



# Image Denoising Based on A CNN Model

4105053118 陳謙慶



# Introduction

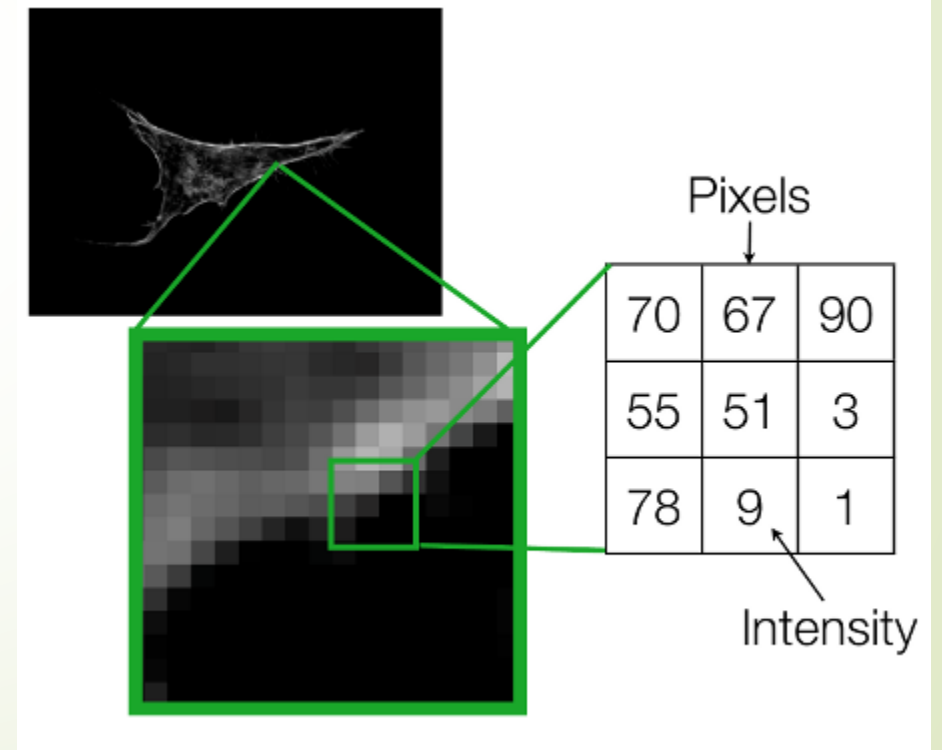
- Why Denoising?

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.
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# 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
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# 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”
- Gaussian 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
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