Preliminary Exam Practice Questions Spring 2022

1. Give an example of a good method for denoising digital image data that contains “hot pixels”. How does this method work? Do you expect this method to blur the data or to preserve contrast? Why?
2. You have bought a cheap machine vision camera that you will use for imaging experiments. This sensor suffers from fixed pattern noise. How could you get rid of the fixed pattern noise in your image data? Describe what you would need to do this and how you would do it.
3. What is the Nyquist sampling criterion? How does this affect how you need to choose your magnification and your digital sensor in a photography / microscopy imaging experiment.
   Hint: How finely do you need to sample a signal (the signal could be a time-varying frequency signal, or spatial frequencies in a 2D image) in order to avoid aliasing?
4. If you are imaging with an optical resolution of 200 nm and your camera sensor has pixels that are 6.5x6.5 micrometers physical size, and you image with a magnification of 60x, are you fulfilling the Nyquist sampling criterion? How big is the “pixel in the sample”?
5. How does a Bayer pattern color camera sensor record images? What processing is applied to the raw data to form the color image that you read out from your camera?
6. Why might you want to transform an RGB (Red, Green, Blue) image to an HSV (Hue, Saturation, Value) image? What could you do with image data using this method?
7. When imaging an object, we get a degraded image g(x,y) of the object f(x,y).
   This degradation process can be described by the equation
   g(x,y) = PSF [convolution] f(x,y) where PSF is the Point Spread Function.
   What would this equation look like in Fourier space?
   Note to avoid confusion: since I have sad experience with the prelim exam PDF systems messing up the convolution operator sign, I here just wrote “convolution” in square brackets.
8. Describe an operation that you could use to visualize edges in an image.
9. A basic operation in mathematical morphology is an erosion. Describe what this does to an image.
10. A powerful operation in mathematical morphology is an opening, which is erosion followed by dilation. Describe what this does to an image.
11. What result do we get if we convolve an image with a gaussian kernel?
12. If we apply a low pass spatial frequency filter to an image in Fourier space, what is the result on the resulting image (when the low pass filtered data is transformed back to image space)?
13. Give an example of how we could get rid of an undesired stripe pattern (this stripe pattern could for example could be an artifact from data transmission) in an image?
14. Describe the difference between an ideal filter and a non-ideal filter. Which filter would be more likely to cause ringing artifacts?
15. What is the Point Spread Function (PSF) of an imaging system and how does this function influence the image quality?
16. What do we expect to happen if we convolve an image with a Laplacian of Gaussian filter kernel?