PREDICTION OF SMARTPHONES' PERCEIVED IMAGE QUALITY
USING SOFTWARE EVALUATION TOOL VIQET

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A great deal of resources and efforts have been made in recent years to assess how the smartphones users perceived the image quality. Unfortunately, only limited success has been achieved and the image quality assessment still based on many physical human visual test. The paper describes the new model proposed for perceived quality based on human visual tests compared with image analysis by the software application tool. The values of parameters of perceived image quality (brightness, contrast, color saturation and sharpness) were calibrated based on results from human visual experiments.

Keywords: *Perceived image quality, human visual test (HVT), objective image quality assessment, image quality attributes (IQAs), Video Quality Experts Group (VQEG), VQEG Image Quality Evaluation Tool (VIQET).*

PREDICŢIA CALITĂŢII PERCEPUTE A IMAGINILOR AFIŞATE DE SMARTPHONE-URI UTILIZÂND APLICAŢIA DE EVALUARE VIQET

În ultimii ani au fost depuse eforturi semnificative pentru a evalua modul în care utilizatorii de smartphone percep calitatea imaginilor. Din păcate, a fost atins doar un progres limitat, evaluarea calităţii imaginiilor bazându-se încă pe multiple teste vizuale umane. În lucrare este descris un nou model al calităţii percepute pe baza testelor vizuale umane, comparate cu analiza imaginii efectuate cu o aplicaţie software. Valorile parametrilor calităţii percepute a imaginii (luminozitate, contrast, saturaţia culorilor şi claritatea) au fost calibrate pe baza rezultatelor experimentelor vizuale umane.

Cuvinte-cheie: *calitate percepută a imaginii, test vizual uman (HVT), evaluarea obiectivă a calităţii imaginii, atributele imaginii de calitate (IQAs), grupul de experţi ai calităţii video (VQEG), instrumentul VQEG pentru evaluarea calităţii imaginilor (VIQET).*

Introduction

This paper provides a comprehensive overview on the perceived image quality measurements and software application calibration process. Using a number of HVT for subjective image quality assessment in order to identify the most effective image quality attributes than creating a set of processed images based on the selected image quality attributes to be used as test content for HVT. Running several HVT and analyzing the same images with the VIQET. The scores of HVT and VIQET were analyzed. The VIQET calibrated due to the outcomes of the scores analysis. Once the VIQET has new image quality parameters a new HVT conducted and the whole process done again. This process was done in several cycles in order to achieve the highest correlation between the HVT scores and VIQET scores. Once the VIQET scores were very close to the HVT scores, performing counter wise process, analyzing new images first by VIQET than in HVT and found a very high correlation.

As a first step the important IQ attributes must be identified. Numerous IQ attributes have been considered as important and evaluated by researchers to quantify IQ. These IQ attributes include for example brightness, sharpness, contrast, noise/graininess, banding, details, naturalness, color , saturation, color rendition, process color gamut, artifacts, color reproduction , tone reproduction, color shift. When reducing these IQ attributes found in the literature, there are several important issues to consider, such as the intention of how IQ attributes should be used, and their origin. A long-term goal of this research is to create a link between subjective and objective IQ of smartphone images. With this intention, the IQ attributes should be based on perception and account for technological IQ issues. The IQ attributes should be general enough to be evaluated by observers, and in order not to exclude novice observers the IQ attributes should be somewhat straightforward to evaluate. In addition, the IQ attributes should be suitable for IQ metrics, being the intended objective method. The existing sets of IQ attributes and models do not fulfill all of these requirements, and therefore a new set of IQ attributes is needed. Many of the IQ attributes listed above are similar and have common denominators, which enables them to be grouped within more general IQ attributes in order to reduce the dimensionality and create a more manageable evaluation of IQ. There is usually a compromise between generality and accuracy when it

comes to dimensionality. Linking most of the above IQ attributes to four different dimensions, considered as important for the evaluation of IQ. This results in a reasonable compromise between accuracy and complexity, as well as being close to the statement by P.Engeldrum [1] that observers will not perceive more than five IQ attributes simultaneously. IQ attributes reduced to the following four:

• **Brightness** is considered so perceptually important that it is beneficial to separate it from the color. Brightness will range from "light" to "dark".

