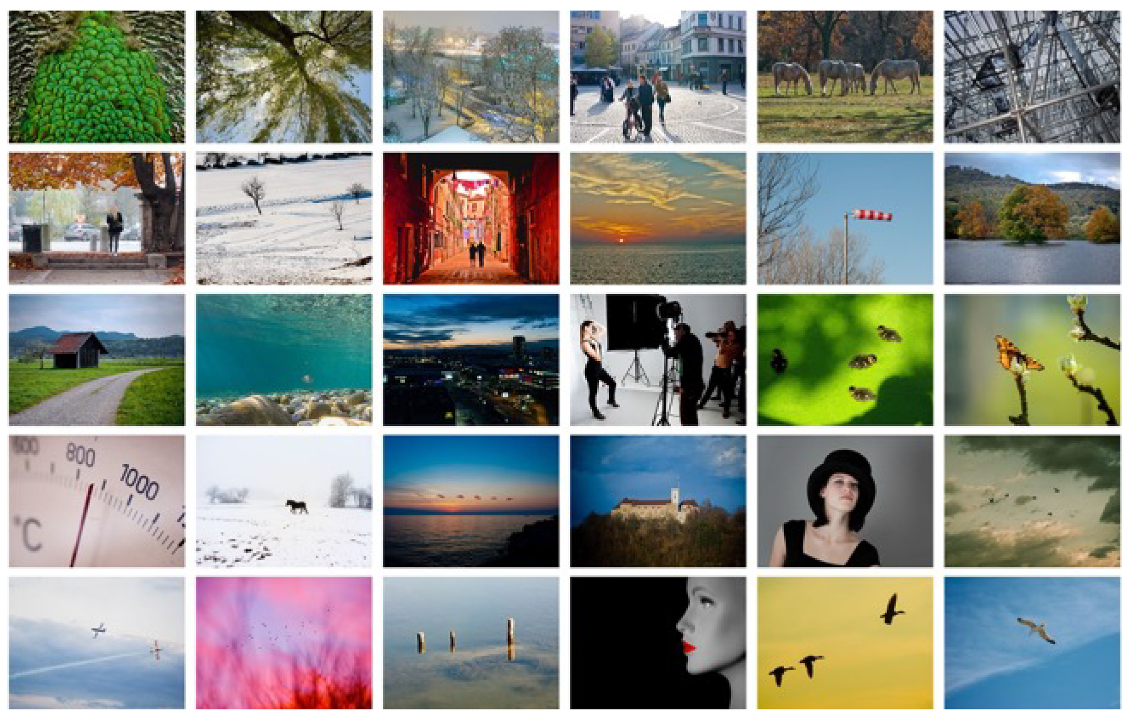
Having in mind the function of photography in graphic communication, we should be aware of many different aspects of the medium. The standard criterion for a correct and successful photograph should always be its technical and artistic aspect. The third aspect is the content or meaning, where final decisions are usually made. With this in mind, editors are usually presented with photos from which they must select those to be used in a final publication.

Since most editorial decisions are made on the basis of content or meaning, which is usually described as communication value, some decisions also involve technical aspects, such as whether it is better to use a slightly underexposed or slightly out-of-focus photo. In these cases, the standard criteria changes because the shooting conditions did not allow the photographer to take a technically correct photo, but the content or meaning is too important not to be published.

The research focuses on measuring how the way people see different photos changes when they are not technically perfect. Using eye-tracking technology, where we can measure where a person is looking and for how long, we can get an accurate idea of what that person is seeing and the way their eyes move. This type of measurement is actually not a problem and has been successfully used in many research studies. The main question to be answered in this study was how the nature of image perception changes when the image is distorted in some way. Therefore, a new method for analysing eye-tracking data was developed. The results show that eye-tracking can be used to determine how technical aspects of photography affect the way we look at it. The final judgement that the method works was made by comparing the data with data gathered with subjective tests in which observers had to choose between different distorted images and decide which is more acceptable. The correlation between the results of new method and a subjective testing is very strong.

