Introduction to MATLAB

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MATLAB

- What is MATLAB?
- Designing Apertures
- Image Processing
- FFT
- Spatial Frequencies
- Low Pass Filter
- High Pass Filter
- Band Pass Filter

What is MATLAB ?

MATLAB= “Matrix Laboratory”

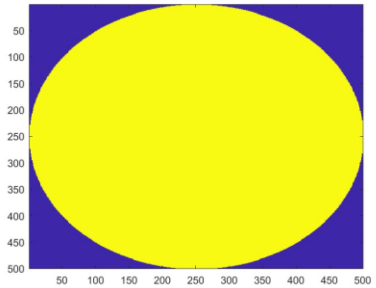
- Programming Platform for Engineers and Scientists
- Analyze and Design Systems
- Numerical computation: Matrix-based language

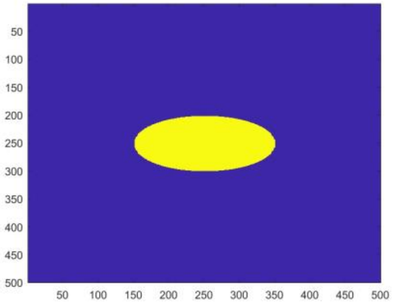
What can I use MATLAB for?

1) Create or develop algorithms
2) Create models of real-world phenomena
3) Create models of systems
4) Make simulations
5) Signal Processing
6) Analyze Data
7) The list goes on….

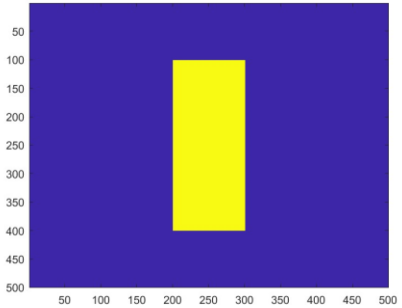
Designing Apertures

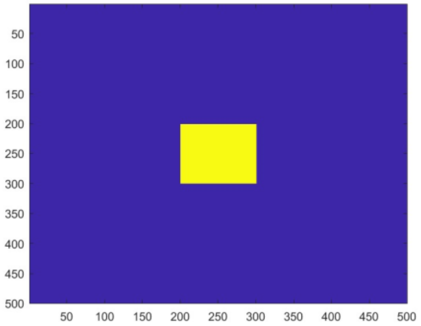
MATLAB's "Paint Brush" Function

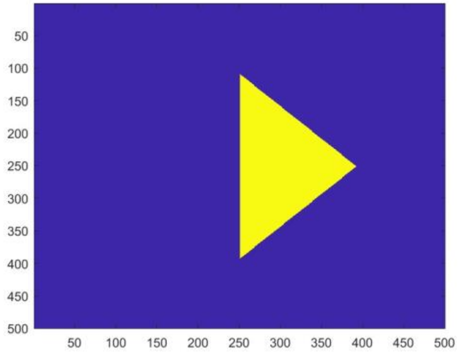




This one might be tricky to design!



