Introduction to Image and Video Processing
coronaproject 2: frequency domain filtering, processing
due May 8

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Logistics:

Each of these mini coronaprojects will count for 25% of your final grade. They will be checked for plagiarism (software + text). There might be small bonuses in some places (it will say "**bonus**"). You are requested to please hand in:

1. A report with your answers to the assignment questions and figures with your results. It should be 5-6 pages, but this is just a general guideline. You can use any doc editor you like.
2. The code for producing these results *with clear comments in the code!*. You can use any programming language you are comfortable with (preferably Python or Matlab for this class, but others are welcome). You should explain what you think are important parts of the code in the report (e.g. if you use a special trick that you are proud of).

Your grade will depend on how clearly you present and explain your results in the report and code. You are allowed some freedom to explore, so there is no one correct answer. However, you should demonstrate you have understood the class material and how it applies to these projects.

Assignment:

1 Periodicity, Frequency Filtering

1. Create a two dimensional periodic signal with one frequency (e.g. sin, cos...).
   (a) Calculate its 2D FT analytically ("on paper" with math) and by applying the 2D FFT.
   (b) Depict its 2D magnitude and phase after shifting the center of frequency coordinates to the center of your image.What do you observe?
2. Create or find a clearly periodic image with a repeating pattern in the x, y or both directions. This should be a more complex 2D periodic function than in the previous question.
   (a) Depict its 2D magnitude and phase after shifting the center of frequency coordinates to the center of your image.What do you observe?
   (b) Remove the strongest frequency from its FT and then find the inverse 2D FFT. Depict the resulting image and discuss your results.

2 Periodic noise removal

1. Choose an image of your liking and add periodic noise to it. You have to decide what kind of periodic noise you want to add. For the rest of this exercise you should assume you have been given only the noisy image and that this noise is unknown to you.
2. Calculate the 2D FFT of the noisy image(using an inbuilt function like fft2, numpy.fft. fft2). Display the noisy image's power spectrum in 1D, 2D, 3D and comment on it. What does it reveal about the noise?
3. Find a way to remove the periodic noise in the frequency domain. Then show the de-noised image (in space) and its power spectrum. Discuss your approach and results.

3 Image restoration

1. Choose an image of your liking and blur it with a spatial kernel h of your choice. Add random noise n following a specific noise distribution.
2. Calculate the frequency transform of your blurring function h.
3. Calculate the 2D FFT of the degraded image(using an inbuilt function like fft2, numpy.fft. fft2). Display the degraded image's power spectrum in 1D, 2D, 3D and comment on it. What does it reveal about the blurring and noise?
4. Find a way to remove the blurring in the frequency domain, using the inverse filtering methods we discussed in class. Then show the denoised image (in space) and its power spectrum. Discuss your approach and results.

Bonus: Look up blind deconvolution methods and try to implement one to de-noise the image, instead of using inverse filtering. Comment on your results and their convergence (or lack thereof).