Introduction to Image and Video Processing
spatial filtering, processing
due May 2

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Instructions:

Each of these projects will count for 1/2 of your final grade. They will be checked for plagiarism (software + text). **You are requested to hand in one zip file with title "YourLastName_project1" (e.g. John Doe should submit "Doe_project1.zip").** The zip file should contain:

1. An about 10 page report with your answers to the questions and figures with your results.

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 we can discuss others). 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 solutions (e.g. if you are asked to come up with your own method), so there is no one correct answer. However, you should demonstrate you have understood the class material and how it applies to these projects.

1 Color Spaces

Choose two colorful image containing distinct colored objects: one with bright colors, and one with pale colors, like the ones below. You can use these or your own.

1. Transform your images from RGB to HSV and display your results. Explain the appearance of each color component with respect to your image structure and colors.

2. Transform the RGB images to an intensity image "I" in HSI space and an intensity image "V" in HSV space. Do not use inbuilt functions. Display the resulting images and explain their appearance and their differences. For this exercise you *cannot* use inbuilt functions. You should find the formulas connecting RGB, I. V and use them.

2   Pontwise transforms, Histogram Equalization

Choose two grayscale images, one with high contrast and one with low contrast, like the ones below. You can use these or your own.

1. Find the histograms of the two images and display them. You can use inbuilt functions. Explain their distribution and how it is related to your original images' appearance.

2. Transform your images with the Negative pointwise transform without using inbuilt functions Display and explain your results.

3. Find the histograms of the "negative" images and display them. Explain how and why they are different or similar to the original images' histograms.

4. Create a power law pointwise transform that transforms pixel intensity values from r to s using $s = r^n$. Use the resulting power law transform to convert the high contrast image to a lower contrast one or vice versa (you can choose which of the two). To do this you have to find a value n for the power that is bigger or smaller than 1 (you have to find which). Display your results and explain how it works.

3   Special Effects

Choose an image with strong circular and straight features. You can choose your own or from below.

1. Convert your image into polar coordinates and display it. Explain its appearance.

2. Cartoonify your image by creating a program that creates a black outline around the shapes and fills in the colored areas with a uniform color. You can choose what methods you will use to do this (more than one way). Explain your work.

4   Frequency domain properties

1. Choose an image of your liking and apply a visible translation to it in the spatial domain. For example, a 586×880 image of a kitten translated only horizontally by 200 pixels would look like the image below if zero padding is used (you can use other kinds of padding if you prefer). Calculate the 2D FFT of the translated image. Display the original and degraded images' FT magnitudes. Do they look the same or different? Explain why, based on properties of the FT.

5   Periodic noise removal

1. Choose an image of your liking and add periodic noise to it. You can 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). 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.