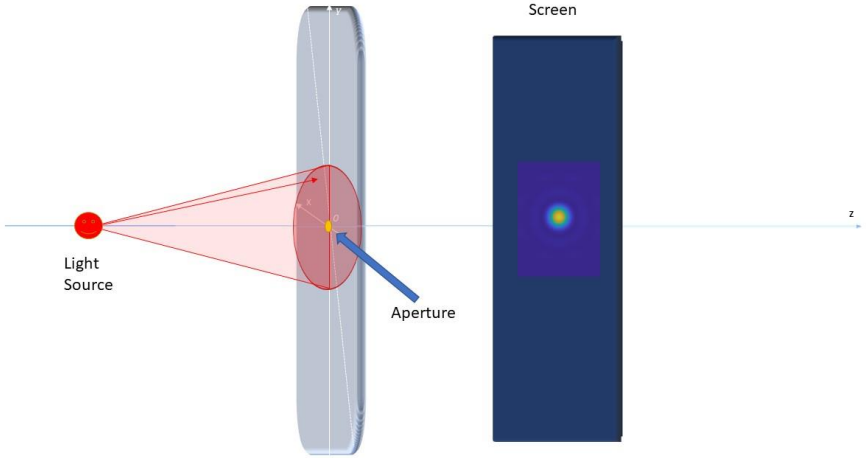


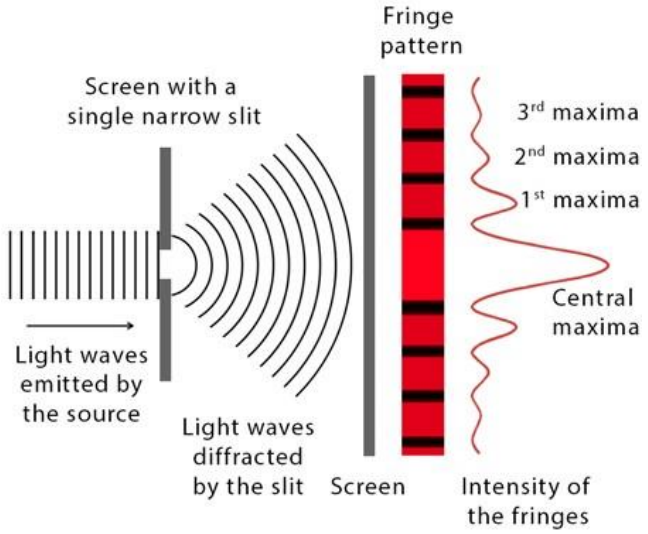


Designing Apertures

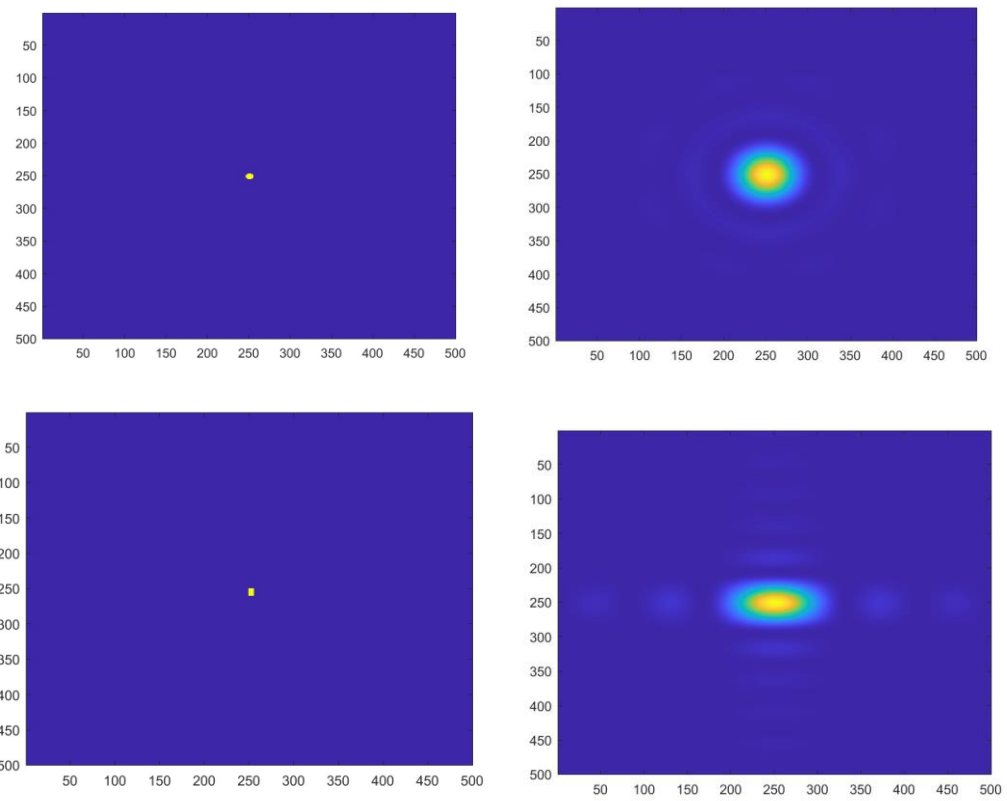
Why not simply upload pre-made images?