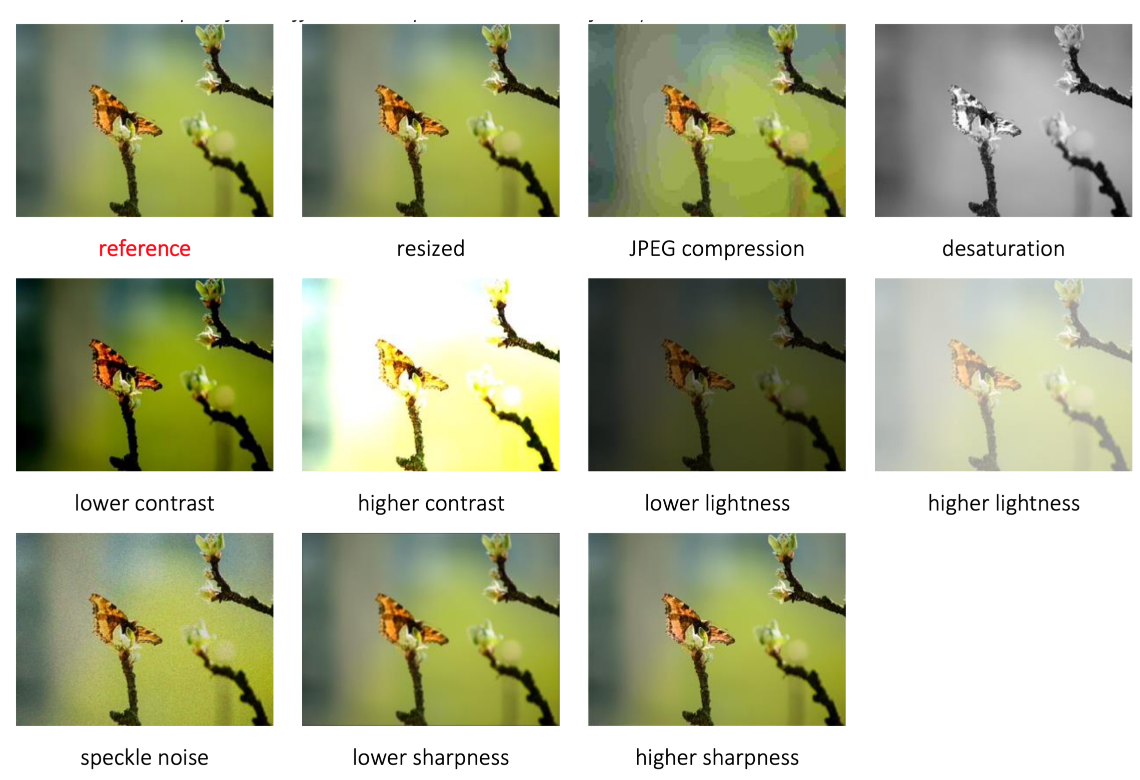
Materials and methods

The research was conducted using the novel image database. The database consists of 30 different motifs, which differ mainly in their complexity and variety of colours. Various manipulations were then applied to the reference images and in total, 330 photos were used. We divided photographs into 11 different tests so that each observer could see each motif only once, but with a different manipulation. We tested a total of 110 participants on a TOBII X120 eye-tracker.

