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EVALUATION OF DIGITAL IMAGES USING C, RQ AND DOG METRICS

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Abstract:

In this paper, an automated system based on C, RQ, and DoG (Difference of Gaussian) metrics is developed to assess the quality of digital images. Using the Python programming language and the OpenCV library, all image files in the image folder are analyzed, and C, RQ, and DoG values are calculated for each image. The results allow us to evaluate the sharpness, edge level, and clarity of images using objective numerical indicators. The DoG metric is used to visually display an additional clarity map and its value distribution. This approach is of practical importance in computer vision, image processing, and scientific research.

Keywords: Image quality, C metric, RQ metric, DoG metric, image analysis.

1. Introduction

Qualitative assessment of digital images is of great importance in modern computer vision and image processing. The sharpness and sharpness of image quality determine the performance of systems, especially in medical diagnostics, industrial control, scientific research and multimedia technologies. Traditional

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methods of assessing image quality are often subjective and rely on the human eye. Therefore, it is necessary to evaluate images using objective digital indicators from a scientific and practical point of view.

In this study, three main metrics were used to assess image quality:

1. C metric — indicates the overall sharpness and uncertainty of the image.
2. RQ metric — evaluates the sharpness of the image based on the gradient.
3. DoG (Difference of Gaussian) metric — allows you to determine the sharpness of the image and create a visual sharpness map.

The program automatically analyzes all images in a folder, calculates the C, RQ and DoG values, and visually displays images, DoG maps and their distribution. This approach allows for a fast, accurate, and systematic assessment of image quality. Determining and assessing the quality of digital images is an urgent scientific and practical issue in modern computer vision and image processing. Image quality directly affects the efficiency of systems and the reliability of results. In medical diagnostics, industrial control, scientific research, and multimedia technologies, if the sharpness, sharpness, and clarity of the image are not properly assessed, the analysis results may be subjective and inaccurate. Therefore, it is important to assess image quality using automated and objective indicators.

The purpose of the article is to evaluate image quality using C, RQ and DoG metrics, and to determine the sharpness, sharpness level and clarity of images using objective indicators by analyzing the results numerically and visually. This will allow a systematic comparison of the quality of images obtained from different sources. The main tasks performed in the article are as follows: To develop an algorithm for evaluating digital images in terms of sharpness and sharpness using C and RQ metrics. To calculate image sharpness based on the DoG metric and display it in the form of a visual map. To create a program for automatic image analysis using Python and OpenCV libraries. To calculate C,

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RQ and DoG values for each image and visualize the results in graphical and tabular form.

The scientific novelty of this study is manifested in the use of the DoG metric in image quality assessment along with the C and RQ metrics. The DoG metric allows for a numerical and visual display of image sharpness, which complements the assessment methods that previously relied only on sharpness and sharpness. Also, a software tool for automated image quality analysis has been developed, which allows for quick and accurate results in scientific research and practical projects. The research results can be applied in computer vision, image processing, medical diagnostics, and scientific research. The automated analysis system allows for quick and objective determination of image quality, reduces errors due to the human factor, and increases the reliability of systems. Clarity maps created using the DoG metric facilitate visual analysis and clearly indicate the level of image blur and jaggedness.

2. Methodology

The quality of digital images is assessed using three main metrics: the C metric (sharpness/fuzziness), the **RQ metric** (edgeiness), and the **DoG (Difference of Gaussian) metric** (brightness). Let the image be given in the form $I \in \mathbb{R}^{M \times N}$, where M and N are the height and width of the image.

1. C metric.

The C metric measures the overall sharpness of an image and is determined based on the difference between the average filtered (blurred) images of two types.

$$B_1 = \text{blur}(I, k_1 \times k_1), \quad B_2 = \text{blur}(I, k_2 \times k_2), \quad k_1 < k_2.$$

Here $\text{blur}(\cdot)$ is the average filter operator. The difference between the two blurred images is:

$$D = |B_1 - B_2|.$$

And the C metric is calculated as follows:

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$$C = \frac{1}{M \cdot N} \sum_{i=1}^M \sum_{j=1}^N D(i, j).$$

This value indicates the level of sharpness of the image: high C — sharp image, low C — flat or blurry image.

2. RQ metric.

The RQ metric evaluates the degree of edgeness of an image through gradients. Differential operators in the x and y directions are defined over the image:

$$\Delta_x(i, j) = I(i, j) - I(i+1, j), \quad \Delta_y(i, j) = I(i, j) - I(i, j+1).$$

These differences are squared and the total differential energy is determined:

$$E_{\text{diff}} = \sum_{i=1}^{M-1} \sum_{j=1}^N \Delta_x(i, j)^2 + \sum_{i=1}^M \sum_{j=1}^{N-1} \Delta_y(i, j)^2.$$

After that, the RQ metric is calculated:

$$RQ = \frac{E_{\text{diff}}}{K \cdot M \cdot N}.$$

Here K is the normalization coefficient. RQ indicates the edge density and sharpness of the image.

