Image Denoising Based on A CNN Model

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Introduction

- Why Denoising?

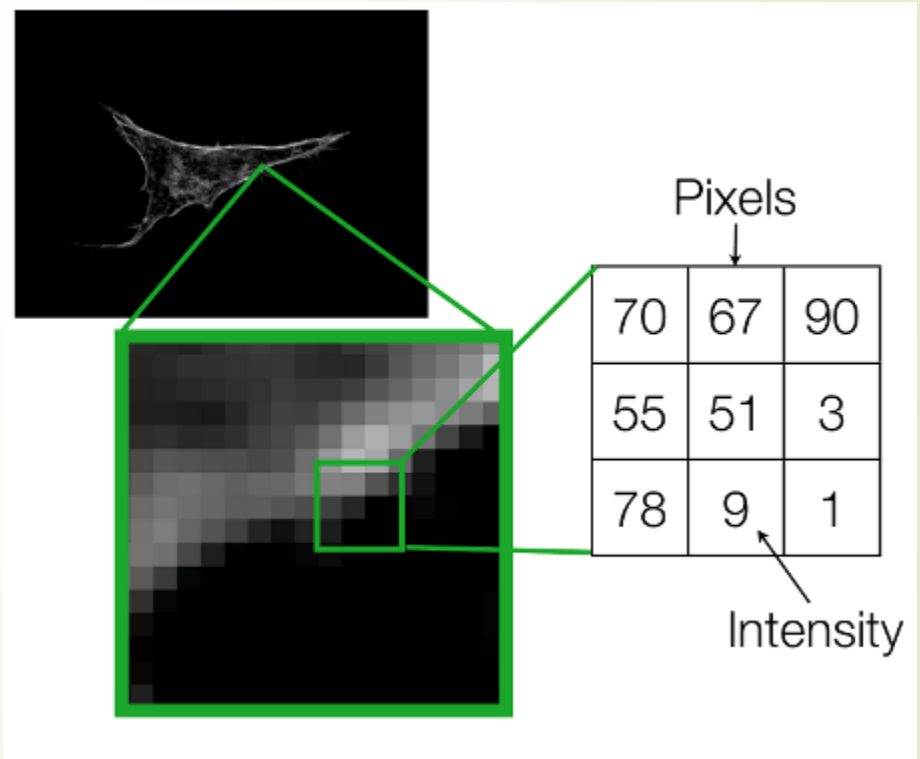
  In digital image processing, filtering noise to reconstruct a high quality image is an important work for further image processing

- Examples: object segmentation, edge detection, recognition,

  feature extraction, etc.

Introduction

- For the 2D visual signals, we usually have two forms of filtering which are based on “spatial domain” and “frequency domain”
- Spatial domain
  - modify the value of the pixels
  - I’(x,y) = T [I(x,y)]
- Frequency domain
  - modify the Fourier transformation of the image
  - the rate of change of pixel values



How to denoise?

- Traditional Denoising Approaches
  - Average filtering
  - Wiener filtering
  - Median filtering
- Image Denoising Using Neural Networks
  - use a CNN model for image denoising

Artificial neural networks

- As a classifier for pattern classification in digital image processing
- Examples: optical characters recognition (OCR), face detection and recognition, image restoration and reconstruction, image enhancement, etc.

Artificial neural networks

- Widely used in image denoising because the networks adapt the nonlinear operations for digital image processing
- Effectively applied to image denoising:
  - pulse coupled neural network models (PCNN)
  - convolutional neural network models (CNN)
  - fuzzy neural network models (FNN)

CNN model

- Use convolutional layers of a linear CNN model to implement image filtering
- Continuously optimizes the weights of convolution kernel during training
- Design the linear CNN model to compare with the traditional linear and nonlinear filtering methods

CNN model

- Compared with traditional image denoising methods
  - CNN model:

    parameters can be optimized through network training
  - Traditional Approaches:

    the parameters are fixed and cannot be adjusted during the filtering, namely, lack of adaptivity

CNN model

- After network training, we get two models which correspond to filter “Gaussian noise” and “salt-and-pepper noise”
- Guassian noise
  - statistical noise having the normal distribution
- Salt-and-pepper noise
  - This noise can be caused by sharp and sudden disturbances in the image signal
  - It presents itself as sparsely occurring white and black pixels.

Implementation

- Implement the CNN model
- Added Gaussian noise and salt-and-pepper noise to the test images
- Compare the results with traditional filtering methods, for each original image
- Use “MSE” to measure the results