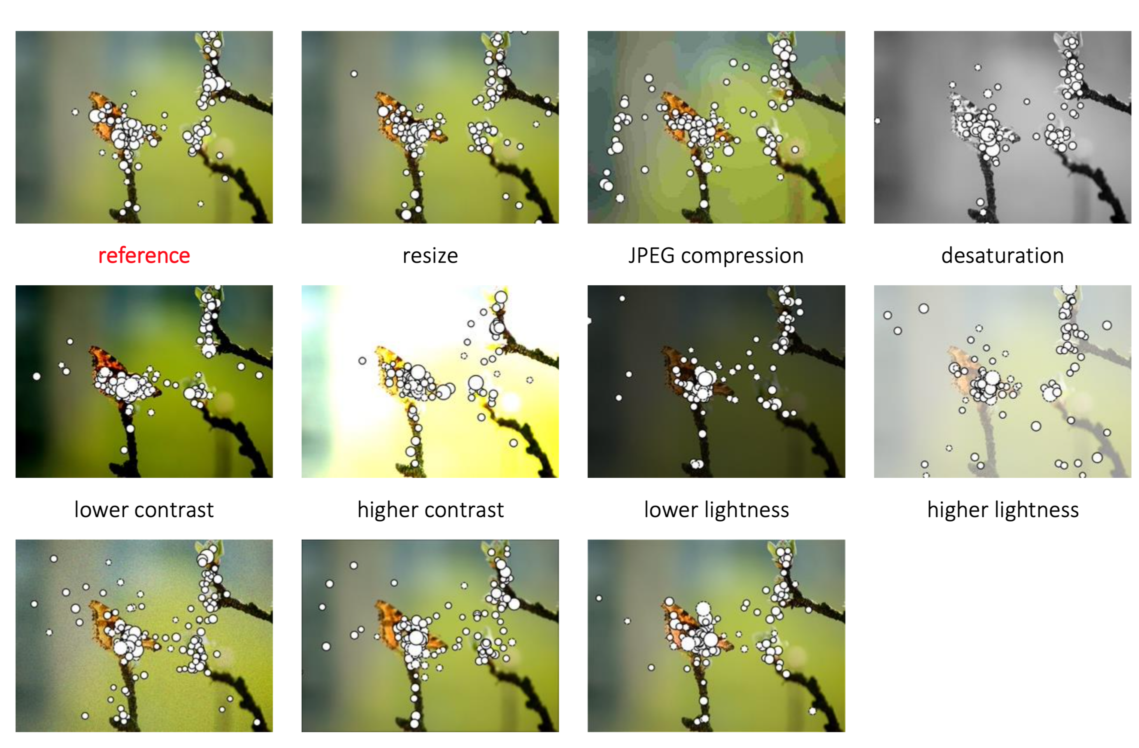


Results and analysis

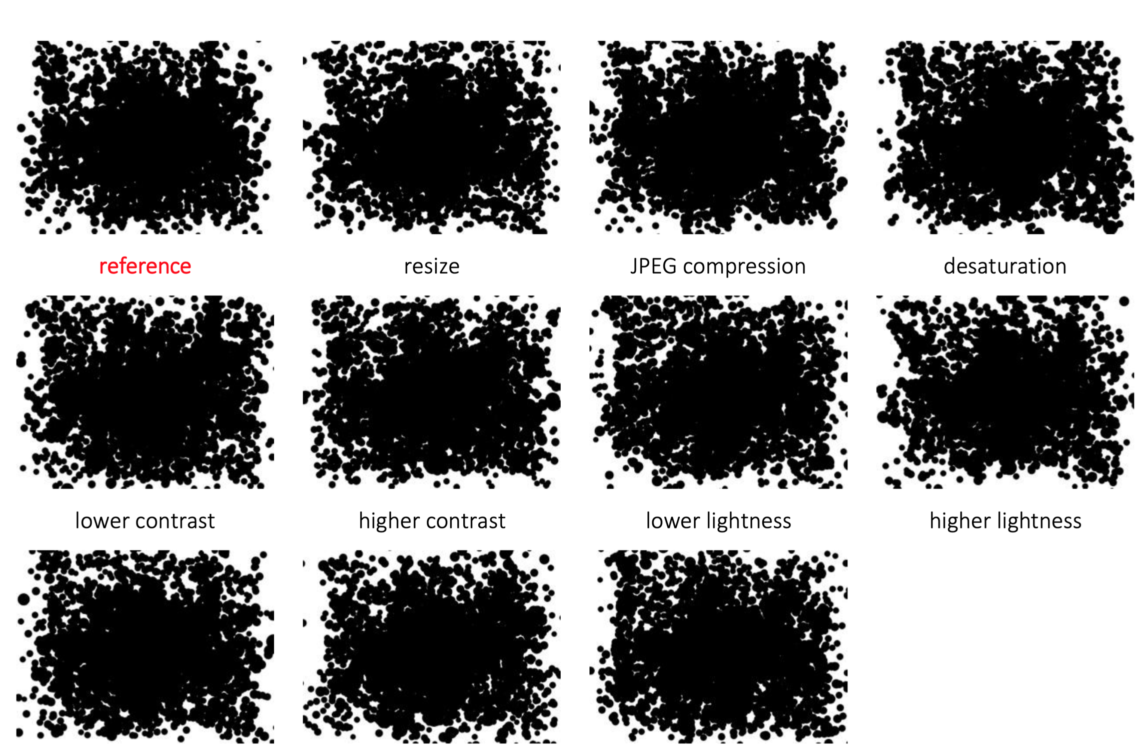
An example of the different manipulations on one of the photos used in the test:



Duration gaze plot of all the different manipulations on one of the photos used in the test:



Combined gaze duration representation of all different manipulations on all photos used in the test:



Since the TOBII Studio 3.4.4 software doesn't offer the possibility to analyse the change in the viewer's perception of different images, a new method was developed. We used TOBII Studio 3.4.4 to export duration gaze plots of each photo for all observers together. The gaze plots were exported as black circles in a transparent PNG file format. Since the aim of the research was to find out which parameter most influences the way people look at photos, regardless of the subject, all gaze plots for each parameter were combined. The end result was a cloud of gaze plots for each of the ten quality parameters and for the reference (unmanipulated) photos. Using Mathworks Matlab R2014a, we subtracted the reference cloud from each of the manipulation clouds and used the difference to obtain the result of which parameter most influenced the way the photos were viewed.

Discussion

The main aim of the research was to determine which photo distortion or manipulation most changes the way a photo is viewed. The way the photos were selected in the novel image database allowed us not to look just at the exact subject, but also at the average of all the photos. In this way, a final conclusion could be drawn that could really show the influence of different distortions on the communication value of photographs.

The manipulations analysed were selected on the basis of the practical use of photography in the real examples. Since photographic equipment, conditions and reproduction techniques often result in distorted photographs, where in many cases editors have to choose the best from the worst for publication, it is important to know what kind of distortion most changes the way we look at photographs. Sharpness, contrast, noise, lightness, compression and resize distortion were chosen in the end as these are the most common photographic errors we deal with. The data presented in Figure 3 shows us that increasing sharpness has the least impact on the viewing of the photographs (only 0.4% change). The result is predictable, as increased sharpness does not have a negative impact on image quality. The result also gives us an indication that our newly developed analysis method provides correct results. Second best was the lower contrast (1.2% change) and third best was the resizing effect (1.5% change). The result of the resize effect is somewhat surprising, as the artefacts that occur after resizing the photo to a larger format are clearly visible to the naked eye. We concluded that the reason for this lies in the observation conditions under which we tracked the eye movement. The observers were not looking at the photos on the full screen, but in a smaller format (Figure 2), and therefore the effect did not have as big an impact as it should. The second worst distortion is speckle noise (1.7% change), followed by desaturation (1.8% change). We see that the influence of colour is not that important for the communication value of photos, as we mainly perceive shapes and details. Lower lightness changed the way observers looked at the photos by 2.5%, lower sharpness by 2.7% and higher contrast by 3.0%. The greatest change was measured with JPEG compression (4%) and higher lightness (7.0%). JPEG compression results in the appearance of posterization artefacts, which are clearly visible in areas that normally hazve smooth gradients. As this posterization appears as details, it is very predictable that the change in viewing will be higher as the artefacts attract the viewer's eyes. The absolute worst result was measured at a higher lightness where the difference between subjects/objects and background is no longer as clear and seems to fade.

Almost all of the results are not surprising despite the effect of the size change and give the newly developed analysis method a solid foundation that can be used for further use cases.

ACKNOWLEDGMENTS

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