Department of Computer Science
University of Bristol

COMS30030 - Image Processing and Computer Vision

Lab Sheet 03

Filtering and Image Enhancement

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The Number Plate Challenge

Introduction: Image filtering techniques have a wide field of application. For instance, the compensation of image defects/corruption, also known as 'image restoration', which is one of many key areas where filtering is applied to solve problems in the real world. In this lab task you will use classical filtering techniques to enhance or recover seemingly 'lost' image information of interest.

Overview: In particular, your task will be to recover number plate information from corrupted imagery by applying image filters in OpenCV that counter-act the corruptive processes (e.g. blur, noise) that the images have undergone. There are many ways to implement filters, if you want some inspiration from first principles, have a look at the code examples provided on the unit webpage to help you along…

Part 1: Recovery by Sharpening

The first number plate image has been captured by a camera that is slightly out of focus resulting in blur. Your first task is to implement sharpening using OpenCV (for instance by modifying the provided filtering code) to recover the number plate. Consider sharpening your image by adding the image to itself and subtracting a blurred version of it (i.e. perform **unsharp masking**). Why and how does this technique work?

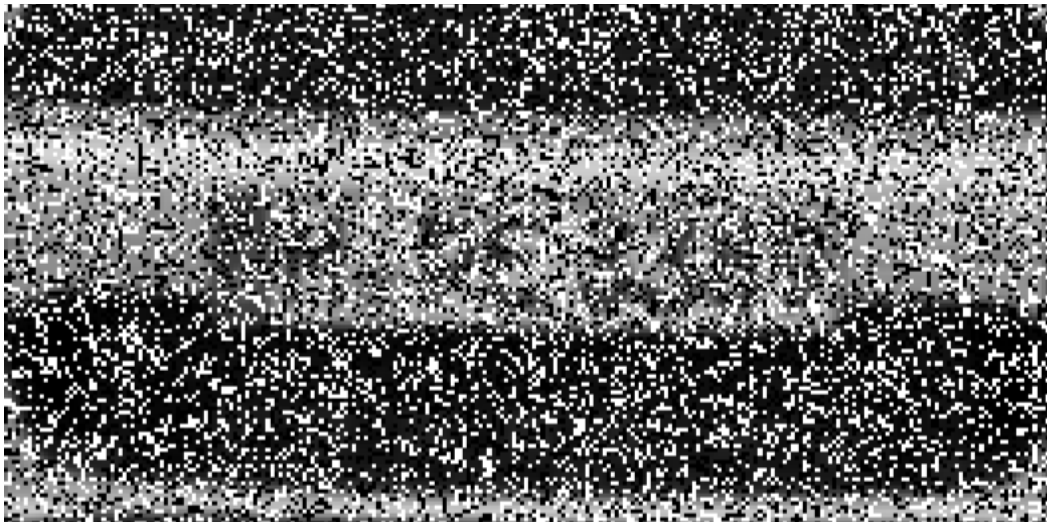
Make sure you avoid out-of-range problems and range shifts, since convolution may produce negative values and large ranges! What effect do different kernel sizes and/or multiple rounds of filtering have on the number plate readability?

You won't get a perfectly sharp image, but should aim at arriving at a sharpened image where the number is clearer than in the original.

Part 2: Recovery by Median Filtering

The second number plate was captured on film material of very poor quality resulting in ‘salt and pepper’ noise. Your task is to implement a **median filter** to recover the number plate information. A median filter operates by replacing a pixel with the median of ‘its neighbouring pixels and the pixel itself’.

What influence does the size of the pixel neighbourhood have (e.g. 8 adjacent pixels, 24 neighbouring pixels) on the number plate readability?



Part 3 - OPTIONAL: Recovery by De-Convolution

This task is optional and advanced, it should be attempted only if you who have finished task 1 and 2 fully. The third number plate is distorted by motion blur. To recover the number plate you may want to use **Wiener Deconvolution**. First, familiarise yourself with the idea of this filter (see next slide or search for it on the web). We have provided you with a Wiener deconvolution function. You need to experiment with the blur length, blur angle and signal to noise ratio to try and get a good reconstruction. Have a close look at the blurred image to help you estimate these parameters.

Optional : Wiener De-Convolution

Norbert Wiener

- **Idea:** Restore an image by convolution with an adjusted inverse kernel that estimates the loss of information per frequency.

inverse of original kernel

$$\frac{1}{H(f)}\left[\frac{|H(f)|^2}{|H(f)|^2+\frac{1}{\mathrm{SNR}(f)}}\right]$$

estimated loss at frequency *f*