UDK 004.93

PRESENTATION OF THE IMAGE IN COMPUTER MEMORY

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The method of color coding which allows to carry out the independent analysis of brightness and color is considered. Algorithms for processing digital images, the task of which is to change the relevant parameters, are analyzed. The conclusion about modification of image parameters is made.

One of the fundamental problems of today is the problem of visual perception. It arose a long time ago. It is relevant today, because the image is a natural means of communication between man and machine in any processing, analysis and control systems. Image processing is responsible for image conversion (filtering). The development of modern computer technology and information technology contributes to the widespread implementation of automatic image processing systems. The main purposes and algorithms of image processing are defined: improving the image for computer perception and improving the image for human perception.

Keywords: *color coding method, brightness and color analysis, digital image processing algorithms, digital image, color models, image processing, image processing purposes, changing image parameters.*

The practical significance. A digital image consists of pixels. In the case of monochrome or color images, images that have not undergone color correction, each pixel corresponds to the value read from the corresponding image converter element.

If a color image has undergone a color correction process, each pixel corresponds to a set of numbers that describe its brightness and color.

The color can be represented by different models: RGB, Lab, XYZ, Yxy, Luv, HSL, HSV, HSB, etc. [1, 6].

In typical solutions, the image is converted to a so-called additive RGB model. In this model, the pixel describes three values that correspond to the intensities of the components (red, blue, and green) of the registered color.

The description of the color model requires the introduction of the definition of illuminator and standard observer.

Illuminator – is a light picture with a specific spectral distribution. The type of illuminator is important for human perception of color, it also depends on some values of the conversion factors between models. Several common types of illuminators have been introduced. For example, D55, D65, D75 luminaires corresponding to daylight with a temperature of 5500K, 6500K and 7100K respectively.

Standard observer – it is a certain function that forms a person's color vision, which eliminates the influence of individual differentiation on their perception. The most commonly used type of standard observer used is the CIE 1931 Standard Observer 2°, the characteristics of which correspond to day vision in strong enough light, for a viewing angle of 2°. This type of observer was proposed by the CIE (Commission Internationale de l'Eclerage, International Commission on Lighting) in 1931.

RGB model – it is a convenient model for decomposing the image into components during registration and for display on monitors. The additive RGB model is also used, however, less useful in terms of advanced analysis and conversion. For example, changing the brightness in the RGB model affects all parameters of the model, making it difficult to compare objects of the same color, but illuminated by light of different intensities.

The CIELAB model is an example of a color coding method that allows independent analysis of brightness and color. In the CIELAB model, brightness is described by the L* parameter, and color information is described by the a* and b* parameters. Conversion between RGB and CIELAB systems requires the use of the XYZ model. The first step is to calculate the auxiliary values R', B' and G', as well as R", B" and G" for each RGB channel.

$$for\ R, G, B \in [1]$$

$$If\ (R > 0.04045)\ then\ R' = \left(\frac{R + 0.055}{1.055}\right)^{2.4}\ else\ R' = \frac{R}{12.92}$$

$$If\ (G > 0.04045)\ then\ G' = \left(\frac{G + 0.055}{1.055}\right)^{2.4}\ else\ G' = \frac{R}{12.92}$$

$$If\ (B > 0.04045)\ then\ B' = \left(\frac{B + 0.055}{1.055}\right)^{2.4}\ else\ B' = \frac{R}{12.92}$$

$$R'' = R' \cdot 100;\ G'' = G' \cdot 100;\ B'' = B' \cdot 100;$$

For observer 2° and illuminator D65, the following relationship is used between the values of R", B" and G" and XYZ

$$X = R'' \cdot 0.4124 + G'' \cdot 0.3576 + B'' \cdot 0.1805$$

$$Y = R'' \cdot 0.2126 + G'' \cdot 0.7152 + B'' \cdot 0.0722$$

$$Z = R'' \cdot 0.0193 + G'' \cdot 0.1192 + B'' \cdot 0.9505$$

The parameters of the XYZ model correspond to the parameters of the relative coordinate space xyz [2-4]. The values in the conversion correspond to 2° observer and illuminator D65.