• **Contrast** can be described as the perceived magnitude of visually meaningful differences, global and local, in lightness and chromaticity within the image.

• **Color** contains aspects related to color, such as hue, saturation, and color rendition, except lightness.

• **Sharpness** is related to the clarity of details and definition of edges.

1. The image quality assessment methods

A large number of subjective metrics have been developed for image quality subjective assessment [2,3,4]. Considering this wide range of applications, this research separated the objective research into two main categories: first, the methods that consider statistical or mathematical measurement (i.e., the image features extraction), and, second, methods that consider the human visual system (HVS) characteristics. In this approach, considering VIQET image analyzer measures with incorporation of HVS.
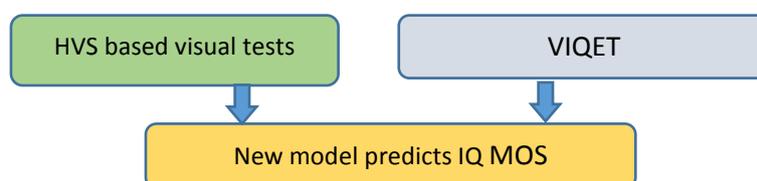

Fig.1. Image quality assessment flow.

1.1. Mathematical model for subjective metrics

The mean squared error (MSE) [5] and the peak signal-to-noise ratio (PSNR) [6] are the most widely used image quality metrics. These techniques require reference images. PSNR is a simple pixel-based comparison method whereas MSE is designed on statistical features for finding differences between reference and original images.

Although MSE or PSNR are considered as a quality metrics but these are not consistent with the HVS as they measure every pixel within with equal priority. In addition, no information of structure, contrast, visibility, etc. are considered in these methods.

MSE is the differences between corresponding pixels of the reference and the distorted images and it can be defined as:

$$MSE = \frac{1}{V} \sum_{n=1}^{V} (S_n - MOS)^2$$

(1)

where V is the number of viewers participated in the Visual tests. S is the corresponding score given by viewer per each individual image in the Visual test.

Mean opinion score (MOS) represents the scores average of each image in visual tests.

PSNR maps the MSE in a logarithmic way which is defined as:

$$PSNR = 10 \log_{10} \frac{MAX}{MSE}$$

(2)

where *MAX* is the maximum value that an image can get according to the scoring table, which is: Poor =1 and Excellent = 5. PSNR is a popular and widely used metric to evaluate and quantify performance of image processing algorithms.

2. Implementation of subjective image quality assessment

In order for the observers to use a sufficiently large set of IQ attributes, a broad range of images should be used in order to reveal different quality issues. To achieve this, following the recommendations of VQEG, where the images were chosen based on the following criteria:

Pictures of 10 natural image contents captured by smartphones camera in native resolution of 1920x1200 pixels. These 10 images will be used as a reference. Each original image will be processed by adding the IQ attributes (brightness, contrast, color and sharpness) than the overall test content will be 50 images. Test content was created according to the VQEG recommendations P.913 [3]. Contents were carefully selected to represent a wide range of different situations and demands for pictures. Also, recommendations of Photo-space standards set by I3A were considered when choosing the image contents.

Each original image was processed in order to enhance image quality attributes of: brightness, contrast, sharpness and color Saturation. The overall test content for human visual assessment and VIQET analysis includes 50 images (5 images of each scene).

1. Outdoor day – landscape, people.
2. Indoor – without backlight.
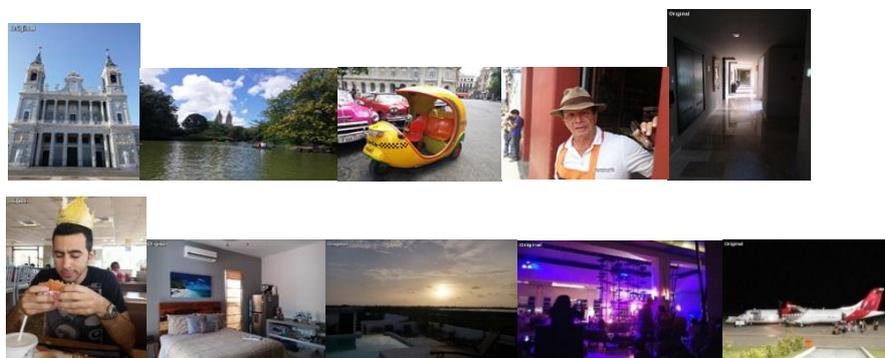3. Indoor – with backlight.
4. Outdoor – night.

