Homework 2 Questions

Instructions

- 4 questions.
- Write code where appropriate.
- Feel free to include images or equations.
- **Please use only the space provided and keep the page breaks.** Please do not make new pages, nor remove pages. The document is a template to help grading.
- If you really need extra space, please use new pages at the end of the document and refer us to it in your answers.

Questions

Q1: Explicitly describe image convolution: the input, the transformation, and the output. Why is it useful for computer vision?

A1: Your answer here.

Image convolution is useful for extracting patterns in an image.

When the image pixel values (RGB values) are given as an input, image filter called kernel (usually 3*3 in size) passes through neighboring pixels and conduct element-wise multiplication. The resulting values are returned according to the properties of the filter(kernel), and you can perform specific transformations such as blurring, sharpening, and edge extraction.

Image convolution is especially useful for computer vision, which is that image convolution works in 2D space rather than 1D. Because a typical neural network is applied to a one-dimensional array, it often loses location information while converting images into 1D, but convolution makes it easier to extract patterns because it considers information from adjacent pixels important.

Q2: What is the difference between convolution and correlation? Construct a scenario which produces a different output between both operations.

A2: Your answer here.

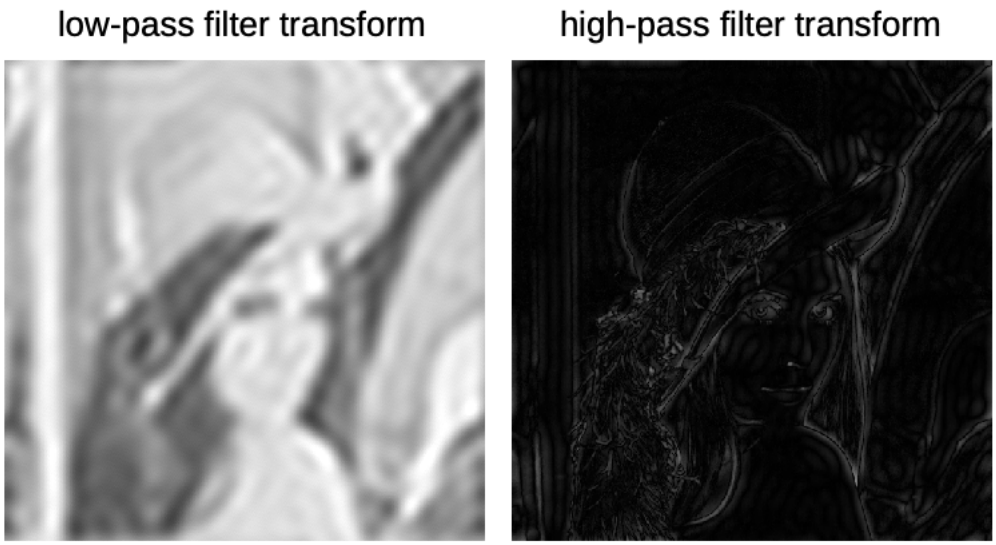
Convolution and correlation are different in terms of formulas. There is a slight difference in applying a function(or filter) to the input . Correlation apply a function without flipping, and the convolution apply a function after flipping the filter. Therefore, correlation is useful for analyzing the correlation between two inputs. Convolution, on the other hand, is primarily used for image filtering due to its inherent characteristics (commutative, associative).

If you want to know which pattern (for example, some letter) appears in an image, you can make the patter as filter, and conduct correlation to see where the pattern appears. However, if you conduct convolution, it is difficult to expect a meaningful information. Rather, it would be easier to find patterns that penetrate the entire image.

Q3: What is the difference between a high pass filter and a low pass filter in how they are constructed, and what they do to the image? Please provide example kernels and output images.

A3: Your answer here.

High pass filter is used for sharpening the image, and low pass filter is used for smoothing the image.

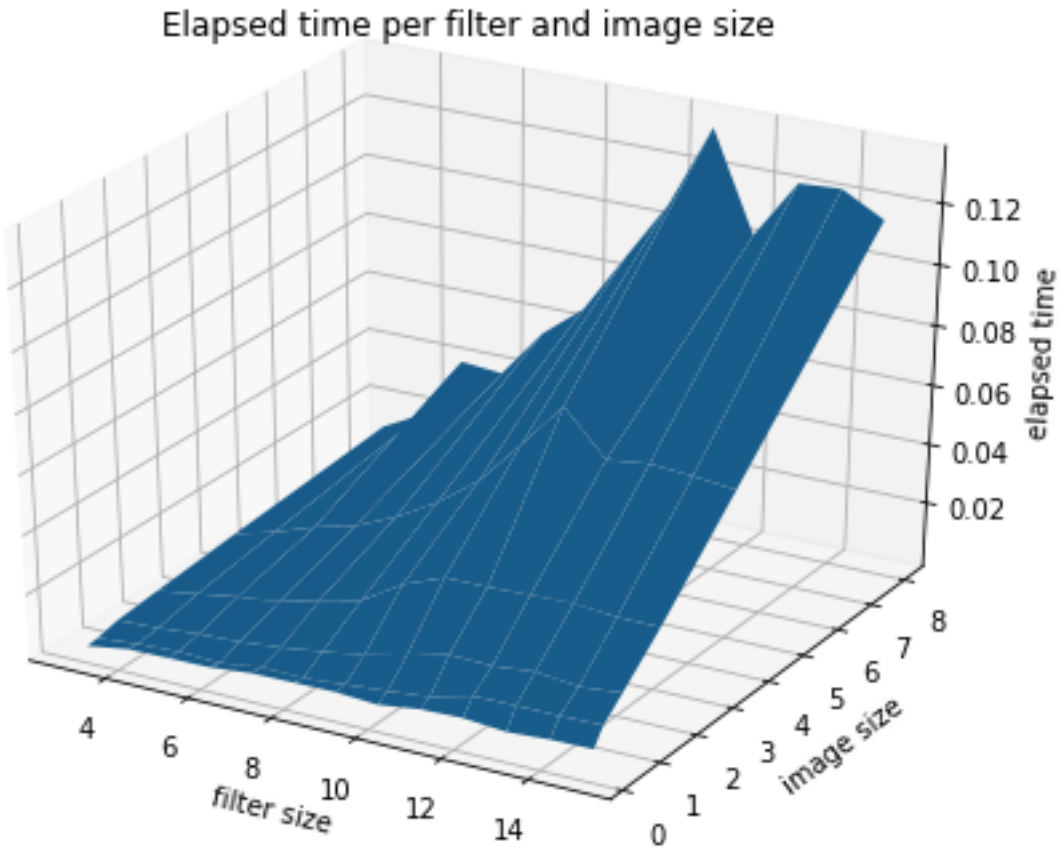


Q4: How does computation time vary with filter sizes from 3×3 to 15×15 (for all odd and square sizes), and with image sizes from 0.25 MPix to 8 MPix (choose your own intervals)? Measure both using $cv2.filter2D()$ to produce a matrix of values. Use the $cv2.resize()$ function to vary the size of an image. Use an appropriate 3D charting function to plot your matrix of results, such as $plot\_surface()$ or $contour3D$.

Do the results match your expectation given the number of multiply and add operations in convolution?

See RISDance.jpg in the attached file.

A4: Your answer here.



As I expected, elapsed time increased linearly as image size grows. And also, elapsed time by filter size was also increased as filter size grows, however, elapsed time when filter size is bigger than 11, was decreased as filter size grows, unlike my expectation.