We are not just drawing shapes, we are simulating light coming from different types of apertures! The resulting patterns happen in real experiments- Fraunhofer Diffraction





Designing Apertures

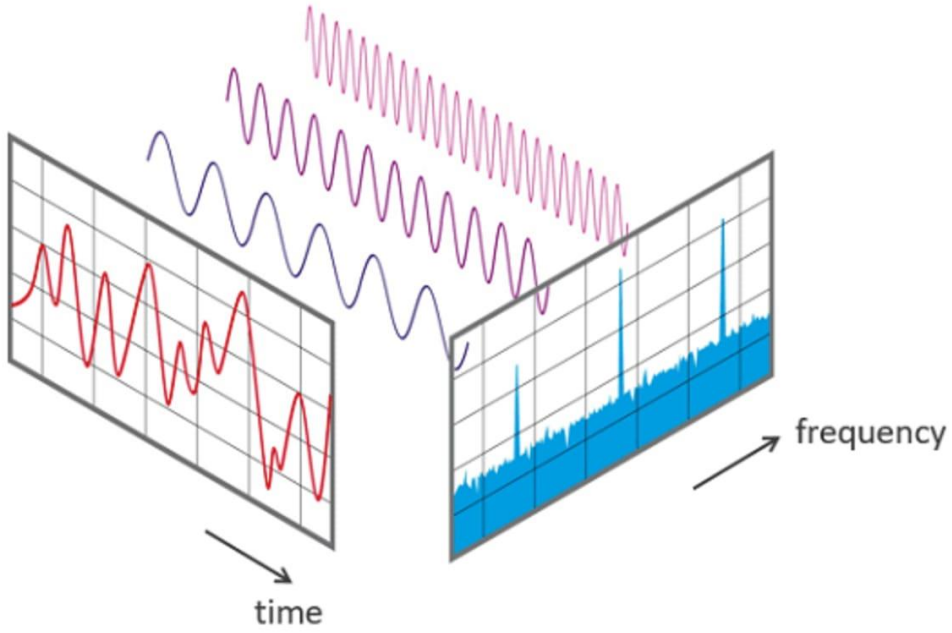


Circular Aperture and Diffraction Pattern

Rectangualr Apperture with Diffraction Pattern

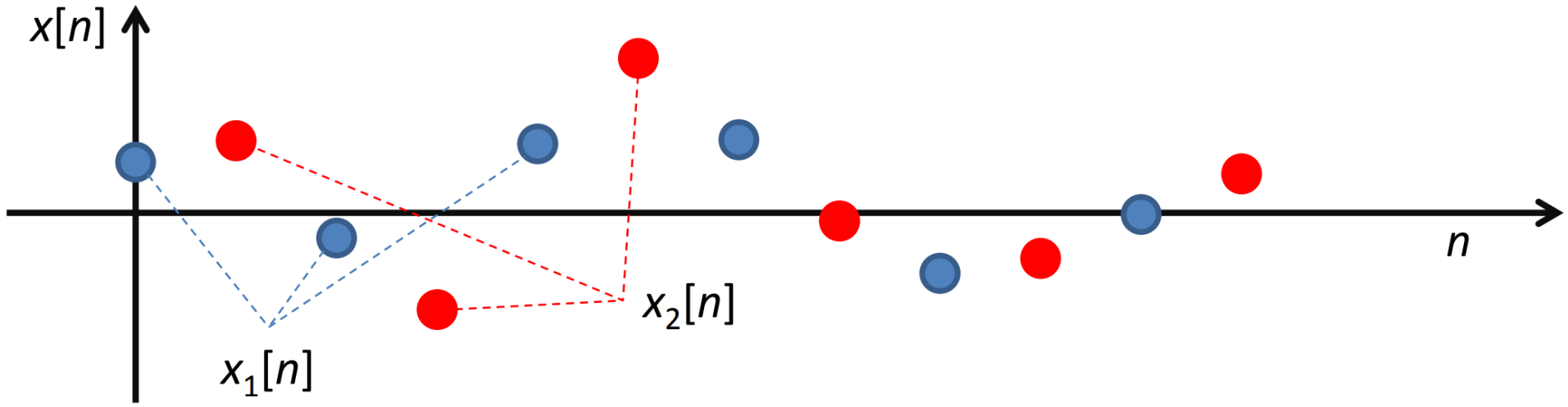
Fast Fourier Transform (FFT)