Fig.2. Tests content for image quality assessment.

2.1. Test content with controlled image quality attributes

In order to measure the image quality attributes effect on perceived image quality, preparing 10 sets of natural images and four image quality attributes were added to each original image. A set of images with four different image quality attributes levels made of each single original image as demonstrated in Figure 3.
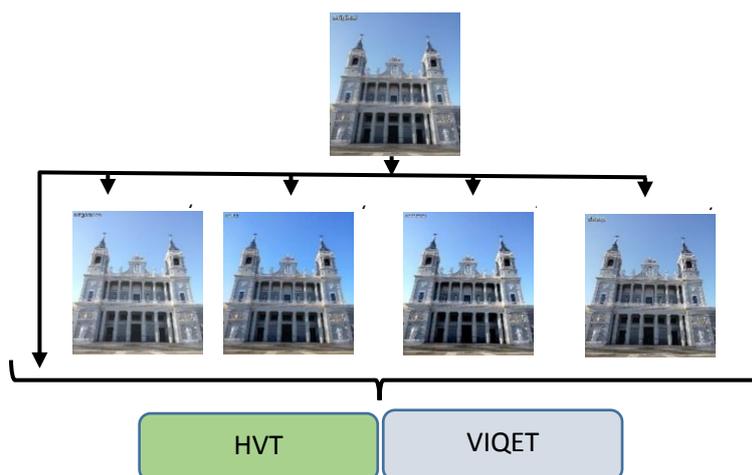

Fig.3. An example of test material processing ("building").

2.2. The proposed new model for perceived image quality prediction

The new model flow chart in Figure 4, presents the method used in this research which includes subjective IQ assessment via HVT and objective IQ assessment with VIQET (VQEG Image Quality Evaluation Tool) which was developed for this purpose.
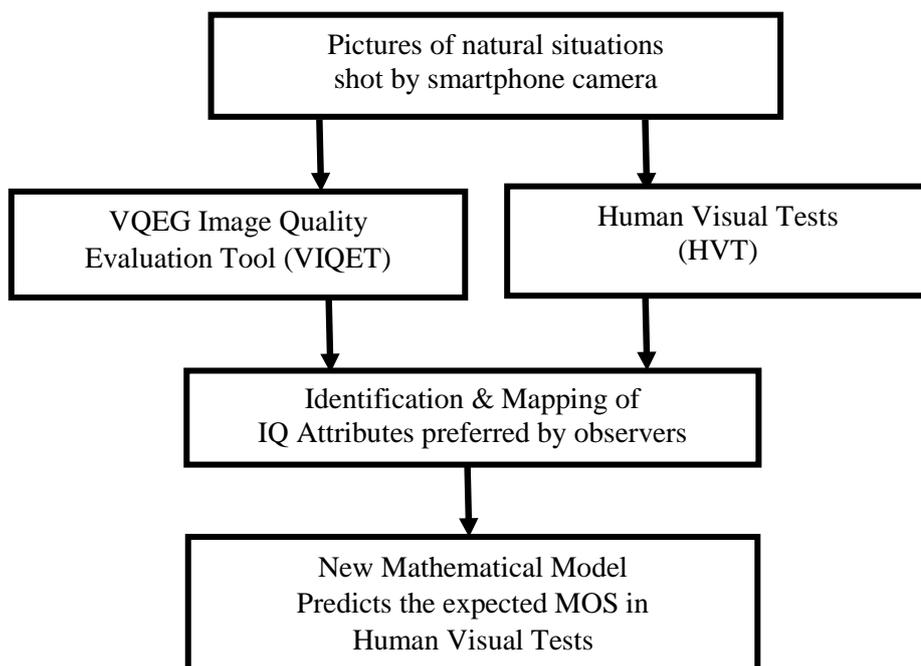
Fig.4. Model of IQ visual tests and image quality evaluation tool.

