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THE INFLUENCE OF SHORT-TERM MEMORY IN SUBJECTIVE IMAGE QUALITY ASSESSMENT

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ABSTRACT

This study delves into the subjective image quality assessment, exploring individuals' perceptions of image quality when comparing different formats of the same image. Using various image formats, such as jpg, tiff, bmp, gif, and png, alongside the original image, the research investigates observers' ability to discern image quality differences. The results reveal a notable divergence in observers' opinions, particularly when assessing image quality sequentially or side by side. The study uncovers a tendency for observers to either overestimate their accuracy in sequential assessments or underestimate themselves when conducting one-by-one evaluations prior to side-by-side comparisons. This research sheds light on the complexities of subjective image quality assessment and its variations based on assessment methods, providing valuable insights into human perceptions of visual quality.

Keywords: Image Quality Assessment, Comparative Image Analysis, Observer Perceptions, Sequential Assessment, Side-By-Side Comparison

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1. PROBLEM STATEMENT

Given two setups namely one-by-one setup and side-by-side setup, will the influence of short-term memory be the same in these two cases?

2. INTRODUCTION

Often when we see two images of the same image, we think of the case where one is better than other in terms of quality. For example if we look at the image below, we can see the original image and as well as jpg,tiff,bmp,gif and png type images of the same original image. So by using our vision of eye we can say which image among all the above has better quality and which image looks more close to the original image.

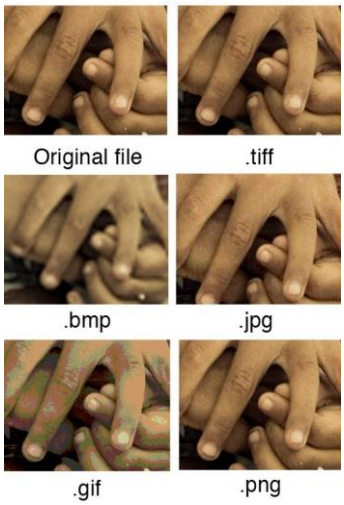

Figure 1: Image with Various extensions

3. QUALITY ASSESSMENT METRICS

There are two types of image quality assessments and they are:

3.1. Mathematical Assessment

1.Structural Similarity Index (SSIM): The structural similarity (SSIM) index is a method for predicting the perceived quality of digital television and cinematic pictures, as well as other kinds of digital images and videos. This is used to measure the similarity between images. This index is the measurement or prediction of image quality is based on an initial uncompressed or distortionfree image as reference. [1] This is given by a mathematical formula,

$$\mathrm{SSIM}(x,y) = \frac{(2\mu_x\mu_y + c_1)(2\sigma_{xy} + c_2)}{(\mu_x^2 + \mu_y^2 + c_1)(\sigma_x^2 + \sigma_y^2 + c_2)}$$

Figure 2: SSIM formula

2.**Universal Image Quality Index (UIQI):** It is a mathematically defined universal image quality index. This approach does not depend upon viewing conditions or the individual observers, hence this is called as “universal”. This aims to provide meaningful comparisons across different types of image distortions.[2] This is given by the formula,

$$Q = \frac{\sigma_{xy}}{\sigma_x\sigma_y} \cdot \frac{2\bar{x}\bar{y}}{(\bar{x})^2 + (\bar{y})^2} \cdot \frac{2\sigma_x\sigma_y}{\sigma_x^2 + \sigma_y^2}.$$

Figure 3: UIQI formula

3.2. Subjective Assessment

1. Change Blindness: This is one of the best approaches before short term memory approach in subjective image quality assessment. In this approach we will concentrate more on some particular features and check only the quality of those features to compare two images. This is more like spot-the-difference game.In that game we will find the objects that are present in one image and not present in other image. In the same way in change blindness we will try to assess the quality of important features of an image.

2. Short Term Memory: In this approach we will look at the image as a whole rather than just the important features of the image like in change blindness approach. So we can assess the image quality better in this approach because we will take care of all the features of the image to assess the quality.

4. EXPERIMENT CONDUCTED

We need to take a set of people and divide them into two groups. We have two setups, one is one-by-one setup and the other is side-by-side setup. So for two groups , firstly we need to give side-by-side setup to group-1 and one-byone setup to group-2 people. Now with at least 24 hours gap we need to give side-by-side to group-1 and one-by-one to group-2 people. We need to maintain at least 24 hours gap because if we don't then there are chances that people remember the choice they made in the previous setup that was given to them and if that is the case then we cant assess the memory influence in the quality assessment.