A Fourier Transform takes a signal from **time domain** to **frequency domain**



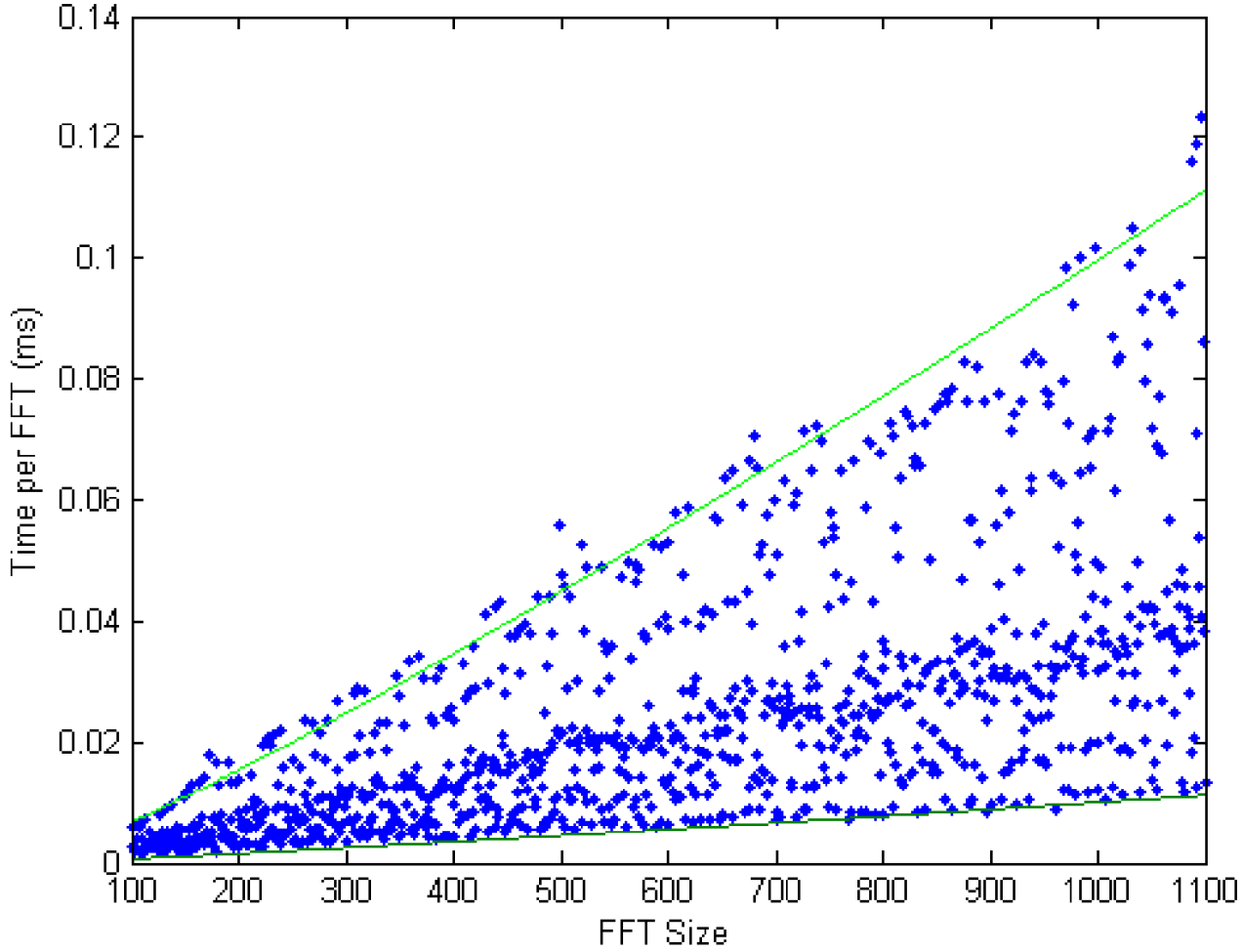
Fast Fourier Transform (FFT)