2.3. Human visual test (HVT) and VIQET image analysis

This part of study begins with an analysis of the images selected for test content for the HVT by the VIQET. The algorithm consists of two parts: first, finding how image quality attributes effect observers' preferences through HVT, and, second image analysis with the VIQET.

Taking brightness, contrast, color saturation and sharpness as major image quality attributes, because these are the most visible everyday images. Image quality attributes improve or degrade the perceived visual quality of an image, in order to verify this relationship. Therefore, the results indicate that visibility of image quality is strongly depended on the IQ attributes added to the image.
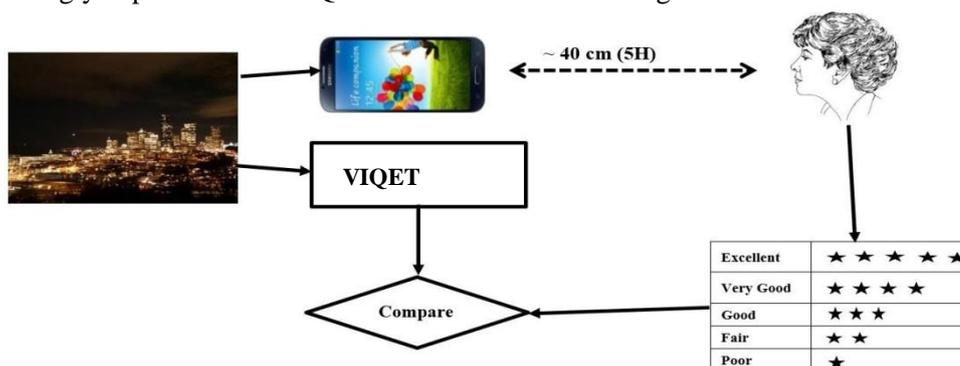

Fig.5. Model of IQ visual tests and VIQET analysis comparison.

2.4. Phase I: rating the perceived IQ using HVT

A total number of 35 non-expert (the term non-expert is used in the sense that the viewers' work does not involve television picture quality and they are not experienced assessors) subjects participated in this experiment, including 20 males and 15 females aged between 16 and 30 years. All of them had normal or correct-to-normal sight. Each subject viewed the images in database with a random order on each mobile device and viewed ten sets of five images in each set (original, + brightness, + contrast, + saturation, + sharpness). He/she rated his/her perceived image quality in the Absolute Category Rating (ACR) 5-point scale as shown in Figure 6 (corresponding to the perceived quality of "excellent," "good," "fair," "poor," and "bad").The environment

to the experiments was set following the suggestion of ITU-R recommendation BT.500-13 [7]. Before the formal test, the subjects were asked to rate a few example images to get familiar with the scoring scale and the image browsers.

Excellent	★ ★ ★ ★ ★
Very Good	★ ★ ★ ★
Good	★ ★ ★
Fair	★ ★
Poor	★

Fig.6. Staring points ranking.

2.5. Human Visual Test (HVT) procedure

The tests assessed the subjective quality of images material presented on a smartphone display (Samsung Galaxy S5) in a simulated viewing environment. The display resolution, however, was 1920 X 1080 in all tests. Each subjective experiment collected valid data from 35 participants. The test material consisted of 50 images, which included the processed images with different IQ attributes. The image samples are presented one at a time, and rated independently using the five-grade image quality scale shown in Figure 6. During the data analysis the ACR scores given to the processed versions were subtracted from the ACR scores given to the corresponding reference to obtain a difference mean opinion score (DMOS).

2.6. Phase II: Rating image quality with VIQET

The VQEG image quality evaluation tool is an objective, no-reference photo quality evaluation tool. VIQET is an open source tool designed to evaluate quality of consumer photos. In order to perform photo quality evaluation, VIQET requires a set of photos from the test device. It estimates an overall mean opinion score for a device based on the individual image MOS scores in the set.