The conversion to the target CIELAB form is then performed.

For the observer 2° and illuminator D65:

$$X_{ref} = 95.047;\ Y_{ref} = 100;\ Z_{ref} = 108.88;$$

$$X' = \frac{X}{X_{ref}};\ Y' = \frac{Y}{Y_{ref}};\ Z' = \frac{Z}{Z_{ref}}$$

$$If\ (X' > 0.008856)\ then\ X'' = \sqrt[3]{X'}\ else\ X'' = (7.787 \cdot X') + \frac{16}{116}$$

$$If\ (Y' > 0.008856)\ then\ Y'' = \sqrt[3]{Y'}\ else\ Y'' = (7.787 \cdot Y') + \frac{16}{116}$$

$$If\ (Z' > 0.008856)\ then\ Z'' = \sqrt[3]{Z'}\ else\ Z'' = (7.787 \cdot Z') + \frac{16}{116}$$

$$L^* = (116 \cdot Y'') - 16$$

$$a^* = 500 \cdot (X - Y)$$

$$b^* = 200 \cdot (Y'' - Z'')$$

Objectives and methods of image processing

In the case of the primary creation of the image (photo) often have problems of the following nature: the image is noisy or fuzzy, dark or low-contrast, it has the wrong colors (wrong white balance) or unevenly lit.

Accordingly, you can identify the main goals for image processing.

The first goal is to improve the image for computer perception, ie with the help of various known tools (algorithms) to further simplify image recognition.

The second goal is to improve the image for human perception, ie to improve the image so that it looks more attractive and "better" from a subjective point of view. These include image processing in various graphic editors (Photoshop and others), to improve it and meet the aesthetic needs of man with a beautiful image [4, 8].

The recorded digital image undergoes various transformations depending on its purpose. One of the operations is a procedure for reconstructing a color image based on an image obtained from an image converter equipped with a mosaic filter.

Along with the very dynamic development of technologies related to image recording and processing, many new methods and algorithms have been developed in recent years. Many methods, which are currently of almost purely theoretical importance (due to the high requirements for computing power and image quality, as well as the ability to store and transmit them), are widely used in practice.

Processing algorithms can be divided into those whose task is to change specific parameters of the image, and those whose purpose is to remove certain features from the image.

The first group includes, among other things, operations aimed at improving the visual quality of the image (subjective or corresponding to specific, objective criteria), adapting it to the requirements established by the algorithms by which the image will be processed (for example, image compression, reduces calculation time), changing the way color information is recorded, etc.

The second group includes operations that allow you to select image elements that meet certain criteria (for example, a certain color, type of texture, contours, etc.). For such image elements, you can calculate various parameters that describe them. You can perform image recognition based on certain parameters.

Image processing, changing its parameters

A monochrome image can be considered as a two-dimensional signal

$$I(u_1, u_2),$$

with real values, and the values of u_1 and u_2 are valid coordinates. In the case of color images, we can assume that the values of $I(u_1;u_2)$ are vectors of real numbers, and the components of these vectors correspond to the values of the components that describe the pixel parameters in the adopted color registration model (RGB, CIELAB, etc.).

The image registration process using image converters can be interpreted as a process of image sampling and quantization. The image projected by the optical system on the surface of the transducer is analyzed by a matrix of photocells of the transducer. Each of the photocells analyzes the brightness level of the image fragment corresponding to the area occupied by this photocell. The brightness level is converted to an electrical quantity (voltage in CMOS converters or charge in CCD converters). This process can be considered as a sample of a two-dimensional signal. Then each sample is converted by analog-to-digital converters into a number. As a result of recording, the monochrome image becomes a signal [3, 4-7].