A **Fast Fourier Transform (FFT)** is a computer's implementation of the **Fourier Transform**



Fast Fourier Transform (FFT)

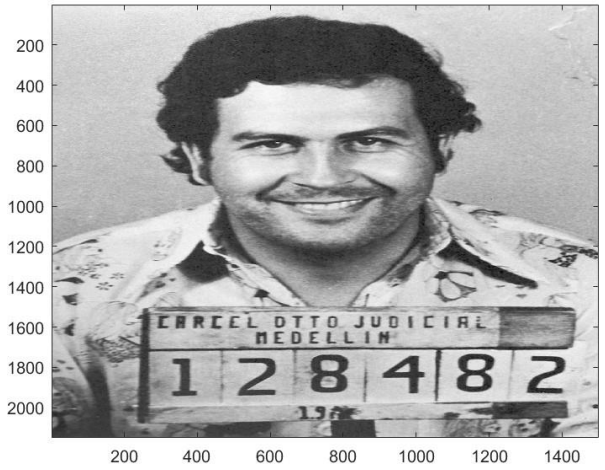
MATLAB implementation for different sizes

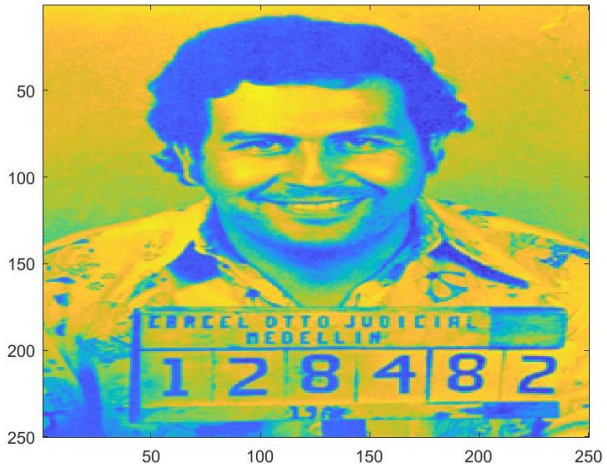


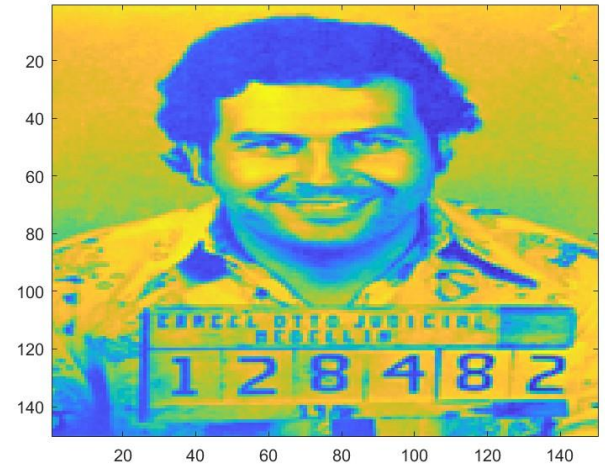
Digital Image Processing

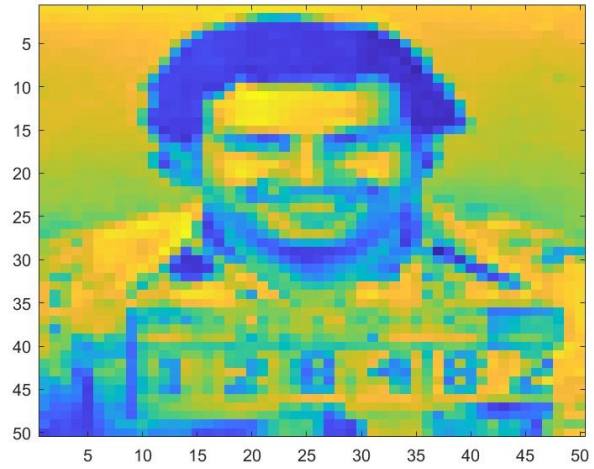
- An image is a function of two continuous variables $f(x, y)$
- To be sampled digitally, it must be transformed into a matrix (algebraic matrix!) of numbers
- Computers are not good at reading images, the numbers are quantized and represented into an array
- By using computers we can make the images better! We simply have to “tell” the computer what to do!

