Image enhancement with DAGNet-based artificial neural network

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Abstract. The article is devoted to an artificial neural network that increases image resolution. According to the meaning of the article, two parts can be distinguished. The first part of the article discusses the process of designing an artificial neural network using DAGNet technology, during which its main parameters and structure are described. The second part is devoted to assessing the quality of functioning of the developed artificial neural network. To evaluate the performance of ANNs a comparative analysis with the bicubic interpolation method was used.

1. Introduction
When it comes to tasks that involve working with graphical information, one of the most frequently used tools is solutions based on artificial neural networks. The reason why neural networks are so popular in some areas is their high efficiency in solving assigned tasks.

The tasks, which are solved using methods based on artificial neural networks include: search for objects in the image; classification of objects represented in the image; increase image resolution and others [1-6].

This article presents the results of developing a deep artificial neural network, the purpose of which is to increase the resolution of a raster image.

2. Neural network design and training
To design an artificial neural network, the principles contained in [7,8] were used. In general, the neural network design approach can be attributed to the group of example-based methods. As the main development tool, “Deep learning toolbox” in “MATLAB” environment was used. The development process consisted of four stages. Brief characteristics of the steps are shown in figure 1.

At the first step, 7000 high-resolution images were prepared, namely in HD and 4K formats.

At the second step, training pairs are formed for the artificial neural network. So, one training pair consists of an image that will be fed to the input of a neural network, and an image that is a reference. The reference image is equivalent to the original, and the input image is obtained by artificially lowering the resolution of the original image by 6 times. It is worth mentioning that, each pair image is transcoded from the RGB color model to the YCbCr color model. After recoding, all components except brightness are discarded.
At the third stage, the structure of the artificial neural network is designed. The basis of the network is three functional blocks, the main task of which is to highlight the parameters for image enhancement. The topology of the entire network is shown in figure 2. The structure of the block of
feature extraction is shown in figure 3. Obviously, convolutional layers highlight features that are subsequently added to the original image, due to which an increase in image resolution is achieved.

After developing the network topology, it was trained. For training an artificial neural network, the Matlab application software was used. The training parameters of the neural network are presented in figure 4. The training schedule for the artificial neural network is shown in figure 5.

**Figure 3.** The architecture of the block that highlights the features of the image.

**Figure 4.** Parameters of learning an artificial neural network.

3. Artificial neural network performance evaluation
To assess the quality of the artificial neural network (figure 6), a comparative analysis of the results on image enhancement using the developed artificial neural network and the bicubic interpolation method (BIM) was performed.
The neural network performance was estimated using two methods: Peak Signal-to-Noise Ratio (PSNR) and Structural Similarity Index (SSIM). As you can see from the table, DAGNet performed better than the bicubic interpolation method.
Table 1. Comparison of results.

|       | PSNR   | SSIM  |
|-------|--------|-------|
| BIM   | 25.6979| 0.9405|
| DAGNet| 26.3373| 0.9407|

4. Conclusion

Improving image resolution can potentially be used in areas that deal with graphic information. For example, in the field of recognition of graphic images. Artificial neural networks can increase the resolution of an image before transmitting a given image to a classification algorithm to improve the quality of its operation. There is a potential possibility of using the method of increasing image resolution using an artificial neural network in research activities in various fields of science.

The dynamic development of the use of artificial neural networks to increase image resolution provides the basis for an optimistic forecast regarding the possibility of implementing theoretical developments in this area in practical solutions.

References

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