Analysis of the relationship between the choice of the color model for the representation of images and the efficiency of solving the problem of improving the image resolution

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Abstract. The article discusses the influence of the choice of a color model for representing a raster image on the efficiency of increasing its resolution using an artificial neural network. The article begins with the essence of the research. After that, the process of obtaining for training networks with an identical topology of a dataset using different color models of image representation, namely RGB, HSV, L*a*b*, NTSC and YCbCr, is described. After that, an assessment of the effectiveness of trained neural networks on the previously described datasets is given. To assess the performance of an artificial neural network, two algorithms are used: SSIM and PSNR. As a result of the assessment, the networks using RGB and YCbCr color models showed the highest results. At the end of the article, there are reflections on the reasons for this result.

1. Introduction
Various machine learning methods are widely used in various fields. We can say that over the past five years, machine learning, as a branch of the science of artificial intelligence, has significantly expanded and become more complex. So, one of these areas of practical application of machine learning algorithms is the processing of information presented in graphical form. In practice, this is expressed in the use of artificial neural networks in medicine, production, security systems, etc. [1-7]

In this paper, one of the areas of the problem of artificial vision is considered, namely, the influence of the choice of the color model of the image, the resolution of which will be improved using an artificial neural network.

2. Main part
A few words about color models of image presentation. In this work, the color model is assumed to be a mathematical model for describing color in the form of a set of numbers. For the analysis, the five most common color models were taken, namely: RGB, HSV, L*a*b*, NTSC and YCbCr.

Briefly about each color model used in the work. RGB is an additive color model based on three colors: red, green and blue. HSV is similarly a three-channel color model, but it is based on hue, saturation, and brightness. L*a*b* consists of three channels of light coordinates, a spectrum from green to magenta, and a spectrum from cyan to yellow. In the NTSC color model, color is represented as 3 components - luminance and two artificial color differences. YCbCr is a subtractive color model consisting of a luminance component and a blue and red color-difference components. [8]

Next, we will consider the methodology of the approach to finding an answer to the above problem. Briefly, a dataset of four thousand high-resolution images was prepared. After that, this set was transformed into five, each of which differed in the used color model to represent information. It is worth noting that if you select a random image in one of the datasets, then the same image will be
present in the remaining four, with the only proviso that each image will have its own color model, different from the others.

Figure 1. Preparing datasets

Once the datasets were formed, they were used to train artificial neural networks. Note that the “Deep learning toolbox” in the “matlab” environment was used as a software development tool. Architecturally trained neural networks are identical. That is, in fact, the difference between the trained neural networks was in the dataset used to train them. The topology of artificial neural networks is identical and is shown in Figure 1.

Figure 2. ANN topology
3. Discussion
The problem of the influence of the choice of a color model for representing a raster image on the efficiency of increasing its resolution using an artificial neural network has not been previously considered. The closest similar study can be considered [9]. In this article, the influence of the choice of a color model on the efficiency of solving the problem of image classification by an artificial neural networks were analyzed. Although the problem considered in the study presented in [9] is different from ours, an important conceptual result of the study described in [9] is the conclusion that the choice of a color model affects the efficiency of solving the problem of classifying images of an artificial neural network. Thus, it can be assumed that for the task of increasing the resolution of a raster image using an artificial neural network, the use of different color models will lead to different efficiency in the operation of typologically identical artificial neural networks.

Evaluation of the efficiency of the trained artificial neural networks, and as a consequence, based on the above material and the applied color model of image representation, was made as follows. A batch of images was prepared, consisting of one hundred pieces. Each neural network processed each image from the package. Then, using the PSNR and SSIM methods, the efficiency of the artificial neural network was evaluated for each of the images. Then the mathematical expectation was calculated for the package for each of the methods. Thus, in Table 1, the averaged values are summarized.

**Table 1. Comparison of results**

| Color Model | PSNR  | SSIM  |
|-------------|-------|-------|
| RGB         | 33.1362 | 0.9036 |
| YCbCr       | 32.4988 | 0.8943 |
| NTSC        | 8.5457  | 0.0321 |
| L*a*b*      | 19.6087 | 0.1485 |
| HSV         | 8.5424  | 0.0317 |

For the convenience of perceiving the information presented in Table 1, it was presented in the form of diagrams in Figure 3 and Figure 4. As seen from Figure 3 and Figure 4. The best choice was the RGB color model. At the same time, it is worth noting the high result when using the YCbCr color model.

![Figure 3. Evaluation of effectiveness with PSNR](image-url)
4. Conclusion

Thus, the two most preferred color models were identified for solving the problem of increasing the image resolution. The fact of such results can, in part, be explained by the fact that most of the means intended for photographing in one way or another represent data in RGB format. And to work with other formats, it is necessary to carry out a series of transformations on the data, which are accompanied by the loss of information.

The presented results in the article can be used in the design of artificial neural networks that are used to increase the image resolution.

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