Digital Imaging Processing



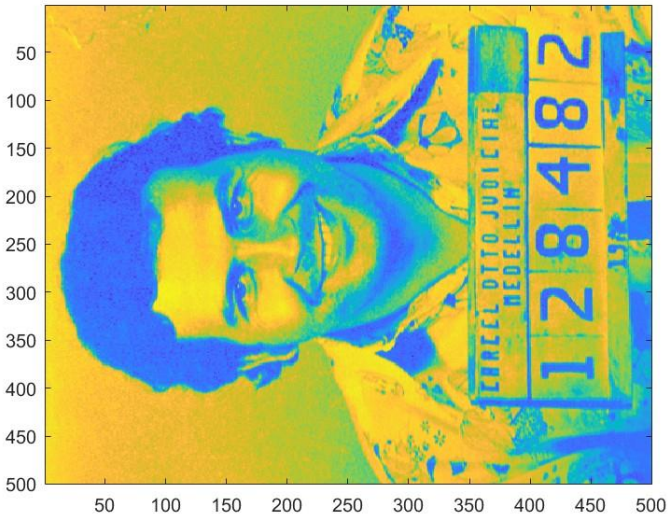






Resizing: See the resolution change?

Digital Image Processing

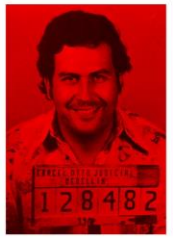


Since the image is simply a matrix, we can rotate it!

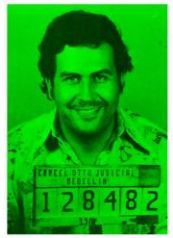
Digital Image Processing

Original RGB Image

Red Channel in Red



Green Channel in Green



Blue Channel in Blue

Recombined to Form Original RGB Image Again

Spatial Frequencies

Spatial Frequency Theory:

a) Visual Stimuli are linked to intensity of light
b) Any curve can be broken down in constituent sine waves

See Fourier Analysis!

Images are essentially composed of Fourier components.