One-by-one Setup: In this setup we will give the user with an image aligned towards left in one frame and allow the user to assess the image then the user needs to click next and then we will provide the user with an image that is aligned towards right in another frame and give time to assess that image too. But the point to be noted is that we will not provide the user with both images at the same time. That is why we call it one-by-one setup. Then after the user is confident about his/her choice then the user will be provided with an option to choose which is better image, right or left?

Side-by-side Setup: In this setup we will give the user with an image aligned towards left and another image that is aligned towards right in the same frame and give time to assess the two images given. But the point to be noted is that we will provide the user with both images at the same time. That is why we call it side-by-side setup. Then after the user is confident about his/her choice then the user will be provided with an option to choose which is better image, right or left?

The point here is that in both the setups the user will be provided with same images with same distortions, place and size.

I have conducted three types of experiments and they are:

1.Based on Image processing people: Divide the whole DIP class into two groups. They are Group-1: First one by one set up and after minimum 24 hours of gap, side by side set up and Group-2: First side by side set up and after minimum 24 hours of gap, one by one set up

2.General people, not necessarily Image processing people.

3.Time Analysis taken for both the scenarios of for Group-1 and Group-2.

The distortion performed are of four types:

1. JPEG Compression: In this we will take the initial image and compress that with five levels of distortion 1,2,3,4,5 where 1 being the least distorted image and 5 being the highest.

2. Poisson Noise: In this we will take the initial image and add noise that with five levels of distortion 1,2,3,4,5 where 1 being the least noise added image and 5 being the highest.

3. Gaussian Blur: In this we will take the initial image and blurr it that with five levels of distortion 1,2,3,4,5 where 1 being the least blurred image and 5 being the highest.

4. SGCK gammut mapping: This mapping is based on Signodial Lightness mapping and cusp knee scaling. In this we map the number of colors to more realistic, that is visble color spectrum. By applying this mapping sometimes the original color of the image might be changed too. In this we will take the initial image and mapping is performed with five levels of distortion 1,2,3,4,5 where 1 being the least changed image and 5 being the highest.

Link to Google form Side by side setup –

https://docs.google.com/forms/d/e/1FAIpQLSc8fskUHEXhsVlgxHJiNRpZxsZnwlRm5tSKFSikYAgEDwzpg/viewform

Link to Google form one by one setup –

https://docs.google.com/forms/d/e/1FAIpQLSdP39J8s1LSqLLu6ev6VZgZhnt57XUqnIQsclfzB5dl7rWuQQ/viewform

5. RESULTS/CONCLUSIONS

1. If we give two images, one being original and other being gaussian blurred image then it is quite easy to identify the quality in both the cases one-by-one and side-by-side for Group-1 as well as Group-2. The results can be seen below.

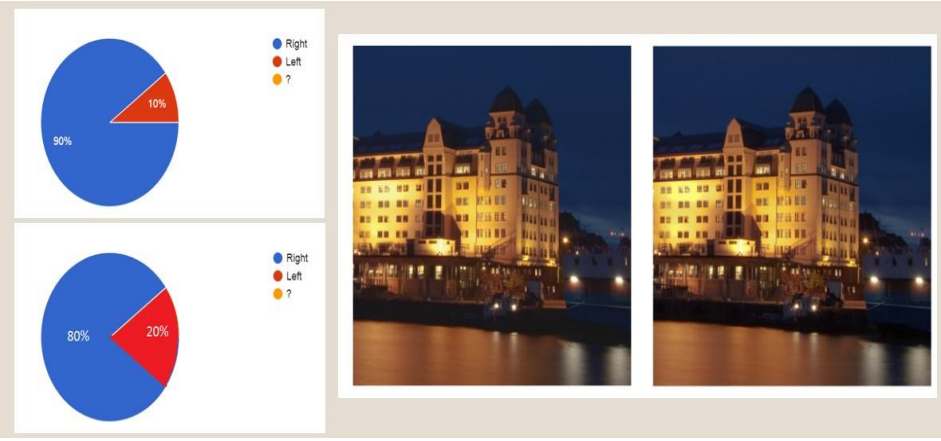

Figure 4: Gaussian Blurring

2. If we give two images, one being original and other being any distorted imageand if the image has homogeneous region then it is quite difficult to identify the quality in both the cases one-by-one and side-by-side for Group-1 as well as Group-2. The results can be seen below.