- VIQET is an open source project that is available at www.GitHub.com/VIQET.
- The desktop tool installer can be downloaded at: https://github.com/VIQET/VIQET-Desktop/releases
- The source code can be found at: https://github.com/VIQET/VIQET-Desktop

In order to perform photo quality evaluation, VIQET requires a set of photos from the test device. It estimates an overall mean opinion score of a device based on the individual image MOS scores in the set. The estimated MOS of each photo is based on a number of image quality features and statistics extracted from the test photo. The mapping from extracted features to MOS is based on psychophysics studies that were conducted to create a large dataset of photos and associated subjective MOS ratings. The studies were used to learn a mapping from quantitative image features to MOS. The estimated MOS by VIQET falls in a range of 1 to 5, where 1 corresponds to a low quality rating and 5 corresponds to excellent quality. Figure 7 demonstrates an example of VIQET RGB histogram (red, green, blue – an abstract mathematical model describing the color model and Figure 8 demonstrates VIQET sharpness map.

Fig.7. An example of VIQET RGB histogram.

Fig.8. An example of VIQET Sharpness map.

2.7. *VIQET image quality attributes*

Table 1 demonstrates an example of VIQET IQ attributes of quantitative image features.

Table 1

VIQET image quality categories

IQ feature	Score	Range
MOS (Mean Opinion Score)	4.5	1 – 5
Multi- scale Edge Acutance	12.14	Higher is better
Noise Signature Index	99.39	0 - 589
Saturation	123.41	0 represents B&W image
Illumination	92.00	0 - 255
Dynamic Range	106.72	Represents Gary levels

Multi-scale edge acutance: refers to how sharp the outline of objects in an image are and how many edges were detected in the scene.
Noise signature index: refers to how noisy or grainy an image is.
Saturation: refers to how vivid and intense a color is.
Illumination: refers to how well-lit an image is.
Dynamic Range: is the range between the lightest and darkest regions in an image.

2.8. *Image quality analysis by VIQET*

VIQET is an objective, no reference photo quality. Evaluation tool VIQET is a free and open source tool designed to evaluate quality of consumer photos. In order to perform photo quality evaluation, VIQET requires a set of photos from the test device. It estimates an overall mean opinion score for a device based on the individual image MOS scores in the set. The estimated MOS for each photo is based on a number of image quality features and statistics extracted from the test photo. The mapping from extracted features to MOS is based on psychophysics studies that were conducted to create a large dataset of photos and associated subjective MOS ratings. The studies were used to learn a mapping from quantitative image features to MOS. The estimated MOS by VIQET falls in a range of 1 to 5, where 1 corresponds to a low quality rating and 5 corresponds to excellent quality.

The same images used in phase I for rating IQ by human visual test were required for IQ rating by VIQET to analyze each individual image and get its IQ scores (IQ categories).

3. Image quality assessment results processing

After the subjective tests, the credibility of assessment results was checked using the linear Pearson correlation coefficient (CC) suggested by ITU-T Recommendation P.913 [8].

The Linear Pearson correlation coefficient (LPCC) measures the linear relationship between a model's performance and the subjective data. Its great virtue is that it is on a standard, comprehensible scale of -1 to 1 and it has been used frequently in similar testing. The CC is calculated as follows:

$$CC = \frac{\sum_{i=1}^{N}(X_i - \overline{X}) * (Y_i - \overline{Y})}{\sqrt{\sum_{i=1}^{N}(X_i - \overline{X})^2} * \sqrt{\sum_{i=1}^{N}(Y_i - \overline{Y})^2}} \tag{3}$$

X_i denotes the subjective score MOS(i) in HVT for processed image (IQ attribute added), X denotes the MOS ("objective") of processed image (IQ attribute added) and Y_i denotes the subjective score MOSp(i) in HVT of original image (no IQ attribute added), Y denotes the MOS ("objective") of original image. N in equation (2.3) represents the total number of images considered in the analysis.

