IMPROVING IMAGE QUALITY BASED ON THE SRCNN ALGORITHM

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Abstract. *Improving the quality of digital images, in particular, restoring high-resolution versions of low-resolution images, is one of the most relevant research areas in artificial intelligence today. This article considers an image quality improvement algorithm based on the Super-Resolution Convolutional Neural Network (SRCNN) model. SRCNN is the first super-resolution model developed based on a convolutional neural network, which has high efficiency in converting low-resolution images into high-quality ones. The article analyzes the architecture, operating principle, advantages and disadvantages of the model, and highlights areas of practical application. The results show that using the SRCNN model provides much higher quality in restoring image clarity and detail compared to traditional interpolation methods.*

Keywords. *Information security, biometric systems, face recognition, crash control, super-resolution, SRCNN, image enhancement, artificial intelligence*

INTRODUCTION

Digital images are widely used in almost all areas of our lives: medical diagnostics, artificial vision systems, security cameras, multimedia, artificial intelligence, etc. The accuracy and quality of images used in these areas directly affect the reliability of the analysis results. However, due to various reasons - technical limitations, signal transmission losses or the use of low-quality devices - in most cases, low-resolution images are obtained. Therefore, the problem of

improving image quality is one of the most relevant areas of modern digital image processing [1-2].

In recent years, the rapid development of deep learning methods has opened up new opportunities for solving this problem. In particular, the SRCNN (Super-Resolution Convolutional Neural Network) model has been recognized as one of the effective solutions for restoring high-quality images from low-resolution images. SRCNN is able to restore high-resolution images by learning the main features of the image using a simple convolutional neural network architecture.

This article discusses in detail the working principle, architecture, advantages, and practical applications of the SRCNN model.

MAIN PART

1. General idea of the SRCNN algorithm. SRCNN is a super-resolution (SR) model based on a convolutional neural network, which aims to restore a high-resolution (HR) image from a low-resolution (LR) image. Unlike traditional interpolation methods, SRCNN is able to restore lost image details based on learned features [3-5].

2. SRCNN algorithm workflow

Stage 1: Pre-processing. In the pre-processing stage of the SRCNN model, the low-resolution image (LR) is first upscaled to the desired size using bicubic interpolation. This stage provides the model with a high-resolution but low-quality image as input.

Stage 2: Processing via a three-layer CNN

The model consists of three main convolutional layers:

3. Layers of the SRCNN architecture. Layer 1: Feature Extraction. This layer detects the main structures (edges, textures, and contours) in the image.

- ✓ Convolution: Conv2D;
- ✓ Number of filters: 64;
- ✓ Filter size: 9×9;

- ✓ Activation function: ReLU.

Mathematical expression:

$$F_1(Y) = \max(0, W_1 * Y + B_1)$$

where,

- ✓ Y: input interpolated image;
- ✓ *: convolution operation;
- ✓ W_1, B_1: 1 - layer weight and shift parameters.

Layer 2: Non-linear Mapping. In this stage, the features in the first layer are transformed into higher-level abstractions.

- ✓ Number of filters: 32;
- ✓ Filter size: 1×1;
- ✓ Activation function: ReLU.

$$F_2(Y) = \max(0, W_2 * F_1(Y) + B_2)$$

This layer is the main "intellectual" part of the neural network, preparing the image for reconstruction.

Layer 3: Reconstruction. This layer reconstructs the final HR image. It produces the final result based on the features in the previous layer.

- ✓ Number of filters: 1;
- ✓ Filter size: 5×5;
- ✓ Activation function: none (linear).

$$F_3(Y) = W_3 * F_2(Y) + B_3$$

4. Loss function. The model is trained using the MSE (Mean Squared Error) loss function:

$$MSE = \frac{1}{n}\sum_{i=1}^{n}\left(\widehat{Y}_i - Y_i\right)^2$$

where:

- ✓ $\widehat{Y}_i$: model output;
- ✓ Y_i: original HR image;

- ✓ n: number of pixels.

5. Model training. The model is trained on datasets such as ImageNet, Set5, Set14, BSD500. For each input image, a low-resolution version is created and fed to the model. The model is trained to produce results that are closer to the original HR image [6].

CONCLUSION

The SRCNN model is the first CNN-based super-resolution model that has made a significant breakthrough in improving image quality. Its simple and efficient architecture, feature-based approach, and high-quality results have made it a model widely used in scientific and practical projects. Currently, many advanced models (FSRCNN, VDSR, EDSR, ESRGAN) have been created inspired by it.

REFERENCES

1. Pratt W.K. Digital image processing. New York: JOHN WILEY & SONG, 2001. - 792 p. Burge M. and Burger W. (1998a) Ear Biometrics. BIOMETRICS: Personal Identification in a Networked Society, - P. 273-286.

2. Zhumaev, T. S., Mirzaev, N. S., & Makhkamov, A. S. (2015). Algorithms for segmentation of color images based on the selection of strongly coupled elements. Studies of technical sciences,(4), 22(27), 4.

3. Jumayev T.S. Shaxsni tanib olish masalasida tasvirdagi obyekt belgilarini ajratish algoritmlari //O‘zbekiston jurnali “Islom tafakkuri”. – Toshkent, 1-son, 2021, -B.172-175.

4. Mahkamov, A. A., Jumayev, T. S., Tuhtanazarov, D. S., & Dadamuxamedov, A. I. (2023). Using AdaBoost to improve the performance of simple classifiers. In Artificial Intelligence, Blockchain, Computing and Security Volume 2 (pp. 755-760). CRC Press.

5. Saminjonovich, T. J. (2022). Algorithm for extraction of identification features in ear recognition. ACADEMICIA: An International Multidisciplinary Research Journal, 12(1), 232-237.

6. Saminjonovich, J. T., & Abdujabborovich, M. A. (2024). ALGORITHM FOR FEATURE EXTRACTION FROM EAR IMAGES ON THE BASE OF DISCRETE COSINE TRANSFORMATIONS. Web of Technology: Multidimensional Research Journal, 2(2), 48-53.