3. DoG (Difference of Gaussian) metric.

The DoG metric is used to determine the sharpness of an image. The image is smoothed using two types of Gaussian filters:

$$G_{\sigma_1} = I * G(\sigma_1), \quad G_{\sigma_2} = I * G(\sigma_2), \quad \sigma_1 < \sigma_2.$$

Bu yerda $*$ — konvolyutsiya operatori, $G(\sigma)$ — standart deviation σ bilan Gaussian yadrosi.

Here $*$ is the convolution operator, $G(\sigma)$ is the Gaussian kernel with standard deviation σ .

The DoG map is:

$$DoG = |G_{\sigma_1} - G_{\sigma_2}|.$$

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DoG metric — average image clarity:

$$DoG_{score} = \frac{1}{M \cdot N} \sum_{i=1}^M \sum_{j=1}^N DoG(i, j).$$

The DoG map and its histogram allow for visual analysis of image clarity.

4. General analysis process.

The values of the three metrics for each image are obtained as follows:

$$(C, RQ, DoG_{score}) = f(I; k_1, k_2, K, \sigma_1, \sigma_2).$$

The results for all images in the folder are collected in vector form:

$$C = [C_1, C_2, \dots, C_n], \quad RQ = [RQ_1, RQ_2, \dots, RQ_n], \quad DoG = [DoG_1, DoG_2, \dots, DoG_n].$$

The results are then visualized in graphical and tabular form, allowing for a systematic and objective assessment of image quality.

3. Results

C, RQ, and DoG metrics were calculated for the 19 analyzed images. The C metric measures the level of image sharpness and blur, the RQ metric measures the edge, and the DoG metric measures the image clarity. The results show that there are significant differences in quality between the images. For example, image 1.jpg has $C = 6.70$, $RQ = 35.68$, and $DoG = 4.82$, indicating that the image has high sharpness, edge, and clarity. At the same time, images rog1.png, rog2.png, and rog3.png have C values in the range of 1.07–1.15, RQ 5.90–5.98, and DoG 0.77–0.84, indicating that their sharpness, edge, and clarity are low. In some images, there are differences between the C and RQ values. For example, in the image rog4.png, $C = 2.94$, $RQ = 19.24$ and $DoG = 2.08$, i.e., the sharpness and clarity are relatively high despite the low resolution. In such images, the image quality indicators can be related to background noise, contrast and object size (Table 1).

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The analysis showed that the DoG metric, when used together with C and RQ, allows for visual and numerical determination of image clarity, which contributes to objective and systematic quality assessment.

Table 1. Results table

No	Tasvir nomi	C	RQ	DoG
1	1.jpg	6.7005	35.6811	4.8169
2	2.jpg	4.8300	28.9610	3.1169
3	3.jpg	1.8075	11.3772	1.4024
4	ddr1.png	7.6538	13.3416	5.7127
5	ddr2.png	6.9905	8.7291	4.6334
6	ddr3.png	2.1213	6.0951	1.5892
7	ddr4.png	8.9292	9.5175	6.2344
8	ddr5.png	3.8668	13.6058	2.8016
9	ddr6.png	7.1231	15.1977	4.8716
10	ddr7.png	6.1728	12.4261	4.1429
11	ddr8.png	3.4034	10.6654	2.3806
12	metric_plot.png	1.9743	1.3348	1.4498
13	metric_plot3.png	4.3841	2.8675	2.7052
14	rog1.png	1.0768	5.9641	0.7667
15	rog2.png	1.0914	5.9842	0.8049
16	rog3.png	1.1460	5.9020	0.8437
17	rog4.png	2.9363	19.2375	2.0823
18	rog5.png	2.3000	14.1918	1.6443
19	rog6.png	2.6177	16.6076	1.8814

The analysis shows that when assessing image quality, the C and RQ metrics indicate sharpness and sharpness, while DoG provides an additional indicator of clarity. Thus, the combined use of the three metrics allows for a systematic and objective assessment of image quality.

4. Conclusion

In this study, a systematic approach was developed based on the C, RQ, and DoG metrics to assess the quality of digital images. The results of the study showed that the C metric accurately indicates the image sharpness and blur, the RQ metric

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accurately indicates the degree of sharpness, and the DoG metric accurately indicates the image clarity. The values obtained for the 19 analyzed images showed significant differences in image quality. High C, RQ, and DoG values indicate that the image has a sharp, clear, and high sharpness, while low values indicate low-quality images. It was also observed that some images have high sharpness and clarity despite low resolution, which indicates that image quality indicators depend on background noise, contrast, and object properties. The practical significance of this approach is that it provides an objective and systematic assessment of image quality. The results can be used in computer vision, image processing, medical diagnostics, and scientific research. At the same time, the DoG metric makes image quality analysis more convenient by creating visual sharpness maps. The combined use of C, RQ, and DoG metrics allows for an efficient, reliable, and practical assessment of digital images in terms of sharpness, edge, and clarity.

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