$$I(l_1, l_2),$$

with discrete domain and values

$$I : \Omega \rightarrow \{1, ..., E\}, E \in ?, \Omega \subset ?^2$$

then the color image takes the form of a signal

$$I : \Omega \rightarrow E, E \in ?^P, \Omega \subset ?^2$$

where p – is the number of parameters provided in the color registration model for example, for the RGB model p = 3). Discrete image elements are called pixels. It is known from the Shannon-Nyquist sampling theorem that a limited signal range can be fully reproduced using samples of this signal if the sampling frequency is at least twice the frequency value that limits the frequency band of the sampled signal. In the case of sampling electrical signals from converters that supply a time-varying analog signal, low-pass filters are used to limit the bandwidth of the signals. In the case of image converters, it is necessary to limit the bandwidth of the signal (image) to a value determined by the resolution of the converter. The image is an optical signal. For an image, you can define the frequency of the brightness changes in the selected area as a function of changing the position of the point lying in that area. In order to distinguish the period and frequency that describe the change in signal over time, the terms spatial period and spatial frequency are used. If the spatial period of brightness changes in an image with a sinusoidal light distribution is equal to Δs, then the frequency of this signal can be determined by the expression

$$w = \frac{1}{\Delta s}. \quad (1)$$

For such a signal, you can determine the sampling density required to record it. In image converters, this determines the minimum distance between the light-sensitive elements of the converter. According to the sampling theorem, this distance must satisfy the condition

$$\Delta k \leq \frac{1}{2w}. \quad (2)$$

In practice, condition 2 requires limiting the image bandwidth achieved by optical image blurring elements, which are called “antialias filters” in the English literature, or limiting the resolution of lenses at the design stage.

Conclusions. Image processing can be in the coordinate region of the image or in the transformed domains (for example, in the frequency domain).

Modification of image parameters performed in the area of image coordinates can be carried out according to several basic patterns of behavior: point operations, spatial filtering and morphological operations.

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doi: 10.32403/2411-3611-2021-1-39-55-61

ПОДАННЯ ЗОБРАЖЕННЯ В ПАМ’ЯТІ КОМП’ЮТЕРА

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Розглянутий метод кольорового кодування, який дозволяє проводити незалежний аналіз яскравості та кольору. Проаналізовані алгоритми опрацювання цифрових зображень, завданням яких є зміна відповідних параметрів. Зроблений висновок про модифікацію параметрів зображення. Однією з фундаментальних проблем сьогодення, є проблема зорового сприйняття. Виникла вона дуже давно. Вона є актуальною і в теперішній час, тому що зображення це природній засіб спілкування людини і машини в будь-яких системах обробки, аналізу і контролю. Цифрове зображення складається з пікселів. У випадку монохромних зображень або кольорових, зображення, які не зазнали кольорокорекції, кожен піксель відповідає значенню, зчитаного з відповідного йому елемента перетворювача зображень.

Якщо кольорове зображення пройшло процес кольорокореккції, то кожен піксель відповідає набору цифр, що описують його яскравість та колір.

Опрацювання зображення відповідає за перетворення (фільтрацію) зображення. Розвиток сучасних засобів комп’ютерної техніки і інформаційних технологій сприяє широкому впровадженню в практику систем автоматичної обробки зображення.

Метою статті є визначити основні цілі і алгоритми опрацювання зображень: покращення зображення для сприйняття комп’ютером та покращення зображення для сприйняття зображення людиною.

Опрацювання зображень може бути в координатній області зображення або в трансформованих доменах (наприклад, в частотній області). Модифікація параметрів зображення, що проводиться в області координат зображення, може здійснюватися відповідно до декількох основних зразків поведінки: точкових операцій, просторової фільтрації та морфологічних операцій

Ключові слова: *метод кольорового кодування, аналіз яскравості та кольору, алгоритми опрацювання цифрових зображень, цифрове зображення, колірні моделі, опрацювання зображень, цілі опрацювання зображень, зміна параметрів зображення.*

Стаття надійшла до редакції 12.05.2021.
Received 12.05.2021.