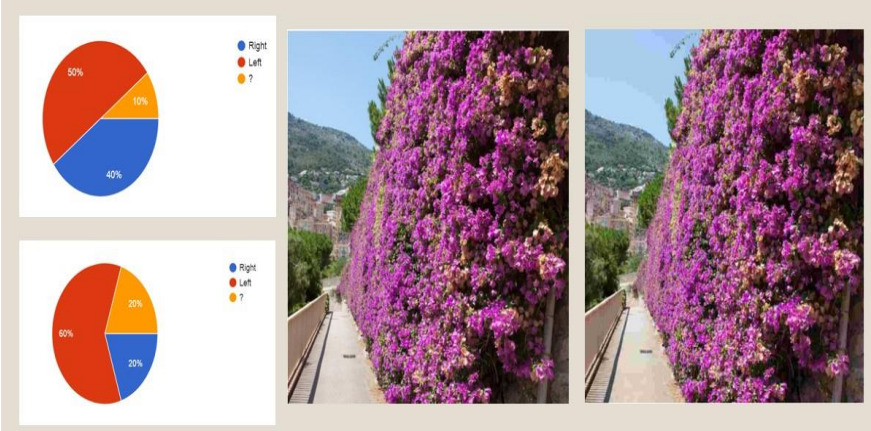

Figure 5: Image with Homogeneous Region

3. If we give two images, one being original and other being any distortedimage using gammut mapping then it is quite difficult to identify the quality in both the cases one-by-one and side-by-side for Group-1 as well as Group-2 because in gammut mapping the color space changes and it is quite difficult to identify the correct image. The results are quite similar to homogeneous region ones and can be seen below.

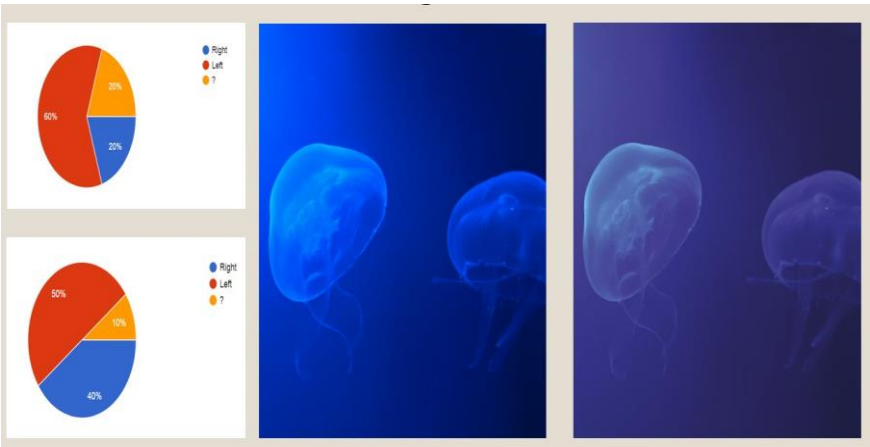

Figure 6: Image with Homogeneous Region

4. If we give two images, one being original and other being any distortedimage and if the image has lot of texture similar region then it is quite difficult to identify the quality in both the cases one-by-one and side-by-side for Group-1 as well as Group-2. The results can be seen below.

Figure 7: Image with Homogeneous Textures

5. We can see below the tables for time analysis and distortion type wise analysis.

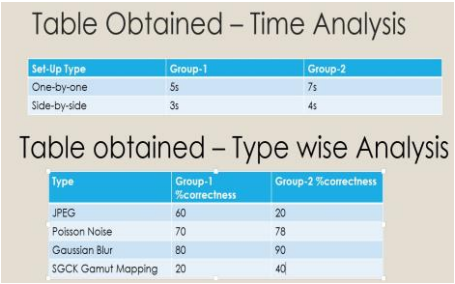

Figure 8: Image with Homogeneous Region

From the table with time analysis we can observe that Group-1 people overestimate themselves because they performed side-by-side first, so they take less time than required for one-by-one setup. Where are Group-2 people underestimate themselves because they start off with one-by-one setup.

From the table with type wise analysis we can observe that for SGCK gammut mapping in both the groups the accuracy is quite low and for Gaussian blurring it is quite high.

6. FINAL CONCLUSION

Results suggest that most observers could not converge to the same opinion in both the cases. In particular, I have found that the observers tended to signicantly over-estimate their ability to make an accurate quality assessment in the one after another session, especially if they carried out the side-by-side session prior before and if they perform one-by-one prior to side-by-side then they tended to under-estimate themselves.

REFERENCES

[1] https://en.wikipedia.org/wiki/Structural similarity

[2] https://ece.uwaterloo.ca/ z70wang/publications/quality 2c.pdf

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