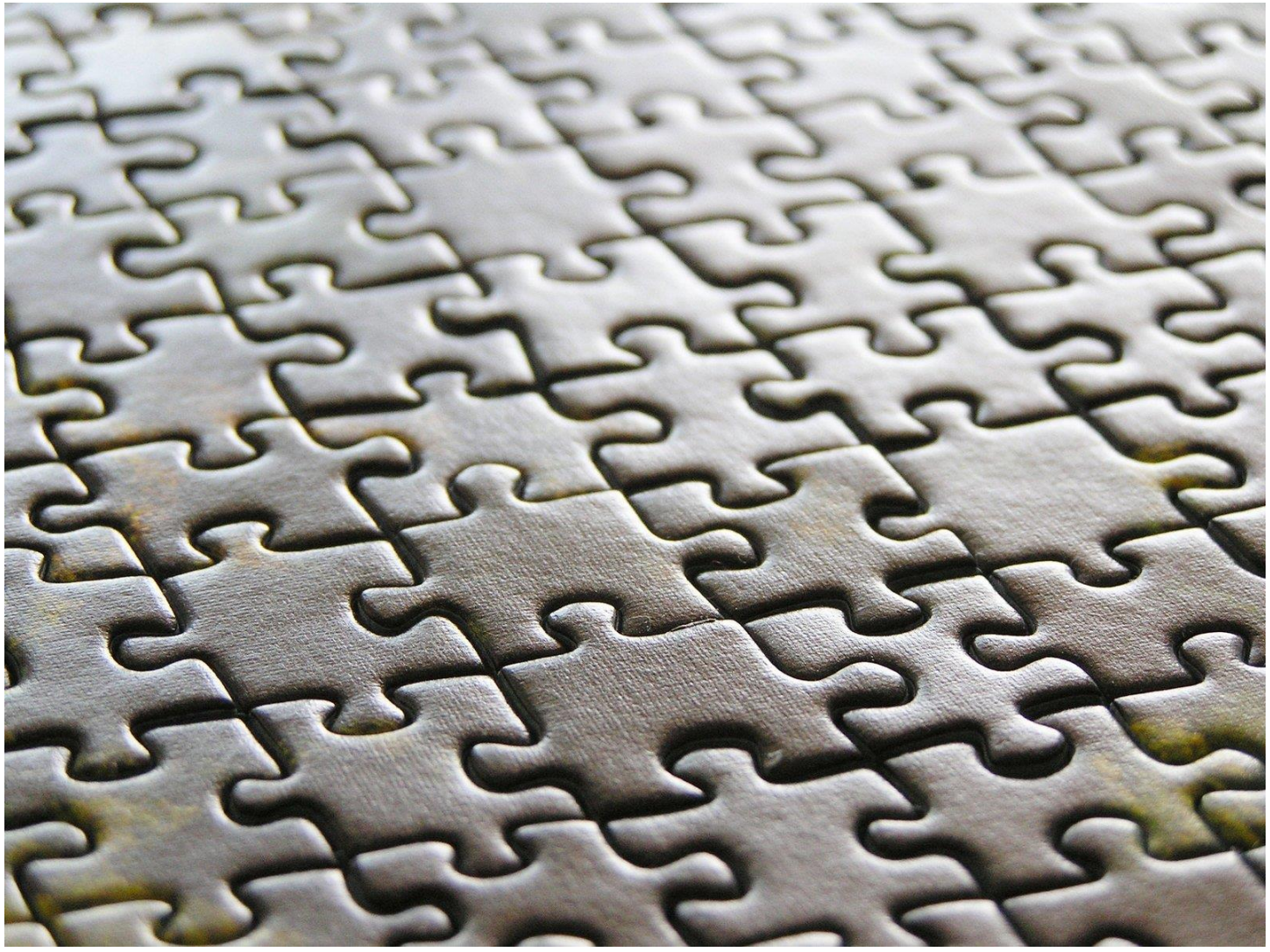
Next Steps: Filtering

- Low Pass
- High Pass
- Band Pass

Filtering is applying windows to the signal of interest.