Therefore, in the context of this test, the value of N in equation (3) is: N=10. The sampling distribution of CC is not normally distributed. "Fisher's z transformation" converts CC to the normally distributed variable z. This transformation is given by the following equation:

$$z = 0.5 \cdot \ln\left(\frac{1+R}{1-R}\right) \tag{4}$$

The statistic of z is approximately normally distributed and its standard deviation is defined by:

$$\sigma_z = \sqrt{\frac{1}{N-3}} \tag{5}$$

The values of LPCC of each subject in HVT (Phase I) were calculated. As a result, the number of the valid subjects (i.e., 35) meets the requirement of the Video Quality Experts Group (VQEG).

Table 2 lists the LPCC of viewer's rating scores on each IQ attribute after the screening process. The perceived image quality of each image was measured in terms of the average score of all valid subjects, also known as the mean opinion score [8].

Table 2

The LPCC of each IQ attributes in HVT (in Phase I)

| IQ attribute	Brightness	Contrast	Original	Color Saturation	Sharpness
LPCC	0.22	0.85	0.28	0.72	0.25

The subjects in VIQET analysis were also screened according to the screening result in Phase I. The perceived image quality difference of all valid subjects, is also known as the Differential Mean Opinion Score (DMOS) [8]. Then, Cronbach's alpha value was computed to measure the internal consistency of the valid scores on each device. The value of alpha of each device is considerably large, which indicates that there is a strong internal consistency among the valid subjects.

4. Characteristic of the image quality attributes

Many of the image quality attributes IQAs, analyzed in many image quality researches, are similar and have common denominators, which enables them to be grouped within more general IQAs in order to reduce the dimensionality and create a more manageable evaluation of IQ. Linking most of the above IQAs to four different dimensions is considered as important for the evaluation of IQ. This results in a reasonable compromise between accuracy and complexity. The IQAs found in the literature were to the following four:

- **Color** contains aspects related to color, such as hue, saturation, and color rendition, except lightness.
- **Brightness** is considered so perceptually important that it is beneficial to separate it from the color. Brightness will range from "light" to "dark".
- **Contrast** can be described as the perceived magnitude of visually meaningful differences, global and local, in lightness and chromaticity within the image.
- **Sharpness** is related to the clarity of details and definition of edges.

The four dimensions are general high-level descriptors, either artefactual, i.e., those which degrade the quality if detectable, or preferential, i.e., those which are always visible in an image and have preferred positions. Most of the IQAs found in the literature can be linked with these four IQAs.
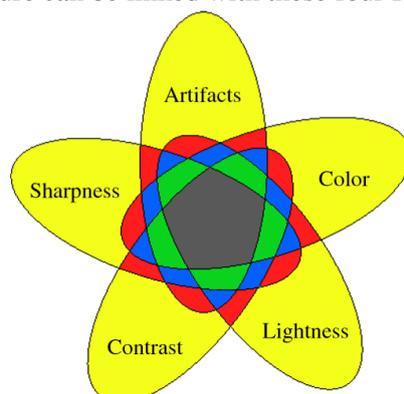
Fig.9. The Venn diagram illustrates how the overall IQ is influenced by lightness (brightness), contrast, color, sharpness and artifacts [9].

5. Perceived image quality results of HVT (Human Visual Tests)

The perceived image quality on diverse IQ attributes is firstly investigated based on the rated scores, which is, MOS, for the images categories: outdoor day, indoor and outdoor night respectively. Considering the possible influence of the IQ attributes, these images have the same resolution (i.e., 1080P) but in different

IQ attributes. Take the high and low quality images with ten randomly selected contents as an example, the relationship between the MOS, MSE, PSNR and the IQ attributes of outdoor day images, indoor images and outdoor night images were analyzed and found that there is no significant increase or decrease in the perceived quality, when the brightness is increased. The viewer's perceived quality is not significantly influenced by the change of brightness during the viewing process. In a general sense, the MOS of the images displayed on all smartphones are used to illustrate the difference of perceived image quality across four IQ attributes (brightness, contrast, color saturation and sharpness). Illustrate the rates of different IQ attributes defined by VQEG (Video Quality Experts Group) that measured and calculated by VIQET (VQEG image quality Evaluation Tool). Furthermore, a statistical analysis, which is, the one-way analysis of variance (ANOVA), is further performed to check the significance of influence of the IQ attributes on the perceived image quality. The test is firstly implemented on HVT (Human Visual Tests) while observers gave scores to each image displayed on mobile phone display. The analysis is conducted under different IQ attributes.

5.1. Calculating root mean square error

The accuracy of the objective metric is evaluated using the RMSE (Root Mean Square Error) evaluation metric, the calculated values presented in Table 3. The difference between measured and predicted DMOS is defined as the absolute prediction error Perror:

$$Perror(i) = Score(i) - MOSp \tag{6}$$

where the index i denotes the image sample.

While score (i) is the score gave by observer in HVT and MOSp is the predicted MOS (which is the average of all observers' scores). The root-mean-square error of the absolute prediction error Perror is calculated with the formula:

$$RMSE = \sqrt{\left(\frac{1}{N}\sum_{i=1}^{N}Perror(i)^2\right)} \tag{7}$$

where N denotes the total number of images considered in the analysis. (Results of the calculation using RMSE formula see Table 3).

Table 3

Results of the accuracy and signification calculation using RMSE formula

IQ attribute	Brightness	Contrast	Original	Color saturation	Sharpness
Building	0.86	0.72	0.73	0.55	0.53
Lake	0.98	0.69	0.63	0.48	0.54
Man	0.74	0.55	0.61	0.44	0.46
Taxi	0.87	0.59	0.81	0.52	0.47
Room	0.64	0.55	0.68	0.50	0.53
King	0.71	0.60	0.72	0.55	0.49
Hall	0.87	0.65	0.84	0.49	0.58
Bar	0.84	0.61	0.77	0.60	0.52
Sunset	0.81	0.61	0.72	0.55	0.44
airplane	0.88	0.56	0.72	0.49	0.44

The scores given by the VIQET which based on the four IQAs to the same images that evaluated in the HVT are presented in Table 4.

Table 4

Results of the VIQET image quality analysis

IQ attribute	Multi-scale Edge Acutance	Noise Signature Index	Saturation	Illumination	Dynamic Range
Brightness	13.09	170.33	68.81	81.56	101.19
Contrast	15.71	259.47	115.78	143.20	95.95
Original	13.11	185.46	95.86	112.56	102.32
Saturation	12.23	196.91	112.25	120.26	102.43
Sharpness	27.74	236.84	96.40	173.21	103.28

The MOS for the fifty images which evaluated by the observers during the HVT are presented in Table 5.

Table 5

MOS of perceived image quality attributes in HVT

IQ attribute	Brightness	Contrast	Original	Color Saturation	Sharpness
MOS	3.46	4.50	3.74	4.62	4.69

5.2. Calculating DMOS Values

The data analysis was performed using the difference mean opinion score (DMOS). DMOS values were calculated for each IQ attribute. DMOS values were calculated using the following formula:

$$DMOS = MOSiq - MOSo \qquad (8)$$

While MOSiq is the average of MOS of IQ attribute and MOSo is the average of MOS of the original image. In using this formula, higher DMOS values indicate better quality. Table 6 presents the DMOS values of ten images with different IQ attributes. Higher values mean better Image Quality. Sharpness, color saturation and contrast received the highest values respectively.

Table 6

DMOS calculations of IQ attributes

IQ attribute	Brightness	Contrast	Color Saturation	Sharpness
Building	-0.37	0.75	0.89	1.06
Lake	-0.31	0.66	0.86	0.83
Man	-0.66	0.69	0.83	0.80
Taxi	-0.43	0.86	0.94	0.91
Room	-0.40	0.69	0.80	0.91
King	-0.31	0.74	0.91	0.97
Hall	-0.31	0.86	0.94	1.00
Bar	-0.06	0.94	1.00	1.11
Sunset	-0.26	0.83	0.91	1.06
Airplane	-0.31	0.66	0.74	0.86