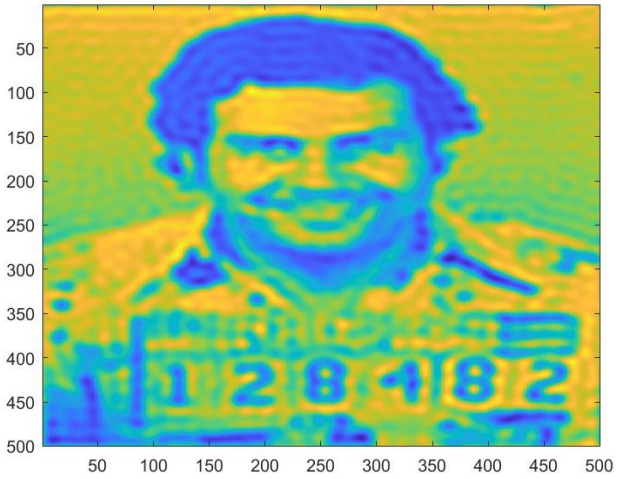
In the case of images, filters eliminate certain spatial frequencies, to reveal interesting details.

Now we combine what we learned!



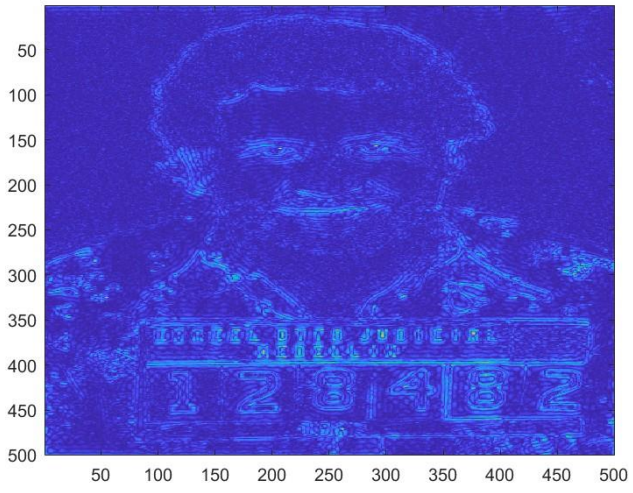
1. Designing an aperture to filter frequencies
2. Reading the image
3. Take FFT's

Low Pass Filtering



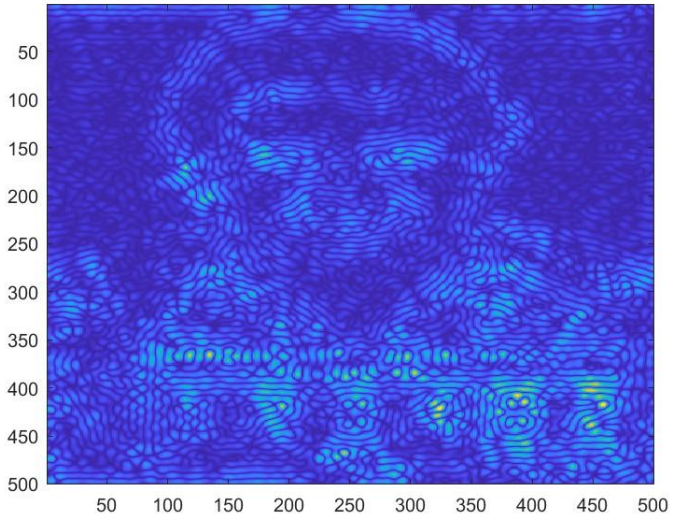
Low Special Frequencies generally give us global information. For example, see the blurred picture. The global information is present, making it easy to distinguish that this is a human being.

High Pass Filtering



High Special Frequencies correspond to abrupt contours, and fine details. The filtered image does not tell us much about the person, but the writing can be seen quite clearly.

Band Pass Filtering



Band Pass Filtering is a combination of the previous two. Both “global” and “detail information” are present. This kind of filtering can be used to conceal information.

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Thank you!

Questions?

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