5.3. Statistical significance analysis

The performance of each objective quality model was characterized by three prediction attributes: accuracy, monotonicity and consistency. The statistical metrics root mean square error (RMSE), Pearson correlation, and outlier ratio together characterize the accuracy, monotonicity and consistency of a model's performance. These statistical metrics are named evaluation metrics in the following. The calculation of each evaluation metric is performed along with its 95% confidence intervals. To test for statistically significant differences among the performance of various models, a test based on the RMSE, tests based on approximations to the Gaussian distribution were constructed for the Pearson correlation coefficient and the Outlier Ratio. The evaluation metrics were calculated using the objective model outputs and the results from viewer subjective rating of the test images. The objective model provides a single number (figure of merit) for every tested images. The same tested images get also a single subjective figure of merit. The subjective figure of merit for an image represents the average value of the scores provided by all subjects viewing the image. The evaluation analysis is based on DMOS scores for the RR models, and on MOS scores for the NR model. Discussion below regarding the DMOS scores was applied identically to MOS scores. For simplicity, only DMOS scores are mentioned for the rest of the chapter. The objective quality model evaluation was performed in three steps. The first step is a mapping of the objective data to the subjective scale. The second calculates the evaluation metrics for the models and their confidence intervals. The third tests for statistical differences between the evaluation metrics value of different models.

Conclusions

This research proposes a new model consists of a framework and SW application for smartphone based display image quality assessment. The framework is composed of a human visual tests procedure and an evaluation procedure by the software application VQEG – VIQET. VIQET is an objective, no-reference photo quality evaluation tool. VIQET is an open source tool designed to evaluate quality of consumer photos. In order to perform photo quality evaluation, VIQET requires a set of photos from the test device. It estimates an overall mean opinion score for a device based on the individual image MOS scores in the set.

- VIQET is an open source project that is available at www.GitHub.com/VIQET.
- The desktop tool installer can be downloaded at: https://github.com/VIQET/VIQET-Desktop/releases
- The source code can be found at: https://github.com/VIQET/VIQET-Desktop

This paper provides a detailed description and analysis of subjective image quality assessment HVT based and objective image quality assessment based on SW application analysis. The correlations between the metrical and perceptual results indicated that MOS, MSE, PSNR metrics give excellent prediction performance in most cases in terms of both correlation and its variance. According to the group comparison had comparatively better prediction performance than no reference metrics. The statistical analyses were conducted to check whether the increase of the image quality attributes would lead to improvement in user's perceived image quality.

The finding is useful for the mobile phone industry to have a better understanding of the concrete benefit of enhancing the image quality attributes. The proposed quality assessment model is useful also for image quality assessment of any mobile or desktop displays. One unique feature of this proposed framework was the capability of incorporating existing full reference image quality metrics without modifying them. This research, implemented the framework for smartphones displays, and used the framework to evaluate the prediction performance of state-of-the-art image quality metrics regarding the most important image quality attributes for displays.

The evaluated image quality attributes were brightness, contrast, color saturation and sharpness, however the proposed framework was not bound by the possibilities. All the metric evaluations were supported by the correlation of objective and subjective experimental results.

Furthermore, there have been investigated the strategies to extend subjective experiments with baseline adjustment method, which is expected to save quite a lot of time and resources for subjective experiments. In a broader point of view, the originally defined research scope have been fully covered by the research presented in this thesis, all research goals have been successfully achieved, and the corresponding research questions have been answered. The proposed image quality assessment framework was originally designed for smartphone displays, but could be easily adapted to other types of displays with limited modifications. In conclusion, with the results obtained, the framework and the new approach provided by this research can be a good process for perceived image quality prediction.

Future work

The research, described in this study, is focused on still images image quality assessment based on four IQ attributes. The continuation of this research will deal with video material in HD (High Definition) content. The perceived image quality of live video is a new challenge in the image quality assessment field. The recommended IQ attributes for future research can be: frame rate conversion quality, band width limitations, video compression/decompression artifacts, motion artifacts and more.

Also, since the VIQET tool for image analysis is an open source application it is highly recommended to use the current version as starting point in order to improve it and make it up to date for future IQ attributes and objective image quality assessment.

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